Investment Grade Proposal: LBH-002

LONDON BOROUGH OF HILLINGDON

Prepared for:

HILLINGDON
LONDON

Submission Date: 19th April 2023

Hillingdon Civic Centre

High St, Uxbridge UB8 1UW

Building Overview

Hillingdon Civic Centre was originally built in 1976 and incorporates the Middlesex county council offices which were built in 1939.

The Civic Centre achieved Listed Grade II status as of 2018 as an early example of English Post-modernism noted for its high level of craftmanship and creative take on traditional brickwork.

Figure 4. Hillingdon Civic Centre Listed area, source: HistoricEngland.org.uk

The building is considered to be 4 levels high with the main Phase 1 quadrant being divided into half-storey elevations to create an environment better suited for communicating horizontally between offices rather than vertically.

The building is constructed from cavity wall external walls designed with Flemish bond snapped headers and single glazed 4-pane Georgian style wooden windows. The older Middlesex building has mostly refurbished single glazed critical style windows which are due to be replaced like-for-like outside of the scope of this project. Roof void areas visited were noted to be partially insulated and there were some indications of roof rafter dry rot.

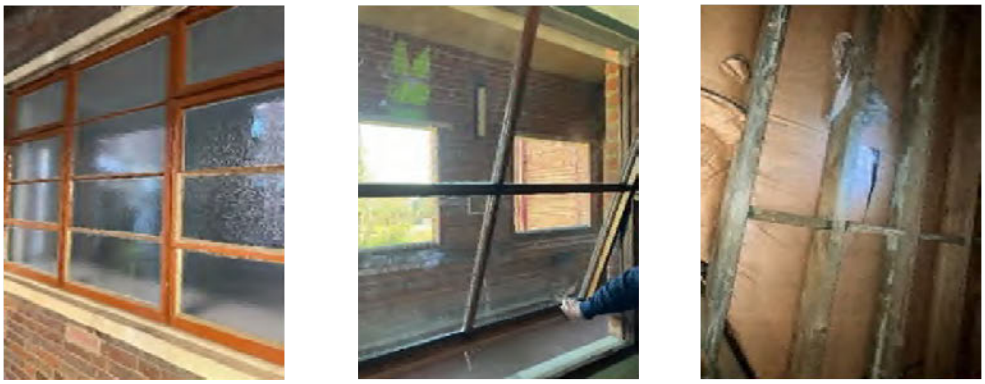

Figure 5. Existing poorly insulated windows and roof

The site spans approximately 12,000m^2 with a gross internal area of 27,242m^2.

The site is supplied by 1no. main electric meter with various HV and LV switch rooms and distribution boards throughout the site. The site also has 2no. gas meters, one of which feeds the main boilers plant and the other feeds the 'meals-on-wheels' Phase 2A plantroom monitoring the gas demand from kitchen equipment and 2no. gas calorifiers which feed this building's DHW.

Phase 2A makes use of domestic heat pumps to supply heating and cooling to the ground floor offices (citizens advice and neighbouring office spaces) and split A/C units to provide cooling throughout the rest of the building. There is also a small array of PV panels on the roof of Phase 2A which Ameresco assumes the Civic Centre own outright.

Figure 6. Existing domestic heat pumps – providing heating and cooling

Figure 7. Existing gas fired boilers

Site heating is provided by 4no. Hoval ST Plus 1450 units (each rated at 1,475kW heat output). These boilers are in the basement plantroom within Phase 1. The heating is provided on a primary heating loop via 4no. 18.5kW pumps (a mix of direct drive and belt driven motors paired running and standby) splitting the supply to Phase 1 and to Phase 1A, 2 & 2A.

During the visit, the outdoor air temperature was 5.5°C but heating was well managed with a 60°C flow

temperature and 49°C return temperature running on only 1 out of 4 boilers. Ameresco are to understand usual Winter operation commonly utilises 2 out of 4 boilers with flow temperatures manually adjusted based on plant performance by on-site maintenance team on a day-to-day basis.

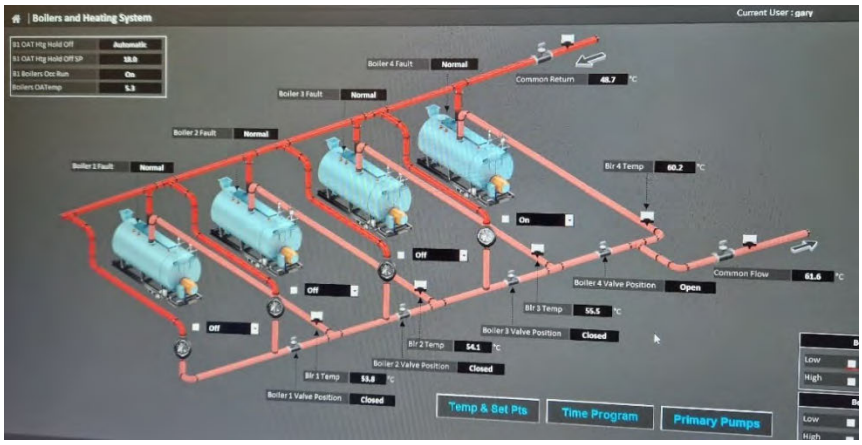

Figure 8. Civic Centre, Operating 1/4 boilers. Flow temp. 61.6°C, Return temp. 48.7°C at OAT of 5.3°C

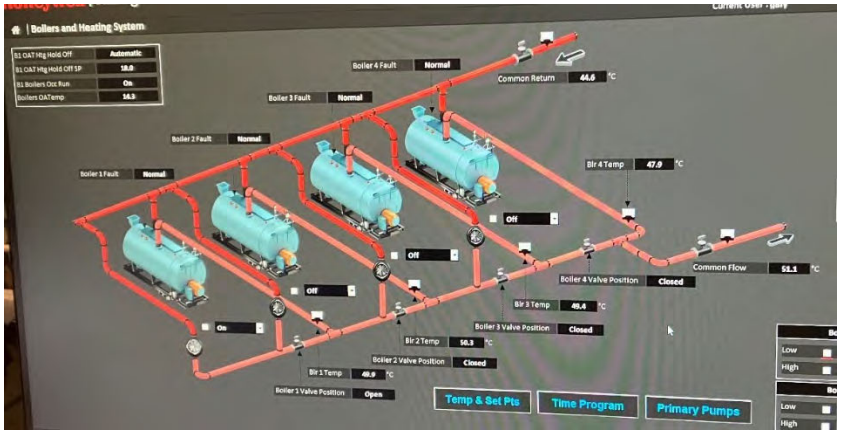

Figure 9. Civic Centre, Operating 1/4 boilers. Flow temp. 51.1°C, Return temp. 44.6°C at OAT of 14.3°C

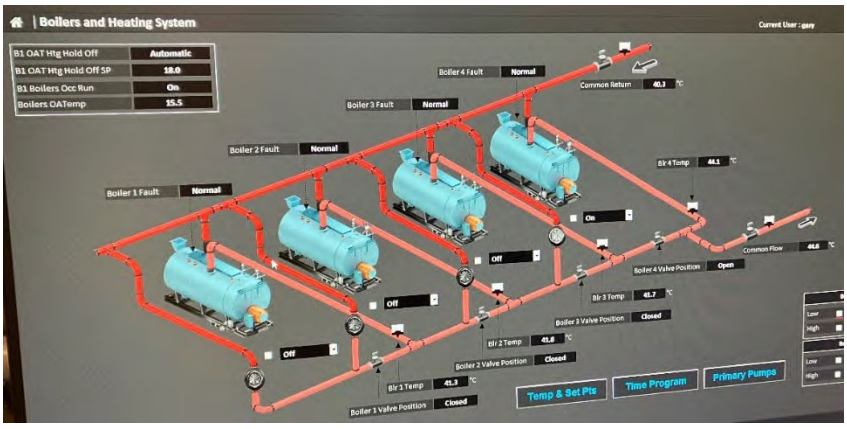

Figure 10. Civic Centre, Operating 1/4 boilers. Flow temp. 44.6°C, Return temp.40.3°C at OAT of 15.5°C

The Phase 1 ground floor plantroom also contains 3no. chillers, 2 of which are Carrier 151kW units with the third chiller no longer in use. The chillers are supported via 3no. induced draught cooling towers located on the roof of Phase 1 with 3no. 15kW pumps circulating the cooling water. These units are thought to perform well and managed site cooling during Summer ’22 heatwave.

All equipment is controlled via various Honeywell control MCC’s and managed by Honeywell Building Energy Management System.

Space heating and cooling throughout the civic centre is provided by an estimated total of 798 Fan Coil Units (FCUs) that are either wall hung, under windows or located within pod units throughout the floors. 682 FCUs

are located in Phase 1 alone. FCUs are capable of running at 3 fan speeds, during Ameresco site visits they were noted to be running at high speed (III). It was also noted that some FCU fans were running without providing heating suggesting potential issues with heating and cooling valve modulation.

