Intended for
Dexter Moren Associates

Project no.
1620005695

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09 November 2018

KINGS CROSS METHODIST CHURCH

CHP ADDENDUM

CONTENTS

Revision History

Rev	Date	Document Ref.	Comments
01	2018/11/02	1620005695-RAM-XX-XX-RT-YS-002	
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1 INTRODUCTION

The Proposed Development comprises a new build Methodist Church and associated accommodation together with 11 leasehold flats on the site of the existing Methodist Church and accommodation which is to be demolished. The scheme is arranged over basement, ground plus four floors and comprises 2,070m^2 of accommodation for the church and associated charity and 852m^2 of leasehold flats.

Decentralised energy production through a combined heat and power (CHP) installation in combination with other fossil fuel sources and/or other renewable technologies is identified as the most cost effective mechanism for delivering carbon dioxide reductions in London. The advantage of a centralised heating system is its flexibility and its ability to utilise a variety of heat sources, including what can be called low-grade heat, in order to supply a wide range of Consumers and Building types.

CHP entails the use of waste heat from an electrical generation for space heating and domestic hot water. It is considered a Low or Zero Carbon technology (LZC) rather than a renewable technology unless a renewable fuel source is used, e.g. biomass. The advantage of CHP is high efficiency – approximately 80% to 90% overall – compared with power stations where heat is not recovered (50% efficiency). It is usually characterised as a low risk, well proven technology.

2 ENERGY DEMAND SIMULATION

2.1 Approach

In this study, Integrated Environmental Solutions (IES) VE dynamic simulation software is used to estimate the space heating, domestic hot water(DHW) and electrical loads. The building model is implement the construction and thermal parameters provided in the Energy Strategy. The drawing below is the Model used in the software package:

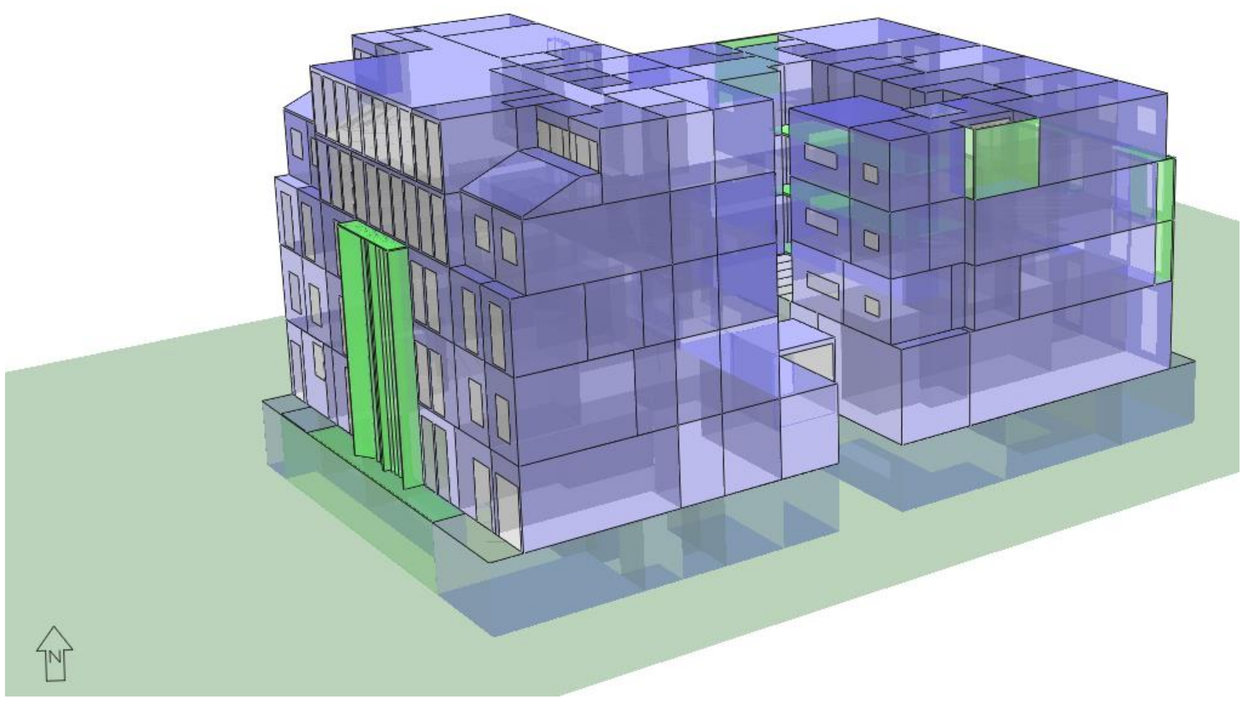


Figure 1 IES model of the proposed development

The proposed building thermal performance is simulated based on dynamic thermal analysis, which has taken account of operational data and heat demand profile for appropriate spaces based on the National Calculation Methodology (NCM) thermal templates.

2.2 Demand profiles

The annual heat demand profile, include space heating and DHW loads, is produced from the hourly dynamic thermal analysis results, as shown in Figure 2. In addition, Figure 3 and xx present the demand profiles of typical winter (January) and summer (July) months.

