Trust Management Executive Meeting: Thursday 26 June 2014
TME2014.170

<table>
<thead>
<tr>
<th>Title</th>
<th>Strategic Outline Case: Energy Investment Programme</th>
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<tbody>
<tr>
<td>Status</td>
<td>A paper for approval</td>
</tr>
<tr>
<td>History</td>
<td>This is the first time this paper has been brought to the committee.</td>
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<tr>
<td>Board Lead</td>
<td>Mr Mark Trumper, Director of Development and the Estate</td>
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<tr>
<td>Key purpose</td>
<td>Strategy</td>
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TME2014.170 Strategic Outline Case: Energy Investment Programme
## Executive Summary

<table>
<thead>
<tr>
<th></th>
<th>The purpose of this document is to present a strategic outline case (SOC) for the provision of an energy infrastructure renewal scheme to meet the heat and power strategy for the John Radcliffe and Churchill Hospitals.</th>
</tr>
</thead>
<tbody>
<tr>
<td>2</td>
<td>If approved then an outline business case will be prepared with due consideration of suitable finance options and is anticipated to be considered by TME over the summer with a view to seeking approval and the September Trust Board. It should be noted that no additional revenue support is requested at this phase in order to proceed to the completion of the next phase.</td>
</tr>
</tbody>
</table>
| 3 | **Recommendation:**  
  TME is asked to approve this strategic outline case so that outline and full business cases can be prepared with a target of major plant installation in summer 2015 to derive in-year benefit against a planned CIP obligation in 2015/16. |
Introduction & Background

1. The purpose of this document is to present a sound strategic outline case (SOC) for the provision of an energy infrastructure renewal scheme to meet the heat and power strategy for the John Radcliffe and Churchill Hospitals.

In particular it demonstrates that the business case:

- is consistent with the Trust's clinical strategy and supports the provision of high quality care
- contributes to improved quality and safety
- enhances the delivery of patient care and performance standards
- assists the health economy in managing present and future issues
- demonstrates that the Trust has the resource and capacity to deliver the investment programme within a realistic timeframe

This project will consider the existing service capability, future trust configuration, the condition, energy usage and the urgent need to re-provide engineering services and equipment to supply heat and electricity to both hospitals.

It is expected the project will seek to achieve:

- An initial capital investment of up to £21,000,000, externally funded at no additional cost to the Trust
- A reduction in annual costs of around £1,400,000
- Reduced backlog of £11,000,000, which addresses the replacement of plant and equipment which are key to providing an environment for the patient that is safe, fit for purpose and strategically aligned.
- The potential for the transfer of risk to the external provider of £2,800,000

This project will also satisfy the strategic objective of the Trust of Delivering Better Value Healthcare through improved utilisation of the Trust estate, plant and equipment, in particular by:

- Reducing the annual carbon footprint of the Trust from c30,000 tonnes to c19,000 tonnes
- Rationalisation of plant, such as the thermal network at John Radcliffe, main chillers and cooling towers, heat exchanger, steam and boilers.
- Improved utilisation of resources by outsourcing the supply and maintenance of critical energy infrastructure to a specialist contractor

There is also the potential for external provision and funding of the project through NHS Shared Business Services Ltd (NHS SBS) which has undertaken a procurement exercise for a Framework Agreement for the purchase and management of the provision of carbon and energy infrastructural upgrade services, as well as considering other finance options at Outline and Full Business Case stage.
The Case for Change

2. The Trust has an aged infrastructure that is struggling to support the demands of an acute 21st century hospital. Whilst most of the patients services delivered on the Churchill Hospital site are provided from PFI funded facilities, many are still provided from the retained estate. This estate contains the original infrastructure, some of which dates back to the 1940s and is no longer fit for purpose. Similarly, the retained estate at the John Radcliffe Hospital was built in the 1970s and there has been no significant investment in the engineering infrastructure that provides electrical and heating supplies to critical patient care areas. Modern technology presents the opportunity to address the concerns outlined above whilst delivering significant reductions in costs and carbon footprint. The main energy infrastructure issues and risks facing the Trust are:

- Boilers which are now over 40 years old and are in regular need of remedial welding work to satisfy insurance inspections
- Electricity consumption, which is nearly three times higher than best practice benchmarks
- Burner controls, which rarely remain at optimum firing efficiencies
- Spare parts are no longer readily available which requires the expensive manufacture of bespoke elements
- Seasonal efficiencies of less than 25%.
- Frequent HPHW leaks, which necessitates shutting down the system which results in subsequent failures elsewhere in the system
- Thermally inefficient fabric with large areas of minimal insulation levels
- Building services installations which are at the end of their useful lives and which have a growing maintenance requirement
- Rudimentary controls which are not matching supply to demand, neither in terms of time or temperature
- The absence of any effective zone control, which means that the potential of the invertors to reduce fan power consumption are not exploited.
- No form of occupancy linked lighting control.
- A proliferation of around 300 independent DX split systems around the site
- The existing Secondary Power Sources (SPS’s), provided by the existing generator sets, although currently operational, are old and in need of replacement.
- In the event of failure of the mains grid electricity service the generators only support essential power circuits and not the entire network.

In summary, the existing and time expired infrastructure presents a risk to patient safety in its present condition. Most of the heating and hot water services are 40 years old and are significantly older than the recommended maximum working life. Equipment and pipework mains are falling and spares for obsolete parts need to be manufactured. Where possible, equipment is patched up to prolong its life. Pipework leaks are frequent occurrences, and the required cooling down of the MTHW system to allow work to take place by itself causes further leaks and joint failures. The existing equipment is inefficient with inadequate controls which further reduce its efficiency. Site distribution mains also represent significant loss of energy due to inadequate
insulation. Upgrading the systems provides an opportunity to improve both heating and hot water, and at the same time reduce energy consumption significantly.

The estate will continue to deteriorate, increasing risks to patient safety, impacting business continuity, reducing comfort levels of patients and staff and costing substantially more than is necessary.

In addition, the NHS Carbon Reduction Strategy for England published in January 2009 set a mandatory framework for NHS organisations to embed sustainability into their culture and activities, contributing to overall carbon emission reduction targets. The Carbon Reduction Strategy sets an initial statutory target for NHS organisations to reduce emissions by 10% by 2015. Without investment, the Trust will not meet these targets.

Possible Options for Consideration

3. Because of the issues described above, doing nothing is not a viable option going forward. The preferred option comprises combined heat and power plant, improved building services controls, new boiler plant, new absorption chiller, replacement of storage calorifiers with plate heat exchangers, replacement of wet cooling towers with adiabatic units and energy efficient lighting.

An energy link between the John Radcliffe and Churchill sites is also to be considered, which maximises the efficiencies and provides the necessary resilience to both sites. This is in the form of a ‘District Heating Pipework and Cabling’ which also offers the potential for significant further opportunities in providing energy to other external sites at reduced costs. These sites include the Nuffield Orthopaedic site and Oxford University’s Old Road campus.

Benefits

4. The anticipated quantified benefits are as follows:

- Reduced energy cost
- Improved estate
- Improved maintenance
- Reduced urgent capital expenditure
- Reduce carbon emissions
- Improve resilience
- Guaranteed provision of heat and electricity

Time Table

5. The indicative timetable for the project for the project is for the outline and full business cases to go to TME prior to the September and November Main Board Meetings respectively, for approval and onward submission to the Trust Development Agency for ratification of the project. It is anticipated that main plant replacement will be undertaken during planned downtime and programmed maintenance periods during summer in 2015, subject to being able to secure a suitable production slot.
Conclusion

6. In conclusion:
   
   - There is a proven strategic case to replace ageing energy equipment (the strategic case).
   - There are options to provide a value for money solution (the economic case).
   - There is a proven procurement methodology that the Trust can access through a sponsored DoH framework scheme (the commercial case).
   - The Trust can generate cash-releasing savings through the investment (the financial case).
   - A sound project management structure will be put in place to deliver the project effectively and to time, cost and quality (the management case).

If approved the Outline Business case will articulate in detail the 5 case model to establish the viability of the project and consider benchmarked options on scheme financing. It will seek to make a recommendation as to the preferred procurement approach to TME and subsequently the board. It should be noted that no additional revenue is requested at this stage to get to produce the Outline Business Case and further phase costs will be considered as part of the next submission.

Recommendation

7. TME is asked to approve this strategic outline case so that outline and full business cases can be prepared with a target of major plant installation in summer 2015 to derive in-year benefit against a planned CIP obligation in 2015/16.

Mark Trumper
Director of Development and the Estate

June 2014
### Title

Energy Outline Business Case (OBC)

<table>
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<tr>
<th>Status</th>
<th>For approval</th>
</tr>
</thead>
<tbody>
<tr>
<td>History</td>
<td>This is the first time the business case has been presented to the Board</td>
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<thead>
<tr>
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<td>Key purpose</td>
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</tbody>
</table>
Executive Summary

1. The purpose of this document is to present a sound outline business case (OBC) for the provision of an energy infrastructure renewal scheme to meet the heat and power strategy for the John Radcliffe and Churchill Hospitals.

2. The main aspects are:

   2.1 A guaranteed reduction in annual energy costs of around £2,200,000. After the annual unitary payment of just under £1,800,000 this results in a net guaranteed annual saving of over £400,000.

   2.2 A reduction in the annual carbon footprint of the Trust from 30,000 tonnes to 19,000 tonnes. The CO₂ levy saving on 11,000 tonnes at today's price is around £165,000. If the levy rises to £30 per tonne by 2020 then this rises to £330,000.

   2.3 An initial capital investment of around £18,400,000 externally funded at no additional cost to the Trust. If the Trust had to fund the initial capital expenditure itself, the initial interest charge would be over £1,000,000 at a rate of 5.64%, which is the cost of finance that the Trust is currently being charged on capital.

   2.4 A reduction in backlog maintenance of £11,000,000, which addresses the replacement of plant and equipment which are key to providing an environment for the patient that is safe, fit for purpose and strategically aligned.

   2.5 A transfer of risk to the external provider estimated to be around £2,800,000

3. Recommendation

   3.1 The TME is asked to support submission of the OBC to the Trust Board, for approval of the outline business case with a target of commencement of major plant installation in summer 2015 to begin to derive in-year benefit.

   3.2 In order to facilitate the savings approval will also be sought from the Trust Board to release £300,000 of phased funding immediately:

   3.2.1 £200,000 to fund the preparation, finalisation and approval of this outline business case and the subsequent final business case

   3.2.2 £100,000 to ensure that the required plant and equipment is earmarked for production to ensure timely installation following signing of the contract.
Energy Outline Business Case (OBC)

1. Purpose

1.1. The purpose of this paper is to present a sound outline business case (OBC) for the provision of an energy infrastructure renewal scheme to meet the heat and power strategy for the John Radcliffe and Churchill Hospitals.

1.2. This paper complies with the Treasury's Five Case model for public sector business cases and contains information required by the Trust Development Authority (TDA) in its business case checklist.

2. Background

2.1. The current energy infrastructures at both sites are 40 to 50 years old and the boilers and thermal distribution systems at Churchill Hospital are over 70 years old. The plant is time expired, inefficient and presents a high risk of failure resulting in interruptions to patient services at both sites.

2.2. The main aspects of the business case are:

2.2.1. A guaranteed reduction in annual energy costs of around £2,200,000. After the annual unitary payment of just under £1,800,000 this results in a net guaranteed annual saving of over £400,000.

2.2.2. An anticipated reduction in the annual carbon footprint of the Trust from 30,000 tonnes to 19,000 tonnes. The CO₂ levy saving on 11,000 tonnes at today's price is around £165,000. It is expected that the levy will rise to £30 per tonne by 2020; if so, then the annual saving will increase to £330,000.

2.2.3. An initial capital investment of around £18,400,000 externally funded at no additional cost to the Trust. If the Trust had to fund the initial capital expenditure itself, the initial interest charge would be over £1,000,000 at a rate of 5.64%, which is the cost of finance that the Trust is currently being charged on capital.

2.2.4. A reduction in backlog maintenance of £11,000,000, which addresses the replacement of equipment which is key to providing an environment for the patient that is safe, fit for purpose and strategically aligned.

2.2.5. A transfer of risk to the external provider estimated to be around £2,800,000.

2.3. This business case:

2.3.1. is consistent with the Trust's clinical strategy and supports the provision of high quality care

2.3.2. contributes to improved quality and safety of services provided to patients

2.3.3. enhances the delivery of patient care and performance standards

2.3.4. assists the health economy in managing present and future issues

2.3.5. demonstrates that the Trust has the resources and capacity to deliver the investment programme within a realistic timeframe
3. The Strategic Case

Organisational Overview

3.1. The Trust provides general hospital services to the people of Oxfordshire and the neighbouring counties of Buckinghamshire, Berkshire, Wiltshire, Northamptonshire and Warwickshire as well as specialist services on a regional and national basis.

3.2. The Trust provides services in more than 90 clinical specialties, which are grouped into seven clinical divisions.

3.3. The Trust currently has limited capital funds and those which become available are likely to continue to be needed to ensure the clinical site development plan, medical equipment, health informatics and backlog maintenance programmes can be funded.

Relevant Trust Strategies

3.4. The mission of the Trust is:

3.4.1. "The improvement of health and the alleviation of suffering and sickness for the people we serve. We will achieve this through providing high quality, cost-effective and integrated healthcare.”

3.5. The Trust's strategic objectives are to deliver:

3.5.1. Compassionate excellence – the kind of healthcare we would all expect for ourselves and our families

3.5.2. A well-governed and adaptable organisation

3.5.3. Better value health care

3.5.4. Integrated local healthcare

3.5.5. Excellent secondary and specialist care through sustainable clinical networks

3.5.6. The benefits of research and innovation to patients

3.6. The Trust is currently applying to become a Foundation Trust.

3.7. The Trust delivered a £3.6m surplus against its break even duty in the financial year 2012/13. In order to meet the financial challenges the Trust expects to need to save at least £45m this year. This is 5.5% of planned turnover.

Aim of the Project

3.8. The aim of this project is to meet the strategic objective (S03) of the Trust to meet the challenges of the current economic climate and changes in the NHS by providing efficient and cost-effective services and better value healthcare – "delivering better value healthcare" by:

3.8.1. Reducing gross energy consumption by around £2,200,000 a year

3.8.2. A reduction in carbon emissions of around 33%

3.8.3. Rationalisation of plant

3.8.4. Improved utilisation of resources
3.9. In particular the scheme will address the following key detailed objectives of the Trust:

3.9.1. Increase productivity and delivery of CIPs year on year in line with the agreed financial strategy and within the agreed performance framework/compacts (3.1) including the Delivery of Cost Services Improvement Programme

3.9.2. Improve utilisation of Trust’s estate (3.4)

3.10. Other strategic objectives that this scheme contributes to include

3.10.1. “patient-centred organisation” (S03): Improves control of heating, cooling and general environmental conditions.

3.10.2. To meet the challenges of the current economic climate” (S05): Reduces energy costs and carbon taxes

3.10.3. “Deliver continued and measurable improvements in patient safety, patient experience” (S03b): Reduces estate-related risk; improves control of heating, cooling and general environmental conditions.

3.10.4. Increase productivity and delivery of CIPs year on year in line with the agreed financial strategy” (S05b): Substantial reduction in energy costs and carbon

3.10.5. “Develop supporting strategies (to include capital plan and estates utilisation strategy, workforce and IT)” (S05e): Improves estate performance and liberates cash from estates budget (energy and carbon budgets).

**NHS Carbon Reduction Strategy for England**

3.11. The NHS Carbon Reduction Strategy for England was published in January 2009 and set a mandatory framework for NHS organisations to embed sustainability into their culture and activities, contributing to overall carbon emission reduction targets. The Strategy followed the introduction of UK Climate Change Act 2008 which set out statutory emission cuts. The Carbon Reduction Strategy sets an initial target for NHS organisations to reduce emissions by 10% by 2015, in the context of the overall NHS carbon footprint arising from buildings (20%), transport (18%) and procurement (60%).

3.12. The current Trust emissions are 30,458 tonnes CO₂ which are expected to reduce to 19,396 tonnes CO₂ on completion of the scheme. This is a reduction of 38% which exceeds the Government’s targets.

**The Estate**

3.13. OUH provides health care services primarily from four sites:

3.13.1. The Churchill Hospital in Headington, Oxford

3.13.2. The John Radcliffe Hospital in Headington, Oxford

3.13.3. The Nuffield Orthopaedic Centre in Headington, Oxford;

3.13.4. The Horton General Hospital in Banbury.

3.14. In total, the estate covers approximately 391,420m² of internal floor area over 73.8 hectares of land.
3.15. On this land the Trust operates and manages 220,720m² of retained estate; the remainder of the properties have been funded by Private Finance Initiatives (PFI), 29% of the estate, or tenanted by the University or other third party occupiers under various tenant agreements.

3.16. 55% of the John Radcliffe Hospital, OUH’s largest site, was constructed in the 1970s. However there has been significant development since 2005 including the West Wing and Children’s Hospital, both of which were financed by PFI, as well as the £29 million Oxford Heart Centre which opened in 2009 and was jointly funded by the NHS and the University of Oxford.

3.17. Similarly, 40% of buildings at the Churchill Hospital site have been built since 2005 including a PFI build incorporating the Oxford Cancer Centre which opened in 2009.

3.18. Over 60% of the Horton General Hospital site was built prior to 1984.

3.19. At June 2011 the backlog maintenance costs were identified as being:

<table>
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<th>High Risk</th>
<th>Significant Risk</th>
<th>Moderate</th>
<th>Low</th>
<th>Total</th>
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<td>£570,000</td>
<td>£2,538,000</td>
<td>£19,600,000</td>
<td>£16,709,000</td>
<td>£39,417,000</td>
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</table>

*Estate Strategy and Objectives*

3.20. The Trust’s Estate Strategy is to:

3.20.1. Provide a clear positive statement to public and staff on the Trust’s plans to maintain and improve facilities in support of clinical services

3.20.2. Ensure that the Estate is aligned to the Trust’s clinical service and business objectives and supports the achievements of the Trust’s IBP

3.20.3. Align the capital investment programme with the Trust’s Clinical Service Strategies and allow future business cases for capital to be measured in a strategic context

3.20.4. Enable the estate to operate flexibly, economically and efficiently, providing and maintaining appropriate and affordable healthcare facilities which are fit for purpose, provide value for money, is compliant with statutory requirements and supports the provision of high quality clinical care

3.20.5. Support the overall alignment of the Trust’s strategies (IT, workforce, financial, performance) and be consistent with operating as a Foundation Trust in the future with the assurance that asset management costs are appropriate and future action is taken to address those which fall outside targets

3.20.6. Keep under review service costs, risk management, support for sustainable development, environmental targets and legislative requirements

3.20.7. Give assurance to staff that they will have appropriate working environment/s and transition to any new facilities will be managed well with minimal disruption to their working lives and services
3.21. These aims will be achieved through:

3.21.1. Provision of inpatient accommodation and outpatient facilities that support patients' needs and in which staff feel proud to work

3.21.2. An improvement in the condition and performance of the estate, as reported to the Department of Health annually

3.21.3. Co-location of appropriate services to achieve greater flexibility, efficiencies in occupancy costs and to realise benefits for patients and staff

3.21.4. Supporting service re-configurations in partnership with clinical staff, stakeholders, other health and social care providers and universities with commissioner support

3.21.5. Partnership arrangements or disposal of property and land that is surplus to future clinical, service and business needs

3.22. Underpinning the Strategy is the need to optimise the use of space, supporting the development of modern working practices to enable staff to maximise their performance and productivity. This supports the Trust's vision for sustainable development, placing emphasis on the health and wellbeing of both staff and service users.

**Current Power Provision and Limitations**

3.23. In 2011 the Trust engaged Halcrow Yolles a leading building services consultancy to carry out a review of its energy infrastructure within the retained hospital estate.

3.24. The aim of the brief was to set out a strategy for the refurbishment of the energy systems which would achieve reductions in carbon emissions and energy running costs whilst ensuring resilience against variation in future fuel costs and minimise the risk of system downtime.

3.25. The main findings of the report were as follows:

**John Radcliffe Hospital**

3.26. Heating and hot water services at the John Radcliffe site are provided from a centralised boiler house located within the Industrial Block Area. The boiler house contains four 5860 kW dual fuel boilers generating high pressure hot water (HPHW) which is pumped to outlying plant rooms around the site. At the plant rooms primary low temperature hot water (LTHW) is then used to provide space heating and hot water. The boilers normally fire on natural gas with diesel as the reserve fuel in case of interruption to the gas supply.

3.27. In addition to generating space heating and hot water the HPHW system is used to generate chilled water via absorption chillers located in the basement. The chilled water is used in air handling units to maintain temperature control in key areas such as theatres. This method of generating chilled water is only cost effective when using unutilised heat generated by a combined heat power (CHP) plant and therefore the chilled water system installed at John Radcliffe is not cost effective.

3.28. The boiler plant is over 40 years old and in regular need of remedial welding work to satisfy insurance inspections. There is also a problem with the burner
control systems on the individual boilers which, because of the old design of the linkage systems, rarely remain at acceptable firing efficiencies.

3.29. Because of the age of the boilers spare parts are no longer readily available and bespoke replacement parts have to be manufactured at considerable expense and time. Boiler no 3 has been out of action recently for this reason.

3.30. There is only a crude boiler sequencing control system which is ineffective. In practice the automatic sequencing of boilers is unreliable and relies on estates staff manually switching on and off boilers as the site heat demand changes.

3.31. New central steam boilers were installed at the end of 1999 to replace local steam generators feeding sterilisers around the site. Each of the two boilers has installed capacity of 3750 kW compared to an estimated point of use demand of only 185 kW. Both boilers are kept live for reasons of security of supply, so are only running on tick-over and are estimated to be operating at a seasonal efficiency of less than 25%. The reason behind the massive oversizing was reported to be to allow for steam to displace the HPHW boilers over time; however, this project was never implemented.

3.32. The main HPHW distribution system is now suffering from frequent leaks, which necessitates shutting down the system or at least sections of it. However the subsequent contraction and expansion this causes to the system results in subsequent failures elsewhere in the system and the operation of long untouched isolation valves is a further source of leakages. Expansion bellows, flange and bend welds, and corroded pipe guides have also been recent sources of failures.

3.33. Site service controls are rudimentary and though some modification have been made since the original installation they are generally not matching supply to demand, neither in terms of time nor temperature. There have been upgrades to the original pneumatic control system with a Johnson Metasys electro-pneumatic system linked to a central PC via dedicated cabling, but maintenance is costly.

3.34. Earlier this year there was a major failure of the controls installation serving the operating theatre ventilation systems, which had to be replaced at a cost of £40,000.

3.35. Domestic hot water is generated via storage calorifiers or vertical shell and tube heat exchangers. The control of these is driven more by minimising the risk of Legionella rather than final demand for domestic hot water. The inspection and maintenance of these domestic hot water generators account for significant labour and financial commitments.

Summary – John Radcliffe

3.36. In summary, the existing and time expired infrastructure presents a risk to patient safety in its present condition.

3.37. The majority of the heating and hot water services is 40 years old and is now significantly older than the recommended maximum economic life for these types of systems. The result of this is that equipment and pipework mains are failing. Spares for obsolete parts need to be manufactured. Where possible, equipment is patched up to prolong its life. Pipework leaks are frequent.
occurrences, and the required cooling down of the MTHW system to allow work to take place by itself causes further leaks and joint failures.

3.38. The existing equipment is inefficient with inadequate controls which further reduce its efficiency. Site distribution mains also represent significant loss of energy due to inadequate insulation. Upgrading the systems is an opportunity to improve both heating and hot water, and at the same time reduce significantly energy consumption.

3.39. The estate will continue to deteriorate, increasing risks to patient safety, impacting business continuity, reducing comfort levels of patients and staff and costing substantially more than is necessary.

3.40. The Trust would also need to use funds from its limited capital programme to maintain services.

Churchill Hospital

3.41. The Churchill Hospital site was originally established in 1942 and has continued to be developed. A large part of the site is served by a modern PFI unit which has new energy generation plant (boilers) and associated infrastructure.

3.42. Hot water, space heating and steam for sterile services for the remainder of the estate is generated from a centralised boiler house, which forms part of the original 1940s construction. The boiler house contains three steam boilers which were installed in the 1960s. All three boilers use heavy fuel oil as the primary fuel. There is currently no gas supply to the boiler house which allows the plant to be converted to cleaner, lower cost natural gas firing.

3.43. Steam is distributed to outlying plant rooms where it is used to generate heating and domestic hot water in local circuits. Steam is also piped directly to the sterile services department.

3.44. Within the boiler house steam is also used to generate low temperature hot water (LTHW) which is then distributed to plant rooms and used for heating and domestic hot water.

3.45. Both the steam and LTHW distribution systems were installed in the 1940s and much of it is buried and not accessible for repairs.

3.46. Whilst the boilers and associated ancillary boiler plant is functional at Churchill Hospital, the system has been prone to failures and is operationally intensive. Burning of HFO in the boilers further increases energy costs (compared to gas) and results increased carbon emissions. In July 2014 one of the steam boilers failed its insurance inspection and currently there is a hire boiler connected to the system to maintain supply resilience.

3.47. An ongoing issue is boilers 2 and 3 regularly dump heavy oil in their combustion chambers.

Controls

3.48. Across the two hospital sites the Trust operates five different BMS systems. These have been unreliable and. Ideally these should be integrated into one system.
Energy Consumption

3.49. The gas consumption and electricity usage for 2011/12 was as follows:

<table>
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<th>Existing Costs</th>
<th>JRH</th>
<th>CH</th>
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<td>EUETS JRH</td>
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3.50. The Trust normally pays VAT at 20% which is not reclaimable. The Trust pays the National Climate Change Levy rates of 0.485p per kWh of electric and 0.169p per kWh of gas. The levy is applied before VAT is calculated; therefore the actual financial effect is greater.

3.51. Annual electricity consumption has increased by 24% between 2000 and 2010. This is a consequence of the addition of the new Trauma building, Heart centre and AVIC building and also the on-going introduction of new medical and office equipment throughout the site, together with the installation of numerous local air conditioning units as part of localised building refurbishment programmes. There is no sign of this trend abating in the foreseeable future.

3.52. Annual gas consumption has increased by 12% between 2000 and 2010. There was a significant jump in 2000 which coincided with the installation of the new steam boilers, which have a capacity much greater than the site demand. Variation in weather conditions can also have an impact, but weighting of the data by “degree days” makes little difference to the overall trends.

3.53. The above conclusion that gas consumption is reasonably well matched to external weather conditions is surprising bearing in mind the state of the controls installation and the existence of absorption chillers. This is partly due to the Energy Manager and site staff who make on-going manual adjustments where automatic facilities do not exist.

3.54. In conclusion, annual electricity and gas consumption has increased by 24% and 12% respectively over the last decade. Energy costs continue to rise above the rate of inflation with the price of electricity increasing by 150% and gas by 200% over the same period. The total energy demand for the site equates to 81 GJ/100 m³ compared to a maximum NHS benchmark target of 65 GJ/100m³, with electricity usage being more profligate than that of fossil fuel. CRC charges are now being levied to the sum of £12/tonne CO₂ per year, and are likely to increase substantially in the near future.
Key Issues

3.55. Much of the original HVAC plant is now coming to the end of its working life after 40 years and is in desperate need of replacement to avoid the risks of major breakdown. System failures are becoming an increasingly common occurrence.

3.56. Recent examples include the BMS controls to the theatre air handling units and leakages in the HPHW mains. These are both costly to repair and pose a risk to the delivery of primary care services. The opportunity needs to be taken to make significant running cost savings by upgrading to new more efficient plant.

3.57. Existing controls are also inadequate and their upgrade will both improve comfort conditions and reduce energy by better matching supply to demand.

3.58. The building fabric insulation standards of forty year old buildings are inevitably greatly inferior to that required under current Building Regulations or would be considered as good practice today. Opportunities should be taken whenever refurbishment of the building envelope is considered to improve its thermal performance. Recovering roofs is one obvious example. Windows are another. If rather than repairing the existing wooden single glazed windows, there was a programme to replace them with high performance double glazed units this would not only achieve substantial reduction in heat loss, but would improve comfort conditions for patients whose sensitivity will be all the greater because of their state of health and their clothing level. There are further benefits of improved sound reduction and the possibility of incorporating encapsulated blinds to reduce glare and summer heat gains without the normal hygiene/maintenance costs of exposed blinds.

3.59. The boilers have reached the end of their economic life and need to be replaced.

3.60. The main HPHW distribution pipework will need to be replaced in a phased programme to ensure that heating, cooling and hot water services are not compromised. The prior removal of the central steam system should be of significant benefit in that it will free up space for new HPHW pipework to be installed in parallel with the existing before final switchover of connections at the energy centre and building plant rooms.

Energy and Emission Targets

3.61. The NHS has introduced the following mandatory targets for NHS bodies in England:

3.61.1. Reduce the level of primary energy consumption by 15% or 0.15 Mtc (million tonnes of carbon) from March 2000 to March 2010

3.61.2. Achieve a target of 35-55GJ/100 m² energy efficiency performance for healthcare estate for all capital developments and major redevelopments or refurbishments and all existing facilities should achieve a target of 55 – 85 GJ/100 m².

3.62. CRC charges are now being levied to the sum of £15/tonne CO₂ per year. This unit carbon cost is likely to increase substantially in the near future. The intended revenue recycling part of the original CRC proposals have subsequently been removed from the scheme so the CRC charge is effectively an energy tax increasing the cost of electricity by 9.5% and gas by 9.8%.
3.63. Energy costs continue to rise above the rate of inflation with the price of electricity increasing by 150% and gas by 200% since 2000.

3.64. The former DETR published good practice benchmarks for fossil fuel and electricity consumption for various building sectors. The energy consumption figures for 2010 are compared with the benchmark figures for acute and maternity hospitals.

<table>
<thead>
<tr>
<th>Utility</th>
<th>Consumption (GJ/100m3)</th>
<th>Benchmark (GJ/100m3)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Low</td>
<td>High</td>
</tr>
<tr>
<td>Fossil fuels</td>
<td>51.5</td>
<td>56</td>
</tr>
<tr>
<td>Electricity</td>
<td>29.8</td>
<td>10</td>
</tr>
<tr>
<td>Total</td>
<td>81.3</td>
<td>66</td>
</tr>
</tbody>
</table>

3.65. Fossil fuel consumption compares favourably with good practice targets. This is somewhat surprising considering the condition of the central plant and control system, and that gas is also used for cooling. However a significant proportion of the site is used for academic and research purposes and as such has significantly reduced occupancy hours and consequently reduced energy demands.

3.66. Conversely electricity consumption is nearly three times best practice yardstick. The benchmark figures are derived from historic studies on buildings, so it is likely that the electricity figure does not make allowance for the recent growth in electrical and electronic equipment that are allied to advances in medical practices. However at the most this might account for say a 20% rise in electricity demand, not 200% as is being experienced.

3.67. In April 2001 the Minister of State for Health set mandatory targets for NHS bodies in England requiring existing facilities to achieve a target of 55 – 65 GJ/100m³.

3.68. Consequently the John Radcliffe site needs to create an annual saving of 16 GJ/100m³ or 20% in total energy consumption to meet these efficiency targets.

3.69. The benchmark comparison suggests that the site is far more profligate with electricity than it is with gas, so as much attention needs to be given to demand side management of electricity as to improving the efficiency of thermal generation.

**Drivers for Change, Scope and Risks**

3.70. A summary of the above issues indicate that the main drivers for change are:

3.70.1. A need to meet carbon emission targets

3.70.2. The need to replace out of date plant and equipment

3.70.3. The risk of major failure endangering patient services

3.70.4. The opportunity to reduce ongoing revenue costs

3.70.5. Taking advantage of external funding

3.70.6. The ability to transfer risk to the private sector
3.71. A summary of the scope and service requirements are as follows:

3.71.1. Installation of CHP combined heat and power plant
3.71.2. Replace obsolete boiler plant and associated equipment
3.71.3. Address issues with HPHW (High Pressure Hot Water) distribution pipework
3.71.4. Reduce operating costs
3.71.5. Improved resilience and business continuity

3.72. The anticipated investment objectives of this project are

3.72.1. A reduction in the Trust’s carbon footprint.
3.72.2. A reduction in the Trust’s energy and site running costs.
3.72.3. Improvements in the Trust’s energy infrastructure.
3.72.4. Recognition as an exemplar for energy efficiency and carbon reduction.
3.72.5. Support of the continued delivery of the clinical services.
3.72.6. Resilience of to the existing time expired infrastructure.
3.72.7. Management of the risk of introducing leading edge technologies by entering into a design, build and operate contract with an industry expert.

3.73. The main strategic risks of not replacing the outdated facilities are:

3.73.1. Not having a mechanical and electrical infrastructure to support the Trust’s future clinical strategy
3.73.2. Catastrophic failure resulting in potential harm to the patient and the reputation of the Trust
3.73.3. Hampering the foundation trust application

3.74. A Quality Impact Assessment (QIA) will be undertaken as required for all cost improvement schemes in the Trust.

3.75. The Senior Responsible Officer (SRO) for this business case is Mark Trumper, Director of Development and the Estate.

3.76. The SRO will be responsible for undertaking a Health Risk Potential Assessment (RPA) against a set of high-level criteria for assessing the risk potential of this project.

3.77. The RPA will be sent to the Health Gateway Team, which will arrange a meeting to assess whether Gateway applies.

3.78. Commissioner involvement or approval is not required for this business case as it does not involve service specific activity which affects patients.
4. The Economic Case

Objectives, Constraints and Benefits

4.1. The anticipated benefits of this project are:

4.1.1. A reduction in the Trust’s energy and site running costs of £2,224,016.

4.1.2. A reduction in the Trust’s carbon footprint from 30,458 tonnes CO₂ to 19,396 tonnes CO₂ saving 11,000 tonnes CO₂.

4.1.3. Renewal of aged boiler plant within the energy centres at both the John Radcliffe and Churchill hospitals.

4.1.4. Innovative energy link between both hospitals that allows for load balancing of thermal and electrical supplies.

4.1.5. Recognition as an exemplar by the Carbon Trust and the SDU for energy efficiency and carbon reduction and meeting specified 10% reduction in CO₂ by 2015.

4.1.6. Support of the continued delivery of clinical services by reducing failures in the HPHW pipework distribution system which directly impacts on main theatre heating and cooling.

4.1.7. Resilience of to the existing time expired infrastructure by providing additional electrical supply capacity in periods of prolonged grid outage.

4.1.8. Management of the risk of introducing leading edge technologies by entering into a design, build and operate contract with an industry expert.

4.1.9. Reduction in the costs and risks by using the CEF’s advisers and a standard suite of contracts.

4.2. The main constraints and dependencies of this project are:

4.2.1. Approval by TDA.

4.2.2. Availability of Trust technical and project management resource.

4.2.3. Trust Board approval

4.2.4. Operational estates champion.

4.2.5. Appreciation of critical state of existing infrastructure.

4.2.6. Agreement of contract terms

4.2.7. Independent review of contract and payment mechanism

4.2.8. Financial and other resource changes that may take place during the project

4.2.9. The skill of managerial staff to manage and motivate personnel in a period of great uncertainty and impending change
4.3. Taking the above factors into account, the Estates professionals determined the following key weighted benefit criteria:

<table>
<thead>
<tr>
<th>Criteria</th>
<th>Weighting</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 Improved energy efficiency</td>
<td>30</td>
</tr>
<tr>
<td>2 Reduce carbon footprint</td>
<td>10</td>
</tr>
<tr>
<td>3 Improved infrastructure resilience</td>
<td>25</td>
</tr>
<tr>
<td>4 Strengthen technical expertise</td>
<td>5</td>
</tr>
<tr>
<td>5 Modernise critical engineering systems</td>
<td>10</td>
</tr>
<tr>
<td>6 Reduce risk to critical clinical services</td>
<td>20</td>
</tr>
</tbody>
</table>

4.4. The critical success factors (CSFs) for this project are:

4.4.1. Suitably qualified and experienced staff in place, with appropriate skills

4.4.2. Trust infrastructure is in place for the savings to be achieved

4.4.3. Stability within the operational estates workforce to assist with the ongoing interface between the Trust and the contractor.

4.4.4. Senior management support and board champion

4.4.5. Trust Board and TDA approvals

4.4.6. Planning approvals

4.4.7. Obtaining a place in the production line for the generator engine

4.4.8. Minimisation of disruption to patient services

4.4.9. Continued involvement of CEF as an independent audit for the monitoring and validation and contract performance monitoring in liaison with the Trust

Option Development Process

4.5. Although the option appraisal process was iterative, the work was undertaken in three main phases:

4.5.1. The Halcrow Yolles report referred to in section 3.25

4.5.2. The Jacobs Report – see below

4.5.3. This business case

The Jacobs Report

4.6. With increasing gas and electricity costs, increasing government targets to reduce carbon emissions and the mandatory targets placed on the NHS to achieve a target of 55-65GJ/100m3 energy efficiency performance for existing
healthcare premises (Department of Health, 2006) It was decided to look at the feasibility of a project that would identify potential energy savings and carbon reduction for Oxford University Hospitals NHS Trust whilst also maintaining the required healthcare standards detailed within the Health Technical Memorandums (HTM).

4.7. In September 2012 Jacobs, acting as Technical advisors for the CEF, attended the John Radcliffe Hospital and Churchill Hospital sites to carry out an initial high level review on the potential for energy saving projects.

4.8. The report summarised the technical feasibility studies undertaken to establish the potential viability of energy saving projects at John Radcliffe Hospital and Churchill Hospital.

4.9. The report was based upon high level feasibility stage assessment of the hospital primary fixed asset infrastructure and services undertaken during September 2012 and summarises the following for each site:

4.9.1. Basis of existing heating energy and power demand
4.9.2. CHP/new boiler Integration into existing heat distribution
4.9.3. Basis of the potential new boiler/CHP operational profile and plant size
4.9.4. Consideration of other potential energy saving projects
4.9.5. Basis of the capital expenditure costs

4.10. The details of plant size and capital costs were considered as a preliminary as they were based upon pre-design stage estimates and subject to development of the feasibility into a working design solution by a specialist energy services company (ESCO), who would be responsible for technical and commercial viability.

4.11. The energy consumption analysis was based upon information provided by the Trust that detailed its existing energy use and utility costs. These were used to form the baseline for energy saving comparisons.

John Radcliffe Hospital

4.12. At the John Radcliffe the study identified that potential energy savings could come from investment in CHP. The report concluded that there was a good level of year round base heat demand that could be delivered from a CHP of circa 2.0 MW capacity. This could also potentially provide the Trust with significant energy cost savings as well as significant carbon savings.

4.13. Further energy savings were identified that could be delivered through other schemes associated with lighting upgrades, pump and fan motor drive variable speed operation, heating control optimisation and replacement of the existing building engineering management system (BEMS). These improvements were estimated to improve on energy saving.

4.14. A core project comprising of a 2.0 MW e gas fuelled reciprocating CHP, replacement of life expired boilers, conversion of existing heat distribution from HPHW to MPH W / LPHW and lighting up-grade installations was established, estimated to deliver, based on a capital investment of c£3 million:

4.14.1. c5,000 tonnes of CO₂ annual savings, with annual carbon savings estimates based on first year operation. Subsequent year's carbon
savings over the life of the scheme to vary depending upon prevailing carbon intensity of National Grid displaced electricity and fuel used to generate savings from CHP or boilers

4.14.2. c£700,000 annual energy savings

4.15. An enhanced core project was also suggested that might also include a 1 MW biomass fuelled boiler, retro-fitting heating, ventilation and air conditioning (HVAC) fan and pump motor variable speed drives, local improvements to existing low temperature hot water (LTHW) controls, upgrades to existing BEMS system and retro-fit of 50 kWp photovoltaic (PV) array. This enhanced core scheme was estimated to deliver, based on a total capital investment of circa £4.3million:

4.15.1. c£6,500 Tonnes CO\textsubscript{2} annual savings, with annual carbon savings estimates based on first year operation. Subsequent year’s carbon savings over the life of the scheme to vary depending upon prevailing carbon intensity of National Grid displaced electricity and fuel used to generate savings from CHP or boilers

4.15.2. c£900,000 annual energy savings, based on initial base year energy costs.

Churchill Hospital

4.16. At the Churchill Hospital the feasibility study was based upon replacement of the life expired centralised boiler plant serving steam and LTHW infrastructure. The existing base heat loads did not appear to be significant enough to support CHP. The feasibility report suggested that improvement could be delivered from new replacement combustion plant with high efficiency and decentralisation of outlying buildings from the existing central steam service. The reduction in heating cost due to changing fuel supply from oil to gas would also benefit the scheme.

4.17. It was identified that centralised steam could be removed if the outlying heating plant was provided with new localised packaged gas fired plant and localised process steam where needed. Core areas currently served by the existing steam would be converted to LTHW distribution.

4.18. A core project comprising of the replacement of the life expired centralised oil fired steam boilers with a new part decentralised boiler installation operating on natural gas, delivering LTHW with steam utilised for localised process use only was established. The report identified that the estimated base heat demand for Churchill Hospital may not support a CHP, however other enhancements could be provided such as retrofitting HVAC fan and pump motor variable speed drives, local improvements to existing LTHW controls, upgrades to existing BEMS system and retro-fit of 50 kWp photovoltaic (PV) array. Based on a total capital investment of c£3.7million, this scheme was estimated to deliver:

4.18.1. c£2,400 Tonnes CO\textsubscript{2} annual savings, with annual carbon savings estimates based on first year operation. Subsequent year’s carbon savings over the life of the scheme to vary depending upon prevailing carbon intensity of National Grid displaced electricity and fuel used to generate savings from CHP or boilers

4.18.2. c£550,000 annual savings, based upon initial base year energy costs.
4.19. A wide range of improvement options were initially identified for consideration. These, and details of whether they were considered further, included:

4.19.1. Refurbishment – The existing time expired plant is reaching its life expiry and the structural components of the plant and infrastructure are becoming unserviceable. Whilst certain elements of the plant and equipment could be replaced/upgraded, this option would not provide resilience with the life expired plant and equipment currently in use. There would also be very little energy savings with this option. Additionally refurbishment of existing plant would not provide carbon reductions in line with the Trust’s carbon management plan.

4.19.2. Biomass – Biomass was considered in detail for each site (JRH and CHH), however the option was discounted based on, uncertainty of fuel supply security and fuel cost risk to supplier, access for fuel deliveries and an increase in traffic movement, insufficient storage space for biomass fuel and low payback compared to CHP options.

4.19.3. Solar energy – Considered but potential that many of the roof areas are not suitable due to structure and potential over shadowing.

4.19.4. Wind power: self-generated - the electricity capacity of a wind turbine would need to be significant in order to achieve sufficient cost savings and carbon reductions for this project. Given the required size of the unit it is wold be impractical to locate and wind turbines in the locale and wind turbines would not address the thermal infrastructure problems at both sites. Obtaining planning consent is also a major risk. In addition, the John Radcliffe Hospital houses a major trauma unit and is the main attendance site in the area for injuries requiring the specialist medical services this unit provides. The hospital also has a state of the art Heart Centre that is also serving a wide community with the specialist care provided within. In many cases patient that require this care need to access the hospital as quickly as possible and this is very often through the services of the air ambulance. With many frequent low flying helicopter visits to the site, wind power may not be a feasible option and further studies will be required to identify whether there is a suitable position on the site that would not affect the flight services.

4.19.5. Wind power – off site generation: not practicable given the inland location of the site.

4.19.6. Hydro power: not practicable as no water resources available. Also, the option doesn’t address the thermal infrastructure problems at the sites.

4.19.7. Connection to a district/community heating scheme: no schemes exist in the locale which would make it practicable or cost effective for connection.

4.19.8. Decentralisation – considered for the Churchill Site

4.19.9. Central plant – Considered for the John Radcliffe site

4.19.10. CHP – Considered for the John Radcliffe site

4.19.11. Heat exchangers – Considered

4.19.12. Controls, metering & monitoring - Considered
4.19.13. Standby Generation - John Radcliffe Hospital: The current standby generation system at site meets HTM requirements. The Trust did consider an option to upgrade the standby generation system to provide additional back-up supplies to the site. However, the capital costs were prohibitive.

4.19.14. Standby Generation Churchill Hospital: The Trust has already made significant in the standby generation system and the system provides suitable back up electricity for the site.

4.19.15. Uninterruptable power supplies (UPS) provision – The size and space required to deliver this type of resilience for this project would not be cost effective, this type of provision is much better suited to localise critical areas when they are refurbished.

**Short List of Options**

4.20. The feasibility study prepared by Jacobs concluded that a combined heat and power plant, high efficiency lighting and other demand side measures were likely to yield both carbon and revenue savings.

4.21. The three options that were taken forward for further consideration were:

4.21.1. Option 1 - Do nothing/minimum Incremental spend year-on-year. This has resulted in long-term dilapidation of the estate. Hence the estate is far more expensive to operate than necessary. In an environment where capital is limited, Estates capital spending priorities have to compete with clinical requirements, including the significant amount of clinical equipment that requires replacing.

4.21.2. Option 2 – Traditional procurement using internal expertise, OJEU procurement route and Trust capital funding. This would involve delaying significant investment until foundation trust status achieved and borrowing c£14m funding. There is a risk of major plant failure before this funding is in place. Income could be used from sale of land assets to fund, but this would mean competing with other financial pressures with Trust or approaching the Trust Development Agency for financial support for initiative. Funding may not be released in near future, resulting in continued dilapidation of the estate.

4.21.3. Option 3 - Proposed investment using external funding. This option would involve the Trust using the skills and experience of the Carbon and Energy Fund to expedite the project.

**Initial Option Appraisal: Do Nothing / Traditional Procurement**

4.22. The business case process involves demonstrating the implications of doing nothing.

4.23. Set out below are the basic discounted cash flow (DCFs) which compare the outcomes of doing nothing (or the minimum required to maintain basic services and modernising the electrical infrastructure to secure the investment objectives and to realise the benefits listed above).
4.24. The main assumptions underlying the analysis are as follows:
   4.24.1. 30 year period, based on useful life of the assets
   4.24.2. 3.5% discount rate
   4.24.3. Net of VAT

4.25. Do Nothing: Capital spend of
   4.25.1. Year 1 £500,000
   4.25.2. Year 3 £1,000,000
   4.25.3. Year 5 £1,000,000
   4.25.4. Year 8 £1,000,000
   4.25.5. Annual revenue spend of £5,298,250

4.26. Trust funded – based on Jacobs report – see above. Capital spend of:
   4.26.1. Year 1 £6,700,000
   4.26.2. Year 3 £1,000,000
   4.26.3. Year 17 £3,000,000
   4.26.4. Annual revenue spend of £4,594,427

4.27. The resulting 30 year discounted cash flow (DCF) analysis of net present cost (NPC) is as follows:
   4.27.1. Do nothing £103,947,196
   4.27.2. Trust investment (Jacobs) £96,760,002

4.28. The qualitative assessment of the professional team at that point was that the trust investment option would also reduce risk and provide more benefits.

4.29. The conclusion was that from a risk, benefit and economic analysis doing nothing was not an option and a major investment in electrical infrastructure was the preferred way forward.

**Benefit Appraisal**

4.30. The preferred option would provide all the benefits listed above.

4.31. The appraisal team considered that most of the benefits were quantified through the anticipated savings in energy costs, reduced maintenance costs and a reduction in the carbon levy.

4.32. However, two examples of possible broader economic benefits were identified:
   4.32.1. Main theatres availability: The main theatres occasionally have to be closed due to power problems. At an estimated cost of £1,000 per hour, 4 times a year, 4 hours per list, for 8 theatres over the 30 year contract period this has a value of nearly £4,000,000
   4.32.2. Additional inpatient bed days. The closure of the theatres result in additional bed days as patients have to stay an additional night. At an estimated cost of £225 per bed day, an average of 3 patients per list, 4 times a year, for 8 theatres over the 30 years of the contract, this could have an economic value of £650,000
Appraisal of the Preferred Option

4.33. Following a procurement exercise, Vital Energi (VE) was selected as the preferred bidder – the Commercial Case explains the process and details of their proposal.

4.34. As part of that process, it became clear that the original trust funded option at the OBC equivalent stage was too narrow in scope and that a more innovative solution would result in a more resilient facility and higher annual savings.

4.35. The main change was that an energy link between the two hospital sites would:

4.35.1. Maximise financial savings
4.35.2. Maximise carbon savings
4.35.3. Provide an optimum engineering solution for infrastructure resilience
4.35.4. Provide the potential for commercial opportunities in providing energy to 3rd parties

4.36. Based on the main engineering elements of the scheme, the main economic assumptions underlying the OBC analysis are as follows:

General
4.36.1. 30 year period, based on useful life of the assets
4.36.2. 3.5% discount rate
4.36.3. Net of VAT

PSC
4.36.4. Capital spend Year 1 £18,394,660
4.36.5. Capital spend Year 17 £3,000,000
4.36.6. Annual revenue spend of £4,039,248

Preferred Option – VE
4.36.7. Capital spend: nil
4.36.8. Annual revenue spend - Years 1 to 25 £4,444,117
4.36.9. Annual revenue spend - Years 26 to 30 £3,398,597

4.37. The resulting 30 year DCF analysis of net present cost is as follows:

4.37.1. PSC £97,014,962
4.37.2. Preferred option – VE £82,529,765

Risk assessment

4.38. A comprehensive risk assessment was undertaken.

4.39. Using an industry specific risk register a Trust specific risk register was developed by Mervyn Phipps and Steve Lloyd of the Trust and Peter Fairclough of CEF.

4.40. This was used to both assess the high impact risks and the high value risks

4.41. External environmental risks, which are common to both the PSC and the preferred options were not included for evaluation purposes. These include, for example, spark gap (see later) and inflation.
4.42. The appraisal involved:

4.42.1. Identifying all the possible business and service risks associated with each option
4.42.2. Assessing the impact and probability for each option
4.42.3. Calculating a risk score
4.42.4. Developing a management response
4.42.5. Valuing the risk
4.42.6. Agreeing responsibility for the risk for the VE option

4.43. The range of scales used to quantify risk for both impact and probability was as follows:

4.43.1. Low  1
4.43.2. High  5

4.44. The main areas of risk identified are:

4.44.1. Financial and funding Risks
4.44.2. Installation Risks
4.44.3. Operational Risks
4.44.4. Technical specific risks – John Radcliffe Hospital
4.44.5. Technical specific risks – Churchill Hospital

4.45. The form of contract provides for a full transfer of risk from the Trust to the contractor. The risks include:

4.45.1. All design and installation
4.45.2. Generation of electricity
4.45.3. Provision of heat and cooling to meet all hospital and third party needs
4.45.4. All operation, maintenance, repair and life cycling of the plant
4.45.5. Guarantee of financial and carbon savings

4.46. The valuation of the risk and its transfer are as follows:

<table>
<thead>
<tr>
<th></th>
<th>PSC</th>
<th>Preferred Option</th>
</tr>
</thead>
<tbody>
<tr>
<td>£s</td>
<td>%</td>
<td>£s</td>
</tr>
<tr>
<td>Trust</td>
<td>3,399,580</td>
<td>627,400</td>
</tr>
<tr>
<td>VE</td>
<td>n/a</td>
<td>2,772,180</td>
</tr>
</tbody>
</table>
4.47. Sensitivity analysis: Savings

4.47.1. The objective of the initiative is delivered through its potential achievement of long-term economic efficiencies. The proposed agreement between the Trust and the preferred bidder, limits the Trust’s financial exposure to the annual pre-defined Unitary Payment Obligation (UPO) of £2,1,800,000 and generates pre-determined annual target savings of £2,200,000. A short fall of these target savings will be underwritten by the preferred bidder.

4.47.2. The UPO is subject to annual indexation at a rate of 2.5% or the Retail Performance Index, whichever is the greater, for a period of 30 years. This pricing mechanism leads to savings sensitivity illustrated in the following table (based on Vita’s latest estimate of savings – which has yet to be verified):

<table>
<thead>
<tr>
<th>Year</th>
<th>Indexed UPO</th>
<th>Net</th>
<th>Indexed UPO</th>
<th>Net</th>
<th>Indexed UPO</th>
<th>Net</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>2.50%</td>
<td>Savings</td>
<td>3.02%</td>
<td>Savings</td>
<td>3.50%</td>
<td>Savings</td>
</tr>
<tr>
<td>£000</td>
<td>£000</td>
<td>£000</td>
<td>£000</td>
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</tr>
<tr>
<td>1</td>
<td>£1,835</td>
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<td>£558</td>
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<tr>
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<td>£2,783</td>
<td>-£390</td>
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4.47.3. At a minimum indexation rate of 2.5% the benefit of the saving falls off by year 12 and for every 1% increase in this rate the gap narrows 25%. As at June 2014, the average RPI over the previous 5 years was 3.02%.

4.47.4. This sensitivity analysis assumes that utility pricing remains static.

4.48. Sensitivity analysis: Carbon Levy

4.48.1. Recently published quarterly energy prices by the Department of Energy and Climate Change suggest that the pricing of gas and electricity will continue to increase over time, resulting in increased savings under this CEF initiative.

4.48.2. Once operational, the projected reduction in CO₂ emission is envisaged to reduce by 11,000 tonnes. This represents a 36% reduction on current levels. At today’s carbon price of £15 per tonne a baseline saving of £165,000 could be delivered.
4.48.3. In March 2011 the Government announced a floor price for carbon in the power sector effective from 1 April 2013 to establish a target price for carbon of £30 per tonne of CO₂ in 2020.

4.48.4. At this price the Trusts potential annual saving doubles to around £330,000.

4.48.5. It is widely accepted that the Carbon Price will rise further during the 2020s.

4.49. Sensitivity analysis: Generating margins (the “spark gap”)

4.49.1. Sensitivity analysis on the generating margins of the proposed scheme has been carried out against the variability (up to 35% deviation in either direction) in current gas and electricity prices and the fluctuations in UK electricity and gas prices over the last 10 years. This has demonstrated that the relationship in price changes of both the commodities has remained relatively constant.

4.49.2. The analysis suggests that the profitability of the scheme improves steadily with the co-related increase in gas and electricity prices, which is the most likely scenario, and that the risk of making a loss on generation would only occur in the unlikely event that both gas prices increase and also electricity prices drop steadily in tandem.

**Preferred Economic Option**

4.50. The result of investment appraisal is as follows

<table>
<thead>
<tr>
<th></th>
<th>Do Nothing</th>
<th>PSC</th>
<th>Preferred Option (VE)</th>
</tr>
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<td>132,073,510</td>
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<td><strong>NPC</strong></td>
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<td>97,014,962</td>
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<td>0</td>
<td>0</td>
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<tr>
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<td>83,157,165</td>
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</table>

4.51. The conclusion is that in economic terms, the Vital Energy proposal is the best way forward.
5. The Commercial Case

*NHS Shared Business Services and Carbon & Energy Fund*

5.1. NHS Shared Business Services Ltd (NHS SBS) has undertaken a procurement exercise for a Framework Agreement for the purchase and management of the provision of carbon and energy infrastructural upgrade services.

5.2. The result is that the Carbon and Energy Fund (CEF) was appointed to manage and operate the Framework. CEF has an agreement with NHS SBS to manage and facilitate the Framework, and within this agreement CEF are written into the Framework documents as the party authorised to run the framework and the model.

5.3. The Carbon and Energy Fund (CEF) is a NHS partnership of the Department of Health, NHS, Carbon Trust, National Services Scotland, National Procurement, NHS Strategic Buying Solutions and HealthCare Solutions that work together to reduce the fossil fuel carbon footprint of the NHS. The CEF, with its strategic partners, is on target with upgrading 60 hospitals over four years, and 240 over 16 years. In full CEF is referred to as the NHS SBS Carbon and Energy Fund.

5.4. The Trustees of the CEF are drawn from:

5.4.1. The Department of Health and Sustainable Development Unit of the NHS

5.4.2. Directors of Estates and Facilities that have managed pilots

5.4.3. NHS SBS CPS (procurement)

5.4.4. Carbon and Energy Fund (3)

5.4.5. Carbon Trust Common Services Agency (National Services Scotland and National Procurement)

5.5. The CEF is a special purpose vehicle (SPV) created to allow different parts of the NHS work together, and governed by a partnering agreement that assures the CEF works in the best interests of the NHS. The CEF gives members a choice of advisors to assist them with the upgrade of their energy infrastructure.

5.6. CEF enables NHS trusts to upgrade their energy infrastructure at no additional revenue or capital cost. The CEF provides capital and expertise to develop projects and has secured over £300m and longer term funding to be invested in schemes that upgrade facilities and generate revenue and carbon savings. The CEF has already been subject to full OJEU process and has a framework of 12 contractors with proven ability to design, build and operate energy infrastructure projects. The funding has been secured from a variety of commercial banks and pension funds offering 15 -30 year terms and is repaid through the life of the contract.

5.7. This framework operates in a similar way to the NHS P21+ process, with the exception that the final selection of the bidder is made under strict competition, that funding is secured through the contract (and via the CEF) and that the term is typically for 25 years or more.

5.8. Bidders are invited to submit their proposals through a competitive process, with the core part of their offers being guaranteed savings against the Trust's existing consumption coupled with carbon reductions and guaranteed provision
of heat and power for the term. Re-payment of savings not achieved and availability deductions form a core part of the contract requirements.

5.9. The funding is secured by the CEF from the markets, using banks, pension funds and institutions. The funding is long term, covering anything from 15 to 25 years which allows for large capital investment to be paid over the longer period, secured by a bankable contract and the Trust as security. The CEF provides capital and expertise to develop projects and has secured over £300m long term funding for schemes that upgrade facilities and generate revenue and carbon savings. The Bidders have access to this funding within their bids, or can offer their own funding if this is more competitive and schemes using external funding will mean that the assets are off balance sheet. Trust funding can also be used, but this option means that the assets will be on balance sheet and this option has not been used on this scheme.

5.10.22 Trusts have taken advantage of the CEF to date with 14 contracts now signed, and the remaining 8 schemes having signed agreements between the Trusts and CEF. The typical infrastructure investment can be up to £15m with considerable annual revenue reductions and carbon savings which could contribute towards a Trust’s strategic objectives. All of the externally funded schemes have been structured so that they remain off the Trust’s balance sheet. This applies to all of the externally funded contracts that have been signed to date, and of those, the Trusts who have decided to keep the scheme off balance sheet (understood to be 9 in total).

5.11. CEF provides an opportunity to access capital which can be invested in energy infrastructure improvements. Such investments:

5.11.1. Allow an accelerated investment in a number of schemes that help deliver OUH’s own key objective of working towards a sustainable low carbon future (releasing both carbon and energy cost savings)

5.11.2. Remove pressure on the Trust’s own internal capital programme.

5.11.3. Introduce significant external funding to re-provide time expired Trust equipment all at no cost to the Trust

5.11.4. Transfer on going energy management (maintenance, repair and replacement) risks to the service provider

5.11.5. Develop a partnership arrangement with CEF for the duration of the contract providing access to the funds expertise in on-going management of implemented schemes.

5.12. Planning Approval has been received for the scheme for both sites.
Procurement Process

5.13. The Trust set up the following project team to oversee the project:
- 5.13.1. Trust board sponsor/champion: Mark Trumper
- 5.13.2. Project Director: Mark Trumper
- 5.13.3. Finance representative: Gemma Boldon
- 5.13.4. Head of Estates & Facilities Operations: Mervyn Phipps
- 5.13.5. Estates Project Manager: Stephen Lloyd
- 5.13.6. Procurement Manager: Pia Larsen
- 5.13.7. Energy Manager: Mike Frankum
- 5.13.8. NHS SBS CEF Project Manager: Peter Fairclough
- 5.13.9. NHS SBS CEF Technical manager: Steven Lowndes
- 5.13.10. Trust Project Administrator: Brenda Stafford

5.14. The CEF have a procurement framework, procured through OJEU between January and July 2011. This saves Trusts considerable procurement time, and for that reason, the Trust’s competitive process is called by the EU, a mini-competition. A mini competition has to follow strict rules set down in the framework, and the CEF procurement team (NHS SBS CPS) oversaw this aspect of the procurement.

5.15. The project was released on 7 January 2013 to the market as a mini-competition to the 12 companies pre-qualified on the CEF Framework.

5.16. An open day was held on 25 January 2013, attended by the following interested companies:
- 5.16.1. Breathe
- 5.16.2. Cofely
- 5.16.3. Dalkia
- 5.16.4. Ener-G
- 5.16.5. Mitle
- 5.16.6. Vital Energi

5.17. The other providers on the framework had demands and costs placed on them by other concurrent schemes.

Assessment of Bids

5.18. The project attracted interest from four of the ten bidders on the framework. The interest reflected the bidders’ understanding that this is a complex project with a wide engineering requirement on both sites and not all bidders can compete effectively for such a complex and diverse project.

5.19. Two of the six bidders that attended the Open day declined the invitation to the selection interview. These decisions were based on similar views as noted above, but with the bidders then having more knowledge regarding the scheme details and the relative strengths of their organisations in the face of the competition.
5.20. One of the remaining four bidders pulled out of the process immediately prior to the selection interview. This was Breathe Energy, one of the smaller companies on the framework, who gave the reason that they had just secured two large contracts on the south coast and would not be able to service this scheme. The view from the project team was that having three keen bidders was a suitable number for the competition, particularly given that there are a limited amount of businesses that can realistically deliver these types of contracts, and they are all included on the CEF Framework.

5.21. The Trust interviewed the three bidders, scoring them (out of 60) as follows:
   5.21.1. Dalkia
   5.21.2. Mitie
   5.21.3. Vital

5.22. A cautious approach was taken in compiling the scores, which is reflected in the final results. However, the team was satisfied that each of the 3 bidders identified had the ability, experience, capacity and expertise to be taken forward to the next stage.

5.23. The project team, therefore, invited Dalkia, Mitie and Vital to take part in the further stages of the mini-competition.

5.24. These stages of the mini-competition comprised:
   5.24.1. Two technical meetings with each of the bidders to work with those bidders to produce the best possible scheme for the hospital, that that bidder was capable of
   5.24.2. The drafting and issue of an Invitation to Tender
   5.24.3. The receipt of bids
   5.24.4. The selection of the best bidder using the framework selection criteria

5.25. The Bidders were informed that they could also submit variant bids.

*Evaluation of the Bids*

5.26. The bids were evaluated by a team comprising OUH Finance and Estates representatives plus a consultant from Jacobs working with the guidance of the CEF Consultant and using the CEF evaluation template.

5.27. An initial review and scoring of the bids was undertaken on 7 June 2013 following presentations from all three of the bidders on their proposals on the 4 June 2013.

5.28. The evaluation was undertaken on the core bids received for a 15 year term.

5.29. All three bidders provided variant bids and different options for contract lengths. The variant bids were widely differing in their design, and in particular Vital identified a district heating main connecting John Radcliffe to the Churchill site within their variant bid.
5.30. The evaluation shows that:

5.30.1. All bidders submitted a legally compliant bid
5.30.2. Vital Energi’s response was joint strongest in terms of project management, service delivery and programme
5.30.3. Vital Energi’s response was the strongest in terms of financial response and design and construction
5.30.4. Vital Energi provided the best NPV after all bids had been “normalised” to account for all avoided costs

5.31. The final scores were as follows:

5.31.1. Dalkia
5.31.2. Mitie
5.31.3. Vital

5.32. All three bidders provided variant bids and different options for contract lengths. The variant bids were widely differing in their design, and in particular Vital identified a district heating main connecting John Radcliffe to the Churchill site within their variant bid.

Preferred Bidder

5.33. Based on the evaluation of bids, the bidder presenting the best bid to the Trust based on the core option over a 15 year period was Vital Energi. This bid obtained the highest overall weighted score (88) and the best net present value (£9m)

5.34. Vital Energi obtained the highest score across the non-financial aspects of the evaluation.

5.35. Vital Energi offered an innovative engineering solution to the high pressure network on the John Radcliffe site which in turn provided the Trust with a series of avoided costs that were not applicable to the other bids.

