NATURAL HISTORY MUSEUM, LONDON
TRI GENERATION

- Saved 2,300 tonnes of CO2 in 2010
- Saved up to £1m in financial savings in 2010
- Reduced risk to the Museum
- Long term partnership approach - 16 years

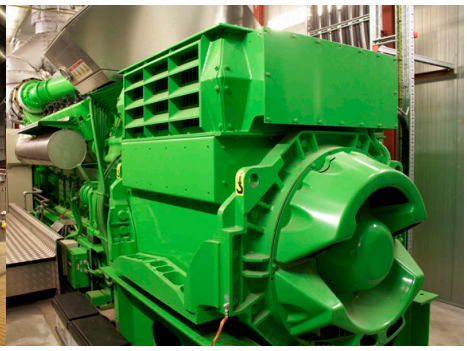
Contract Value: **£1.5 million**
Client: **Natural History Museum**
Timescale: **16 year agreement**

Introduction

The Central Boiler House (CBH) at the Natural History Museum has had a long operational history going back to the 1880's. Originally a coal-fired installation it until recent times provided the core heating for the South Kensington Cultural and Academic Estate comprising The Natural History Museum, The Victoria and Albert Museum, Imperial College and The Science Museum. The installation was most recently upgraded in the early 1980's, some 25 years ago and at this time it comprised of 4 large duel fuel Danks water-tube boilers totalling 42MW of heat output at 130°C. However in 2000 Imperial College and The Science Museum withdrew from the heat network leaving the CBH with only half its original load. Imperial College was the largest load of the four institutions at 45% and with their increasing estate combined with major power growth, they opted for their own dedicated CHP installation.

This left the Natural History Museum (NHM) and the Victoria and Albert Museum (V&A) as relatively minor consumers each with approximately 25% of total heat consumption. Removing half of the heat consumption inevitably led to under utilisation of the existing plant, 2 Danks boilers were mothballed and the reduction in economies meant fixed and variable cost increases, resulting in the cost of heat for the remaining parties rising from 1.8p/kWh to 2.7p/kWh in 2000.





"This is a fantastic project. The Natural History Museum's building might date back to Victorian times, but it houses an energy centre fit for the 21st century."

"The Co-operative Bank has developed a long term relationship with Vital Energi having provided funding solutions to support a number of their energy projects. The Bank would rate Vital as a strong performer within its sector and a company that can be relied upon to successfully deliver high quality sustainable energy solutions."

Chris Matthews, Senior Business Development Manager, Co-operative Bank

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The Brief

The challenge that the Environment & Special Projects Manager at the NHM, Simon Tilleard set himself was to achieve a relative level of cost of heat of 1.8p/kWh at 2000 prices. The actions to achieve this being 1) Energy Centre refurbishment 2) Automating and De manning and 3) Reducing Risk to NHM. A budget of £3 million had been set aside to undertake this target and an assessment of possible improvements showed that in increasing order of investment the following unit heat charges could be achieved:- 2.5p/kWh by plant refurbishment and replacement; 2.2p/kWh by achieving PM5 requirements to allow automation and de-manning; 2.1p/kWh with further investment in a 375kWe CHP engine: 2.0p/kWh with a 750kWe CHP engine and the target 1.8p/kWh with a 1,300kWe CHP engine. Looking at the demand profiles and paybacks the results did not appear to be so good economically. The existing HTHW operating conditions limited selection options. The critical summer base heating load for CHP operation was limited by the V&A having no heat requirement during the summer, their DHW being provided by local boilers, leaving the NHM with a relatively low 375kWth summer base load. This meant the larger the CHP engine chosen the greater the heat that would be dumped in the summer. The 1,300kWe CHP engine showed a £3m payback over 16 years!

The Solution

Vital Energi offered to the NHM a turnkey capability covering Energy Centre, energy distribution (heat, cooling and power), consumer interface and metering. Vital Energi's core market is the small and medium scale CHP/Trigeneration/Biomass market in combination with being the UK's leading supplier and installer of pre-insulated pipe products serving district-heating and cooling applications. Vital Energi worked with the NHM over several years to ensure the best solution technically, financially and environmentally leading to Vital Energi taking responsibility for design, build, finance and operation of a Trigeneration scheme rated at 1,800kWe, surpassing the NHM's best case scenario. For Vital Energi and our clients there is the opportunity to innovate in the final energy solution in the case of the NHM this was by providing more sustainable measures such as CHP and re-engineering the delivery systems to maximise efficiency. A business gets paid for taking and managing risks, with businesses willing to take those risks provided that those risks can be managed profitably. A financed ESCo installation requires risk management and to achieve a quality delivery of services there has to be effective risk management. The basis of risk allocation should be that they are allocated to the party best able to manage them. If this is not the case then an investor will charge a disproportionately higher price for risks they cannot manage effectively.