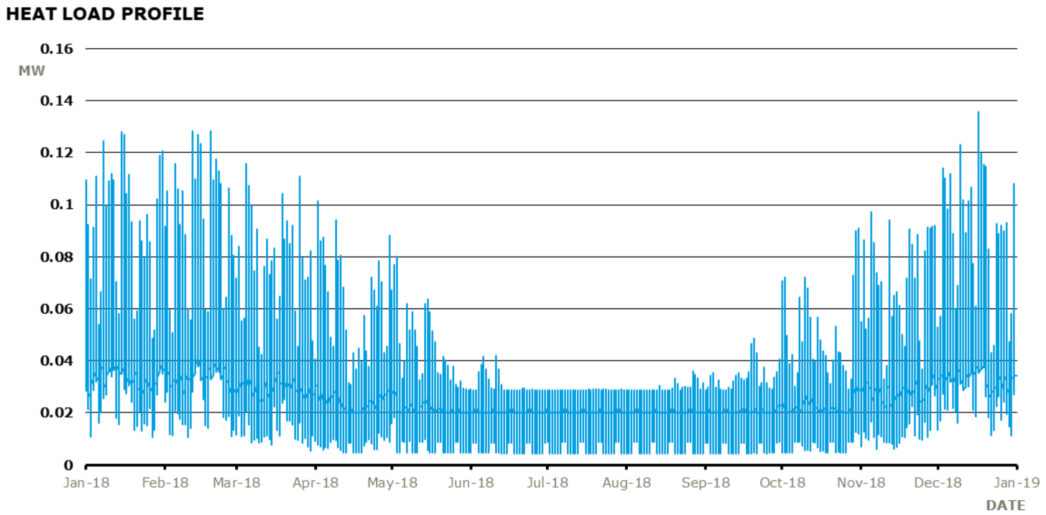


Figure 2: Annual Hourly Heat Demand Profile

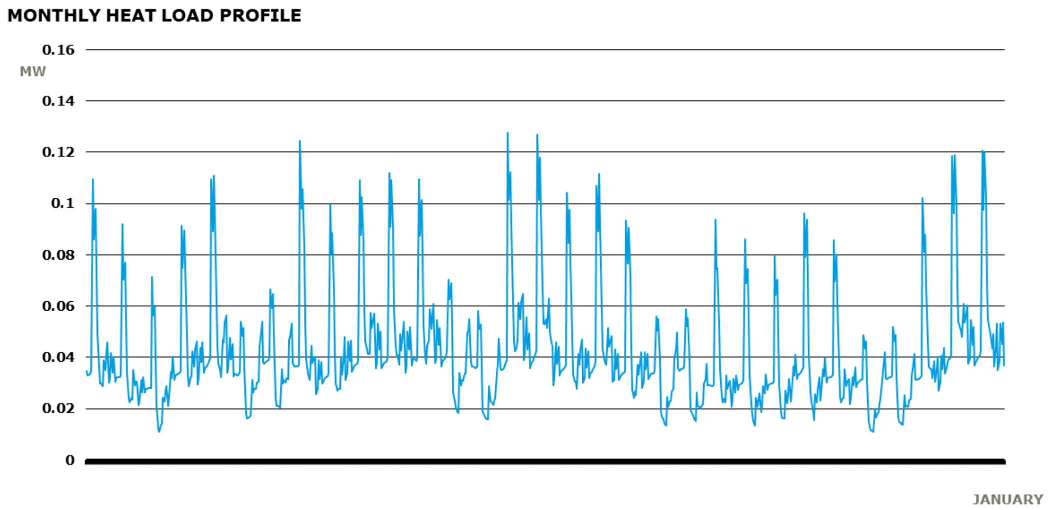


Figure 3: January Hourly Heat Demand Profile

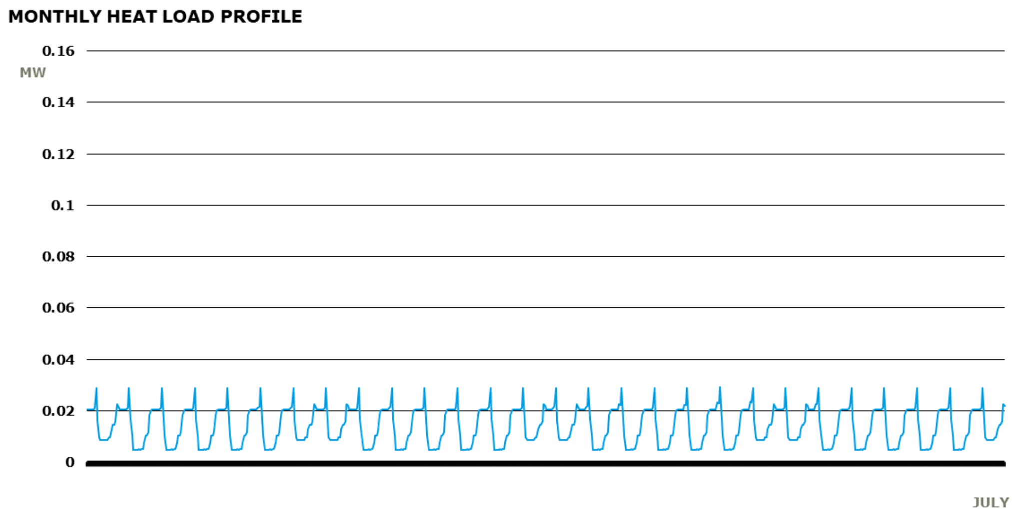


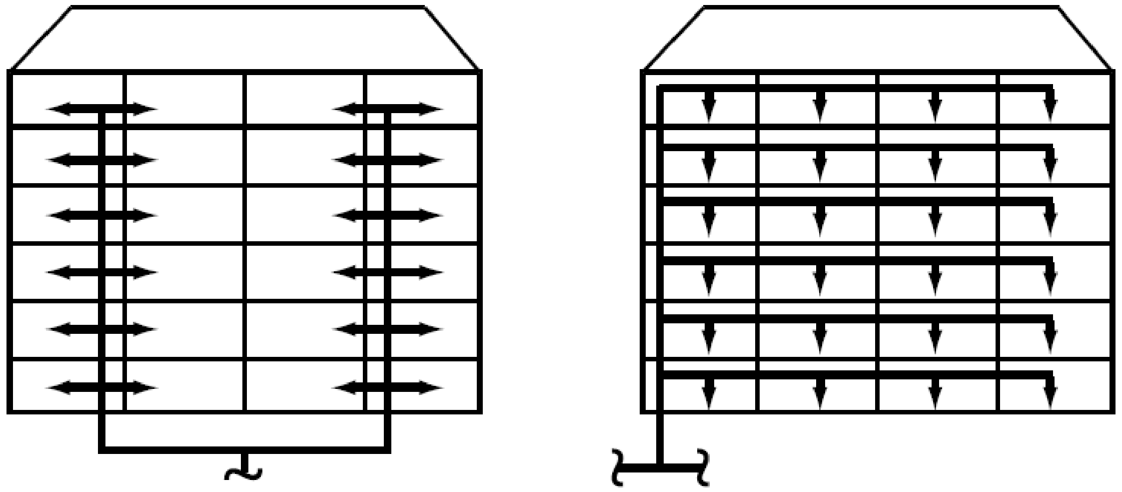
Figure 4: July Hourly Heat Demand Profile