5.36. Based on the evaluation work undertaken and the sensitivity analysis that had been completed it was concluded that Vital Energi should be the Trust’s preferred bidder.

Contract Period

5.37. The project team carried out an analysis of the funding and term options.

5.38. It was concluded from this analysis that the best value option for the Trust was a funding term of 25 years, and a contract length of 30 years, as this gave the best balance between overall NPV value and year 1 savings.

Funding Options

5.39. There are three main sources of funding for this type of project:

5.39.1. User-financed
5.39.2. Supplier-financed
5.39.3. Grants

5.40. There are only limited opportunities to get financial assistance for energy improvement measures through feed in tariffs and renewable heat incentive and
enhanced capital allowance schemes. However the Trust would find it difficult to raise the necessary capital for the extent of plant replacement that is now essential for the John Radcliffe site's continued operation, which is why Contract Energy Management (CEM) or some form of third party financing might be more appropriate.

5.41. NHS SBS CEF NCIS Fees "(NCIS Fees)" due on contract award are £547,820.

Overview of Proposed Commercial Arrangements

5.42. The Project Agreement will be the principal scheme document. The Project Agreement will oblige Vital to install the company site equipment and company non site equipment, provide energy and energy management services to a pre-determined standard and maintain the facilities on the sites. The Project Agreement will also contain the obligation on each of the parties to enter into the Leases.

5.43. The Funders Direct Agreement will be a tri-partite agreement between the Trust, VITAL and the Funder setting out the terms on which the Funder will hold security over the company equipment and step-in rights. The principal provisions of the Funders Direct Agreement will cover:

5.43.1. Annual charge and payment
5.43.2. Substitution and step-in
5.43.3. Ownership of the plant and equipment
5.43.4. Risk transfer
5.43.5. Performance guarantees
5.43.6. Insurances
5.43.7. TUPE
5.43.8. Assignment
5.43.9. Termination

Emerging Technologies

5.44. Throughout the Project Term, Vital Energi acting as the Trust's service provider has an obligation to analyse each of the Services and, in respect of each service, produce a programme that details any proposals for changes to the services or any method statement, the likely impact of those changes, the financial implications of the changes, the impact of the timing of such changes or the Trust's ability to carry out its functions and any other matter which the Trust may require according to the agreed variation procedure.

5.45. This would include to regularly undertake affordability testing of alternative technologies and services which may become available throughout the contract term that could deliver financial, operational and/or environmental benefits to the Trust, which could be implemented through the raising of a variation enquiry by the Trust. The variation procedure also allows for Trust to raise a variation enquiry instructing the service provider to investigate financial/service delivery benefits should the Trust become aware of any new or existing technology advancements that it considers may provide a financial and/or service delivery benefits to the Trust.
Personnel Implications

5.46. The likely personnel implications of the preferred option are:

5.46.1. A reduction in the daily checks required for items, such as boilers, plant rooms etc
5.46.2. A reduction in first response reactive maintenance
5.46.3. A reduction in maintenance contract management

5.47. The above represents a minimum of 2 WTE which will be redeployed within the existing operational structure

Implementation Timescales

5.48. Subject to Board and TDA approval, the key contractual milestones and anticipated delivery dates are as follows:

<table>
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<th>Date</th>
<th>Description</th>
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</thead>
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<tr>
<td>12/11/2014</td>
<td>Trust Board full business case submission</td>
</tr>
<tr>
<td>05/01/2015</td>
<td>TDA approval</td>
</tr>
<tr>
<td>02/02/2015</td>
<td>Contract signature</td>
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<tr>
<td>02/03/2015</td>
<td>Mobilise on-site works</td>
</tr>
<tr>
<td>30/09/2015</td>
<td>Steam boilers and system shut-down at Churchill Hospital</td>
</tr>
<tr>
<td>30/09/2015</td>
<td>Energy conservation measures completed – both sites</td>
</tr>
<tr>
<td>18/02/2016</td>
<td>CHP unit delivered to John Radcliffe Hospital</td>
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<td>17/03/2016</td>
<td>HTHW steam or LTHW boilers and system shut-down at John Radcliffe Hospital</td>
</tr>
<tr>
<td>05/04/2016</td>
<td>Absorption chillers and adiabatic coolers installed &amp; operational</td>
</tr>
<tr>
<td>31/08/2016</td>
<td>Anticipated practical completion date</td>
</tr>
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6. The Financial Case

Assumptions

6.1. The main financial assumptions are as follows:

6.1.1. The energy fuel cost indexation is 2.5%. Industry expectations are that actual cost increases will be considerably higher in the next 25 years. Savings will be greater if energy fuel costs increase at a rate above 2.5% per annum.

6.1.2. The increasing cost of labour and materials over the next 25 years is accounted for in the model as 2.5% or RPI, whichever is higher.

Balance Sheet Treatment

6.2. This section outlines the accounting treatment adopted for the analysis of the bids against the public sector comparator:

6.3. Whilst the CEF advise that the schemes it has delivered to date have been 'off balance sheet', until formal auditor opinion is obtained on the final proposed solution, there is a risk that the transaction will be deemed to be on-balance sheet.

6.4. Under the public sector comparator the Trust would purchase plant and equipment and also upgrade buildings using operational or strategic capital and incur the associated capital charges (depreciation over the equipment's useful economic life and an annual 3.5% rate of return on capital).

6.5. The Trust would have ownership of the equipment on its balance sheet and as such all the risks and rewards of ownership rest with the Trust. In particular, the organisation would be responsible for all aspects of equipment maintenance, although this could be contracted out to a maintenance provider. The maintenance expenditure would be met out of the Trust's revenue budget.

6.6. A managed energy services contract is accounted for largely in the same way as the PFI, but does not utilise a structured procurement route and standardised documentation although a variant of the PFI Standard Form of Agreement will be employed. All equipment would be owned, repaired, replaced and maintained by the MES provider however the building structure would continue as a Trust asset.

6.7. The Trust provides an output specification that the private sector partner has complete discretion as to how it will be fulfilled. Consequently, all risks and rewards of ownership rest with the MES provider although the majority of operational risk transfers. If a piece of equipment fails or the service reduces the provider would face performance penalties as specified in the contract.

6.8. Replacement of existing equipment would be at the discretion of the provider, assuming it continues to meet the output specifications. The equipment is assumed to be 'off balance sheet'.

6.9. A unitary payment would be charged to the Trust representing the total cost of the service, including an element of profit for the provider and this would be met out of the Trust's revenue budget.

6.10. Where a capital investment is made by OUH then that element will always be on balance sheet.
6.11. The Trust is taking advice from its internal auditors about the likely balance sheet treatment of the proposed scheme.
7. The Management Case

Overview of Project Management Arrangements

7.1. The main roles and responsibilities are as follows:

7.1.1. The Director of Development and the Estate is the project sponsor and will be accountable at board level for this project.

7.1.2. Head of Capital Projects will take over responsibility for delivering the scheme.

7.1.3. The Head of Capital Projects will be required to establish a project team.

7.1.4. The Head of Estates and Facilities Operations will require additional resources to provide the necessary enabling and commissioning works.

7.1.5. The Head of Capital Projects will require external validation and verification of the commissioning process and outcomes.

Project Organisation

7.2. The key components of the project organisation will be:

7.2.1. The project board

7.2.2. The project director

7.2.3. The project manager

7.2.4. Sub groups / workstreams

7.2.5. Senior Responsible Owner/ Project Director (Project Sponsor)

7.3. The Senior Responsible Owner (SRO) or Project Sponsor/Director for this project is Mark Trumper, Director of Development and the Estate.

7.4. The SRO/Project Director has the following high-level responsibilities to:

7.4.1. Ensure that a project of change meets its objectives and delivers the projected benefits

7.4.2. Ensure agreement amongst stakeholders about the objectives and benefits and commitment to the delivery of the benefits

7.4.3. Monitor delivery of the objectives and benefits, taking appropriate action where necessary to ensure their successful delivery.

7.4.4. Ensure that the project is subject to review at the key decision points.

7.4.5. Make certain that any recommendations or concerns from reviews are met or addressed before progressing to the next stage.

7.4.6. Oversee development of the brief for change.

7.4.7. Ensure that the aims of the planned change continue to be aligned with the business, and establish a firm basis for the project during its initiation and definition.

7.4.8. Develop the project organisation structure and logical plans

7.4.9. Monitor and control of progress

7.4.10. Formally close the project and ensure that the lessons learned are documented within the 'end of project' or 'end of programme' evaluation report.
7.4.11. Plan the post project review when the benefits realisation process will be assessed.

7.4.12. Ensure that the post implementation review takes place, the output is forwarded to the appropriate stakeholders and the benefits have been realised.

7.4.13. Regularly consult with those delivering the change and the stakeholders and sponsors.

7.4.14. Ensure that the communication processes are effective and linkages are maintained between the change team/s and the organisation's strategic direction.

7.5. The Project Director's role is crucial for creating and maintaining enthusiasm and momentum. Specific responsibilities include:

7.5.1. Planning and designing the project and proactively monitoring its overall progress, resolving issues and initiating corrective action as appropriate

7.5.2. Defining the project's governance arrangements and quality assurance

7.5.3. Managing the project's budget, monitoring the expenditures and costs against delivered and realised benefits as the programme progresses

7.5.4. Facilitating the appointment of individuals to the project delivery teams

7.5.5. Ensuring that there is efficient allocation of common resources and skills

7.5.6. Managing the communications with all stakeholders and third parties

7.5.7. Managing both the dependencies and the interfaces between projects

7.5.8. Managing risks

7.6. The project manager role will be to oversee day to day activities and ensure that progress is maintained in accordance with the project plans agreed by the Project Director. In addition, the project manager will be expected to coordinate and manage the contribution of the project team including external advisors. Regular contact with the team and the Project Director will be required in order to achieve this and to inform and communicate progress and issues up and down the chain of command.

7.7. Specific responsibilities include

7.7.1. Managing project priorities.

7.7.2. Acting as a catalyst to resolve project problems and conflicts, escalating when necessary.

7.7.3. Assessing strengths and weaknesses at project completion

7.7.4. Ensuring that related and partner teams are involved and informed as early as possible in the project management process.

7.7.5. Preparing Project Schedules and Plans

7.7.6. Providing regular reports to the SRO on progress of the business change.

7.7.7. Monitoring actual project progress against agreed schedules and plans.
7.7.8. Using defined Project Processes to manage Quality, Risks, Changes, Issues and Financial Implications

7.7.9. Monitoring Project Performance and Publish Project Status data at key stages throughout the Project.

7.7.10. Managing day-to-day Project tasks and escalate any issues that impact on the Project Performance and Timetable

7.7.11. Providing updates or adjustments to the Project Plan as necessary to ensure the project continues to meet the Key Deliverables defined at the start of the Project.

7.8. The support services significant for this case are as follows:

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<th>Support Service</th>
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<td>N/A</td>
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<tr>
<td>Pathology</td>
<td>N</td>
<td>N/A</td>
</tr>
<tr>
<td>Radiology and Imaging</td>
<td>N</td>
<td>N/A</td>
</tr>
<tr>
<td>Pharmacy</td>
<td>N</td>
<td>N/A</td>
</tr>
<tr>
<td>Physio, OT, SALT</td>
<td>N</td>
<td>N/A</td>
</tr>
<tr>
<td>Infection Control</td>
<td>N</td>
<td>N/A</td>
</tr>
<tr>
<td>Outpatients</td>
<td>N</td>
<td>N/A</td>
</tr>
<tr>
<td>Medical Records</td>
<td>N</td>
<td>N/A</td>
</tr>
<tr>
<td>Estates /Capital Development</td>
<td>Y</td>
<td>Major programme of works, led by Estates</td>
</tr>
<tr>
<td>Other (please specify)</td>
<td>N</td>
<td>N/A</td>
</tr>
</tbody>
</table>
Outline Project Plan

7.9. The outline integrated approval and installation timetable is as follows:

<table>
<thead>
<tr>
<th>Date</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>28/08/2014</td>
<td>TME outline business case submission</td>
</tr>
<tr>
<td>10/09/2014</td>
<td>Trust Board outline business case submission</td>
</tr>
<tr>
<td>11/09/2014</td>
<td>Amended preferred bidder letter</td>
</tr>
<tr>
<td>12/09/14 to 30/10/14</td>
<td>Finalise design for additional district heating and chiller plant-up-grade</td>
</tr>
<tr>
<td>30/09/2014</td>
<td>CHP - reserve engine production slot</td>
</tr>
<tr>
<td>30/10/2014</td>
<td>Finalise key contract terms</td>
</tr>
<tr>
<td>12/11/2014</td>
<td>Trust Board full business case submission</td>
</tr>
<tr>
<td>05/01/2015</td>
<td>TDA approval</td>
</tr>
<tr>
<td>02/02/2015</td>
<td>Contract signature</td>
</tr>
<tr>
<td>02/03/2015</td>
<td>Mobilise on-site works</td>
</tr>
<tr>
<td>30/09/2015</td>
<td>Steam boilers and system shut-down at Churchill Hospital</td>
</tr>
<tr>
<td>30/09/2015</td>
<td>Energy conservation measures completed -- both sites</td>
</tr>
<tr>
<td>18/02/2016</td>
<td>CHP unit delivered to John Radcliffe Hospital</td>
</tr>
<tr>
<td>17/03/2016</td>
<td>HTHW steam or LTHW boilers and system shut-down at John Radcliffe Hospital</td>
</tr>
<tr>
<td>05/04/2016</td>
<td>Absorption chillers and adiabatic coolers installed &amp; operational</td>
</tr>
<tr>
<td>31/08/2016</td>
<td>Anticipated practical completion date</td>
</tr>
</tbody>
</table>

7.10. The impacts/risks associated with the project have been scored against the Gateway Risk Potential Assessment (RPA) for projects. It has been assessed as low risk.
8. Conclusion

8.1. In summary, the existing and time expired infrastructure presents a risk to patient safety in its present condition.

8.2. The majority of the heating and hot water services are 40 years old and are now significantly older than the recommended maximum economic life for these types of systems. The result of this is that equipment and pipework mains are failing. Spares for obsolete parts need to be manufactured. Where possible, equipment is patched up to prolong its life. Pipework leaks are frequent occurrences, and the required cooling down of the system to allow work to take place by itself causes further leaks and joint failures.

8.3. The existing equipment is inefficient with inadequate controls which further reduce its efficiency. Site distribution mains also represent significant loss of energy due to inadequate insulation. Upgrading the systems is an opportunity to improve both heating and hot water; and at the same time to reduce energy consumption significantly.

8.4. The financial benefits of this business case are:

8.4.1. A guaranteed reduction in annual energy costs of around £2,200,000. After the annual unitary payment of just under £1,800,000 this results in a net guaranteed annual saving of over £400,000.

8.4.2. A reduction in the annual carbon footprint of the Trust from 30,000 tonnes to 19,000 tonnes. The CO₂ levy saving on 11,000 tonnes at today's price is around £165,000. If the levy rises to £30 per tonne by 2020 then this rises to £330,000.

8.4.3. An initial capital investment of around £18,400,000 externally funded at no additional cost to the Trust. If the Trust had to fund the initial capital expenditure itself, the initial interest charge would be over £1,000,000 at a rate of 5.64%, which is the cost of finance that the Trust is currently being charged on capital.

8.4.4. Reduced backlog of £11,000,000, which addresses the replacement of plant and equipment which are key to providing an environment for the patient that is safe, fit for purpose and strategically aligned.

8.4.5. A transfer of risk to the external provider estimated to be around £2,600,000.
9. **Recommendation**

9.1. The Trust Board is asked to approve this outline business case with a target of commencement of major plant installation in summer 2015 to begin to derive in-year benefit.

9.2. In order to facilitate the savings approval is also sought from the Trust Board to release £300,000 of phased funding immediately:

9.2.1. £200,000 to fund the preparation, finalisation and approval of this outline business case and the subsequent final business case

9.2.2. £100,000 to ensure that the required plant and equipment is earmarked for production to ensure timely installation following signing of the contract.

Prepared by Terry Dennis

On behalf of

Mr Mark Trumper,

Director of Development and the Estate

26 August 2014
Trust Board Meeting: Wednesday 10 September 2014  
TBC2014.42

<table>
<thead>
<tr>
<th>Title</th>
<th>Energy Outline Business Case (OBC)</th>
</tr>
</thead>
</table>

<table>
<thead>
<tr>
<th>Status</th>
<th>For approval</th>
</tr>
</thead>
</table>

**History**
This business case was supported by the Trust Management Executive at its meeting on 28 August 2014.

<table>
<thead>
<tr>
<th>Board Lead(s)</th>
<th>Mr Mark Trumper, Director of Development and the Estate</th>
</tr>
</thead>
<tbody>
<tr>
<td>Key purpose</td>
<td>Strategy  Assurance  Policy  Performance</td>
</tr>
</tbody>
</table>

TBC2014.42 Energy Outline Business Case (OBC)
Executive Summary

1. The purpose of this document is to present the Board with a sound outline business case (OBC) for the provision of an energy infrastructure renewal scheme to meet the heat and power strategy for the John Radcliffe and Churchill Hospitals.

2. The main aspects are:
   2.1 A guaranteed reduction in annual energy costs of around £2,200,000. After the annual unitary payment of just under £1,800,000 this results in a net guaranteed annual saving of over £400,000.
   2.2 A reduction in the annual carbon footprint of the Trust from 30,000 tonnes to 19,000 tonnes. The CO₂ levy saving on 11,000 tonnes at today’s price is around £165,000. If the levy rises to £30 per tonne by 2020 then this rises to £330,000
   2.3 An initial capital investment of around £18,400,000 externally funded at no additional cost to the Trust. If the Trust had to fund the initial capital expenditure itself, the initial interest charge would be over £1,000,000 at a rate of 5.64%, which is the cost of finance that the Trust is currently being charged on capital.
   2.4 A reduction in backlog maintenance of £11,000,000, which addresses the replacement of plant and equipment which are key to providing an environment for the patient that is safe, fit for purpose and strategically aligned.
   2.5 A transfer of risk to the external provider estimated to be around £2,800,000

3. Recommendation
   3.1 The Board is asked to approve the outline business case for onward submission to the Trust Development Authority for their consideration. The plan envisages a target of commencement of major plant installation in summer 2015 to begin to derive in-year benefit.
Energy Outline Business Case (OBC)

1. Purpose

1.1. The purpose of this paper is to present a sound outline business case (OBC) for the provision of an energy infrastructure renewal scheme to meet the heat and power strategy for the John Radcliffe and Churchill Hospitals.

1.2. This paper complies with the Treasury's Five Case model for public sector business cases and contains information required by the Trust Development Authority (TDA) in its business case checklist.

2. Background

2.1. The current energy infrastructures at both sites are 40 to 50 years old and the boilers and thermal distribution systems at Churchill Hospital are over 70 years old. The plant is time expired, inefficient and presents a high risk of failure resulting in interruptions to patient services at both sites.

2.2. The main aspects of the business case are:

2.2.1. A guaranteed reduction in annual energy costs of around £2,200,000. After the annual unitary payment of just under £1,800,000 this results in a net guaranteed annual saving of over £400,000.

2.2.2. An anticipated reduction in the annual carbon footprint of the Trust from 30,000 tonnes to 19,000 tonnes. The CO₂ levy saving on 11,000 tonnes at today's price is around £165,000. It is expected that the levy will rise to £30 per tonne by 2020; if so, then the annual saving will increase to £330,000.

2.2.3. An initial capital investment of around £18,400,000 externally funded at no additional cost to the Trust. If the Trust had to fund the initial capital expenditure itself, the initial interest charge would be over £1,000,000 at a rate of 5.64%, which is the cost of finance that the Trust is currently being charged on capital.

2.2.4. A reduction in backlog maintenance of £11,000,000, which addresses the replacement of equipment which is key to providing an environment for the patient that is safe, fit for purpose and strategically aligned.

2.2.5. A transfer of risk to the external provider estimated to be around £2,800,000.

2.3. This business case:

2.3.1. is consistent with the Trust's clinical strategy and supports the provision of high quality care

2.3.2. contributes to improved quality and safety of services provided to patients

2.3.3. enhances the delivery of patient care and performance standards

2.3.4. assists the health economy in managing present and future issues

2.3.5. demonstrates that the Trust has the resources and capacity to deliver the investment programme within a realistic timeframe
3. The Strategic Case

Organisational Overview

3.1. The Trust provides general hospital services to the people of Oxfordshire and the neighbouring counties of Buckinghamshire, Berkshire, Wiltshire, Northamptonshire and Warwickshire as well as specialist services on a regional and national basis.

3.2. The Trust provides services in more than 90 clinical specialties, which are grouped into seven clinical divisions.

3.3. The Trust currently has limited capital funds and those which become available are likely to continue to be needed to ensure the clinical site development plan, medical equipment, health informatics and backlog maintenance programmes can be funded.

Relevant Trust Strategies

3.4. The mission of the Trust is:

3.4.1. “The improvement of health and the alleviation of suffering and sickness for the people we serve. We will achieve this through providing high quality, cost-effective and integrated healthcare.”

3.5. The Trust’s strategic objectives are to deliver:

3.5.1. Compassionate excellence – the kind of healthcare we would all expect for ourselves and our families

3.5.2. A well-governed and adaptable organisation

3.5.3. Better value health care

3.5.4. Integrated local healthcare

3.5.5. Excellent secondary and specialist care through sustainable clinical networks

3.5.6. The benefits of research and innovation to patients

3.6. The Trust is currently applying to become a Foundation Trust.

3.7. The Trust delivered a £3.6m surplus against its breakeven duty in the financial year 2012/13. In order to meet the financial challenges the Trust expects to need to save at least £45m this year. This is 5.5% of planned turnover.

Aim of the Project

3.8. The aim of this project is to meet the strategic objective (S03) of the Trust to meet the challenges of the current economic climate and changes in the NHS by providing efficient and cost-effective services and better value healthcare – “delivering better value healthcare” by:

3.8.1. Reducing gross energy consumption by around £2,200,000 a year

3.8.2. A reduction in carbon emissions of around 33%

3.8.3. Rationalisation of plant

3.8.4. Improved utilisation of resources
3.9. In particular the scheme will address the following key detailed objectives of the Trust:

3.9.1. Increase productivity and delivery of CIPs year on year in line with the agreed financial strategy and within the agreed performance framework/compacts (3.1) including the Delivery of Cost Services Improvement Programme

3.9.2. Improve utilisation of Trust’s estate (3.4)

3.10. Other strategic objectives that this scheme contributes to include

3.10.1. "patient-centred organisation" (S03): Improves control of heating, cooling and general environmental conditions.

3.10.2. To meet the challenges of the current economic climate" (S05): Reduces energy costs and carbon taxes

3.10.3. "Deliver continued and measurable improvements in patient safety, patient experience" (S05b): Reduces estate-related risk; improves control of heating, cooling and general environmental conditions.

3.10.4. Increase productivity and delivery of CIPs year on year in line within the agreed financial strategy" (S05b): Substantial reduction in energy costs and carbon

3.10.5. "Develop supporting strategies (to include capital plan and estates utilisation strategy, workforce and IT)" (S05e): Improves estate performance and liberates cash from estates budget (energy and carbon budgets).

**NHS Carbon Reduction Strategy for England**

3.11. The NHS Carbon Reduction Strategy for England was published in January 2009 and set a mandatory framework for NHS organisations to embed sustainability into their culture and activities, contributing to overall carbon emission reduction targets. The Strategy followed the introduction of UK Climate Change Act 2008 which set out statutory emission cuts. The Carbon Reduction Strategy sets an initial target for NHS organisations to reduce emissions by 10% by 2015, in the context of the overall NHS carbon footprint arising from buildings (20%), transport (18%) and procurement (60%).

3.12. The current Trust emissions are 30,458 tonnes CO₂ which are expected to reduce to 19,396 tonnes CO₂ on completion of the scheme. This is a reduction of 38% which exceeds the Government’s targets.

**The Estate**

3.13. OUH provides health care services primarily from four sites:

3.13.1. The Churchill Hospital in Headington, Oxford

3.13.2. The John Radcliffe Hospital in Headington, Oxford

3.13.3. The Nuffield Orthopaedic Centre in Headington, Oxford;

3.13.4. The Horton General Hospital in Banbury.

3.14. In total, the estate covers approximately 391,420m² of internal floor area over 73.8 hectares of land.
3.15. On this land the Trust operates and manages 220,720m² of retained estate; the remainder of the properties have been funded by Private Finance Initiatives (PFI), 29% of the estate, or tenanted by the University or other third party occupiers under various tenant agreements.

3.16. 55% of the John Radcliffe Hospital, OUH's largest site, was constructed in the 1970s. However there has been significant development since 2005 including the West Wing and Children's Hospital, both of which were financed by PFI, as well as the £29 million Oxford Heart Centre which opened in 2009 and was jointly funded by the NHS and the University of Oxford.

3.17. Similarly, 40% of buildings at the Churchill Hospital site have been built since 2005 including a PFI build incorporating the Oxford Cancer Centre which opened in 2009.

3.18. Over 60% of the Horton General Hospital site was built prior to 1984.

3.19. At June 2011 the backlog maintenance costs were identified as being:

<table>
<thead>
<tr>
<th>High Risk</th>
<th>Significant Risk</th>
<th>Moderate</th>
<th>Low</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>£570,000</td>
<td>£2,538,000</td>
<td>£19,600,000</td>
<td>£16,709,000</td>
<td>£39,417,000</td>
</tr>
</tbody>
</table>

**Estate Strategy and Objectives**

3.20. The Trust’s Estate Strategy is to:

3.20.1. Provide a clear positive statement to public and staff on the Trust’s plans to maintain and improve facilities in support of clinical services.

3.20.2. Ensure that the Estate is aligned to the Trust’s clinical service and business objectives and supports the achievements of the Trust’s IBP.

3.20.3. Align the capital investment programme with the Trust’s Clinical Service Strategies and allow future business cases for capital to be measured in a strategic context.

3.20.4. Enable the estate to operate flexibly, economically and efficiently, providing and maintaining appropriate and affordable healthcare facilities which are fit for purpose, provide value for money, is compliant with statutory requirements and supports the provision of high quality clinical care.

3.20.5. Support the overall alignment of the Trust’s strategies (IT, workforce, financial, performance) and be consistent with operating as a Foundation Trust in the future with the assurance that asset management costs are appropriate and future action is taken to address those which fall outside targets.

3.20.6. Keep under review service costs, risk management, support for sustainable development, environmental targets and legislative requirements.

3.20.7. Give assurance to staff that they will have appropriate working environment/s and transition to any new facilities will be managed well with minimal disruption to their working lives and services.
3.21. These aims will be achieved through:

3.21.1. Provision of inpatient accommodation and outpatient facilities that support patients' needs and in which staff feel proud to work

3.21.2. An improvement in the condition and performance of the estate, as reported to the Department of Health annually

3.21.3. Co-location of appropriate services to achieve greater flexibility, efficiencies in occupancy costs and to realise benefits for patients and staff

3.21.4. Supporting service re-configurations in partnership with clinical staff, stakeholders, other health and social care providers and universities with commissioner support

3.21.5. Partnership arrangements or disposal of property and land that is surplus to future clinical, service and business needs

3.22. Underpinning the Strategy is the need to optimise the use of space, supporting the development of modern working practices to enable staff to maximise their performance and productivity. This supports the Trust's vision for sustainable development, placing emphasis on the health and wellbeing of both staff and service users.

**Current Power Provision and Limitations**

3.23. In 2011 the Trust engaged Halcrow Yolles a leading building services consultancy to carry out a review of its energy infrastructure within the retained hospital estate.

3.24. The aim of the brief was to set out a strategy for the refurbishment of the energy systems which would achieve reductions in carbon emissions and energy running costs whilst ensuring resilience against variation in future fuel costs and minimise the risk of system downtime.

3.25. The main findings of the report were as follows:

**John Radcliffe Hospital**

3.26. Heating and hot water services at the John Radcliffe site are provided from a centralised boiler house located within the Industrial Block Area. The boiler house contains four 5860 kW dual fuel boilers generating high pressure hot water (HPHW) which is pumped to outlying plant rooms around the site. At the plant rooms primary low temperature hot water (LTHW) is then used to provide space heating and hot water. The boilers normally fire on natural gas with diesel as the reserve fuel in case of interruption to the gas supply.

3.27. In addition to generating space heating and hot water the HPHW system is used to generate chilled water via absorption chillers located in the basement. The chilled water is used in air handling units to maintain temperature control in key areas such as theatres. This method of generating chilled water is only cost effective when using unutilised heat generated by a combined heat power (CHP) plant and therefore the chilled water system installed at John Radcliffe is not cost effective.

3.28. The boiler plant is over 40 years old and in regular need of remedial welding work to satisfy insurance inspections. There is also a problem with the burner
control systems on the individual boilers which, because of the old design of the linkage systems, rarely remain at acceptable firing efficiencies.

3.29. Because of the age of the boilers spare parts are no longer readily available and bespoke replacement parts have to be manufactured at considerable expense and time. Boiler no 3 has been out of action recently for this reason.

3.30. There is only a crude boiler sequencing control system which is ineffective. In practice the automatic sequencing of boilers is unreliable and relies on estates staff manually switching on and off boilers as the site heat demand changes.

3.31. New central steam boilers were installed at the end of 1999 to replace local steam generators feeding sterilisers around the site. Each of the two boilers has installed capacity of 3750 kW compared to an estimated point of use demand of only 185 kW. Both boilers are kept live for reasons of security of supply, so are only running on tick-over and are estimated to be operating at a seasonal efficiency of less than 25%. The reason behind the massive oversizing was reported to be to allow for steam to displace the HPHW boilers over time; however, this project was never implemented.

3.32. The main HPHW distribution system is now suffering from frequent leaks, which necessitates shutting down the system or at least sections of it. However the subsequent contraction and expansion this causes to the system results in subsequent failures elsewhere in the system and the operation of long untouched isolation valves is a further source of leakages. Expansion bellows, flange and bend welds, and corroded pipe guides have also been recent sources of failures.

3.33. Site service controls are rudimentary and though some modification have been made since the original installation they are generally not matching supply to demand, neither in terms of time nor temperature. There have been upgrades to the original pneumatic control system with a Johnson Metasys electro-pneumatic system linked to a central PC via dedicated cabling, but maintenance is costly.

3.34. Earlier this year there was a major failure of the controls installation serving the operating theatre ventilation systems, which had to be replaced at a cost of £40,000.

3.35. Domestic hot water is generated via storage calorifiers or vertical shell and tube heat exchangers. The control of these is driven more by minimising the risk of Legionella rather than final demand for domestic hot water. The inspection and maintenance of these domestic hot water generators account for significant labour and financial commitments.

Summary -- John Radcliffe

3.36. In summary, the existing and time expired infrastructure presents a risk to patient safety in its present condition.

3.37. The majority of the heating and hot water services is 40 years old and is now significantly older than the recommended maximum economic life for these types of systems. The result of this is that equipment and pipework mains are failing. Spares for obsolete parts need to be manufactured. Where possible, equipment is patched up to prolong its life. Pipework leaks are frequent.
occurrences, and the required cooling down of the MTHW system to allow work to take place by itself causes further leaks and joint failures.

3.38. The existing equipment is inefficient with inadequate controls which further reduce its efficiency. Site distribution mains also represent significant loss of energy due to inadequate insulation. Upgrading the systems is an opportunity to improve both heating and hot water, and at the same time reduce significantly energy consumption.

3.39. The estate will continue to deteriorate, increasing risks to patient safety, impacting business continuity, reducing comfort levels of patients and staff and costing substantially more than is necessary.

3.40. The Trust would also need to use funds from its limited capital programme to maintain services.

Churchill Hospital

3.41. The Churchill Hospital site was originally established in 1942 and has continued to be developed. A large part of the site is served by a modern PFI unit which has new energy generation plant (boilers) and associated infrastructure.

3.42. Hot water, space heating and steam for sterile services for the remainder of the estate is generated from a centralised boiler house, which forms part of the original 1940s construction. The boiler house contains three steam boilers which were installed in the 1960s. All three boilers use heavy fuel oil as the primary fuel. There is currently no gas supply to the boiler house which allows the plant to be converted to cleaner, lower cost natural gas firing.

3.43. Steam is distributed to outlying plant rooms where it used to generate heating and domestic hot water in local circuits. Steam is also piped directly to the sterile services department.

3.44. Within the boiler house steam is also used to generate low temperature hot water (LTHW) which is then distributed to plant rooms and used for heating and domestic hot water.

3.45. Both the steam and LTHW distribution systems were installed in the 1940s and much of it is buried and not accessible for repairs.

3.46. Whilst the boilers and associated ancillary boiler plant is functional at Churchill Hospital, the system has been prone to failures and is operationally intensive. Burning of HFO in the boilers further increases energy costs (compared to gas) and results increased carbon emissions. In July 2014 one of the steam boilers failed its insurance inspection and currently there is a hire boiler connected to the system to maintain supply resilience.

3.47. An ongoing issue is boilers 2 and 3 regularly dump heavy oil in their combustion chambers.

Controls

3.48. Across the two hospital sites the Trust operates five different BMS systems. These have been unreliable and. Ideally these should be integrated into one system.
Energy Consumption

3.49. The gas consumption and electricity usage for 2011/12 was as follows:

<table>
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<th>JRH</th>
<th>CH</th>
<th>Total energy costs</th>
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<tr>
<td>Gas consumption</td>
<td>£907,132.38</td>
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<td>£1,072,745.05</td>
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<td>Oil</td>
<td></td>
<td>£687,352.70</td>
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<tr>
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<td>CRC Churchill</td>
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<td>£3,373,184.59</td>
<td>£1,701,340.86</td>
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</table>

3.50. The Trust normally pays VAT at 20% which is not reclaimable. The Trust pays the National Climate Change Levy rates of 0.485p per kWh of electric and 0.169p per kWh of gas. The levy is applied before VAT is calculated; therefore the actual financial effect is greater.

3.51. Annual electricity consumption has increased by 24% between 2000 and 2010. This is a consequence of the addition of the new Trauma building, Heart centre and AVIC building and also the on-going introduction of new medical and office equipment throughout the site, together with the installation of numerous local air conditioning units as part of localised building refurbishment programmes. There is no sign of this trend abating in the foreseeable future.

3.52. Annual gas consumption has increased by 12% between 2000 and 2010. There was a significant jump in 2000 which coincided with the installation of the new steam boilers, which have a capacity much greater than the site demand. Variation in weather conditions can also have an impact, but weighting of the data by "degree days" makes little difference to the overall trends.

3.53. The above conclusion that gas consumption is reasonably well matched to external weather conditions is surprising bearing in mind the state of the controls installation and the existence of absorption chillers. This is partly due to the Energy Manager and site staff who make on-going manual adjustments where automatic facilities do not exist.

3.54. In conclusion, annual electricity and gas consumption has increased by 24% and 12% respectively over the last decade. Energy costs continue to rise above the rate of inflation with the price of electricity increasing by 150% and gas by 200% over the same period. The total energy demand for the site equates to 81 GJ/100 m³ compared to a maximum NHS benchmark target of 65 GJ/100 m³, with electricity usage being more profligate than that of fossil fuel. CRC charges are now being levied to the sum of £12/tonne CO₂ per year, and are likely to increase substantially in the near future.
Key Issues

3.55. Much of the original HVAC plant is now coming to the end of its working life after 40 years and is in desperate need of replacement to avoid the risks of major breakdown. System failures are becoming an increasingly common occurrence.

3.56. Recent examples include the BMS controls to the theatre air handling units and leakages in the HPHW mains. These are both costly to repair and pose a risk to the delivery of primary care services. The opportunity needs to be taken to make significant running cost savings by upgrading to new more efficient plant.

3.57. Existing controls are also inadequate and their upgrade will both improve comfort conditions and reduce energy by better matching supply to demand.

3.58. The building fabric insulation standards of forty year old buildings are inevitably greatly inferior to that required under current Building Regulations or would be considered as good practice today. Opportunities should be taken whenever refurbishment of the building envelope is considered to improve its thermal performance. Recovering roofs is one obvious example. Windows are another. If rather than repairing the existing wooden single glazed windows, there was a programme to replace them with high performance double glazed units this would not only achieve substantial reduction in heat loss, but would improve comfort conditions for patients whose sensitivity will be all the greater because of their state of health and their clothing level. There are further benefits of improved sound reduction and the possibility of incorporating encapsulated blinds to reduce glare and summer heat gains without the normal hygiene/maintenance costs of exposed blinds.

3.59. The boilers have reached the end of their economic life and need to be replaced.

3.60. The main HPHW distribution pipework will need to be replaced in a phased programme to ensure that heating, cooling and hot water services are not compromised. The prior removal of the central steam system should be of significant benefit in that it will free up space for new HPHW pipework to be installed in parallel with the existing before final switchover of connections at the energy centre and building plant rooms.

Energy and Emission Targets

3.61. The NHS has introduced the following mandatory targets for NHS bodies in England:

3.61.1. Reduce the level of primary energy consumption by 15% or 0.15 Mtc (million tonnes of carbon) from March 2000 to March 2010.

3.61.2. Achieve a target of 35-55GJ/100 m² energy efficiency performance for healthcare estate for all capital developments and major redevelopments or refurbishments and all existing facilities should achieve a target of 55 – 65 GJ/100 m².

3.62. CRC charges are now being levied to the sum of £15/tonne CO₂ per year. This unit carbon cost is likely to increase substantially in the near future. The intended revenue recycling part of the original CRC proposals have subsequently been removed from the scheme so the CRC charge is effectively an energy tax increasing the cost of electricity by 9.5% and gas by 9.6%.
3.63. Energy costs continue to rise above the rate of inflation with the price of electricity increasing by 150% and gas by 200% since 2000.

3.64. The former DETR published good practice benchmarks for fossil fuel and electricity consumption for various building sectors. The energy consumption figures for 2010 are compared with the benchmark figures for acute and maternity hospitals.

<table>
<thead>
<tr>
<th>Utility</th>
<th>Consumption (GJ/100m3)</th>
<th>Benchmark (GJ/100m3)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fossil fuels</td>
<td>51.5</td>
<td>Low 56</td>
</tr>
<tr>
<td>Electricity</td>
<td>29.8</td>
<td>High 68</td>
</tr>
<tr>
<td>Total</td>
<td>81.3</td>
<td></td>
</tr>
</tbody>
</table>

3.65. Fossil fuel consumption compares favourably with good practice targets. This is somewhat surprising considering the condition of the central plant and control system, and that gas is also used for cooling. However a significant proportion of the site is used for academic and research purposes and as such has significantly reduced occupancy hours and consequently reduced energy demands.

3.66. Conversely electricity consumption is nearly three times best practice yardstick. The benchmark figures are derived from historic studies on buildings, so it is likely that the electricity figure does not make allowance for the recent growth in electrical and electronic equipment that are allied to advances in medical practices. However at the most this might account for say a 20% rise in electricity demand, not 200% as is being experienced.

3.67. In April 2001 the Minister of State for Health set mandatory targets for NHS bodies in England requiring existing facilities to achieve a target of 55 – 85 GJ/100m³.

3.68. Consequently the John Radcliffe site needs to create an annual saving of 16 GJ/100m³ or 20% in total energy consumption to meet these efficiency targets.

3.69. The benchmark comparison suggests that the site is far more profligate with electricity than it is with gas, so as much attention needs to be given to demand side management of electricity as to improving the efficiency of thermal generation.

Drivers for Change, Scope and Risks

3.70. A summary of the above issues indicate that the main drivers for change are:

3.70.1. A need to meet carbon emission targets
3.70.2. The need to replace out of date plant and equipment
3.70.3. The risk of major failure endangering patient services
3.70.4. The opportunity to reduce ongoing revenue costs
3.70.5. Taking advantage of external funding
3.70.6. The ability to transfer risk to the private sector
3.71. A summary of the scope and service requirements are as follows:

3.71.1. Installation of CHP combined heat and power plant
3.71.2. Replace obsolete boiler plant and associated equipment
3.71.3. Address issues with HPHW (High Pressure Hot Water) distribution pipework
3.71.4. Reduce operating costs
3.71.5. Improved resilience and business continuity

3.72. The anticipated investment objectives of this project are

3.72.1. A reduction in the Trust’s carbon footprint.
3.72.2. A reduction in the Trust’s energy and site running costs.
3.72.3. Improvements in the Trust’s energy infrastructure.
3.72.4. Recognition as an exemplar for energy efficiency and carbon reduction.
3.72.5. Support of the continued delivery of the clinical services.
3.72.6. Resilience of to the existing time expired infrastructure.
3.72.7. Management of the risk of introducing leading edge technologies by entering into a design, build and operate contract with an industry expert.

3.73. The main strategic risks of not replacing the outdated facilities are:

3.73.1. Not having a mechanical and electrical infrastructure to support the Trust’s future clinical strategy
3.73.2. Catastrophic failure resulting in potential harm to the patient and the reputation of the Trust
3.73.3. Hampering the foundation trust application

3.74. A Quality Impact Assessment (QIA) will be undertaken as required for all cost improvement schemes in the Trust.

3.75. The Senior Responsible Officer (SRO) for this business case is Mark Trumper, Director of Development and the Estate.

3.76. The SRO will be responsible for undertaking a Health Risk Potential Assessment (RPA) against a set of high-level criteria for assessing the risk potential of this project.

3.77. The RPA will be sent to the Health Gateway Team, which will arrange a meeting to assess whether Gateway applies.

3.78. Commissioner involvement or approval is not required for this business case as it does not involve service specific activity which affects patients.
4. **The Economic Case**

**Objectives, Constraints and Benefits**

4.1. The anticipated benefits of this project are:

4.1.1. A reduction in the Trust’s energy and site running costs of £2,224,016.

4.1.2. A reduction in the Trust’s carbon footprint from 30,458 tonnes CO₂ to 19,396 tonnes CO₂ saving 11,000 tonnes CO₂.

4.1.3. Renewal of aged boiler plant within the energy centres at both the John Radcliffe and Churchill hospitals.

4.1.4. Innovative energy link between both hospitals that allows for load balancing of thermal and electrical supplies.

4.1.5. Recognition as an exemplar by the Carbon Trust and the SDU for energy efficiency and carbon reduction and meeting specified 10% reduction in CO₂ by 2015.

4.1.6. Support of the continued delivery of clinical services by reducing failures in the HP/WH pipework distribution system which directly impacts on main theatre heating and cooling.

4.1.7. Resilience of to the existing time expired infrastructure by providing additional electrical supply capacity in periods of prolonged grid outage.

4.1.8. Management of the risk of introducing leading edge technologies by entering into a design, build and operate contract with an industry expert.

4.1.9. Reduction in the costs and risks by using the CEF’s advisers and a standard suite of contracts.

4.2. The main constraints and dependencies of this project are:

4.2.1. Approval by TDA.

4.2.2. Availability of Trust technical and project management resource.

4.2.3. Trust Board approval

4.2.4. Operational estates champion.

4.2.5. Appreciation of critical state of existing infrastructure.

4.2.6. Agreement of contract terms

4.2.7. Independent review of contract and payment mechanism

4.2.8. Financial and other resource changes that may take place during the project

4.2.9. The skill of managerial staff to manage and motivate personnel in a period of great uncertainty and impending change
4.3. Taking the above factors into account, the Estates professionals determined the following key weighted benefit criteria:

<table>
<thead>
<tr>
<th>Criteria</th>
<th>Weighting</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Improved energy efficiency</td>
<td>30</td>
</tr>
<tr>
<td>2. Reduce carbon footprint</td>
<td>10</td>
</tr>
<tr>
<td>3. Improved infrastructure resilience</td>
<td>25</td>
</tr>
<tr>
<td>4. Strengthen technical expertise</td>
<td>5</td>
</tr>
<tr>
<td>5. Modernise critical engineering systems</td>
<td>10</td>
</tr>
<tr>
<td>6. Reduce risk to critical clinical services</td>
<td>20</td>
</tr>
<tr>
<td></td>
<td>100</td>
</tr>
</tbody>
</table>

4.4. The critical success factors (CSFs) for this project are:

4.4.1. Suitably qualified and experienced staff in place, with appropriate skills
4.4.2. Trust infrastructure is in place for the savings to be achieved
4.4.3. Stability within the operational estates workforce to assist with the ongoing interface between the Trust and the contractor.
4.4.4. Senior management support and board champion
4.4.5. Trust Board and TDA approvals
4.4.6. Planning approvals
4.4.7. Obtaining a place in the production line for the generator engine
4.4.8. Minimisation of disruption to patient services
4.4.9. Continued involvement of CEF as an independent audit for the monitoring and validation and contract performance monitoring in liaison with the Trust

Option Development Process

4.5. Although the option appraisal process was iterative, the work was undertaken in three main phases:
4.5.1. The Halcrow Yolles report referred to in section 3.25
4.5.2. The Jacobs Report – see below
4.5.3. This business case

The Jacobs Report

4.6. With increasing gas and electricity costs, increasing government targets to reduce carbon emissions and the mandatory targets placed on the NHS to achieve a target of 55-65GJ/100m3 energy efficiency performance for existing
healthcare premises (Department of Health, 2006) it was decided to look at the feasibility of a project that would identify potential energy savings and carbon reduction for Oxford University Hospitals NHS Trust whilst also maintaining the required healthcare standards detailed within the Health Technical Memorandums (HTM).

4.7. In September 2012 Jacobs, acting as Technical advisors for the CEF, attended the John Radcliffe Hospital and Churchill Hospital sites to carry out an initial high level review on the potential for energy saving projects.

4.8. The report summarised the technical feasibility studies undertaken to establish the potential viability of energy saving projects at John Radcliffe Hospital and Churchill Hospital.

4.9. The report was based upon high level feasibility stage assessment of the hospital primary fixed asset infrastructure and services undertaken during September 2012 and summarises the following for each site:

4.9.1. Basis of existing heating energy and power demand

4.9.2. CHP/new boiler integration into existing heat distribution

4.9.3. Basis of the potential new boiler/CHP operational profile and plant size

4.9.4. Consideration of other potential energy saving projects

4.9.5. Basis of the capital expenditure costs

4.10. The details of plant size and capital costs were considered as a preliminary as they were based upon pre-design stage estimates and subject to development of the feasibility into a working design solution by a specialist energy services company (ESCO), who would be responsible for technical and commercial viability.

4.11. The energy consumption analysis was based upon information provided by the Trust that detailed its existing energy use and utility costs. These were used to form the baseline for energy saving comparisons.

John Radcliffe Hospital

4.12. At the John Radcliffe the study identified that potential energy savings could come from investment in CHP. The report concluded that there was a good level of year round base heat demand that could be delivered from a CHP of circa 2.0 MWe capacity. This could also potentially provide the Trust with significant energy cost savings as well as significant carbon savings.

4.13. Further energy savings were identified that could be delivered through other schemes associated with lighting upgrades, pump and fan motor drive variable speed operation, heating control optimisation and replacement of the existing building engineering management system (BEMS). These improvements were estimated to improve on energy saving.

4.14. A core project comprising of a 2.0 MWe gas fuelled reciprocating CHP, replacement of life expired boilers, conversion of existing heat distribution from HPHW to MPHW / LPHW and lighting up-grade installations was established, estimated to deliver, based on a capital investment of £3million:

4.14.1. c5,000 tonnes of CO₂ annual savings, with annual carbon savings estimates based on first year operation. Subsequent year’s carbon
savings over the life of the scheme to vary depending upon prevailing carbon intensity of National Grid displaced electricity and fuel used to generate savings from CHP or boilers

4.14.2. c£700,000 annual energy savings

4.15. An enhanced core project was also suggested that might also include a 1 MW biomass fuelled boiler, retro-fitting heating, ventilation and air conditioning (HVAC) fan and pump motor variable speed drives, local improvements to existing low temperature hot water (LTHW) controls, upgrades to existing BEMS system and retro-fit of 50 kWp photovoltaic (PV) array. This enhanced core scheme was estimated to deliver, based on a total capital investment of circa £4.3million:

4.15.1. c£6,500 Tonnes CO₂ annual savings, with annual carbon savings estimates based on first year operation. Subsequent year’s carbon savings over the life of the scheme to vary depending upon prevailing carbon intensity of National Grid displaced electricity and fuel used to generate savings from CHP or boilers

4.15.2. c£900,000 annual energy savings, based on initial base year energy costs.

Churchill Hospital

4.16. At the Churchill Hospital the feasibility study was based upon replacement of the life expired centralised boiler plant serving steam and LTHW infrastructure. The existing base heat loads did not appear to be significant enough to support CHP. The feasibility report suggested that improvement could be delivered from new replacement combustion plant with high efficiency and decentralisation of outlying buildings from the existing central steam service. The reduction in heating cost due to changing fuel supply from oil to gas would also benefit the scheme.

4.17. It was identified that centralised steam could be removed if the outlying heating plant was provided with new localised packaged gas fired plant and localised process steam where needed. Core areas currently served by the existing steam would be converted to LTHW distribution.

4.18. A core project comprising of the replacement of the life expired centralised oil fired steam boilers with a new part decentralised boiler installation operating on natural gas, delivering LTHW with steam utilised for localised process use only was established. The report identified that the estimated base heat demand for Churchill Hospital may not support a CHP, however other enhancements could be provided such as retrofitting HVAC fan and pump motor variable speed drives, local improvements to existing LTHW controls, upgrades to existing BEMS system and retro-fit of 50 kWp photovoltaic (PV) array. Based on a total capital investment of c£3.7million, this scheme was estimated to deliver:

4.18.1. c 2,400 Tonnes CO₂ annual savings, with annual carbon savings estimates based on first year operation. Subsequent year’s carbon savings over the life of the scheme to vary depending upon prevailing carbon intensity of National Grid displaced electricity and fuel used to generate savings from CHP or boilers

4.18.2. c£550,000 annual savings, based upon initial base year energy costs.
Long List of Options

4.19. A wide range of improvement options were initially identified for consideration. These, and details of whether they were considered further, included:

4.19.1. Refurbishment – The existing time expired plant is reaching its life expiry and the structural components of the plant and infrastructure are becoming unserviceable. Whilst certain elements of the plant and equipment could be replaced/upgraded, this option would not provide resilience with the life expired plant and equipment currently in use. There would also be very little energy savings with this option. Additionally refurbishment of existing plant would not provide carbon reductions in line with the Trust’s carbon management plan.

4.19.2. Biomass – Biomass was considered in detail for each site (JRH and CHH), however the option was discounted based on, uncertainty of fuel supply security and fuel cost risk to supplier, access for fuel deliveries and an increase in traffic movement, insufficient storage space for biomass fuel and low payback compared to CHP options

4.19.3. Solar energy – Considered but potential that many of the roof areas are not suitable due to structure and potential over shadowing.

4.19.4. Wind power: self-generated - the electricity capacity of a wind turbine would need to be significant in order to achieve sufficient costs savings and carbon reductions for this project. Given the required size of the unit it is would be impracticable to locate and wind turbines in the locale and wind turbines would not address the thermal infrastructure problems at both sites. Obtaining planning consent is also a major risk. In addition, the John Radcliffe Hospital houses a major trauma unit and is the main attendance site in the area for injuries requiring the specialist medical services this unit provides. The hospital also has a state of the art Heart Centre that is also serving a wide community with the specialist care provided within. In many cases patient that require this care need to access the hospital as quickly as possible and this is very often through the services of the air ambulance. With many frequent low flying helicopter visits to the site, wind power may not be a feasible option and further studies will be required to identify whether there is a suitable position on the site that would not affect the flight services.

4.19.5. Wind power – off site generation: not practicable given the inland location of the site.

4.19.6. Hydro power: not practicable, as no water resources available. Also, the option doesn’t address the thermal infrastructure problems at the sites.

4.19.7. Connection to a district/community heating scheme: no schemes exist in the locale which would make it practicable or cost effect for connection

4.19.8. Decentralisation – considered for the Churchill Site

4.19.9. Central plant – Considered for the John Radcliffe site

4.19.10. CHP – Considered for the John Radcliffe site

4.19.11. Heat exchangers – Considered

4.19.12. Controls, metering & monitoring – Considered
4.19.13. Standby Generation - John Radcliffe Hospital: The current standby generation system at site meets HTM requirements. The Trust did consider an option to upgrade the standby generation system to provide additional back-up supplies to the site. However, the capital costs were prohibitive.

4.19.14. Standby Generation Churchill Hospital: The Trust has already made significant in the standby generation system and the system provides suitable back up electricity for the site.

4.19.15. Uninterruptable power supplies (UPS) provision -- The size and space required to deliver this type of resilience for this project would not be cost effective, this type of provision is much better suited to localise critical areas when they are refurbished.

**Short List of Options**

4.20. The feasibility study prepared by Jacobs concluded that a combined heat and power plant, high efficiency lighting and other demand side measures were likely to yield both carbon and revenue savings.

4.21. The three options that were taken forward for further consideration were:

4.21.1. Option 1 - Do nothing/minimum Incremental spend year-on-year. This has resulted in long-term dilapidation of the estate. Hence the estate is far more expensive to operate than necessary. In an environment where capital is limited, Estates capital spending priorities have to compete with clinical requirements, including the significant amount of clinical equipment that requires replacing.

4.21.2. Option 2 -- Traditional procurement using internal expertise, OJEU procurement route and Trust capital funding. This would involve delaying significant investment until foundation trust status achieved and borrowing £14m funding. There is a risk of major plant failure before this funding is in place. Income could be used from sale of land assets to fund, but this would mean competing with other financial pressures with Trust or approaching the Trust Development Agency for financial support for initiative. Funding may not be released in near future, resulting in continued dilapidation of the estate.

4.21.3. Option 3 - Proposed investment using external funding. This option would involve the Trust using the skills and experience of the Carbon and Energy Fund to expedite the project.

**Initial Option Appraisal: Do Nothing / Traditional Procurement**

4.22. The business case process involves demonstrating the implications of doing nothing.

4.23. Set out below are the basic discounted cash flow (DCFs) which compare the outcomes of doing nothing (or the minimum required to maintain basic services and modernising the electrical infrastructure to secure the investment objectives and to realise the benefits listed above).
4.24. The main assumptions underlying the analysis are as follows:

4.24.1. 30 year period, based on useful life of the assets
4.24.2. 3.5% discount rate
4.24.3. Net of VAT

4.25. Do Nothing: Capital spend of

4.25.1. Year 1 £500,000
4.25.2. Year 3 £1,000,000
4.25.3. Year 5 £1,000,000
4.25.4. Year 8 £1,000,000
4.25.5. Annual revenue spend of £5,298,250

4.26. Trust funded – based on Jacobs report – see above. Capital spend of:

4.26.1. Year 1 £6,700,000
4.26.2. Year 3 £1,000,000
4.26.3. Year 17 £3,000,000
4.26.4. Annual revenue spend of £4,594,427

4.27. The resulting 30 year discounted cash flow (DCF) analysis of net present cost (NPC) is as follows:

4.27.1. Do nothing £103,947,196
4.27.2. Trust investment (Jacobs) £96,760,002

4.28. The qualitative assessment of the professional team at that point was that the trust investment option would also reduce risk and provide more benefits.

4.29. The conclusion was that from a risk, benefit and economic analysis doing nothing was not an option and a major investment in electrical infrastructure was the preferred way forward.

 Benefit Appraisal

4.30. The preferred option would provide all the benefits listed above.

4.31. The appraisal team considered that most of the benefits were quantified through the anticipated savings in energy costs, reduced maintenance costs and a reduction in the carbon levy.

4.32. However, two examples of possible broader economic benefits were identified:

4.32.1. Main theatres availability: The main theatres occasionally have to be closed due to power problems. At an estimated cost of £1,000 per hour, 4 times a year, 4 hours per list, for 8 theatres over the 30 year contract period this has a value of nearly £4,000,000

4.32.2. Additional inpatient bed days. The closure of the theatres result in additional bed days as patients have to stay an additional night. At an estimated cost of £225 per bed day, an average of 3 patients per list, 4 times a year, for 8 theatres over the 30 years of the contract, this could have an economic value of £650,000
Appraisal of the Preferred Option

4.33. Following a procurement exercise, Vital Energi (VE) was selected as the preferred bidder – the Commercial Case explains the process and details of their proposal.

4.34. As part of that process, it became clear that the original trust funded option at the OBC equivalent stage was too narrow in scope and that a more innovative solution would result in a more resilient facility and higher annual savings.

4.35. The main change was that an energy link between the two hospital sites would:

4.35.1. Maximise financial savings
4.35.2. Maximise carbon savings
4.35.3. Provide an optimum engineering solution for infrastructure resilience
4.35.4. Provide the potential for commercial opportunities in providing energy to 3rd parties

4.36. Based on the main engineering elements of the scheme, the main economic assumptions underlying the OBC analysis are as follows:

General
4.36.1. 30 year period, based on useful life of the assets
4.36.2. 3.5% discount rate
4.36.3. Net of VAT

PSC
4.36.4. Capital spend Year 1 £18,394,660
4.36.5. Capital spend Year 17 £3,000,000
4.36.6. Annual revenue spend of £4,039,248

Preferred Option – VE
4.36.7. Capital spend: nil
4.36.8. Annual revenue spend - Years 1 to 25 £4,444,117
4.36.9. Annual revenue spend - Years 26 to 30 £3,398,597

4.37. The resulting 30 year DCF analysis of net present cost is as follows:

4.37.1. PSC £97,014,962
4.37.2. Preferred option – VE £82,529,765

Risk assessment

4.38. A comprehensive risk assessment was undertaken.

4.39. Using an industry specific risk register a Trust specific risk register was developed by Mervyn Phipps and Steve Lloyd of the Trust and Peter Fairclough of CEF.

4.40. This was used to both assess the high impact risks and the high value risks.

4.41. External environmental risks, which are common to both the PSC and the preferred options were not included for evaluation purposes. These include, for example, spark gap (see later) and inflation.
4.42. The appraisal involved:
   4.42.1. Identifying all the possible business and service risks associated with each option
   4.42.2. Assessing the impact and probability for each option
   4.42.3. Calculating a risk score
   4.42.4. Developing a management response
   4.42.5. Valuing the risk
   4.42.6. Agreeing responsibility for the risk for the VE option

4.43. The range of scales used to quantify risk for both impact and probability was as follows:
   4.43.1. Low 1
   4.43.2. High 5

4.44. The main areas of risk identified are:
   4.44.1. Financial and funding Risks
   4.44.2. Installation Risks
   4.44.3. Operational Risks
   4.44.4. Technical specific risks – John Radcliffe Hospital
   4.44.5. Technical specific risks – Churchill Hospital

4.45. The form of contract provides for a full transfer of risk from the Trust to the contractor. The risks include:
   4.45.1. All design and installation
   4.45.2. Generation of electricity
   4.45.3. Provision of heat and cooling to meet all hospital and third party needs
   4.45.4. All operation, maintenance, repair and life cycling of the plant
   4.45.5. Guarantee of financial and carbon savings

4.46. The valuation of the risk and its transfer are as follows:

<table>
<thead>
<tr>
<th></th>
<th>PSC</th>
<th>Preferred Option</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>£s</td>
<td>%</td>
</tr>
<tr>
<td>Trust</td>
<td>3,399,580</td>
<td>100%</td>
</tr>
<tr>
<td>VE</td>
<td>n/a</td>
<td>n/a</td>
</tr>
</tbody>
</table>
4.47. Sensitivity analysis: Savings

4.47.1. The objective of the initiative is delivered through its potential achievement of long term economic efficiencies. The proposed agreement between the Trust and the preferred bidder, limits the Trust’s financial exposure to the annual pre-defined Unitary Payment Obligation (UPO) of £1,800,000 and generates pre-determined annual target savings of £2,200,000. A short fall of these target savings will be underwritten by the preferred bidder.

4.47.2. The UPO is subject to annual indexation at a rate of 2.5% or the Retail Performance Index, whichever is the greater, for a period of 30 years. This pricing mechanism leads to savings sensitivity illustrated in the following table (based on Vita’s latest estimate of savings – which has yet to be verified):

<table>
<thead>
<tr>
<th>Year</th>
<th>Indexed UPO</th>
<th>Net Savings</th>
<th>Indexed UPO</th>
<th>Net Savings</th>
<th>Indexed UPO</th>
<th>Net Savings</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>£1,835</td>
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<td>£2,111</td>
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<td>£2,129</td>
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</table>

4.47.3. At a minimum indexation rate of 2.5% the benefit of the saving falls off by year 12 and for every 1% increase in this rate the gap narrows 25%. As at June 2014, the average RPI over the previous 5 years was 3.02%.

4.47.4. This sensitivity analysis assumes that utility pricing remains static.

4.48. Sensitivity analysis: Carbon Levy

4.48.1. Recently published quarterly energy prices by the Department of Energy and Climate Change suggest that the pricing of gas and electricity will continue to increase over time, resulting in increased savings under this CEF initiative.

4.48.2. Once operational, the projected reduction in CO2 emission is envisaged to reduce by 11,000 tonnes. This represents a 36% reduction on current levels. At today’s carbon price of £15 per tonne a baseline saving of £165,000 could be delivered.
4.48.3. In March 2011 the Government announced a floor price for carbon in the power sector effective from 1 April 2013 to establish a target price for carbon of £30 per tonne of CO₂ in 2020.

4.48.4. At this price the Trusts potential annual saving doubles to around £330,000.

4.48.5. It is widely accepted that the Carbon Price will rise further during the 2020s.

4.49. Sensitivity analysis: Generating margins (the “spark gap”)

4.49.1. Sensitivity analysis on the generating margins of the proposed scheme has been carried out against the variability (up to 35% deviation in either direction) in current gas and electricity prices and the fluctuations in UK electricity and gas prices over the last 10 years. This has demonstrated that the relationship in price changes of both the commodities has remained relatively constant.

4.49.2. The analysis suggests that the profitability of the scheme improves steadily with the co-related increase in gas and electricity prices, which is the most likely scenario, and that the risk of making a loss on generation would only occur in the unlikely event that both gas prices increase and also electricity prices drop steadily in tandem.

**Preferred Economic Option**

4.50. The result of investment appraisal is as follows

<table>
<thead>
<tr>
<th></th>
<th>Do Nothing</th>
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<th>Preferred Option (VE)</th>
</tr>
</thead>
<tbody>
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<td>Cash cost</td>
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<tr>
<td>NPC</td>
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<td>97,014,962</td>
<td>84,102,826</td>
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<td>Quantified</td>
<td>Included in</td>
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<td>0</td>
</tr>
<tr>
<td>Benefits</td>
<td>savings</td>
<td></td>
<td></td>
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<tr>
<td>Adjusted NPC</td>
<td>103,947,196</td>
<td>97,014,962</td>
<td>82,529,765</td>
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<tr>
<td>Risk</td>
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<td>627,400</td>
<td></td>
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<tr>
<td>Adjusted NPC</td>
<td>100,414,542</td>
<td>83,157,165</td>
<td></td>
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</tbody>
</table>

4.51. The conclusion is that in economic terms, the Vital Energi proposal is the best way forward.
5. The Commercial Case

*NHS Shared Business Services and Carbon & Energy Fund*

5.1. NHS Shared Business Services Ltd (NHS SBS) has undertaken a procurement exercise for a Framework Agreement for the purchase and management of the provision of carbon and energy infrastructural upgrade services.

5.2. The result is that the Carbon and Energy Fund (CEF) was appointed to manage and operate the Framework. CEF has an agreement with NHS SBS to manage and facilitate the Framework, and within this agreement CEF are written into the Framework documents as the party authorised to run the framework and the model.