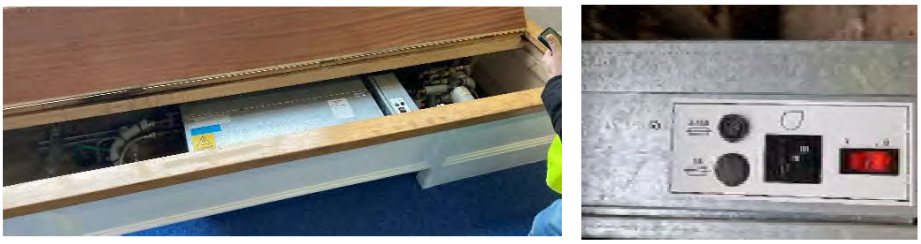

Figure 11. Space heating FCUs

Other heating is provided by various Air Handling Units (AHUs) across the site.

- *Phase 1: 4no. AHUs located in roof plant room (plant room 4)*
  - Serving North, South, East and West Phase 1 Quadrant office areas.
  - Excludes 2no. Conservatory AHUs no longer in use.
- *Phase 1A: 1no. AHU located in the Phase 1A plant room / Engineering workshop*
  - Serves Phase 1A (reception and offices).
- *Phase 2: 2no. AHUs located in Phase 2 roof plant room*
  - 1no. serving the Council Chamber and 1no. serving the party offices.
- *Phase 2A: 2no. AHUs located in Phase 2A "meals-on-wheels" plant room*
  - 1no. serving the Middlesex Suite and 1no. serving level 1 of Phase 2A (It was noted the AHU serving the Middlesex Suite is currently offline due to an inoperable supply fan motor.)

There is an additional 'Civil Defence' plantroom located in the basement of Phase 2 which includes an AHU but Ameresco have been advised this is no longer in service with no plans to reinstate.

Domestic Hot Water (DHW) throughout the site is provided by 2no. Andrews 90kW gas direct fired calorifiers located in Phase 1 roof plant room (plant room 4), 2no. Andrews 30kW gas direct fired calorifiers located in Phase 2A plant room (also serves Phase 2) and 2no. 3kW electric immersion calorifiers located in Phase 1A plantroom and local to reception area all of which maintain DHW at 60°C setpoint.

Ameresco found consistently during site visits that multiple automatic doors at the Phase 1A reception (and other entrances to the Civic Centre) were either switched to stay fully open or motorised door closers not operational. Ameresco recommends that the door closers are maintained/replaced to ensure heat remains in the building and that the draught lobby creates and airlock barrier from heat escaping.

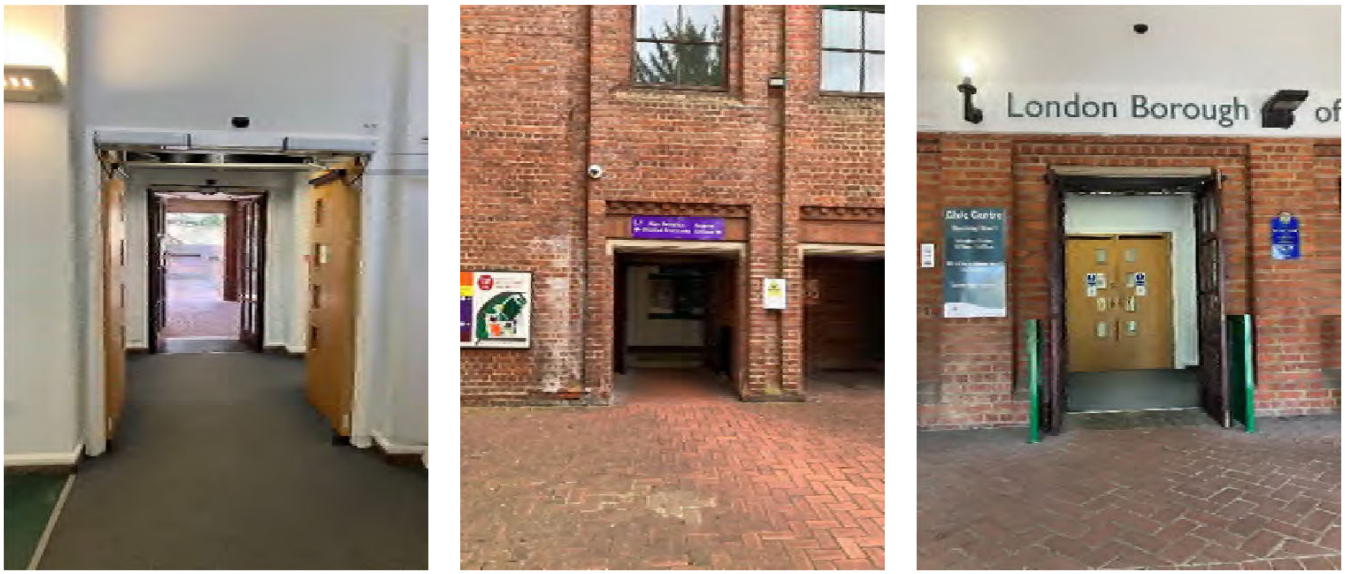

Figure 12. Civic Centre, door closers not functioning as designed

Premises Energy Consumption Baselines and Profiles

Electricity Consumption Profile

An in-depth energy consumption analysis has been undertaken to better understand the site's energy consumption on the most granular basis available. Seasonal patterns, night and day loads, week and week-end consumption are thoroughly studied. The analysis enables the identification of potential savings opportunity by highlighting out-of-hours energy consumption and energy management improvement opportunities for electricity only.

Data for gas was unavailable and a granular level to be able to carry out consumption analysis.

Energy data analysis needs to be representative of a typical year to better identify any savings opportunity and consumption patterns. The Covid-19 crisis significantly impacted operations throughout 2020 and continues to disturb business as usual. Data submitted to Ameresco by LBH was for a full year ranging 2022 - 2023 which may include ongoing site specific Covid-19 measures.

Electricity Consumption Profile Analysis

The figures below show the site daily electricity demand (kWh) between 1st February 2022 to 31st January 2023 and monthly electricity demand (kWh) for a year. The Half-Hourly dataset provided was made of 365 days of data - a full year.

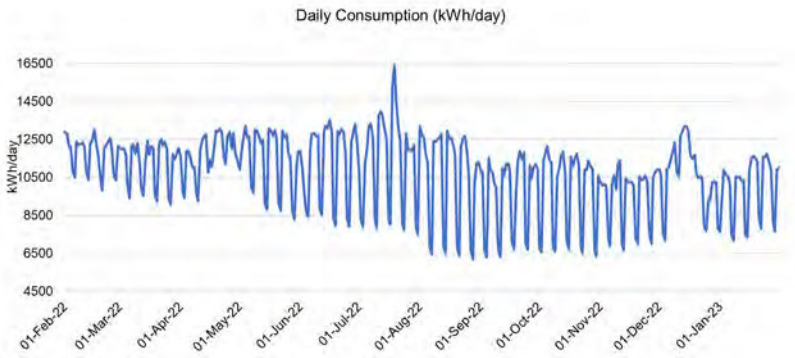

Figure 13. Civic Centre, Site Daily Electricity Demand (kWh)

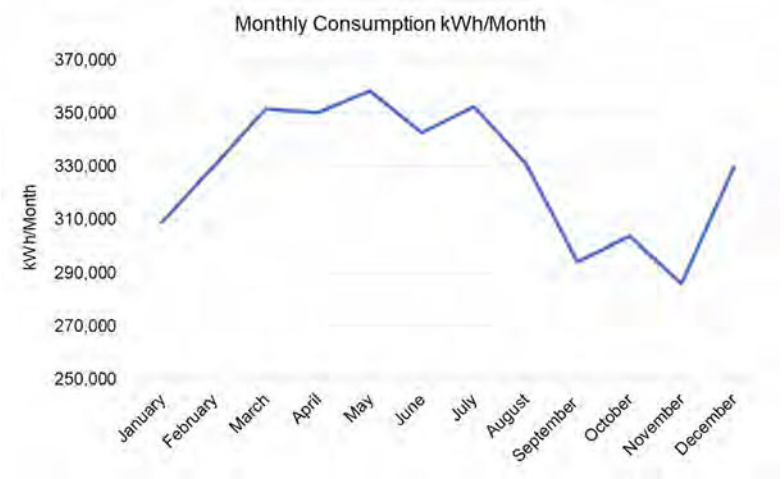

Figure 14. Civic Centre, Site Monthly Electricity Demand (kWh)

The daily consumption graph shows an increase in variance of consumption through the shoulder seasons and the summer months with a peak use during August. This may illustrate an increase in cooling demand during these months by running the site 3no. cooling towers and 2no. chillers to provide space cooling around the site. In particular this can be seen during the heatwave event in August 2022.