3 CHP ASSESSMENT

3.1 CHP Performance

For this project, the assessment tool of Energy Pro has been used to combine the space heating, Domestic Hot Water (DHW) and electrical loads and simulate the performance of the CHP system within the energy network.

The space heating and hot water demand profiles estimated in Section 2 were used as input for the software. Secondary heat losses were calculated using a benchmark of 15% of the total heat demand as mentioned in the Heat Code of Practice[1]. It was assumed that the heat distribution system will be designed with shared risers to minimize heat losses as indicated in the Figure 5 below.



(a) Shared risers, minimal horizontal distribution

(b) Single riser, horizontal distribution

Figure 5: Schematic of shared risers (a) and horizontal runs (b)[1].

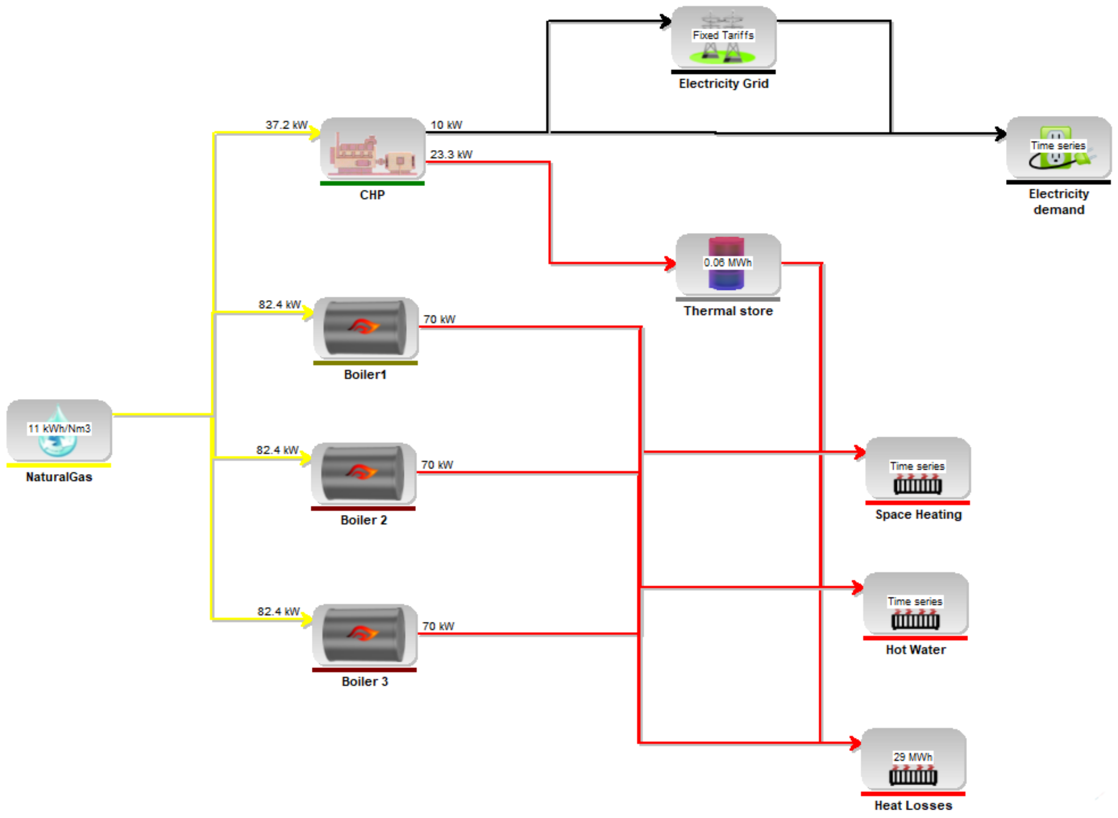


Figure 6: Energy pro model

The energy model was developed in energy pro to estimate the CHP contributions to heat and electricity demand along with the thermal storage input. It should be noted that no cooling demand was modelled, and it was assumed that the electricity produced is exported to the grid at a fixed tariff or used to cover the local demand. The configuration of the Energy Pro model can be seen in Figure 6.