5.3. The Carbon and Energy Fund (CEF) is a NHS partnership of the Department of Health, NHS, Carbon Trust, National Services Scotland, National Procurement, NHS Strategic Buying Solutions and HealthCare Solutions that work together to reduce the fossil fuel carbon footprint of the NHS. The CEF, with its strategic partners, is on target with upgrading 60 hospitals over four years, and 240 over 16 years. In full CEF is referred to as the NHS SBS Carbon and Energy Fund.

5.4. The Trustees of the CEF are drawn from:

5.4.1. The Department of Health and Sustainable Development Unit of the NHS

5.4.2. Directors of Estates and Facilities that have managed pilots

5.4.3. NHS SBS CPS (procurement)

5.4.4. Carbon and Energy Fund (3)

5.4.5. Carbon Trust Common Services Agency (National Services Scotland and National Procurement)

5.5. The CEF is a special purpose vehicle (SPV) created to allow different parts of the NHS work together, and governed by a partnering agreement that assures the CEF works in the best interests of the NHS. The CEF gives members a choice of advisors to assist them with the upgrade of their energy infrastructure.

5.6. CEF enables NHS trusts to upgrade their energy infrastructure at no additional revenue or capital cost. The CEF provides capital and expertise to develop projects and has secured over £300m and longer term funding to be invested in schemes that upgrade facilities and generate revenue and carbon savings. The CEF has already been subject to full OJEU process and has a framework of 12 contractors with proven ability to design, build and operate energy infrastructure projects. The funding has been secured from a variety of commercial banks and pension funds offering 15-30 year terms and is repaid through the life of the contract.

5.7. This framework operates in a similar way to the NHS P21+ process, with the exception that the final selection of the bidder is made under strict competition, that funding is secured through the contract (and via the CEF) and that the term is typically for 25 years or more.

5.8. Bidders are invited to submit their proposals through a competitive process, with the core part of their offers being guaranteed savings against the Trust’s existing consumption coupled with carbon reductions and guaranteed provision
of heat and power for the term. Re-payment of savings not achieved and availability deductions form a core part of the contract requirements.

5.9. The funding is secured by the CEF from the markets, using banks, pension funds and institutions. The funding is long term, covering anything from 15 to 25 years which allows for large capital investment to be paid over the longer period, secured by a bankable contract and the Trust as security. The CEF provides capital and expertise to develop projects and has secured over £300m long term funding for schemes that upgrade facilities and generate revenue and carbon savings. The Bidders have access to this funding within their bids, or can offer their own funding if this is more competitive and schemes using external funding will mean that the assets are off balance sheet. Trust funding can also be used, but this option means that the assets will be on balance sheet and this option has not been used on this scheme.

5.10.22 Trusts have taken advantage of the CEF to date with 14 contracts now signed, and the remaining 8 schemes having signed agreements between the Trusts and CEF. The typical infrastructure investment can be up to £15m with considerable annual revenue reductions and carbon savings which could contribute towards a Trust’s strategic objectives. All of the externally funded schemes have been structured so that they remain off the Trust’s balance sheet. This applies to all of the externally funded contracts that have been signed to date, and of those, the Trusts who have decided to keep the scheme off balance sheet (understood to be 9 in total).

5.11. CEF provides an opportunity to access capital which can be invested in energy infrastructure improvements. Such investments:

5.11.1. Allow an accelerated investment in a number of schemes that help deliver OUH’s own key objective of working towards a sustainable low carbon future (releasing both carbon and energy cost savings)

5.11.2. Remove pressure on the Trust’s own internal capital programme.

5.11.3. Introduce significant external funding to re-provide time expired Trust equipment all at no cost to the Trust

5.11.4. Transfer on-going energy management (maintenance, repair and replacement) risks to the service provider

5.11.5. Develop a partnership arrangement with CEF for the duration of the contract providing access to the funds expertise in on-going management of implemented schemes.

5.12. Planning Approval has been received for the scheme for both sites.
Procurement Process

5.13. The Trust set up the following project team to oversee the project:

- 5.13.1. Trust board sponsor/champion: Mark Trumper
- 5.13.2. Project Director: Mark Trumper
- 5.13.3. Finance representative: Gemma Boldon
- 5.13.4. Head of Estates & Facilities Operations: Mervyn Phipps
- 5.13.5. Estates Project Manager: Stephen Lloyd
- 5.13.6. Procurement Manager: Pia Larsen
- 5.13.7. Energy Manager: Mike Frankum
- 5.13.8. NHS SBS CEF Project Manager: Peter Fairclough
- 5.13.9. NHS SBS CEF Technical manager: Steven Lowndes
- 5.13.10. Trust Project Administrator: Brenda Stafford

5.14. The CEF have a procurement framework, procured through OJEU between January and July 2011. This saves Trusts considerable procurement time, and for that reason, the Trust's competitive process is called by the EU, a mini-competition. A mini competition has to follow strict rules set down in the framework, and the CEF procurement team (NHS SBS CPS ) oversaw this aspect of the procurement.

5.15. The project was released on 7 January 2013 to the market as a mini-competition to the 12 companies pre-qualified on the CEF Framework.

5.16. An open day was held on 25 January 2013, attended by the following interested companies:

- 5.16.1. Breathe
- 5.16.2. Cofely
- 5.16.3. Dalkia
- 5.16.4. Ener-G
- 5.16.5. Mitie
- 5.16.6. Vital Energi

5.17. The other providers on the framework had demands and costs placed on them by other concurrent schemes.

Assessment of Bids

5.18. The project attracted interest from four of the ten bidders on the framework. The interest reflected the bidders' understanding that this is a complex project with a wide engineering requirement on both sites and not all bidders can compete effectively for such a complex and diverse project.

5.19. Two of the six bidders that attended the Open day declined the invitation to the selection interview. These decisions were based on similar views as noted above, but with the bidders then having more knowledge regarding the scheme details and the relative strengths of their organisations in the face of the competition.
5.20. One of the remaining four bidders pulled out of the process immediately prior to the selection interview. This was Breathe Energy, one of the smaller companies on the framework, who gave the reason that they had just secured two large contracts on the south coast and would not be able to service this scheme. The view from the project team was that having three keen bidders was a suitable number for the competition, particularly given that there are a limited amount of businesses that can realistically deliver these types of contracts, and they are all included on the CEF Framework.

5.21. The Trust interviewed the three bidders, scoring them (out of 60) as follows:

5.21.1. Dalkia
5.21.2. Mitie
5.21.3. Vital

5.22. A cautious approach was taken in compiling the scores, which is reflected in the final results. However, the team was satisfied that each of the 3 bidders identified had the ability, experience, capacity and expertise to be taken forward to the next stage.

5.23. The project team, therefore, invited Dalkia, Mitie and Vital to take part in the further stages of the mini-competition.

5.24. These stages of the mini-competition comprised:

5.24.1. Two technical meetings with each of the bidders to work with those bidders to produce the best possible scheme for the hospital, that that bidder was capable of
5.24.2. The drafting and issue of an Invitation to Tender
5.24.3. The receipt of bids
5.24.4. The selection of the best bidder using the framework selection criteria

5.25. The Bidders were informed that they could also submit variant bids.

**Evaluation of the Bids**

5.26. The bids were evaluated by a team comprising OUH Finance and Estates representatives plus a consultant from Jacobs working with the guidance of the CEF Consultant and using the CEF evaluation template.

5.27. An initial review and scoring of the bids was undertaken on 7 June 2013 following presentations from all three of the bidders on their proposals on the 4 June 2013.

5.28. The evaluation was undertaken on the core bids received for a 15 year term.

5.29. All three bidders provided variant bids and different options for contract lengths. The variant bids were widely differing in their design, and in particular Vital identified a district heating main connecting John Radcliffe to the Churchill site within their variant bid.
5.30. The evaluation shows that:

5.30.1. All bidders submitted a legally compliant bid
5.30.2. Vital Energi’s response was joint strongest in terms of project management, service delivery and programme
5.30.3. Vital Energi’s response was the strongest in terms of financial response and design and construction
5.30.4. Vital Energi provided the best NPV after all bids had been “normalised” to account for all avoided costs

5.31. The final scores were as follows:

5.31.1. Dalkia
5.31.2. Mitie
5.31.3. Vital

5.32. All three bidders provided variant bids and different options for contract lengths. The variant bids were widely differing in their design, and in particular Vital identified a district heating main connecting John Radcliffe to the Churchill site within their variant bid.

Preferred Bidder

5.33. Based on the evaluation of bids, the bidder presenting the best bid to the Trust based on the core option over a 15 year period was Vital Energi. This bid obtained the highest overall weighted score (88) and the best net present value (£9m)

5.34. Vital Energi obtained the highest score across the non-financial aspects of the evaluation.

5.35. Vital Energi offered an innovative engineering solution to the high pressure network on the John Radcliffe site which in turn provided the Trust with a series of avoided costs that were not applicable to the other bids.

5.36. Based on the evaluation work undertaken and the sensitivity analysis that had been completed it was concluded that Vital Energi should be the Trust’s preferred bidder.

Contract Period

5.37. The project team carried out an analysis of the funding and term options.

5.38. It was concluded from this analysis that the best value option for the Trust was a funding term of 25 years, and a contract length of 30 years, as this gave the best balance between overall NPV value and year 1 savings.

Funding Options

5.39. There are three main sources of funding for this type of project:

5.39.1. User-financed
5.39.2. Supplier-financed
5.39.3. Grants

5.40. There are only limited opportunities to get financial assistance for energy improvement measures through feed in tariffs and renewable heat incentive and
enhanced capital allowance schemes. However the Trust would find it difficult to raise the necessary capital for the extent of plant replacement that is now essential for the John Radcliffe site's continued operation, which is why Contract Energy Management (CEM) or some form of third party financing might be more appropriate.

5.41. NHS SBS CEF NCIS Fees "(NCIS Fees)" due on contract award are £547,820.

Overview of Proposed Commercial Arrangements

5.42. The Project Agreement will be the principal scheme document. The Project Agreement will oblige Vital to install the company site equipment and company non site equipment, provide energy and energy management services to a pre-determined standard and maintain the facilities on the sites. The Project Agreement will also contain the obligation on each of the parties to enter into the Leases.

5.43. The Funders Direct Agreement will be a tri-partite agreement between the Trust, VITAL and the Funder setting out the terms on which the Funder will hold security over the company equipment and step-in rights. The principal provisions of the Funders Direct Agreement will cover:

5.43.1. Annual charge and payment
5.43.2. Substitution and step-in
5.43.3. Ownership of the plant and equipment
5.43.4. Risk transfer
5.43.5. Performance guarantees
5.43.6. Insurances
5.43.7. TUPE
5.43.8. Assignment
5.43.9. Termination

Emerging Technologies

5.44. Throughout the Project Term, Vital Energi acting as the Trust's service provider has an obligation to analyse each of the Services and, in respect of each service, produce a programme that details any proposals for changes to the services or any method statement, the likely impact of those changes, the financial implications of the changes, the impact of the timing of such changes or the Trust's ability to carry out its functions and any other matter which the Trust may require according to the agreed variation procedure.

5.45. This would include to regularly undertake affordability testing of alternative technologies and services which may become available throughout the contract term that could deliver financial, operational and/or environmental benefits to the Trust, which could be implemented through the raising of a variation enquiry by the Trust. The variation procedure also allows for Trust to raise a variation enquiry instructing the service provider to investigate financial/service delivery benefits should the Trust become aware of any new or existing technology advancements that it considers may provide a financial and/or service delivery benefits to the Trust.
Personnel Implications

5.46. The likely personnel implications of the preferred option are:

5.46.1. A reduction in the daily checks required for items, such as boilers, plant rooms etc

5.46.2. A reduction in first response reactive maintenance

5.46.3. A reduction in maintenance contract management

5.47. The above represents a minimum of 2 WTE which will be redeployed within the existing operational structure

Implementation Timescales

5.48. Subject to Board and TDA approval, the key contractual milestones and anticipated delivery dates are as follows:

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<tr>
<th>Date</th>
<th>Description</th>
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<tr>
<td>12/11/2014</td>
<td>Trust Board full business case submission</td>
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<td>05/01/2015</td>
<td>TDA approval</td>
</tr>
<tr>
<td>02/02/2015</td>
<td>Contract signature</td>
</tr>
<tr>
<td>02/03/2015</td>
<td>Mobilise on-site works</td>
</tr>
<tr>
<td>30/09/2015</td>
<td>Steam boilers and system shut-down at Churchill Hospital</td>
</tr>
<tr>
<td>30/09/2015</td>
<td>Energy conservation measures completed – both sites</td>
</tr>
<tr>
<td>18/02/2016</td>
<td>CHP unit delivered to John Radcliffe Hospital</td>
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<td>17/03/2016</td>
<td>HTHW steam or LTHW boilers and system shut-down at John Radcliffe Hospital</td>
</tr>
<tr>
<td>05/04/2016</td>
<td>Absorption chillers and adiabatic coolers installed &amp; operational</td>
</tr>
<tr>
<td>31/08/2016</td>
<td>Anticipated practical completion date</td>
</tr>
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6. The Financial Case

Assumptions

6.1. The main financial assumptions are as follows:

6.1.1. The energy fuel cost indexation is 2.5%. Industry expectations are that actual cost increases will be considerably higher in the next 25 years. Savings will be greater if energy fuel costs increase at a rate above 2.5% per annum.

6.1.2. The increasing cost of labour and materials over the next 25 years is accounted for in the model as 2.5% or RPI, whichever is higher.

Balance Sheet Treatment

6.2. This section outlines the accounting treatment adopted for the analysis of the bids against the public sector comparator:

6.3. Whilst the CEF advise that the schemes it has delivered to date have been 'off balance sheet', until formal auditor opinion is obtained on the final proposed solution, there is a risk that the transaction will be deemed to be on-balance sheet.

6.4. Under the public sector comparator the Trust would purchase plant and equipment and also upgrade buildings using operational or strategic capital and incur the associated capital charges (depreciation over the equipment's useful economic life and an annual 3.5% rate of return on capital).

6.5. The Trust would have ownership of the equipment on its balance sheet and as such all the risks and rewards of ownership rest with the Trust. In particular, the organisation would be responsible for all aspects of equipment maintenance, although this could be contracted out to a maintenance provider. The maintenance expenditure would be met out of the Trust's revenue budget.

6.6. A managed energy services contract is accounted for largely in the same way as the PFI, but does not utilise a structured procurement route and standardised documentation although a variant of the PFI Standard Form of Agreement will be employed. All equipment would be owned, repaired, replaced and maintained by the MES provider however the building structure would continue as a Trust asset.

6.7. The Trust provides an output specification that the private sector partner has complete discretion as to how it will be fulfilled. Consequently, all risks and rewards of ownership rest with the MES provider although the majority of operational risk transfers. If a piece of equipment fails or the service reduces the provider would face performance penalties as specified in the contract.

6.8. Replacement of existing equipment would be at the discretion of the provider, assuming it continues to meet the output specifications. The equipment is assumed to be 'off balance sheet'.

6.9. A unitary payment would be charged to the Trust representing the total cost of the service, including an element of profit for the provider and this would be met out of the Trust's revenue budget.

6.10. Where a capital investment is made by OUH then that element will always be on balance sheet.
6.11. The Trust is taking advice from its internal auditors about the likely balance sheet treatment of the proposed scheme.

The Management Case

Overview of Project Management Arrangements

6.12. The main roles and responsibilities are as follows:

6.12.1. The Director of Development and the Estate is the project sponsor and will be accountable at board level for this project.

6.12.2. Head of Capital Projects will take over responsibility for delivering the scheme.

6.12.3. The Head of Capital Projects will be required to establish a project team.

6.12.4. The Head of Estates and Facilities Operations will require additional resources to provide the necessary enabling and commissioning works.

6.12.5. The Head of Capital Projects will require external validation and verification of the commissioning process and outcomes.

Project Organisation

6.13. The key components of the project organisation will be:

6.13.1. The project board

6.13.2. The project director

6.13.3. The project manager

6.13.4. Sub groups /workstreams

6.13.5. Senior Responsible Owner/ Project Director (Project Sponsor)

6.14. The Senior Responsible Owner (SRO) or Project Sponsor/Director for this project is Mark Trumper, Director of Development and the Estate.

6.15. The SRO/Project Director has the following high-level responsibilities to:

6.15.1. Ensure that a project of change meets its objectives and delivers the projected benefits

6.15.2. Ensure agreement amongst stakeholders about the objectives and benefits and commitment to the delivery of the benefits.

6.15.3. Monitor delivery of the objectives and benefits, taking appropriate action where necessary to ensure their successful delivery.

6.15.4. Ensure that the project is subject to review at the key decision points.

6.15.5. Make certain that any recommendations or concerns from reviews are met or addressed before progressing to the next stage.

6.15.6. Oversee development of the brief for change.

6.15.7. Ensure that the aims of the planned change continue to be aligned with the business, and establish a firm basis for the project during its initiation and definition.

6.15.8. Develop the project organisation structure and logical plans
6.15.9. Monitor and control of progress

6.15.10. Formally close the project and ensure that the lessons learned are documented within the ‘end of project’ or ‘end of programme’ evaluation report.

6.15.11. Plan the post project review when the benefits realisation process will be assessed.

6.15.12. Ensure that the post implementation review takes place, the output is forwarded to the appropriate stakeholders and the benefits have been realised.

6.15.13. Regularly consult with those delivering the change and the stakeholders and sponsors.

6.15.14. Ensure that the communication processes are effective and linkages are maintained between the change team/s and the organisation's strategic direction.

6.16. The Project Director's role is crucial for creating and maintaining enthusiasm and momentum. Specific responsibilities include:

6.16.1. Planning and designing the project and proactively monitoring its overall progress, resolving issues and initiating corrective action as appropriate

6.16.2. Defining the project's governance arrangements and quality assurance

6.16.3. Managing the project's budget, monitoring the expenditures and costs against delivered and realised benefits as the programme progresses

6.16.4. Facilitating the appointment of individuals to the project delivery teams

6.16.5. Ensuring that there is efficient allocation of common resources and skills

6.16.6. Managing the communications with all stakeholders and third parties

6.16.7. Managing both the dependencies and the interfaces between projects

6.16.8. Managing risks

6.17. The project manager role will be to oversee day to day activities and ensure that progress is maintained in accordance with the project plans agreed by the Project Director. In addition, the project manager will be expected to coordinate and manage the contribution of the project team including external advisors. Regular contact with the team and the Project Director will be required in order to achieve this and to inform and communicate progress and issues up and down the chain of command.

6.18. Specific responsibilities include:

6.18.1. Managing project priorities.

6.18.2. Acting as a catalyst to resolve project problems and conflicts, escalating when necessary.

6.18.3. Assessing strengths and weaknesses at project completion

6.18.4. Ensuring that related and partner teams are involved and informed as early as possible in the project management process.

6.18.5. Preparing Project Schedules and Plans
6.18.6. Providing regular reports to the SRO on progress of the business change.

6.18.7. Monitoring actual project progress against agreed schedules and plans.

6.18.8. Using defined Project Processes to manage Quality, Risks, Changes, Issues and Financial Implications

6.18.9. Monitoring Project Performance and Publish Project Status data at key stages throughout the Project.

6.18.10. Managing day-to-day Project tasks and escalate any issues that impact on the Project Performance and Timetable.

6.18.11. Providing updates or adjustments to the Project Plan as necessary to ensure the project continues to meet the Key Deliverables defined at the start of the Project.

6.19. The support services significant for this case are as follows:

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<th>Support Service</th>
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<th>Assessment of Impact</th>
</tr>
</thead>
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<td>Critical Care, Theatres and Anaesthetics</td>
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<td>N/A</td>
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<tr>
<td>Pathology</td>
<td>N</td>
<td>N/A</td>
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<tr>
<td>Radiology and Imaging</td>
<td>N</td>
<td>N/A</td>
</tr>
<tr>
<td>Pharmacy</td>
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<td>N/A</td>
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<tr>
<td>Physio, OT, SALT</td>
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<tr>
<td>Infection Control</td>
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<td>N/A</td>
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<td>Outpatients</td>
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<tr>
<td>Medical Records</td>
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<td>N/A</td>
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<tr>
<td>Estates /Capital Development</td>
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<td>Major programme of works, led by Estates</td>
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<tr>
<td>Other (please specify)</td>
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### Outline Project Plan

6.20. The outline integrated approval and installation timetable is as follows:

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<tr>
<th>Date</th>
<th>Description</th>
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<tr>
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<td>TME outline business case submission</td>
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<tr>
<td>10/09/2014</td>
<td>Trust Board outline business case submission</td>
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<tr>
<td>11/09/2014</td>
<td>Amended preferred bidder letter</td>
</tr>
<tr>
<td>12/09/14</td>
<td>to</td>
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<tr>
<td>30/10/14</td>
<td>Finalise design for additional district heating and chiller plant-up-grade</td>
</tr>
<tr>
<td>30/09/2014</td>
<td>CHP - reserve engine production slot</td>
</tr>
<tr>
<td>30/10/2014</td>
<td>Finalise key contract terms</td>
</tr>
<tr>
<td>12/11/2014</td>
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</tr>
<tr>
<td>05/01/2015</td>
<td>TDA approval</td>
</tr>
<tr>
<td>02/02/2015</td>
<td>Contract signature</td>
</tr>
<tr>
<td>02/03/2015</td>
<td>Mobilise on-site works</td>
</tr>
<tr>
<td>30/09/2015</td>
<td>Steam boilers and system shut-down at Churchill Hospital</td>
</tr>
<tr>
<td>30/09/2015</td>
<td>Energy conservation measures completed – both sites</td>
</tr>
<tr>
<td>18/02/2016</td>
<td>CHP unit delivered to John Radcliffe Hospital</td>
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<tr>
<td>17/03/2016</td>
<td>HTHW steam or LTHW boilers and system shut-down at John Radcliffe Hospital</td>
</tr>
<tr>
<td>05/04/2016</td>
<td>Absorption chillers and adiabatic coolers installed &amp; operational</td>
</tr>
<tr>
<td>31/08/2016</td>
<td>Anticipated practical completion date</td>
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</table>

6.21. The impacts/risks associated with the project have been scored against the Gateway Risk Potential Assessment (RPA) for projects. It has been assessed as low risk.
7. Conclusion

7.1. In summary, the existing and time expired infrastructure presents a risk to patient safety in its present condition.

7.2. The majority of the heating and hot water services are 40 years old and are now significantly older than the recommended maximum economic life for these types of systems. The result of this is that equipment and pipework mains are failing. Spares for obsolete parts need to be manufactured. Where possible, equipment is patched up to prolong its life. Pipework leaks are frequent occurrences, and the required cooling down of the system to allow work to take place by itself causes further leaks and joint failures.

7.3. The existing equipment is inefficient with inadequate controls which further reduce its efficiency. Site distribution mains also represent significant loss of energy due to inadequate insulation. Upgrading the systems is an opportunity to improve both heating and hot water, and at the same time to reduce energy consumption significantly.

7.4. The financial benefits of this business case are:

7.4.1. A guaranteed reduction in annual energy costs of around £2,200,000. After the annual unitary payment of just under £1,800,000 this results in a net guaranteed annual saving of over £400,000.

7.4.2. A reduction in the annual carbon footprint of the Trust from 30,000 tonnes to 19,000 tonnes. The CO₂ levy saving on 11,000 tonnes at today's price is around £165,000. If the levy rises to £30 per tonne by 2020 then this rises to £330,000.

7.4.3. An initial capital investment of around £18,400,000 externally funded at no additional cost to the Trust. If the Trust had to fund the initial capital expenditure itself, the initial interest charge would be over £1,000,000 at a rate of 5.64%, which is the cost of finance that the Trust is currently being charged on capital.

7.4.4. Reduced backlog of £11,000,000, which addresses the replacement of plant and equipment which are key to providing an environment for the patient that is safe, fit for purpose and strategically aligned.

7.4.5. A transfer of risk to the external provider estimated to be around £2,800,000.
8. Recommendation
The Trust Board is asked to approve the Outline Business Case for the renewal of the Trust's energy infrastructure for onward submission to the Trust Development Authority.

Mr Mark Trumper,
Director of Development and the Estate

26 August 2014
<table>
<thead>
<tr>
<th>Title</th>
<th>Full Business Case – New Energy Investment Programme at Oxford University Hospital Trust</th>
</tr>
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<tr>
<td>Status</td>
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</tr>
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<td>Board Lead(s)</td>
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Trust Management Executive Meeting: Thursday 26 February 2015
TME2015.57

TME2015.57 Full Business Case for Energy Investment
1. The Full Business Case (FBC) for an investment in a new energy programme follows the approval of the Outline Business Case in September 2014 and the information update presented to the Board in January 2015.

Since the approval of the OBC, the Project Team have been working together to review and agree the inclusions of the Energy Services Performance Agreement ("PA") between the Trust and Vital Energy Solutions Limited ("VE" or the "Contractor") to successfully deliver a robust solution in this schemes delivery.

The following is a summary of the main points included in the energy scheme:

- The contract term has been agreed at 25 years.
- A guaranteed reduction in annual energy costs of around £2.294m. Once payment of the annual service payment in the region of £1.831m is considered, a net guaranteed annual saving of circa £461k will be achieved.
- A reduction in the annual carbon footprint of the Trust from 30,000 tonnes to 19,000 tonnes. The CO2 levy saving on 11,000 tonnes at today's price is around £165,000. Should the levy rise to £30 per tonne by 2020 as predicted by industry experts, this benefit rises to £330k. The scheme will also reduce the Trust's overall energy consumption to 64GJ/m3, meeting the DH target.
- Inclusion of the procurement pathway in arriving at the Preferred bidder is detailed in the Economic Case
- Investment in the infrastructure by the Trust would require an initial Capital Investment of £20.2m (based on a PSC) with an additional capital injection in the region of £3.6m required after 17 years.
- Risk is transferred to the Contractor at an annualised value of £2.8m. In addition, operational risk is further reduced as the Contractor engaged to design and implement the scheme and operate the energy services are one and the same.
- A reduction in backlog maintenance of a minimum £11m, which addresses the replacement of plant and equipment which are key to providing an environment for the patient that is safe, fit for purpose and strategically aligned.
- Monitoring performance over the life of the term is a continued role by the CEF as Trust advisors. This safeguards the delivery of the guaranteed savings and quality of contract performance.
- Successful delivery is subject to the approval of the TDA.

This FBC presents a solid document for the provision of an energy infrastructural renewal scheme to meet the heat and power strategy for the John Radcliffe and Churchill Hospitals.
2. Approving this scheme benefits the Trust in that it has the potential to extend to the Nuffield Orthopaedic Centre and Horton Hospital.

The linking of sites between the John Radcliffe and Churchill Hospitals (a solution offered by the Contractor) offers further commercial benefit to the Trust in that they could potentially offer energy to consumers both on-site and in the surrounding Oxford area.

3. The Trust’s relationship with the Carbon and Energy Fund Limited (“CEF”) is detailed in the Economic Case. The CEF is a special purpose vehicle in collaboration with the NHS and driven by the Department of Health (“DoH”). Their purpose is to enable NHS Trusts nationally to deliver energy schemes to meet the National Carbon Reduction Strategy at no extra cost to themselves. The Director of Development and Estate on behalf of the OUHT signed a Membership Agreement with CEF Limited in December 2012.

4. In 2011, the Trust engaged the Halcrow Group to carry out a review of its energy infrastructure within the retained hospital estate and to set out a strategy for the refurbishment of the energy systems.

In 2012, Jacobs Engineering U.K. Limited carried out a review of the scope, costs and feasibility of the integration of energy improvements on the John Radcliffe and Churchill Hospital sites.

These reports informed the requirements within the Mini Competition specification.

5. In delivering anticipated energy efficiencies and infrastructure upgrade the FBC explores a range of options, including the development of a Do Minimum/Nothing option, the traditional procurement route under OJEU supported by Trust capital funding, outsourcing service delivery and investment using external funding.

We are recommending the delivery of services through an Energy Services Performance Agreement with Vital Energy Solutions Limited as Preferred Bidder and investment using external funding from Aviva Investors Global Services.

We believe this option will deliver the most efficient and effective outcome for the Trust.

6. Energy consumption by the Trust has been rising since the year 2000 as a result of new and increased developments on the Hospital sites, and new
medical technologies being introduced which are increasingly energy reliant.

Energy prices have also been rising over the same period. This FBC demonstrates that since 2011/12 energy pricing has risen 17% resulting in additional charges being levied which include the Carbon Reduction Commitment (CRC) charge.

Such energy usage is consuming an increasing proportion of Trust resources when the Trust is experiencing a low level of income growth. This project will go some way to readdress the balance.

7. There are no TUPE considerations attached to this Project and this has been confirmed by the Human Resource Manager to the Directorate.

To ensure that this project is delivered on time and without issues, it is envisaged that a dedicated and experienced Project Manager position at Grade 8c, will be created by the Trust following approval of this business case and signature of the Project Agreement.

The Project Manager’s role will be to oversee day to day activities and ensure that progress is maintained in accordance with the project programme agreed by the Project Director.

In addition the Project Manager will be expected to co-ordinate and manage the contribution of the project delivery team including external advisors. Regular contact with the team and the Project Director will be required in order to achieve this and to inform and communicate progress and issues up and down the chain of command.

8. Intellectual Property considerations have been included as part of the PA such that the Contractor will use all reasonable efforts to ensure that any Intellectual Property Rights created, brought into existence or acquired during the term of the Agreement are governed in accordance with the PA.

9. The TME is asked to note that the Trust Board will be asked to review and note the following:

The findings of the report submitted by DAC Beachcroft LLP as Trust advisors for the proposed energy scheme. The report includes summary findings of the basis and structure of the Project and the key commercial principles agreed between the Trust, Vital Energi Solutions Limited as preferred bidder and the Project funder Aviva Investors Global Services. This report includes:

- Project Agreement – key contractual obligations
- Lease arrangements
- The Funder's Direct Agreement
- Powers to enter into the Agreement
- Project commencement issues
- Other matters for consideration

Key funding considerations include:
- the Investment Fund is to grant a licence to Vital Energi Solutions Ltd to permit it to occupy the premises to be leased to the Investment Fund at the John Radcliffe and Churchill Hospital sites during the term of those leases;
- the PA will oblige the Trust to make certain payments to Vital Energi Solutions Ltd monthly in arrears, a proportion of which payments will be payable in all circumstances regardless of its performance of the services (but, without prejudice to the Trust's other rights, including under the parent company guarantee referred to in the PA); and
- on early termination of the Project Agreement (including on the default of Vital Energi Solutions Ltd), the Trust will be obliged to pay certain termination compensation sums as reflected in the PA.

The potential risks, including interest rate exposure, assumptions within calculations, impact of policy and price changes, were considered. It was noted that these had been properly assessed in working up the full business case associated with the Project.

The Trust’s standing orders, scheme of reservation and delegation and standing financial instructions and other applicable governance procedures, and the power and authority of the Trust to enter into the Project, were also considered.

10. In order to facilitate the savings, we note that the Board previously approved the release of £300,000 in funding which has been used as follows:

- £200,000 to fund the design, preparation, finalisation and approval of the outline business case to final business case
- £100,000 to secure the required plant and equipment required for production and to ensure timely installation following signing of the contract.

11. **Recommendation**

The TME is asked to support the following recommendations to the Trust Board:
That the Trust Board approve this full business case, targeting commencement of major plant installation in early June 2015 and to begin achieving in-year benefit, delivering efficiencies as part of the Trust’s Cost Improvement Programme (CIP) by October 2015.

That the Trust Board accept the recommendation for the delivery of services through an Energy Services Performance Agreement ("PA") with Vital Energi Solutions Limited as Preferred Bidder and with Parent guarantee by Vital Holdings Limited.

That the Trust Board approve the proposed funder arrangements between VE and Aviva Investors Global Services ("Investment Fund"); details or which are set out under Schedule 6 of the PA.

That the Trust Board review and note the findings submitted by DAC Beachcroft LLP as Trust advisors for the proposed energy scheme.

That the Trust Board note the key funding considerations outlined above.

That the Trust Board approve the Project Manager position at Grade 8c for the duration of the Project implementation through to completion.

That the Trust Board note that further detail may be required by the TDA in answer to outstanding queries to complete its FBC decision making process, and that the Trust Board approve continued liaison with the TDA in its requests.
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1. **Summary**

1.1 **Introduction**

1.1.1 This FBC seeks to confirm Board approval to the design, upgrade, installation and commissioning of an energy infrastructural scheme to meet the heat and power strategy for the John Radcliffe and Churchill hospital sites. The design has the potential to accommodate future expansion on these sites and include the Nuffield Orthopaedic Centre and Horton Hospital if desired. The scheme aims to:

- Achieve compliance with the initial round of carbon reductions for the site from October 2015;
- Achieve carbon energy and financial savings;
- Make provision for future site development;
- Reduce site backlog maintenance;
- Meet the infrastructural needs of the Trust in the most cost effective way through long term sustainable development.

1.1.2 In so doing this FBC seeks Board approval to awarding the contract to Vital Energi Solutions Limited for the installation and operation of an energy system for the John Radcliffe and Churchill hospital sites.

1.1.3 Specifically this energy system includes:

- Installation of CHP combined heat and power plant;
- Replacement of obsolete boiler plant and associated equipment;
- Addressing issues with HTHW (High Temperature Hot water) distribution pipework;
- Installation of an energy link between the two sites improving efficiency and resilience;
- Reductions in operating costs;
- Improvements in resilience and Business continuity;
- Reductions in risk through improved infrastructure and risk transfer to contractor.

1.1.4 As preferred bidder Vital Energi Solutions Limited will sign an Energy Services Performance Agreement which incorporates provisions for the operating and management of the energy system for a period of 25 years from the completion of the installation phase.

1.1.5 The options considered by the Trust are fully discussed in this FBC under the following approaches:

- Do Minimum/Nothing;
- Trust investment in an upgrade against a Public Sector Comparator (PSC);
- Upgrading by means of a contractor through open competition.
1.1.6 Vital Energi Solutions Limited have been chosen as preferred bidder against a number of contractors following a mini-competition in early 2013. Details of the bidding process and Project Team conclusions are discussed in the economic case which follows.

1.1.7 The proposed solution demonstrates how the Trust, as members of the Carbon and Energy Fund Limited, benefit from access to pre-procured contractors, experienced advisors and funding options.

1.1.8 Award of this contract to Vital Energi Solutions Limited will result in the upgrading and improvement of the Trust's energy systems without any call on the Trust's capital allocation. The capital funding for the required upgrade and replacement of energy infrastructure is provided through the CEF arrangement by the contractor and will form part of the annual operator maintenance payment received from the Trust. Payments to the contractor only commence on completion of the installation.

1.1.9 Vital Energi Solutions Limited have negotiated the funding requirements for the successful delivery of this scheme with Aviva Investors Global Services Limited through their Infrastructure and Renewable Energy Division.

1.1.10 It is expected that on implementation the scheme will generate annual efficiencies in energy costs of around £2.294m and is designed to deliver annual guaranteed net non-spend savings of £0.461m.

1.1.11 Since the completion of the OBC, further work has been undertaken with the preferred bidder to develop the proposed scheme to ensure that it meets the Trust's current needs. This has resulted in an increase in the contractor's capital expenditure and a reduction in net savings generated by the scheme. However the project remains self-financing with an NPV for its 25 year life of £7.610m.

1.1.12 It is envisaged that this scheme will reduce the Trust's annual carbon footprint from around 30,000 tonnes to 19,000 tonnes at an annual saving to the trust in the region of £165,000 in carbon costs based on current CRC charge of £15/tonne CO₂. The scheme will also reduce the Trust's overall energy consumption to 64GJ/m³, meeting the DH target.

1.1.13 Based on a Public Sector Comparator, an investment spend of circa £20.2m by the Trust would be necessary to meet the project costs with an additional projected capital injection in the region of £3.6m required after 17 years.

1.1.14 This paper complies with the Treasury's Five Case Model for public sector business cases and contains information required by the Trust Development Authority (TDA) in its business case checklist.

1.2 The Strategic Case

1.2.1 The strategic case discusses the current position of the Trust and the age and condition of its estate. Although much of the Trust has been renewed in recent years, there remain large sections of estate that are in need of expenditure to
bring up to modern standards, as evidenced by the Trust's backlog maintenance exposure.

1.2.2 In recent years the Government and NHS have introduced targets for NHS Trusts to meet in energy and carbon consumption. Oxford University Hospital Trust is required to reduce its carbon footprint by 10% by 2015. The Trust's current energy consumption is above national benchmarks, and the Trust has targeted reductions in this consumption.

1.2.3 The section demonstrates that the development is in line with the OUHT strategic objectives as far as they relate to investment in this energy programme.

1.2.4 Energy consumption by the Trust has been rising since the year 2000 as a result of new and increased developments on the Hospital sites, and new medical technologies being introduced which are increasingly energy reliant.

1.2.5 Energy prices have also been rising over the same period meaning that additional charges have been levied including the Carbon Reduction Commitment (CRC) charge, currently standing at £15/tonne CO₂. This means that energy usage is consuming an increasing proportion of Trust resources when the Trust is experiencing a low level of income growth.

1.2.6 The Carbon and Energy Fund Limited (CEF) is a collaborative agreement with the NHS whose aim is to assist NHS Trusts to deliver energy infrastructure project which will reduce energy costs and carbon consumption through a Membership Agreement, a copy of which is attached under appendix 1. CEF provide members access to expertise, finance and a readily available procurement route in engaging the right contractor in delivering a tailored energy solution.

1.2.7 The Trust engaged the Halcrow Group Limited to review the energy infrastructure across the John Radcliffe and Churchill Hospital sites and report on its current position and suggested improvements from the range currently available on the market. This report is included as appendix 2 to this business case.

1.2.8 The strategic case reviews the investment objectives and benefits of this development and the constraints and dependencies that the project faces.

1.2.9 The solution proposed by this business case will address these strategic issues and deliver a renewed energy infrastructure that gives the Trust the resilience it requires. It will pass construction and operational risk to a contractor and ensure guaranteed financial and carbon savings for the Trust.

1.3 The Economic Case

1.3.1 The economic case considers the options available to the Trust in addressing its infrastructural deficiencies. It discusses the implications of a "do minimal/nothing" approach, it considers the costs of self-financing an energy upgrade and explains why we propose entering into an Energy Services
Performance Agreement for the implementation, operation and maintenance needs of the Trust’s energy infrastructure.

1.3.2 The comparison exercise of a do minimal/do nothing, public sector comparator and contractor bid options was conducted by the Project Team and showed that the contractor bid delivered the best value for money, risk profile and non-financial benefits across the proposed life of 25 years.

1.3.3 This case maps out the pathway in which the Trust identified and considered the possibilities for the energy scheme and how the Project Team arrived at its decision to award preferred bidder status to Vital Energi Solutions Limited.

1.3.4 The Halcrow report commissioned by the Trust in December 2011 identified the variety of options available to the Trust for updating its energy infrastructure and recommended the viable options which were suitable for the Trust. This allowed the Trust to form both a long-list and short list of options for development.

1.3.5 The shortlisted options were further developed by the Jacobs report which was commissioned jointly by the Trust and the CEF and is attached as appendix 3.

1.3.6 Using the basis of the Jacobs report the Trust issued an output based specification as part of an Invitation to Mini Competition under the CEF procurement framework and invited contractors to bid for the project works at the John Radcliffe and Churchill hospital sites.

1.3.7 There was initial interest from six of the ten companies on the CEF framework at that point. Following a site open day and negotiations, this was reduced to three companies who expressed a firm interest in bidding for the work. These companies all submitted formal bids in line with the mini competition exercise.

1.3.8 Each company submitted bids covering the Trust’s core requirement over periods of 15 and 25 years, and a variant bid for a 25 year term which allowed them to show innovation and offer additional benefits to the Trust. These bids were all evaluated by the Project Team using criteria established by CEF as part of their agreed procurement framework.

1.3.9 An optimum mix of energy cost savings and design innovation which offered future income generation potential, greater flexibility and resilience, led to the Trust choosing Vital Energi Solutions Limited as their preferred bidder. A contract length of 25 years was agreed as offering the optimal in service provision.

1.3.10 The Trust used the information within the bid documents to develop a Public Sector Comparator option which delivered the same benefits as the contractor bid, but allowed for additional costs being incurred by the Trust to do so. These costs included an allowance for Optimism Bias which has been increased between OBC and FBC stages to correct for a perceived underestimation of risk in the OBC.
1.3.11 Sensitivity analysis was conducted which showed that the contractor bid remained the preferred option in all but exceptional circumstances which were not considered likely to occur. This is demonstrated by the results of the appraisal as shown in the table below.

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<th>Criteria</th>
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1.3.12 The preferred bid also offers the Trust opportunities for future income generation through the innovative energy link between sites that could be expanded to cover other non-domestic entities on site and in the area.

1.4 The Commercial Case

1.4.1 The Commercial Case of this FBC details the agreed contractual arrangements with Vital Energi Solutions Limited as preferred bidder. It details the installation of plant and equipment and the service provisions over the 25 year life of the contract.

1.4.2 The contract has been prepared using the standard Performance Agreement ("PA") format and is issued under the CEF procurement framework. The PA is tailored to reflect the contractual arrangements for the scope of works and operational responsibilities for the energy scheme and details the reliance data, the Trust’s obligations; Contractor considerations and the funder arrangement.

1.4.3 The Trust has engaged legal and insurance advisors to support the final negotiation of the project agreement and to provide comfort to the Trust Board that the Trust’s interests are protected.

1.4.4 The Head of Procurement has reviewed the process adopted to date, has confirmed that it complies with good practice and that he is satisfied with the outcome.

1.4.5 The contract form transfers significant risk to the contractor, including design, construction/installation and operational risk.

1.4.6 The equipment and installation phase will be paid for by AVIVA, the agreed funder, and the Trust will be committed to commence payments to the Operator under the contract once the operational phase begins; subject to the Certificate of Completion being signed off. At this point the savings guarantee will take effect resulting in the Trust’s financial exposure being greatly restricted.

1.4.7 During the operational term the Trust will pay the contractor a service payment. A liaison group made up of representatives of the Trust, contractor and CEF will review performance on a monthly basis. Deductions will be
made from the service payment should service delivery experience a lack of availability or fail to meet the defined KPI's set out in the PA. These deductions cannot reduce the amount paid below the 'hard deck' which is the amount required to repay the funder's investment. The full mechanics of payments and deduction weighting are set out in Schedule 18 of the PA and are discussed in the Commercial Case that follows.

1.4.8 A significant benefit in renewing the energy infrastructure is the resultant savings the Trust can expect on the utility costs. Guaranteed utility savings are an element under the PA and should these savings not materialise, the contractor will make payment to the Trust to meet any shortfall. If the contractor demonstrates energy requirements have been reduced by more than the guarantee there is a sharing arrangement for 'excess savings'.

1.4.9 The Trust exposure to future price rises will be reduced as its energy demand is significantly reduced by the development. The development remains value for money until the energy price falls to unprecedented level of 60% of current prices or less.

1.4.10 The key terms of the contract have been reviewed in the Commercial Case to provide assurance to the Trust Board regarding the agreement it is being asked to approve.

1.4.11 The trust has reviewed the staffing involved in current services and is satisfied that there are no TUPE implications of this scheme.

1.4.12 The implementation programme and timescales have been considered by the Trust along with the key milestones, and are summarised in the following table:

<table>
<thead>
<tr>
<th>Activity</th>
<th>Completion dates / Milestones</th>
</tr>
</thead>
<tbody>
<tr>
<td>Project feasibility and initiation</td>
<td>December 2011 - August 2014</td>
</tr>
<tr>
<td>Outline Business Case</td>
<td>September 2014 - March 2015</td>
</tr>
<tr>
<td>Project design and Agreement finalisation</td>
<td>January 2015 - April 2015</td>
</tr>
<tr>
<td>Full Business Case</td>
<td>January 2016 - May 2016</td>
</tr>
<tr>
<td>Project Implementation</td>
<td>May 2015 - October 2016</td>
</tr>
</tbody>
</table>

1.4.13 The Trust has reviewed the accounting treatment for this arrangement and discussed it with the Trust's external auditors. The plant and equipment involved in the development will appear on the Trust balance sheet as non-current assets, and a liability will be created for the value of future capital repayments to the funder.

1.5 The Financial Case

1.5.1 The Financial Case uses the preferred option as selected in the economic case to determine the expected effect on the Trust's overall financial position that entering into this agreement will have.

1.5.2 The Trust's recent trading history and forecast financial performance as detailed in the latest version of the Integrated Business Plan have been
reviewed, and this development is not sufficiently large to require a change in these forecasts.

1.5.3 The impact upon the Trust Income and Expenditure Account is shown as a small cost in the current year related to advance costs of the project, but thereafter net savings throughout the life of the Agreement.

1.5.4 These savings exclude the avoidance of the expected rise in energy costs above the rate of inflation and the savings generated through uninterrupted front line service delivery.

1.5.5 This OBC has adopted an on-balance sheet transaction approach following discussion and agreement with the Trust auditors. This accounting treatment and its impact on the balance sheet of the Trust is shown, and a consequence of the treatment is a small impact on the Trust's Continuity of Service Risk Rating which is insufficient to affect the Trust's overall rating.

1.5.6 The impact on the Trust Cash Flow reflects the Income and Expenditure impact in showing a small outflow in the current year, which revert to an inflow throughout the remaining life of the contract resulting from the guaranteed savings.

1.5.7 The overall cost of the Agreement (excluding inflation) is £45.8m over the expected 25 year life span of the contract. This is made up of the Unitary Payment of £1.831m per annum.

1.5.8 The contract will generate savings of £2.294m per annum, a total sum of £57.3m (excluding inflation).

1.5.9 This means the business case delivers a net saving of £0.461m per annum (excluding inflation) and a NPV of £7.610m over the life of the contract.

1.5.10 Both annual payments and savings will be indexed at RPI or 2.5% (whichever is higher) meaning that the scheme will generate net savings to the Trust in every year of its operations.

1.5.11 The savings are guaranteed by the contractor under the terms of the contract, and any shortfall will be made up to the Trust.

1.5.12 These figures have changed and are slightly worse than those included in the OBC because of the effect bringing the agreement onto the Trust balance sheet, and as a result of some changes in the overall scheme proposed. These changes are shown in detail under the Bid Development heading in section 3.

1.6 The Management Case

1.6.1 The Management Case details how the Trust expects to maintain control over the implementation and operation phases of this development, including the actions that have been taken in order to reach the FBC stage.

1.6.2 The Director of Development and the Estate is the Senior Responsible Owner
and Project sponsor for this development.

1.6.3 It is envisaged that the Trust will create role for a dedicated Project manager at grade 8c for this development to help to ensure that it is delivered on time and that the benefits are realised in the way intended.

1.6.4 The Trust is a member of the Carbon and Energy Fund, and the fund has acted as advisor to the Trust in reaching this stage of the contract development. The CEF will continue to advise the Trust during the operational phase of the contract.

1.6.5 The Trust has also been advised by DAC Beachcroft regarding the basis and structure of the Project and the key commercial principles agreed between the Trust, the Contractor and the Project funder. Willis Limited have been engaged to review the insurance arrangements for the plant and equipment and their relationship with the Trust’s insurable interest. The Trust has sought advice from Ernest and Young as external auditors regarding the accounting treatment of the contract.

1.6.6 There is in place a Benefits Realisation Plan which will be used to ensure that the development delivers the benefits that the Trust expects. The Trust also has in place arrangements for Post Project Evaluation, so that we can learn any lessons arising at key stages of the project, for implementation either later in this project or in other projects.

1.6.7 The need for OGC Gateway Reviews of this project has been assessed and it was found that the project is viewed as very low risk. As such gateway reviews are not deemed to be necessary.

1.7 Conclusion and Recommendation

1.7.1 The existing and time expired infrastructure presents a risk to patient safety in its present condition.

1.7.2 The majority of the heating and hot water services are 40 years old and are now significantly older than the recommended maximum economic life for these types of systems. The result of this is that equipment and pipework mains are failing. Spares for obsolete parts need to be manufactured. Where possible, equipment is patched up to prolong its life. Pipework leaks are frequent occurrences, and the required cooling down of the system to allow work to take place by itself causes further leaks and joint failures.

1.7.3 The existing equipment is inefficient with inadequate controls which further reduce its efficiency. Site distribution mains also represent significant loss of energy due to inadequate insulation. Upgrading the systems is an opportunity to improve both heating and hot water, and at the same time to reduce energy consumption significantly.

1.7.4 The financial benefits of this business case are:

- The contract term has been agreed at 25 years.
• A guaranteed reduction in annual energy costs of around £2.294m. Once payment of the annual service payment in the region of £1.831m is considered, a net guaranteed annual saving of circa £461k will be achieved.

• A reduction in the annual carbon footprint of the Trust from 30,000 tonnes to 19,000 tonnes. The CO2 levy saving on 11,000 tonnes at today's price is around £165,000. Should the levy rise to £30 per tonne by 2020 as predicted by industry experts, this benefit rises to £330k. The scheme will also reduce the Trust's overall energy consumption to 64GJ/m3, meeting the DH target.

• Investment in the infrastructure by the Trust would require an initial Capital Investment of £20.2m (based on a PSC) with an additional capital injection in the region of £3.6m required after 17 years.

• Risk is transferred to the Contractor at an annualised value of £2.8m. In addition, operational risk is further reduced as the Contractor engaged to design and implement the scheme and operate the energy services are one and the same.

• A reduction in backlog maintenance of a minimum £11m, which addresses the replacement of plant and equipment which are key to providing an environment for the patient that is safe, fit for purpose and strategically aligned.

• Monitoring performance over the life of the term is a continued role by the CEF as Trust advisors. This safeguards the delivery of the guaranteed savings and quality of contract performance.

1.7.5 In addition, operational risk is further reduced as the Contractor engaged to design and implement the scheme and operate the energy service is one and the same.

1.7.6 Approving this scheme benefits the Trust in that it has the potential to extend to the Nuffield Orthopaedic Centre and Horton Hospital.

1.7.7 The linking of sites between the John Radcliffe and Churchill Hospitals (a solution offered by the Contractor) offers further commercial benefit to the Trust in that they could potentially offer energy to consumers both on-site and in the surrounding Oxford area.

1.7.8 In delivering anticipated energy efficiencies and infrastructure upgrade the FBC explores a range of options, including the development of a Do Minimum/Nothing option, the traditional procurement route under OJEU supported by Trust capital funding, outsourcing service delivery and investment using external funding.

1.7.9 We are recommending the delivery of services through an Energy Services Performance Agreement with Vital Energi Solutions Limited as Preferred Bidder and investment using external funding from Aviva Investors Global Services.

We believe this option will deliver the most efficient and effective outcome for
the Trust.

1.7.10 Energy consumption by the Trust has been rising since the year 2000 as a result of new and increased developments on the Hospital sites, and new medical technologies being introduced which are increasingly energy reliant.

Energy prices have also been rising over the same period. This FBC demonstrates that since 2011/12 energy pricing has risen 17% resulting in additional charges being levied which include the Carbon Reduction Commitment (CRC) charge.

Such energy usage is consuming an increasing proportion of Trust resources when the Trust is experiencing a low level of income growth. This project will go some way to readdress the balance.

1.7.11 There are no TUPE considerations attached to this Project and this has been confirmed by the Human Resource Manager to the Directorate.

To ensure that this project is delivered on time and without issues it is envisaged that a dedicated and experienced Project Manager position at grade 8c will be created by the Trust following approval of this business case and signature of the Project Agreement.

The Project Manager's role will be to oversee day to day activities and ensure that progress is maintained in accordance with the project programme agreed by the Project Director.

In addition the Project Manager will be expected to co-ordinate and manage the contribution of the project delivery team including external advisors. Regular contact with the team and the Project Director will be required in order to achieve this and to inform and communicate progress and issues up and down the chain of command.

Intellectual Property considerations have been included as part of the PA such that the Contractor will use all reasonable efforts to ensure that any Intellectual Property Rights created, brought into existence or acquired during the term of the Agreement are governed in accordance with the PA.

1.7.12 The Trust Board are asked to review and note the findings submitted by DAC Beachcroft LLP as Trust advisors for the proposed energy scheme. The review includes summary findings of the basis and structure of the Project and the key commercial principles agreed between the Trust, Vital Energi Solutions Limited as preferred bidder and the Project funder Aviva Investors Global Services. This report includes:

- Project Agreement – key contractual obligations
- Lease arrangements
- The Funder's Direct Agreement
- Powers to enter into the Agreement
- Project commencement issues
Other matters for consideration

1.7.13 In order to facilitate the savings, we note that the Board previously approved the release of £300,000 in funding which has been used as follows:

- £200,000 to fund the design, preparation, finalisation and approval of the outline business case to final business case
- £100,000 to secure the required plant and equipment required for production and to ensure timely installation following signing of the contract.

1.7.14 The Trust Board is asked to approve this full business case, targeting commencement of major plant installation in early June 2015 and to begin achieving in-year benefit, delivering efficiencies as part of the Trust’s Cost Improvement Programme (CIP) by October 2015.

1.7.15 We are recommending the delivery of services through an Energy Services Performance Agreement (“PA”) with Vital Energi Solutions Limited as Preferred Bidder.

1.7.16 The Trust Board is asked to approve the proposed funder arrangements between VE and Aviva Investors Global Services (“Investment Fund”); details or which are set out under Schedule 6 of the PA.

1.7.17 The Board are asked to note the key funding considerations which include:

- the Investment Fund is to grant a licence to Vital Energi Solutions Ltd to permit it to occupy the premises to be leased to the Investment Fund at the John Radcliffe and Churchill Hospital sites during the term of those leases;
- the PA will oblige the Trust to make certain payments to Vital Energi Solutions Ltd monthly in arrears, a proportion of which payments will be payable in all circumstances regardless of its performance of the services (but, without prejudice to the Trust’s other rights, including under the parent company guarantee referred to in the PA); and
- on early termination of the Project Agreement (including on the default of Vital Energi Solutions Ltd), the Trust will be obliged to pay certain termination compensation sums as reflected in the PA.

1.7.18 The Trust Board are asked to review and note the findings submitted by DAC Beachcroft LLP as Trust advisors for the proposed energy scheme.

1.7.19 The Board are asked to approve the Project Manager position at grade 8c for the duration of the Project implementation through to completion. The Trust Board is asked to approve this outline business case with a target of commencement of major plant installation in summer 2015 to begin to derive in-year benefit.
2. Strategic Case

2.1 Structure and Content of the document

2.1.1 This FBC has been prepared using the agreed standards and format for business cases, as set out in:

- HM Treasury Green Book guidance.
- The NHS Trust Development Authority guidance on the “Capital Regime in Investment Business Case Approvals”

2.1.2 It follows the Five Case Model, which comprises the following key components:

- The strategic case section. This sets out the strategic context and the case for change, together with the supporting investment objectives for the scheme.
- The economic case section. This section identifies and evaluates the options for meeting the investment objectives, and identifies the preferred option taking account of benefits, costs and risks.
- The commercial case section. This outlines the content and structure of the proposed commercial arrangements.
- The financial case section. This confirms funding arrangements and affordability and explains the impact on the balance sheet and financial position of the Trust.
- The management case section. This demonstrates that the scheme is achievable and can be delivered successfully to cost, time and quality.

2.1.3 The strategic case section provides

- An overview of the Oxford University Hospital NHS Trust, and the key business strategies as far as they relate to the proposed investment;
- The case for change;
- The proposed investment objectives, scope, constraints and benefit criteria;
- An assessment of the strategic risks in relation to the investment.

2.2 Organisational Overview

2.2.1 The OUH provides a wide range of general and specialist health care services, primarily from four hospital sites: the Churchill Hospital, the John Radcliffe Hospital and the Nuffield Orthopaedic Centre in Oxford and the Horton General Hospital in Banbury.

2.2.2 The Trust provides general hospital services to people in Oxfordshire and neighbouring counties and specialist services on a regional and national
basis.

2.2.3 As well as Oxfordshire, a significant proportion of OUH's patients come from Buckinghamshire, Berkshire, Gloucestershire, Northamptonshire, Warwickshire and Wiltshire. OUH provides services in more than 90 clinical specialties.

2.2.4 It is one of the largest acute teaching hospitals in the UK. It has a national and international reputation for the excellence of its services and its role in teaching and research.

2.2.5 In 2013/14, the Trust's turnover was £868.3m. The Trust employs over 11,000 people.

2.2.6 The Trust's main commissioners are the Clinical Commissioning Groups covering Buckinghamshire, Berkshire, Gloucestershire, Northamptonshire, Oxfordshire, Warwickshire and Wiltshire, and NHS England.

2.3 The Estate

2.3.1 In total, the estate covers approximately 391,420m² of internal floor area over 73.8 hectares of land.

2.3.2 On this land the Trust operates and manages 220,720m² of retained estate; the remainder of the properties have been funded by Private Finance Initiatives (PFI), 29% of the estate, or are tenanted by the University or other third party occupiers under various tenant agreements.

2.3.3 55% of the John Radcliffe (JR) Hospital, OUH's largest site, was constructed in the 1970s. However there has been significant development since 2005 including the West Wing and Children's Hospital, both of which were financed by PFI, as well as the £29m Oxford Heart Centre which opened in 2009 and was jointly funded by the NHS and the University of Oxford.

2.3.4 Similarly 40% of the buildings at the Churchill Hospital site have been built since 2005, including a PFI build incorporating the Oxford cancer centre which opened in 2009.

2.3.5 Over 80% of the Horton General Hospital site was built prior to 1984.

2.3.6 The Nuffield Orthopaedic Centre site has been substantially renewed in the last ten years principally through the construction of the PFI funded main building.

2.3.7 At June 2014 the backlog maintenance costs at the JR and Churchill sites were identified as being:
### Table

<table>
<thead>
<tr>
<th>Risk Level</th>
<th>John Radcliffe</th>
<th>Churchill</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>High Risk</td>
<td>£20,000</td>
<td></td>
<td>£20,000</td>
</tr>
<tr>
<td>Significant Risk</td>
<td>£7,615,000</td>
<td>£647,000</td>
<td>£8,262,000</td>
</tr>
<tr>
<td>Moderate</td>
<td>£10,845,000</td>
<td>£2,726,000</td>
<td>£13,570,000</td>
</tr>
<tr>
<td>Low</td>
<td>£5,365,000</td>
<td>£1,350,000</td>
<td>£6,715,000</td>
</tr>
<tr>
<td>Risk Adjusted</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Backlog</td>
<td>£8,715,667</td>
<td>£918,667</td>
<td>£9,634,334</td>
</tr>
<tr>
<td>Total</td>
<td>£32,560,667</td>
<td>£5,640,667</td>
<td>£38,201,334</td>
</tr>
</tbody>
</table>

#### 2.4 The national strategic context

2.4.1 The NHS is one of the UK’s most energy intensive organisations, spending £750m on energy costs each year.

2.4.2 Energy costs and usage have been rising significantly over recent years. The cost of energy has risen ahead of inflation, and the usage has been rising as new medical technologies are introduced which are ever more demanding of energy.

2.4.3 It has been estimated that the NHS could save up to 20 per cent of its energy budget, a sum of £150m each year, through the use of energy efficiency measures.

2.4.4 The NHS Carbon Reduction Strategy for England was published in January 2009 and set a mandatory framework for NHS organisations to embed sustainability into their culture and activities, contributing to overall carbon emission reduction targets. The Strategy followed the introduction of the UK Climate Change Act 2008 which set out statutory emission cuts. The Carbon Reduction Strategy sets an initial target for NHS organisations to reduce emissions by 10% by 2015, in the context of the overall NHS carbon footprint arising from buildings (20%), transport (18%) and procurement (60%).

#### 2.5 The Trust strategic context

2.5.1 The Trust’s Mission is stated as: “The improvement of health and the alleviation of pain, suffering and sickness for the people we serve. We will achieve this by providing high quality and cost-effective healthcare.”

2.5.2 The Trust currently has six strategic goals set out in the IBP. The impact of the current energy system against these goals is set out in the table below.
<table>
<thead>
<tr>
<th>Trust Strategic Objectives</th>
<th>Key links to business case</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>S01</strong> To be a patient centred organisation, providing high quality, compassionate care with integrity and respect for patients and staff. <em>delivering compassionate excellence</em></td>
<td>There is substantial risk that care for patients could be compromised by failures in the existing and aged heating and electricity systems.</td>
</tr>
<tr>
<td><strong>S02</strong> To be a well-governed organisation with high standards of assurance responsive to members and stakeholders in transforming services to meet future needs. <em>a well governed and adaptable</em></td>
<td>The Trust cannot prepare adequate contingency and mitigation plans to address the risks presented by the unreliability of the current equipment.</td>
</tr>
<tr>
<td><strong>S03</strong> To meet the challenges of the current economic climate and changes in the NHS by providing efficient and cost-effective services and better value healthcare. <em>delivering better value healthcare</em></td>
<td>The existing equipment is expensive to operate and maintain, and does not deliver value for money.</td>
</tr>
<tr>
<td><strong>S04</strong> To provide high quality general acute healthcare to the people of Oxfordshire, including more joined up care across local health and social services. <em>delivering integrated healthcare</em></td>
<td>The quality of the care that the Trust provides is potentially put at risk by the high risk of failure of the current equipment.</td>
</tr>
<tr>
<td><strong>S05</strong> To develop extended clinical networks that benefit our partners and the people they serve. This will support the delivery of safe sustainable services throughout the network of care that we are part of and our provision of high quality specialist care for the people of Oxfordshire and beyond. <em>excellent secondary and specialist care through sustainable clinical</em></td>
<td>Network working could be compromised by potential failures in the current Trust energy systems.</td>
</tr>
<tr>
<td><strong>S06</strong> To realise the development of durable partnerships with academic health and social care partners and life sciences industry to facilitate discovery and implement its benefits. <em>delivering the benefits of research and innovation to partners</em></td>
<td>The Trust may not be seen as a reliable partner if its energy systems cannot be relied upon.</td>
</tr>
</tbody>
</table>

### 2.6 Estate Strategy and Objectives

#### 2.6.1 The Trust’s estate strategy is to:

- Provide a clear positive statement to public and staff on the Trust’s plans to maintain and improve facilities in support of clinical services;
- Ensure that the estate is aligned to the Trust’s clinical service and business
objectives and supports the achievements of the Trust's IBP;

- Align the capital investment programme with the Trust's clinical service strategies and allow future business cases for capital to be measured in a strategic context;

- Enable the estate to operate flexibly, economically and efficiently, providing and maintaining appropriate and affordable healthcare facilities which are fit for purpose, value for money, compliant with statutory requirements and support the provision of high quality clinical care;

- Support the overall alignment of the Trust's strategies (IT, workforce, financial, performance) and be consistent with operating as a Foundation Trust in the future with the assurance that asset management costs are appropriate and future action is taken to address those which fall outside targets;

- Keep under review service costs, risk management, support for sustainable development, environmental targets and legislative requirements;

- Give assurance to staff that they will have appropriate working environments and transition to any new facilities will be managed well with minimal disruption to their working lives and services.

2.6.2 These aims will be achieved through:

- Provision of inpatient accommodation and outpatient facilities that support patients' needs and in which staff feel proud to work;

- An improvement in the condition and performance of the estate as reported to the Department of Health annually;

- Co-location of appropriate services to achieve greater flexibility, efficiencies in occupancy costs and to realise benefits for patients and staff;

- Supporting service re-configurations in partnership with clinical staff, stakeholders, other health and social care providers and universities;

- Partnership arrangements or disposal of property and land that is surplus to future clinical, service and business needs.

2.6.3 Underpinning the strategy is the need to optimise the use of space, supporting the development of modern practices to enable staff to maximise their performance and productivity. This supports the Trust's vision for sustainable development, placing emphasis on the health and wellbeing of both staff and service users.

2.7 Energy and Emission Targets

2.7.1 The NHS has introduced the following mandatory targets for NHS bodies in England.

- Reduce the level of primary energy consumption by 15% or 0.15Mtc (Million tons of Carbon) from March 2000 to March 2010.
Achieve a target of 35-55GJ/100m$^3$ energy efficiency performance for healthcare estate for all capital developments and major redevelopments or refurbishments and all existing facilities should achieve a target of 55-65 GJ/100m$^3$.