At a high level the profile illustrated in Figure 14 appears to show seasonality with an increase leading into summer seasons and a subsequent decrease approaching autumn. However, there is an obvious increase in December electrical use - represented by an increased use during day and night hours through the second and third week of December – although it is not clear what may have caused this.

The figure below takes a closer look to the average daily half-hourly electricity profile for each month.

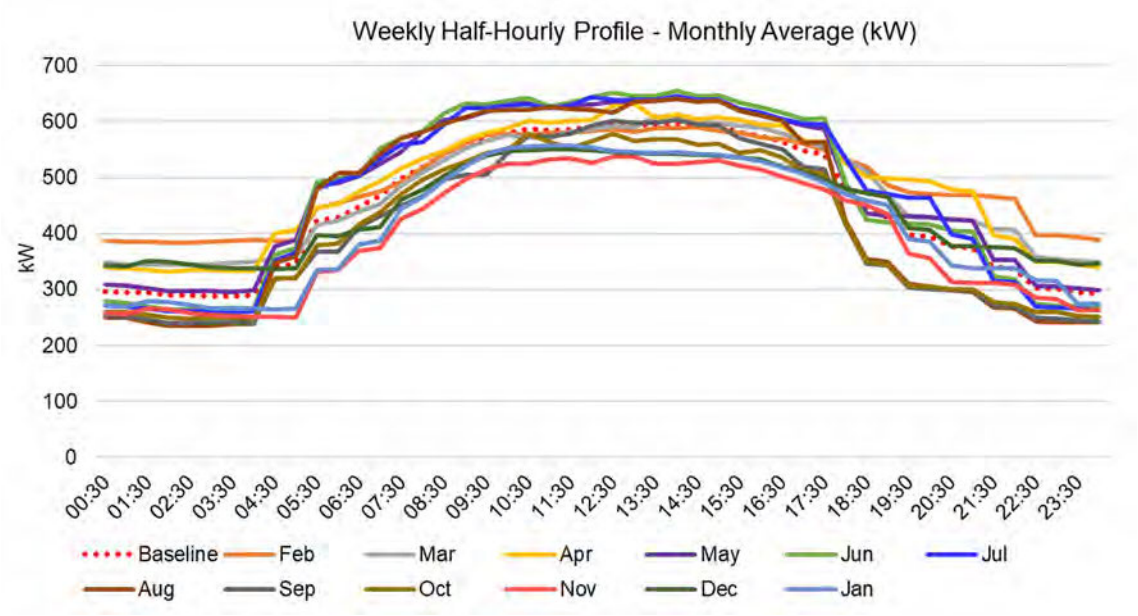

Figure 15. Civic Centre, Site daily Half-Hourly electricity profile monthly averages

The graph in Figure 15 clearly shows an increased electrical consumption outside of operating hours in the winter months compared to the summer months, this is illustrated in Figure 16 below with the night load showing a decrease into the warmer months.

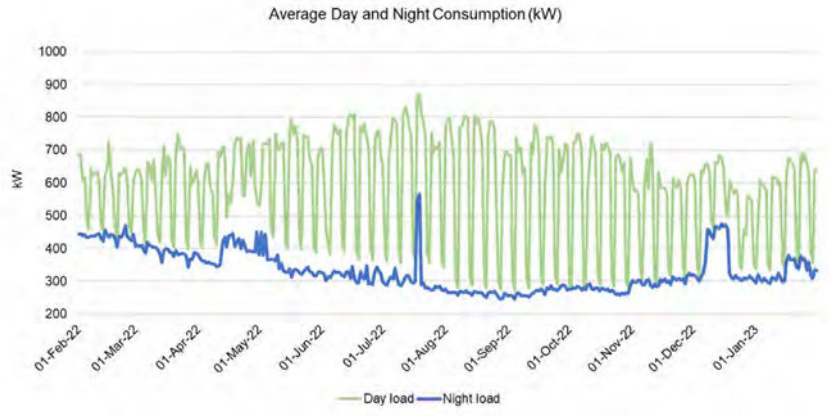

Figure 16. Civic Centre, Site daily Half-Hourly electricity profile day load vs. night load

Figure 17 below again shows a clear increase in electrical consumption during summer months midweek, most likely representing the increased cooling load for large office areas that will not be as prevalent during weekends. Agreeably, there is a reduction of electrical consumption in winter months during midweek days. Interestingly the seasonal demand midweek vs weekends is not consistent which may suggest changes in occupancy across the seasons in a year.

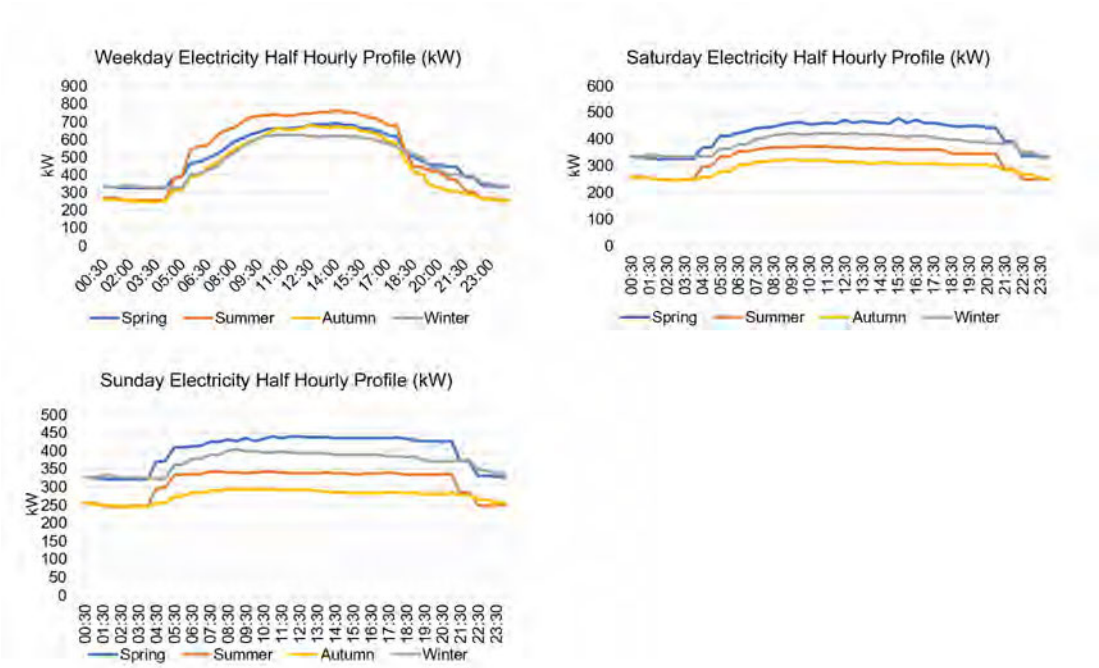

Figure 17. Civic Centre, Site Half-Hourly Electricity Demand (kW)

Overall findings from data submitted:

- There is marginal seasonality
- The average night load (331kW) is less than the average weekend load (372kW) which may indicate reasonable energy use. LBH has informed Ameresco that there is some weekend use in these buildings but occupancy data was not available to assess the impact.
- The average night load is over 50% of the average day load (assume operating hours from 06:00 to 20:00) which suggests there is scope for night load reduction of electrical consuming units.
- Weekends account for 22% of electrical consumption throughout the year which should be compared with occupancy data if available.

Please note this analysis has been carried out on data submitted by LBH. Ameresco has reviewed this data for anomalies but otherwise these graphs are show raw, non-modified data presented in more digestible formats.

The building is operating hours to the public are generally from 09:00 to 17:00 however we have allowed for extend operating hours to allow for those starting early or finishing late working for LBH. It still supports the case that out-of-operating hours electricity consumption is high and may be minimised with better controls and measures such as a “last-man-out” procedure.

Gas Consumption Profile Analysis

No gas HH data was available for this site so it was not possible to develop or analyse the consumption profiles for this site. It was therefore not possible to identify demand outside of operational hours. Monthly gas and electricity consumption data was used to develop the site baselines.

Summary of Site Baselines

The table below shows the site annual energy baselines for gas and electricity consumptions based on 2021/2022 data. These are obtained from the client.

[redacted]

Table 8. Civic Centre energy baselines

Overview of Proposed ECMs, Cost and Savings

Following our investigation of all ECMs, we have prioritised ECMs based on their maximum value to the site, including capital cost and energy savings. The proposed ECMs are shown in the following table.

ECMs	LED (new fitting)	Solar PV	Double Glazing	Secondary glazing	Cavity wall insulation (CWI)	Loft insulation	BMS (remotely managed)	Air source heat pump (ASHP)	Draught lobby (internal)	Fans - high efficiency	Ventilation - distribution	Pool Cover	Floor Insulation	External wall insulation (EWI)
Civic Centre		✓		✓	✓	✓		✓			✓			

Table 9. Proposed ECMs – Civic Centre

The table below summarises the savings and capital cost for all the proposed ECMs at this site.