[1] CP1: Heat Networks: Code of Practice for the UK, (2015)

In this study, an ultra-low oxides of nitrogen (NO_x) CHP unit (model: Smith AO Totem T10) with 2000 litres of thermal store and 3 ultra-low NOx gas boilers bas been proposed. The results has proven that the optimal configuration covering the demand with the smallest engine footprint, while meeting the 60%-80% CHP share of heat requirement[2].

The CHP engine achieved 6,906 running hours and 72% of the annual heat share. The total gross of the CHP is 89.7%. The CHP engine data sheets providing additional technical information are included in Appendix 1.

A separate Air Quality Assessment has been carried out by Ramboll (ref: RUK18-24230_3_AQA). It confirms that the CHP would be fitted with a catalyst to significantly reduce emissions of NOx to levels that would comfortably meet the emission limits included within the Mayor of London's Sustainable Design and Construction SPG. The assessment, the scope of which was agreed by Camden Council Officers, has demonstrated that the emissions from the CHP will have a negligible impact on air quality.

It was assumed that the CHP would be out of service for maintenance for three weeks during the summer months. The duration curve for the heat demand can be seen below.

DURATION CURVE OF HEAT

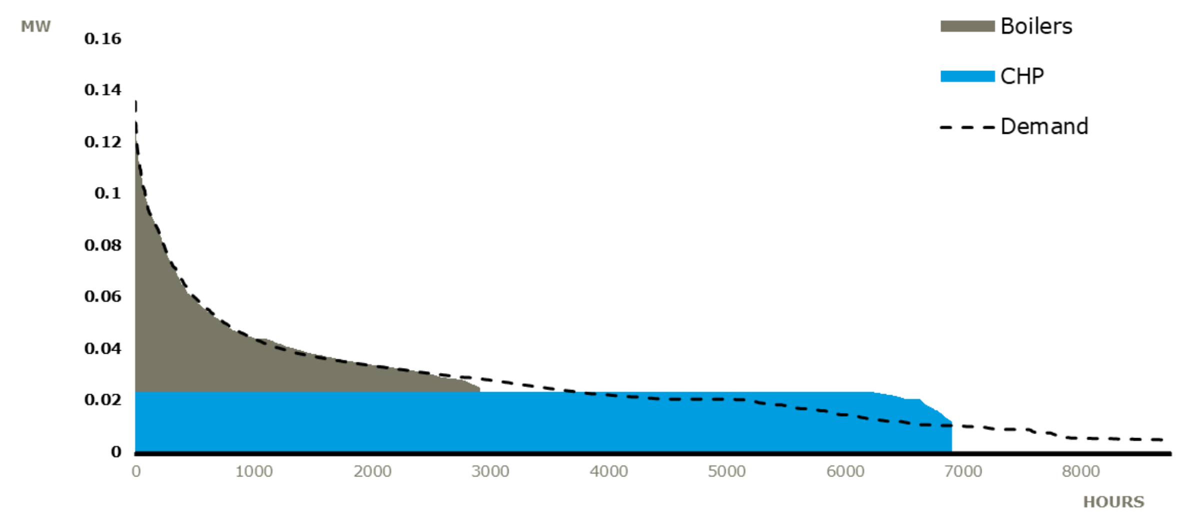


Figure 7 and Figure 8 set out the asset contribution in production for a typical winter and summer period respectively.