2.7.2 Carbon Reduction Commitment (CRC) charges are now being levied in the sum of £15/Tonne CO2 per year. Industry expectations suggest that unit carbon cost is likely to increase substantially in the near future. The intended revenue recycling part of the CRC proposals has subsequently been removed from the scheme so the CRC charge is effectively an energy tax increasing the cost of electricity by 9.5% and gas by 9.6%.

2.7.3 The former DETR published good practice benchmarks for fossil fuel and electricity consumption for various building sectors. The energy consumption figures for 2010 are compared with the benchmark figures for acute and maternity hospitals. The following table illustrates this comparison:

<table>
<thead>
<tr>
<th>Utility</th>
<th>Consumption (GJ/100m3)</th>
<th>Benchmark (GJ/100m3)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fossil Fuels</td>
<td>51.5</td>
<td>56</td>
</tr>
<tr>
<td>Electricity</td>
<td>29.8</td>
<td>10</td>
</tr>
<tr>
<td>Total</td>
<td>81.3</td>
<td>66</td>
</tr>
</tbody>
</table>

Fossil fuel consumption compares favourably with good practice targets. Given that a significant proportion of the site is used for academic and research purposes there are notably reduced occupancy hours and consequently reduced energy demands. This is fortunate considering the condition of the central plant and the control system. In addition this gas is also used for cooling.

Conversely electricity consumption is nearly three times the best practice yardstick. The benchmark figures are derived from historic studies on buildings so it is likely that the electricity figure does not make allowance for the recent growth in electrical and electronic equipment that are allied to advances in medical practices. However at the most this might account for a potential circa 20% rise in electricity demand and not 200% as is being experienced.

As a result the John Radcliffe needs to create an annual saving of 16GJ/100m$^3$ or 20% in total energy consumption to meet these efficiency targets.

The benchmark comparison suggests that the site is far more profligate with electricity than it is with gas, so as much attention needs to be given to demand side management of electricity as to improving the efficiency of thermal generation.
2.8 Energy Consumption

2.8.1 Annual electricity consumption has increased by 24% between 2000 and 2010. This is a consequence of the addition of the new trauma building, Heart centre and AVIC building and also the on-going introduction of new medical and office equipment throughout the site, together with the installation of numerous local air conditioning units as part of the localised building refurbishment programmes. There is no sign of this trend abating in the foreseeable future.

2.8.2 Annual gas consumption has increased by 12% between 2000 and 2010. There was a significant jump in 2000 which coincided with the installation of the new steam boilers, which have a capacity much greater than the site demand. Variation in weather conditions can also have an impact, but weighting of the data by degree days makes little difference to the overall trends.

2.8.3 Therefore we can summarise that annual electricity and gas consumption has increased by 24% and 12% respectively over the last decade. Energy costs continue to rise above the rate of inflation with the price of electricity increasing by 150% and gas by 200% over the same period.

2.8.4 The base-year pricing for the investment appraisal is set at FY 2011/12. Over the last two financial years the Trust has experienced a further increase in energy costs. This is reflected in the table below.
### Existing Costs - John Radcliffe

<table>
<thead>
<tr>
<th></th>
<th>2011/2012</th>
<th>2013/2014</th>
<th>% Increase</th>
</tr>
</thead>
<tbody>
<tr>
<td>Gas Consumption</td>
<td>£907,132.38</td>
<td>£1,077,815.00</td>
<td>16%</td>
</tr>
<tr>
<td>Gas CCL</td>
<td>£70,554.74</td>
<td>£73,357.00</td>
<td>4%</td>
</tr>
<tr>
<td>Electricity Consumed</td>
<td>£1,685,068.87</td>
<td>£1,987,991.00</td>
<td>15%</td>
</tr>
<tr>
<td>Electricity CCL</td>
<td>£145,236.28</td>
<td>£159,453.00</td>
<td>9%</td>
</tr>
<tr>
<td>Electricity DUOS</td>
<td>£420,455.36</td>
<td>£428,238.00</td>
<td>2%</td>
</tr>
<tr>
<td>Electricity TNUOS</td>
<td>£142,091.00</td>
<td>£136,944.00</td>
<td>-4%</td>
</tr>
<tr>
<td>EUETS JRH</td>
<td>£2,645.96</td>
<td>£2,645.96</td>
<td>0%</td>
</tr>
</tbody>
</table>

**Average Increase** 15%

**Sub Total** £3,373,184.59 £3,868,143.96

### Existing Costs - Churchill

<table>
<thead>
<tr>
<th></th>
<th>2011/2012</th>
<th>2013/2014</th>
<th>% Increase</th>
</tr>
</thead>
<tbody>
<tr>
<td>Gas Consumption</td>
<td>£165,612.67</td>
<td>£196,207.00</td>
<td>16%</td>
</tr>
<tr>
<td>Gas CCL</td>
<td>£12,558.96</td>
<td>£12,352.00</td>
<td>-2%</td>
</tr>
<tr>
<td>Oil</td>
<td>£687,352.70</td>
<td>£815,205.00</td>
<td>16%</td>
</tr>
<tr>
<td>Electricity Consumed</td>
<td>£841,066.64</td>
<td>£726,490.00</td>
<td>12%</td>
</tr>
<tr>
<td>Electricity CCL</td>
<td>£55,162.87</td>
<td>£57,588.00</td>
<td>4%</td>
</tr>
<tr>
<td>Electricity DUOS</td>
<td>£75,036.00</td>
<td>£108,221.00</td>
<td>28%</td>
</tr>
<tr>
<td>Electricity TNUOS</td>
<td>£44,231.45</td>
<td>£52,607.00</td>
<td>16%</td>
</tr>
<tr>
<td>CIC Churchill</td>
<td>£20,319.57</td>
<td>£108,675.00</td>
<td>81%</td>
</tr>
</tbody>
</table>

**Average Increase** 22%

**Sub Total** £1,701,340.86 £2,075,345.00

**Total** £5,074,525.45 £5,941,488.96 17%

2.8.5 The average increase in energy cost at the John Radcliffe over these reporting periods was 15% but more concerning was the increase in energy costs at the Churchill Hospital at 22%. The cumulative effect of these rises was an average increase of 17%.
2.8.6 The corresponding average increase in the prices due to inflation over this timeframe was 2.9%. As the Performance Contract is activity based it is envisaged that the base year of 2011/12 will remain.

2.8.7 The following diagram is extracted from the Energy Price Index published by the Department of Energy & Climate Change in June 2014 and demonstrates the price effect of industrial fuels between 1995 and 2013:

- Compared to 2003, the average price of heavy fuel oil in 2013 has increased by 206 per cent in real terms, with a decrease of 4.9 per cent in 2013.
- In comparison, the annual average price of gas, including CCL, has increased by 133 per cent in real terms since 2003, with a rise of 8.5 per cent in the latest year.
- The average price of electricity, including CCL, has risen by 112 per cent in real terms since 2003, and by 3.7 per cent in the latest year.

2.8.8 The Trust pays VAT at 20% which is not reclaimable. The Trust also pays National Climate Change Levy rates of 0.485p per kWh for electricity and 0.169p per kWh for gas. The levy is applied before VAT is calculated; therefore the actual financial effect is greater.

2.9 The Carbon and Energy Fund Limited (CEF)

CEF Background

2.9.1 In 2011, Carbon and Energy Fund Limited (“CEF”) was launched by Greg Barker, the then Minister of State for Energy & Climate Change. Operating on a not for profit basis CEF was set up to make is as easy as possible for individual Trusts to upgrade their energy facilities. CEF enables NHS Trusts to carry out self-funded energy upgrades with implementation costs fully repaid over time through improved energy efficiency.

2.9.2 Governed by a partnering agreement CEF is a special purpose vehicle allowing different parts of the NHS work together. CEF employs an experienced team drawn from The Department of Health, NHS, Carbon Trust, National Services Scotland, National Procurement and NHS Strategic Buying Solutions. In effect CEF has drawn together key stakeholders, expertise and resource and provided a streamlined and cost efficient framework within which individual NHS Trusts can upgrade their energy systems. The CEF supports the entire project from feasibility to termination with significant benefits to member Trusts in the form of:
- Provision of expert advice, technical and legal.
- Significantly reduced project implementation time and costs.
- A streamlined procurement process drawing from a pool of carefully selected contractors.
- Reduced risk including implementation.

2.9.3 The energy upgrade framework developed by CEF includes access to a proven contract, payment mechanism, financial model and audit process, a panel of specialist advisors, access to capital and to a much reduced procurement process a pool of carefully selected contractors who tender for the works. Trusts get the right contractor whose performance can be guaranteed, measured and verified. There are sanctions under the contract and the framework for contractors who do not perform - for the life of the contract. CEF charges members no fees, but does recover costs from successful projects.

2.9.4 CEF with its strategic partners is on target with 240 sites over 16 years and through its success is set to become the vehicle of choice, for this type of project, for the whole public sector in the UK.

2.9.5 The Trust has selected to utilise the CEF as the procurement framework for the business case. The reasoning for this is set out below.

2.9.6 The CEF Limited has gathered together all the essential elements learned and developed from previous pilot projects and schemes, making them available to all Trusts in the NHS who are considering investing in their infrastructural supports.

2.9.7 In December 2012 Oxford University Hospital Trust became a member of this fund and has been working with key personnel in delivering the Energy Investment Programme for OUHT.

2.9.8 In full the CEF are referred to as the NHS SBS Carbon and Energy Fund, and the relationship between all the parties can be shown as:
2.9.9 The Trustees of the CEF represent:
- The Department of Health & Sustainable Development Unit of the NHS;
- Directors of Estates and Facilities that have managed pilots to the Fund (3);
- NHS SBS CPS (procurement);
- Carbon and Energy Fund (3);
- Carbon Trust Common Services Agency (National Services Scotland and National Procurement).

**CEF Purpose**

2.9.10 The CEF is a Special Purpose Vehicle created to allow different parts of the NHS to work together, and is governed by a Collaboration Agreement that assures the CEF works to secure the interests of the NHS.

2.9.11 The CEF gives Members a choice of advisors to assist them with the upgrade of their energy infrastructure. Advisors have been chosen for experience and are trained and supported from the CEF, working to the same standards and process, and all paid from the CEF. This assists Trusts to implement their projects without the costs and issues associated with appointing advisors.

2.9.12 The way that the Fund supports the Trust can be shown as follows:
Overview of how Trusts are supported

The CEF is intended by the Trustees to be the very best way for hospitals and NHS facilities to upgrade their energy infrastructure at no net cost to the Trust.

A copy of a signed Membership Agreement for OUHT is attached under Appendix 1.

CEF Procurement

OJEU process: Procuring an Energy Services Performance Contract would use an OJEU route, going to tender at European level in line with EU Procurement Regulations. Such a procurement process would usually take in the region of 24 months or more and is costly and time consuming. The Trust preference was the use of a framework compliant with European procurement regulations. Currently there are 2 main energy retrofit frameworks available to public sector bodies in the UK, namely RE:FIT and the Carbon Energy Fund.

The RE:FIT framework: The Greater London Authority established RE:FIT as a building retrofitting scheme to support public sector organisations to reduce their carbon footprint and subsequent energy bills. The RE:FIT Framework streamlines the procurement process for energy services by providing pre-negotiated contracts that can be used with a group of pre-qualified Energy Service Companies. RE:FIT is available to all public sector organisations in the UK but has mainly been used for the delivery of projects in the London area, with a strong focus on local authorities. The capital value of schemes is typically less than £1m with an emphasis on demand side measures.
2.9.17 The Carbon Energy Fund framework: The Carbon and Energy Fund manages a NHS framework specifically designed for energy retrofits repaid through guaranteed savings over a long term. The Framework was procured in 2011 under OJEU 2011S/ 23-037565, under the procurement guidance of NHS Shared Business Services (NHS SBS). The framework appointed ten bidders, and laid out a structured mini-competition process allowing for final bids after ITT, followed by a contract completion phase with a preferred bidder. The Carbon and Energy Fund provides very similar benefits to RE:FIT but with the additional advantage of being specially designed for the NHS, including a NHS developed contract that transfers guaranteed savings risk to the contractor. The capital value of schemes is typically between £1m and £40m.

2.9.18 Through the development of the OBC, the Trust identified the Carbon Energy Fund as the most effective available procurement route for delivery, owing to its NHS focus and experience with larger schemes such as the Trust proposal.

2.9.19 Market Interest: A soft marketing exercise was carried out with the CEF in autumn 2012 to ensure that the project would attract sufficient market interest from suitable contractors. This was the case.

2.10 Current Power Provision and Limitations

2.10.1 In 2011 the Trust engaged Halcrow Group Limited, a leading building services consultancy firm to carry out a review of its energy infrastructure within the retained hospital estate.

2.10.2 The aim of the brief was to set out a strategy for the refurbishment of the energy systems which would achieve reductions in carbon emissions and energy running costs whilst ensuring resilience against variation in future fuel costs and minimise the risk of system downtime.

2.11 The Halcrow report

2.11.1 A copy of the report is attached under appendix 2 and the main findings of the report with regard to the current systems were as follows:

John Radcliffe Hospital

2.11.2 Heating and hot water services at the John Radcliffe site are provided from a centralised boiler house located within the Industrial Block Area. The boiler house contains four 5860kW dual fuel boilers generating high temperature hot water (HTHW) which is pumped to outlying plant rooms around the site. At the plant rooms primary low temperature hot water (LTHW) is then used to provide space heating and hot water. The boilers normally fire on natural gas with diesel as the reserve fuel in case of interruption to the gas supply.

2.11.3 In addition to generating space heating and hot water the HTHW system is used to generate chilled water via absorption chillers located in the basement. The chilled water is used in air handling units to maintain temperature control in key areas such as theatres. This method of generating chilled water is only
cost effective when using unutilised heat generated by a combined heat and power plant (CHP) and therefore the chilled water system installed at John Radcliffe is not cost effective.

2.11.4 The boiler plant is over 40 years old and in regular need of remedial welding work to satisfy insurance inspectors. There is also a problem with the burner control systems on the individual boilers which, because of the old design of the linkage systems, rarely remain at acceptable firing efficiencies.

2.11.5 Because of the age of the boilers spare parts are no longer readily available and bespoke replacement parts have to be manufactured at considerable expense and time. Boiler no 3 has been out of action recently for this reason.

2.11.6 There is only a crude boiler sequencing control system which is ineffective. In practice the automatic sequencing of boilers is unreliable and requires estates staff to manually switch on and off boilers as the site heat demand changes.

2.11.7 New central steam boilers were installed at the end of 1999 to replace local steam generators feeding sterilisers around the site. Each of the two boilers has installed capacity of 3750kW compared to an estimated point of use demand of only 185kW. Both boilers are kept live for reasons of security of supply, so are only running on tick-over and are estimated to be operating at a seasonal efficiency of less than 25%. The reason behind the massive oversizing was reported to be to allow for steam to displace the HTHW boilers over time; however this project was never implemented.

2.11.8 The main HTHW distribution system is now suffering from frequent leaks, which necessitates shutting down the system or at least sections of it. However the subsequent contraction and expansion this causes to the system results in subsequent failures elsewhere in the system and the operation of long untouched isolation valves is a further source of leakages. Expansion bellows, flange and bend welds, and corroded pipe guides have also been recent sources of failures.

2.11.9 Site service controls are rudimentary and though some modifications have been made since the original installation they are generally not matching supply to demand, neither in terms of time nor temperature. There have been upgrades to the original pneumatic control system with an electro-pneumatic system linked to a central PC via dedicated cabling, but maintenance is costly.

2.11.10 Last year there was a major failure of the controls installation serving the operating theatre ventilation systems, which had to be replaced at a cost of £40,000.

2.11.11 Domestic hot water is generated via storage calorifiers or vertical shell and tube heat exchangers. The control of these is driven more by minimising the risk of legionella rather than final demand for domestic hot water. The inspection and maintenance of these domestic hot water generators account for significant labour and financial commitments.
Churchill Hospital

2.11.12 The Churchill Hospital site was originally established in 1942 and has continued to be developed. A large part of the site is served by a modern PFI unit which has new energy generation plant (boilers) and associated infrastructure.

2.11.13 Hot water, space heating and steam for sterile services for the remainder (non-PFI element) of the estate is generated from a centralised boiler house, which forms part of the original 1940s construction. The boiler house contains three steam boilers which were installed in the 1960s. All three boilers use heavy fuel oil (HFO) as the primary fuel. There is currently no gas supply to the boiler house which would allow the plant to be converted to cleaner, lower cost natural gas firing.

2.11.14 Steam is used to generate domestic hot water and heating, either by conversion to low temperature hot water which is circulated to outlying plant rooms or by direct conversion in the boiler house. Steam is also piped directly to the sterile services department.

2.11.15 Both the steam and LTHW distribution systems were installed in the 1940s and much of it is buried and not accessible for repairs.

2.11.16 Whilst the boilers and associated ancillary boiler plant is functional at Churchill Hospital, the system has been prone to failures and is operationally resource intensive. Burning of HFO in the boilers further increases energy costs (compared to gas) and results in increased carbon emissions. In July 2014 one of the steam boilers failed its insurance inspection and currently there is a hire boiler connected to the system to maintain supply resilience.

2.11.17 An on-going issue is that boilers 2 and 3 regularly dump heavy oil in their combustion chambers causing the boiler to be shut down for cleaning and repairs. The Trust has leased a further boiler to ensure continuity of supply as a result of this.

2.11.18 Controls across the two hospital sites are operated by five different BMS systems. These have been unreliable and should ideally be integrated into one system.

General

2.11.19 The benefits of good housekeeping should not be overlooked as evidence suggests that instilling awareness amongst staff not only results in significant energy savings but can also improve the building users’ satisfaction with their working environment.

2.11.20 The building fabric insulation standards of forty year old buildings are inevitably greatly inferior to that required under current Building Regulations or would be considered as good practice today. Opportunities should be taken whenever refurbishment of the building envelope is considered to improve its thermal performance. Recovering roofs is one obvious example, windows are
another.

2.11.21 If rather than repairing the existing wooden single glazed windows, there was a programme to replace them with high performance double glazed units this would not only achieve substantial reductions in heat loss, but would improve comfort conditions for patients whose sensitivity will be all the greater because of their state of health and their clothing level.

2.11.22 There are further benefits of improved sound reduction and the possibility of incorporating encapsulated blinds to reduce glare and summer heat gains without the normal hygiene issues and maintenance costs associated with exposed blinds.

Summary

2.11.23 The existing and time expired infrastructure presents a risk to the continued provision of the Trust’s clinical services in its current condition.

2.11.24 The majority of the heating and hot water services is 40 years old and is now significantly older than the recommended maximum economic life for these types of systems. The result of this is that equipment and pipework mains are failing. Spares for obsolete parts need to be manufactured. Where possible, equipment is patched up to prolong its life. Pipework leaks are frequent occurrences, and the required cooling down of the system to allow work to take place by itself causes further leaks and joint failures.

2.11.25 The existing equipment is energy inefficient with inadequate controls which further reduce operational efficiency. Site distribution mains also represent significant loss of energy due to inadequate insulation. Upgrading the systems is an opportunity to improve both heating and hot water, and at the same time reduce energy consumption significantly.

2.11.26 The systems will continue to deteriorate, impacting business continuity, reducing comfort levels of patients and staff and costing substantially more than is necessary.

2.11.27 The Trust would also need to use funds from its limited capital programme to maintain services.

2.12 Drivers for Change

2.12.1 The Trust does not believe that the current energy infrastructure is fit for purpose. Its age and condition mean that partial failures resulting in additional maintenance or hire cost are regular, and full failure is a significant risk. In addition it is inefficient by current standards.

2.12.2 With the introduction of the UK Climate Change Act 2008 requiring a statutory emission reduction, the introduction of the Climate Change Levy and the publication of the NHS Carbon Reduction Strategy for England in January 2009 there is a requirement for NHS organisations to make changes in their estate, operational activities and cultural attitudes to sustainability.
2.12.3 The Carbon and Energy Fund Limited (CEF) has been created in recent years to share best practice for implementation of new energy schemes, and to assist Trusts to access funding which means their own capital allocations are not required for the work to be carried out.

2.12.4 The CEF model for energy schemes is to place contracts with energy companies for the implementation and operation of energy systems over a number of years. This allows Trusts to place reliance on companies to deliver safe and efficient energy systems without requiring further operational cost or investment of additional capital.

2.12.5 A summary of the above indicate that the main drivers for change include:

- The risk of major failure endangering patient services;
- The need to replace out of date plant and equipment;
- The need to reduce carbon emissions and energy consumption to meet targets;
- The opportunity to reduce on-going revenue costs;
- The opportunity to take advantage of external funding rather than requiring the Trust's capital programme to be amended, also reaching investment areas that would not be sufficient priorities for the Trust;
- The ability to transfer risk to the private sector.

2.13 Aim and Benefit of the Energy Investment Programme

2.13.1 In addition to supporting the Trust’s strategies, this project aims to:

- Reduce gross energy consumption
- Deliver a reduction in carbon emissions of around 33%
- Rationalise plant and improve utilisation of resources
- Make provision for future development
- Reduce site backlog and invest in long term sustainable development

2.13.2 In addition to this it is expected that the reduced energy consumption will result in reduced costs for the Trust, freeing on-going revenue resources.

2.13.3 The investment objectives and benefit criteria used within this FBC are set out below. The FBC economic appraisal also assesses the financial impact of the options and the relative risk.
<table>
<thead>
<tr>
<th>Benefit</th>
<th>Performance Measure</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Reduced energy cost</td>
<td>Annual energy expenditure</td>
<td>Reduction of circa £2.2m a year From circa £8.5m to £3.3m</td>
</tr>
<tr>
<td>Improved estate infrastructure</td>
<td>Risk adjusted backlog costs</td>
<td>A reduction in backlog maintenance of circa £11m</td>
</tr>
<tr>
<td>Improved maintenance</td>
<td>Reactive/proactive maintenance ratio</td>
<td>Change in ratio from 90/10 to 20/80</td>
</tr>
<tr>
<td>Reduced urgent capital expenditure</td>
<td>Reduce pressure on Capital Funds</td>
<td>Annual capital costs on replacement Infrastructure @ 3.5%</td>
</tr>
<tr>
<td>Reduce carbon</td>
<td>Measured reduction</td>
<td>Annual 11,000 tonnes reduction in CO2. From 30,500t to 19,500t</td>
</tr>
</tbody>
</table>

2.14 Scope

2.14.1 The Halcrow report is discussed at 2.11 above but a summary of the scope and service requirements recommended in the report is as follows:

- Installation of CHP combined heat and power plant;
- Replace obsolete boiler plant and associated equipment;
- Address issues with HTHW (High Temperature Hot Water) distribution pipework;
- Reduce operating costs;
- Improve resilience and business continuity.

2.14.2 The anticipated investment objectives of this project are:

- A reduction in the Trust's carbon footprint;
- A reduction in the Trust's site running costs;
- Improvements in the Trust's energy infrastructure;
- Recognition as an exemplar for energy efficiency and carbon reduction;
- Support of the continued delivery of clinical services
- Improve resilience of the existing time expired infrastructure
- Management of the risk of introducing leading edge technologies by entering into a design, build and operate contract with an industry expert.

2.15 Constraints and Dependencies

2.15.1 The main constraints and dependencies of this project are:

- Approval by TDA
- Availability of Trust Technical and project management resource
- Trust Board approval
- Operational estates champion
- Appreciation of critical state of existing infrastructure
- Agreement of contract terms
- Independent review of contract and payment mechanism
- Financial and other resource changes that may take place during this period
- The skill of managerial staff to manage and motivate personnel in a period of great uncertainty and impending change.

2.16 Strategic Risk

2.16.1 The main strategic risks of not replacing the outdated facilities are:
- Not having a mechanical and electrical infrastructure to support the Trust’s future clinical strategy;
- Catastrophic failure resulting in potential harm to the patient and the reputation of the Trust;
- Possible breakdowns in energy and heating systems which can impact on delivery of clinical services;
- Issues arising which may hamper the Foundation Trust application;
- Non-compliance with National Guidelines and Targets.

2.16.2 As part of the Halcrow and Jacobs reports a quality assessment on the existing infrastructure at the John Radcliffe and Churchill sites was undertaken. The findings and recommendations are considered under section 7 and 5 of their reports respectively. A separate Quality Impact Assessment forms part of this Full Business case and is included in section 6.

2.16.3 The Senior Responsible Officer (SRO) for this business case is Mark Trumper, Director of Development and the Estate.

2.16.4 The SRO will be responsible for undertaking a Health Risk Potential Assessment (RPA) against a set of high-level criteria for assessing the risk potential of this project. This is referred to in the management case.

2.17 Summary and proposed solutions

2.17.1 As we have seen the existing Trust energy infrastructure covering the John Radcliffe and Churchill Hospital sites is no longer fit for purpose, being unreliable, inefficient and expensive to maintain.

2.17.2 This has led the Trust to undertake a review of options for updating and upgrading the energy infrastructure. The Trust has received professional advice on the various energy solutions currently available to it, and the options which best fit its needs.

2.17.3 As a result of this the Trust has become a member of the Carbon and Energy Fund Limited, a NHS partnership which aims to help Trusts upgrade their
existing energy infrastructure to reduce carbon emissions and deliver financial savings to the Trust.

2.17.4 As the economic case will show, the preferred option is based on collaboration between the Trust, Carbon and Energy Fund Limited and Vital Energi Solutions Limited as preferred bidder. While the Trust will benefit from improved infrastructure and associated savings Vital Energi Solutions Limited will:

- Carry out the installation works;
- Manage the provision of services;
- Manage the maintenance of the facilities.

2.17.5 In doing so they take the majority of the risk associated with the energy infrastructure for the life of the proposed contract (25 years).

2.17.6 The proposed contract will deliver guaranteed financial and carbon savings, and a substantial reduction in overall energy consumption, allowing the Trust to meet its targets in these areas.
3. The Economic Case

3.1 Introduction

3.1.1 In accordance with the Capital Investment Manual and the requirements of HM Treasury’s Green Book (A Guide to Investment Appraisal in the Public Sector), this section of the FBC documents the procurement process and provides evidence to show that we have selected the most economically advantageous offer which best meets our service needs and optimises value for money.

3.1.2 The Trust has reached the FBC stage of this development working in partnership with the Carbon Energy Fund Limited (CEF), a special purpose vehicle created by the Department of Health and others to promote shared learning on energy developments of this kind. The CEF have initiated a framework purchasing arrangement which the Trust has made use of to minimise procurement costs and timescales.

3.2 Critical Success Factors

3.2.1 The critical success factors shown within the OBC were as follows:
- Achieving the mandatory target of 10% reduction in carbon emissions;
- Suitably qualified and experienced staff in place, with appropriate skills;
- Trust infrastructure is in place for savings to be achieved;
- Robust processes to ensure economic, operational and other benefits are delivered;
- Stability within the operational estates workforce to assist with the on-going interface between the Trust and the contractor;
- Senior management support and board champion
- Trust Board and TDA approvals;
- Planning approvals;
- Obtaining a place in the production line for the generator engine;
- Minimisation of disruption to patient services;
- Continued involvement of CEF as an independent audit for the monitoring and validation and contract performance monitoring in liaison with the Trust.

3.2.2 Of these factors, planning approvals and the place in the production line for the generation engine have been achieved, and are in place for the development to move forward.

3.3 Option Development Process

3.3.1 As described in the OBC the option development process was an iterative one in which the work was undertaken in the following main phases:
• The Halcrow report
• Obtaining an experienced strategic partner
• The Jacobs report
• Tendering process for contractor
• Preparation of the public sector comparator
• Options appraisal process
• Recommendation of the preferred option

3.3.2 To describe this process in more detail, the Trust had identified the need to undertake work to improve its energy infrastructure, particularly at the Churchill and John Radcliffe sites where existing plant and equipment was close to the end of its useful life.

3.3.3 The age, condition, maintenance, outputs and risk to Trust services of the energy infrastructure leaves the Trust with little option but to make changes in this area. The option development process will arrive at the preferred option for the Trust in making these changes.

3.3.4 Rather than direct replacement of the existing plant and equipment, and in view of the Trust’s targets discussed in section 2 to reduce energy consumption and carbon emissions, the Trust commissioned the engineering consultancy company Halcrow Group Limited to set out a strategy for refurbishment of the energy systems. The full report is attached as appendix 2 and is discussed at 2.11 above.

3.4 Development of Long-list

3.4.1 The issuance of the Halcrow report in December 2011 identified considerable opportunities for improvements and efficiency gains in the Trust’s energy systems. This report reviewed the Trust’s options for improvements, covering demand and supply side changes including lighting controls and upgrades, biomass generation and photovoltaic cells.

3.4.2 The full list of options is shown in the table below.
<table>
<thead>
<tr>
<th>Long Listing alternatives for consideration</th>
<th>OSC decision on shortlisting</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Refurbishment</td>
<td>The existing time expired plant is reaching its life expiry and the structural components of the plant and infrastructure are becoming unserviceable.</td>
</tr>
<tr>
<td>2. Biomass</td>
<td>Biomass was considered in detail for both sites</td>
</tr>
<tr>
<td>3. Solar energy</td>
<td>Considered</td>
</tr>
<tr>
<td>4. Wind power</td>
<td>Self-generated - the electricity capacity of a wind turbine would need to be significant in order to achieve sufficient costs savings and carbon reductions for this project.</td>
</tr>
<tr>
<td>5. Wind power</td>
<td>Off site generation</td>
</tr>
<tr>
<td>6. Hydro power</td>
<td>Considered</td>
</tr>
<tr>
<td>7. Connection to a district/community heating scheme</td>
<td>Considered</td>
</tr>
<tr>
<td>8. Decentralisation</td>
<td>Considered for the Churchill site</td>
</tr>
<tr>
<td>9. Central Plant</td>
<td>Considered for the JR site</td>
</tr>
<tr>
<td>10. CHP</td>
<td>Considered for the JR site</td>
</tr>
<tr>
<td>11. Heat exchange</td>
<td>Considered</td>
</tr>
<tr>
<td>12. Controls, metering &amp; Monitoring</td>
<td>Considered</td>
</tr>
<tr>
<td>13. Standby Generation - John Radcliffe site</td>
<td>The current standby generation system at site meets HTM requirements. The Trust did consider an option to upgrade the standby generation system to provide additional back-up supplies to the site.</td>
</tr>
<tr>
<td>14. Standby Generation - Churchill site</td>
<td>Considered</td>
</tr>
<tr>
<td>15. Uninterrupted power supplies (UPS)</td>
<td>Considered</td>
</tr>
<tr>
<td>16. Demand Side reductions</td>
<td>Reductions in demand for power through replacement of light fittings with modern efficient equivalents, and campaigns to increase awareness of need for power conservation are sensible for the Trust to undertake.</td>
</tr>
</tbody>
</table>
3.4.3 It was concluded in the report that the Combined Heat and Power (CHP) arrangement with demand side measures was the best way forward for the Trust.

3.4.4 The Trust then conducted an informal review of the market place for a strategic partner with experience in delivering energy system improvements including potential funding solutions for the scheme.

3.4.5 The Carbon and Energy Fund Limited (CEF) was identified as the best option for the Trust. In line with established CEF procedures, the Trust and CEF jointly commissioned a feasibility report on the proposed energy scheme to establish that it met the requirements of CEF’s funders, and delivered a positive return for the Trust. This is the Jacobs report included as Appendix 3.

3.4.6 In order to complete the option appraisal the Trust went to the market to identify the range of technical solutions available.

3.4.7 In early January 2013 an Invitation to Mini Competition (ITMC) was issued to all ten contractors on the CEF framework at that time. Contractors were also invited to attend a formal Open Day on the 25th of that month where the suppliers were given an introductory address by the Trust Director of Development and the Estate, followed by a presentation from the Trust project team and the CEF, demonstrating the scope of projects identified in the Jacobs feasibility study. This was followed by a question and answer session and a site tour of the relevant parts of the John Radcliffe and Churchill hospitals.

3.4.8 It is important to note that the content of the Jacobs report was indicative only of the type of measures that could have been undertaken at the two sites with an assessment of the scheme’s viability (i.e. could the capital be paid by the savings generated over a long term). The CEF process then allows the selected bidders to use their expertise and innovation to prepare bids that find the optimum balance to maximise the savings to the Trust for the level of investment required.

3.4.9 The following companies attended the open day:

- Cofely Energy Services Ltd (then Balfour Beatty Workplace)
- MCW (Breathe)
- Dalkia
- EnerG
- Mitie
- Vital Energi

3.4.10 Following the presentations and site visits, these companies were invited to express an interest in joining the tender exercise to deliver the Trust’s requirements. At this stage Cofely Energy Services and EnerG withdrew.

3.4.11 The Trust and CEF then held discussions with the representatives of the remaining four companies to confirm their understanding of and interest in
bidding for the work, and following these meetings MCW (Breathe) withdrew as they confirmed that they did not have the capacity to undertake the required level of work.

3.4.12 Considering suppliers have to underwrite a significant financial investment at their own risk right up to preferred bidder appointment, it is to be expected for only a limited number of suppliers to pursue a particular project. Suppliers will focus their resources on projects which meet an acceptable risk profile in terms of probability of contract award, based on the match between the supplier's known strengths, supply chain and the defined project scope.

3.4.13 Therefore the following three companies were shortlisted to enter into technical dialogues with the Trust prior to the resumption of the mini competition procurement process:

- Dalkia
- Mitie
- Vital Energi

3.4.14 The purpose of the technical dialogue was to ensure that the bidders each had a full understanding of the Trust site data, plant and equipment before the tender process which works to very tight timescales.

3.4.15 A period was allowed to the bidders to carry out any survey/investigative works that they wished prior to the issue of the tender documents. In this period 2 meetings were held with each bidder to allow them the opportunity of discussing the content of their bids (in confidence). This also allowed the Trust to consider any innovation being offered by the market.

3.4.16 The specification used in the tender documentation was an output specification and bidders were free to plan the delivery of the output in any way that they saw fit. This was incorporated within the ITT document itself, which was issued with the template form of contract and the financial proformas for the scheme. This lead to differences in approach, and it was necessary to ensure that additional costs to the Trust were identified to confirm that the whole life cost of the arrangements were included in the bid evaluation.

3.4.17 As bids were developed and amended the Trust maintained a Public Sector Comparator (PSC) that was in line with the bids and this was updated to the preferred bid following the evaluation, and subsequently through the bid development phase, to ensure that the options appraisal carried out was fair.

3.5 The Long-listed Options

3.5.1 Using the analysis of viable and non-viable options included in the Halcrow and Jacobs reports, the Trust and CEF were able to draw up the following long-list of acceptable options.

John Radcliffe Hospital
3.5.2 In summary a core project comprising of a 2.0MWe gas fuelled reciprocating CHP, replacement of life expired boilers, conversion of existing heat distribution from HTHW to MTHW/LTHW and lighting up-grade installations should all be technically viable, and deliver a positive NPV for the Trust.

3.5.3 To describe this part of the scheme in more detail:

- A 2.0MWe natural gas fuelled spark ignition reciprocating CHP engine located within the existing boiler house in the space currently occupied by the existing process steam generation plant.

- Separate stand-alone localised steam generators would be installed to replace the existing central steam boilers that are currently significantly oversized for the level of load served. This would remove the maintenance costs associated with existing steam distribution and improve process steam utilisation efficiency.

- An alternative option could be considered that looked at retaining one of the existing steam boilers and converting it to utilise waste heat recovery from the new CHP high temperature exhaust. This would avoid installation of new localised process steam generators but retains the existing steam distribution.

- The existing life expired gas fired HTHW boilers would be replaced with new high efficiency gas fired boilers with a dual fuel option if required.

- Approximately 70% of the existing HTHW pipework distribution capacity would be retained and operated at MTHW (circa 120°C). This would enable optimum compatibility with the CHP high temperature exhaust heat recovery and retain compatibility with existing absorption chiller heat input temperatures.

- An alternative option could be considered that looked at providing an engine optimised to deliver MTHW only. This is likely to involve a de-rated electrical output engine selection. This arrangement has been provided on other projects and would negate the requirement to run separate LTHW circuits, although the overall energy efficiency of the scheme would reduce.

- Works may also encompass remedial repairs and replacement of sections of existing HTHW pipework if necessary. The extent of works required would be subject to a detailed pipework condition survey.

- A new LTHW distribution circuit would be installed to utilise recovered heat from the CHP engine jacket to connect into local space heating and domestic hot water (DHW) calorifiers. Existing plant room shell and tube heat exchangers would be replaced with new plate heat exchangers where required.

- New pipework would be routed via the existing basement level service tugways at high level.

- The new CHP and boilers would utilise the existing retained or refurbished boiler house flue stacks.

- The power generated by the new CHP would be at LV and a new step-up transformer would be provided to enable connection to the site HV ring via
a new HV switch installed within the existing HV main intake substation adjacent to the existing boiler house within the 'Industrial Block'

- Replacement of existing T8 and T12 fluorescent lighting within ward, circulation, administration and academic blocks with new T5 fluorescent tubes and/or LED replacement where possible. This might also be enhanced with PIR and daylight controls in certain areas. An approximate lighting retrofit change-out of 2,500 fittings across the hospital has been estimated initially. The exact number would require a detailed lighting survey to estimate.

**Churchill Hospital**

3.5.4 In summary a core project comprising replacement of the life expired centralised oil fired steam boilers with a new part decentralised boiler installation operating on natural gas, delivering LTHW with steam utilised for localised process use only should be technically viable. The estimated base heat demand for Churchill hospital may not support a CHP, however other enhancements could be provided such as retrofitting HVAC fan and pump motor variable speed drives, local improvements to existing LTHW controls, upgrades to existing BEMS and retro-fit of 50kWp photovoltaic (PV) array. This scheme should all be technically viable, and deliver a positive NPV for the Trust.

3.5.5 To describe this part of the scheme in more detail:

- Retention of the existing LTHW and DHW distribution systems serving the central core.
- Disconnection of the life expired steam distribution system serving the outlying heat exchanger plant rooms.
- Existing steam boilers would be removed and replaced with high efficiency dual fuel (natural gas and oil) LTHW boilers and new distribution pumps to serve the central core.
- Generally the outlying plant rooms would be disconnected from the redundant steam service and provided with new packaged gas fired LTHW boilers. The viability for this would need to be looked at in more detail and it is likely to be subject to ability to locate plant and route new gas adjacent to utilisation. The requirement for dual fuel operation in outlying plant rooms would need to be agreed with the Trust. The potential for pumping oil from the Trust's existing storage is unlikely to be viable and so new localised storage would need to be considered.
  - Existing steam calorifiers/heat exchangers within outlying plant rooms would be replaced with LTHW plate heat exchangers or direct connections to new LTHW boilers.
  - Where steam is still required for process use, then localised packaged gas-fired steam generators would be provided in local plant areas or areas close to point of use if possible. The viability for this would need to be looked at in more detail and it is likely to be subject to ability to locate plant and route new gas adjacent to utilisation.
• Any steam utilised within kitchens would be replaced with electrical or gas appliances.

• A new 90mm dia PE gas service including utility and meter would be provided connecting to the existing 125mm MP PE within Churchill Drive. The service would be extended from the main meter to serve the new LTHW boilers in the existing boiler house and the new localised LTHW packaged boilers and packaged process steam generators within the outlying plant rooms.

• Replacement of existing T8 and T12 fluorescent lighting within ward, circulation and administration areas with new T5 fluorescent tubes and/or LED replacement where possible. This might also be enhanced with PIR and daylight controls in certain areas. An approximate lighting retrofit change-out of 800 fittings across the hospital has been estimated initially. The exact number would require a detailed lighting survey to estimate.

3.6 Further development of Long-list Options

3.6.1 Prior to shortlisting of the viable options, the Trust invited each of the bidders to create a feasible scheme involving a core and variant bids. The invitation to Tender used an output specification which required the bidders to deliver an energy scheme which met the energy needs of the Trust, delivered significant reductions in energy cost and carbon usage, and accept the risks of installation and delivery of the scheme over its lifespan.

3.6.2 Bidders were invited to submit core bids which met the Trust's specification, and also any variant bids that could enhance the core proposal and improve the overall value of the project to the Trust.

3.6.3 The critical success factors as defined at the OBC stage and listed at 3.2 above remain relevant to these short-listed options.

3.6.4 As described below in section 3.9 these bids were scored and ranked using a predetermined methodology which is standard across CEF projects and determined for the OJEU process for the selection of contractors on to the framework. This gave a preferred contractor option for comparison.

3.6.5 The Trust calculated the amount of capital investment that would be required over the proposed period of any contract, as a minimum to maintain security of supplies, and reduce the risk of failure to acceptable levels.

3.6.6 The Trust also prepared calculations for a public sector comparator which would involve undertaking the same level of work, and introducing the same new equipment as the preferred bid, but with using internal Trust resources for funding and management of the project rather than a commercial partner. As bids were developed, this was updated to ensure it remained comparable.

3.6.7 The public sector comparator includes allowance for contingencies and optimism bias (allowances for unforeseen cost pressures emerging) of 22.98% of the capital cost.
3.7 Contract Period

3.7.1 The project team carried out an analysis of the funding and term options as set out in the following table.

<table>
<thead>
<tr>
<th>Criteria</th>
<th>Weighting 15 Years</th>
<th>Weighting 25 Years</th>
</tr>
</thead>
<tbody>
<tr>
<td>Saving benefit</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>Risk Transfer</td>
<td></td>
<td>1</td>
</tr>
<tr>
<td>Impact on Tendering Process</td>
<td>-1</td>
<td></td>
</tr>
<tr>
<td>Lifecycle Ownership</td>
<td>-1</td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td>-1</td>
<td>2</td>
</tr>
</tbody>
</table>

3.7.2 In considering the savings benefits at 15 and 25 years there are no additional financial savings made by moving to the longer period. However running the savings guarantee over a longer period delays the risk associated with retendering the contract after 15 years as it may be found that the savings are no longer available at that point.

3.7.3 As the majority of risk transfers to the preferred bidder over the life of the agreement, a longer contract period is more attractive to the Trust.

3.7.4 The cost to the Trust in carrying out a tendering process for such a specialist service provision is onerous and restrictive when considering both financial and time resources. In extending the contract to 25 years we are reducing these costs to the Trust and managing cash availability.

3.7.5 Much of the equipment required for the energy strategy has an economic life of 15 years. Extending the contract to a longer term means that the contractor will be required to repair and replace this equipment, whereas ending the contract at 15 years would mean that the Trust must find a method to replace the equipment at the end of the contract.

3.7.6 Extending the life of the contract has enabled the contract to include an energy link between sites, without increasing costs or reducing savings by a great deal. Given the relative close proximity of the John Radcliffe and Churchill sites the Trust has a unique opportunity to further reduce carbon emissions by utilising heat and electricity generated by the CHP engine at John Radcliffe site at the Churchill site. To achieve this, an “energy link”, which comprises installing heating pipes and electric cable between the sites, will interconnect the two energy centres and respective sites. By linking the two energy centres a larger capacity CHP can be installed at the John Radcliffe site which increases efficiencies compared to installing a smaller standalone solution for John Radcliffe site and having boilers only at the Churchill site which in itself does not have sufficient loads to warrant having its own standalone CHP unit.

3.7.7 These efficiencies generate additional savings which over the longer life of the contract mean that the energy link is paid for without greatly impacting on the overall savings level. Although the financial savings are consumed by the cost
of the energy link, the Trust does realise additional savings in carbon usage as a result of this development.

3.7.8 It was concluded from this analysis that the best option for the Trust was a contract length of 25 years.

3.8 Short list

3.8.1 The Trust used the CEF procurement framework and selected a preferred bidder which then resulted in a shortlist of 3 options:

- Do minimum/nothing
- The Trust to carry out the upgrade themselves benchmarking against a Public Sector Comparator
- Outsource to a contract provider through a procurement route

3.8.2 The preferred and agreed option at OBC stage was to outsource the contract to the preferred bidder, Vital Energi Solutions Limited, who could design and install an energy scheme for the Trust and provide operation and maintenance services for a 25 year period.

3.8.3 Standard practice would be to go to procurement for this option, but as this has already been conducted using the CEF procurement framework, the Trust is able to move forward promptly with the FBC. However for completeness the bidding process is summarised below.

3.9 Procurement Process and Appraisal of Bids

3.9.1 As described in section 3.4 above the Trust worked within the CEF procurement framework to issue an output based tender specification which allowed bidders to innovate in order to provide the largest energy and carbon reductions and best value for money.

3.9.2 Invitation to Tender documentation was released to the three shortlisted suppliers on 12th April 2013 via the Carbon Energy Fund’s secure project website. Mid Term reviews were held on 12th May 2013 and all three companies submitted fully costed bids on 29th May 2013. Following that the suppliers formally presented to the Trust team on the 4th June 2013. Formal evaluation began on the 7th June 2013.

3.9.3 Each of the three companies submitted a core bid covering the minimum specified in the tender documentation, and a variant bid describing the additional savings opportunities for the Trust and any consequent costs. The core bids were over terms of 15 and 25 years and the variant bids were also over a 25 year term.

3.9.4 This meant that there were 9 bids to be scored. The principal difference between the bids was the financial element, in that the differing bids had differing capital investments, annual costs and guaranteed savings for the Trust.
3.9.5 The Bid evaluation criteria are defined in the following table which is the CEF framework standard evaluation criteria, and put a strong emphasis on the NPV of each bid.

<table>
<thead>
<tr>
<th>Criteria</th>
<th>Weighting - Excluding Sub Criteria</th>
</tr>
</thead>
<tbody>
<tr>
<td>A. Project Management</td>
<td>5%</td>
</tr>
<tr>
<td>B. Legal</td>
<td>Pass/Fail</td>
</tr>
<tr>
<td>C. Financial</td>
<td>10%</td>
</tr>
<tr>
<td>D. Savings</td>
<td>40%</td>
</tr>
<tr>
<td>E. Innovation and services / design</td>
<td>30%</td>
</tr>
<tr>
<td>F. Service Delivery</td>
<td>10%</td>
</tr>
<tr>
<td>G. Programme</td>
<td>5%</td>
</tr>
<tr>
<td>Total</td>
<td>100%</td>
</tr>
</tbody>
</table>

3.9.6 Further information on the methodology used to derive the scores against these criteria is shown in appendix 5.

3.9.7 These criteria align with the Trust project objectives and the project critical success factors.

3.9.8 Clarifications were sought to ensure that bidders hadn’t misinterpreted the Trust’s requirements which allowed the Trust to confirm that the bids were being compared equally. The evaluation team also reviewed external data sources to compare capital costs to understand if any bid had been under-priced and ensure gaming (bidding low and hoping to reduce costs at the contract stage) had not occurred.

3.9.9 The scoring matrix used by the evaluation team to arrive at a preferred bidder is shown in the table below. The evaluation team included the Director of Development and the Estate, The Deputy Director of Development, and the Estate, senior estates operational managers, estates business partner, Trust procurement representative and CEF representatives.

3.9.10 The headings used in the scoring matrix are:

- Project management approach – the project management structure and process that the bidder will use to oversee the installation of the scheme;
- Legal response – pass or fail on whether the contractor accepts the contract terms of the standard CEF project agreement;
- Financial Response – the manner of the bids’ financial construction i.e. how the bidder is funding the scheme;
- Guaranteed Savings response – the level of monetary savings provided by the scheme as identified by the Net Present Value;
- Approach to design and construction – the technical detail included in the design of the scheme, including the innovations proposed;
- Approach to service delivery – the way services will be managed and delivered during the operational period of the contract; and
- Project programme and timescales – the length of time for installation and
how this will be co-ordinated with the Trust's energy needs.

3.9.11 Scores given for Project Management, Legal, Service Delivery and Programme criteria were identical. This means that the deciding criteria were the Financial, Savings and Innovation shown by the bids. These were the areas given the highest weighting.

3.9.12 The guaranteed savings response score is based solely on the NPV of the bid in which the savings available to the Trust form a significant factor. NPVs have been calculated by the Trust using the information in the bids, and the judgement of the evaluation team regarding any additional costs that the Trust may need to incur as part of the bidders plans.

3.9.13 The evaluation team assessed all bids received but to ensure comparability the scoring template above was prepared for the core bids received for 15 and 25 years and the variant bids covering 25 year terms. Each company submitted a minimum of three bids covering these options.

<table>
<thead>
<tr>
<th>Decision Number</th>
<th>07.06.13</th>
<th>Visit</th>
<th>Core A 15 Years</th>
<th>Core A 15 Years</th>
<th>Vendor 25 Years</th>
<th>Core 15 Years</th>
<th>Core 25 Years</th>
<th>Core 30 Years</th>
<th>Variant 25 Years</th>
<th>Core 25 Years</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>Project Management Approach</td>
<td>5.15%</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>B</td>
<td>Legal response</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>C</td>
<td>Financial</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>D</td>
<td>Guaranteed savings response</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>E</td>
<td>Approach to design and construction</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>F</td>
<td>Approach to service delivery</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>G</td>
<td>Project programme and timelines</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

3.9.14 The key features of, and differences between the companies’ bids were as follows:

- The Vital 15 year bid replaces the HTHW system and boilers at the John Radcliffe site, and replaced the boiler house at Churchill with decentralised plant;
- Dalkia and Mitie bids do not replace HTHW systems, Dalkia re-use the John Radcliffe boilers at Churchill, while Mitie routed pipework externally to buildings, both of which are regarded as sub-optimal solutions;
- Each bid included a CHP engine although of differing sizes which impacted on available savings;
- The Vital 25 year variant bid added in the innovative energy link between the John Radcliffe and Churchill sites which generates increased efficiencies and the opportunity for potential further energy sharing schemes which may prove to be an income generating opportunity for the Trust. This option also increases the resilience of the whole scheme,
removing some of the need for backup equipment at both sites;

- Dalkia and Mitie Variant bids introduced varying amounts of replacement work to the HTHW systems, but no further innovations or benefits;
- The Dalkia and Mitie bids did not show sufficient clarity over funding arrangements, and in particular the Mitie bid did not show certainty on the availability of funding.

3.9.15 The scoring template above shows that Vital Energi scored best in each of the three areas that had been given the greatest weighting, and achieved a significantly higher NPV for their scheme. This was in large part due to the Dalkia and Mitie bids requiring the Trust to incur additional costs over those included in the bid document.

3.9.16 Detailed NPV tables for every bid received are included in appendix 6.

3.9.17 In light of the scoring and NPV calculations, Vital Energi Solutions Limited have been selected as the Trust’s preferred bidder. The Trust then entered a period of detailed negotiation during which requirements were confirmed and the bid developed to ensure that the Trust received maximum benefit from the contract.

3.9.18 The bid submitted by Vital Energi Solutions Limited would bring significant advantages to the Trust including:

- Reduced Carbon emissions of over 11,000 tonnes per annum;
- Reduced energy costs giving guaranteed net savings to the Trust;
- Significantly reduced maintenance backlog on both hospital sites;
- Innovative design ideas including energy link between sites;
- Improved environmental profile;
- Lifecycle costs covered for the life of the contract;
- All in cost contract including all necessary connections, infrastructure equipment and plant;
- Expansion potential for future income generation opportunities.

3.9.19 Vital Energi Solutions Limited is a very experienced and reputable company in this field, and has a commendable history. They have been appointed as preferred bidder on CEF schemes at York, Northampton and Grampian amongst others.

3.9.20 The scheme requires no infrastructure capital outlay by the Trust, as the proposal includes all funding required.

3.9.21 The Trust and Vital Energi have agreed a limited preferred bidder letter that includes clarity on essential commercial and legal terms for incorporation in the draft contract. This was done on a limited basis, and in advance of the OBC, to allow all parties to complete technical evaluations that the Trust considered necessary before OBC. This work is now complete.
3.10 Bid development

3.10.1 Following the selection process the Trust has been through a period in which the bid was developed between Vital and the Trust to ensure that it best met all of our needs.

3.10.2 This period covered a considerable length of time (almost eighteen months) and is marked by the change in project team which has occurred owing to staff turnover in the relevant areas. Vital Energi required a contribution of £200K to their bid development costs to vouch for the Trust's intentions to complete the deal owing to the length of time that had passed since the original bid.

3.10.3 The key work undertaken during the period between OBC and FBC was:

- Expansion of the size of the Combined Heat and Power engine to 4.5mW to ensure Trust needs and flexibility for future developments are covered;
- Detailed review of the electrical and mechanical installations proposed to ensure that they fit within Trust requirements;
- Further analysis of existing Trust utilities and other issues which may impact on design of energy link route;
- Confirming the usage of existing Trust plant and its requirement for future service provision either under the energy scheme or otherwise;
- Detailed review of the lighting retrofit proposal to ensure only buildings to be retained are included;
- Detailed review of the ‘termination points’ to ensure that the outputs from the energy system meet the current needs of the Trust;
- Re-routing of the energy link due to highways block on work to Osler Road;

3.10.4 Following this development process, a final bid was arrived at which represents the financial information included in the draft contract. This has been used in the economic analysis from this point forward, and in the financial analysis shown in section 5.

3.10.5 It should be noted that the bid development process has reduced the Net Present Value of the scheme to the Trust. This is because additional costs have been introduced to the scheme to reduce the Trust’s backlog maintenance to ensure that the existing Trust infrastructure is upgraded or replaced sufficiently to operate reliably over the 25 year term of the contract.

3.10.6 The changes between the capital cost of the bid at OBC stage and the final bid encapsulated in this FBC are summarised in the following table:
### Movements in Preferred Bid

<table>
<thead>
<tr>
<th>Description</th>
<th>£</th>
</tr>
</thead>
<tbody>
<tr>
<td>Increase in size of CHP engine from 4.3 to 4.5 mW</td>
<td>153,662</td>
</tr>
<tr>
<td>Increase length of District Heating Network</td>
<td>685,000</td>
</tr>
<tr>
<td>Removal of Insulation and pipework from scope</td>
<td>(432,526)</td>
</tr>
<tr>
<td>Reduction in number of lighting upgrades needed</td>
<td>(83,671)</td>
</tr>
<tr>
<td>Sundry other changes to design</td>
<td>(93,243)</td>
</tr>
<tr>
<td>Inflation on equipment costs</td>
<td>463,510</td>
</tr>
<tr>
<td>Additional finance costs</td>
<td>310,000</td>
</tr>
<tr>
<td>Allocation of overheads etc to above costs</td>
<td>235,935</td>
</tr>
<tr>
<td><strong>Total increase in CapEx</strong></td>
<td><strong>1,218,667</strong></td>
</tr>
</tbody>
</table>

### 3.11 Economic Appraisal

**3.11.1** This section provides an overview of the main costs and benefits associated with each of the three options identified in the short list at 3.9 above. As the preferred bidder option has developed through the bid development process, so the other options on the shortlist have been reviewed and updated to ensure that they provide a full comparison.

**Estimating Costs and Benefits**

**3.11.2** The Trust has not included any non-financial benefits in the appraisal of the short listed options. The economic benefits used in the appraisal of the bidder option and the public sector comparator are derived from the bidder’s own calculations, and allow for the Trust being less efficient at driving the savings from the equipment than the contractor. The savings delivered by the PSC are estimated to be 85% of those generated by Vital.

**3.11.3** In order to ensure that this business case identifies all of the expected costs and benefits of the Trust led options, the Trust has included the expert opinion of its own estates staff, and consulted with CEF engineers and project managers.

**3.11.4** One area where the Trust is suffering additional costs is in the high level of maintenance costs currently required to keep the existing plant functional, and hire costs for stand-in equipment. These have been excluded from the calculations as all three options will contain sufficient capital expenditure to remove the need for such levels of maintenance and hire costs in future.

**3.11.5** The Public Sector Comparator (PSC) figures have been prepared using the bidder’s documentation to ensure that all comparable equipment is included, and include allowances for on-costs, contingencies, inflation and Optimism Bias. The Government’s Green Book recommends the application of an Optimism Bias calculation on Government funded capital schemes. This is a calculation based on a template which firstly calculates an “Upper Bound” percentage based on fairly high level criteria and where any particular scheme...
fits within these criteria. This Upper Bound percentage is then mitigated by a series of more detailed scheme specific criteria to give a percentage reduction to the Upper Bound, which results in an overall Optimism Bias percentage for the scheme.

3.11.6 In calculating the costs of the PSC for this scheme for the OBC, the overall Optimism Bias percentage was initially calculated at 10.73%, which was then applied as an addition to the estimated capital costs on the Cost Forms. It was also applied to the estimated annual costs for the duration of the contract.

3.11.7 When reviewing the scheme during the preparation of the FBC the optimism bias has been reviewed and uplifted to 17.98% to correct a perceived underestimation of the risks relating to acquisition of equipment, and management of the installation phase.

3.11.8 Applying this factor to the PSC is an accepted and approved methodology of ensuring that a fair comparison is made between the bids obtained from the market with an estimate of what could be procured independently by the Public Sector.

Net Present Value Findings

3.11.9 The detailed economic appraisals of each option are included at appendix 7, and the table below shows the summary results of the economic appraisal, being the calculated Net Present Value (NPV) of each option.

<table>
<thead>
<tr>
<th>Option number</th>
<th>Title</th>
<th>NPV</th>
<th>Rank</th>
<th>Variance to rank 1</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Do Nothing</td>
<td>£16,230,062</td>
<td>3</td>
<td>£24,956,395</td>
</tr>
<tr>
<td>2</td>
<td>Public Sector Comparator</td>
<td>£3,901,472</td>
<td>2</td>
<td>£4,824,861</td>
</tr>
<tr>
<td>3</td>
<td>Vital preferred bid</td>
<td>£8,726,333</td>
<td>1</td>
<td>£0</td>
</tr>
</tbody>
</table>

3.11.10 This clearly shows that the preferred bid from Vital Energi Solutions Limited offers the Trust the best return over the period of the proposed contract. The variances between the options are substantial, with the preferred bid being a considerable distance ahead of the two Trust based options.

3.11.11 None of the calculated NPVs include the effect of VAT or CRC costs or savings.

3.11.12 The net present value of the Vital bid and the PSC do not include any assumed financial benefits from the potential sale of energy from the energy link.

3.11.13 In calculating NPVs the Trust has included the effects of the PDC dividend paid by the Trust where relevant. This is to ensure that this cost of capital charge is matched against the cost of capital charges built into the contractor’s bids.

3.11.14 Appendix 8 has been prepared in order to fully assess the impact of the PSC on the Trust financial position and how this will develop over the life of the scheme. As the NPV indicates and as these appendices show, the financial
position of the Trust is significantly worse if it were to make the investment itself.

3.12 Qualitative Benefits Appraisal

3.12.1 The main qualitative benefits delivered by this development are the increased resilience of the new plant. The Trust is currently at significant risk of breakdown due to the age of the plant across the two sites. For this reason the do nothing/do minimum option is not tenable for the Trust.

3.12.2 A breakdown of the energy system could have significant impact on the patient experience, resulting in lack of lighting or heating in ward or circulation areas, temporary unavailability of equipment including CT and MRI scanners used for urgent diagnostics, and potential delays in theatres causing cancellations of operations. The PSC and contractor bid options would minimise this risk, with the contractor bid transferring the costs of reducing the risk outside the organisation.

3.12.3 The Trust currently has a fully subscribed capital programme for the current and immediate future years and so allocating the capital required for the Trust led do: minimum and PSC options would necessitate the restriction of spending in other areas.

3.12.4 In the case of the Public Sector Comparator the requirement for capital investment is substantial. As the Trust will not be able to recover VAT on most of the capital costs, and has included allowances for contingencies and for being less efficient at the procurement and installation of the equipment than a contractor, the total expected capital spend included in the PSC is £23.3m. This amounts to almost 40% of the Trust’s capital allocation over the next two years.

3.12.5 This significant requirement for capital investment in the PSC would be likely to mean that the Trust is unable to go ahead with the energy scheme on this basis in the next couple of years. This would not meet the requirements for urgent upgrade of the systems. If the development did go ahead using the PSC option it would mean delaying or abandoning a significant value of developments in clinical schemes.

3.12.6 Therefore a qualitative benefit of the Vital Energi agreement is that it does not place any call on the Trust’s capital allocation during the life of the contract.

3.12.7 The Vital Energi agreement and the PSC will also enhance the Trust’s reputation by managing its energy usage and carbon emissions in accordance with, and in excess of, UK Government and NHS England’s binding carbon reduction targets.

3.12.8 The scheme, incorporating as it does the energy link between the John Radcliffe and Churchill hospitals, demonstrates innovation and design excellence. This scheme could become a beacon for others in design terms.

3.12.9 The scheme is also the largest scheme to date to be completed through the
CEF, and so will garner positive attention for the Trust.

3.12.10 The Vital Energi and PSC options will also provide greater flexibility to deal with changes in energy demand in future. The Trust has found that new medical technologies are more energy intensive than old ones and so energy usage is increasing. The schemes will make provision for further expansion of the energy systems if and when required.

3.12.11 The Trust will also be better able to cope with future developments across the two sites or elsewhere, as the Vital and PSC schemes allow greater flexibility in expansion of the infrastructure to cope with significant changes in demand from developments such as the potential theatre complex development at the JR.

3.12.12 The Vital Energi and PSC options include the energy link between John Radcliffe and Churchill sites. Not only does this link improve the resilience of the whole energy system of the two sites combined, it also provides the Trust with the ability to supply energy to other commercial users in the area, including sites belonging to the University of Oxford, and Oxford Brookes University. This could become a source of income generation for the Trust in future.

3.12.13 The option of developing the scheme with Vital Energi Solutions gives the Trust access to design and engineering skills and a source of industry and equipment knowledge that would not be available should the Trust decide to develop the scheme on its own.

3.12.14 In summary the best selection of qualitative benefits available for the energy infrastructure schemes are provided by the preferred bid from Vital Energi Solutions Limited.

3.13 Risk Appraisal

3.13.1 The Trust reviewed the risks associated with the three short listed options, doing nothing/minimum, public sector comparator and contractor bid. The key risks that were identified are explained below, and the standing of each option with regard to these risks is shown in the table.

3.13.2 The risk of failure of parts of the equipment, or the power supply more generally poses a threat to the provision of healthcare services, as recorded on the relevant Trust risk register.

3.13.3 The Trust is required to meet targets for reduction of its carbon footprint, and reduction in energy consumption as measured in annual returns to the Department of Health. A considerable element of energy usage and carbon consumption is driven by the energy systems of the Trust, and so the risk of not meeting the targets for reduction falls mainly on the energy systems.

3.13.4 Due to the nature of the scheme proposed the Trust has the opportunity to establish itself as a reference site for other similar schemes, enhancing the reputation of the Trust in its local and national communities. The manner in
which the scheme is completed will represent a risk of not achieving this reputational gain.

3.13.5 The Trust is currently exposed to on-going repair and maintenance cost and the hire costs of stand-in equipment. There is a risk of these costs remaining in full or in part following the completion of the scheme.

3.13.6 The current backlog maintenance for the energy system represents a call on the Trust's capital resources, although this currently has not been prioritised sufficiently highly to become part of the in-year allocation of capital. Despite each of the options including some element of additional expenditure to update equipment, the risk remains that in the event of breakdown or increasing age of equipment, the Trust will still be required to allocate scarce capital resources to the energy systems.

3.13.7 While the options available at present will provide the Trust with an updated energy system that meets its current needs, the risk remains that this will become obsolete during the proposed life of the scheme, either through new developments in energy provision, or through significant changes in the Trust's demand for energy.

3.13.8 The options before the Trust represent a range of improvements to the energy systems and their efficiency, however this efficiency will only be maintained if the systems are correctly operated and maintained. There is a risk that the expertise is not available within the Trust to do this, and efficiency of the systems will be lost, resulting in additional energy costs and backlog maintenance.