ECM Description	kWh Savings (kWh/Yr)	Cost Savings (£/Yr)	CO2 Savings (te/Yr) (PSDS)	Lifetime CO2 savings (PSDS)
Solar PV	11,541	£ 2,425	-	-
Secondary glazing	176,399	£ 15,841	32	255
Cavity wall insulation (CWI)	202,195	£ 18,157	37	1,107
Loft insulation	90,734	£ 8,148	17	447
Air source heat pump (ASHP	3,268,499	£ 110,022	875	17,501
Ventilation - distribution	390,446	£ 35,062	71	2,138
DNO upgrade works	-	£ -	-	
Design costs	-	£ -	-	
Extra costs (M&V, financing)				
TOTAL	**4,139,814**	**£ 189,654**	**1,032**	**21,449**

Table 10. Summary of Civic Centre ECM and savings table

Proposed ECMs

ECM: Solar Photovoltaic

To support the larger heat decarbonisation project and the increased electrical demand placed on the site as a result of installing heat pumps, Ameresco proposes the following self-generation electrical solution.

Equipment Specifications

The proposed design will utilise QCells MLG10 series panels rated at 410W. Full Equipment specifications including datasheets and information regarding declarations, production compliance and codes of conduct can be found in Appendix C .

The panels will be integrated with fixed voltage inverters from SolarEdge SE16K range, details are provided in Appendix C.

Design Capacity

The design for this array is based on replacing the existing array on a like-for-like basis in order to comply with the listed building consent - “hiding” the array whilst ensuring sufficient space is available for our proposed ASHP installation.

Although Ameresco are proposing this replacement (and have included costs for decommissioning the existing system) we will investigate the possibility of reinstating the original PV array in an effort to reduce cost to LBH. This work will be part of the detailed design and will require information from LBH regarding the history of the current array.

It should be noted Ameresco are guaranteeing project performance in the form of electrical production of the system, not electricity self-consumption.

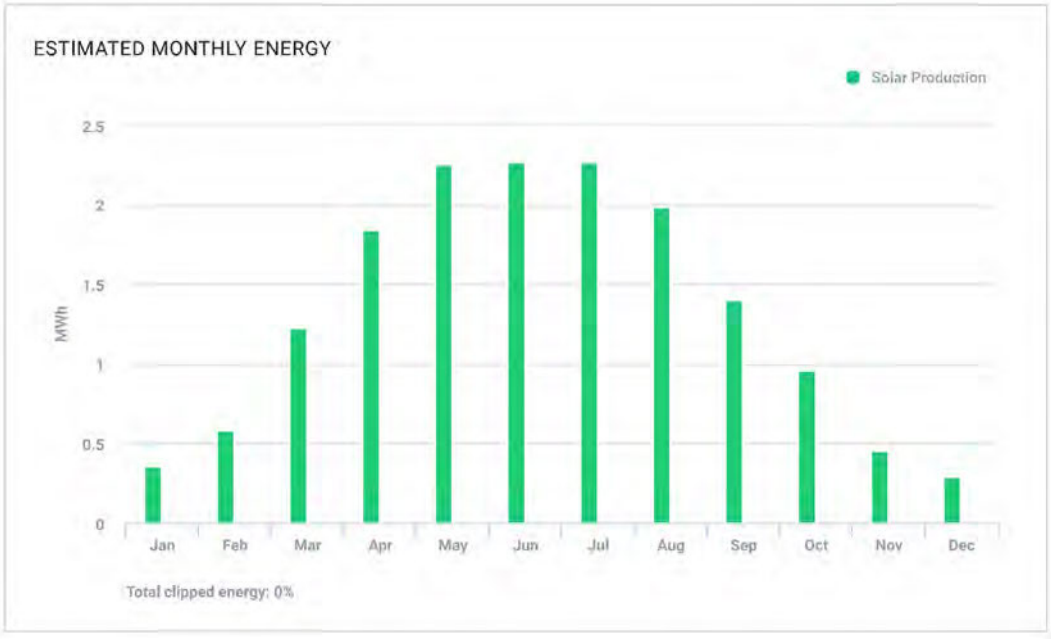

Figure 18. Civic Centre, PV production

**clipped energy loss % refers to the lost energy caused in a solar photovoltaic (PV) system due to the inverter derating its output to meet either its maximum power rating or the maximum allowable power at the grid connection.*

Preliminary Design

Ameresco proposes to install 17.22kWp of PV system mounted to the roof with an annual yield up to 15,900kWh/yr.

This design will utilise 42 modules assorted into 2 strings with each module fitted with an optimiser to ensure maximum generation per string. The inverter will be installed in the same cupboard within the Middlesex Suite as the existing inverter, under the roof where the PV is to be installed.

Ameresco has included in the design for Lightning Protection System (LPS) bonding.

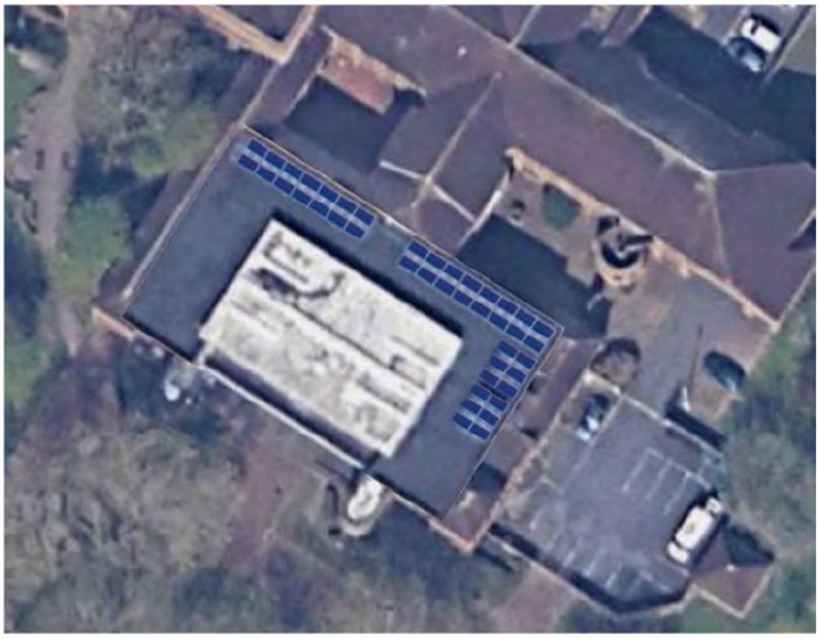

Figure 19. Indicative Solar PV Layout, Civic Centre (Phase 2A)

Scope of Supply

The detail scope of supply is outlined below.

Detailed mounting and electrical design	Included
Structural Assessment	Included
42 x Solar PV QCell	Included
Solar Edge 16K solar inverter	Included
Appropriate mounting kits required to fix the panels	Included
All accessories required for connecting the system to the Network	Included
DC cabling between panels and inverters, and AC cabling between inverters and switch boards	Included
New protection switch, to be installed in spare way of boards	Included
Total Generation kWh meter with remote monitoring capability	Included
Labour and standard materials required for the complete installation of the system	Included
Main AC and DC Cables	Included
Access and Lifting Equipment	Included
Scaffolding and Edge protection as required	Included
Solar Edge Monitoring System	Included

Figure 20. Solar PV Detailed Scope of Supply, Civic Centre

The solar PV system will be designed as a single unit and is proposed to be delivered in a single installation phase to minimise disruption and contractor time on site. It will be installed in compliance with all relevant health and safety regulations and designed to be in complete agreement with the latest editions of:

- ***MIS3002:*** *Requirements for Contractors Undertaking the Design, Supply, Installation, Set to Work Commissioning and Handover of Solar Photovoltaic Microgeneration Systems - published by MCS.*
- ***Photovoltaics in Buildings****: Guide to the installation of PV systems. 2nd Ed. 2006: published by DTI.*
- ***BS EN 62548:*** *Installation and Safety Requirements for Photovoltaic (PV) Generators Guide to the Installation of Photovoltaic Systems as published by the MCS.*
- ***BS 7671:2015:*** *Requirements for Electrical Installations: IET Wiring Regulations.*
- ***BS EN 62446:2009:*** *Grid connected photovoltaic systems -Minimum requirements for system documentation, commissioning tests and inspection.*

Anticipated Savings and Other Benefits

The table below summarises the overall performance of this ECM.

Solar PV	Energy Savings			
	kWh/Yr	£/Yr		CO2 (te/Yr)
				PSDS
Electricity	11,541	£	2,425	-
Gas	-	£	-	-
Total	11,541	£	2,425	-

Figure 21. PV Energy Savings

All savings will be separately measured and/or verified as detailed in the M&V plan.