PRODUCTION CURVE CHP (23.3 KW THERMAL)

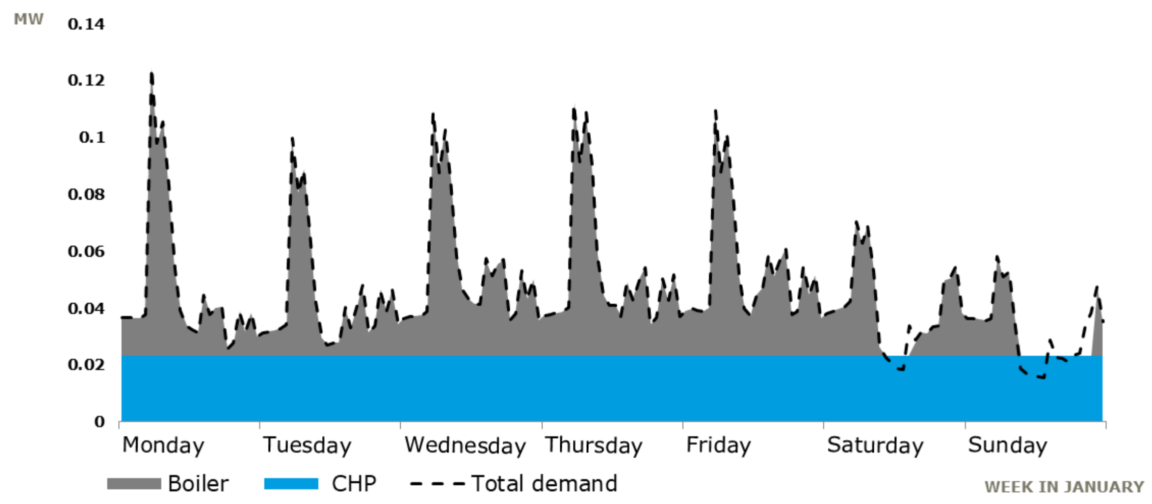


Figure 7: Production curve during winter

Winter is assumed to be the maximum demand scenario where the CHP meets the majority of the demand while during summer, the thermal store and boilers have a larger share.

PRODUCTION CURVE CHP (23.3 KW THERMAL)

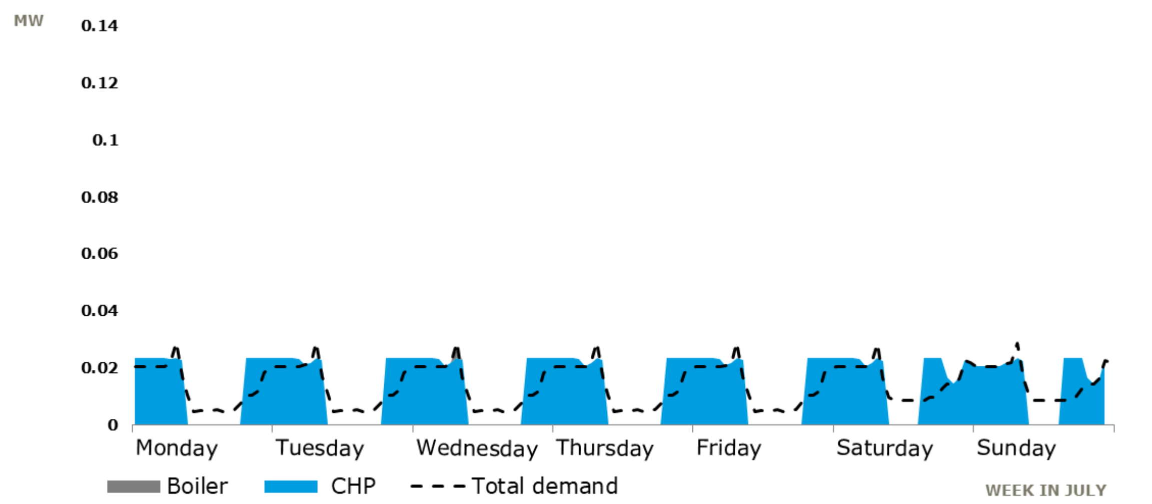


Figure 8: Production curve during summer

[2] CP1: Heat Networks: Code of Practice for the UK, (2015)

3.2 Thermal Store

This study also includes the influence of a thermal store to ensure that the CHP maximises its contribution. The thermal store is charged during low demand hours and discharged during peak conditions to flatten out the heat demand.