A risk matrix for this project will include specific risks such design, construction, operation and financial all of which can be on the whole managed by Vital Energi; other risks such as development of concept, political and energy (electricity, heat, and cooling) supply source guarantees are possibly shared or the ownership of the customer. In the case of the NHM the development of the concept was undertaken jointly by agreeing common objectives and a decision process for key decisions along with a review procedure for variations. To ensure that the NHM achieved its expected returns over the 16-year life of the ESCo a performance management process was instigated. The targets included specific and measurable outputs including a minimum of 8.9 GWh/yr electricity production from the CHP unit, heating and cooling temperatures to be met and guaranteed savings plus a share of any additional savings over and above. Key Performance Indicators (KPI's) were set to provide a clear definition of failure to achieve required standards. Service requirements were set covering operation, planned preventative maintenance and 24 hour callout (the NHM has a 24 hour need to maintain the collections and prevent any deterioration). In addition performance reporting was agreed to provide operational feedback to the NHM on a quarterly and annual basis. The museums have critical heating, cooling and power requirements 24 hrs/day to preserve world-renowned collections and any major alterations proposed to these systems, has to ensure a robust and reliable supply is maintained.

The existing heating installation was a HTHW system operating at 130°C/100°C and the proposal was to adopt a LTHW scheme at 95°C/65°C to achieve the maximum energy and environmental benefits. The adoption of LTHW was a significant change for the museums and the customer care involved demonstrating the worth of these benefits and Vital Energi's ability to implement these by utilising the existing distribution network and modifying the 89 distributed plantrooms within the NHM and the V&A museums. A part of this demonstration included the hydraulic modelling of the existing pipework to operate at the lower temperatures. The hydraulic analysis of the V&A museum highlighted an area as possibly suffering insufficient heat supply. This was confirmed by the V&A, who had previously applied further heat provision to this particular area but the problem lay in the restriction of the pipework serving this area. The initial enabling works within the Central Boiler House was to refurbish the two 25 year-old 12MW boilers that had been mothballed for 5 years since the disconnection of the Imperial College load. The two existing operational boilers were run whilst refurbishment was undertaken.

The mothballed boilers were mechanically and electrically refurbished including:-
• New dual fuel burners
• New gas train and oil lines
• Replacement sensors
• Controls to comply with PM5 regulations;
• Complete rewiring
• Frequency inverters
...and these boilers are now predicted to have a further 25-year life! In summer 2006 the refurbished boilers were brought on line, commissioned and the two existing operational boilers were removed to accommodate the engine, waste-heat boiler and absorption chillers. Fortunately the existing substantial flooring of the Central Boiler House designed to contain the original coal-fired boilers did not need any reinforcement. The Jenbacher engine was delivered in August 2006 and commissioned and operational in early December 2006.

The NHM had previously had localised cooling and to facilitate the district-cooling, a new chilled water circuit had to be installed to link all the existing distributed chiller plantrooms to the Energy Centre. In addition new NHM buildings under construction such as the Darwin Centre 2, were designed from the outset to utilise only absorption cooling and this contributed to achieving Part L compliance. The district-cooling network at over 1,000m was quite a complex undertaking, having to find practical routes over and around various buildings, with the network being commissioned for summer 2007 operation. The Natural History Museum (NHM) and Victoria & Albert Museum (V&A) project is one example of an ESCo developed as Public Private Partnership (PPP) scheme, with finance also being provided by Vital Energi. The Co-operative Bank granted a discounted receivables facility of £3.57 million against the future earnings of an Energy Performance Contract for the supply of a central energy centre and plantrooms. The facility involved the ability to draw down funds during construction and a 15 year term receivables facility. We were able to raise the facility with Coop because of their experience of what is a very complicated format of contract and their support for the renewables sector generally. The UK public sector has a substantial and variety of service requirements and this therefore offers great opportunities for the private sector. The primary driver for Vital Energi is to develop on-going business with a profit/risk profile that is sustainable and acceptable to both our shareholders and to our clients.

Conclusion

The development of the PPP agreement and finance package combined with the commissioning of the CHP unit on programme in December 2006 has made this a success story for both Vital Energi, The Co-operative Bank and our client The Natural History Museum who are set to save in excess of £500,000 per annum over the 16-year agreement of the project and saving 1,800 tonnes CO2 emissions annually. With investment by Vital Energi, the museums £3m investment fund available for plant refurbishment could be assigned elsewhere. The onus on the designer from CDM regulations is to eliminate hazards where feasible and we are particularly proud of the improvement with regard to safety that our Natural History Museum installation has achieved. The conversion from a HTHW at 130°C/100°C to a LTHW scheme at 95°C/65°C has achieved the following benefits:-

• PM5 compliance – does not fall under terms of Pressure System regulations
• Calorifier failure – no risk of pressurising the heating systems
• Reduced risk to staff, public and museum exhibits

Vital's alternative proposal demonstrating that a 1.8MWe CHP engine could be accommodated with the existing and future loads, has brought greater benefits overall including:-
• Increased heat and electrical outputs
• Increased absorption cooling
• Financial savings – Capex and Opex
• Producing CO2 and financial savings above the guaranteed level – achieving reductions of 2,300 tonnes of CO2 and up to £1million in 2010.