Cost Breakdown

[redacted]

ECM: Air Source Heat Pump (ASHP)

Heat Loss Analysis

Ameresco attended site to carry out laser measurements of all windows and doors and selected internal rooms to cross reference against general arrangement floor plans throughout all sections of the building. Note was taken of building materials and glazing, as well as estimates of air change factors (passive and via mechanical ventilation) given the building's expected configuration and use.

An external temperature of - 3°C which was considered appropriate for the Hillingdon area was used for peak load analysis. Internal design temperatures and ventilation rates were used following BS EN12831.

The room-by-room simulation result was derived considering all windows upgraded with secondary glazing, cavity wall insulation, loft insulation and excluding non-heated areas such as plant rooms or stairwells and areas heated by renewable technologies already i.e. Phase 2A citizens advice offices. Ameresco has determined a combined heat loss per phase as follows:

- *Phase 1 (office quadrants etc.),* ***1,431kW.***
- *Phase 1A (reception area etc.),* ***109kW.***
- *Phase 2 (council chambers etc.),* ***187kW.***
- *Phase 2A (Middlesex suite etc.),* ***175kW.***

A total site peak heat loss of **1,902kW**. Detailed heat loss analysis can be found in Appendix F.

System Sizing and Building Limitations

The building electrical supply is rated at 1500 kVA and the max demand occurring in the past 12 months is 1054 kVA, 70.3% utilisation. At this stage, the indicative additional load required on the building supply is estimated up to 980 kVA – this will be confirmed during the detailed design.

Ameresco has contacted SSEN to obtain a budgetary cost for increasing the site supply by 590kVA to account for site current maximum demand and the additional load placed upon it by ASHP installation. LBH will be subjected to a Connection Offer Expense (COE) to cover SSEN Design fees to carry out a full assessment and final fixed pricing for this work – this cost is included in the Detailed Design proposal.

Hillingdon Civic Centre has a HV metered supply and SSEN has advised that the current transformers for this supply are suitable up to 3.8MVA. As such, SSEN has indicated that no further upgrades will be required and therefore a **budgetary cost of £0** has been included to upgrade the network to support the increased capacity to Hillingdon Civic Centre. This price does not include any possible 2nd-comer reinforcement charges that may apply, and does not confirm that there is available capacity on the network to meet the required demand – this would be an outcome of the detailed assessment being carried out by SSEN which is currently in progress.

Scope of ECM Work Proposed

Ameresco has undertaken a diligent review the site, including site surveys to establish space availability inside plantrooms, as well as outside areas for the outdoor evaporator units. Areas identified for the location of the external units have not been agreed with LBH at this time although discussions have been held with the heritage planning officer. Ameresco has allowed costs for preparation of planning permission / listed building consent for the site, which are required for the evaporator units and heat pump unit installations placed externally. Ameresco would seek approval from the LBH to proceed with the works concurrently to the planning submission to limit any impact to the project timeline.

The general scope of works is to provide a solution including supply, installation, testing and commissioning of 4no. high temperature (65°C) air source heat pump packages for the Civic Centre.

Detailed design includes for all electrical, mechanical, controls and civils work.

- *DNO connection and Planning applications.*
- *Structural surveys and civil works.*
- *Noise assessment where applicable*
- *Ground assessment where applicable*
- *Foundations for external units.*
- *Trenching, excavation works, where applicable.*
- *Inclusion/modification to existing concrete plinths to accommodate equipment, where applicable.*
- *Fencing around the external units, where applicable.*
- *Mechanical works.*
- *Wiring and heat transfer pipework between indoor and outdoor units.*
- *Buffer tanks and interconnection and integration pipework connections.*
- *Insulation to pipework, valves etc. that we installed in plantrooms.*
- *Electrical works.*
- *Connection of heat pumps to site electrical supply.*
- *Integration of the new heat pump systems to newly proposed BMS.*
    - *This also includes integration between the new BMS and existing equipment for interface as outlined in BMS section of this ECM.*
- *Supply and installation of heat pump units to be located in external area.*
- *Thermal and hydraulic integration of the heat pump into the existing heating system which includes correct pump and pipe sizing.*
- *Hydraulic separation of new installed ASHP & associated equipment from existing distribution system.*
- *Site training and handover.*
- *Removal of the 4no. existing boilers in the main plant room.*
- *Removal of 2no. gas calorifiers in Phase 2A plant room.*
- *Removal of 2no. gas calorifiers in Plant Room 4.*

Equipment Positioning and Detailed ECM Schedule

Given the required sizing of the heat pump and the associated large spaces required for Air Source Heat Pump (ASHP) evaporators, space for install without infringing the building listed consent is greatly limited around the Civic Centre.

Equipment positioning is to be agreed with LBH and heritage planning – although Ameresco have maintained a line of communication with LBH heritage planning to ensure expectations are managed early on. Ameresco are proposing a 4no. ASHPs systems in order aid in splitting the Civic Centre phases in supply and demand.

The scoped locations, subject to final approval by LBH or heritage planning at detailed design are shown labelled in Figure 23 below.

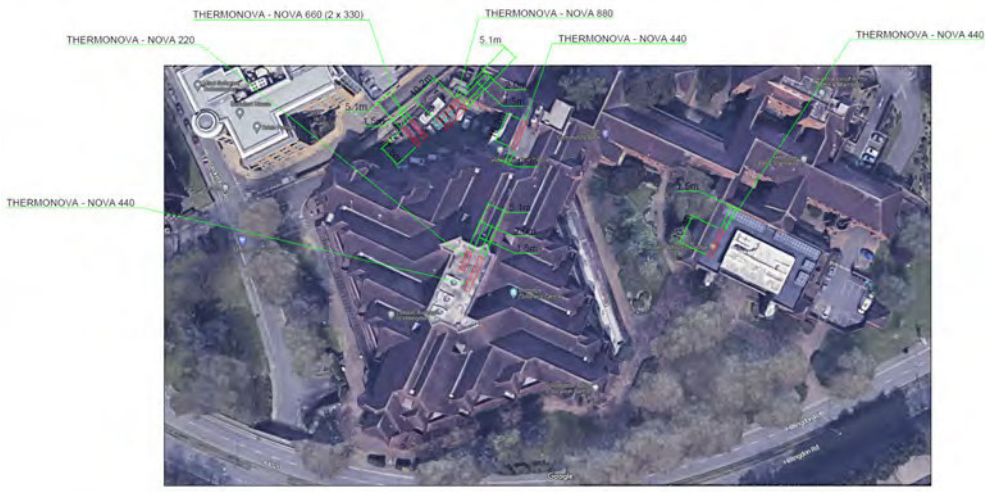

Figure 23. ASHP locations, Civic Centre

Location 1 – Phase 2A / Middlesex Suite Roof

- *A ThermoNova NOVA 440 ASHP will supply the Middlesex suite (Phase 2A) with an independent system and replace DHW 2no. 30.5kW Andrews gas calorifiers located in the ground floor plant room of this building. By connecting to the existing heating distribution pipework within Phase 2A the existing AHUs will be served from this system and separated from the main existing infrastructure. The main benefit in this separation of phases will be recognised during weekend and out of hours events held in the Middlesex suite that do not align with the operating hours in the rest of the Civic Centre Phases.*
- *Heating thermal store will be located in one of the following areas (confirmed during detailed design)*
    - Phase 2A plantroom subject to space restrictions.
    - "Meals-on-wheels" carpark (subject to planning approval).
    - Gas incomer shed located within the "Meals-on-wheels" carpark subject to space restrictions.
    - Members carpark
- *The 2no. 30.5kW Andrews gas calorifiers will be replaced with indirectly heated calorifiers served by the ASHP which will be located in situ of the existing gas calorifiers. These calorifiers will feed Phase 2 and 2A DHW as advised by the on-site maintenance team.*
    - DHW distribution drawings / information had not been supplied to Ameresco and as such the design will consider a like for like coverage from the DHW generation.
- *This location would be subject to roof structural survey and client / planning approval. Ameresco note that the roof area is obstructed from view by general public and has the general agreement of the Hillingdon heritage planning officer - listed building consent application to be submitted/approved.*
- *Access route to the rooftop area after project handover is the responsibility of LBH and excluded from Ameresco scope.*

Location 2 – Chimney Rooftop

- *A ThermoNova NOVA 440 ASHP will be located on this rooftop with a thermal store linked to Option 3 ASHPs within Plant Room 4 located in the top floor of Phase 1. This thermal store will tie in as a booster to the existing flow and return pipework that runs through the plantroom suppling 4no. AHUs and various FCUs in the building.*
- *The ASHP will also replace Phase 1 DHW supplied by 2no. 91kW gas fired calorifiers with indirectly heated calorifiers which will be located in situ of the existing gas calorifiers once removed.*
- *Equipment on this rooftop will be visible to surrounding high rise buildings and subject to roof structural survey and client/planning approval. Hillingdon heritage planning officer has indicated this is a suitable location – listed building consent application to be submitted and approved.*
- *Installation of this AHSP will be via crane lift arranged which is included in the cost.*