The vessel used has a 2000L capacity with a height of 2.5m and thus a ratio of vessel diameter to vessel height exceeding 2.5, ensuring good water stratification. The thermal store profile for a week in summer is illustrated in Figure 9.

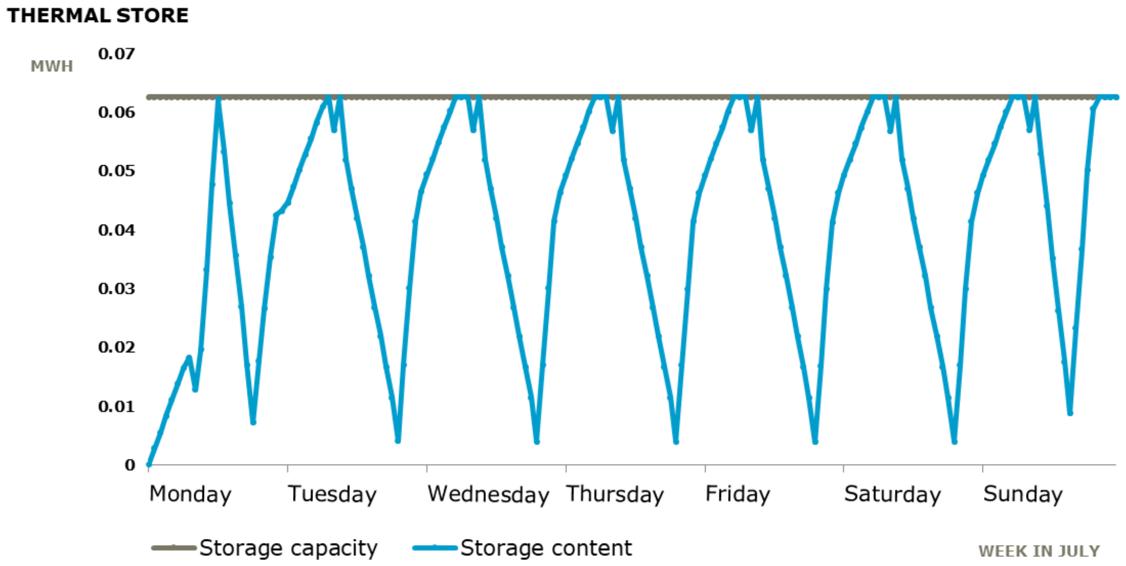


Figure 9: Thermal store charge/discharge profile

4 CONCLUSIONS

In this assessment, an ultra-low oxides of nitrogen (NOx) CHP unit is implemented in the proposed Methodist Church and accommodation development. Based on the simulated heating and electrical demand profile of the proposed development, the CHP engine could achieve 6,906 running hours and 72% of the annual heat share.

A separated Air Quality Assessment has also been carried out confirmed that the NOx emission of the CHP unit would comfortably meet the emission limits included within the Mayor of London's Sustainable Design and Construction SPG. The assessment, the scope of which was agreed by Camden Council Officers, has demonstrated that the emissions from the CHP will have a negligible impact on air quality. (Report ref: RUK18-24230_3_AQA)

Appendix 1 – CHP Datasheet

TECHNICAL SUBMITTAL
TR400018.r2

ADVECO

TOTEM
Cogeneration (CHP) Range

A+++

Highest total efficiency with modulating output and lowest NO_X emissions available