3.13.9 The Trust has reviewed the risks and applied scores to each risk in relation to each option using the following set of scales to quantify both impact and probability:

- Low risk equals 2
- Medium risk equals 3
- High risk equals 5

<table>
<thead>
<tr>
<th>Risk Description</th>
<th>Impact</th>
<th>Do Nothing Probability</th>
<th>Total</th>
<th>Do Minimum Probability</th>
<th>Total</th>
<th>PSC Probability</th>
<th>Total</th>
<th>Contractor Bid Probability</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Failure to meet carbon and energy reduction targets</td>
<td>3</td>
<td>5</td>
<td>15</td>
<td>5</td>
<td>15</td>
<td>2</td>
<td>8</td>
<td>2</td>
<td>6</td>
</tr>
<tr>
<td>Failure to become a reliance site</td>
<td>2</td>
<td>5</td>
<td>10</td>
<td>5</td>
<td>10</td>
<td>2</td>
<td>4</td>
<td>2</td>
<td>4</td>
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<tr>
<td>Risk of breakdown impacting healthcare provision</td>
<td>5</td>
<td>5</td>
<td>25</td>
<td>3</td>
<td>15</td>
<td>2</td>
<td>10</td>
<td>2</td>
<td>10</td>
</tr>
<tr>
<td>Loss of earnings opportunities</td>
<td>6</td>
<td>6</td>
<td>25</td>
<td>5</td>
<td>25</td>
<td>2</td>
<td>10</td>
<td>2</td>
<td>10</td>
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<tr>
<td>Exposure to future price rises</td>
<td>3</td>
<td>5</td>
<td>15</td>
<td>5</td>
<td>15</td>
<td>2</td>
<td>6</td>
<td>2</td>
<td>6</td>
</tr>
<tr>
<td>Continuing hire and repair costs</td>
<td>3</td>
<td>6</td>
<td>15</td>
<td>3</td>
<td>9</td>
<td>2</td>
<td>6</td>
<td>0</td>
<td>0</td>
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<tr>
<td>Risk of need for future capital allocation</td>
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<td>8</td>
<td>3</td>
<td>8</td>
<td>2</td>
<td>4</td>
</tr>
<tr>
<td>Risk of obsolescence</td>
<td>2</td>
<td>5</td>
<td>10</td>
<td>5</td>
<td>15</td>
<td>3</td>
<td>6</td>
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<td>Risk of loss of efficiency</td>
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<td>6</td>
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<td>3</td>
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<td>115</td>
<td>300</td>
<td>100</td>
<td>300</td>
<td>30</td>
<td>30</td>
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<td>30</td>
</tr>
<tr>
<td>Rank</td>
<td>4</td>
<td>3</td>
<td>2</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
</tr>
</tbody>
</table>
3.13.10 Note that the contractor bid option has been ranked as zero for:

- Risk of loss of savings as these are guaranteed under the agreement and the contractor will be obliged to make up any shortfall that the Trust may experience;
- Risk of continuing hire and repair costs as these will be entirely the responsibility of the contractor, and the Trust will not be exposed to these costs;
- Risk of obsolescence as this sits with the contractor, not the Trust; and
- Risk of loss of efficiency as it is the contractor's responsibility to maintain the efficiency of the equipment, or to make up to the Trust any savings lost as a result.

3.13.11 Therefore the result of the risk appraisal is that the contractor bid offers the most attractive risk profile for the Trust.

3.13.12 The risk profile of the preferred option has been quantified and this is included within the business case in section 5, the Commercial case.

3.14 The Preferred Option

3.14.1 As a result of the economic appraisal, qualitative benefits appraisal and risk appraisal, the Trust has decided that the contractor bid represents the best way forward for this scheme.

3.14.2 The public sector comparator offers substantially worse value for the Trust, and leaves the Trust fully exposed to the risks of running the energy system. The contractor bid transfers these risks to a specialist energy management company.

3.14.3 The contractor bid option is the only one which does not require the investment of Trust capital at a time when the capital scheme is already oversubscribed. It also means that further Trust capital investment will not be needed during the life of the scheme.

3.14.4 The Public Sector Comparator delivers the substantial gross savings for the Trust, but at considerably greater cost and risk to the Trust, and at a lower level than those savings guaranteed by the contractor bid.

3.14.5 The Trust-based do nothing or do minimum options do not address the urgent need to upgrade the Trust's energy infrastructure to ensure continuity of supply. They also do not deliver any financial savings or reduction in energy usage or carbon emissions, and so do not meet any of the Trust's targets in this area.

3.15 Sensitivity Analysis

3.15.1 Sensitivity analysis has been performed on the contractor bid model and the Trust-based public sector comparator.

3.15.2 The Trust has undertaken sensitivity analysis by assessing what change in
values would be required in the PSC option in order to deliver the same return as the preferred contractor bid.

3.15.3 The Table below shows the values in percentage terms at which the preferred option would change:

<table>
<thead>
<tr>
<th>Change in costs %</th>
<th>PSC</th>
<th>Preferred bid</th>
</tr>
</thead>
<tbody>
<tr>
<td>Capital costs</td>
<td>55%</td>
<td>0</td>
</tr>
<tr>
<td>Current costs</td>
<td>154%</td>
<td>0</td>
</tr>
<tr>
<td>Total costs</td>
<td>85%</td>
<td>0</td>
</tr>
<tr>
<td>Cash releasing benefits</td>
<td>61%</td>
<td>0</td>
</tr>
<tr>
<td>Net Present Value</td>
<td>268%</td>
<td>0</td>
</tr>
</tbody>
</table>

3.15.4 As the table shows the changes required in any and all variables for the NPV of the PSC to reach that of the preferred bid are so large as to be unrealistic. The changes in the Do Minimum option would be even larger as this NPV is further from that of the preferred bid than the PSC.

3.15.5 Although the Public Sector Comparator includes allowances for optimism bias and contingencies, the required reduction in capital costs to achieve the same NPV as the contractor bid would actually reduce capital expenditure below the contractor’s level.

3.15.6 The required increase in cash releasing benefits is shown in the table above at an increase of 61%, but it should be noted that this represents an increase in savings of just over £1m annually.

3.15.7 The Trust has not conducted extensive scenario planning sensitivity analysis as it is not relevant. The capital and revenue costs and benefits of the preferred bid option are fixed by the agreement and the Trust is not exposed to any risk of uncertainty in these values as this is borne entirely by the contractor.

3.15.8 The main variables that can change in the future are the price and usage of energy. The Trust is protected from the effects of price rises and falls by the savings guarantee written into the contract.

3.15.9 If usage stays constant, then as the table below shows, the Overall energy prices paid by the Trust would need to fall by more than 20% to 79.87% of their base level in the contract before the deal becomes uneconomic for the Trust. Analysis shows that current prices are 17% above the base level prices included in the contract, and so the fall required from these current prices to the break-even point would be 32%.

3.15.10 It is considered unreasonable to assume that prices would fall by this amount or more. As soon as prices rise, the gains to the Trust increase, and so prices would need to fall by this much and remain at this level for the life of the contract.
<table>
<thead>
<tr>
<th>Price (% of current)</th>
<th>Original energy costs</th>
<th>Revised energy costs</th>
<th>Guaranteed savings</th>
<th>Contract payment</th>
<th>Total cost</th>
<th>Net saving to Trust</th>
</tr>
</thead>
<tbody>
<tr>
<td>160</td>
<td>9,508,362</td>
<td>5,744,619</td>
<td>2,381,194</td>
<td>1,721,702</td>
<td>7,666,222</td>
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<td>6,130,092</td>
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<td>1,721,702</td>
<td>5,771,080</td>
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<td>5,412,077</td>
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<td>90</td>
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<td>3,231,292</td>
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<td>1,721,702</td>
<td>5,052,896</td>
<td>284,345</td>
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<tr>
<td>80</td>
<td>4,753,191</td>
<td>2,872,280</td>
<td>2,351,646</td>
<td>1,721,702</td>
<td>4,893,962</td>
<td>59,229</td>
</tr>
<tr>
<td>77.48</td>
<td>4,803,817</td>
<td>2,781,815</td>
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<td>1,721,702</td>
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<td>70</td>
<td>4,159,042</td>
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<td>2,970,745</td>
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<td>30</td>
<td>1,782,447</td>
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<td>2,898,800</td>
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<td>1,721,702</td>
<td>2,539,767</td>
<td>1,351,470</td>
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<td>10</td>
<td>594,148</td>
<td>359,032</td>
<td>2,351,646</td>
<td>1,721,702</td>
<td>2,160,735</td>
<td>1,556,568</td>
</tr>
</tbody>
</table>

3.15.11 The Trust will be less exposed to any future price rises, as its overall energy consumption will be reduced by approximately 40%, and the impact of rises on the Trust’s cost base will be consequently smaller. The savings guarantee will remain in place ensuring that the contractor achieves the reductions in energy consumption, and the Trust obtains the financial benefit.

3.15.12 Spark gap (sometimes spark spread) is the difference between the price received by the generator for electricity produced and the cost of natural gas needed to produce that electricity. All other costs e.g. operation and maintenance, capital and other must be covered from spark gap.

3.15.13 The larger the spark gap the better. As an example, if the electricity prices were to go up by 25% and gas prices by 26%, the value of the spark gap would be £16MWh.

3.15.14 If electricity and gas prices increase in tandem – which has been the case historically, the spark gap would also rise e.g. from £14/MWh to £20.06/MWh as highlighted in the chart in appendix 9. It should be noted that under the preferred contractor bid, this risk of the spark gap closing sits with the contractor, and the Trust’s savings remain guaranteed regardless of changes in the spark gap.

3.15.15 The savings generated by the contractor’s bid are driven by two factors. Firstly gas is cheaper than electricity and so consuming the same amount of energy will be cheaper for the Trust, driving a price saving and secondly the
CHP uses less gas to generate the required electricity and heat thus driving an efficiency saving.

3.15.16 This means that variations in the demand for energy by the Trust following the implementation of the scheme will have a proportionally smaller impact on the savings under the scheme, as the table below shows.

<table>
<thead>
<tr>
<th>Changes in site electricity and heat demand</th>
<th>Remaining Savings</th>
<th>Movement in savings</th>
</tr>
</thead>
<tbody>
<tr>
<td>-15%</td>
<td>£2,214,158</td>
<td>-4.78%</td>
</tr>
<tr>
<td>-10%</td>
<td>£2,247,678</td>
<td>-3.34%</td>
</tr>
<tr>
<td>-5%</td>
<td>£2,287,774</td>
<td>-1.62%</td>
</tr>
<tr>
<td>0%</td>
<td>£2,325,352</td>
<td>0.00%</td>
</tr>
<tr>
<td>5%</td>
<td>£2,360,159</td>
<td>1.50%</td>
</tr>
<tr>
<td>10%</td>
<td>£2,390,497</td>
<td>2.80%</td>
</tr>
<tr>
<td>15%</td>
<td>£2,412,911</td>
<td>3.77%</td>
</tr>
</tbody>
</table>

3.15.17 While we have not completed this calculation for all possible movements in energy demand, it can be seen that the fall in demand required for savings to drop below the annual service payment is so large as to not be feasible. It can also been seen that greater movements in demand produce diminishing levels of change in the savings.

3.15.18 Given the history of energy usage in the Trust, and the foreseeable changes in medical technologies, it is expected that usage of energy will continue rising in the Trust. In this instance the savings under this contract will remain in place and it may be that the Trust can negotiate an extension of the contract to cover the increasing usage.

3.15.19 The Trust used the 2011/12 financial year for the base year information during the tender exercise and this is the information on which the scheme and the savings guarantee are based.

3.15.20 The Trust have confirmed that energy prices have risen by c. 17% since the baseline data was set. Up to FBC, the information on which the contractor’s bid is based has not been changed. If the base tariffs were adjusted to today’s values, the risk premium attached to the pricing mechanism counteracts an increase in guaranteed savings. It was agreed that maintaining the base tariff was the most appropriate course of action.

3.15.21 Additionally these extra savings following price rises do not qualify as ‘excess savings’ under the project agreement, and so will not be shared with the contractor.

3.16 Preferred Option

3.16.1 The appraisal process can be summarised in the following table:
3.16.2 The preferred option based upon this work was to procure a contractor to partner with the Trust in delivering the energy scheme as described and any additional savings or income generation opportunities that may arise. We continue to recommend that the Trust move forward with Vital Energi Solutions Limited as the preferred bidder for that contract.

3.17 Project Opportunities

3.17.1 The energy link enables low temperature hot water and power from the energy centre at John Radcliffe to be sent to Churchill Hospital. This has been designed with sufficient diversity to allow additional users to be added to the network once the project is complete. New users identified could include Oxford University, Oxford Brookes and other large commercial buildings and apartments in the local vicinity, although domestic connections would not be economically viable.

3.17.2 Should new users be interested in LTHW supplies from the energy link, Vital Energi will manage all of the commercial and technical arrangements in close liaison with the Trust. These will include heat supply contracts, business case compilation for new users along with any and all capital works required to attach new users. Any sales will be managed by Vital Energi who will then pass revenues back to the Trust once the billing cycle is completed. This potential economic upside has not been included in any of the financial modelling for this FBC but could represent a further gain for the Trust under the preferred option.
4. The Commercial Case

4.1 Introduction

4.1.1 This section of the Full Business Case sets out the arrangements that have been negotiated with the Trust's preferred supplier and aims to capture the salient elements which are set out in the Energy Services Performance Agreement ("PA"). The PA has been prepared using the CEF standard framework agreement and has then been tailored to reflect the requirements of the Trust, the Contractor, the Funder and the proposed service deliverables.

4.1.2 The Trust has engaged DAC Beachcroft LLP as legal advisors to support the final negotiation of the PA. DAC Beachcroft LLP have a proven proficiency in this form of contract negotiation and will provide written comfort to the Board that the PA is written such that the Trust's interests are best protected.

4.1.3 Willis Limited have been engaged to endorse the insurance specifications within the PA which are detailed under Schedule 21.

4.1.4 Aviva Investors Global Services Limited through their Infrastructure and Renewable Energy Division has been identified as the funder for this energy investment scheme.

4.1.5 The PA is for the provision of an energy service for the Churchill and John Radcliffe sites including:

- Installation of CHP combined heat and power plant;
- Replacement of obsolete boiler plant and associated equipment;
- Addressing issues with HTHw (High Temperature Hot Water) distribution pipework;
- Installation of an energy link between the two sites improving efficiency and resilience;
- Reduction in operating costs and carbon footprint;
- Improvement in resilience and business continuity;
- Reduction in risk through improved infrastructure and risk transfer to contractor.

4.1.6 The contract will run for 25 years following the installation period. The installation is expected to take 18 months from the proposed date of contract signature which is anticipated to take place in late May/early June 2015, and is conditional on the TDA's approval.

4.1.7 The Contractor will install all required equipment, and fund this with drawdowns from the funder during the construction period. Once the operational contract begins, the Trust guarantees to make the minimum payments necessary for the funder to recover their costs. The Contractor costs will be at risk of with-holding in the event of non-performance. The operating performance is subject to Key Performance Indicators ("KPI's") and the
mechanism of non-performance or qualifying failures are detailed under Schedule 18 of the PA.

4.1.8 This FBC proposes that the PA will be between the Trust and Vital Energi Solutions Limited. The PA sets out in detail the arrangements between the two parties and include the considerations the funder agreement.

4.1.9 The CEF as advisors to the Trust have provided key Project Management to date and once the PA is in operation, they will continue to provide monitoring assistance to ensure the energy services are being performed in accordance with the contract.

4.1.10 The PA specifies the required outputs from the energy systems which form the base data from which the guaranteed savings are calculated. These are set out under Schedule 12 and include details of water and steam temperatures and pressures at fixed points, specified numbers of kWh of electricity from the CHP engine, uptime requirements for the boilers and so on. The requirements to conduct maintenance that impacts on system availability at key times are also stated e.g. no boiler maintenance shut downs in winter.

4.1.11 During January and February key personnel from Vital Energy Solution Ltd and senior managers from the Trust’s Development and the Estate’s Operations Division reviewed the all aspects of the reliance data which is required to drive these energy outputs. This included several on-site visits and a revision of inclusions to ensure that the most up to date and relevant data was included. Backlog maintenance that has been addressed since the original specification was removed and relevant new additions were included. Detailed reliance data can be found under Schedule 12 of the PA.

4.2 Required Services

4.2.1 The Trust issued an output based specification at the tender stage of the procurement process to the contractors who were members of the CEF framework. It required bidders to provide a robust energy service solution, including investment in an energy infrastructure, for the John Radcliffe and Churchill Hospital sites.

4.2.2 The specification required bidders to provide proposals for investment in an energy infrastructure that would enable the Trust to meet the NHS requirement and reduce the Trust’s carbon footprint. In so doing, the Trust also looked to reduce both the cost of and demand for energy whilst improving the infrastructure sustainability of the sites.

4.2.3 This allowed bidders to explore a range of delivery options and funding arrangements, including any grants or tax deductions, which may be available to reduce the cost of the proposals to the Trust.

4.2.4 The project team with the responsibility of evaluating the bidding process during this feasibility phase was made up of the following members:
The Director of Development and The Estate as project sponsor and member accountable at board level for this project;
- The Deputy Director of Development and The Estate;
- Senior Operations Manager;
- Utilities Manager;
- Directorate Business Partner;
- Finance representative;
- Trust Procurement representative;
- CEF senior representatives.

4.2.5 In early January 2013 an Invitation to Mini Competition (ITMC) was issued to all ten contractors on the CEF framework at that time. Contractors were also invited to attend a formal Open Day on the 25th of that month where the suppliers were given an introductory address by the Trust Director of Development and The Estate, followed by a presentation from the Trust Project Team and the CEF, demonstrating the scope of projects identified in the Jacobs feasibility study. This was followed by a question and answer session and a site tour of the Oxford Radcliffe and Churchill Hospitals.

4.2.6 The procurement route used meets the definitions and requirements of the OJEU restricted route with competitive tendering.

4.2.7 As detailed in the economic case in section 3 above six companies attended the Open Day including Vital Energi Solutions Limited.

4.2.8 Following presentations and site visits, these companies were invited to express an interest in joining a tender exercise to deliver the Trust’s requirements. Four of the six companies proceeded to the next stage.

4.2.9 The Project team then held discussions with the representatives of the remaining four companies to confirm their understanding of and interest in bidding for the work. Only three companies had the capacity to undertake the required level of work and were shortlisted to enter into a technical dialogue with the Trust prior to the resumption of the mini competition procurement process. These companies were:

- Dalkia
- Mitie
- Vital Energi Solutions Limited.

4.2.10 The purpose of the technical dialogue was to ensure that the bidders each had a full understanding of the Trust site data, plant and equipment before the tender process which works to very tight timescales.

4.2.11 A period was allowed to the bidders to carry out any survey or investigative works that they wished prior to the issue of the tender documents. In this period two meetings were held with each bidder to allow them the opportunity of discussing the content of their bids (in confidence). This also allowed the
Trust to consider any innovation being offered by the market.

4.2.12 Invitation to Tender documentation was released to the three shortlisted suppliers on 12th April 2013 via the Carbon Energy Fund’s secure project website. Mid Term Reviews were held on 12th May 2013 and all three companies submitted fully costed bids on 29th May 2013. Following that the suppliers formally presented to the Trust team on the 4th June 2013. Formal evaluation began on the 7th June 2013.

4.2.13 The specification used in the tender documentation was an output specification and bidders were free to plan the delivery of the output in any way that they saw fit. This was incorporated within the ITT document itself, which was issued with the template form of contract and the financial proformas for the scheme.

4.2.14 The Head of Procurement within the Trust has reviewed the procurement route adopted at all stages detailed in this business case. He has confirmed that it follows good practice and he is satisfied with the outcome. His letter of confirmation is included as appendix 16 to this business case.

4.2.15 Full detail of the bidding evaluation is set out in the economic case, section 3.

4.3 Agreed Risk Transfer

4.3.1 This section provides an overview of how the general risks associated with the project are to be apportioned between the Trust and its chosen supplier, Vital Energi Solutions Limited.

4.3.2 A comprehensive risk assessment was undertaken where the general risks associated with the project are to be apportioned between the Trust and Vital Energi Solutions Limited as preferred bidder.

4.3.3 This was used to identify both the high impact risks and the high value risks.

4.3.4 External environmental risks which are common to both the PSC and the preferred options were not included for evaluation purposes. These include, for example, spark gap and inflation.

4.3.5 Included in the risk appraisal criteria were:

- Design risks;
- Construction and development risk;
- Transition and Implementation risk;
- Termination risk;
- Control risk;
- Other project risks;
- Identifying all the possible business and service risks associated with each option;
• Calculating a risk score;
• Developing a management response;
• Valuing the risk; and
• Agreeing responsibility for the risk for the VE option.

4.3.8 The following table sets out the risks and associated categories:
### Qualitative Risk Allocation Matrix

<table>
<thead>
<tr>
<th>ID</th>
<th>Risk Category</th>
<th>Allocation</th>
<th>Trust</th>
<th>VE</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.1</td>
<td>Change in design to meet HTMs or any other requirements which may apply to meet NHS estates design standards</td>
<td></td>
<td></td>
<td>V</td>
</tr>
<tr>
<td>1.2</td>
<td>Change in project/design requirements by Trust outside of the suppliers proposal scope or above necessary standards</td>
<td></td>
<td></td>
<td>V</td>
</tr>
<tr>
<td>2.1</td>
<td>Planning permits</td>
<td>V</td>
<td></td>
<td></td>
</tr>
<tr>
<td>2.2</td>
<td>Time overruns / delays</td>
<td>V</td>
<td></td>
<td></td>
</tr>
<tr>
<td>2.3</td>
<td>Project management, contractors &amp; subcontractors management</td>
<td>V</td>
<td></td>
<td></td>
</tr>
<tr>
<td>2.4</td>
<td>Commissioning / build to design</td>
<td>V</td>
<td></td>
<td></td>
</tr>
<tr>
<td>2.5</td>
<td>Heating plant and pipeline</td>
<td>V</td>
<td></td>
<td></td>
</tr>
<tr>
<td>2.6</td>
<td>Shut-downs and service disruptions</td>
<td>V</td>
<td></td>
<td></td>
</tr>
<tr>
<td>2.7</td>
<td>Unknown ground conditions</td>
<td>V</td>
<td></td>
<td></td>
</tr>
<tr>
<td>2.8</td>
<td>Unknown asbestos conditions</td>
<td>V</td>
<td></td>
<td></td>
</tr>
<tr>
<td>2.9</td>
<td>District Network Operator approval</td>
<td>V</td>
<td></td>
<td></td>
</tr>
<tr>
<td>2.11</td>
<td>Trust-Supplier communication</td>
<td>V</td>
<td>V</td>
<td></td>
</tr>
<tr>
<td>3.1</td>
<td>The transfer of loads and demands from existing plant and systems to newly commissioned equipment and plants</td>
<td></td>
<td></td>
<td>V</td>
</tr>
<tr>
<td>4.1</td>
<td>Availability of heat &amp; power and any other contract deliverables, Performance of equipment and plants</td>
<td>V</td>
<td></td>
<td></td>
</tr>
<tr>
<td>5.1</td>
<td>Performance Standards</td>
<td>V</td>
<td></td>
<td></td>
</tr>
<tr>
<td>5.2</td>
<td>Equipment and plant operation</td>
<td>V</td>
<td></td>
<td></td>
</tr>
<tr>
<td>5.3</td>
<td>Force Majeure</td>
<td>V</td>
<td>V</td>
<td></td>
</tr>
<tr>
<td>6.1</td>
<td>Any unforeseen planning or emission requirements</td>
<td>V</td>
<td></td>
<td></td>
</tr>
<tr>
<td>6.2</td>
<td>Planning or emission requirements after completion</td>
<td>V</td>
<td></td>
<td></td>
</tr>
<tr>
<td>6.3</td>
<td>Electricity/Gas prices variations</td>
<td>V</td>
<td></td>
<td></td>
</tr>
<tr>
<td>6.4</td>
<td>Change in baseline demand</td>
<td>V</td>
<td></td>
<td></td>
</tr>
<tr>
<td>7.1</td>
<td>Termination due to default of the supplier’s</td>
<td></td>
<td></td>
<td>V</td>
</tr>
<tr>
<td>7.2</td>
<td>Termination due to default by the Trust</td>
<td>V</td>
<td></td>
<td></td>
</tr>
<tr>
<td>8.1</td>
<td>Equipment and plants not meeting required output performance</td>
<td>V</td>
<td></td>
<td></td>
</tr>
<tr>
<td>9.1</td>
<td>Monitoring of contract deliverables and outcomes (energy and cost savings) Provided by the CEF</td>
<td>V</td>
<td></td>
<td></td>
</tr>
<tr>
<td>10.1</td>
<td>Disposal of surplus operational plant and equipment at the end of the contract if not required by the Trust</td>
<td>V</td>
<td></td>
<td></td>
</tr>
<tr>
<td>10.2</td>
<td>Disposal of surplus operational plant and equipment at the beginning of the contract that is not required by the Trust or contractor</td>
<td>V</td>
<td>V</td>
<td></td>
</tr>
<tr>
<td>11.1</td>
<td>Interest rate movements prior to Financial Close</td>
<td>V</td>
<td></td>
<td></td>
</tr>
<tr>
<td>11.2</td>
<td>All other financing aspects</td>
<td>V</td>
<td></td>
<td></td>
</tr>
<tr>
<td>12.1</td>
<td>Legislative/Regulatory changes not foreseen at FC</td>
<td>V</td>
<td></td>
<td></td>
</tr>
<tr>
<td>13.1</td>
<td>CHP and district energy availability</td>
<td>V</td>
<td></td>
<td></td>
</tr>
<tr>
<td>13.2</td>
<td>Taxation risks</td>
<td>V</td>
<td></td>
<td></td>
</tr>
<tr>
<td>13.3</td>
<td>Accessibility and enabling utilities</td>
<td>V</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
4.3.7 The range of scales used to quantify risk for both impact and probability was as follows:

- Low  1
- High  5

4.3.8 The main areas of risk identified are:

- Financial and funding risks
- Installation risks
- Operational risks
- Technical specification risks – John Radcliffe Hospital
- Technical specification risks – Churchill Hospital

4.3.9 A key feature of an Energy Services Performance Agreement is the transfer of inherent construction and operational risk to the private sector that traditionally would be carried by the public sector. These risks include:

- Inclusion of all project costs within the financial model;
- Contract payments only start once installation is complete and the installation has been proven to be fully functional;
- All design and installation risks;
- Generation of electricity to required standards;
- Provision of heat and cooling to meet all hospital and third party needs;
- All operation, maintenance, repair and life cycling of the plant;
- Financial and carbon savings are guaranteed to the Trust.

4.3.10 The valuation of the risks and their transfer are shown in appendix 10 and are summarised as follows:

<table>
<thead>
<tr>
<th></th>
<th>PSC</th>
<th>Preferred Option</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>£'000</td>
<td>%</td>
</tr>
<tr>
<td>Trust</td>
<td>3,400</td>
<td>100%</td>
</tr>
<tr>
<td>VE</td>
<td>n/a</td>
<td>n/a</td>
</tr>
</tbody>
</table>

4.3.11 As this table shows, the majority of the risk by financial value sits with the contractor during the life of the project.

4.3.12 As part of the Funder’s Direct Agreement the funder has the right to step in and perform the contractors’ responsibilities under the contract or procure another contractor to do so, subject to Trust approval of the new contractor. This right is enacted should the contractor default and takes priority over the Trust’s right of termination which helps to assure the Trust that it will receive the services over the entire contract term.
4.4 Agreed Charging Mechanisms
4.5 Agreed Contract Length

4.5.1 As discussed in section 3 the contract will be for a period of twenty-five years from Practical Completion of the installation. The contractor currently expects to take 18 months for installation, and so the contract will expire 26.5 years after signature.

4.5.2 The contract allows tolerances on the installation period, and so the contract length may vary by a number of months if the installation is completed sooner or later than expected.

4.5.3 The benefit of a contract of 25 years compared with one of 15 years is that it has allowed the contractor to include the energy link between the John Radcliffe and Churchill Hospital sites. This improves the resilience of the scheme and provides an opportunity for future financial gains through energy sales.

4.5.4 Additionally the longer contract term transfers the risks to the contractor for a longer period, reduces the Trust costs related to re-tendering, and provides a longer period of guaranteed savings.

4.6 Key Contractual Clauses

4.6.1 The Project Agreement uses the CEF standard pro formas for an energy services agreement but has been tailored to suit the circumstances of the proposed arrangement with Vital Energy.

4.6.2 There are two main parts to the agreement, an introductory section containing the legal terms required to bind the parties to their commitments, and the schedules which contain the detailed information on Trust requirements, the construction design and process, the operational KPIs, the financial model and the payment mechanism and so on.

4.6.3 In the introductory section there are clauses covering the following:

- The requirements for execution and delivery of documents;
- General descriptions of the position with regard to indemnities and liability and any limits thereon;
- Rules regarding use of the Trust’s data;
- Appointment and duties of the parties’ representatives to each other;
• The establishment and operations of the liaison committee for joint review of day to day aspects of the agreement, including initial dispute resolution;

• Information regarding land issues, including the issuing of leases and licences to the funder and the contractor, covering the construction period and the operational period;

• The responsibility of the contractor for confirming the status of land used in the contract operations, including any contamination, and requirement for planning consents;

• The responsibility of the Trust to review applicable design data before construction;

• The rights of the Trust's representative to access the construction site, open up and inspect any part of the works;

• The requirements surrounding the programme of construction including the process for requests for access, and the process in the event of any delays to the programme.

• The requirements for pre-completion commissioning and certification;

• The obligation of the contractor to have in place suitable quality assurance systems for all aspects of the project operations and the ability of the Trust to confirm this by audit if required;

• The contractor may submit proposals for changes to services provided for Trust approval, and proceed with such changes in the absence of objections from the Trust;

• The rights of the Trust to make deductions from service payments for poor performance or availability issues, and the requirement for the contractor to reimburse the Trust should guaranteed savings not be achieved.

• The provisions for maintenance, both planned and unplanned, and the requirement for the Trust to approve periods of maintenance to ensure impact on Trust operations is minimised;

• The rights of the Trust to take action in the event of non-delivery of aspects of the contract, actions to include increased review, requiring the contractor to rectify or taking action itself;

• Indemnities against the impact of TUPE should it be relevant at either the beginning or the end of the contract;

• The requirement of the contractor to comply with Trust policies during the life of the contract, including those in relation to security and personnel issues;

• The requirements of the contractor to maintain safe stores of materials and consumables, including those which may be regarded as hazardous;

• The processes for payment following the commencement of the operational services;

• The arrangements with regard to insurance, either by the contractor or jointly with the Trust;

• The contractor will be responsible for meeting the costs resultant from any
change in law within two years of the agreement date generally, and five years in respect of equipment, including any impact on guaranteed savings;

- The processes covering delay events, relief events and force majeure;
- The definition of a Company Event of Default and the Trust's options in responding to this;
- The definition of a Trust Event of Default and the contractor's options in responding to this;
- The processes to be followed in the event of termination of the agreement, and the processes for determination and payment of any compensation on termination;
- The processes for assignment of the contract;
- The rights and requirements surrounding intellectual property of both the company and the Trust;
- Procedures regarding confidential information and its disclosure, and the requirements of the Freedom of Information act;
- The definition of and implications of any corrupt gifts or payments.

4.6.4 This introductory section can be seen as providing a set of over-arching rules which apply to the interpretation and use of the agreement as a whole. The details of what services are to be provided and how the contractor and Trust will interact with each other are included in the schedules to the agreement.

4.6.5 The schedules and the key aspects of their contents are as follows:

- Schedule 1 – Definitions. The terms used throughout the contract
- Schedule 2 – Completion Documents. This is a list of documents that are required to be delivered by both the contractor and the Trust at the point of signature of the agreement.
- Schedule 3 – Construction and Installation matters. This is one of the key schedules in the document and provides details of the works to be carried out during this phase, including building works, existing plant and equipment to be removed and new equipment to be installed. There is a full detailed list of the equipment to be installed, the location it is to be installed in and the saving it will provide in energy consumption (in kWh). The schedule also details the respective responsibilities and requirements during the construction phase. The schedule has been reviewed in detail by the Trust’s engineering staff, with assistance from CEF and the contractor.
- Schedule 4 – Disaster plan. How the contractor will react in the event of the Trust declaring a major incident. This includes the Trust's latest major incident plan, version 8.1 approved by the Trust Board in September 2014. The contractor will be required to comply with this plan and support the Trust in its implementation should this be necessary at any time during the life of the contract. As the major incident plan is updated, the contract provides that the latest version shall be followed.
- Schedule 5 – Not used
- Schedule 6 – Funder’s Direct Agreement.

- Schedule 7 – Lease. The Trust will grant the funder a lease over the boiler houses for the period of the agreement. The funder will then grant a licence to the contractor to operate and maintain the equipment as required. The Leases will expire on termination of the contract.
- Schedule 8 – Collateral Warranties. Warranty arrangements between subcontractors and the Trust.
- Schedule 9 – The Programme. The construction and installation programme up to practical completion, which marks the beginning of the operational phase. This enables the Trust to confirm the contractors proposed timescales and ensure the impact on Trust services are minimised.
- Schedule 10 – Review Procedure. The process for reviewing data, designs, programmes, documents or any changes in such items already reviewed. This includes the Trust’s commitments to respond to reviewable items in a timely fashion.
- Schedule 11 – Transferring Equipment. A list of the equipment that will be installed by the contractor on the Trust site and will become the responsibility of the Trust to operate and maintain following the expiration of the manufacturers’ warranty period. An example of this would be the lighting scheme.
- Schedule 12 – Reliance Data. Confirmation of the information supplied by the Trust upon which the contractor has placed reliance for the purpose of designing the energy scheme. Errors in this information that lead on to efficiencies not being achieved would give the contractor an excusing clause in not meeting the guaranteed savings.
- Schedule 13 – Equipment. A list of the equipment that forms part of the energy scheme, either currently or as part of the new energy scheme to be installed and operated under the contract. This is separated into three categories which are existing equipment (that which is in place at the date of agreement), continuing equipment (that which is in place and will remain as part of the new energy scheme), and company equipment (which is installed and owned by the contractor). The schedule also shows which equipment will transfer to the Trust (linked to schedule 11) and which is covered by either a replacement guarantee or warranties (schedule 8).
- Schedule 14 – Trust’s Requirements. The schedule lists the specific requirement which the Trust has for energy and heat, for the maintenance
and quality assurance of the energy scheme, the reporting that is expected from the contractor during the term of the contract, and the standards, policies and procedures which the Trust requires the contractor to observe during the term.

- Schedule 15 – Termination Points and Delivery Points. A detailed listing of the physical points at which the energy facilities and hospital distribution systems meet, that is the points at which responsibility for the energy, heat and related equipment is taken on from the contractor by the Trust. These are often the points at which the inputs and outputs of the system are measured to ensure that the Trust and contractor are both meeting their requirements.

- Schedule 16 – Trust's Responsibilities. The duties of the Trust to provide the contractor with access to relevant areas, the incoming utility services, and to undertake its maintenance etc. in a proper manner. Failure to do so may provide the contractor with an excusing cause meaning they would not be required to stand by the guaranteed savings.

- Schedule 17 – Not used

- Schedule 18 – Payment Mechanism.

- Schedule 19 – Plans. Copies of relevant plans of the hospital estates, energy schemes and energy link.

- Schedule 20 – Financial Model. A copy of the financial model used by the contractor in bidding for the contract and agreeing the final price.

- Schedule 21 – Insurance Requirements. Details of the insurances that the contractor will be required to hold during the various phases of the contract. The Trust engaged the services of Willis Limited to review the contents of insurance cover to ensure that the Trust interests are best served.

- Schedule 22 – Variation Procedure. This describes the process to be undergone should the Trust or contractor feel that a variation to the contract is necessary. It also describes the process to be undergone should it be necessary to obtain finance for the variation (other than NHS capital allocations), and the method for calculating the service payment on the contract following a variation.
• Schedule 23 – Compensation on Termination.

• Schedule 24 – Handback Procedure. This schedule details the process for confirming that any parts of the energy scheme to be handed back to the Trust are in the appropriate condition at the time of expiry of the contract.

• Schedule 25 – Record Provisions. This summarises and details the records to be kept by the contractor over the life of the contract.

• Schedule 26 – Dispute Resolution Procedure. This details the procedures to be followed by both parties in the event of a dispute which the liaison committee is unable to resolve satisfactorily. This includes mediation, expert resolution and fast track dispute resolution.

• Schedule 27 – Capital Investment Schedule. This is a listing of items which are included within the project as capital investments.

• Schedule 28 – Certificates. These are proforma copies of the certificates needed throughout the contract term including Certificate of Commencement and Certificate of Practical Completion.

• Schedule 29 – Refinancing. The contractor may not refinance the arrangement without the Trust’s express consent and subject to the Trust receiving 50% of the resultant gain.

• Schedule 30 – Not used

• Schedule 31 – Insurance Proceeds Account Agreement. These are the procedures to be followed to create and administer a joint insurance proceeds account if the Trust and contractor agree to set up joint insurance policies.

• Schedule 32 – Commercially Sensitive Information. The definition of which information is regarded as commercially sensitive.

4.6.6 The project agreement including all of its schedules, tables and appendices represent the totality of the agreement between the Trust and the contractor.

4.6.7 The final negotiations of the Project Agreement have been conducted by the Trust and the Contractor. The Trust has been supported by the CEF and its legal advisors to ensure its interests and rights are fully protected. The Trust legal advisors, DAC Beachcroft will provide a report to the Trust Board for consideration alongside this FBC confirming their views on this contract.

4.6.8 This report will cover project agreement key contractual obligations and has headings including:

• Term;
• Commencement of project operations;
• Payment;
• Minimum service payment;
• Guaranteed minimum savings;
• Service credits;
• Compensation on Termination;
• Insurance;
• Temporary Trust step in;
• Limitation of liability;
• Termination;
• Consequences of Termination/expiry;
• Lease;
• Funders Direct Agreement;
• Powers to enter into the agreement;
• Project commencement issues; and
• Other issues for consideration.

4.7 Personnel Implications (including TUPE)

4.7.1 Under the agreed contract, the operation and maintenance (O&M) of all plant and equipment supplied will be undertaken by the preferred bidder.

4.7.2 Apart from boiler house staff and specialist sub-contractors there is minimal impact on Trust staff.

4.7.3 One example of a workforce implication is the LED retrofit which will see a net reduction in labour for the replacement of lamps. However any Trust pay labour efficiencies delivered by the scheme will only be implemented through natural wastage.

4.7.4 As a result the scheme will support the estates workforce strategy but those benefits have not been accounted for and will effectively be additional benefits of the scheme for the Trust.

4.7.5 There are no TUPE implications as a result of this scheme. Existing staff share duties and no one person or post will be sufficiently affected for TUPE to apply. A letter of confirmation by the Directorate Human Resource Manager is attached under appendix 17.

4.7.6 The likely personnel implications of the preferred option are:

• A reduction in the daily checks required for items, such as boilers, plant rooms etc.
• A reduction in first response reactive management.
• A reduction in maintenance contract management

4.7.7 The above represents a minimum of 2 WTE which will be redeployed within the existing operational structure.

4.8 Implementation timescales and key milestones

4.8.1 The timetable and project key milestones to practical completion are detailed in the management case under section 6 and a summary is set out as follows

<table>
<thead>
<tr>
<th>Activity</th>
<th>Completion dates / Milestones</th>
</tr>
</thead>
<tbody>
<tr>
<td>Project feasibility and initiation</td>
<td>December 2011 - August 2014</td>
</tr>
<tr>
<td>Outline Business Case</td>
<td>September 2014 - March 2015</td>
</tr>
<tr>
<td>Project design and Agreement finalisation</td>
<td>January 2015 - April 2015</td>
</tr>
<tr>
<td>Project implementation</td>
<td>May 2015 - October 2016</td>
</tr>
</tbody>
</table>

4.8.2 It is important to note that for the project plan to succeed the drop dead date for the approval process and works commencement is May 2015. Failure to achieve this deadline will result in a delay in essential works being completed prior to the winter period when heating is most in demand.

4.8.3 Once the FBC has been approved by the TDA the project key milestones become:

• Contract signature between OUHT and Vital Energi Solutions Limited
• Certificate of commencement: i.e., a certificate issued by the Trust to Vital Energi Solutions Limited to start work on site
• Project operations covering the works (construction)
• Practical Completion
• Operational Term – delivery of the energy service over the 25 year contract term.

4.9 Accounting Treatment under Accounting Standards

4.9.1 The Trust has reviewed the terms of the agreement to ascertain how these are required to be treated under International Financial Reporting Standards. Although it is the intention of the Trust and the contractor that this is an ongoing service provision contract, the contract contains an implied equipment lease as it is dependent on specific equipment being installed in order to provide the services.

4.9.2 As there is an implied equipment lease, the Trust must assess this under IAS 17 to determine if it is classified as an operating lease in which case it is not recorded on the Trust's balance sheet, or if it is a finance lease in which case it is on balance sheet.

4.9.3 The assets underpinning the delivery of the services will be on the balance sheet of the Trust as it is felt that the contract falls within the definitions of a finance lease under IAS 17. This means that the Trust will treat the plant and
equipment as non-current assets, and the discounted sum of the future capital repayment element of the service payments will be treated as a loan on the Trust's balance sheet.

4.9.4 This treatment is different from that included in the OBC where it was stated that the contract would be an off-balance sheet one. The change has come about owing to additional information being supplied regarding the amount of the annual service payment which relates to capital repayment and lifecycle replacement of equipment. In conjunction with the trust's auditors it has been agreed that the contract should be accounted for as an on-balance sheet arrangement.

4.9.5 The effect of this treatment is shown in the analysis of the impact on the Trust balance sheet under section 5.
5. The Financial Case

5.1 Introduction

5.1.1 This section sets out the forecast financial implications of the preferred option (as detailed in the economic case section 3). This option is an Agreement with Vital Energi Utilities Limited to provide the Trust's energy requirements for the John Radcliffe and Churchill sites over a 25 year Term.

5.1.2 In modelling the financial impact of the Agreement, the following assumptions have been made:

- The operational period of the Agreement will commence on the 1st October 2016;
- The savings available to the Trust under the scheme will only be those guaranteed by the contractor. The Trust believes additional savings will accrue due to price rises, but these are not certain and so have not been modelled;
- The inflationary uplift for the Service Payment and guaranteed savings will be 2.5% (the contract allows for 2.5% or RPI, whichever is higher);
- VAT at 20% will be payable on the Service Payment and on the avoided energy costs;
- The effects of CRC charges have not been included;
- The Agreement will be accounted for as on-balance sheet;
- As the preferred option is an agreement with a contractor to provide the specified services, it is not appropriate to include optimism bias or contingencies in the financial models as detailed in this section.

5.1.3 As project financing will be arranged by the contractor, the Trust will not need to apply for public sector financing. The interest costs associated with this are built into the annual Service Payment.

5.1.4 Revenue funding for this scheme will be made available through reduced energy charges, which are greater than the incremental costs of the project.

5.2 Value Added Tax

5.2.1 Under current HMRC regulations, the Trust is not able to recover VAT on energy costs, or the costs of capital work on the energy systems. This means that all Trust costs shown in the economic case are required to be uplifted.

5.2.2 This works in the Trust's favour, however, with the savings under the scheme being a reduction in energy consumption as these energy costs currently incur VAT and therefore the gross saving to the Trust of the reduction in energy usage will also be uplifted.

5.2.3 Although a small proportion of the Trust's current energy costs are subjected to VAT at 5%, on balance this value is immaterial and most costs are subject to 20% VAT, and so the higher rate has been used throughout the modelling
in this business case for consistency.

5.2.4 The VAT treatment adopted by the Trust in relation to this contract is standard and does not include any assumptions that are novel or contentious. The Trust has discussed the treatment with its VAT advisors but as no deviation from standard treatment is proposed no formal advice has been obtained.

5.3 Current / Historic Trading

5.3.1 Historically the Trust has performed well reporting a surplus against its breakeven duty in each of the three previous financial years. Clinical income has grown substantially from £638.7m in 2011/12 to £742.5m in 2013/14, of which £90.1 million is attributable directly to increased levels of activity, particularly in critical care and chemotherapy. This increase in activity has also led to a corresponding increase in operating costs, including £44.3m of pay costs and £32.0m of non-pay costs. Separately, inflationary pressures have led to an increase in pay, drugs and clinical supplies costs of £33.8m over the period from 2011/12 to 2013/14.

5.3.2 From 2011/12 to 2013/14 the Trust has demonstrated its ability to control its cost base through strong performance against Cost Improvement Plan (CIP) targets, reporting £145.4m in cost savings. In 2013/14, the Trust had planned for a retained surplus of £8.4m and in fact delivered a £17.4m surplus, driven primarily by activity increases and following on from this, the Trust plans to deliver a surplus of £11.5m in 2014/15. As at November 2014, the Trust is on target to achieve this plan.

5.3.3 Summary financial performance from 2011/12 to 2014/15 forecast outturn is displayed in the table below:

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Emission</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Income</td>
<td>638.7</td>
<td>691.8</td>
<td>742.5</td>
<td>754.0</td>
</tr>
<tr>
<td>Clinical Income</td>
<td>149.5</td>
<td>129.9</td>
<td>125.8</td>
<td>149.9</td>
</tr>
<tr>
<td>Other Income</td>
<td>788.2</td>
<td>821.7</td>
<td>868.3</td>
<td>903.9</td>
</tr>
<tr>
<td>Total Income</td>
<td>(428.0)</td>
<td>(447.5)</td>
<td>(480.8)</td>
<td>(491.7)</td>
</tr>
<tr>
<td>Expenses</td>
<td>(230.7)</td>
<td>(305.4)</td>
<td>(314.4)</td>
<td>(337.5)</td>
</tr>
<tr>
<td>Pay</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Non-Pay</td>
<td>(718.7)</td>
<td>(752.9)</td>
<td>(795.2)</td>
<td>(829.2)</td>
</tr>
<tr>
<td>EBITDA</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Non-operating Items</td>
<td>69.5</td>
<td>68.8</td>
<td>73.1</td>
<td>74.7</td>
</tr>
<tr>
<td>Retained Surplus (deficit)</td>
<td>(61.9)</td>
<td>(70.1)</td>
<td>(55.8)</td>
<td>(69.5)</td>
</tr>
<tr>
<td>Adjustment for Impairment</td>
<td>7.6</td>
<td>(1.3)</td>
<td>17.3</td>
<td>8.2</td>
</tr>
<tr>
<td>Adjustment for IFRIC12 and donated asset reserve</td>
<td>(2.3)</td>
<td>4.6</td>
<td>(8.4)</td>
<td>0.0</td>
</tr>
<tr>
<td>Breakeven duty surplus/deficit</td>
<td>1.9</td>
<td>0.4</td>
<td>1.9</td>
<td>3.4</td>
</tr>
<tr>
<td>EBITDA %</td>
<td>8.6%</td>
<td>8.4%</td>
<td>8.4%</td>
<td>8.3%</td>
</tr>
<tr>
<td>Net Margin %</td>
<td>0.9%</td>
<td>0.4%</td>
<td>1.3%</td>
<td>1.3%</td>
</tr>
</tbody>
</table>

5.3.4 Over the last few years, the Trust has received non-recurrent income to meet non-recurrent costs, such as winter pressure funding and funding for
improving maternity care settings. A summary of the normalisation adjustments is reflected in the table below:

<table>
<thead>
<tr>
<th>Summary of normalisation adjustments</th>
<th>2011/12</th>
<th>2012/13</th>
<th>2013/14</th>
<th>2014/15</th>
</tr>
</thead>
<tbody>
<tr>
<td>Million</td>
<td>actual</td>
<td>actual</td>
<td>actual</td>
<td>actual</td>
</tr>
<tr>
<td>Break even duty surplus/deficit</td>
<td>7.2</td>
<td>3.7</td>
<td>10.8</td>
<td>11.6</td>
</tr>
<tr>
<td>(Profit)/loss on asset disposals</td>
<td>0.2</td>
<td>0.0</td>
<td>(0.4)</td>
<td>0.2</td>
</tr>
<tr>
<td><strong>Less non-recurring income</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Less non-recurring income</td>
<td>(15.2)</td>
<td>6.0</td>
<td>1.8</td>
<td>3.7</td>
</tr>
<tr>
<td>Winter pressures ED (offset by cost)</td>
<td>0.0</td>
<td>0.0</td>
<td>(2.1)</td>
<td>0.0</td>
</tr>
<tr>
<td>Less non-recurring income from prior years</td>
<td>(5.1)</td>
<td>1.2</td>
<td>0.0</td>
<td>0.0</td>
</tr>
<tr>
<td>Oxbridge CCG contract cap income</td>
<td>0.0</td>
<td>0.0</td>
<td>0.0</td>
<td>(3.6)</td>
</tr>
<tr>
<td>Other</td>
<td>1.8</td>
<td>(2.0)</td>
<td>(6.4)</td>
<td>0.0</td>
</tr>
<tr>
<td><strong>Plus non-recurring costs</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Less non-recurring cost savings</td>
<td>(4.2)</td>
<td>(4.3)</td>
<td>(2.3)</td>
<td>(2.7)</td>
</tr>
<tr>
<td>Restructuring and merger costs</td>
<td>8.1</td>
<td>4.0</td>
<td>0.0</td>
<td>0.0</td>
</tr>
<tr>
<td>Winter pressures ED (see income above)</td>
<td>0.0</td>
<td>0.0</td>
<td>2.7</td>
<td>0.0</td>
</tr>
<tr>
<td>Annual leave accrual</td>
<td>2.9</td>
<td>3.0</td>
<td>0.6</td>
<td>0.0</td>
</tr>
<tr>
<td>Adjustments on stock, provisions and depreciation</td>
<td>4.3</td>
<td>(0.1)</td>
<td>(0.1)</td>
<td>0.0</td>
</tr>
<tr>
<td>Other</td>
<td>3.0</td>
<td>1.5</td>
<td>6.4</td>
<td>0.0</td>
</tr>
<tr>
<td>Normalised Net Surplus</td>
<td>3.0</td>
<td>9.3</td>
<td>11.1</td>
<td>9.2</td>
</tr>
</tbody>
</table>

5.4 **Projected Income and Expenditure**

5.4.1 The forecast financial information in this section demonstrates the projections made by the Trust as part of the IBP. Overall the trust anticipates maintaining a retained surplus of 1% of income each year. This is based on continuing the strong performances against CIP targets and growing income through on going activity increases and continuing to control costs. This will enable the Trust to improve the strength of its Balance Sheet and maintain liquidity.

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Million</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Income</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Clinical Income</td>
<td></td>
<td>765.9</td>
<td>796.0</td>
<td>816.6</td>
<td>837.3</td>
<td>858.6</td>
</tr>
<tr>
<td>Other Income</td>
<td>149.9</td>
<td>142.8</td>
<td>144.9</td>
<td>143.5</td>
<td>141.9</td>
<td>141.7</td>
</tr>
<tr>
<td>Total Income</td>
<td>903.7</td>
<td>908.7</td>
<td>960.5</td>
<td>960.1</td>
<td>979.4</td>
<td>999.6</td>
</tr>
<tr>
<td>Expenses</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Pay</td>
<td></td>
<td>(491.7)</td>
<td>(491.5)</td>
<td>(511.1)</td>
<td>(518.3)</td>
<td>(521.9)</td>
</tr>
<tr>
<td>Non-Pay</td>
<td>(337.5)</td>
<td>(335.2)</td>
<td>(348.8)</td>
<td>(351.6)</td>
<td>(377.2)</td>
<td>(392.9)</td>
</tr>
<tr>
<td>Adjustments for donated asset income</td>
<td>(2.3)</td>
<td>(2.4)</td>
<td>(1.7)</td>
<td>(0.9)</td>
<td>(0.3)</td>
<td></td>
</tr>
<tr>
<td>Total Expenses</td>
<td>(829.9)</td>
<td>(833.5)</td>
<td>(823.2)</td>
<td>(870.6)</td>
<td>(899.7)</td>
<td>(922.2)</td>
</tr>
<tr>
<td>EBITDA</td>
<td>74.4</td>
<td>77.2</td>
<td>76.8</td>
<td>80.5</td>
<td>79.4</td>
<td>77.3</td>
</tr>
<tr>
<td>Non-operating Items</td>
<td>(65.3)</td>
<td>(67.5)</td>
<td>(67.0)</td>
<td>(65.4)</td>
<td>(69.9)</td>
<td>(67.3)</td>
</tr>
<tr>
<td>Retained Surplus (deficit)</td>
<td>9.1</td>
<td>9.7</td>
<td>11.8</td>
<td>11.1</td>
<td>10.4</td>
<td>10.0</td>
</tr>
<tr>
<td>Normalised net surplus</td>
<td>9.1</td>
<td>9.0</td>
<td>10.5</td>
<td>11.1</td>
<td>10.9</td>
<td>10.0</td>
</tr>
<tr>
<td>EBITDA %</td>
<td>8.3%</td>
<td>8.5%</td>
<td>8.4%</td>
<td>8.4%</td>
<td>8.1%</td>
<td>7.7%</td>
</tr>
<tr>
<td>Net Margin %</td>
<td>0.5%</td>
<td>1.1%</td>
<td>1.2%</td>
<td>1.2%</td>
<td>1.1%</td>
<td>1.0%</td>
</tr>
</tbody>
</table>

5.4.2 Total income for the period 1 April 2015 to 31 March 2020 is expected to increase from £903.9m to £999.5m.

5.4.3 The increase in income is primarily driven by an increase in clinical activity and income received relating to high cost drugs. In line with the IBP of the
Trust, income from NHS commissioners is expected to grow by £97.6m from 2014/15 to 2019/20 (before the additional Marginal Rate Emergency Tariff impact applied by Monitor to account for significant changes in the pattern of emergency admissions). Tariff deflation is based on the guidance from Monitor and is expected to decrease by £24.3m, while income to offset pass-through drugs costs is inflated by £29.8m over the period. Changes in clinical income are summarised in the table below.

<table>
<thead>
<tr>
<th>Clinical income bridge 2014/15 to 2019/20</th>
<th>£m</th>
</tr>
</thead>
<tbody>
<tr>
<td>Clinical income 2014/15 (exc. Private Patients)</td>
<td>742.6</td>
</tr>
<tr>
<td>Drugs Inflation</td>
<td>29.8</td>
</tr>
<tr>
<td>Growth and developments</td>
<td>85.9</td>
</tr>
<tr>
<td>Income efficiency savings</td>
<td>21.6</td>
</tr>
<tr>
<td>MRET impact on growth</td>
<td>(9.8)</td>
</tr>
<tr>
<td>Tariff deflation</td>
<td>(24.4)</td>
</tr>
<tr>
<td><strong>Clinical income FY20 (exc. Private Patients)</strong></td>
<td><strong>845.7</strong></td>
</tr>
<tr>
<td>Other income (inc. Private Patients) 2019/20</td>
<td>153.8</td>
</tr>
<tr>
<td><strong>Total Income 2019/20</strong></td>
<td><strong>999.5</strong></td>
</tr>
</tbody>
</table>

5.4.4 Other income not received from commissioners is projected to remain relatively stable from the expected outturn of £149.9m in 2014/15 to £141.7m in 2019/20.

5.4.5 Income assumptions are in line with the Trust's IBP as this project has no incremental impact on the Trust's income, which was developed in consultation with commissioners. The Table below sets out the key assumptions used to model the income for the Trust in the LTFM.

### Key income forecast assumptions

<table>
<thead>
<tr>
<th>Tariffs</th>
<th>a) Tariff deflator based on difference between the expected tariff efficiency factor and the input cost inflation given in the Monitor 2014/15 guidance. For 2015/16 this is 1.6%.</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>b) No tariff price change has been assumed for education and training and a 1.3% increase has been assumed for other income based on a weighted analysis of the components.</td>
</tr>
<tr>
<td></td>
<td>c) Payment by results, best practice tariffs and the impact of national initiatives have been considered in the development of the IBP.</td>
</tr>
<tr>
<td>QIPP</td>
<td>d) QIPP rates are modelled on the 2014/15 profile as per IBP in line with 14/15 regional plans and national policy initiatives, QIPP plans are developed in consultation with commissioners.</td>
</tr>
<tr>
<td>Growth</td>
<td>e) Income projections are based on factors relating to market share and specifically changing demand and demography.</td>
</tr>
<tr>
<td></td>
<td>f) Demographic – adds an average of £2.2m a year based on ONS statistics</td>
</tr>
<tr>
<td></td>
<td>g) Demand changes are projected to add an average of £16.3m a year based on the trust's plans to become a centre of acute excellence. This is driven by factors such as an increase in cancer survival rates, geriatric care requirement and increased demand for cardiology services.</td>
</tr>
<tr>
<td>CQuIN</td>
<td>h) CQuIN funding uplifts to tariffs are assumed to remain at current percentage levels over the forecast period.</td>
</tr>
<tr>
<td>Education &amp; Training</td>
<td>i) A reduction in education and training income of £1.5m in 2015/16 and a further £1.5m net following this is anticipated through the changes to funding implemented by the Department of Health.</td>
</tr>
<tr>
<td>Other clinical</td>
<td>j) The Trust anticipates an additional £1.2m due to improved efficiency in</td>
</tr>
</tbody>
</table>
5.4.6 Total expenses in the period 2019/20 are forecast to increase to £922.2m from £829.5m at 31st March 2015. The increase is primarily driven by projected activity growth which is expected to result in a £48.0m increase in costs in this period. This cost growth has been calculated from the Trust's Patient Level Costing System (PLICS) data on semi-fixed and variable cost profiles. This information was used to calculate marginal cost growth at Point of Delivery (POD) and specialty level and results in an overall marginal cost rate of 62% for future years.

5.4.7 CIPs reduce the real cost base by an average of 4% per annum, which equates to £145.5m over the next five years.

5.4.8 Weighted average inflation costs of 4.3% are added to the cost base in 2015/16, dropping to 3.9% in 2016/17 and 2017/18 before rising to 4.1% in 2018/19 and 4.2% in 2019/20. This is comprised of inflation relating to employee benefits, drug costs, clinical supplies, clinical negligence insurance and other items.

5.4.9 Key underlying assumptions used to forecast pay and non-pay costs for the Trust are detailed below.

**Key expenditure forecast assumptions**

| Pay costs | a) 1% rising to 2.5% by 2017/18 per annum based on the NHS pay award |
| Non-Pay costs | d) Drugs: inflation of 7% per annum which comprises 4.5% as a weighted average from the Baxter's database for the previous three years plus a 2.5% premium for new drugs coming on stream (including those from NICE) |
|             | e) Clinical supplies: 1.9% from the GDP deflator forecast |
|             | f) Inflation of 2.75% is assumed for operating and maintenance costs |
| Cost of financing | g) 2.45% based on national loan fund (NLF) rate for 24 year loan with an equal instalments of principal repayment profile as per TDA Guidance |
| CIPs         | h) 4% per annum for 2015/16 and 2017/17 then 4.4% per annum in line with latest planning guidance. Savings scheme CIPAs are reviewed and monitored by the Medical Director and Director of Nursing. |

5.5 Workforce

5.5.1 There are no expected changes in the Trust workforce as a result of this business case. Existing operation and maintenance work is undertaken by a number of estates staff in rotation as part of a range of duties, and no individual post or posts can be linked to this work.

5.5.2 There is no expectation of TUPE transfer or redundancy, and those staff who do lose a small number of duties following transfer of the plant to the contractor will have additional duties ascribed.

5.5.3 As a result of this there are no staff costs or savings included in the financial modelling in this business case.
5.6 Accounting Treatment

5.6.1 As discussed in section 4 the contract will be accounted for as if it were a finance lease meaning that the plant and equipment will be accounted for as non-current assets and brought onto the Trust balance sheet at their initial fair value which will be their cost to the contractor. An equal liability will be created as a loan against which the future capital element of service payments will be allocated.

5.6.2 Bringing the plant and equipment on to the Trust balance sheet will result in a technical adjustment to the Trust’s Capital Resource Limit. This adjustment recognises the assets as additions that are not due to allocation of capital.

5.6.3 As the arrangement will be accounted for as on-balance sheet, there will be additional accounting entries associated with the ownership of these assets including depreciation and PDC dividend charges. However there are no expected impairments, deferred asset or residual interest charges, and all operational and maintenance costs are covered by the Service Payment.

5.6.4 In calculating the impact on the Trust’s financial position these accounting entries have been included to give the complete picture.

5.6.5 Over the life of the agreement the effect of bringing the contract onto the balance sheet actually represents a small gain due to the value of the outstanding capital element of service payments exceeding the net value of the depreciated assets, and this excess liability reducing PDC dividend payments during the life of the contract.

5.6.6 At OBC stage it was expected that the scheme would be accounted for as off balance sheet but following further discussion with the Trust auditors it has been agreed that this scheme more closely meets the definitions of a finance lease and so has now been accounted for as on balance sheet. A letter or opinion has been requested from the auditors to confirm this.

5.7 Impact on the Organisation’s Income and Expenditure Account

5.7.1 The impact on the organisation’s Income and Expenditure Account is shown in appendix 11 for the life of the contract and an extract is shown in the table below for the current financial year and five forecast financial years (in line with the Trust’s Long Term Financial Model):

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Year number</td>
<td>0</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>Income from operations</td>
<td>£0</td>
<td>£0</td>
<td>£0</td>
<td>£0</td>
<td>£0</td>
<td>£0</td>
</tr>
<tr>
<td>Total Income</td>
<td>£0</td>
<td>£0</td>
<td>£0</td>
<td>£0</td>
<td>£0</td>
<td>£0</td>
</tr>
<tr>
<td>Pay</td>
<td>£0</td>
<td>£0</td>
<td>£0</td>
<td>£0</td>
<td>£0</td>
<td>£0</td>
</tr>
<tr>
<td>Non-Pay - Service Payment</td>
<td>£0</td>
<td>£0</td>
<td>£346,046</td>
<td>£1,113,000</td>
<td>£1,283,629</td>
<td>£1,339,666</td>
</tr>
<tr>
<td>Non-Pay - Professional Fees</td>
<td>£250,000</td>
<td>£100,000</td>
<td>£50,000</td>
<td>£0</td>
<td>£0</td>
<td>£0</td>
</tr>
<tr>
<td>Non-Pay - Savings</td>
<td>£0</td>
<td>£250,000</td>
<td>£1,098,093</td>
<td>£3,775,377</td>
<td>£3,844,792</td>
<td>£3,915,826</td>
</tr>
<tr>
<td>Capital Charges</td>
<td>£0</td>
<td>£0</td>
<td>£414,950</td>
<td>£1,242,078</td>
<td>£1,338,064</td>
<td>£1,279,321</td>
</tr>
<tr>
<td>Total costs</td>
<td>£250,000</td>
<td>£949,006</td>
<td>£350,495</td>
<td>£410,344</td>
<td>£422,777</td>
<td>£438,039</td>
</tr>
<tr>
<td>Contributions</td>
<td>£250,000</td>
<td>£949,006</td>
<td>£350,495</td>
<td>£410,344</td>
<td>£422,777</td>
<td>£438,039</td>
</tr>
</tbody>
</table>

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5.7.2 The agreement represents a gain to the Trust in excess of £300K per annum once the scheme is fully operational. This benefit increases year on year over the life of the contract as the inflationary rises to Service Payment and Guaranteed Savings take effect. The Trust anticipates that in the long run the inflation on energy bills will continue to be in excess of the RPI inflation used in calculating the annual increase to the unitary payment.

5.7.3 At OBC stage the expected impact on the Income and Expenditure account was greater. Due to the amendments to the contractors discussed in section 3.10, and the change in accounting treatment to bring the assets of the scheme on balance sheet the net savings have reduced but the scheme still represent a net gain to the Trust.