Location 3 – Cooling Rooftop

- *1no. ThermoNova NOVA 440 and 1no. NOVA 220 ASHP will be located on this rooftop with a thermal store linked to Option 2 ASHP within Plant Room 4 located in the top floor of Phase 1. This thermal store will tie in as a booster to the existing flow and return pipework that runs through the plantroom suppling 4no. AHUs and various FCUs in the building.*
- *Equipment on this rooftop will be visible to surrounding high rise buildings and subject to roof structural survey and client/planning approval. Hillingdon heritage planning officer has indicated this is a suitable location – listed building consent application to be submitted and approved.*
- *Installation of this AHSP will be via crane lift arranged which is included in the cost.*

Location 4 – Goods in:

- *This location is in the area of the site delivery bay and bin store. 1no. ThermoNova NOVA 880 and 1no. NOVA 660 ASHP will be located at floor level adjacent to the existing black start generator.*
    - As part of the detailed design, Computational Fluid Dynamic (CFD) air plume modelling will be carried out to verify that the airflow around these units is sufficient. This is in order to ensure ASHP efficiency is not reduced resulting in increased electrical demand / kWh heat generated.
    - If air recirculation is found to be an issue, Ameresco proposes to use the same ASHPs in the same position but raised up on a gantry to ensure sufficient airflow around ASHP evaporators. This gantry would be designed to minimise visual impact and not impede delivery traffic. The additional cost of this gantry would be estimated during detailed design and is **not** included in this proposal.
    - A thermal store will be incorporated in the design in order to minimising the required number of ASHP units where possible without jeopardising ASHP operation.
    - In the event that a gantry solution is not agreeable with listed building consent, Ameresco proposes to develop an electric water boiler option - currently not included in this scope of work. Cost for this are not included in this proposal and would be considered as variation if required.
- *A design in this location will be subject to acoustic survey, ground radar relating to platform foundations and heritage planning agreement - listed building consent application to be submitted and approved.*
- *Hillingdon heritage planning officer has indicated the preferential option will be to locate ASHPs at ground level for this location.*

System Design and Schematics

To be produced as part of the detailed design.

Equipment Selection (Preliminary)

Ameresco propose at this site ThermoNova products for the following reasons:

- High flow temperatures available to cover DHW requirements and buildings that do not include for emitter upgrades.
- Flexible return temperature solution.
- Very Low Global Warming Potential Refrigerant – R290 GWP of 3.0.
- Small compact size vs thermal output – monobloc approach means evaporators combined with compressors.
- Excellent coefficient of performance (COP).
- Simple hydraulic connection.
- Modular frame based design to enable expansion and quick installation.
- Strong remote monitoring capabilities.
- Great for integrating into existing buildings.
- Reliable construction techniques.

The nature of the monobloc units having combined compressors means we are able to allow for great redundancy across each installation i.e. NOVA 440 will have 4 compressors which are able to continue operating should a compressor fail. The expectation would be a drop in efficiency from a cascade unit due to a failed compressor and a balance would be struck between flow temperature and rate of heat delivery if the unit was at maximum load.

A NOVA 110 unit is considered a singular modular unit which can be incorporated up to a NOVA 880. For each package up to 4 units, a control panel will be included e.g. a NOVA 660 would include 2no. control panels for that associated package.

Figure 24. ThermoNova, NOVA 110 ASHP

Figure 25. ThermoNova, NOVA 440 AHSP

This is a preliminary selection of equipment for this measure as decided upon surveying the site. As an outcome of the detailed design the type and number of units will be confirmed and this may vary from the preliminary selection.

Building Management System

To allow for holistic control of the buildings / phases and the plant that serve them, Ameresco proposes full BMS upgrade. The Hillingdon Civic Centre operation is considered reasonable and well managed by the maintenance team and Honeywell R600 building integrator. The equipment viewed was mostly run in Auto mode rather than hand and equipment schedules are driven by the R600, however it was noted boiler plant is running 05:00 – 19:00 on Saturdays and Sundays when the building is generally closed to the public.

The Civic Centre currently does not allow for zoning and it was noted vacant rooms such as the Middlesex Suite were running heating emitters.

Ameresco proposes a design that will changeover FCU controls from pneumatic to electronic and create achievable zoning with additional temperature sensors and weather compensation. The benefits of these changes:

- *Zoned control*
  - To prevent the unnecessary heating of areas and of those already at temperature.
- *Electronic controlled emitters*
  - Will not suffer typical maintenance issues of pneumatic controls such as air leaks and blocked capillary tubes.
  - Higher operational efficiency.
  - Better ability to allow for data collection in equipment use and identify high/low use areas.
- *Weather compensation*
  - To allow for primary heating loop reduced flow temperature in warmer ambient conditions when heating is still required i.e. shoulder seasons (spring / fall).
  - Currently without dependence on maintenance teams changing flow setpoints ad hoc.

FCU Scope:

- Ameresco have allowed for a maximum of 798 FCU wiring and controllers to be included in this scope as submitted by the Civic Centre maintenance team.
  - This covers FCUs controls present in Phase 1, 1A and 2.
  - Any further FCUs requiring controls upgrades identified will be at additional cost to LBH.
- Each of the FCU control upgrades will include:
  - 1no. 24V BACnet controller.
  - 1no. 230/24V transformer.
  - 2no. 24V actuators, one for heating and one for cooling.
  - 2no. Air temperature sensors, one for air flow and one for air return.
- We will arrange for the free issue of 2no. Conex 3-port zone valves 15mm per FCU but Ameresco has not included cost for the installation of these valves or any pipework modifications or mechanical replacements of the FCU heat exchangers, fans or motors.
  - Free issued valves will exclude any fittings or couplings relating to the valves.
- FCUs that require remedial works to the enclosure or housing which may inhibit the control upgrade or be affected by the upgrade will be agreed with the client before proceeding. These remedial works are not included within the scope of the project.
- We have not included for out of hours working, if required with would be an additional cost to LBH.

Ameresco proposes an open source software solution to allow for a choice of maintenance contractor servicing and where possible will reuse existing equipment as appropriate.

The current proposed system will be based on the Honeywell Centraline Niagara 4 NX Building Energy Management System. Three new control panels will be installed to provide control/monitoring of the three proposed ASHP's (one of which will be across 2 HP packages located local to Plant room 4).

The estimated 798 existing pneumatic controlled FCUs will have BACnet communicating FCU controllers installed, with networking provided by 17 Honeywell Niagara 4 Hawk 8000 controllers.

The 2 Roof Level AHU Panels existing Honeywell CPO controllers will communicate with the new NX Arena Supervisor via Bacnet IP communications.

Hillingdon Civic Centre current has 14 Excel 5000 controllers (obsolete) and 1 CPO controller (new), both models are Honeywell with the CPO being closed source. The Excel 5000 controllers, although considered obsolete, are operational. The CPO controller is relatively new and was included as part of the Phase 1 AHU refurbishments (2 out of 4 operational AHUs in Plantroom 4 were refurbished).

Ameresco proposes to continue using the existing Excel 5000 and CPO controllers and manage these with the Honeywell Niagara 4 Hawk 8000 controller by connecting to the existing controllers via C-bus driver. This

will allow the Hawk 8000 controller to control LTHW plant via the Excel 5000 controllers. The existing Honeywell CPO controllers will communicate with a new NX Arena Supervisor via Bacnet IP communications in a similar fashion. This solution will require the client to request the Honeywell engineering CARE files (a standard procedure).

Primary user interface will be by a PC supplied complete with the Honeywell NX Arena Supervisor Software Package. The NX Arena Supervisor will be integrated with the 14 existing obsolete Excel 5000 controllers & the new AHU CPO controller, with the Honeywell Centraline Niagara 4 NX Building Energy Management System. As part of this measure, Ameresco will require the current Honeywell CARE project files to be shared.

Should the obsolete Excel 5000 controllers fail, they can be replaced with a Niagara Hawk 8000 controller (or a CPO controller but bearing in mind that these are closed source and may not be as competitively priced as open market controllers).

The cost per Niagara Hawk 8000 controller depends on how many points and graphics are required. In broad terms, a controller could therefore cost in range of £1,000 to £10,000 each. Ameresco recommends that LBH actively budget for this in the near term should an Excel 5000 controller fail. Alternatively, Ameresco would be pleased to quote for replacing all controllers as a variation on project scope but would need access to the Honeywell Engineering CARE files to accurately quote. This work has not been included in scope nor have provisional sums been allocated due to the potentially large variation in cost depending on the number of points/graphics required. .

The main focus of this project is to replace the gas boilers with low carbon technology, a new BMS system with remote monitoring will ensure the best integration with new major equipment installed and allow for Ameresco to remote monitor performance to ensure the best delivery. This is dependent on LBH providing a suitable network connection, where necessary, in order to allow 2-way access to the new control units.