5.7.4 The small cost incurred in the current year to support the development of the business case has been met from current budgets, and does not affect the Trust's ability to breakeven in the current year.

5.7.5 The net gain will be an actual reduction in expenditure of the Trust based on current levels. The following table is a summary of the table shown in section 2 and demonstrates that the Trust has experienced significant growth in energy costs over previous financial years.

<table>
<thead>
<tr>
<th>Energy Costs</th>
<th>2011/2012</th>
<th>2013/2014</th>
<th>% Increase</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total</td>
<td>£5,074,525.45</td>
<td>£5,941,488.96</td>
<td>17%</td>
</tr>
</tbody>
</table>

5.7.6 Future excess rises of this nature will be avoided in part owing to the reduction of energy consumption by the Trust during the life of the contract, freeing resources for re-investment by the Trust in other areas.

5.8 Impact on the Organisation's Balance Sheet

5.8.1 The whole life impact of the contract on the Trust’s Balance Sheet is shown in appendix 12 and the table below shows an extract of this appendix covering the period of the Trust's Long Term Financial Model, being the current financial year and five forecast years.

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Year number</td>
<td>0</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>Non-Current assets</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Plant and Equipment</td>
<td>£100,000</td>
<td>£100,000</td>
<td>£14,000,000</td>
<td>£19,000,000</td>
<td>£13,320,000</td>
<td>£19,600,000</td>
</tr>
<tr>
<td>Current liabilities</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Financial lease accounts due under one year</td>
<td>£0</td>
<td>£0</td>
<td>-£329,134</td>
<td>-£330,652</td>
<td>-£355,540</td>
<td>-£372,834</td>
</tr>
<tr>
<td>Financial lease accounts due over one year</td>
<td>£0</td>
<td>£0</td>
<td>-£314,451,202</td>
<td>-£34,112,340</td>
<td>-£13,757,001</td>
<td>-£13,384,307</td>
</tr>
<tr>
<td>Net Current Assets/(liabilities)</td>
<td>£100,000</td>
<td>£100,000</td>
<td>£11,000,000</td>
<td>£13,320,000</td>
<td>£19,600,000</td>
<td>£19,277,209</td>
</tr>
</tbody>
</table>

5.8.2 Treating the contract as if it contains a finance lease means that the assets and liabilities implied by this treatment will be included on the Trust's balance sheet. Over the life of the contract the way in which the assets are depreciated and the liability repaid are not the same which means that at various points in the contract life there is either a net asset or a net liability
created. This in turn creates a PDC charge or credit which has been reflected in the Income and Expenditure account forecast.

5.8.3 The net position of including the contract on the Trust Balance sheet is that an overall reduction of PDC of £791K over the life of the contract is created.

5.8.4 Bringing the arrangement onto the Balance Sheet also results in repayments of the liability counting against the Trust's Continuity of Service Rating. These repayments are £106K in the first financial year due to part year effects, rising to £323K in the first full financial year and steadily increasing over the life of the contract to £919K at their largest. The impact of the Continuity of Service Rating is not sufficient to change the Trust's overall position.

5.9 Impact on the Organisation's Cash Flow

5.9.1 The table below shows the impact of the contract on the Trust's cash flow over the term of the Long Term Financial Model and is an extract of appendix 13 which shows the impact for the entire life of the contract.

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Year number</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
<td>6</td>
</tr>
<tr>
<td>Income from operations</td>
<td>£50</td>
<td>£50</td>
<td>£50</td>
<td>£50</td>
<td>£50</td>
<td>£50</td>
</tr>
<tr>
<td>Charitable funds</td>
<td>£50</td>
<td>£50</td>
<td>£50</td>
<td>£50</td>
<td>£50</td>
<td>£50</td>
</tr>
<tr>
<td>Pay</td>
<td>£50</td>
<td>£50</td>
<td>£50</td>
<td>£50</td>
<td>£50</td>
<td>£50</td>
</tr>
<tr>
<td>Net operating profit</td>
<td>£250,000</td>
<td>£166,000</td>
<td>£96,000</td>
<td>£76,000</td>
<td>£70,000</td>
<td>£60,000</td>
</tr>
<tr>
<td>Total operating activities</td>
<td>£250,000</td>
<td>£166,000</td>
<td>£96,000</td>
<td>£76,000</td>
<td>£70,000</td>
<td>£60,000</td>
</tr>
<tr>
<td>Cumulative cash from operations</td>
<td>£250,000</td>
<td>£256,000</td>
<td>£352,000</td>
<td>£428,000</td>
<td>£504,000</td>
<td>£564,000</td>
</tr>
<tr>
<td>Capital expenditure</td>
<td>£50</td>
<td>£50</td>
<td>£50</td>
<td>£50</td>
<td>£50</td>
<td>£50</td>
</tr>
<tr>
<td>Total capital expenditure</td>
<td>£50</td>
<td>£50</td>
<td>£50</td>
<td>£50</td>
<td>£50</td>
<td>£50</td>
</tr>
<tr>
<td>Total investing activities</td>
<td>£100,000</td>
<td>£100,000</td>
<td>£367,000</td>
<td>£690,000</td>
<td>£923,000</td>
<td>£1,156,000</td>
</tr>
<tr>
<td>Cumulative cash</td>
<td>£100,000</td>
<td>£100,000</td>
<td>£367,000</td>
<td>£690,000</td>
<td>£923,000</td>
<td>£1,156,000</td>
</tr>
<tr>
<td>Total cash</td>
<td>£350,000</td>
<td>£354,000</td>
<td>£467,000</td>
<td>£537,000</td>
<td>£644,000</td>
<td>£708,000</td>
</tr>
</tbody>
</table>

5.9.2 As this table and the appendix show the Scheme represents a significant cash gain to the Trust once it is operating fully. This is not as great as expected at OBC stage owing to the additional costs and reduced savings that have been included following finalisation of the design.

5.9.3 The interim savings expected to begin accruing during the installation phase go part way to reimbursing the Trust's costs of negotiating and agreeing the contract. These include a contribution to the contractor's bid costs and equipment deposits that will be repaid by means of a reduction in operating cost once the installation is complete. The costs also include the advisors used by the Trust for legal, insurance and accounting advice, and the appointment of the project manager for the period of the installation. This expenditure totals £500K with £300K being repaid.

5.9.4 The Trust Board approved the expenditure of £200K for contractor's bid costs and £100K for equipment deposits at the time that it approved the OBC in September 2014.

5.9.5 The cash flow to the Trust remains positive both year by year and cumulatively throughout the life of the contract once these initial costs have been recovered.
5.10 Procurement Costs

5.10.3 The Trust has allowed a sum of £50K in the 2014/15 financial year for professional advice required to reach contract signature. It has also allowed a sum of £100K in the 2015/16 financial year for final professional fees up to signature of the agreement and the employment of a project manager to ensure that the installation project is delivered, and the Trust obtains the expected benefits. This project manager will remain in post until practical completion, expected in October 2016, and so additional costs of £50K have been allowed to cover this expense in 2016/17.

5.10.4 We estimate that the Trust project team that has been involved in delivering the agreed contract, OBC and FBC has cost approximately £175,000 in the current financial year, although this does not represent expenditure additional to Trust budgets and is based on an allocation of costs.

5.11 Overall Affordability

5.11.1 The total cost of the proposed scheme is £45.8m over the 25 years of the expected lifespan of the contract. The total of the expected savings over the life of the contract is £57.3m. This means the contract is self-funding and does not need any allocation of Trust financial resource.

5.11.2 The Trust incurs a small cost in 2014/15 and 2015/16 related to completion of the business case, and the operation of the project team during the early stages of the installation, before the interim savings begin to accrue. This is within current budgets, and does not need any further approval or allocation of expenditure by the Board.

5.11.3 This total cost represents the full value of the payments to the contractor over the life of the contract in current price terms (i.e. excluding inflation). These are £1,831K per annum. This figure also excludes VAT and CRC charges. As detailed in the savings section below the comparable annual savings figure is £2,294K per annum.

5.11.4 All payments to the contractor are included within the Service Payment, which is made up of a capital repayment element and operation and maintenance costs as shown in the table below (the charge is shown at base year prices –
2014/15 – without inflationary uplift).

<table>
<thead>
<tr>
<th>Makeup of Vital Energy Service Payment</th>
<th>£</th>
</tr>
</thead>
<tbody>
<tr>
<td>Capital repayment element</td>
<td>1,041,633</td>
</tr>
<tr>
<td>Lifecycle cost - CHP</td>
<td>259,143</td>
</tr>
<tr>
<td>Lifecycle cost - others</td>
<td>149,586</td>
</tr>
<tr>
<td>Operation and Maintenance</td>
<td>92,918</td>
</tr>
<tr>
<td>Prelims incl insurance costs as a percentage</td>
<td>10,033</td>
</tr>
<tr>
<td>Contribution to overheads</td>
<td>20,066</td>
</tr>
<tr>
<td>Profit margin as a percentage of total costs</td>
<td>29,168</td>
</tr>
<tr>
<td>Carbon and Energy Fund Admin costs (NCIS)</td>
<td>91,746</td>
</tr>
<tr>
<td>Savings risk premium as a percentage of the savings</td>
<td>137,620</td>
</tr>
<tr>
<td>Total of Service Payment</td>
<td>1,831,913</td>
</tr>
</tbody>
</table>

5.11.5 The payments are offset by savings throughout the life of the contract so that this total cost does not represent the impact upon the Income and Expenditure position of the Trust (see section 5.7).

5.11.6 As both the Service payment and the guaranteed savings will increase at a rate of 2.5% or RPI if higher, the Trust will always make net savings on this scheme. Inflation will begin at the date of the signature of the contract.

5.12 Summary Savings

5.12.1 As demonstrated earlier the proposed contract represents a net gain to the Trust with an NPV of £7.601m over the 25 year life span. This is achieved through the guaranteed savings of £2.294m in each year of the contract (excluding the effects of indexation).

5.12.2 Savings and costs are indexed in future years using a rate of 2.5% or the Retail Prices Index (whichever is higher).

5.12.3 The proposed savings in today’s values (excluding indexation) accumulate to £57.3m over the 25 years of the expected lifespan of the contract.

5.12.4 The annual savings (Base year) are shown in detail in appendix 14, but can be summarised as follows:

<table>
<thead>
<tr>
<th>Summary of Savings</th>
<th>£</th>
</tr>
</thead>
<tbody>
<tr>
<td>Reduction in energy costs - boiler house</td>
<td>2,058,549</td>
</tr>
<tr>
<td>Savings from Lighting retrofit across trust</td>
<td>115,110</td>
</tr>
<tr>
<td>Avoided costs e.g. maintenance</td>
<td>120,000</td>
</tr>
<tr>
<td>Guaranteed savings</td>
<td>2,293,659</td>
</tr>
</tbody>
</table>

5.12.5 The Trust will continue to pay utility bills for the energy used throughout the Trust including the new equipment in the boiler houses; therefore the savings will be immediately apparent on invoices received from the energy suppliers. The Trust and CEF will participate in monthly, quarterly and annual monitoring processes with the contractor to ensure that these savings achieve the
expected levels.

5.12.6 It is anticipated that the Trust will begin to benefit from these savings from October 2015.

5.12.7 The savings are guaranteed under the Agreement. This means that should the savings not be achieved, for instance because the new equipment is not as efficiently operated as was planned, the contractor will be obliged to make up the difference to the Trust by means of a reduction in charges.

5.12.8 Should actual energy reductions (not costs avoided) exceed the guarantee, for instance through the equipment being more efficient than expected, the excess financial savings will be split between the Trust and the contractor using a profit share formula, which also allows for the creation of a reserve of up to £50K to offset future shortfalls in savings.

5.12.9 The effective savings to be made by the Trust will be higher than the guaranteed figure, as this is calculated on prices excluding VAT, and the Trust is not able to recover VAT suffered on energy costs.

5.12.10 Similarly the effects of the Carbon Reduction commitment scheme (CRC) charges which are levied on energy have not been included in the figures above, and so add to the overall impact.

5.12.11 Note that the VAT and CRC effects of the savings are not included in the table at 5.12.4 above as they do not form part of the contractor’s guarantee.

5.12.12 Additional savings will accrue to the Trust including the removal of costs currently being incurred as a result of energy related system breakdowns. This includes delays to operations resulting in additional inpatient stays which is estimated to cost the Trust approximately £150K per annum.

5.12.13 The savings mechanism forms part of the Energy Services Performance Agreement.

5.13 Abortive Costs

5.13.1 Should the Trust decide not to proceed with the development, the sum of £300,000 which has been approved by the Board for release in September 2014 is non-recoverable.
6. Management case

6.1 Introduction

6.1.1 This section of the FBC addresses in detail how the scheme will be delivered successfully.

6.1.2 The FBC builds on the SOC and OBC and sets out in detail the actions that will be required to ensure the successful delivery of the scheme in accordance with best practice.

6.2 Programme Management Arrangements

6.2.1 The scheme is a core part of the OUH Estate Strategy and development programme which consists of various schemes to ensure the Trust estate is in optimum conditions within available resources and supports the achievement of the Trust’s strategic objectives.

6.2.2 The FBC sets out the programme and project management arrangements in detail. The scope and complexities of this new energy investment programme has resulted in the Trust adopting a phased approach as follows:

- Phase 1 – Feasibility, incorporating planning, design
- Phase 2 – Approval and implementation
- Phase 3 – Monitoring and control

6.2.3 The core driver of the energy investment programmes was the publication of the NHS Carbon Reduction Strategy ("Strategy"). This set a mandatory framework for NHS organisations to embed sustainability into their culture and activities, contributing to overall carbon emission reduction targets. The Strategy followed the introduction of the UK Climate Change Act 2008 which set out statutory emission cuts. The Carbon Reduction Strategy sets an initial target for NHS organisations to reduce emissions by 10% by 2015. At the point of completing this FBC the Trust is on course to achieve the targeted reduction.

6.2.4 As a result of the publication of the Strategy the Trust began a review of the management and delivery of energy services. Whilst it was generally accepted that the energy infrastructure support at that time was in need of repair and replacement, the extent of works was not determined. The Trust therefore mobilised this project, led by the Director of Development and the Estate to investigate the level of work needed and see this through to implementation.

6.2.5 The Trust commissioned Halcrow Group Limited to carry out a review of its energy infrastructure within the retained hospital estate and to set out a strategy for the refurbishment of the energy systems. In so doing the report considered the strengths and weaknesses of the existing energy infrastructure. The report also considered options for change using
technologies readily available in the current market, and considered which of these were suitable for the Trust's position.

6.2.6 To build on this review the Trust became a member of the Carbon and Energy Fund, a special purpose vehicle, governed by a collaborative agreement with the NHS intended to support NHS Trusts in this kind of energy infrastructure development through project management expertise and sharing of knowledge throughout the project lifecycle.

6.2.7 The Trust and CEF jointly engaged Jacobs Engineering U.K. Limited to carry out a review of potential upgrades to the energy infrastructure in the retained estate at the John Radcliffe and Churchill Hospital sites. This report was to provide the Trust and CEF with guidance on an energy upgrade that was viable for the Trust and would fit within the CEF model in meeting the requirement of the strategy, benefit from access to external funders and deliver net savings to the Trust over the operational period.

6.2.8 The Halcrow and Jacobs reports are discussed throughout this business case and form the basis of the assessment of infrastructure requirements of the Trust and are fully discussed in the strategic and economic cases. They provide an objective, unbiased approach in providing the data which enables the Trust to move forward with this project.

6.2.9 The planning and design of the project in meeting our needs has been encompassed in the tendering process of the contractors. This project is based on an output specification and thus the design of its delivery and associated risks sit with the preferred bidder. This process has been described in the economic section.

6.2.10 Throughout Phase 1, the Project team worked together to ensure the correct solution was chosen for the Trust and that the procurement of Preferred Bidder was reached following a fair and open competition.

6.2.11 The main roles and responsibilities of the Project Team during phase 1 of this development were as follows:

- The Director of Development and the Estate as the project sponsor and is accountable at board level for this project.
- The Deputy Director of Development and the Estate worked with the Senior Operations Manager and Utilities Manager in understanding the energy needs and infrastructural weaknesses of the Trust and how they are best managed. In this work the Deputy Director of Development and the Estate and the Senior Operations Manager have reported to the Director of Development and the Estate.
- The Divisional Business Partner and Finance Managers worked with the Team to develop the business case and consider the financial support necessary to inform the pathway and mechanics adopted in reaching the design of the proposed solution. The projected business case was agreed bilaterally throughout this phase with final approval resting with the Project Sponsor.
CEF were instrumental in the feasibility phase in working with the Team in identifying the scope of work needed and procurement of the preferred Bidder.

The Preferred Bidder worked with the trust to tailor the design to meet the trust's needs and address backlog issues.

Phase 2 – Approval and implementation

6.2.12 In September 2014 the Trust Board approved the OBC for this project which included the decision to award preferred bidder status to Vital Energi Solutions Limited.

6.2.13 Due to the value of the expenditure incurred by the Trust under this project, the business case has been submitted to the TDA for their consideration; firstly at committee stage in February followed by TDA Board in March 2015. In order to support the decision making process at the TDA, the project team amended elements within the OBC and have submitted additional information to support the TDA’s due diligence process. The Board were advised of these amendments and approved the provision of supplementary support at their meeting in January 2015.

6.2.14 Concurrently the project team have prepared this FBC for Board approval ensuring that the areas which required additional information for both Board and TDA have been fully addressed in this FBC.

6.2.15 Should this FBC achieve Trust Board approval at their meeting in March, this case will go to the TDA for review and decision following the process at OBC stage.

6.2.16 The TDA role is to ensure that where expenditure as part of a development exceeds the Trust’s delegated limits, then the Trust Board has received sufficient information to take the decision to proceed with a full understanding of the risks and benefits that the development offers to the Trust.

6.2.17 Assuming the TDA agree with the decision of the Trust Board, the Trust will then be in a position to enter into the Project Agreement with Vital Energi Solutions Limited as described in the commercial case. It is anticipated this agreement will be signed in late May or early June 2015 allowing construction to begin immediately. This will achieve the trust’s objective of strengthening the resilience of the energy infrastructure before the winter of 15/16 begins.

6.2.18 Following approval of the FBC and signature of the Project Agreement, it is anticipated that a dedicated specialist Project Manager at Grade 8c, will be appointed and will lead the delivery of the scheme, reporting directly to the Director of Development and the Estate.

6.2.19 The Project Manager will be required to establish a project team during the construction phase and will require external validation and verification of the commissioning process and outcomes.

6.2.20 Throughout the enabling and commissioning works the Trust team will work in
tandem with the contractor and CEF to ensure completeness and compliance with project specifications.

The Project Team

6.2.21 The project Team for Phase 2 of the scheme comprises all the members of phase 1 and will be strengthened at the implementation stage by a Project Manager.

6.2.22 An over view of the structure of this arrangement can be set out as follows:

Phase 3 – Monitoring and Control

6.2.23 Post construction, the role of the project manager will be complete. Responsibility for overseeing the service delivery will sit with the Head of Strategic Asset Management (SAM).

6.2.24 The Energy Manager will report directly to the Head of SAM and act as liaison with CEF as appointed third party monitor of service delivery.

6.2.25 The Deputy Director of Development and the Estate and the Senior
Operations Manager will maintain relationships with the contractor to ensure a smooth infrastructural support is in place.

6.2.26 The Head of SAM and the Deputy Director will provide feedback and progress reports to the Director of Development and the Estate. This support system is summarised as follows:

![Diagram]

6.3 Project Management Arrangements

6.3.1 Implementing the project considers processes used to complete the works defined in the project plan and involves co-ordinating the team and resources, in addition to integrating and performing the activities of the project in accordance with the project management plan.

6.3.2 The programme reporting arrangements for implementation remain as above however project management processes include:

- Direct and manage project implementation;
- Continuous review of quality assurance of outcomes;
- Acquire, develop and manage project team;
• Distribute information;
• Manage stakeholder expectations;
• Conduct procurement;
• Test the deliverables against the initial design.

Project Organisation

6.3.3 The key components of the project organisation are:

• The Project Board
• The Project Director/Project Senior Responsible Officer
• The Project Manager
• Sub groups/work-streams as required

6.3.4 The Project Board has no executive powers and is accountable to the Trust Board. It oversees and implements all aspects of this project as directed by the Trust Board.

6.3.5 The primary purpose of the Project Board is to:

• Ensure that the project delivers the plans set out in the Project Agreement;
• Ensure the project is delivered to agreed timescales and within agreed budgets;
• Obtain the appropriate support from partner agencies to realise the vision set out in the Trust's strategy;
• Maintain visible and sustained programme commitment from members of TME and Trust Board;
• Demonstrate leadership for all elements of the project including joint working between OUHT and CEF Limited;
• Ensure best value is achieved which reflects the needs of service users and staff while maintaining public and stakeholder confidence;
• Provide assurance to the Trust Board via the agreed reporting structure.

6.3.6 The Project Board for this scheme will be led and chaired by the Director of Development and the Estate as Senior Responsible Owner. The Director of Finance and Procurement will also sit on this Board.

6.3.7 As the project concerns the Trust infrastructure and predominantly concerns behind-the-scenes aspects of the Trust estate, Directorate representatives will not form a permanent part of the Project Board, but will be invited to join the Board or its sub-groups as required.

6.3.8 We anticipate that the Project Board will be made up as follows:
<table>
<thead>
<tr>
<th><strong>Project Board Representation</strong></th>
<th><strong>Work Stream Sub-Groups</strong></th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Directorate</strong></td>
<td><strong>Directorate Lead</strong></td>
</tr>
<tr>
<td>Development and the Estate</td>
<td>Mark Trumper</td>
</tr>
<tr>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
</tr>
<tr>
<td>Finance &amp; Procurement</td>
<td>Mark Mansfield</td>
</tr>
<tr>
<td></td>
<td></td>
</tr>
</tbody>
</table>

6.3.9 The Senior Responsible Owner (SRO) or Project Sponsor/Director for this project is Mark Trumper, Director of Development and the Estate. He holds the following high-level responsibilities for this project:

- Ensure that a project of change meets its objectives and delivers the projected benefits;
- Ensure agreement amongst stakeholders about the objectives and benefits and commitment to the delivery of benefits;
- Monitor delivery of the objectives and benefits, taking appropriate action where necessary to ensure their successful delivery;
- Ensure that the project is subject to review at the key decision points;
- Make certain that any recommendations or concerns from reviews are met or addressed before progressing to the next stage;
- Oversee development of the brief for change;
- Ensure that the aims of the planned change continue to be aligned with the business, and establish a firm basis for the project during its initiation and definition;
- Develop the project organisation structure and logical plans;
- Monitor and control of progress;
- Formally close the project and ensure that the lessons learned are documented within the 'end of project' or 'end of programme' evaluation report;
- Plan the post project review when the benefits realisation process will be assessed;
- Ensure that the post implementation review takes place, the output is forwarded to the appropriate stakeholders and the benefits have been realised;
- Regularly consult with those delivering the change and the stakeholders and sponsors;
- Ensure that the communication processes are effective and linkages are maintained between the change team(s) and the organisations strategic direction.
6.3.10 The Project Director's role is crucial for creating and maintaining enthusiasm and momentum. Specific responsibilities include:

- Planning and designing the project and proactively monitoring its overall progress, resolving issues and initiating corrective action as appropriate;
- Defining the project's governance arrangements and quality assurance;
- Managing the project's budget, monitoring the expenditures and costs against delivered and realised benefits as the programme progresses;
- Facilitating the appointment of individuals to the project delivery teams;
- Ensuring that there is efficient allocation of common resources and skills;
- Managing the communications with all stakeholders and third parties;
- Managing both the dependencies and the interfaces between projects;
- Managing risks.

6.3.11 It is envisaged that a dedicated Project Manager role will be created by the Trust following approval of this business case and signature of the Project Agreement.

6.3.12 The Project Manager's role will be to oversee day to day activities and ensure that progress is maintained in accordance with the project plans agreed by the Project Director.

6.3.13 In addition the Project Manager will be expected to co-ordinate and manage the contribution of the project delivery team including external advisors. Regular contact with the team and the Project Director will be required in order to achieve this and to inform and communicate progress and issues 'up and down the chain of command.'

6.3.14 A job description and person specification for the Project Manager are included under appendix 18 with specific responsibilities including:

- Develop, implement and maintain a rigorous project management methodology for the development;
- Managing project priorities;
- Acting as a catalyst to resolve project problems and conflicts, escalating when necessary;
- Assessing strengths and weaknesses at project completion;
- Ensuring that related and partner teams are involved and informed as early as possible in the project management process;
- Co-ordinating Project Management Groups including Project Board, ensuring information is supplied and meetings are held regularly;
- Preparing project schedules, plans and forecasts;
- Providing regular reports to the SRO on progress of the Business change;
- Monitoring actual progress against agreed schedule and plans;
- Using defined Project processes to manage quality, risks, changes, issues and financial implications;
- Monitoring project performance and publishing project status data at key stages throughout the project;
- Managing day-to-day project tasks and escalating any issues that impact on the project performance and timetable; and
- Providing updates or adjustments to the project plan as necessary to ensure the project continues to meet the key deliverables defined at the start of the project.

6.3.15 The support services significant for this case are as follows:

<table>
<thead>
<tr>
<th>Support Service</th>
<th>Impact Y/N</th>
<th>Assessment of impact</th>
</tr>
</thead>
<tbody>
<tr>
<td>Critical Care, Theatres and Anaesthetics</td>
<td>N</td>
<td>N/A</td>
</tr>
<tr>
<td>Pathology</td>
<td>N</td>
<td>N/A</td>
</tr>
<tr>
<td>Radiology and Imaging</td>
<td>N</td>
<td>N/A</td>
</tr>
<tr>
<td>Pharmacy</td>
<td>N</td>
<td>N/A</td>
</tr>
<tr>
<td>Physio, OT, SALT</td>
<td>N</td>
<td>N/A</td>
</tr>
<tr>
<td>Infection Control</td>
<td>N</td>
<td>N/A</td>
</tr>
<tr>
<td>Outpatients</td>
<td>N</td>
<td>N/A</td>
</tr>
<tr>
<td>Medical Records</td>
<td>N</td>
<td>N/A</td>
</tr>
<tr>
<td>Estates/Capital Development</td>
<td>Y</td>
<td>Major programme of works, led by Estates</td>
</tr>
<tr>
<td>Other</td>
<td>N</td>
<td>N/A</td>
</tr>
</tbody>
</table>

Outline Project Plan

6.3.16 The outline integrated approval and installation timetable is as follows:
<table>
<thead>
<tr>
<th>Activity</th>
<th>Completion dates / Milestones</th>
</tr>
</thead>
<tbody>
<tr>
<td>Project Initiation</td>
<td></td>
</tr>
<tr>
<td>Energy Strategy Study - The Hainor Group Limited</td>
<td>December 2011</td>
</tr>
<tr>
<td>Complete due diligence and become a member of the Carbon and Energy Fund</td>
<td>December 2012</td>
</tr>
<tr>
<td>Complete feasibility and identity energy delivery weaknesses - Jacobs</td>
<td>December 2012</td>
</tr>
<tr>
<td>SOG approval</td>
<td>December 2012</td>
</tr>
<tr>
<td>Establish Project Team - Feasibility Phase</td>
<td>Ongoing 2012</td>
</tr>
<tr>
<td>Procurement of Preferred Boiler - Vital Energy Utilities Limited</td>
<td>July 2013</td>
</tr>
<tr>
<td>Prepare and obtain planning permissions</td>
<td>November 2013</td>
</tr>
<tr>
<td>Outline Business Case</td>
<td></td>
</tr>
<tr>
<td>TME outline business case submission</td>
<td>August 2014</td>
</tr>
<tr>
<td>Outline business case to Trust Board</td>
<td>September 2014</td>
</tr>
<tr>
<td>Business case introduction to TDA</td>
<td>October 2014</td>
</tr>
<tr>
<td>Revised OBC approval from Trust Board</td>
<td>January 2015</td>
</tr>
<tr>
<td>OBC approval from TDA</td>
<td>March 2015</td>
</tr>
<tr>
<td>Project Design &amp; Agreement Finalisation</td>
<td></td>
</tr>
<tr>
<td>Confirm Project Team membership</td>
<td>January 2015</td>
</tr>
<tr>
<td>Review detailed project plan</td>
<td>January/February 2015</td>
</tr>
<tr>
<td>Reserve engine production slot</td>
<td>January 2015</td>
</tr>
<tr>
<td>Finalise design for additional district heating and chiller plant up-grade</td>
<td>January/February 2015</td>
</tr>
<tr>
<td>Finalise legal Agreement arrangements</td>
<td>Q1 2015</td>
</tr>
<tr>
<td>Full Business Case - FBC</td>
<td></td>
</tr>
<tr>
<td>Submit FBC for Trust Board approval</td>
<td>March 2015</td>
</tr>
<tr>
<td>FBC approval from TDA</td>
<td>Month end May 2015</td>
</tr>
<tr>
<td>Project Implementation</td>
<td></td>
</tr>
<tr>
<td>Contract signature</td>
<td>Early June 2015</td>
</tr>
<tr>
<td>Mobilise on-site works</td>
<td>Early June 2015</td>
</tr>
<tr>
<td>Steam boilers and system shut-down at Churchill Hospital</td>
<td>Beginning October 2015</td>
</tr>
<tr>
<td>Energy conservation measures completed – both sites</td>
<td>October 2015</td>
</tr>
<tr>
<td>Anticipated completion of works on the Churchill site</td>
<td>May 2016</td>
</tr>
<tr>
<td>CHP unit delivered to John Radcliffe Hospital</td>
<td>May 2016</td>
</tr>
<tr>
<td>HTHW steam or LTHW boilers and system shut-down at John Radcliffe Hospital</td>
<td>June 2016</td>
</tr>
<tr>
<td>Final CHP commissioning</td>
<td>October 2016</td>
</tr>
</tbody>
</table>

6.3.17 The impacts/risks associated with the project have been scored against the Gateway Risk Potential Assessment (RPA) for projects and are discussed under the Gateway Review section which follows under 6.10.

6.4 Use of Special Advisors

6.4.1 Special advisors will be used in a timely and cost-effective manner in accordance with the Treasury Guidance: Use of Special Advisors.

6.4.2 In 2012 the Trust entered a membership agreement with the CEF Limited who act as advisors to the Trust on all aspects of this proposed energy programme.

6.4.3 We are also recommending that a dedicated and experienced Project Manager role be created for the successful delivery of the installation period of this scheme.

6.4.4 As mentioned in the financial case, financial advisors have been used to
ensure that the correct accounting treatment will be adopted by the Trust.

6.4.5 In order to ensure that the contract appropriately protects the Trust interests, the Trust has engaged legal advisors to support the finalisation of the project agreement up to signature, and insurance advisors to review the proposed contractual arrangements regarding insurance of plant, equipment and buildings.

6.4.6 The Trust legal advisors will provide a formal report for the Trust to consider alongside this FBC that will cover:

- The Project Agreement – key contractual obligations
- Lease arrangements
- The Funder's Direct Agreement
- Powers to enter into the Agreement
- Project commencement issues
- Other matters for consideration

6.5 Arrangements for Change Management

6.5.1 As mentioned above the scheme concerns the 'behind the scenes' energy infrastructure, and impact on staff, patients and other stakeholders is minimised as long as the infrastructure works. Therefore the arrangements for change management concern ensuring continuity of supply to public/staff areas.

6.5.2 The installation programme has been phased to ensure that work is conducted according to a pattern that prioritises delivery of heating services during the winter and cooling services in the summer. This will be part of the project management arrangements to ensure that this delivery of services remains viable.

6.5.3 The retro-fit of the lighting across public, staff and ward areas will impact upon trust services, and may impact patient privacy and dignity. The Trust has procedures in place which ensure minimum impact on patient experience and service delivery during lighting maintenance of this kind. Further, patient experience is considered as part of the Quality Impact Assessment under section 6.12 and supported by appendix 19.

6.5.4 Vital Energi Solutions Limited have a history of delivering schemes of this nature and in doing so have developed a programme of communication and liaison with Trust staff to ensure that impact on services is understood and minimised wherever possible. This programme will be part of the Trust installation process.

6.6 Arrangements for Benefits Realisation

6.6.1 The Benefits Realisation Plan (BRP) shows how the benefit will be achieved
and includes any changes in working practice, in addition to how the benefit is to be monitored and utilised.

6.6.2 The BRP is effectively a schedule of all the benefits profiles in an easy-to-view format for a business/benefits manager.

6.6.3 It details who does what and when – to achieve, measure and report the benefits.

6.6.4 An effective BRP needs to:

- Link to or include monitoring, measurement and reporting plans for the benefits;
- Include baseline scheduling which should ideally be completed before the change intervention;
- Have agreed targets. Contextual and utilisation information will be required to indicate when benefits are likely to start being realised and at what rate.

6.6.5 The benefits identified in the plan relate to the carbon and energy efficiencies and the associated financial savings. In addition, the scheme will generate non-financial benefits in terms of the increased resilience of the energy infrastructure. Non-financial benefit realisations include:

- Reduced risk of interruption to patient services
- Reduced risk of Theatre cancellations
- Contributing to overall patient experience
- Innovative design excellence which will enhance Trust reputation
- Greater flexibility to deal with changes in future energy demands

6.6.6 These benefits are not included in the BRP due to it not being quantifiable in the same way as the financial benefits.

6.6.7 Delivery of this scheme offer the Trust a further commercial benefit in that excess energy supply may potentially be offered to consumers both on-site and in the surrounding Oxford area. This potential benefit does not form part of the BRP.

6.6.8 The key benefits anticipated from this investment and the approach for achieving them is outlined in the table below. These benefits are directly linked to the objectives for the investment as described earlier.
<table>
<thead>
<tr>
<th>Item No.</th>
<th>Perspective</th>
<th>Outcomes</th>
<th>Measurements</th>
<th>Presently monitored VN</th>
<th>Measurement Method</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Patient Care</td>
<td>Significantly improved resilience on both hospital sites, with risk of heating failures minimised</td>
<td>Heating or electric failures</td>
<td>N</td>
<td>Annual review</td>
</tr>
<tr>
<td>2</td>
<td>Staff</td>
<td>Deployment of engineering staff on to more front line services, given that 3rd party will be operating the boiler houses</td>
<td>Reduction in time taken for rectification of estates matters around the sites</td>
<td>N</td>
<td>Annual review</td>
</tr>
<tr>
<td>3</td>
<td>Environment</td>
<td>Reduce carbon</td>
<td>Annual 11,000 tonnes reduction in CO2. From 30,500t to 19,500t</td>
<td>Y</td>
<td>Measured reduction, using figures contained within the contract</td>
</tr>
<tr>
<td>4</td>
<td>Finance</td>
<td>Reduced energy cost</td>
<td>Reduction of circa £2.2m a year from circa £5m to £2.8m</td>
<td>Y</td>
<td>Measured reduction, using figures contained within the contract</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Reduced urgent capital expenditure</td>
<td>Annual capital costs on replacement infrastructure @ 3.5%</td>
<td></td>
<td></td>
</tr>
<tr>
<td>5</td>
<td>Estates</td>
<td>Improved maintenance</td>
<td>Change in ratio from 00/10 to 20/60</td>
<td>N</td>
<td>Annual review</td>
</tr>
<tr>
<td>6</td>
<td>Trust Performance</td>
<td>Improved estate infrastructure</td>
<td>A reduction in backing maintenance of circa £11m</td>
<td>Y</td>
<td>Annual review</td>
</tr>
<tr>
<td>7</td>
<td>Wider NHS</td>
<td>Improved environmental profile</td>
<td>Carbon savings</td>
<td>Y</td>
<td>ERIC reports</td>
</tr>
</tbody>
</table>

6.6.9 Given that the vast majority of the benefit will be delivered directly by the implementation of the scheme, the benefits realisation plan is effectively the same as the overall programme plan for delivering the scheme.

6.6.10 The opportunity of further benefits could and should be delivered through the proposed scheme. The BRP will be reviewed at each stage to ensure that it includes movements and that it continues to reflect the aims and objectives of the Trust.

6.6.11 In the future stages of the planning process, the benefits realisation plan will be used as a means for ensuring that the planned development will deliver the maximum benefits to the Trust. Some benefits may be achieved in the early stages of implementation, planned benefits may move and more may be added, i.e. as a result of NHS requirements.

6.6.12 Once the energy scheme is fully operational the final BRP will be evaluated to ensure that the benefits being delivered match and/or exceed all of the benefits sought.

6.7 Arrangements for Risk Management

6.7.1 Earlier in section 4.3 we reviewed the general risks associated with the project. A further risk assessment focusing on how services will be maintained during the installation phase of the project was undertaken. A comprehensive risk assessment is included under appendix 15.
6.7.2 This assessment considers the risks associated with the potential to interrupt Trust services during implementation. Risks considered relate to:

- Mobilisation and site establishment
- Removal of old plant and installation of new plant
- Commissioning of new plant

6.7.3 Vital as preferred bidder will work closely with the operations team prior to and during the implementation phase, ensuring all risks are monitored and alleviated should the need arise.

6.8 **Arrangements for Contract Management**

6.8.1 Management of the contract once signed falls into two distinct parts; the installation phase and the on-going operational phase. In both of these phases, CEF will assist the Trust to monitor the work undertaken by the contractor.

6.8.2 During the installation phase the Project Manager will ensure that Vital Energy Solutions Limited form a key part of the project management process, and that their information is regularly reviewed: This will include reviewing their responsibilities under the Project Agreement, and working with them and CEF to ensure these are all delivered.

6.8.3 Once the project reaches practical completion, and the operational phase begins, primary responsibility for contract management will fall to CEF. This is because the contract stipulates that metering devices installed as part of the scheme to validate the delivery of savings will electronically submit information to CEF to allow live monitoring of the scheme. Vital will also be responsible for submitting to the Trust a monthly performance report highlighting savings and performance against all KPIs in the contract (on an exception basis).

6.8.4 There will be quarterly and annual review meetings held with the contractor and CEF to review this performance and reach agreement on the performance achieved, and whether any service credits or other contract adjustments are due.

6.8.5 Throughout both phases of the contract there will be a liaison committee consisting of members of the Trust and the contractor's staff. The committee will be the first point of contact for any queries and disputes.

6.9 **Arrangements for Post Project Evaluation**

6.9.1 The outline arrangements for Post Implementation Review (PIR) and Project Evaluation Review (PER) have been established in accordance with best practice and are as follows:

- Post Implementation Review: within 12 months of scheme completion
- Project Evaluation Review: within 24 months of scheme completion
6.9.2 This section sets out how these arrangements will be managed and how information will be disseminated.

6.9.3 The Trust will ensure that a thorough post implementation evaluation is undertaken at key stages in the process to ensure that positive lessons can be learnt from the introduction of this scheme and approach to energy management in general. These will be of benefit to:

- The Trust – in understanding and supporting future expansion and increased energy requirements;
- Other key local stakeholders – to inform their decisions on future energy investments and in particular in energy management and broader environmental impacts;
- The NHS more widely – as this is primarily driven by the DH in managing carbon emissions across the country, the NHS will benefit from all stages of the process and as it tests whether the policies and procedures used in this procurement have been used effectively.

6.9.4 Post Project Evaluation (PPE) also sets in place a framework within which the benefits realisation plan can be tested to identify which of the anticipated project benefits have been achieved – with the reasons made clear. The Trust will comply with the newly published guidance on PPE during the various evaluation stages. The plan for each of these stages is set out below:
### POST PROJECT EVALUATION

**Energy Investment Scheme**

<table>
<thead>
<tr>
<th>Perspective</th>
<th>Benefit/Outcome</th>
<th>Measurement</th>
<th>Score</th>
<th>Notes/Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td>Patient Care</td>
<td>Significantly improved resilience on both Hospital sites, with risk of heating failures minimised</td>
<td>Heating or electrical failures</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Staff</td>
<td>Deployment of engineering staff to ensure on-time services, given that the party will be operating the boiler houses</td>
<td>Reduction in time taken for rectification of estates matters around the sites</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Environment</td>
<td>Reduce carbon</td>
<td>Annual 17,000 tonnes reduction in CO2, From 38,000 to 21,000</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Finance</td>
<td>Reduced energy cost</td>
<td>Reduction of circa £2.5m a year From circa £6m to £3.5m</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Finance</td>
<td>Reduced urgent capital expenditure</td>
<td>Annual capital costs on replacement infrastructure @ 3.5%</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Estates</td>
<td>Improved maintenance</td>
<td>Change in ratio from 90/10 to 20/80</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Trust Performance</td>
<td>Improved estate infrastructure</td>
<td>A reduction in backlog maintenance of circa £1.5m</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Trust Performance</td>
<td>Process</td>
<td>Project Structure</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Trust Performance</td>
<td>Process</td>
<td>Timescales</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Trust Performance</td>
<td>Process</td>
<td>IT stage</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Trust Performance</td>
<td>Process</td>
<td>Preferred Bidder stage</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Trust Performance</td>
<td>Process</td>
<td>Contract stage</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Trust Performance</td>
<td>Process</td>
<td>Installation on site</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Wider NHS</td>
<td>Improved environmental profile</td>
<td>Carbon savings</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**6.9.5** The evaluation will examine the following elements, where applicable at each stage:

- The effectiveness of the project management of the scheme – viewed internally and externally;
- The quality of the documentation prepared by the Trust for the contractors and suppliers;
- Communications and involvement during procurement;
- The effectiveness of advisors utilised on the scheme;
- The efficacy of NHS guidance in delivery of the scheme; and
- Perceptions of advice, guidance and support from the Trust Development Authority and CEF in progressing the scheme.

**6.9.6** The method and plan for undertaking this evaluation is set out in the table below:
<table>
<thead>
<tr>
<th>Theme</th>
<th>Elements</th>
</tr>
</thead>
</table>
| Effectiveness of Project team | • Robustness of the team  
• The right skills were in place  
• The team were properly resourced  
• Outputs were delivered in a timely way  
• Outputs were of a high quality  
• Communication was satisfactory  
• Change was well managed  
• Reporting on progress was satisfactory  
• The internal Trust organisation was supportive of the team  
• Commercial confidentiality was respected  
• Advisors were well managed  
• Appropriate feedback was given  
• Sufficient contact was provided to users during the process  
• Overall impressions of the project delivery  
• Aspects which were particularly well managed  
• Aspects where there was room for improvement |
| Effectiveness of Constructor Team | Same elements as above                                                                                                                                 |
| Project Documentation         | • Content  
• Style  
• Substance  
• Clarity  
• Timeliness of document issue  
• Overall usefulness  
• Structure  
• Communications and involvement during procurement  
• Internal consultation well managed  
• External consultation well managed  
• Timeliness of communications  
• Effectiveness of involvement sought  
• Aspects which were exemplars  
• Aspects where there was room for improvement |
| Effectiveness of Advisors      | • Quality of advice  
• Timeliness of advice  
• Value for money  
• Problem solving  
• Accessibility  
• Overall contribution  
• Areas of exemplary performance  
• Areas for improvement |
| Effectiveness of NHS Guidance | • Comprehensive  
• User friendly  
• Addressed key issues well  
• Areas which were exemplary  
• Areas where there was room for improvement |
| Communications and Involvement | • Internal consultation well managed  
• External consultation well managed  
• Timeliness of communications  
• Effectiveness of involvement sought  
• Effective liaison with local people and residents  
• Aspects which were undertaken well  
• Aspects where there was room for improvement |
Support from Trust Development Authority

- Responsive
- Timely
- Supportive
- Pro-active
- Facilitative

Assessment of Overall Success Factors

- Delivery on time
- Delivery to cost
- Delivery to high quality
- Delivery of non-financial benefits
- Delivery of financial benefits

6.10 OGC Gateway Review Arrangements

6.10.1 We identified in section 2 that the Director of Development and the Estate is the Senior Responsible Officer for the project. As such the SRO is responsible for undertaking a Health Risk Potential Assessment (RPA) against a set of high level criteria for assessing the risk potential of this project.

6.10.2 The RPA determines the level at which the project meets Gateway review requirements.

6.10.3 The RPA considers the programme/project complexities over the varying stages of the scheme which includes:

- Strategic area – GR Table A;
- Strategic profile – GR Table B1;
- Delivery Challenge – GR Table B2;
- Capacity and capability – GR Table B3;
- Scale – GR Table B4
- Complexity Assessment Summary (feeding from GR Table B);
- Overall consequential impact assessment – GR Table C.

6.10.4 The guidance for completion of the most recent RPA states that a very low risk result in GR Table A makes completion of GR Table B optional.

6.10.5 GR Table A considers the strategic assessment of the consequential impact in the following strategic areas:

- Political;
- Public;
- Financial;
- Operational business and commercial change;
- Dependencies.

6.10.6 The result of the Risk Potential Assessment for this project was deemed very low as it is being managed by CEF, an NHS initiative to upgrade energy facilities and reduce carbon across the NHS.
6.10.7 A Trust summary GR Table A is set out below:

<table>
<thead>
<tr>
<th>Strategic Area</th>
<th>Very low</th>
<th>Low</th>
<th>Med</th>
<th>High</th>
<th>Very high</th>
<th>Details</th>
</tr>
</thead>
<tbody>
<tr>
<td>Political</td>
<td>x</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Replacing existing plant with new</td>
</tr>
<tr>
<td>Public</td>
<td>x</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Sever backlog risk if the project does not proceed</td>
</tr>
<tr>
<td>Financial</td>
<td>x</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>The CEF framework passes design, finance, operation, lifecycle and</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>maintenance risk to the Preferred Bidders</td>
</tr>
<tr>
<td>Operational business &amp;</td>
<td>x</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>No changes apart from the introduction of CHP</td>
</tr>
<tr>
<td>commercial change</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Dependencies</td>
<td>x</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Stand alone project</td>
</tr>
</tbody>
</table>

6.10.8 The Trust risk is very low in each category and therefore the Trust is advised that a Gateway review is not necessary.

6.11 Contingency Plans

6.11.1 The Trust already has contingency plans in place for breaks in energy and heating supply which include the use of standby generators to provide essential areas with power for short periods. These will remain in place during and after the installation of the project plant and equipment.

6.11.2 In order to minimise impact the installation programme has been designed such that those parts of the system required for winter use will be installed in the summer and those for summer use in the winter.

6.11.3 Should the contractor fail to complete the installation in line with the programme, the Trust retains the right to step in and procure an alternate contractor to complete the installation, and then operate the systems. This would be done in co-operation with the funder and CEF and so should not represent a cost to the Trust.

6.11.4 The contractor bears the risk of operation of the equipment, and will be penalised under the contract for non-availability of supply, and lack of savings in the event of breakdown. Therefore the contractor is incentivised by the contract to ensure delivery of the services. The transfer of this risk is new to the Trust and will give greater assurance of continued supply and reduced downtime.

6.11.5 The CHP engine itself provides additional contingency as it will be able to supply the electrical needs of the sites in the event of breakdown of the supply to the Trust from the national grid.

6.11.6 During the operational period the Trust is able to step in and operate the plant and equipment itself, and conduct maintenance and statutory checks. This gives the Trust assurance that it will be able to maintain supplies if the contractor fails to live up to their responsibilities.
6.12 Quality Impact Assessment

6.12.1 In evaluating the impact on the delivery of services, a QIA was undertaken which considered the following key indicators:

- Compliance with NHS Constitution, partnerships and equality
- Patient Safety
- Patient experiences
- Productivity and Innovation
- Mitigation

6.12.2 Patient safety and experience is core to the Trust's objectives and the use of a checklist of considerations provided a useful tool in assessing the impact on the quality of care as set out below:

**Patient Safety**

- What is the impact on partner organisation and any aspect of shared risk
- Will this impact on the organisations duty to protect children, young people and adults
- Impact on patient safety
- Impact on preventable harm
- Will it affect the reliability of safety systems

**Patient experience**

- Impact on access to services and experience for individual and community health
- Likely impact on self-reported experience of patients and service users
- Impact on the compassionate and personalised care agenda

6.12.3 Should the Trust experience a major incident, reliance can be placed on the latest major incident plan, version 8.1 approved by the Trust Board in September 2014. The PA under Schedule 4 provides that the contractor will be required to comply with this plan and support the Trust in its implementation should this be necessary at any time during the life of the contract. As the major incident plan is updated, the contract provides that the latest version shall be followed.

6.13 Consideration of the QIA

6.13.1 The QIA was performed by the Trust Engineer and co-approved by the Director of Development and the Estate and the Director of Finance and Procurement.

6.13.2 A copy of the signed QIA is included under appendix 19.
7. Conclusion and Recommendation

7.1 Conclusion

7.1.1 The existing and time expired infrastructure presents a risk to patient safety in its present condition.

7.1.2 The majority of the heating and hot water services are 40 years old and are now significantly older than the recommended maximum economic life for these types of systems. The result of this is that equipment and pipework mains are failing. Spares for obsolete parts need to be manufactured. Where possible, equipment is patched up to prolong its life. Pipework leaks are frequent occurrences, and the required cooling down of the system to allow work to take place by itself causes further leaks and joint failures.

7.1.3 The existing equipment is inefficient with inadequate controls which further reduce its efficiency. Site distribution mains also represent significant loss of energy due to inadequate insulation. Upgrading the systems is an opportunity to improve both heating and hot water, and at the same time to reduce energy consumption significantly.

7.1.4 The financial benefits of this business case are:

- The contract term has been agreed at 25 years.
- A guaranteed reduction in annual energy costs of around £2,294m. Once payment of the annual service payment in the region of £1.831m is considered, a net guaranteed annual saving of circa £461k will be achieved.
- A reduction in the annual carbon footprint of the Trust from 30,000 tonnes to 19,000 tonnes. The CO2 levy saving on 11,000 tonnes at today's price is around £165,000. Should the levy rise to £30 per tonne by 2020 as predicted by industry experts, this benefit rises to £330k. The scheme will also reduce the Trust’s overall energy consumption to 64GJ/m3, meeting the DH target.
- Inclusion of the procurement pathway in arriving at the Preferred bidder is detailed in the Economic Case
- Investment in the infrastructure by the Trust would require an initial Capital Investment of £20.2m (based on a PSC) with an additional capital injection in the region of £3.6m required after 17 years.
- Risk is transferred to the Contractor at an annualised value of £2.8m. In addition, operational risk is further reduced as the Contractor engaged to design and implement the scheme and operate the energy services are one and the same.
- A reduction in backlog maintenance of a minimum £11m, which addresses the replacement of plant and equipment which are key to providing an environment for the patient that is safe, fit for purpose and strategically aligned.
- Monitoring performance over the life of the term is a continued role by the
CEF as Trust advisors. This safeguards the delivery of the guaranteed savings and quality of contract performance.

- Successful delivery is subject to the approval of the TDA.

7.1.5 Approving this scheme benefits the Trust in that it has the potential to extend to the Nuffield Orthopaedic Centre and Horton Hospital.

7.1.6 The linking of sites between the John Radcliffe and Churchill Hospitals (a solution offered by the Contractor) offers further commercial benefit to the Trust in that they could potentially offer energy to consumers both on-site and in the surrounding Oxford area.

7.1.7 In delivering anticipated energy efficiencies and infrastructure upgrade the FBC explores a range of options, including the development of a Do Minimum/Nothing option, the traditional procurement route under OJEU supported by Trust capital funding, outsourcing service delivery and investment using external funding.

7.1.8 We are recommending the delivery of services through an Energy Services Performance Agreement with Vital Energy Solutions Limited as Preferred Bidder and investment using external funding from Aviva Investors Global Services.

We believe this option will deliver the most efficient and effective outcome for the Trust.

7.1.9 Energy consumption by the Trust has been rising since the year 2000 as a result of new and increased developments on the Hospital sites, and new medical technologies being introduced which are increasingly energy reliant.

Energy prices have also been rising over the same period. This FBC demonstrates that since 2011/12 energy pricing has risen 17% resulting in additional charges being levied which include the Carbon Reduction Commitment (CRC) charge.

Such energy usage is consuming an increasing proportion of Trust resources when the Trust is experiencing a low level of income growth. This project will go some way to readdress the balance.

7.1.10 There are no TUPE considerations attached to this Project and this has been confirmed by the Human Resource Manager to the Directorate.

To ensure that this project is delivered on time and without issues it is envisaged that a dedicated and experienced Project Manager position at Grade 8c, will be created by the Trust following approval of this business case and signature of the Project Agreement.

The Project Manager's role will be to oversee day to day activities and ensure that progress is maintained in accordance with the project programme agreed by the Project Director.

In addition the Project Manager will be expected to co-ordinate and manage
the contribution of the project delivery team including external advisors. Regular contact with the team and the Project Director will be required in order to achieve this and to inform and communicate progress and issues up and down the chain of command.

Intellectual Property considerations have been included as part of the PA such that the Contractor will use all reasonable efforts to ensure that any Intellectual Property Rights created, brought into existence or acquired during the term of the Agreement are governed in accordance with the PA.

7.1.11 The Trust Board are asked to review and note the findings submitted by DAC Beachcroft LLP as Trust advisors for the proposed energy scheme. The review includes summary findings of the basis and structure of the Project and the key commercial principles agreed between the Trust, Vital Energi Solutions Limited as preferred bidder and the Project funder Aviva Investors Global Services. This report includes:

- Term;
- Commencement of project operations;
- Payment;
- Minimum service payment;
- Guaranteed minimum savings;
- Service credits;
- Compensation on Termination;
- Insurance;
- Temporary Trust step in;
- Limitation of liability;
- Termination;
- Consequences of Termination/expiry;
- Lease;
- Funders Direct Agreement;
- Powers to enter into the agreement;
- Project commencement issues; and
- Other issues for consideration.

7.1.12 In order to facilitate the savings, we note that the Board previously approved the release of £300,000 in funding which has been used as follows:

- £200,000 to fund the design, preparation, finalisation and approval of the outline business case to final business case
- £100,000 to secure the required plant and equipment required for production and to ensure timely installation following signing of the contract.
7.2 Recommendation

7.2.1 The Trust Board is asked to approve this full business case, targeting commencement of major plant installation in early June 2015 and to begin achieving in-year benefit, delivering efficiencies as part of the Trust's Cost Improvement Programme (CIP) by October 2015.

7.2.2 We are recommending the delivery of services through an Energy Services Performance Agreement with Vital Energi Solutions Limited as Preferred Bidder.

7.2.3 The Trust Board is asked to approve the proposed funder arrangements between VE and Aviva Investors Global Services ("Investment Fund"); details or which are set out under Schedule 6 of the PA.

7.2.4 The Board is asked to note the key funding considerations which include:

- the Investment Fund is to grant a licence to Vital Energi Solutions Ltd to permit it to occupy the premises to be leased to the Investment Fund at the John Radcliffe and Churchill Hospital sites during the term of those leases;
- the PA will oblige the Trust to make certain payments to Vital Energi Solutions Ltd monthly in arrears, a proportion of which payments will be payable in all circumstances regardless of its performance of the services (but, without prejudice to the Trust's other rights, including under the parent company guarantee referred to in the PA); and
- on early termination of the Project Agreement (including on the default of Vital Energi Solutions Ltd), the Trust will be obliged to pay certain termination compensation sums as reflected in the PA.

7.2.5 The Trust Board is asked to review and note the findings submitted by DAC Beachcroft LLP as Trust advisors for the proposed energy scheme.

7.2.6 The Board is asked to approve the Project Manager position at grade 8c for the duration of the Project implementation through to completion. The Trust Board is asked to approve this outline business case with a target of commencement of major plant installation in summer 2015 to begin to derive in-year benefit.

7.2.7 Further detail may be required by the TDA in answer to outstanding queries to complete their FBC decision making process. We ask the Board to approve continued liaison with the TDA in their requests.

Appendix 1 – The Carbon & Energy Fund Membership Agreement
Appendix 2 – The Halcrow Report – Halcrow Group Limited
Appendix 4 – Preferred Bidder Letter – Vital Energi Utilities Limited
Energy Strategy Study for the John Radcliffe Hospital

Document: 2 Version:B

Oxford University Hospitals NHS Trust

16 December 2011
Energy Strategy Study for the
John Radcliffe Hospital

Oxford University Hospitals NHS Trust

16 December 2011
## Document history

**Energy Strategy Study for Oxford Radcliffe Hospital**

Oxford Radcliffe Hospitals NHS Trust

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<th>Description</th>
<th>Created by</th>
<th>Verified by</th>
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[Logo: Halcrow]
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1 Summary

1.1 Brief

The aim of this report is to set out a strategy for the refurbishment of the energy systems at the John Radcliffe site that will achieve reductions in carbon emissions and energy running costs and at the same time ensure resilience against variation in future fuel cost and availability and minimise the risk of system downtime.

Indicative costs have been included but the intention is that more detailed financial information will be developed by the Trust in the transition to a business case.

1.2 Background

Annual electricity and gas consumption has increased by 24% and 12% respectively over the last decade. Energy costs continue to rise above the rate of inflation with the price of electricity increasing by 150% and gas by 200% over the same period. The total energy demand for the site equates to 81 GJ/100 m² compared to a maximum NHS benchmark target of 65 GJ/100 m², with electricity usage being more profligate than that of fossil fuel. CRC charges are now being levied to the sum of £12/tonne CO₂ per year, and are likely to increase substantially in the near future.

<table>
<thead>
<tr>
<th>Utility Usage 2010</th>
<th>Consumption (kWh)</th>
<th>Cost (£)</th>
<th>CO₂ (tonnes)</th>
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</thead>
<tbody>
<tr>
<td>Gas (interruptible)</td>
<td>44,220,917</td>
<td>£935,722</td>
<td>8,120</td>
</tr>
<tr>
<td>Gas (firm)</td>
<td>3,783,019</td>
<td>£80,237</td>
<td>695</td>
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<td>£1,765,595</td>
<td>15,013</td>
</tr>
<tr>
<td><strong>totals</strong></td>
<td><strong>£2,771,104</strong></td>
<td></td>
<td><strong>23,828</strong></td>
</tr>
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Much of the original HVAC plant is now coming to the end of its economic life after 40 years service and is in desperate need of replacement to avoid the risks of major breakdown. System failures are becoming an increasingly common occurrence. Recent examples include the BMS controls to the theatre air handling units and leakages in the HPEHW mains. These are both costly to repair and pose a risk to the delivery of primary care services. The opportunity needs to be taken to make significant running cost savings by upgrading to new more efficient plant. Existing controls are also inadequate and their upgrade will both improve comfort conditions and reduce energy by better matching supply to demand.

1.3 Demand Reduction

The first priority of the energy strategy should be to reduce demand and eliminate avoidable waste. There are plenty of opportunities through upgrading luminaires to new more energy efficient versions with new lighting controls; replacing ventilation fan motors and adding variable speed drives; replacing mixing box controls; rationalising the use of local air conditioning units; and adding local thermostatic zone controls to the heating system. The benefits of good housekeeping should not be overlooked as evidence suggests that instilling awareness amongst staff not only results in significant energy savings but can also improve the building users' satisfaction with their working environment.
The building fabric insulation standards of forty year old buildings are inevitably greatly inferior to that required under current Building Regulations or would be considered as good practice today. Opportunities should be taken whenever refurbishment of the building envelope is considered to improve its thermal performance. Recovering roofs is one obvious example. Windows are another. If rather than repairing the existing wooden single glazed windows, there was a programme to replace them with high performance double glazed units this would not only achieve substantial reduction in heat loss, but would improve comfort conditions for patients whose sensitivity will be all the greater because of their state of health and their clothing level. There are further benefits of improved sound reduction and the possibility of incorporating encapsulated blinds to reduce glare and summer heat gains without the normal hygiene/maintenance costs of exposed blinds.

1.4 Decentralisation

On balance there seem to be more benefits in remaining with a centralised HPHW or heating system than moving to de-centralised LTHW systems. However there are some areas of the site that might still be better decoupled from the HPHW system and there is little justification for the existing centralised steam system.

1.5 Central Plant

The boilers have reached the end of their economic life and need to be replaced. Installing four 4.0 MW dual fuel HPHW boilers would meet the current 8MW peak demand and retain the security of two “spare” boilers (to allow a fault to develop in one while the fourth is off line for maintenance). This should achieve an improvement in seasonal efficiency of at least 10% through combination of new fully modulating burners and new controls.

On site generation of combined heat and power (CHP) offers significant environmental and economic advantages to hospital developments. The fact that the central HPEIW heating systems also supplies heat to absorption chillers and domestic hot water heat exchangers creates a substantial year round base thermal load which is ideal for CHP. The present electrical and thermal base loads of 2.0 MW and 2.5MW respectively would be well matched to a pair of 1MWc gas turbine CHP units.

A biomass boiler offers by far the greatest reduction in carbon dioxide emissions for a given capital investment and so would be the first choice if the priority was to minimise absolute carbon emissions. However there are substantial civil engineering works associated with the fuel storage and delivery and high on-going maintenance commitment to ensure that the system operates at peak efficiency and down time is minimised. The physical restrictions to incorporating the necessary ground works for fuel storage and delivery will determine the viability of its inclusion.

1.6 Site Distribution

The main HPHW distribution pipework will need to be replaced in a phased programme to ensure that heating, cooling and hot water services are not compromised. The prior removal of the central steam system should be of significant benefit in that it will free up space for new HPHW pipework to be installed in parallel with the existing before final switchover of connections at the energy centre and building plantrooms. The removal of the steam system will also greatly reduce
the temperatures in the service trenches which will make the working conditions for
the new installation much safer and more bearable. There will also be the
opportunity to ensure that all the new distribution pipework and valves are well
insulated and so greatly reduce the standing heat losses presently being experienced.

The mains connection will need to be programmed in with the replacement of heat
exchangers in the various building plantrooms and are likely to need the hire of
temporary containerised heating and domestic hot water plant to be connected to the
downstream systems while this work is carried out.

1.7 BMS

For the healthcare sector, quality of control and operational down time are of primary
importance. However upgrading the BMS and including pulsed output metering of
the electrical and HVAC systems can achieve substantial energy savings. It also
enables more efficient use of personnel for remote plant monitoring, optimisation and
fault diagnosis. Improved zonal control will also better able the supply of heating
and cooling to be more closely matched to actual demand within different areas.

1.8 Renewable Energy

Of the available renewable energy technologies photovoltaic (PV) electricity
generation has the advantage of minimal maintenance and with the introduction of
feed-in-tariffs now offers a good financial return over its lifetime. Across the Radcliffe
site there might be 4,000m² of available roof space on which PV could be installed but
for reasons of access the industrial block might be the best site subject to a detailed
shading analysis.

1.9 Funding

There is little in the way of public capital funding available for the proposed
improvement measures. The Enhanced Capital Allowance provides support for
investment in low carbon technologies under the climate change levy package and
enables businesses to take 100% of the tax relief for their investment in plant on the
full cost in the first year. The “feed-in tariff” was introduced in April 2010 as a
financial incentive for low and zero carbon technologies for electrical generation. This
provides a guaranteed payment over a 20–25 year period based on the amount of
electricity generated. However the rates were drastically cut on 12 December 2011 but
would still make the difference in the Trust achieving an economic return on the PV
installation over its lifetime, which would not otherwise be the case.

If securing capital investment is a problem then some form of private partnership or
contract energy management arrangement might be an option, which would transfer
the broader responsibilities of energy supply to the site (capital investment, operation
and maintenance, investment in energy saving schemes, fuel purchase etc.).
Effectively this trades the initial investment against the long term financial benefits.

1.10 Standby Generation

A replacement strategy has been considered for a system that has 57% of it’s current
equipment in excess of 20 years of age (45% being in excess of 30 years) and a system
that provides standby cover over a number of disparate areas.
Although the number of sets in the system provides a generated load in excess of the current electrical demand of the hospital, the system is currently configured such that failure of a set will render the associated area without an electrical provision in the event of loss of mains supply.

The new strategy will provide a secondary power source which will be connected into the electrical network such that the standby power protects the hospital electrical supplies as a whole rather than in sections or designated areas.

Presently there is no uninterruptible power supply (UPS) provision on the site. This is recommended for critical care areas such as ITU/ICU, operating theatres, and special baby units to provide no-break protection until the generators are on line.

1.11 Summary of Refurbishment Measures

A suggested scope for refurbishment is outlined below which should achieve a reduction of around 30% in CO₂ emissions, and reduce the site energy performance to within 65 GJ/100 m² NFES target for existing facilities.

<table>
<thead>
<tr>
<th>Measure</th>
<th>Capital</th>
<th>Energy (kW)</th>
<th>CO₂ (tonnes)</th>
<th>Energy cost</th>
<th>years</th>
</tr>
</thead>
<tbody>
<tr>
<td>Replace central steam boilers with local steam generators</td>
<td>£65,000</td>
<td>2,000</td>
<td>375</td>
<td>£42,000</td>
<td>1.5</td>
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<tr>
<td>Install four new central 4.0MW HPFW dual fuel boilers</td>
<td>£240,000</td>
<td>2,470</td>
<td>470</td>
<td>£52,000</td>
<td>4.6</td>
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<tr>
<td>Replace HPFW distribution pipework</td>
<td>£700,000</td>
<td>1,400</td>
<td>270</td>
<td>£29,500</td>
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<tr>
<td>Install two 1.0MW gas turbine CHP units</td>
<td>£2,600,000</td>
<td>-</td>
<td>2845</td>
<td>£489,300</td>
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<td>Install 1.0 MW biomass boiler system</td>
<td>£500,000</td>
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<td>750</td>
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<td>-</td>
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<tr>
<td>Replace heat exchangers</td>
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<td>80</td>
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<td>Separate heating of BTS from Academic Block</td>
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<td>45</td>
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<td>Decentralise heating in manor house and annexe</td>
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<tr>
<td>New BMS controls including metering</td>
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<td>4,400</td>
<td>960</td>
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<td>Install 250 kW PV array</td>
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<td>Upgrade lighting to high frequency fluorescents</td>
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<td>Install daylight/occupancy lighting controls</td>
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<td>650</td>
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<td>New fan motors and inverters to AHUs</td>
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<td>135</td>
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<td>New standby generation sets</td>
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<td>-</td>
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<tr>
<td>New UPS system</td>
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<td>-</td>
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<td><strong>total capex</strong></td>
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<td><strong>-</strong></td>
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<td><strong>-</strong></td>
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</table>
2 Aims & Drivers

2.1 Existing Installation and Equipment

The majority of the heating and hot water services is 40 years old and is now significantly older than the recommended maximum economic life for these types of systems. The result of this is that equipment and pipework mains are failing. Spares for obsolete parts need to be manufactured. Where possible, equipment is patched up to prolong its life. Pipework leaks are frequent occurrences, and the required cooling down of the MTHW system to allow work to take place by itself causes further leaks and joint failures.

The existing equipment is inefficient with inadequate controls which further reduce its efficiency. Site distribution mains also represent significant loss of energy due to inadequate insulation. Upgrading the systems is an opportunity to improve both heating and hot water, and at the same time reduce significantly energy consumption.

2.2 Energy Issues and Consumption

The NHS has introduced the following mandatory targets for NHS bodies in England:

1. Reduce the level of primary energy consumption by 15% or 0.15 Mtc (million tonnes of carbon) from March 2000 to March 2010

2. Achieve a target of 35-55GJ/100 m² energy efficiency performance for healthcare estate for all capital developments and major redevelopments or refurbishments and all existing facilities should achieve a target of 55–65 GJ/100 m².

CRC charges are now being levied to the sum of £17/tonne CO₂ per year. This unit carbon cost is likely to increase substantially in the near future. The intended revenue recycling part of the original CRC proposals have subsequently been removed from the scheme so the CRC charge is effectively an energy tax increasing the cost of electricity by 9.5% and gas by 9.6%.

Energy costs continue to rise above the rate of inflation with the price of electricity increasing by 150% and gas by 200% since 2000.
3 Current Energy Consumption

Daily records of site and central boiler gas consumption have been provided by the Energy Manager, together with half hourly electricity usage for the last two years.

This data is summarised graphically in Figures 1 to 7 and the annual totals for 2010, the latest year with a complete data set, are tabulated below:

<table>
<thead>
<tr>
<th>Utility</th>
<th>Consumption (kWh)</th>
<th>Cost (£)</th>
<th>CO2 (tonnes)</th>
</tr>
</thead>
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<tr>
<td>totals</td>
<td>£2,771,104</td>
<td></td>
<td>23,828</td>
</tr>
</tbody>
</table>

The Trust normally pays VAT at 20% which is not reclaimable. The Trust pays the National Climate Change Levy rates of 0.485p per kWh of electric and 0.169p per kWh of gas. The Levy is applied before VAT is calculated, therefore the actual financial effect is greater.

3.1 Electricity

The current electricity supply contract with Southern Electric runs to 31st March 2012 with a fixed two rate tariff of 6.668 p/kWh and 5.26 p/kWh for day and night units respectively. These unit cost exclude standing charges, data collection charges, Climate Change Levy, Triad charges, VAT, etc. From 1st April 2012 to 31st March 2013 this will change to a fixed price contract, probably with EDF Energy, via a Buying Solutions Framework Contract. The energy prices are not yet known.

Annual electricity consumption has increased by 24% between 2000 and 2010. This is a consequence of the addition of the new Trauma building, Heart centre and AVIC building and also the on-going introduction of new medical and office equipment throughout the site, together with the installation of numerous local air conditioning units as part of localised building refurbishment programmes. There is no sign of this trend abating in the foreseeable future.

Monthly consumption is summarised in Figure 1. This is plotted as the mean daily usage to account for variation due to the differing metering periods. There appears to be only a small variation with season, consumption rising slightly during the summer months. The increased cooling demand could warrant a slight increase in fan power and chilled water pumping power, but the main energy source for chilled water generation by the absorption chillers is gas. Historic analysis by the energy manager suggests that the electricity consumption by HVAC plant accounts for about 15% of the annual total. Consequently seasonal variations in HVAC demand will have a limited impact on the overall electricity consumption.
**Figure 1: Monthly Electricity Consumption**

Half-hourly data is plotted for a one week period in December, April and July in Figures 2 to 4 which gives an indication of daily and seasonal variations in consumption. These show a continuous base load of around 2.5 MW, and a peak load rising from just under 3.75 MW in winter to close to 4.5 MW in summer. With absorption chillers and effective control of lighting arguably the electrical demand should drop during summer months rather than increase. However it is apparent that lighting is not switched in response to daylight availability and there has been a proliferation of local DX air conditioning units which are likely to be a major contributor to the summer time peak.

**Figure 2: Daily Electricity profile - December**
Figure 3: Daily Electricity profile - April

Figure 4: Daily Electricity profile - July
3.2 Gas

The interruptible gas contract runs to 31st March 2012 with Total Gas & Power. The fixed price is 2.115 p per kWh (excluding standing charges, CCL and Vat). With effect from 1st October 2011 the site will no longer be on an interruptible contract, but will be "deemed" to be a Firm gas site. This is due to National changes for appointing interruptible sites. From 1st April 2012 to 31st March 2013 we will be on a gas fixed price contract, Supplier yet to be appointed, via a Buying Solutions Framework Contract. The energy prices are currently unknown.

During periods of interruption / failure of gas supply or gas emergency all the boilers can be switched to Gas Oil. The cost of this is governed by the daily contract prices obtained via NHS Purchasing and Supply Agency (now part of Buying Solutions). The current price is about 66p per litre, excluding Vat.

This contract for Firm gas is with Total Gas & Power to 31st March 2012. The fixed price for the JR is 2.121p per kWh. (excluding CCL and Vat).

Annual gas consumption has increased by 12% between 2000 and 2010. There was a significant jump in 2000 which coincided with the installation of the new steam boilers, which have a capacity much greater than the site demand. Variation in weather conditions can also have an impact, but weighting of the data by "degree-days" makes little difference to the overall trends.

Consumption by the central HPHW boiler plant is plotted in Figure 5. This shows that the system generally operates with two boilers and although there are occasions during the winter when a third boiler has been used, the combined output could have been provided by two boilers if required, and a single boiler could meet the required demand for significant parts of the year peak. The winter load appears to peak at the equivalent of around 8.0 MW, with a base summer load in the order of 2.5 MW (24 hour mean).

![Figure 5: Annual HPHW Gas consumption](image)
To assess how well gas usage is matched to external weather conditions, Figure 6 compares average daily gas consumption for each month in 2010 with the average degree days per day for the same period. Degree day figures with a base temperature of 18.5°C have been used to reflect the higher internal space temperatures normally associated with hospitals. The low level of scatter around the regression line indicates that control of heating appears to respond reasonably well to variation in weather conditions. The intercept of the data with the Y-axis at 72.5 MWh/day indicates the base or non weather dependent consumption of the site which equates to about 26,460 MWh per year or mean load of 3.0MW.

![Daily interruptible gas MWh v. Daily degree days](image)

**Figure 6: Interruptible Gas Consumption v Degree Days**

The above conclusion that gas consumption is reasonably well matched to external weather conditions is surprising bearing in mind the state of the controls installation and the existence of absorption chillers. However credit should be given to the Energy Manager and site staff for achieving such a result through their on-going manual adjustments where automatic facilities do not exist. While there is a consistency in the relationship between fossil fuel consumption and external weather this does not mean that there are no opportunities for reduction. Future improvements in the weather dependent consumption will be identifiable by a reduction in gradient of the trend line, whereas improving the efficiency of domestic hot water generation and minimising standing losses will appear as a lowering of the Y-axis intercept.

Figures 7 plots of the gas consumption of the two central steam boilers. It can be seen that both boilers are kept running throughout the year even though the actual steam demand is very limited.
3.3 Comparative Performance

The former DETR published good practice benchmarks for fossil fuel and electricity consumption for various building sectors. The energy consumption figures for 2010 are compared with the benchmark figures for acute and maternity hospitals.

Table 3.1: Energy Consumption Yardstick

<table>
<thead>
<tr>
<th>Utility</th>
<th>Consumption (GJ/100m3)</th>
<th>Benchmark (GJ/100m3)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>2010</td>
<td>Low</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Total</td>
<td></td>
</tr>
</tbody>
</table>

Fossil fuel consumption compares favourably with good practice targets. This is somewhat surprising considering the condition of the central plant and control system, and that gas is also used for cooling. However, a significant proportion of the site is used for academic and research purposes and as such has significantly reduced occupancy hours and consequently reduced energy demands.

Conversely, electricity consumption is nearly three times best practice yardstick. The benchmark figures are derived from historic studies on buildings, so it is likely that
the electricity figure does not make allowance for the recent growth in electrical and electronic equipment that are allied to advances in medical practices. However at the most this might account for say a 20% rise in electricity demand, not 200% as is being experienced.

In April 2001 the Minister of State for Health set mandatory targets for NHS bodies in England requiring existing facilities to achieve a target of 55-65 GJ/100 cu.m. Consequently the John Radcliffe site needs to create an annual saving of 16 GJ/100 cu.m or 20% in total energy consumption to meet these efficiency targets.

The benchmark comparison suggests that the site is far more profligate with electricity than it is with gas, so as much attention needs to be given to demand side management of electricity as to improving the efficiency of thermal generation.
4 Existing Services

4.1 Energy Centre

The energy centre contains four 5860 kW dual fuel high pressure hot water (HPHW) boilers, with forced draft burners. The boilers normally fire on interruptible gas with gas oil as the reserve fuel in case of interruption to the gas supply. The boilers are now over 40 years old and are in regular need of remedial welding work to satisfy the client’s insurance inspections. There is also a problem with the set up of the burner controls, which because of the linkages, rarely remain at optimum firing efficiencies. Combustion tests generally record instantaneous gross efficiencies of around 82% at maximum flame after servicing but seasonal efficiencies will be considerably lower with unreliable two stage firing control. Because of their age, spare parts are no longer readily available which requires the expensive manufacture of bespoke elements. Boiler no 3 is currently out of action for this reason with its forced draught fan.

As previously identified a single boiler could meet the majority of demand, with a second boiler required only occasionally during peak winter loads. There is only a very crude boiler sequence control and in practice this is done manually. The off line boilers are isolated from the primary circulation to avoid unnecessary heat loss. However this suggests there is well over 200% spare capacity, which is arguably a greater degree of redundancy than is warranted, particularly when this is not replicated elsewhere in the circulation and distribution equipment.

New central steam boilers were installed at the end of 1999 to replace local steam generators feeding sterilisers around the site. Each of the two boilers has installed capacity of 6000Kg/hr (~3750 kW) compared to an estimated point of use demand of only 300Kg/hr (185 kW). Both boilers are kept live for reasons of security of supply, so are only running on tick-over and are estimated to be operating at a seasonal efficiency of less than 25%. The reason behind the massive oversizing was reported to be to allow for steam humidification on ventilation plant and possible conversion of the frost coils to use steam as their heat source. Neither of these projects was implemented nor are there any plans to do so.

The main HPHW distribution is now suffering from frequent leaks, which necessitates shutting down the system or at least sections of it. However the subsequent contraction and expansion this causes to the system more often than not results in subsequent failures elsewhere in the system, and the operation of long untouched isolation valves is a further source of leakages. Expansion bellows, flange and bend welds, and corroded pipe guides have also been recent sources of failures.

4.2 Site Services

Even though the majority of the buildings on the site give the appearance of a “new” hospital, the 1960s designs have thermally inefficient fabric with large areas of single glazing, and minimal insulation levels in line with the standards of the period. The deep plan spaces reduce the area of exposed façade so lead to reduced fabric heat losses, yet conversely have a higher dependency on mechanical ventilation systems and artificial electric lighting. This is in line with benchmark performance highlighted in Section 3.3.
The building services installations are now generally at the end of their useful lives and so have a growing maintenance requirement. Investment appears to have been limited just to keep the plant operational and there has been no significant investment in improvement measures over the last decade.

The space temperatures in calorifier rooms and distribution pipework ducts are very high because of excessive heat losses, reported to reach 50°C in the main ducts and closer to 60°C in cross over valve chambers. Insulation has been left off flanges, valves, and calorifier access plates etc. after servicing and the general insulation specification is unlikely to match what is considered to be a current economic standard.

Controls are rudimentary and though some modification have been made since the original installation they are generally not matching supply to demand, neither in terms of time or temperature. There have been upgrades to the original Johnson pneumatic control system with a Johnson Metasys electro-pneumatic system linked to a central PC via dedicated cabling, but maintenance is reported to be costly. There has been an increasing move across to Andover electronic controls linked to a central BMS. In addition there is a stand alone Trenomics system within the Bio medical area. Earlier this year there was a major failure of the controls installation serving the operating theatre ventilation systems, which had to be replaced at a cost of £60,000.

Domestic hot water is generated via storage calorifiers or vertical shell and tube heat exchangers. The control of these is driven more by minimising the risk of Legionella rather than final demand for domestic hot water. The inspection and maintenance of these domestic hot water generators account for significant labour and financial commitments.

Supply air plant for the ventilation of the deep plan spaces and central corridors in the linear wards in JR2 are located on level 3 with extract plant mounted at roof level. The separation of the two air streams means that there is no form of heat recovery present and no real opportunity for its introduction. Invertors have been installed to control the fan speed on some of the larger air handling units (AHUs) but the absence of any effective zone control means that the potential of the invertors to reduce fan power consumption are not exploited.

Perimeter radiators are generally controlled by manual valves, and in public areas the heads have generally been removed presumably to avoid tampering. Not only does this mean that there is no local trimming to suit specific solar or casual heat gains but it also poses a risk of injury to anyone falling against the exposed spindle.

A large proportion of electric lighting is old, inefficient and uncontrolled. Controls do not take advantage of available daylight in perimeter spaces, nor is there any form of occupancy linked control.

The local zone controls for the central air handling systems are not functioning in many areas, so when areas are refurbished there is a tendency to install local air conditioning units to achieve the desired temperature control. This has led to a proliferation of independent DX split systems around the site which are now reported to number 300. Observation also suggests that in most cases there is no form of interlock between the AC units and the existing heating system so it is likely that they will be "fighting" each other to control space temperatures. The present hospital policy appears to be that these units are the responsibility of the local
departments rather than the Estates Division. This means that not only is the maintenance of the equipment outside the scope of the Estates responsibility but the energy manager literally has no control over their operation. This does not facilitate the aims of longer term energy savings.

4.3 **Standby Generation**

The existing Secondary Power Sources (SPS's), provided by the existing generator sets, although currently operational, are considered old and in need of replacement.

In addition to the need to replace the sets due to their age, there is also a requirement to upgrade the entire SPS system so as to provide a system that ensures compliance with HTM 06-01; Section 8, in the provision of a N+1 arrangement.

The current system provides coverage with an approximate load support of 5MVA via a network of disparate sets that service designated sections of the hospital. Therefore, failure of a particular unit will result in that area of the hospital being without standby power support. The current arrangement is identified as follows:

<table>
<thead>
<tr>
<th>Location</th>
<th>Load Rating (kVA)</th>
<th>Power Rating</th>
<th>Manufacturer &amp; Model</th>
<th>Approx Age (Years)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Substation A</td>
<td>394</td>
<td>Continuous</td>
<td>Dorman 6QTCA</td>
<td>40</td>
</tr>
<tr>
<td>Substation B</td>
<td>640</td>
<td>Continuous</td>
<td>Perkins 2906CE1BTAG2</td>
<td>20</td>
</tr>
<tr>
<td>Substation C1/2</td>
<td>750</td>
<td>Continuous</td>
<td>Faxman 12YHX MK6</td>
<td>40</td>
</tr>
<tr>
<td>Substation C3/4</td>
<td>2000</td>
<td>Continuous</td>
<td>MTU G4706130</td>
<td>4</td>
</tr>
<tr>
<td>Substation D</td>
<td>750</td>
<td>Continuous</td>
<td>Faxman 12YHX MK6</td>
<td>40</td>
</tr>
<tr>
<td>Trauma Substation</td>
<td>200</td>
<td>Continuous</td>
<td>SDMO GS200K</td>
<td>10</td>
</tr>
<tr>
<td>Substation W</td>
<td>300</td>
<td>Continuous</td>
<td>Swang/Scania</td>
<td>8</td>
</tr>
<tr>
<td>Total Load Provision</td>
<td>5034</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

The existing sets have, to date, provided the necessary support required to the Primary Electrical Supply (PES), which has also to date been reasonably secure. However, there is concern that failure of one or more sets, due to failure to start or mechanical failure, will leave the Hospital vulnerable, with particular concern to critical care areas such as ITU; Operating Theatres; Special Baby Unit; etc.,

It should also be noted that in the event of failure of the mains grid electricity service the generators only support essential power circuits and not the entire network.
Pre-planned “black starts” of the standby generation system, for trial runs and testing of the system, have been periodically undertaken however, this has always been undertaken without the level of confidence that should be in place when carrying out these procedures. The reduced level of confidence is due to the age of some of the sets and concern as to whether they will actually start-up. This situation should obviously not be so and therefore, remedial/replacement works should be implemented to provide the confidence necessary. The maintenance of the system and the fact the sets are still usable has been due to the diligence and skills of the maintenance teams.

It is also noted that these areas also have no support from centralised Tertiary Power Supplies (TPS’s) such UPS’s, although these are not to be considered as long-term energy sources but are provided to ensure a “no-break” facility between loss of electrical supply and the connection and support provided by the Standby Generators.

In the current arrangement, failure of an existing generator set will leave the hospital vulnerable, in that failure of any set will lead to no standby supplies being available for the area of designated cover and thereby, leaving the area without electrical services. A system therefore, where standby generation can be provided to protect the entire hospital site, regardless of where the standby generators are interfaced into the electrical system, will be of great benefit to the hospital, providing a greater level of resilience and protection to vulnerable patients and critical items of equipment and departments.

It has been requested by the Client that the existing standby sets be considered, as the +1 provision in the N+1 requirements of the HTM. In addition, consideration is to be also given within the new system for a plug-in facility at either a centralised location or at each new generator location to provide the ability to support the system in the event of a set being unavailable due to failure or for maintenance purposes.

The focus for this section of the report is the review and feasibility of providing new standby generation to the existing Electrical Network. Therefore, it has been assumed, for the purposes of this report, that no works shall be required to the existing network, with the exception of the need to provide interface facilities and equipment etc. to allow the connection of the new equipment to the existing network.

If however, works are required to the existing system, then a separate dedicated and focussed survey and report will need to be undertaken.
5 Refurbishment Strategy

A wide range of improvement options were initially identified for discussion. From these a shortlist was agreed with the Estates Department of those measures that were thought to be most worthy of further investigation. Suppliers have been approached to obtain costs for specific items of plant and general pricing guides such as SPONS have been used to estimate labour and installation costs. Running costs savings have been derived from a combination of predicted improvement in system efficiency, estimations of current avoidable waste and experience of actual performance in use at other similar installations.

The majority of the mechanical services installations date back to the original construction of the buildings and so have reached the end of their useful economic life. This is evident from the high maintenance commitment required for the central boilers, calorifiers and other heat exchangers. Replacement is therefore essential for the reliable operation of the service rather than to save energy. As such the benefit of any enhancement to plant specification to improve energy efficiency should be considered against only the marginal cost compared to a like-for-like replacement, rather than the full capital value.

The implications of capital charges and funding routes are not included within the individual measures but are briefly considered in the section 6 of the report.

5.1 Demand Reduction

5.1.1 Building Fabric

The building fabric insulation standards of forty year old buildings are inevitably greatly inferior to that required under current Building Regulations or would be considered as good practice today. Opportunities should be taken whenever refurbishment of the building envelope is considered to improve its thermal performance. Recovering roofs is one obvious example. Windows are another. It has been reported that there is an annual expenditure of £300,000 to repair the existing wooden single glazed windows. Replacement with high performance double glazed units would not only achieve substantial reduction in heat loss, but would improve comfort conditions from reduced radiant losses and convective downdraughts associated with the low surface temperature of single glazing. This is all the more critical for patients whose sensitivity will be all the greater because of their state of health and their clothing level. There are further benefits of improved sound reduction and the possibility of incorporating encapsulated blinds to reduce glare and summer heat gains without the normal hygiene/maintenance costs of exposed blinds.

5.1.2 Upgrade Lighting

A large proportion of the existing lighting uses traditional T12 linear fluorescent lamps. Modern high frequency T8 or T5 lamps use approximately 30% less electricity for the same light output, have longer life and do not flicker. The energy manager has already started to replace sections of lighting in some ward corridors. The existing bodies have been retained but the control gear and lamps replaced with high frequency units. This replacement programme should be continued through all
buildings commencing with those areas with the longest hours of usage such as internal corridors, lift lobbies etc.

Typically the installed power density for lighting corridors is around 11 - 13W/m². With new high frequency fittings it should be possible to achieve 100 lux for half the installed power density. In some cases this may entail modifying the spacing and hence wiring of the luminaires to maximise energy savings.

Angle poise lamps with tungsten filament lamps are used for bed head lighting. GLS lamps are cheap to purchase but consume about four times the power as a compact fluorescent lamp and have only 1/8th of the life. If new low energy bed head lights were installed not only would there be a reduction in electricity consumption but also a reduction in heat gain which would help to reduce summer time temperatures.

5.1.3 Lighting Controls

All lighting is presently manually switched, so it is down to users and staff to turn off unnecessary lighting. Observation suggests that certain members of staff in ward areas are being vigilant as lighting is switched when daylight is available or rooms are unoccupied. However this is not universal and it is difficult to rely on staff who have more pressing responsibilities. It is also unlikely that individuals will take responsibility for communal areas beyond their immediate work space. Automatic control of lighting in communal areas therefore offers the greatest potential benefit and so should be the first areas to be addressed.

Occupancy sensors should be installed in internal corridors. Passive infra red sensors may be adequate for some areas, but it is likely that longer corridors will require microwave detectors. Where corridors are well daylit a photocell should be used to switch lighting off during daylight hours. A detailed survey will be necessary to determine the most appropriate control equipment and whether the priority is for replacement high efficiency luminaires or lighting controls or both. Automatic controls will take priority where the true demand for artificial lighting is only of a short duration, and replacement luminaires where they need to be on permanently.

In most locations lighting circuits are split between essential and non essential supplies. The automatic controls would only switch non essential circuits.

5.1.4 Upgrade fan motors in Air Handling Units (AHUs)

The specific fan power of a new well-designed AHU can be well below 2 W/ls (electrical power per unit of air volume handled by the fans). Plant inventories show that the specific fan powers for the existing systems are in excess of 3 W/ls. The design of the ductwork distribution will determine the system resistance and in turn the external static pressure that the fan must achieve. The internal elements within the AHU, such as heating/cooling coils and particularly the filtration, add further resistance, which influence the overall size of the fan. The power input is then dependent on the actual motor efficiency and drive losses. Bearings and motor windings deteriorate over time and so replacement of the fan motors with new high efficiency models will result in a reduction in power consumption even within the existing AHU/fan arrangement.

Variable speed drives can effect further savings by reducing the speed at which the fan runs. The air volume through a fan is directly proportional to its speed but the electrical energy consumption used by the fan motor is proportional to the cube of its
speed. Thus reducing the speed (and air volume) to 80% capacity effectively halves the fan energy consumption. Inverter drives also have smoother starting characteristics which reduces both the starting current peaks and mechanical wear on belt drives and couplings.

A report on the air handling units serving the operating theatres has previously suggested that they need to be replaced to meet improved air quality requirements. When this is implemented the specification should require specific fan powers of better than 2 W/l/s and include inverter drives.

In the short term the other larger air handling units should have new fan motors and inverter drives installed. This should be implemented in tandem with the controls upgrade so that opportunities to reduce fan speed can be fully exploited.

5.1.5 Replace Mixing Boxes

A dual duct air system is installed in the deep plan areas on the lower floors of JR2. Local zone control is achieved by mixing varying volumes of air from the hot (~30°C) duct and the cold duct (~10°C). A large proportion of the original pneumatically controlled mixing boxes are no longer operating so the temperatures of both ducts has been set to around 20°C to limit the discomfort that might otherwise occur with mixing control. In some areas the requirement for zonal temperature variation is now being met by the introduction of DX air conditioning units and local electrical heaters with a consequent increase in electricity consumption. As areas in the building are refurbished or re-fitted, the controls to the mixing boxes should be upgraded or the entire mixing box replaced so that temperature control can be delivered via the central plant.

5.1.6 Rationalise DX air conditioning systems

The inability of the central air handling systems to provide local zone controls has led to a proliferation of independent DX split systems around the site. Refurbishing the central air handling system would offer a more energy efficient solution, yet this involves considerable disruption across large areas of the building which extend beyond the boundaries of an individual ward or area refurbishment contract.

The second problem is that the DX cooling units are the responsibility of local departments rather than the Estates Division so there is literally no integrated control of central and local systems, and heating and cooling will be “fighting” each other. This policy should be reviewed so that a broader overview of environmental control can be taken in the future with selection of the most energy efficient solution. Also timed on/off controls and interlocks can be retrofitted to existing DX units to minimise energy wastage. This has been included within the scope of the BMS package.

5.1.7 Thermostatic Radiator Valves (TRVs)

The variable temperature LTHW circuits feeding each building are generally separately compensated according to orientation. But this zoning applies to the full height of the building and there is no further local trimming of the heating system. Tamperproof thermostatic radiator valves (or zone valves for large areas with multiple radiators) should be introduced to areas that are subject to local variation in
heat gains and where additional control gives the opportunity for reducing heating energy consumption.

This will also provide and health & safety benefit in protecting the exposed spindles which are evident in many buildings. A suitable manufacturer should be specified that includes the facility to remove the valve body without draining down the system. Pressure differential valves will also need to be added to some circuits to ensure noise/balancing problems that might otherwise occur.

5.1.8 Energy Management

The benefits of good housekeeping should not be overlooked as evidence suggests that instilling awareness amongst staff not only results in significant energy savings but can also improve the building users' satisfaction with their working environment.
5.2 Energy Supply

5.2.1 Options for Decentralisation

A centralised energy centre for the site offers the following benefits over the use of dispersed, local boiler systems:

- More choices of fuel and tariff.
- Dual fuel options more easily incorporated.
- Identical boilers reducing spares, inventory and costs.
- A reduction in manual supervision releases labour for other duties on site.
- Economic sizing of boiler plant to suit diversified demand.
- Exhaust emissions are more easily monitored and controlled.
- Safety and efficiency protocols are more easily monitored and controlled.

However there can be energy penalties if the distribution mains are extensive and/or are in poor condition as at present with the John Radcliffe site. Rather than replacing the site heating mains distribution, one option would be install local LTHW boilers and hot water generators in place of the existing heat exchangers in the various distributed plantrooms. Standing losses would be reduced and there may be opportunities to better match plant operation to building demand and even to integrate low carbon energy sources such as solar thermal hot water generation. Further benefits can include reduced water treatment costs, and elimination of statutory inspections.

But there would be a significant spatial impact to accommodate local boiler plant, flues, fuel storage tanks etc. in each building and overall there would need to be a significantly greater redundancy of installed plant if each plantroom is to have standby plant which includes allowance for off line units.

The other factor working against a de-centralisation strategy is that it would inevitably need to be phased over a number of years with buildings progressively transferred across from the HPHW system. The concern would be that the HPHW system in its present state is unlikely to last long enough to allow this and substantial capital expenditure would be necessary on plant at the outset to ensure its reliable operation even though it will subsequently become redundant.

CHP could be introduced on a decentralised basis but both reciprocating engines and gas turbines tend to be quite noisy and so will be more costly to attenuate when located close to accommodation rather than in a remote compound. Similarly when considering alternative fuel sources such as biomass, the fueling, fuel storage and delivery requirements are all more easily dealt with in a remote energy centre.

On balance there seem to be more benefits in remaining with a centralised HPHW or MPHW heating system than moving to de-centralised LTHW systems. However there are some areas of the site that might still be better decoupled from the HPHW system and there is little justification for the existing centralised steam system.

5.2.1.1 Separate BTS from Academic Block

BTS is a 24 hour facility while the remainder of the Academic building is used only during office hours. However all plant for the block is run permanently to cater for BTS, which occupies only a quarter of one level. Ideally separate plant would be installed to cater for BTS, but the cost, space requirements and disruption make such
an option impractical. At very least zone valves should be installed on the variable temperature circuits feeding the rest of the Academic building so that the space temperature can be set back overnight. This would be best implemented as part of the proposed controls upgrade to the calorifier room.

5.2.1.2 Use local boilers for Manor House and Annexe

The manor house and annexe are occupied during office hours only and arguably do not have the same need for security of supply. The existing heat exchangers in the calorifier rooms could be replaced with local gas fired boilers. This would permit this section of the MPH/W distribution to be isolated and reduce the losses through the continuous circulation even when there is no demand. Flat water generation in the both buildings has been replaced by local electric point of use water heaters, which has greatly reduced unnecessary circulation losses of a centralised storage system.

5.2.1.3 Local Steam Generation

There are presently 11 steam sterilisers distributed around the site in TSSU, JR2, Academic block and Media prep area, of which the one in the Academic block is no longer in use. As previously highlighted the present steam boiler installation is massively oversized in anticipation of an increased demand that has not transpired. The possibility has also been mentioned that equipment sterilisation could also be out sourced and happen off site. Therefore the demand for steam is more likely to reduce than increase.

The removal of the steam mains distribution pipework through the underground services ducts would also greatly assist with installation of new MPH/W pipework, in that it will free up some of the space required for the new pipework to be installed in parallel with the old. Likewise the removal of the central steam boilers will free up valuable space for the installation of CHP plant.

The present central plant is costing approximately £90,000 in annual maintenance and nearly £32,000 in gas to meet a demand, which is about 1/40th of the total installed capacity. Although a relatively new installation it is difficult to justify its continued operation. It would be much more efficient to generate steam locally for such small distributed loads. The installation could be rationalised to three steam generators: one to serve the four sterilisers at level 1 in JR2, one for the two sterilisers on level 7 of JR2 and a third in the industrial building to cater for the eleven sterilisers in media prep and biomedical.

5.2.2 Central Plant

5.2.2.1 Dual Fuel Boilers

The boilers have reached the end of their economic life and need to be replaced. Recent repair costs of £50,000 for the boilers alone are indicative of this fact.

The existing installation consists of four 5.86 MW units compared to the current estimated peak load of between 7.0 and 8.0 MW. As such there is at least 200% spare capacity, which seems excessive. It is a reasonable approach for a hospital site to have the security of two “spare” boilers so that the peak load can be met under the extreme scenario of one boiler being off line for maintenance and a fault developing on a second unit. Hence if the peak load is taken as 8MW then a suitable arrangement might be four boilers of 4.0 MW or five of 3.0MW. Capital costs of the
alternative arrangements are based on quotations obtained from Foval for their Royalist range, dual fuel with fully modulating Belilo burners.

Replacement boilers with the same output but with new fully modulating burners could be expected to achieve an improvement in seasonal efficiency of 5 - 6%. However, the combination of smaller output units, fully modulating burners and new controls should further increase the improvement in seasonal efficiency to as much as 10%.

Once commissioned, maintenance costs should be limited to one annual service/inspection, so this will also deliver significant resource savings.

5.2.2.2 CHP

First impressions are that the John Radcliffe site has the necessary characteristics to make CHP a viable option. The presence of absorption chillers and domestic hot water exchangers both linked to the MPhW ensures that there is a high year round base thermal demand. Reference to section 3.1 and 3.2 shows that base electrical and thermal demand is of the order of 2.5MW and this exists 365 days a year.

CHP plant involves a high initial capital investment, so for it to be an economic prospect the revenue savings need to be maximised. To this end the unit needs to run at full output for as long as possible. Consequently it is important that the CHP machine is not oversized and the site demand always exceeds generated supply.

The magnitude of the site electrical and thermal demands are inflated by the inefficiencies in the systems already identified. Also the source data is averaged over hourly or half hourly periods and so could disguise troughs in demand. Consequently a 1 MWe (electrical output) CHP unit seems to be a suitable size to use for initial investigations. At this size of unit a gas turbine or gas engine would be possible options although the former is better suited to the current 150°C operating temperature for the HPhW system. Gas engines are available for connection to HPhW systems although this is normally for temperatures of around 120°C and there is a reduction in useful thermal output with increasing temperatures.

The Government introduced the Climate Change Levy (CCL) on the purchase of fuels in proportion to associated CO₂ emissions. Hence a charge of 0.48p per kWh is levied on electricity and 0.169p per kWh on gas before VAT which further increases the overall impact of the levy. Fuel used for “good quality” CHP is exempt from CCL which is determined through calculation of a quality index. This is subject to obtaining reliable performance data from manufacturers. A CHP scheme would only be implemented if it was of adequate quality, so it is assumed that gas consumed by CHP would be CCL exempt.

The CHP could also be used to improve the resilience of the electrical supply. It is possible to configure the CHP engine to run in “island mode” i.e. run independent of the grid electrical supply. Also, the CHP and emergency generator can be linked – engines running in parallel or independently of each other thus offering greater resilience. Automatic change over controls can switch from REC to island mode operation with auto back synchronisation. However, it must be remembered that when paralleling the CHP with the generators there is the potential for harmonics and therefore, it should be ensured that the windings are matched, which will assist in mitigating this. In addition, the CHP should be shed from the site load whilst the generators start-up and are ready to take the load.
Tables 5.1 and 5.2 outline simple economic appraisals of a 1 MWe gas turbine and a 1 MWe gas engine CHP unit operating continuously throughout the year.

### Table 5.1: 1MWe Gas Turbine CHP Unit

<table>
<thead>
<tr>
<th>Assumptions</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Gas turbine CHP</td>
<td>electrical output 1000 kWe</td>
</tr>
<tr>
<td></td>
<td>Thermal output 1664 kWt</td>
</tr>
<tr>
<td></td>
<td>Gas input 3690 kW</td>
</tr>
<tr>
<td>Average unit gas cost for CHP</td>
<td>2.341 p/kWh</td>
</tr>
<tr>
<td>Average unit gas cost for boiler (inc. CCL)</td>
<td>2.510 p/kWh</td>
</tr>
<tr>
<td>Average unit electricity cost (inc. CCL)</td>
<td>7.464 p/kWh</td>
</tr>
<tr>
<td>Estimated seasonal efficiency of existing boilers</td>
<td>75%</td>
</tr>
<tr>
<td>Hours of operation (90% availability)</td>
<td>7,884</td>
</tr>
</tbody>
</table>

### CHP Annual Running Costs

<table>
<thead>
<tr>
<th>Description</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Gas consumed per annum</td>
<td>29,091,960 kWh</td>
</tr>
<tr>
<td>Cost of gas consumption</td>
<td>£681,043</td>
</tr>
<tr>
<td>Maintenance cost @ 0.35 p/kWh electricity generation</td>
<td>£101,822</td>
</tr>
<tr>
<td>Total running costs per annum</td>
<td>£792,805</td>
</tr>
</tbody>
</table>

### Annual Savings Of Displaced Utility Use

<table>
<thead>
<tr>
<th>Description</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Utilised heat generated by CHP per annum</td>
<td>13,118,976 kWh</td>
</tr>
<tr>
<td>Displaced gas consumption</td>
<td>17,491,968 kWh</td>
</tr>
<tr>
<td>Cost of displaced gas</td>
<td>£639,048</td>
</tr>
<tr>
<td>Electricity generated per annum</td>
<td>7,884,000 kWh</td>
</tr>
<tr>
<td>Cost of displaced electricity</td>
<td>£588,462</td>
</tr>
<tr>
<td>Total displaced costs</td>
<td>£1,027,510</td>
</tr>
</tbody>
</table>

### Payback Period

<table>
<thead>
<tr>
<th>Description</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Net total saving</td>
<td>£248,646</td>
</tr>
<tr>
<td>Capital cost</td>
<td>£1,300,000</td>
</tr>
<tr>
<td>Simple Payback period</td>
<td>5.3</td>
</tr>
</tbody>
</table>

### CO2 Saving

<table>
<thead>
<tr>
<th>Description</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Gas consumed</td>
<td>5,528 tonnes</td>
</tr>
<tr>
<td>Gas displaced</td>
<td>3,324 tonnes</td>
</tr>
<tr>
<td>Electricity displaced</td>
<td>3,627 tonnes</td>
</tr>
<tr>
<td>Net saving</td>
<td>1,423 tonnes (7%)</td>
</tr>
</tbody>
</table>
### Table S.2: 1 MWe Gas Engine CHP Unit

**Assumptions:**

<table>
<thead>
<tr>
<th>Description</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Gas Engine CHP</td>
<td>979 kWe</td>
</tr>
<tr>
<td>Thermal output</td>
<td>1164 kWt</td>
</tr>
<tr>
<td>Gas input</td>
<td>3075 kW</td>
</tr>
<tr>
<td>Average unit gas cost for CHP</td>
<td>2.341 p/kWh</td>
</tr>
<tr>
<td>Average unit gas cost for boiler (inc. CCL)</td>
<td>2.510 p/kWh</td>
</tr>
<tr>
<td>Average unit electricity cost (inc. CCL)</td>
<td>7.464 p/kWh</td>
</tr>
<tr>
<td>Estimated seasonal efficiency of existing boilers</td>
<td>75%</td>
</tr>
<tr>
<td>Hours of operation (90% availability)</td>
<td>7,884</td>
</tr>
</tbody>
</table>

**CHP Annual Running Costs**

<table>
<thead>
<tr>
<th>Description</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Gas consumed per annum</td>
<td>24,243,300 kWh</td>
</tr>
<tr>
<td>Cost of gas consumption</td>
<td>£567,556</td>
</tr>
<tr>
<td>Maintenance cost @ 0.6 p/kWh electricity generation</td>
<td>£145,460</td>
</tr>
<tr>
<td>Total running costs per annum</td>
<td>£712,995</td>
</tr>
</tbody>
</table>

**Annual Savings Of Displaced Utility Use**

<table>
<thead>
<tr>
<th>Description</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Utilised heat generated by CHP per annum</td>
<td>9,176,976 kWh</td>
</tr>
<tr>
<td>Displaced gas consumption</td>
<td>12,235,968 kWh</td>
</tr>
<tr>
<td>Cost of displaced gas</td>
<td>£307,123</td>
</tr>
<tr>
<td>Electricity generated per annum</td>
<td>7,718,436 kWh</td>
</tr>
<tr>
<td>Cost of displaced electricity</td>
<td>£576,104</td>
</tr>
<tr>
<td>Total displaced costs</td>
<td>£883,227</td>
</tr>
</tbody>
</table>

**Payback Period**

<table>
<thead>
<tr>
<th>Description</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Net total saving</td>
<td>£170,231</td>
</tr>
<tr>
<td>Capital cost</td>
<td>£850,000</td>
</tr>
<tr>
<td>Simple Payback period</td>
<td>5.0</td>
</tr>
</tbody>
</table>

**CO₂ Saving**

<table>
<thead>
<tr>
<th>Description</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Gas consumed</td>
<td>4,606 tonnes</td>
</tr>
<tr>
<td>Gas displaced</td>
<td>2,325 tonnes</td>
</tr>
<tr>
<td>Electricity displaced</td>
<td>3,550 tonnes</td>
</tr>
<tr>
<td>Net saving</td>
<td>1,269 tonnes (6%)</td>
</tr>
</tbody>
</table>

---

Of the two options the gas turbine looks the more favourable, and is a better match to the HPHW heating system. A CHP unit will always provide environmental benefit by reducing CO₂ emissions. In the case of a 1MWe gas turbine running with 95% availability a reduction in site CO₂ of 7% is achievable, which is nearly half of the NHS target to be achieved by 2010. The introduction of the CRC charges and likely increasing cost of carbon emissions will further enhance the economic return.

Figures 8 and 9 show how the electricity and thermal outputs from two 1 MWe gas turbine CHP units would cover the year round base loads.

**Figure 8**: CHP Electrical Output compared to Seasonal Daily Consumption

**Figure 9**: CHP Thermal Output compared to Summer Daily Consumption
Biomass

Biomass refers to burning natural, vegetative matter to produce heat. This heat can be used both to temper the building, and to meet the hot water requirements. The fuel used for the boiler is typically wood, which comes in the form of either chips or pellets. The CO₂ released when burning this matter is equivalent to the CO₂ the trees have absorbed in their lifetime. Thus, the whole process becomes almost carbon neutral. The only additional emissions will be from processing and transportation of the fuel to the site and a regular supply of fuel will be required, similar to oil for an oil boiler. Therefore, it is desirable to use a local supplier.

Although the capital cost of a bio-mass boiler is much higher than that of a gas or oil-fired boiler, the fuel cost is low and stable and this could result in long term financial rewards in the face of rising gas and oil prices.

Bio-mass, like any solid fuel, requires storage on site. Fuel deliveries produce associated CO₂ emissions due to the transportation involved and in order to minimize the frequency of these deliveries significant space should be allowed for storage of fuel on site. To simplify fuel delivery, the fuel store should be installed below ground so that it can be refilled by emptying the load of a standard tipper lorries directly into the store.

A 1.0MW lead woodchip boiler could displace 1500 tonnes of CO₂ annually if run continuously as lead boiler. The boiler would consume around 40 m³ of wood chip per day and need an underground store approximately 15m x 10m x 2.8m deep. This would provide about 6 days storage and need a 20 tonne truck delivery every other day.

The installed capital cost of the biomass boiler would be in the order of £250,000 but the cost of the store could double this price and there is a question whether it is feasible to create a suitable space in the vicinity of the existing energy centre.

A biomass boiler offers by far the greatest reduction in carbon dioxide emissions for a given capital investment and so would be the first choice if the priority was to minimize absolute carbon emissions. However there are substantial civil engineering works associated with the fuel storage and delivery and high on-going maintenance commitment to ensure that the system operates at peak efficiency and down time is minimised. Fuel delivery mechanisms can be susceptible to blockage if there is too great a variance in fuel quality, moisture content or excessive dust. A 1.0MW biomass boiler could displace a similar amount of carbon as a 1.0 MWe CHP at a lower installed capital cost but it may be that physical restrictions to incorporating the necessary ground works for fuel storage and delivery that precludes this option.
5.2.3 Replace HPHW mains

The main HPHW distribution is suffering from an increasing number of leaks over recent months and the expansion/contraction of the system during shut down tends to cause further leaks elsewhere in the network. There are also serious health and safety concerns over the lack of double isolation facility coupled with antiquated valves and the risk of serious injury to operatives working on the HPHW mains.

The main distribution pipework will need to be replaced in a phased programme to ensure that heating, cooling and hot water services are not compromised. The prior removal of the central steam system should be of significant benefit in that it will free up space for new HPHW pipework to be installed in parallel with the existing before final switchover of connections at the energy centre and building plantrooms. The removal of the steam system will also greatly reduce the temperatures in the service trenches which will make the working conditions for the new installation much safer and more bearable.

The mains connection will need to be programmed in with the replacement of heat exchangers in the various building plantrooms and are likely to need the hire of temporary containerised heating and domestic hot water plant to be connected to the downstream systems while this work is carried out.

There will also be the opportunity to ensure that all the new distribution pipework and valves are well insulated and so greatly reduce the standing heat losses presently being experienced.

5.2.4 Heat Exchangers

The existing calorifiers and heat exchangers like the boilers are showing evidence of reaching the end of their economic life. Annual inspection, repair and maintenance costs amount to over £20,000.

The earlier buildings have Rycroft horizontal shell and tube exchangers which are used to convert MTHW to LTHW for space heating. In JR3 vertical inverted non storage calorifiers are used in a similar manner. A series of Baric unit calorifiers were installed 1985 in the air handling plant rooms to provide LTHW to the AHU frost coils. This followed multiple leaks from the original MTHW coils which froze and burst. The original coils were re-used so effectively they are now under capacity.

Generally domestic hot water is generated by via Angelsey heat exchangers. These are vertical shell and helical tube exchangers primarily designed for a steam primary although they are often used with HTHW and MTHW. There are a few locations where traditional copper storage calorifiers are used. These date back to 1969 and insulation standards tend to be poor. The pair of calorifiers in JR1 each has a capacity of over 11,000 litres and their size has resulted in permanent scaffolding being erected around them for maintenance access.

Because of their age, most of the heat exchangers are now in need of replacement, and so it is an opportune time to look for more energy efficient alternatives. Keen to avoid the current maintenance commitment for inspection descaling and repair of the various exchangers, the energy manager has stated his preference for plate heat exchangers. While susceptible to scaling, the view is that the plates are easily opened up and in the worst case simple to replace. An alternative option for domestic hot water would be a stacked horizontal twin wall cylinders which claim to be less
susceptible to scale and consequently reduce maintenance. With either option the improved efficiency in operation should be similar through better and reduced standing losses. The capacity of water within the hot water systems in the larger buildings effectively provides a significant “storage” volume, but in the smaller installations a buffer vessel may be worthwhile to reduce the primary thermal input to the exchanger.

Energy savings will accrue from improved heat transfer efficiency and reduced standing losses. Maintenance costs should also be reduced to a single annual service/inspection.

5.2.5 Controls, Metering & Monitoring

As the Johnson BMS system can only be supplied and installed by the manufacturer with no other options for procurement and the reportedly high maintenance costs, an alternative procurement option is required for the proposed upgrade of the BEMS. In order to promote competitiveness and yet provide a level of uniformity within the installation, it is recommended that all future BMS systems should be supplied by one of two BEMS suppliers, either Trend Control Systems Ltd or Andover Controls and to use an independent system house/system integrator. Hence the preferred suppliers should have the option of two possible procurement routes, namely:

1. Direct purchase from nominated controls supplier.
2. Direct purchase from systems integrator (who obtains controls equipment from manufacturer then designs, installs and commissions systems to user requirements.

An additional caveat to the choice of supplier would be the provision that independent system integrator could provide ongoing maintenance of the BEMS once it is installed in addition to the traditional maintenance provided by the manufacturer thus promoting competitiveness in the post installation/service costs.

A budget cost has been derived for the HVAC control from selective quotations from the two nominated controls suppliers in conjunction with an asset register/schedule of plantrooms (including a minimum hardware spare capacity of 15%). Integration of different engineering systems such as lighting, life safety, access etc. is excluded, except for limited alarm monitoring or sequence initiation. The budget cost also precludes the re-use of any existing peripherals (actuators/valves/cabling) and nor does it include costs for the physical communication system between the different parts of the BEMS. The cost element of the BEMS taken up with the installation of the communication network may be reduced if the existing communication network cabling or hospital IT cabling system is utilised.

Where a BEMS is being overlaid on an existing site, it will not compensate for fundamentally inefficient plant. So the BEMS installation programme needs to phased in with the upgrade of HVAC systems.

For the healthcare sector, quality of control and operational down time are of primary importance. Otherwise the 3 main reasons for upgrading/replacing a conventional control system with a BEMS system:

1. Energy Savings
2. Reduced labour costs and/or more economic use of existing resources

3. Improved demand side management and management information

A BEMS can enable more efficient use of personnel for remote plant operation, alarm monitoring, plant optimisation and fault diagnosis. Pulsed output metering of the electrical and HVAC systems should be included as an integral part of the refurbishment programme and extended throughout the site connected to the central BMS. Improved management information, such as historical records and alarm logs, can demonstrate that environmental criteria have been met and that plant running hours can be used to determine the frequency of maintenance, which in turn should lead to improved life expectancy of the plant.

The potential benefits are only realised if sufficient commitment is made to the BEMS throughout its operational life. People who use, operate and maintain the system need to be trained to allow them a good understanding of its capabilities, purpose and potential. Experience has shown that the most successful applications are those where the BMS management staff fully understand the system and are thus able to make most of the facilities.

5.2.6 PV

Solar energy can be converted to electricity using the photo-electric effect. Simply, Photo Voltaic (PV) cells use the energy from the sun to induce a current in a circuit. The total area of an array for a rated power is dependent on the technology used. For a 1kWp array this would range from 6.5 to 8.5m² for commonly used crystalline modules, but up to 25m² for thin film technologies.

The amount of energy generated by a PV system is dependent on, size of PV array, the type of PV module, UK location and array tilt and orientation. As a general rule of thumb, for every kWp of PV installed facing near south with a tilt angle of 30-40 deg, the annual output will be in the region of 750kWh per year.

PV installations have a limited life of approximately 20 years. However during its life a PV system needs very little maintenance. In all but exceptional cases modules are self-cleaning with rainfall.

Costs of PV systems depend on the PV module and the method of installation but are typically in the region of £3,000 - £4,000 per kW installed but can be significantly cheaper in larger scale applications. The introduction of feed-in-tariffs has made PV one of the most attractive renewable energy options as it now offers a good financial return over its lifetime and requires only minimal maintenance resource. This has given rise to a flood of applications for large scale developments purely as a financial investment. In response the Government has drastically reduced the level of funding for installations over 50kW.

Across the Radcliffe site we have estimated that there might be 4,000m² of available roof space that PV could be installed, which would be equivalent to about 500 kW peak output. However the FIT tariffs drop substantially with larger installations and there is an economic advantage of restricting the total installed capacity to below 250 kW, which should achieve a payback of 18 years compared to 25 years for a 500 kW system. It should be feasible to concentrate the majority of a 250 kW installation on the roof of the industrial block. The installed cost for a 250 kW PV installation would
be around £750,000 and produce around 188 MWh of electricity saving £42,000 annually, and displace 97 tonnes of carbon dioxide.

To ensure maximum output, the PV arrays need to avoid being shaded by adjacent buildings so a detailed sun path analysis will be required to identify the optimum locations.

5.2.7 Standby Generation

To overcome the disparate arrangement of the existing SPS system and to bring the network in line with the requirements of HTM 06-01 of an N+1 arrangement, it is recommended that new standby generators be introduced into the electrical site network at HV, thereby providing standby supplies to the entire Hospital electrical network.

Although it is recognised that 11 kV generators have a higher unit cost, they can be cheaper or more convenient to distribute electricity to the points of use on the network.

Solcor protection shall be provided to the new arrangements so as to reflect the existing HV network arrangements for system protection.

The Client has advised that the current Maximum Demand (MD) of the site is between 4.6 & 4.7MVA. However, it has been requested that future provision for expansion be taken into consideration when sizing the Standby Generation load and as such it has been agreed that this load be 6MVA.

The most cost effective approach to the provision of standby generation is to keep the number of sets to a minimum, which will inevitably lead to a reduction in capital costs; maintenance costs and construction costs, if new formed facilities are to be provided.

Therefore, the proposal, to accommodate the current load is for the provision of 2 no. 3MVA sets supported by the existing LV generators (N+1). The requirement to utilise the LV generators as the +1 element of the system is a requirement of the Client and with a good, regular and robust maintenance regime there is no reason why this could not be utilised as the support system for the new sets. However, it must be recognised that the age of some of the sets are approximately 40 years old. Future considerations should therefore, be considered to replacing these units when economic times are more favourable. However, the confidence required that a standby system is available when it is required, will be given by the provision of the 2 no. new 3MVA sets.
To enable the LV sets to be utilised as the +1 arrangement, control systems shall need to be implemented so that they do not run at the same time as the new HV sets, when the mains supply is lost. The control regime is therefore, proposed to be as follows:

1. Electrical Mains failure –
   - CHP units disconnects from system.
   - New 2 no. 3MVA HV generators start and take up the site load
   - Existing LV generators hold off.

2. Generators Run Up to speed
   - Site Electrical System connects
   - CHP reconnects to support load (if required).
   - Existing LV Generators hold off

3. 1 no HV generator fails to Start.
   - 2nd HV generator shuts down
   - CHP unit disconnects from supply.
   - Existing LV Generators start up and take the load (in existing arrangement).

4. Existing Generators are on Line (whilst HV are disconnected)
   - CHP reconnects to support load (if required).

5. Electrical Mains becomes Available
   - Existing Generators or new HV generators (whichever are running) disconnect from load.
   - CHP continues to run.

As previously noted above, a strict monitoring and control system will need to be implemented to ensure that both the HV and the existing LV generators are not running in parallel and attempting to start at the same time.

The following sections identify the potential costs and room sizes required to accommodate this arrangement.

Non-containerised Arrangement

With the provision of non-containerised units, there needs to be further evaluation, which does not at this time form part of this report, as to whether there is flexibility within the existing site as to whether it can accommodate the units within the existing structure(s). Therefore, to enable the Client to carry out this evaluation, this report will identify the anticipated spatial requirements needed to accommodate:

- Single unit arrangement(s).
- Twin unit arrangement(s).
The following schedule identifies the anticipated equipment requirements as well as costs for this arrangement:

<table>
<thead>
<tr>
<th>Quantity</th>
<th>Equipment</th>
<th>Unit Cost</th>
<th>Total Cost</th>
</tr>
</thead>
<tbody>
<tr>
<td>2</td>
<td>3.1MVA Standby / 2.825MVA Prime Power Generator Sets.</td>
<td>£450,000</td>
<td>£900,000</td>
</tr>
<tr>
<td>2</td>
<td>Set-to-Set Synchronising Controllers, (Excludes remote MCC, master panel, G59 relays etc.)</td>
<td>£9,000</td>
<td>£18,000</td>
</tr>
<tr>
<td>2</td>
<td>30DegC Vertical Electrically Driven Radiator (ambient operating temperature estimated at 30°C temperature).</td>
<td>£38,000</td>
<td>£76,000</td>
</tr>
<tr>
<td>2</td>
<td>Bulk Fuel Tank 146,400 litres useable / 80 hours operation per generator set at 100%. Including duty / standby pump skid set, local pump skid control panel, leak detection etc.</td>
<td>£181,000</td>
<td>£362,000</td>
</tr>
<tr>
<td>1</td>
<td>Testing procedures, both factory &amp; site, including 6.2MVA resistive reactive Loadbank for 1 week.</td>
<td>£50,000</td>
<td>£50,000</td>
</tr>
<tr>
<td>1</td>
<td>Commissioning &amp; testing personnel and management etc.</td>
<td>£30,000</td>
<td>£30,000</td>
</tr>
<tr>
<td>1</td>
<td>Delivery of all goods to site, offloading with a 250tonne crane</td>
<td>£19,000</td>
<td>£19,000</td>
</tr>
<tr>
<td></td>
<td><strong>Total</strong></td>
<td><strong>£1,455,000</strong></td>
<td></td>
</tr>
</tbody>
</table>

Notes:

1. Discussions are required as to whether the HTM requirement of 300 hrs continuous running is required. If the HTM requirement is to be implemented then it must be borne in mind that 2 x 121,900 litre tanks (i.e. 243,800 for two sets) will be required, which when delivered may involve a police escort; abnormal loads considerations and the involvement of local councils; telecom providers (for overhead cables) etc.

2. The above costs and equipment are based upon the Finning Caterpillar range of products, at this time. If an alternative manufacturer is to be considered, then the above costs shall need to be re-evaluated.

3. The above costs do not include for construction costs of suitable structures to accommodate the generators and associated equipment.

Dimensional requirements of equipment:

Generator Sets - The Unit dimensions for each set is 6.7m x 2.4m x 2.5m (L x W x H)

Radiator - The Unit dimensions are 3.3m x 3.1m x 1.9m (H x W x D)

8 hour day tank / 4,500 litres usable - The unit dimensions are 2,260mm x 1,460mm x 1,830mm (L x W x H)
Therefore, to accommodate these along with the component parts and equipment the following constructed spaces are required:

<table>
<thead>
<tr>
<th>Generator Arrangement</th>
<th>Approx. Room Dimension (LxWxH Internal)</th>
<th>Notes</th>
</tr>
</thead>
<tbody>
<tr>
<td>Single Unit</td>
<td>15.5 x 6.0 x 5m</td>
<td></td>
</tr>
<tr>
<td>Twin Units</td>
<td>15.5 x 11 x 5m</td>
<td>Final agreed arrangement will determine L x W dimensions</td>
</tr>
</tbody>
</table>

Containerised sets

As an alternative to providing sets within a structured space, there is the option to provide containerised units located to external areas, at locations conducive to the layout and operation of the hospital as well as the most convenient connection point into the electrical system network.

The following schedule identifies the anticipated equipment requirements as well as costs for this alternative arrangement:
<table>
<thead>
<tr>
<th>Quantity</th>
<th>Equipment</th>
<th>Unit Cost</th>
<th>Total Cost</th>
</tr>
</thead>
<tbody>
<tr>
<td>2</td>
<td>3.1MVA Standby / 2.825MVA Prime Power Generator Sels.</td>
<td>£450,000</td>
<td>£900,000</td>
</tr>
<tr>
<td>2</td>
<td>Set-to-Set Synchronising Controllers, (Excludes remote MCC, master panel, G59 relays etc.)</td>
<td>£9,000</td>
<td>£18,000</td>
</tr>
<tr>
<td>2</td>
<td>30DagC Vertical Electrically Driven Radiator (ambient operating temperature estimated at 30°C temperature)</td>
<td>£38,000</td>
<td>£76,000</td>
</tr>
<tr>
<td>2</td>
<td>60dB(A) at 1 metre Acoustic Enclosure including lighting, (Incl. emergency); power; heaters; fire valves; sump; motorised inlet &amp; gravity outlet louvers; etc.</td>
<td>£175,000</td>
<td>£350,000</td>
</tr>
<tr>
<td>1</td>
<td>Bulk Fuel Tank 146,400 litres useable / 80 hours operation per generator set at 100%. Including duty / standby pump skid set, local pump skid control panel, leak detection, etc.</td>
<td>£181,000</td>
<td>£181,000</td>
</tr>
<tr>
<td>1</td>
<td>Testing procedures, both factory &amp; site, including 6.2MVA resistive reactive Loadbank for 1 week.</td>
<td>£20,000</td>
<td>£20,000</td>
</tr>
<tr>
<td>1</td>
<td>Commissioning &amp; testing personnel and management etc.</td>
<td>£30,000</td>
<td>£30,000</td>
</tr>
<tr>
<td>1</td>
<td>Delivery of all goods to site, offloading with a 25tonne crane</td>
<td>£19,000</td>
<td>£19,000</td>
</tr>
<tr>
<td></td>
<td><strong>Total</strong></td>
<td><strong>£1,624,000</strong></td>
<td></td>
</tr>
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</table>

Whether a non-containerised or containerised option is opted for, a plug-in facility shall be provided at each generator location to allow the provision of connecting a mobile set into the system in the event of a set malfunction or the need to reinforce the standby requirement.

**Uninterruptable Power Supplies (UPS) Provision**

To accommodate the requirement of HTM 06-01 new UPS systems providing no-break protection, until such time the generators are on line and providing standby support, should be provided to Critical care type areas throughout the hospital such as:-

- ITU/ICU
- Operating Theatres
- Special Baby Unit

At this present time this provision does not exist and so the Trust is at risk of loss of power supplies to critical facilities during the transition period before the standby generation kicks in. A separate load profile analysis will need to be undertaken to determine the exact capacities, but for costing purposes a provisional allowance of 100kW to each area has been allowed based on discussions between Mr. Stephen Lloyd; Mr. Mike Frankum & Halcrow.

Once further analysis of each department’s requirements has been ascertained, consideration as to whether independent provision is given to each area or whether a centralised system should be provided will be determined.
Consideration to MEIGaN Annex 1 shall be given with regard the ultimate establishment of UPS provision, although the above identified departments are of prime concern at this time.

However, the provision of independent systems does provide resilience of supply, as failure of one unit will not affect the operational requirements of another and as such consideration should be given to this arrangement.

In addition, provision of independent systems will have the need for individual spatial requirements (dependant upon department locality) which shall require either good ventilation but preferably cooled spaces so as to maximise battery life and efficiencies. This will obviously impact upon capital costs and as such the final arrangement to be agreed.

The UPS system is recommended, as stated above, to provide no-break protection until such time the generators are on line, however, they should not be considered as a long-term energy source and as such discussions with the Client are necessary to determine the autonomy of each UPS unit.

The cost of providing a UPS system to protect the above areas is:

<table>
<thead>
<tr>
<th>Quantity</th>
<th>Equipment</th>
<th>Unit Cost</th>
<th>Total Cost</th>
</tr>
</thead>
<tbody>
<tr>
<td>3</td>
<td>100kVA Uninterruptible Power Supply unit with a 30 minute autonomy</td>
<td>£47,000</td>
<td>£94,000</td>
</tr>
<tr>
<td>1</td>
<td>Testing; commissioning &amp; delivery to site</td>
<td>£5,000</td>
<td>£5,000</td>
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<tr>
<td></td>
<td><strong>Total</strong></td>
<td></td>
<td><strong>£99,000</strong></td>
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</table>

Consultation with the relevant clinical staff will also need to be undertaken to ascertain the level of autonomy, with particular regard to the operating theatres. Therefore, to accommodate a potential for a greater level of protection, the cost to provide UPS units with a greater autonomy is as follows:

<table>
<thead>
<tr>
<th>Quantity</th>
<th>Equipment</th>
<th>Unit Cost</th>
<th>Total Cost</th>
</tr>
</thead>
<tbody>
<tr>
<td>3</td>
<td>100kVA Uninterruptible Power Supply unit with a 60 minute autonomy</td>
<td>£55,000</td>
<td>£135,000</td>
</tr>
<tr>
<td>1</td>
<td>Testing; commissioning &amp; delivery to site</td>
<td>£5,000</td>
<td>£5,000</td>
</tr>
<tr>
<td></td>
<td><strong>Total</strong></td>
<td></td>
<td><strong>£135,000</strong></td>
</tr>
</tbody>
</table>
1. Discussions are required as to implementation of MEIGaN Annex 1 with regard the ultimate establishment of UPS provision.

2. The above costs and equipment are based upon the Eaton range of products, at this time. If an alternative manufacturer is to be considered, then the above costs shall need to be re-evaluated.

3. The above costs do not include for construction costs of suitable structures to accommodate the UPS equipment and associated plant such as ventilation and cooling systems.