Assessment of Existing Heat Distribution System

Current FCUs are supplied with flow temperatures between 60°C and 65°C depending on setpoint variance by maintenance team to offset ambient temperature changes. This shown in the following screenshots taken from the existing control system (note the Outside Air Temperature (OAT) at this time was 5.3°C):

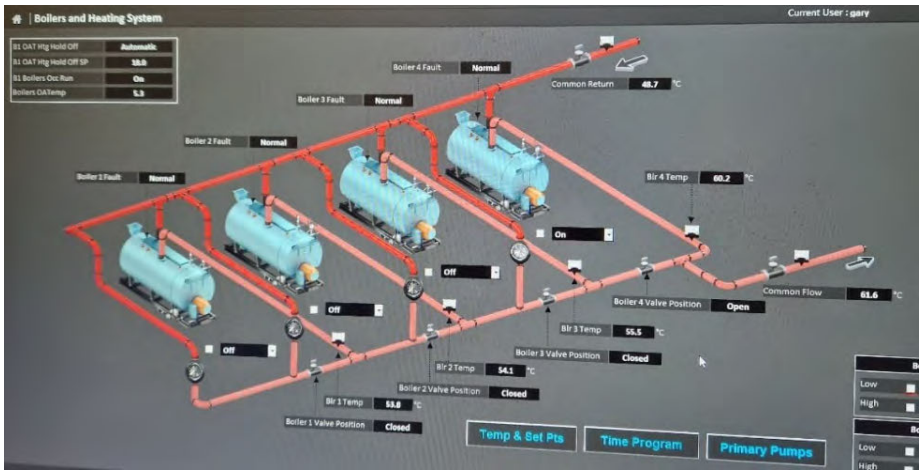

Figure 26. Civic Centre, Operating 1/4 boilers. Flow temp. 61.6°C, Return temp. 48.7°C at OAT of 5.3°C

Given the currently operating temperatures it is not intended to upgrade the existing heat emitters in the Civic Centre although the project does includes for upgrades to the control functionality of the existing emitters to ensure best efficiency and control of the existing equipment. Upgrading heat emitters is extremely disruptive to the building users, is a prolonged process and very costly to implement. Consequently the upgrade of heat emitters in the Civic Centre is considered to be out of scope. Rooms / areas that are currently felt to be cold will not necessarily be improved through the installation of the ASHP solution although the localised control of heat emitters may help.

Heat pump integration to the Civic Centre will include for a hydraulic break via 1no. plate heat exchanger (PHX) per heat pump package to protect the newly installed equipment from contamination contained within the existing pipework distribution. It is not standard engineering practice to install a standby plate heat exchanger due to the additional cost and space requirements involved and the low failure rate of PHX. Significant redundancy is already built into the proposed solution through the use of modular compressors and control panels.

Ameresco strongly recommends existing distribution system is flushed and inspected to ensure adequate delivery of low temperature hot water from heating plant.

In order to split Phase 2A from the rest of the Civic Centre, allowance will be made to isolate Phase 2A heating network from Phase 1 heating supply with minimal dead leg where possible and isolated pipework drained with the option to deisolate as an emergency redundancy should Phase 2A ASHP become inoperable. Ameresco do not take responsibility of the reinstatement of original supply to Phase 2A and recommend LBH create a Standard Operating Procedure (SOP) and consider regular pipework flushing and inspection.

Electrical Requirements and DNO Application

Ameresco have applied for DNO approval and are currently awaiting final and fixed connection / upgrade costs. As previously mentioned, SSEN has stated that no upgrades will be necessary for this site and provided a budgetary cost of £0. Ameresco has therefore not allocated a provisional sum on this basis. Full DNO connection costs have not been included within this proposal and will be quoted as part of the DNO full assessment, the cost of which is included in the Ameresco Detailed Design proposal. Should the DNO come back stating a differing cost from the budgetary indication, then LBH will be responsible for these upgrade costs. In our experience it is rare for a full assessment to identify a cost in excess of the budgetary figure initially offered.

As part of this project, and included within the project costings for this ECM, Ameresco has allocated a cost for connecting the new heating equipment, including the heat pumps themselves and any ancillary equipment, to an identified distribution board or isolator, within a switch room, that is unused. Ameresco has assumed all existing on-site electrical systems comply with current regulations and any upgrade to bring up to standard are out of our scope.

Noise Assessment

Ameresco will appoint an acoustic consultant to carry out noise surveys and assess the noise impact to the neighbouring buildings once confirming heat pump locations subject to heritage planning approval. Ameresco will share the information with the council following completion of the survey and its noise assessment report. This work will be carried out as part of the detailed design stage and any unforeseen additional costs arising from these surveys will be discussed with LBH.

Planning

Ameresco recognizes that the Hillingdon Civic Centre is a Grade II listed site and as such, external installations such as heat pumps will be subject to planning consent and heritage planning consent. In order to keep with the required funding timelines, long lead items such as heat pumps may need to be ordered prior to obtaining full planning. If agreed, then LBH will be responsible for any plant/equipment ordered prior to planning and heritage planning approval.

Anticipated Savings and Other Benefits

The table below summarises the overall performance of this ECM.

Air source heat pump (ASHP)	Energy Savings		
	kWh/Yr	£/Yr	CO2 (te/Yr)
			PSDS
Electricity	- 1,525,265	-£ 320,458	
Gas	4,793,765	£ 430,480	875.05
Total	**3,268,499**	**£ 110,022**	**875.05**

Table 11. ASHP Performance Summary – Civic Centre

All savings will be separately measured and/or verified as detailed in the M&V plan.

[redacted]

Assumptions and Exclusions

The boiler and associated obsolete plant will be decommissioned and removed (if necessary) from site. During construction a temporary boiler may be used to help transition from the existing boiler system to the new ASHP solution. We have included costs for this temporary boiler to be on site for 3 weeks. This will be further refined during the detailed design stage. If a temporary boiler is required for more than 3 weeks due to issues outside of our control this will be at an additional cost to the Council.

We have not priced in asbestos removal, Ameresco require LBH to conduct retrofit & demolition asbestos surveys in all areas to be affected by work prior to Ameresco starting work. In the case of asbestos discovery during construction phase previously not known or recorded, LBH will take full responsibility in the safe removal and disposal before work can continue. Work areas to be affected include but are not limited to ASHP equipment installation and enabling works, connection to existing site distribution, power connection and related enabling works, any associated civils works.

We have not priced for removing the gas pipes or gas meters from site due to their requirement for kitchen gas supply. Kitchen equipment that operates on gas can be replaced with electric equivalent by Ameresco taken as a variation on contract and will be at additional cost to LBH.

Although we will process the DNO upgrade application, costs for the upgrade are outside of Ameresco scope and not considered as part of this project and therefore within LBH scope.

We have not priced in upgrades to existing distribution system including pipework, pumps, valves and existing metering.

ECM: Building Fabric Improvement

Cavity Wall Insulation (CWI)

Installing CWI is a cost effective measure that will result in reduced heat loss and therefore reduced heat demand on the ASHP packages – this may result in the requirement for less equipment and consequently a reduction in CAPEX associated with ASHP installation. In addition, a reduction in overall heat loss will mean lower OPEX costs in the form of electricity consumption by the ASHP units.

Ameresco has investigated the potential for cavity wall insulation at the Civic Centre to establish if this could be carried out safely and appropriately in order to reduce the site's thermal load requirement. Ameresco has included cavity wall insulation in this proposal after extensive site visits and intrusive investigation with multiple subject matter experts. Areas around windows and throughout the site include a decorative outer leaf layer of bricks creating a solid wall section on top of a cavity. This can result in a differing U-value across the same wall between internal and external heat transmission.

Ameresco approached The Installation Assurance Authority (The IAA) to verify this approach as part of the detailed design and confirm this application is a suitable installation in keeping with current building regulations and best practices. The IAA have reviewed photographs of the installation areas, cavity condition and description of the work undertaken and have offered a 25 year installers guarantee which is included within our pricing for this measure. The proposal also includes for a 2 year workmanship guarantee.

Ameresco noted some areas of balconies were of a solid wall construction with metal frame within. Ameresco initially costed for the option of including External Wall Insulation (EWI) with a brick slip finish in these areas but Hillingdon Heritage Planning have indicated this installation would be rejected under listed building consent. Similarly, Ameresco had proposed EWI to the underside of the Link / Phase 1A floor which is subjected to a wind tunnel effect between Phase 1 and Phase 2 buildings (Figure 27) however this was also strongly rejected by Hillingdon Heritage Planning.

Figure 27. Civic Centre, solid wall on outdoor balcony Phase 1 (left), underside of Link / Phase 1A (right)

Roof / Loft Insulation

The roof void areas visited during site surveys displayed approx. 50mm roof insulation between rafters. Ameresco investigated the option of either topping up the insulation where feasible or considering loft / joist insulation as an alternative to further improve the Civic Centre's thermal envelope – thereby reducing heat losses associated with natural convection.