BMS Interface

The Hospital utilises the Andover format of Building Management Systems and all equipment shall be selected to ensure interface with this type of system. The level of monitoring and control of equipment and systems shall be provided to reflect the existing site requirements.
6 Funding Options

The main scope of this study has been to identify the most appropriate future strategy for energy generation on the Radcliffe site rather than the method of procurement. The extent of the plant replacement now necessary represents a substantial capital investment for the Trust and so will warrant consideration of a variety of funding strategies other than direct finance such as supplier-financed or joint venture schemes. Specialist advice will be required as the scheme proposals are developed but some of the issues are covered briefly below.

6.1 User-financed Schemes

User-financed schemes are self-explanatory. The user provides the capital to finance the installation, either from in-house resources or from one of the external financing sources available to the organisation. There will clearly be specific arrangements/constraints, which the Trust will have for assessing financial but the principal advantage is that the Trust will have the full benefit of all the savings generated. However, they will in doing so have take full responsibility for all the associated risk. The risk can be minimised by using suitable contractors and/or establishing appropriate performance clauses in installation and maintenance contracts.

With the ever-increasing demands on health budgets, there are often objections to major capital outlay for IIVAC plant if it is seen to be competing with demands for primary care. However there is now a very real risk that, without appropriate investment at the John Radcliffe site, plant failure will prevent the deliver of primary care altogether. On a more positive note, for the measures highlighted there will be an on-going return on the investment, which will help to ease pressure on daily running cost budgets.

Leasing is sometimes proposed as a way of avoiding initial capital outlay. In its simplest form (finance leasing), it only differs from a medium term loan in its tax effect and who actually owns the plant. The leasing companies rarely carry the risk themselves and are more likely to lay it off elsewhere, perhaps to the supplier of the plant who will value its capital fairly highly. This is usually only available on specific packaged installations such as CHP.

6.2 Supplier-Financed Schemes

These represent a widely used alternative to user-financed project funding. They come in two main forms; hardware related contracts with the principal equipment supplier; and energy focused arrangements, probably with a wider scope, with Contract Energy Management companies (CEMs).

Equipment-related contracts such as the Build Own Operate type again are normally associated with new energy centres and particularly CHP generation. The capital cost of the installation and responsibility for its lifetime operation are provided by an outside agency (e.g. the equipment manufacturer, perhaps in conjunction with another organisation) with no recourse to the user. The user will often be responsible for purchasing fuel for the plant but will be contracted to purchase electricity and/or heat from it. While this has the principal advantage of avoiding initial capital
expenditure and subsequent maintenance costs, the Trust would need to be convinced that there are overall energy cost advantages.

CEM arrangements usually have broader responsibilities, embracing all aspects of energy supply to the site (capital investment, operation and maintenance, investment in energy saving schemes, fuel purchase etc.). Such agreements are focused mainly on relatively large sites and most are concerned with managing the site's thermal requirements. While CEMs often work closely with preferred equipment manufacturers, they are unlikely to be tied to a particular source. In some respects, the CEM arrangement is simpler than a hardware-related supplier-financed contract (although both are likely to require an undertaking from the site owner to reach minimum consumption levels for an agreed period). The wider scope of the CEM agreement leaves less scope for argument - for example, on exactly when particular plant should be operated.

Both types of supplier-financed arrangement raise suspicions that the site owner is giving away some of the benefits of any efficiency improvement savings. After all, the companies would not be offering the service unless they expected to make a profit which, it is argued, could be retained by the site operator. The counter-arguments are that the supplier is a specialist and can perform the task more cost-effectively, and there are economies of scale in running a number of schemes or negotiating with fuel suppliers which are not available to a single site, and internal finance may be difficult. While the site does have an energy manager in place with the scale of demand to be able to negotiate very competitive utility tariffs, evidence suggests that the site services have suffered from a lack of access to the necessary capital funding over the last decade.

6.3 Grants

6.3.1 The Enhanced Capital Allowance Scheme

The scheme provides support for investment in low carbon technologies under the climate change levy package and enables businesses to take 100% of the tax relief for their investment in plant on the full cost in the first year.

The ECA scheme supports CHP, boilers, heat pumps, motors and variable speed drives, lighting, refrigeration, pipe insulation, solar thermal and UPS systems which meet the relevant energy efficiency criteria. The criteria are set out in Energy Technology List which consists of two parts: The Energy Technology Criteria List which is updated and published annually, and the Energy Technology Product List which is published annually and updated each month on the ECA website.

The key features of the Scheme are:

- all businesses are now able to claim enhanced capital allowances, regardless of size, industrial or commercial sector or location except where the assets are leased in the course of the business;

- enhanced capital allowances permit the full cost of the investment in specified technologies to be relieved for tax purposes against taxable income of the period of the investment;
• the qualifying technologies will have to meet defined energy saving criteria. They will be published in a List, and the criteria will be reviewed on an annual basis;
• there are no territorial restrictions on manufacturers wishing to place their products on the list or the source of products;
• only investments in new and unused machinery and plant can qualify.

6.3.2 Feed in Tariff (FIT)

The latest financial incentive for low and zero carbon technologies for electrical generation, introduced from April 2010, is “feed-in tariffs”. Although the name suggests payment for energy fed into the national grid, FITs payments are in fact made for all electricity generated by on site renewable energy sources but with an additional sum for any excess exported to the wider energy market. The generation tariff is fixed price per kilowatt hour, set at different levels for different technologies and installation sizes. The level of the tariff will reduce for new projects in future years, but any individual installation which has started to receive a tariff at a certain level, will continue to receive the same generation tariff level throughout the entire support period (guaranteed for 20 – 25 years).

FITs only cover domestic micro CHP rather than larger scale installations, so it would only be PV installations at the ORH site that would qualify for this funding stream.

6.3.3 Renewable Heat Incentive (RHI)

In a similar manner the Government has also this year introduced the Renewable Heat Incentive (RHI). In the first phase, long-term tariff support will be targeted at the big emitters in the non-domestic sector, covering everything from large-scale industrial heating to small business and community heating projects. The funding structure is identical to that for FITs with the generation tariff fixed price per kilowatt hour; set at different levels for different technologies and installation sizes but guaranteed at the same level for a 20 year period. The Gas and Electricity Market Authority (Ofgem) will administer the RHI including: dealing with applications; accrediting installations; making incentive payments to recipients; and monitoring compliance with the rules and conditions of the scheme. If a biomass boiler is included in the energy centre than it would be worth ensuring that its supply and installation was in accordance with RHI criteria so qualifying for this subsidy.
7 Recommendations

7.1 Demand Reduction

Comparison of the energy consumption at the John Redcliffe site with national benchmarks, suggests that electricity usage is more profligate than that of fossil fuel. There has been a continual rise year on year of both gas and electricity consumption on the site and though due mainly to an increasing building floor area and equipment demand, probably also reflects the deteriorating condition of the building services installations.

The first priority should always be to reduce energy demand before looking at improved means of energy generation to meet that demand. This not only reduces energy running costs but also potentially reduces the required capacity, and associated capital investment, for any new plant.

The benefits of good housekeeping should not be overlooked as evidence suggests that instilling awareness amongst staff not only results in significant energy savings but can also improve the building users’ satisfaction with their working environment.

Lighting in hospitals is a high user of electricity because of the long hours of operation. The majority of luminaires have older lower efficacy lamps and control gear. Lights being left on in unoccupied spaces or when there is sufficient available daylight is also probably the single largest user of “avoidable” electricity consumption. Both the light fittings and their control need to be upgraded.

Opportunities should be taken whenever refurbishment of the building envelope is considered to improve its thermal performance. Recovering roofs is one obvious example. Windows are another. Replacement high performance double glazed units, would not only achieve substantial reduction in heat loss, but would improve comfort conditions. There are further benefits of improved sound reduction and the possibility of incorporating encapsulated blinds to reduce glare and summer heat gains without the normal hygiene/maintenance costs of exposed blinds.

7.2 Central Plant

On balance there seem to be more benefits in remaining with a centralised HPFW or MPFW heating system than moving to de-centralised LTHW systems. However there are some areas of the site that might still be better decoupled from the HPFW system such as the manor house and annexe.

However the centralised steam system should be replaced by localised generation as soon as possible as it wastes far more energy than it usefully delivers.

The central HPFW boiler equipment, heat exchangers and control equipment in calorifier rooms have all reached the end of their economic life and need to be replaced. The existing 23 MW installed boiler capacity seems excessive for an 8 MW peak demand. Installing four new 4.0MW dual fuel boilers would achieve the same performance security as present with the peak load met by two from three available units with one off line for maintenance.

The improved combustion efficiency and modulating control of the new boilers should increase seasonal efficiency by as much as 10% but further cuts in carbon emissions can be achieved by using CHP and or biomass boiler as the lead thermal
units. Two 1.0MW<sub>e</sub> CHP units could reduce the annual carbon emissions by as much as 15% and would meet the base electrical and thermal loads for the site.

7.3 Controls

Effective control is essential to ensure that supply is as closely as possible matched to actual demand. At present the automatic control systems are deficient and so a new comprehensive BMS system should be installed in tandem with plant refurbishment. This will include comprehensive metering to better able the energy manager to disaggregate energy usage across the site and adjust control strategies accordingly.

7.4 Renewable Energy Supplies

Biomass offers by far the greatest reduction in carbon dioxide emissions for a given capital investment and so would be the first choice if the priority was to minimise absolute carbon emissions. However it will be particularly costly to try to retrofit subterranean fuel storage and delivery facilities and to create the necessary space around the existing energy centre. Fuel delivery mechanisms can be susceptible to blockage if there is too great a variance in fuel quality, moisture content or excessive dust and there would be a high on-going maintenance commitment to ensure that the system operates at peak efficiency and down time is minimised. Biomass is arguably more compatible with for a new build project where the energy centre can be designed around the fuel delivery system. The economic argument for adding biomass boilers to an existing hospital will not be as attractive and so it is unlikely that biomass will be included in a CEM funded scheme.

Conversely PV is practically maintenance free and with the FIT subsidies can achieve a positive financial contribution over its operation lifetime.

7.5 Finance

There are only limited opportunities to get financial assistance for energy improvement measures through Feed in Tariffs and Renewable Heat Incentive and Enhanced Capital Allowance schemes. However the Trust may find it difficult to raise the necessary capital for the extent of plant replacement that is now essential for the John Radcliffe site's continued operation, which is why Contract Energy Management (CEM) or some form of third party financing might be more appropriate.

7.6 Integrated Strategy

The agreed energy strategy needs to be integrated into any "projects" carried out on the site as most economic to include the outlined demand reduction works as part of general refurbishment works. The installation of high frequency luminaires and appropriate automatic controls, together with the upgrading of the BMS controls need all to be a requirement of future maintenance and project works.

The only chance of getting the central air handling plant to provide effective local control and avoid the further addition of local DX plant is for there to be an agreed Estates brief specifying the controls and mixing boxes that should be installed as part of any refurbishment works.

There should also be a moratorium on the installation of DX cooling units, unless sanctioned by the Estates Department. Perhaps Estates might have to take on the
responsibility for installation and maintenance of units to ensure that the energy performance and control interlocks are optimised.

7.7 Specific Measures

A suggested scope of improvement measures is outlined below, which in total should achieve a reduction of around 30% in CO₂ emissions, which would exceed the NHS target reduction in primary energy. The site energy performance would also come in line within the 55 - 65 GJ/100 cu.m NHS target for existing facilities.

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<th>Payback</th>
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<tr>
<td></td>
<td>Energy (MWh)</td>
<td>CO₂ (tonnes)</td>
</tr>
<tr>
<td>Replace central steam boilers with local steam generators</td>
<td>£65,000</td>
<td>2,000</td>
</tr>
<tr>
<td>Install four central 4.0MW HPHW dual fuel boilers</td>
<td>£240,000</td>
<td>2,470</td>
</tr>
<tr>
<td>Replace HPHW distribution pipework</td>
<td>£700,000</td>
<td>1400</td>
</tr>
<tr>
<td>Install two 1.0MW gas turbine CHP units</td>
<td>£2,600,000</td>
<td>-</td>
</tr>
<tr>
<td>Install 1.0 MW biomass boiler system</td>
<td>£500,000</td>
<td>-</td>
</tr>
<tr>
<td>Replace heat exchangers</td>
<td>£44,000</td>
<td>425</td>
</tr>
<tr>
<td>Separate heating of BTS from Academic Block</td>
<td>£9,000</td>
<td>225</td>
</tr>
<tr>
<td>Decentralise heating in manor house and annexe</td>
<td>£20,000</td>
<td>145</td>
</tr>
<tr>
<td>New BMS controls including metering</td>
<td>£500,000</td>
<td>4,400</td>
</tr>
<tr>
<td>Install 250 kW PV array</td>
<td>£750,000</td>
<td>188</td>
</tr>
<tr>
<td>Upgrade lighting to high frequency fluorescents</td>
<td>£500,000</td>
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<tr>
<td>Install daylight/occupancy lighting controls</td>
<td>£145,000</td>
<td>1,340</td>
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<tr>
<td>New fan motors and invertors to AHUs</td>
<td>£90,000</td>
<td>295</td>
</tr>
<tr>
<td>Install TRVs/zone control</td>
<td>£175,000</td>
<td>1,135</td>
</tr>
<tr>
<td>totals</td>
<td>£6,336,000</td>
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</tr>
<tr>
<td>New standby generation sets</td>
<td>£1,624,000</td>
<td>-</td>
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<tr>
<td>New UPS system</td>
<td>£135,000</td>
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<tr>
<td><strong>Total Capex</strong></td>
<td><strong>£8,997,000</strong></td>
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The Carbon and Energy Fund (CEF) Feasibility Study

Oxford University Hospital NHS Trust

John Radcliffe and Churchill Hospitals

Feasibility Stage Potential Energy Project Review

December 2012
Document control sheet

Client: CEF Oxford University Hospital Trust
Project: John Radcliffe and Churchill Hospitals
Document Title: Feasibility Stage Potential Energy Project Review
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<td>NAME: P Maryan</td>
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Executive Summary

This document presents the initial high level feasibility on the integration of energy improvement projects that could potentially be carried out under the Carbon and Energy Fund at two Oxford University Hospital NHS Trust sites:

- John Radcliffe Hospital
- Churchill Hospital

A summary of the feasibility at each site is presented below:

1. John Radcliffe Hospital

A core project comprising of a 2.0 MWe gas fuelled reciprocating CHP, replacement of life expired boilers, conversion of existing heat distribution from HPHW to MP-HW / LPHW and lighting up-grade installations should be all be technically viable. Such a scheme is estimated to deliver:

Circa 5,000 Tonnes CO2 annual savings\(^1\)
Circa £700,000 annual guaranteed energy savings\(^2\)
Require a total capital investment of circa £3million
Deliver an NPV of circa £1.8million over a 15 year scheme term

An enhanced core project might also include a 1 MW biomass fuelled boiler, retro-fitting HVAC fan and pump motor variable speed drives, local improvements to existing LTHW controls, upgrades to existing BEMS system and retro-fit of 50 kWp photovoltaic (PV) array. This enhanced core scheme should deliver:

Circa 6,500 Tonnes CO2 annual savings\(^1\)
Circa £900,000 annual guaranteed energy savings\(^2\)
Require a total capital investment of circa £4.3million
Deliver an NPV of circa £2.1million over a 15 year scheme term.

2. Churchill Hospital

A core project comprising replacement of the life expired centralised oil fired steam boilers with a new part decentralised boiler installation operating on natural gas, delivering LTHW with steam utilised for localised process use only should be technically viable. The estimated base heat demand for Churchill Hospital may not support a CHP, however other enhancements could also be provided such as retrofitting HVAC fan and pump motor variable speed drives, local improvements to existing LTHW controls, upgrades to existing BEMS system and retro-fit of 50 kWp photovoltaic (PV) array. The basic core scheme (oil fired steam replacement to gas fired LTHW and lighting upgrade only) should deliver:

Circa 1,675 Tonnes CO2 annual savings\(^1\)
Circa £481,000 annual guaranteed savings\(^2\)
Require a total capital investment of circa £2.9 million
Deliver an NPV of circa £1.33 million over a 15 year scheme term.

\(^1\)Annual carbon savings estimated are based on first year operation. Subsequent years carbon savings over the life of the scheme will vary depending upon prevailing carbon intensity of National Grid displaced electricity and fuel used to generate savings from CHP or boilers.

\(^2\)Annual guaranteed energy savings are based upon initial base year energy costs.
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Introduction

The Oxford University Hospitals (OUH) NHS Trust is looking to utilise the Carbon and Energy Fund (CEF) to assist in energy asset improvement works at the John Radcliffe Hospital and Churchill Hospital sites.

Jacobs are acting as Technical advisors for the CEF and attended the John Radcliffe Hospital and Churchill Hospital sites on the 14th September 2012 to carry out an initial high level review on the potential for energy saving projects that could be considered as part of the fund.

This report summarises the technical feasibility studies undertaken to establish the potential viability of energy saving projects at John Radcliffe Hospital and Churchill Hospital sites that could offer savings under the Carbon and Energy Fund.

This report is based upon high level feasibility stage assessment of the existing Hospital primary fixed asset infrastructure and services undertaken during September 2012 and summarises the following for each site:

- Basis of existing heating energy and power demand
- CHP/new boiler Integration into Existing Heat Distribution
- Basis of the potential new boiler/CHP operational profile and plant size
- Consideration of other potential energy saving projects
- Basis of the Capital Expenditure costs

The details of plant size and capital costs are to be considered as preliminary as they are based upon pre-design stage estimates and are subject to development of feasibility into a working design solution by a specialist energy services company (ESCO), who would be responsible for technical and commercial viability.

The energy consumption analysis is based upon information provided by the Trust that details their existing energy use and utility costs. These are used to form the baseline for energy saving comparisons.
2 Basis of existing heating energy and power demand

2.1 John Radcliffe Hospital

2.1.1 Thermal Demand

The main hospital site is served by a central boiler house located within the 'Industrial Block' on the North East perimeter. This boiler house serves the majority of the hospital campus via a distributed High Pressure Hot Water (HPHW) heating mains connecting to 4 no. 5.86 MW gas fired boilers. The peak load is understood to be circa 8 MW. The existing boilers are approximately 40 years old and have reached the end of their economic life expectancy.

The HPHW distributes from the main boiler house to serve the main areas of the hospital via dedicated basement level service ducts and within service ducts adjacent to basement level service tug-ways. There have been problems with pipework joint leaks and due to limitations on isolation capability, remediation is often difficult to address without disrupting heat service availability.

Within the main hospital block plant rooms HPHW generally connects directly to Air Handling Unit (AHU) coils or to shell and tube calorifiers that deliver low temperature hot water for space heating and domestic hot water.

In addition to connecting to heat services the HPHW also connects to three absorption chillers ranging in age from approx. 15 years old to a very recently installed replacement machine. The oldest absorption chiller capacities are to be confirmed but based upon the installed capacity of the newest machine they are estimated to be circa 1 MW each. The chillers provide a central chilled water service to the main AHUs.

A separate steam service serves a limited process steam demand of approx. 185 kW. The steam is generated by two dedicated gas fired central steam boilers, rated at approximately 3.75 MW each, located adjacent to the main HPHW boilers within the 'Industrial Block' boiler house. It is understood these boilers are circa 12 years old. They were originally sized to be utilised for process steam demand and humidification within the AHUs and as a consequence oversized for their current limited utilisation.

Utilising the gas consumption data provided by the OUH NHS Trust, the estimated annual heat demand for the John Radcliffe Hospital has been established. The initial heat demand assessment utilises the half-hourly (HH) gas consumption data from the main boiler house meter using the 12 months from April 2011 to March 2012 as follows;
Month | Gas Consumption kWh
--- | ---
January | 4,170,433
February | 4,244,454
March | 3,542,133
April | 2,824,744
May | 2,618,159
June | 2,659,189
July | 2,579,092
August | 2,541,102
September | 2,992,470
October | 3,180,323
November | 3,347,477
December | 3,866,765
**TOTAL** | **38,766,341**

It should be noted that the feasibility will need to be refined through sensitivity testing this consumption to develop a set of data that takes into account longer term consumption trends, for example by normalisation with degree-days. It is also noted that the main boiler house meter also feeds the process steam raising boilers and further refinement in feasibility may make an allowance for this, however since the load steam load is very low in comparison the HPHW demand the initial feasibility ignores this effect. In consequence of the above the gas consumption is considered adequate for initial feasibility testing only and may not reflect the finalised consumption used in the CEF bidding stage.

To obtain an equivalent heat demand an assumed existing boiler efficiency of 70% has been utilised, giving a monthly heat demand as follows:

Month | Estimated Heat Demand from Existing Boilers kWh
--- | ---
January | 2,919,303
February | 2,971,118
March | 2,479,493
April | 1,977,321
May | 1,972,712
June | 1,861,432
July | 1,805,364
August | 1,770,772
September | 2,094,729
October | 2,226,226
November | 2,343,234
December | 2,706,735
**TOTAL** | **27,138,439**

It should be noted that this heat demand would be subject to further feasibility sensitivity testing as a consequence of the adjustments to gas consumption identified above.

Using the HH gas data and the assumed plant efficiencies a heat demand profile for the year has been modelled. The annual demand profile is shown in figure 2.1 and indicates a year round base heat demand of approximately 2 MW.
2.1.2 Power

The main intake sub-station at the 'Industrial Block' serves a HV ring connecting to a further 4 sub-stations located at the Academic, Maternity, FMRIB and main hospital block areas. The infrastructure generally dates from the original 1960s construction but has been extended and reinforced in more recent times.

A number of dispersed stand-by generator sets are located around the hospital site some of which are understood to be up to 40 years old. The total stand-by generation capacity is circa 5MVA for essential power circuits only. The existing arrangement does not provide an N+1 coverage to meet the requirements of HTM-06.

Utilising the electrical metered consumption data provided by the OUH NHS Trust, the estimated annual power demand for the John Radcliffe Hospital has been established. The initial power demand assessment utilises the half-hourly (HH) electrical consumption data from the main intake meter using the 12 months from April 2011 to March 2012 as follows;
<table>
<thead>
<tr>
<th>Month</th>
<th>Total Grid Electrical Energy Import kWh</th>
</tr>
</thead>
<tbody>
<tr>
<td>January</td>
<td>2,390,438</td>
</tr>
<tr>
<td>February</td>
<td>2,199,512</td>
</tr>
<tr>
<td>March</td>
<td>2,398,294</td>
</tr>
<tr>
<td>April</td>
<td>2,245,276</td>
</tr>
<tr>
<td>May</td>
<td>2,307,532</td>
</tr>
<tr>
<td>June</td>
<td>2,251,720</td>
</tr>
<tr>
<td>July</td>
<td>2,322,498</td>
</tr>
<tr>
<td>August</td>
<td>2,345,614</td>
</tr>
<tr>
<td>September</td>
<td>2,258,954</td>
</tr>
<tr>
<td>October</td>
<td>2,352,500</td>
</tr>
<tr>
<td>November</td>
<td>2,295,534</td>
</tr>
<tr>
<td>December</td>
<td>2,348,976</td>
</tr>
<tr>
<td><strong>TOTAL</strong></td>
<td><strong>27,716,848</strong></td>
</tr>
</tbody>
</table>

Using the HH electricity consumption data, a demand profile for the year has been modelled. The annual demand profile is shown in figure 2.2 and indicates a year-round base electrical demand of approximately 2.5 MW, with a peak demand of 4.6 MW.

Figure 2.2: John Radcliffe Hospital Annual Power Demand Profile
2.2 Churchill Hospital

2.2.1 Thermal Demand

The main hospital site is served by a central boiler house located to the North of the Clinic blocks that form part of the original hospital construction dating back to the 1940s. This boiler house serves the majority of the original hospital campus via a distributed steam mains connecting to 2 no. circa 3.4 MW dating to 1944 and 1 no. circa 2.0 MW oil fired boilers dating to 1968. The existing boilers have reached the end of their economic life expectancy.

The steam distributes from the main boiler house to serve outlying plant rooms generally within the original 1940/60s campus buildings via service ducts in the ground / ground floor corridors. There are obvious issues with maintaining reliable operation of infrastructure of this age. It is understood that the overall steam heating efficiency maybe no more than 50% at best. Repairs and remediation is often difficult to address without disrupting heat service availability. Over recent years there have been some elements of decentralisation particularly for new construction which has utilised local gas fired boiler plant. The Trust have previously been advised of a £100,000 budget to provide a new gas service connection of sufficient capacity to replace the existing oil fired steam boiler plant.

Within the main hospital block plant rooms steam generally connects directly to Air Handling Unit (AHU) coils or to shell and tube calorifiers that deliver low temperature hot water for space heating and domestic hot water. Steam is also used for autoclave units within the TSSU and Research Institute.

Utilising the gas consumption data provided by the OUH NHS Trust, the estimated annual heat demand for the Churchill Hospital has been established. The initial heat demand assessment utilises monthly heating oil consumption data from the main boiler house meter using the 12 months from April 2011 to March 2012 as follows;

<table>
<thead>
<tr>
<th>Month</th>
<th>Oil Consumption</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Litres</td>
</tr>
<tr>
<td>January</td>
<td>157,122</td>
</tr>
<tr>
<td>February</td>
<td>132,842</td>
</tr>
<tr>
<td>March</td>
<td>129,349</td>
</tr>
<tr>
<td>April</td>
<td>77,126</td>
</tr>
<tr>
<td>May</td>
<td>52,965</td>
</tr>
<tr>
<td>June</td>
<td>76,199</td>
</tr>
<tr>
<td>July</td>
<td>57,391</td>
</tr>
<tr>
<td>August</td>
<td>65,768</td>
</tr>
<tr>
<td>September</td>
<td>74,971</td>
</tr>
<tr>
<td>October</td>
<td>120,541</td>
</tr>
<tr>
<td>November</td>
<td>58,200</td>
</tr>
<tr>
<td>December</td>
<td>192,924</td>
</tr>
<tr>
<td>TOTAL</td>
<td>1,195,396</td>
</tr>
</tbody>
</table>

It should be noted that the feasibility will need to be refined through sensitivity testing this consumption to develop a set of data that takes into account longer term consumption trends, for example by normalisation with degree-days. In consequence of the above the oil consumption is considered adequate for initial feasibility testing only and may not reflect the finalised consumption used in the CEF bidding stage.
To obtain an equivalent heat demand an assumed existing boiler efficiency of 50% has been utilised, giving a monthly heat demand as follows:

<table>
<thead>
<tr>
<th>Month</th>
<th>Estimated Heat Demand from Existing Boilers kWh</th>
</tr>
</thead>
<tbody>
<tr>
<td>January</td>
<td>870,801</td>
</tr>
<tr>
<td>February</td>
<td>736,238</td>
</tr>
<tr>
<td>March</td>
<td>716,879</td>
</tr>
<tr>
<td>April</td>
<td>427,445.</td>
</tr>
<tr>
<td>May</td>
<td>293,541</td>
</tr>
<tr>
<td>June</td>
<td>422,311</td>
</tr>
<tr>
<td>July</td>
<td>318,072</td>
</tr>
<tr>
<td>August</td>
<td>209,862</td>
</tr>
<tr>
<td>September</td>
<td>216,751</td>
</tr>
<tr>
<td>October</td>
<td>570,708</td>
</tr>
<tr>
<td>November</td>
<td>724,352</td>
</tr>
<tr>
<td>December</td>
<td>1,069,225</td>
</tr>
<tr>
<td>TOTAL</td>
<td>6,576,187</td>
</tr>
</tbody>
</table>

It should be noted that this heat demand would be subject to further feasibility sensitivity testing as a consequence of the adjustments to oil consumption identified above.

There is no HH oil consumption data available. So to model a usage profile that represents the heat use related to the total monthly oil consumption records a HH heat profile available for the original Roosevelt Drive site has been used. To help in substantiating making this assumption a check was first carried out to compare the relationship between consumption and heating degree days to ensure there was a fairly accurate relationship with gas use.

The HH heat profile was then factored against the oil boiler assumed efficiency to model an assumed heat demand profile for the year. The annual demand profile is shown in figure 2.3 and indicates a year round base heat demand of approximately 250 kW.
2.2.2 Power

The main intake sub-station serves a HV ring connecting to a further 8 sub-stations located at the Central, Residential, Vaccine, Haemophilia, Haemodialysis, OCDEM, Oncology and Clifford's Corner areas. The infrastructure generally dates from the original 1960s construction but has been extended and reinforced in more recent times.

Utilising the electrical metered consumption data provided by the OUH NHS Trust, the estimated annual power demand for the Churchill Hospital has been established. The initial power demand assessment utilises the half-hourly (HH) electrical consumption data from the main intake meter using the 12 months from April 2011 to March 2012 as follows;

<table>
<thead>
<tr>
<th>Month</th>
<th>Total Grid Electrical Energy Import kWh</th>
</tr>
</thead>
<tbody>
<tr>
<td>January</td>
<td>952,660</td>
</tr>
<tr>
<td>February</td>
<td>868,658</td>
</tr>
<tr>
<td>March</td>
<td>914,416</td>
</tr>
<tr>
<td>April</td>
<td>854,460</td>
</tr>
<tr>
<td>May</td>
<td>856,122</td>
</tr>
<tr>
<td>June</td>
<td>823,124</td>
</tr>
<tr>
<td>July</td>
<td>845,904</td>
</tr>
<tr>
<td>August</td>
<td>845,594</td>
</tr>
<tr>
<td>September</td>
<td>826,672</td>
</tr>
<tr>
<td>October</td>
<td>888,136</td>
</tr>
<tr>
<td>November</td>
<td>895,562</td>
</tr>
<tr>
<td>December</td>
<td>931,614</td>
</tr>
<tr>
<td>TOTAL</td>
<td>10,502,922</td>
</tr>
</tbody>
</table>

Using the HH electricity consumption data a demand profile for the year has been modelled. The annual demand profile is shown in figure 2.4 and indicates a year round base electrical demand of approximately 0.8 MW, with a peak demand of 1.9 MW.
Figure 2.4: Churchill Hospital Annual Power Demand Profile
3

Existing Utility Energy Costs

3.1 General

The OUH NHS Trust has provided advice on existing gas, oil and electricity prices. The current prices have been utilised in the initial feasibility study and it is understood that these are in effect fixed until 31st March 2013, although transportation costs may vary as when agreed by the network operators.

VAT is excluded from the financial model.

Climate Change Levy (CCL) has been applied to fuels in energy model as follows:
Gas 0.177 p/kWh
Electricity 0.509 p/kWh
Oil 0.081 p/kWh (1.137 p/kg)

3.2 John Radcliffe Hospital

Electricity:
Day Electricity rate = 6.375 p per kWh, excluding CCL
Night Electricity rate = 5.3501 per kWh, excluding CCL
DUOS, TUOS and other standing charges equate to 2.154p per kWh

Gas:
Gas Rate = 2.3366 p per kWh, excluding CCL
Standing Charge of £142.72p per day, this equates to about 0.1640p per kWh

3.3 Churchill Hospital

Electricity:
Day Electricity rate = 6.385 p per kWh
Night Electricity rate = 5.3547 per kWh
DUOS, TUOS and other standing charges, equate to 1.6892p per kWh

Medium Oil:
Weekly price variation is dependent upon the wholesale price of oil. Over recent deliveries prices per litre have been:
£0.5822, £0.6044, £0.6008, £0.6018, £0.5824, £0.5488, £0.5233
Average of above: £0.5748 / litre
Potential core energy reduction projects

4.1  John Radcliffe Hospital

4.1.1  Core Energy Project

The potential for utilising combined heat and power (CHP) has been assessed for
the John Radcliffe Hospital on the basis of:

- The presence of good levels of heat demand all year round
- The need to replace existing life expired central boiler plant
- The existing utilisation of heat for generating chilled water using existing
  absorption chillers

A high-level feasibility model for CHP indicates a potential scheme based upon the
following:-

- A 2.0 MWe natural gas fuelled spark ignition reciprocating engine located
  within the existing boiler house in the space currently occupied by the
  existing process steam generation plant would be installed.

- Separate stand-alone localised steam generators would be installed to
  replace the existing central steam boilers that are currently significantly
  oversized for the level of load served. This would remove the maintenance
  costs associated with existing steam distribution and improve process steam
  utilisation efficiency.

- An alternative option could be considered that looked at retaining one of the
  existing steam boilers and converting it to utilise waste heat recovery from
  the new CHP high temperature exhaust. This would avoid installation of new
  localised process steam generators, but retains the existing steam
  distribution.

- The existing life expired gas fired HPHW boilers would be replaced with new
  high efficiency gas fired boilers (dual fuel option if required).

- Approximately 70% of the existing HPHW pipework distribution capacity
  would be retained and operated at MPHW (circa 120°C). This would enable
  optimum compatibility with the CHP high temperature exhaust heat recovery
  and retain compatibility with existing absorption chiller heat input
  temperatures.

- An alternative option could be considered that looked at providing an engine
  optimised to deliver MTHW only. This is likely to involve a de-rated electrical
  output engine selection. This arrangement has been provided on other
  projects and would negate the requirement to run separate LTHW circuits,
  although the overall energy efficiency of the scheme would reduce.

- Works may also encompass remedial repairs / replacement of sections of
  existing HPHW pipework if necessary. The extent of works required would
  be subject to a detailed pipework condition survey.
- A new LTHW distribution circuit would be installed to utilise recovered heat from the CHP engine jacket to connect into local space heating and domestic hot water (DHW) calorifiers. Existing plant room shell and tube heat exchangers would be replaced with new plate heat exchangers where required.

- New pipework would be routed via the existing basement level service tugways at high level.

- The new CHP and boilers would utilise the existing retained / refurbished boiler house flue stacks.

- The power generated by the new CHP would be at LV and a new step-up transformer would be provided to enable connection to the site HV ring via a new HV switch installed within the existing HV main intake substation adjacent to the existing boiler house within the 'Industrial Block'.

- DUOS (direct use of system) and TUOS (transmission use of system) savings are anticipated, due to the reduction in overall site electrical demand from the National Grid connection that should occur whilst the CHP is operating electricity. According to the OUH Trust Energy Manager advice these costs are currently significant equating to the equivalent to 2.154p/kWh, however this includes other standing charges. Savings modelled for initial scheme feasibility therefore take an initial conservative view on likely annual DUOS and TUOS savings achieved in practice. More detailed modelling is likely to show potential for increased savings.

- Replacement of existing T8 and T12 fluorescent lighting within ward, circulation administration and academic blocks with new T5 fluorescent tubes and / or LED replacements where possible. This might also be enhanced with PIR and daylight controls in certain areas. An approximate lighting retrofit change-out of 2,500 fittings across the hospital has been estimated initially. The exact number would require a detailed lighting survey to estimate.

The viability of this core scheme is summarised in table 3.1 below. The capital cost estimates and NPV calculations are detailed within the appendix of this report.
<table>
<thead>
<tr>
<th>Additional scheme items</th>
<th>Core scheme savings</th>
<th>Standard CHP performance</th>
<th>Performance, plant under the regulated energy limit</th>
</tr>
</thead>
<tbody>
<tr>
<td>Investment - capital costs</td>
<td>£ 2,888,556</td>
<td>£</td>
<td>£</td>
</tr>
<tr>
<td>Site works &amp; lighting present</td>
<td>£ 101,449</td>
<td>£</td>
<td>£</td>
</tr>
<tr>
<td>Site works &amp; lighting present</td>
<td>£ 204,775</td>
<td>Incl</td>
<td>Incl</td>
</tr>
<tr>
<td>Site works &amp; lighting present</td>
<td>£</td>
<td>£ 589,829</td>
<td>£ 566,169</td>
</tr>
<tr>
<td>Site works &amp; lighting present</td>
<td>£</td>
<td>£ 14,376</td>
<td></td>
</tr>
<tr>
<td>Site works &amp; lighting present</td>
<td>£ 546,809</td>
<td>£ 701,165</td>
<td>£ 701,165</td>
</tr>
<tr>
<td>Site works &amp; lighting present</td>
<td>£ 599,193</td>
<td>£ 1,117,241</td>
<td>£ 1,829,259</td>
</tr>
</tbody>
</table>

Table 3.1: Core Scheme Savings (2.0 MWe gas CHP + lighting retrofit)

4.1.2 Additional core project items

Further enhancements to the core scheme could include the following:

- Provision of a biomass boiler to form part of the replacement gas fired boiler capacity identified within the core scheme. A circa 1 MW biomass boiler could operate on pellets or chips and be supplied as a containerised unit adjacent to the main boiler house complete with fuel hopper to avoid significant civil engineering and building works. Alternatively a rebuild of the boiler house may enable an acceptable bespoke solution to be developed, although the disruption to maintaining the existing energy service may not be manageable and the additional building cost would impact on the overall net present value of the project. Typical packaged containerised biomass boiler of circa 1.0 MW requires 50 – 100m² footprint (depending on use of pellet or chip fuel and size of fuel storage).

- Replacement of fixed speed fan and pump motors with VSD controls.

- Additional control to localised LTHW space heating. This would also help in promoting lower LTHW return water temperatures back to the new low temperature heat recovery circuit proposed for the core CHP project.

- Replacement and/or upgrade to existing building energy management system.
• Potential PV retrofit to existing roof space.

The viability of this enhanced core scheme is summarised in Table 3.2 below. The capital cost estimates and NPV calculations are detailed within the appendix of this report.

| Table 3.2: Enhanced core scheme including biomass boilers, VSDs, LTHW zone control, BEMS upgrade and 50 kWp PV. |
| --- | --- | --- | --- |
| | Total capital cost (excl. VAT) | Total capital cost (incl. VAT) | NPV (tax free) |
| Biomass boiler upgrade | £ 4,274,456 | | £  |
| Endurance & reliability testing | £ 149,605 | £ | £ |
| Commissioning & pre-commissioning | £ 208,722 | incl | incl |
| Plant commissioning & pre-commissioning | £ | £ 771,518 | £ 740,865 |
| Commissioning & pre-commissioning | £ | £ 21,200 | |
| Annualised capital cost-savings | £ 699,135 | £ 896,327 | £ 896,327 |
| Capex over annualised savings | £ 649,763 | £ 1,185,645 | £ 2,110,553 |

4.1.3 Non energy savings

The core energy saving schemes could be further enhanced to include non-energy or operational savings. Some of these (not modelled) are outlined as follows:

• Transfer of all boiler house operation to the Contractor.

• New additional stand-by generation capacity connected to Short Term operating Reserve (STOR) scheme. Additional $2 \times 2.5$MVA new generation sets assumed to provide a total $N+1$ capacity including existing generators of 10$MVA$. New generators would be HV to enable utilisation around the HV ring. Since the existing generators are localised LV, then a operational protocol would be needed to avoid simultaneous operation with existing LV generation.
Figure 3.1: John Radcliffe Hospital Potential Core Scheme (Primary Plant Only)
4.2 Churchill Hospital

4.2.1 Core Energy Project

The focus for core energy improvement works at Churchill Hospital is based upon replacing life expired central oil fired boilers and moving away from the existing oil fired steam distribution system.

This would necessitate partial decentralisation of the existing heating service. This was recommended in a previous report commissioned by the Trust and the general philosophy is considered to remain the appropriate course of action.

The primary energy savings would come from the significant improvement in both combustion and distribution efficiency from removal of very old boiler plant and steam reticulation in favour with modern high efficiency gas boilers as well as the lower price paid for mains natural gas compared to delivered oil prices.

Carbon emission savings would result from the replacement of old life expired inefficient boiler plant with new high efficiency equipment and controls. Further carbon savings resulting from the utilisation of natural gas rather than fuel oil will also be achieved.

Key features of the Churchill Hospital core scheme would probably include (but not be limited to) the following:-

- Generally all existing the out-lying plant rooms would be disconnected from the steam service and provided with new packaged gas fired LTHW boilers. The viability for this would need to be looked at in more detail and it is likely to be subject to ability to locate plant and route new gas adjacent to utilisation. The requirement for dual fuel operation in outlying plant rooms would need to be agreed with the Trust. The potential for pumping oil from the Trusts existing storage is unlikely to be viable and so new localised storage would need to be considered.

- Existing steam calorifiers/heat exchangers within outlying plant rooms would be replaced with LTHW plate heat exchangers or direct connections to new LTHW boilers.

- Where steam is still required for process use, then localised packaged gas-fired steam generators would be provided in local plant areas or areas close to point of use if possible. The viability for this would need to be looked at in more detail and it is likely to be subject to ability to locate plant and route new gas adjacent to utilisation.

- A new 90 mm dia PE gas service including utility and meter from would be provided connecting to the existing 125mm MP PE main within Churchill Drive. The service would be extended from the main meter to serve new LTHW boilers proposed within the existing calorifier room and the new localised LTHW packaged boilers and packaged process steam generators within the outlying plant rooms as described below:-

**Works within existing central calorifier plant room:**

- Remove old redundant generator sets within existing calorifier plant room to free-up space for installation of new high efficiency gas fired LTHW boilers and flues. This will enable disconnection of existing steam to LTHW heat...
exchangers within the main calorifier plant room and serve LTHW directly from new LTHW boiler installation.

- Install new LTHW plate heat exchangers and storage buffer vessel to enable removal of old storage calorifiers serving DHWS system.

- Install new boiler controls and energy management system, ideally incorporating new outstations serving the existing blocks fed with LTHW.

Works within the existing steam boiler plant room:
- Following installation of new LTHW boilers within central calorifier plant room and remote steam plant rooms, disconnect existing central oil fired steam boilers and decommission existing steam service.

Works to external infrastructure;
- Provide a new incoming gas service from Churchill Drive to connect to the new boiler plant facilities within the central calorifier plant room and within the remote outlying steam plant rooms identified below.

Works to remote steam plant rooms;
- Install new high efficiency gas fired LTHW boilers and flues within existing Renal plant room (serving Blocks 80, 79 and 89). Disconnect and remove existing steam to LTHW calorifiers. Existing recently replaced direct gas fired DHW calorifiers are likely to be retained, new boiler energy management localised outstation should also be installed.

- It is likely that fan assisted flues will be required for the new boilers installed in the Renal plant room.

- Replace existing steam autoclaves within existing TSSU (Block 67) plant room with either new packaged gas fired or all-electric autoclave units. It may be possible to remove existing redundant theatre AHUs within the plant room to provide additional space for replacement gas or electric steam raising plant, alternatively plant could potentially be externally located.

- Install new high efficiency gas fired LTHW boilers and flues within existing Oncology plant room (Block 90). Disconnect and remove existing steam to LTHW calorifiers. It is likely new flues could be installed to rise externally on the outside of the building (subject to Planning Approval) or fan assisted flues utilised. A new boiler energy management localised outstation should also be installed.

- Install new LTHW plate heat exchangers and storage buffer vessel within the Oncology plant room to enable removal of old storage calorifiers serving DHWS system.

- Install new high efficiency gas fired LTHW boilers and flues within existing Dermatology plant room (serves Blocks 93 and 104). Disconnect and remove existing steam to LTHW calorifiers. It is likely new flues could be installed to rise externally on the outside of the building (subject to Planning Approval) or fan assisted flues utilised. A new boiler energy management localised outstation should also be installed.
• Install new LTHW plate heat exchangers and storage buffer vessel within the Dermatology plant room to enable removal of old storage calorifiers serving DHWS system.

• Install new high efficiency gas fired LTHW boilers and flues within existing Haemophilia Centre roof plant room (Block 31). Disconnect and remove existing steam to LTHW calorifiers. It is likely new flues could be installed to rise externally on the outside of the building (subject to Planning Approval) or fan assisted flues utilised. A new boiler energy management localised outstation should also be installed.

• Install new LTHW plate heat exchangers and storage buffer vessel within the Haemophilia plant room to enable removal of old storage calorifiers serving DHWS system.

The above summary is not considered as a fully inclusive of all works necessary to de-steam the Churchill House. Detailed surveys will be required to establish the full decentralisation of the site and other viable solutions may also be considered by the Trust to achieve the same objectives.

In addition to the removal of steam from the Churchill site, it is considered that a core CEF project may also include a lighting upgrade program;

• Replacement of existing T8 and T12 fluorescent lighting within ward, circulation administration areas with new T5 fluorescent tubes and / or LED replacements where possible. This might also be enhanced with PIR and daylight controls in certain areas. An approximate lighting retrofit change-out of 800 fittings across the hospital has been estimated initially. The exact number would require a detailed lighting survey to estimate.

The viability of this core scheme is summarised in Table 3.3 below. The capital cost estimates and NPV calculations are detailed within the appendix of this report.
<table>
<thead>
<tr>
<th>Proposed Option</th>
<th>Trust Option</th>
<th>Standard Option</th>
<th>Replacement Option</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>£ 2,878,963</td>
<td>£</td>
<td>£</td>
</tr>
<tr>
<td></td>
<td>£ 100,694</td>
<td>£</td>
<td>£</td>
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<tr>
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<td>£ 24,342</td>
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<td>Incl</td>
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<td></td>
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<td>£ 480,934</td>
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<td>£ 1,331,576</td>
<td>£ 1,318,787</td>
<td>£ 1,318,787</td>
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</tbody>
</table>

Table 3.3: Core Scheme Savings (Replacement of Oil fired Steam boilers and decentralisation to LTHW)
Conclusions

The initial study shows there is a potential for viability for significant energy improvement works to be undertaken at both the John Radcliffe and Churchill Hospitals.

John Radcliffe

The core project energy savings would come from investment in CHP. There is a good level of year round base heat demand that could be delivered from a CHP of circa 2.0 MWe capacity with potential provide the Trust with significant energy cost savings as well as significant carbon savings.

The annual carbon savings could be further enhanced through incorporation of packaged biomass boilers. Those have been considered since the existing conventional boiler plant is essentially life expired and requires replacement. There is a base heat demand that appears to be large enough to accommodate efficient and viable operation of both CHP and biomass boiler operation. New replacement boilers would also encompass dual fuel gas/oil fired plant. Biomass provides the Trust with additional flexibility and resilience in heating fuel utilisation.

Additional renewable energy generation may also be generated through retrofitting PV to existing roof areas. Further detailed studies on the practicality of doing this, together with potential planning impact would need to be carried out.

Further energy savings could be delivered through other energy savings associated with lighting upgrades, pump and fan motor drive variable speed operation, heating control optimisation and replacement of the existing BEMS. These improvements are estimated to improve on energy saving and overall NPV.

Non-energy savings have been identified and include the potential for boiler house operation to be handed over to the ESCo company. The financial impact for this is currently excluded from the initial feasibility. More detailed costs would be required to model this accurately, however it is envisaged that the annual net savings for the Trust would increase further along with resulting NPV.

It is possible that other investments in energy infrastructure, such as the provision of new stand-by generation could also be accommodated with the core carbon and energy fund scheme. The potential to provide additional increased stand-by generator capacity of circa 5MVA together with associated controls has been reviewed. Although not currently modelled there would be significant increases in capital investment for the scheme which would reduce the core schemes overall NPV. This may be off-set slightly by potential revenue from STOR, however since the additional stand-by plant would not generate income from energy savings, the revenue from STOR alone will not usually be significant enough to fund the additional significant investment required in its own right.

Churchill

The core project is based upon replacement of life expired centralised boiler plant serving steam and LTHW infrastructure. The existing base heat loads do not appear to be significant enough to support CHP. The primary energy savings therefore come from firstly the improvement delivered from new replacement combustion plant efficiency and decentralisation of outlying buildings from the existing central
steam service and secondly from the reduction in heating cost due to the lower cost of gas compared to oil. These energy savings should also deliver significant carbon savings.

Centralised steam could be removed if outlying heating plant is provided with new localised packaged gas fired plant and localised process steam where needed. Core areas currently served by the existing steam would be converted to LTHW distribution.

It might be possible to utilise ‘micro’ CHP in replacement boiler configurations, however the viability for doing so may be limited as there is already a significant investment that will be required in new plant and infrastructure tending to weaken the potential levels of NPV possible at this site.

To deliver the switch from existing oil to gas requires a new gas utility infrastructure service to the site. The OUH NHS Trust has had quotations for this work in the recent past that identify capital contributions of circa £100,000. These have been used within the initial feasibility business case, in addition estimates of the further post meter gas installation works which would be needed to connect outlying plant rooms.

The potential for utilisation of biomass as part of the boiler replacement works could also be considered in the same way as has been considered for John Radcliffe. However, the lower base heating demand of the Churchill site means that biomass plant would be at a much smaller scale. Since the primary objective for considering biomass is based around carbon rather than energy saving, the overall net benefits to the Churchill site are less, given the lower levels of biomass heat production and increase in capital cost. Hence biomass is currently excluded from the initial Churchill core scheme. However, if biomass is deployed at John Radcliffe, then it might make sense to deliver an additional small scheme at Churchill as there may be economies from a combined fuel and maintenance contract at both sites.

Non-energy savings may also include the potential for boiler house operation to be handed over to the ESCo company as identified for the John Radcliffe site. The financial impact for this is currently excluded from the initial feasibility. More detailed costs would be required to model this accurately, however it is envisaged that the annual net savings for the Trust would increase further along with resulting NPV.
Appendix A - Project Cost Estimates and Pay-backs

A high level assessment has been made on the likely capital expenditure costs for the potential projects.

These are preliminary estimates; and strictly a first-pass indicator of the order of costs that might be involved. Accordingly, for a preliminary level estimate, the expected accuracy range in the costs is set at -25% to +35% (Class 3/4 Feasibility / Early Budget stage as noted below).

Jacobs classifies Total Installed Cost estimates based on the amount and quality of information available at the time the estimate is developed. The following table shows the classification used.

<table>
<thead>
<tr>
<th>Estimation Class</th>
<th>Primary Characteristics</th>
<th>Secondary Characteristics</th>
</tr>
</thead>
<tbody>
<tr>
<td>Class 6 (Order of Magnitude)</td>
<td>Estimate only</td>
<td>Typical purpose of estimate</td>
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<tr>
<td></td>
<td>Concept Screening</td>
<td>Conceptual or Pre-Feasibility</td>
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<tr>
<td></td>
<td>Cost Estimate</td>
<td>Typical variation in low and high ranges (a)</td>
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<tr>
<td></td>
<td></td>
<td>AACE Expected Accuracy Range</td>
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<tr>
<td></td>
<td></td>
<td>Jacobs Expected Accuracy Range</td>
</tr>
<tr>
<td>Class 4 (Preliminary)</td>
<td>Study or Feasibility</td>
<td>Equipment Definition of Estimate Models</td>
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<tr>
<td></td>
<td></td>
<td>L: -10% to -30%</td>
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<td></td>
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<td>H: +20% to +50%</td>
</tr>
<tr>
<td>Class 3 (Early Budget)</td>
<td>Budget, Authorization, or Control</td>
<td>Equipment and Cost Estimate Models</td>
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<tr>
<td></td>
<td></td>
<td>L: -10% to -20%</td>
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<tr>
<td></td>
<td></td>
<td>H: +10% to +30%</td>
</tr>
<tr>
<td>Class 2 (Budget/Control)</td>
<td>Control or Bid/Tender</td>
<td>Detailed Cost Estimate Models</td>
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<tr>
<td></td>
<td></td>
<td>L: -5% to -15%</td>
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<td>Class 1 (Definitive/Construction)</td>
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<td>Final Detailed Estimate Models</td>
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<td>L: -5% to -10%</td>
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<tr>
<td></td>
<td></td>
<td>H: +3% to +10%</td>
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</table>

Notes:

The state of process technology and availability of applicable reference cost data affect the range markedly. The +/- value represents typical percentage variation of actual costs from the cost estimate after application of A/E (typically at a 50% probability of under/overrun) for given scope.
We have developed the estimates on the basis of knowledge gained from published CHP facility cost benchmarking database.

We have supplemented our estimates from these sources with discussions with specialist suppliers who have experience of these types of facilities, plant or equipment. We have made estimates of the split in capital expenditure between plant and builders' work costs.
## John Radcliffe Core Scheme:

### Overall Capex versus Op-ex Savings and Payback

<table>
<thead>
<tr>
<th>Trusts</th>
<th>Oxford University Hospitals</th>
<th>The John Radcliffe</th>
<th>Net annual saving</th>
<th>Simple payback</th>
</tr>
</thead>
<tbody>
<tr>
<td>Period</td>
<td>UK</td>
<td>Years</td>
<td>Net annual saving</td>
<td>Simple payback</td>
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<td>Capex</td>
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<td>2012-2013</td>
<td>£1,235,000</td>
<td>£25,643,000</td>
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<tr>
<td>Opex</td>
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<td>2012-2013</td>
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<tr>
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<td>2013-2014</td>
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<tr>
<td>Opex</td>
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### Scheme Component

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<th>Cost Saving</th>
<th>Annual Cost</th>
<th>Net Annual Savings</th>
<th>Other</th>
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<th>Simple Payback</th>
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<tr>
<td>Opex</td>
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### Adjustments for Different Options

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<th>Simple Payback</th>
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<td>Financial Year</td>
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<td>Projected Cashflow</td>
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<tr>
<td>Projected Cashflow</td>
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<td>Projected Cashflow</td>
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<td>Projected Cashflow</td>
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### Notes

- CEF: OUGH NHS Trust
- OUGH: OUGH NHS Trust
John Radcliffe Enhanced Core Scheme:

**Overall Capex- verses Op-ex Savings and Payback**

<table>
<thead>
<tr>
<th>Scheme Component</th>
<th>Cost (000's)</th>
<th>Oxford University Hospitals - enhanced scheme</th>
<th>Stage Facility</th>
<th>Shire John Radcliffe</th>
<th>Total annual saving (000's)</th>
<th>Gross payback</th>
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<td><strong>GEP</strong></td>
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<td>429</td>
<td>714</td>
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| Adjustments for different options                    |              |                                              |                |                     |                             |                 |
| Safety Management                                      | 8,052        |                                              |                |                     |                             |                 |
| Maintenance Management                                  | 8,052        |                                              |                |                     |                             |                 |
| Environment                                            | 8,052        |                                              |                |                     |                             |                 |
| Health and Safety                                      | 8,052        |                                              |                |                     |                             |                 |
| **Net Savings** with adjustments**                     | 189,192      |                                              |                |                     |                             |                 |

CEF OUH NHS Trust
Churchill Hospital Core Scheme (including enhancements):

Overall Capex-versus Op-ex Savings and Payback

<table>
<thead>
<tr>
<th>Period</th>
<th>Oxford University Hospitals - enhanced scheme</th>
<th>Stage 2: Selly Oak</th>
<th>Net annual saving</th>
<th>Simple payback</th>
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<tbody>
<tr>
<td>Year 1</td>
<td>$10,000</td>
<td>$8,000</td>
<td>$2,000</td>
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<tr>
<td>Year 2</td>
<td>$12,000</td>
<td>$9,000</td>
<td>$3,000</td>
<td>3.0</td>
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<tr>
<td>Year 3</td>
<td>$14,000</td>
<td>$10,000</td>
<td>$4,000</td>
<td>4.0</td>
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<tr>
<td>Year 4</td>
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<td>4.0</td>
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<tr>
<td>Year 5</td>
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<td>Total</td>
<td>$64,000</td>
<td>$40,000</td>
<td>$24,000</td>
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Adjustments for different options

- Non-Capex savings
- Energy savings
- Capital cost savings
- Revenue savings
- Operating cost savings

CEF | CUH NHS Trust
**CAPITAL COST BREAKDOWNS:**

**John Radcliffe Core Scheme:**

<table>
<thead>
<tr>
<th>Description</th>
<th>£</th>
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</thead>
<tbody>
<tr>
<td>1x 2.0 MW&lt;sub&gt;e&lt;/sub&gt; CHP UNIT</td>
<td>250,000</td>
</tr>
<tr>
<td>EXHAUST GAS MTHW HEAT RECOVERY</td>
<td>80,000</td>
</tr>
<tr>
<td>CHP FLUE CONNECTION TO WHB</td>
<td>50,000</td>
</tr>
<tr>
<td>NEW FLUE CONNECTION FROM WHB TO EXISTING FLUE EXIT</td>
<td>50,000</td>
</tr>
<tr>
<td>DRY COOLER</td>
<td>25,000</td>
</tr>
<tr>
<td>DRY COOLER PUMP AND PIPEWORK</td>
<td>25,000</td>
</tr>
<tr>
<td>BUILDERSWORK</td>
<td>50,000</td>
</tr>
<tr>
<td>CONTROLS AND LOCAL METERS</td>
<td>25,000</td>
</tr>
<tr>
<td>NEW MTHW BOILERS 4MW each (4off)</td>
<td>320,000</td>
</tr>
<tr>
<td>EXTEND MTHW (HT) PIPEWORK</td>
<td>100,000</td>
</tr>
<tr>
<td>REPAIR TO MTHW PIPEWORK</td>
<td>200,000</td>
</tr>
<tr>
<td>ALTERATION TO EXISTING HPHW AHU COILS</td>
<td>150,000</td>
</tr>
<tr>
<td>NEW LTHW F&amp;R PIPEWORK</td>
<td>200,000</td>
</tr>
<tr>
<td>PIPEWORK INSULATION</td>
<td>100,000</td>
</tr>
<tr>
<td>LTHW PLATE HEAT EXCHANGER &amp; VALVES</td>
<td>80,000</td>
</tr>
<tr>
<td>BMS CONTROLS</td>
<td>50,000</td>
</tr>
<tr>
<td>BUILDERSWORK, BASES, OPENINGS ETC</td>
<td>50,000</td>
</tr>
<tr>
<td>HEAT METERS</td>
<td>10,000</td>
</tr>
<tr>
<td>WATER TREATMENT, FLUSHING AND CLEANING</td>
<td>25,000</td>
</tr>
<tr>
<td>COMMISSIONING AND BALANCING</td>
<td>30,000</td>
</tr>
<tr>
<td>REMOVAL OF EXISTING REDUNDANT STEAM BOILER</td>
<td>10,000</td>
</tr>
<tr>
<td>REPLACEMENT STEAM GENERATORS LOCAL TO POINT OF USE</td>
<td>75,000</td>
</tr>
<tr>
<td>TRANSFORMER incl. BREAKERS (HV), CABLELING, PANELS</td>
<td>200,000</td>
</tr>
<tr>
<td>HV CABLE FROM NEW TRANSFORMER TO QEQM INTAKE</td>
<td>60,000</td>
</tr>
<tr>
<td>LV 300MM&lt;sup&gt;2&lt;/sup&gt; 3 CORE LSF CABLE FROM CHP TO NEW TRANSFORMER</td>
<td>45,000</td>
</tr>
<tr>
<td>Description</td>
<td>Cost</td>
</tr>
<tr>
<td>-------------------------------------------------------</td>
<td>-------</td>
</tr>
<tr>
<td>CABLE TERMINATIONS</td>
<td>10,000</td>
</tr>
<tr>
<td>CABLE JOINTS</td>
<td>8,000</td>
</tr>
<tr>
<td>MODS TO EXISTING SWITCHGEAR CONNECTIONS AND METER</td>
<td>50,000</td>
</tr>
<tr>
<td>(EXCLD G69)</td>
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<tr>
<td>CABLE ROUTING DUCTS AND BUILDERSWORK</td>
<td>37,500</td>
</tr>
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**John Radcliffe Enhanced Core Scheme:**
*As above plus the following:*

<table>
<thead>
<tr>
<th>Description</th>
<th>Cost</th>
</tr>
</thead>
<tbody>
<tr>
<td>NEW 1 MW BIOMASS BOILER IN PACKAGED CONFIGURATION</td>
<td>£200,000</td>
</tr>
<tr>
<td>PLANT ENCLOSURE</td>
<td>£30,000</td>
</tr>
<tr>
<td>FUEL HOPPER (PART OF PACKAGE)</td>
<td>£75,000</td>
</tr>
<tr>
<td>FLUE</td>
<td>£50,000</td>
</tr>
<tr>
<td>BUILDERSWORK PLINTH AND DELIVERY FUEL AREA</td>
<td>£75,000</td>
</tr>
<tr>
<td>PIPE CONNECTION LINKAGES</td>
<td>£40,000</td>
</tr>
<tr>
<td>COMMISSIONING / TESTING</td>
<td>£25,000</td>
</tr>
</tbody>
</table>
Churchill Hospital Core Scheme (including enhancements): £

CENTRAL CALORIFIER PLANT ROOM:

Remove old redundant generator sets within existing central calorifier plant room 20,000

Installation of new high efficiency gas fired LTHW boilers and flues in central calorifier plant room 350,000

Disconnection of existing steam to LTHW heat exchangers within the main calorifier plant room 20,000

Install new LTHW plate heat exchangers and storage buffer vessel to enable removal of old storage calorifiers serving DHWS system. 75,000

Install new boiler controls and energy management system 100,000

Incorporate new outstations serving the existing blocks fed with LTHW 50,000

WORKS WITHIN EXISTING STEAM BOILER PLANT ROOM:

Disconnect existing central oil fired steam boilers and decommission existing steam service. 85,000

WORKS TO EXTERNAL INFRASTRUCTURE:

Provide a new incoming gas service from Churchill Drive to connect to the new boiler plant facilities within the central calorifier plant room and within the remote outlying steam plant rooms 300,000

WORKS TO REMOTE STEAM PLANT ROOMS:

Install new high efficiency gas fired LTHW boilers and flues within existing Renal plant room (serving Blocks 80, 79 and 89). 120,000

Disconnect and remove existing steam to LTHW calorifiers 5,000

New boiler energy management localised outstation 20,000

Replace existing steam autoclaves within existing TSSU (Block 67) plant room with either new packaged gas fired units 125,000
<table>
<thead>
<tr>
<th>Description</th>
<th>Cost</th>
</tr>
</thead>
<tbody>
<tr>
<td>Install new high efficiency gas fired LTHW boilers and flues within existing Oncology plant room (Block 90).</td>
<td>120,000</td>
</tr>
<tr>
<td>Install new LTHW plate heat exchangers and storage buffer vessel within the Oncology plant room for DHW</td>
<td>30,000</td>
</tr>
<tr>
<td>Disconnect and remove existing steam to LTHW calorifiers</td>
<td>5,000</td>
</tr>
<tr>
<td>New boiler energy management localised outstation</td>
<td>120,000</td>
</tr>
<tr>
<td>Install new high efficiency gas fired LTHW boilers and flues within existing Dermatology plant room (serves Blocks 93 and 104)</td>
<td>120,000</td>
</tr>
<tr>
<td>Install new LTHW plate heat exchangers and storage buffer vessel within the Oncology plant room for DHW</td>
<td>30,000</td>
</tr>
<tr>
<td>Disconnect and remove existing steam to LTHW calorifiers</td>
<td>5,000</td>
</tr>
<tr>
<td>New boiler energy management localised outstation</td>
<td>20,000</td>
</tr>
<tr>
<td>Install new high efficiency gas fired LTHW boilers and flues within existing Haemophilia Centre roof plant room (Block 31)</td>
<td>120,000</td>
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<td>Install new LTHW plate heat exchangers and storage buffer vessel within the Oncology plant room for DHW</td>
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<td>Disconnect and remove existing steam to LTHW calorifiers</td>
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<td>New boiler energy management localised outstation</td>
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NPV: Net Present Value
John Radcliffe Enhanced Core Scheme:

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NPV: $5,000,000

Performance Contract:

Carbon and Energy Fund:

CEF: OUIH NHS Trust
### Churchill Hospital Core Scheme (including enhancements):

#### Net Present Value Calculation

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#### Performance Contract

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#### Carbon and energy fund

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CEF: CUH NHS Trust
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<th>Received (Y/N/Date)</th>
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Appendix C - Proposed location of CHP System (John Radcliffe)

CHP to be installed in place of existing steam generation boilers within main 'Industrial Block' Boiler Room (Steam boilers replaced with local process packaged units at point of use).
New MTHW and LTHW pipework to be routed along existing service corridors above/below ceiling as appropriate.