Ameresco proposes to install loft / joist insulation in various areas across the Civic Centre. This will include a

mix of applications where appropriate such as 300mm cross lay over non-suspended areas and 200mm over pitched slopes within the loft space. In areas which were found to already include 150mm of loose fill insulation in good condition, Ameresco proposes to top these areas up with an additional 150mm of glass mineral wool roll (this product is a non-combustible insulation with Euroclass A1 reaction to fire classification).

Additionally, Ameresco has included, as part of this measure, costs to install encapsulated loft insulation within the ceiling void of the Middlesex suite. Ameresco was unable to gain full access to the investigate this void area but in areas of lifted / missing ceiling tiles it was clear there is ample space to include for this measure. Prior to installation further surveying will be carried out but we do not currently foresee this installation being an issue.

The installation of loft or encapsulated loft insulation will result in reduced heat loss and therefore reduced heat demand on the ASHP packages – this may result in the requirement of less equipment resulting in reduced CAPEX associated with ASHP install in addition to less OPEX costs in the form of electricity consumption.

Windows

Hillingdon Civic Centre is estimated to include an estimated 350 single glazed windows across all phases with a small number of secondary glazed windows located in the conservative party council offices within Phase 2. Ameresco proposes to fit secondary glazing to all units throughout the site that are capable of being removed or opened for maintenance needs.

The nature of building heating and cooling supplied via FCUs and AHU supply / extract in addition to all windows locked via budget key locks does not necessitate the need for opening windows under day-to-day operation. However, we understand this may be desirable if the site's chilled water supply underperforms on a hot day and we have included a solution that allows users to partially open the windows.

The secondary glazed units will not impact the view of the windows externally, nor will the units cause a visible disruption to the style of current windows seen from external to the building i.e. mullions or joins running interiorly in front of existing glass panes that can be seen from outside.

Secondary glazing reduces the amount of heating fuel required to heat up the building in the morning, maintain it at occupancy temperatures and allows the boilers / heat pumps to be turned off earlier. A typical secondary glazing application can reduce thermal transmittance of window areas by up to 60% resulting in a reduction passive building heat loss.

Figure 28. Secondary Glazing, example of a horizontal sliding system installed

It is understood LBH are interested in a solution of secondary glazing by installing an additional pane into the existing primary window frames. Although Ameresco have a quote for this service, we do not recommend progressing with this option for the following reasons:

- This install would require routing out and modifying the existing wooden frame.
  - This work carries risks with damage to the frame necessitating repair or replacement depending on the severity of damage.
    - Damage from routing out a groove for the new pane.
    - Damage from modifying/planing an existing window to ensure it is square and suitable for a new pane install.
  - Metal associated with the window tilt hinges may need adjusting / shaving down which can impact their performance given their age.
  - Hillingdon Heritage Planning have strongly indicated this is **not** a recommended option due to altering a fabric that forms part of the externals.
- The effect of adding an additional pane of glass to the window is not known.
  - The additional weight can provide undue stress on the tilt hinges.
- Although the new pane would be sealed (and potentially the outer existing windows too), the frame is made of wood and this will naturally change shape with ambient temperature. The nature of this will mean it is a risk that the seal between the existing window and the new window will be broken leading to condensation which will not be able to be reached / cleaned.

Planning

The Hillingdon Civic Centre has a significant amount of windows, all single glazed, which are inherent to the design and style of the building. Ameresco proposes to install a solution that reduces heat loss but doesn't affect the external façade of the building. This solution may still require heritage planning approval, via listed building consent application, and discussions with the heritage planners are ongoing on the proposed design.

Anticipated Savings and Other Benefits

The table below summarises the overall performance of this ECM.

Secondary glazing	Energy Savings			
	kWh/Yr	£/Yr		CO2 (te/Yr)
				PSDS
Electricity	-	£	-	-
Gas	176,399	£	15,841	32.20
Total	**176,399**	**£**	**15,841**	**32.20**

Table 13. Secondary Glazing Performance Summary – Civic Centre

All savings will be separately measured and/or verified as detailed in the M&V plan.

[redacted]

Assumptions and Exclusions

Due to the timescales of this project, pricing for windows is strictly indicative and based on our initial site survey. During the Detailed Design phase accurate, for manufacture, measurements will be taken and a reforecast of the costs made. It is not expected that the price will change significantly based on the estimated number of windows stated. However, it should be noted that the windows in Phase 2A have been surveyed and measured and, as such, the cost provided for the windows forming this part of the building are firm and fixed.

Due to the age of this building and the presence of asbestos on site, Ameresco require full retrofit & demolition asbestos surveys of all window openings and adjacent areas affected within the scope of this measure to be carried out. Any, and all, asbestos found during these surveys must be safely removed and disposed of, as required, prior to Ameresco starting work at LBH's cost. If during the construction phase of this project previously unknown asbestos is discovered, it is the responsibility of LBH to safely remove and make the area safe for work.

ECM: AHU Heat Recovery Recommissioning

The Civic Centre includes 9 operating AHUs across the site. Of these 9 AHUs, 7 already fitted with function heat recovery in for the form of direct mixing dampers. An illustration in the existing Honeywell BMS graphics is shown in Figure 29.

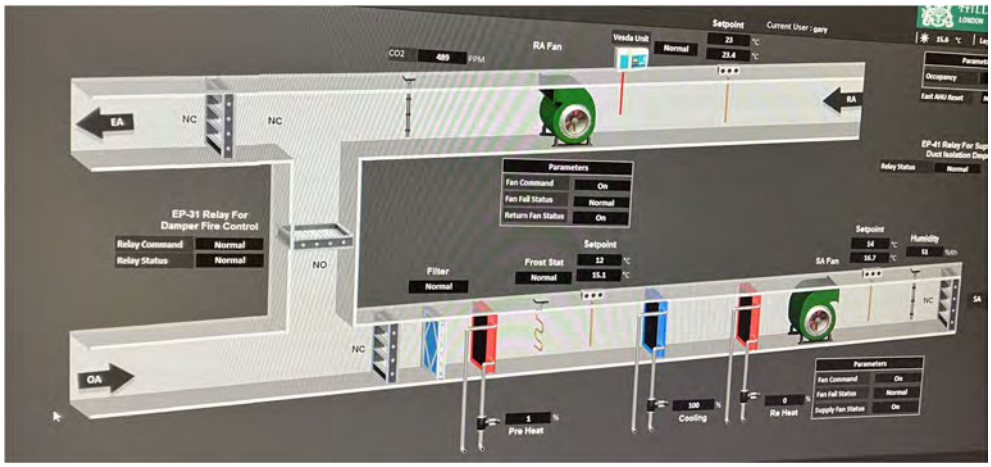

Figure 29. Civic Centre, AHU graphic from BMS remote monitoring page

Figure 30. Civic Centre, Phase 1 South AHU heat recovery actuator and damper disconnected

Ameresco have been advised that during COVID-19 return to work sequence LBH instructed for AHUs in the Civic Centre to lock off and disconnect actuators in order to prevent the mixing of return air and supply air. This will result in a significant increase in heating supply to the AHUs in order to keep up with supply air temperature setpoint heating solely fresh air.

The resultant loss of heat recovery across this range of AHUs will be significant and likely a large contributor to the increase in heating bills the Civic Centre has seen across the past 2 years.

Air Handling Units (AHUs) across the site that include heat recovery:

- *Phase 1: 4no. AHUs located in roof plant room (plant room 4).*
  - Serving North, South, East and West Phase 1 Quadrant office areas.
  - Excludes 2no. Conservatory AHUs no longer in use.
- *Phase 2: 1no. AHUs located in Phase 2 roof plant room.*
  - 1no. serving the Council Chamber.
- *Phase 2A: 2no. AHUs located in Phase 2A "meals-on-wheels" plant room.*
  - 1no. serving the Middlesex Suite and 1no. serving level 1 of Phase 2A.

Anticipated Savings and Other Benefits

Savings for this measure are based on Phase 1 AHUs only. This is due to the limited information in volumetric flowrates for AHUs in Phase 2 and 2A.

Ventilation - distribution	Energy Savings			
	kWh/Yr	£/Yr		CO2 (te/Yr)
				PSDS
Electricity	-	£	-	-
Gas	390,446	£	35,062	71.27
Total	**390,446**	**£**	**35,062**	**71.27**

Table 15. Ventilation Performance Summary – Civic Centre

All savings will be separately measured and/or verified as detailed in the M&V plan.

During the detailed design phase Ameresco will investigate these further and potential further energy savings and/or reduction in carbon emissions could be identified. .

Cost Breakdown

[redacted]

Assumptions and Exclusions

Ameresco assumed the existing damper mechanism is in full working order and damper condition is considered to be adequate for required duty. Any works to the damper or mechanism are excluded from project scope and would be subject to additional cost with LBH's agreement.

Costs for this project only include for fitting a new actuator, associated cabling and recommissioning the operation and control philosophy.