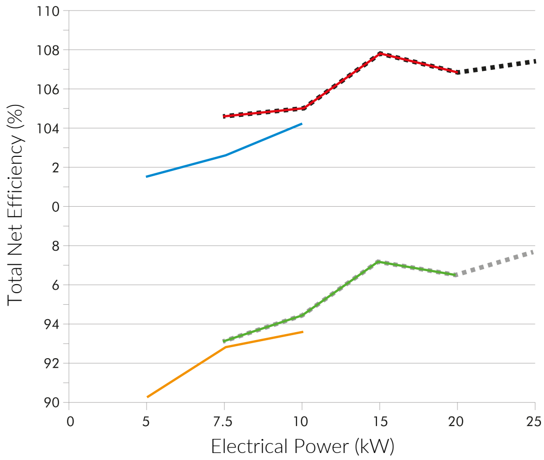
PRACTICAL, EFFICIENT & SUSTAINABLE BUILDING SERVICES SOLUTIONS

Totem Product Range

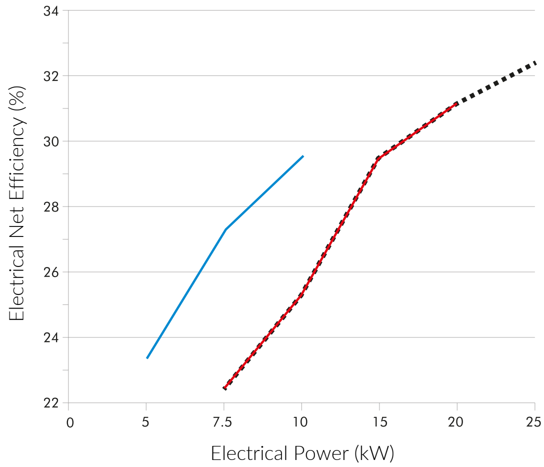
MODEL		T10	T20	T25	T50
OUTPUT air inlet @ 25°C and 101.3 kPa, natural gas (G20) @ 20 mbar					As 2× T25
MAX Output:					
Rated electrical power	kW	10	20	25	50
Power modulation range	kW	≥5	≥7.5	≥7.5	≥7.5
Seasonal space heating efficiency†	%	200	226	251	251
Electrical efficiency (net of machine consumption)*	% LHV (HHV)	29.6 (26.9)	31.2 (28.4)	32.5 (29.5)	32.5 (29.5)
Thermal output (35°C return temperature)*	kW	25.0	48.5	57.6	115.2
Thermal output (70°C return temperature)*	kW	21.6	41.9	50.2	100.4
Thermal efficiency (35°C return temperature)*	% LHV (HHV)	74.7 (67.7)	75.6 (68.7)	74.9 (68.1)	74.9 (68.1)
Thermal efficiency (70°C return temperature)*	% LHV (HHV)	64.0 (58.1)	65.3 (59.4)	65.3 (59.4)	65.3 (59.4)
Total efficiency (35°C return temperature)*	% LHV (HHV)	104.3 (94.7)	106.8 (97.1)	107.4 (97.6)	107.4 (97.6)
Total efficiency (70°C return temperature)*	% LHV (HHV)	93.6 (84.8)	96.5 (87.7)	97.8 (88.9)	97.8 (88.9)
Gas energy input*	kW LHV (HHV)	33.4 (37.0)	64.0 (70.9)	76.6 (84.9)	76.6 (84.9)
Natural gas (G20)*	Nm^3/hr	3.29	6.27	7.56	15.12
Heat to power ratio**		2.50	2.42	2.30	2.30

LHV = Lower Heat Value (Net)   HHV = Higher Heat Value (Gross)

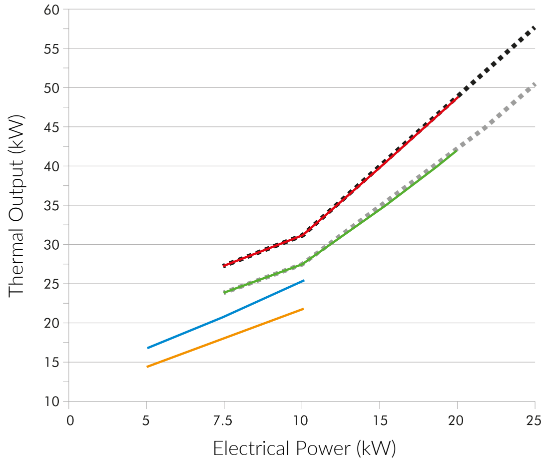
Total Efficiency vs. Electric Load



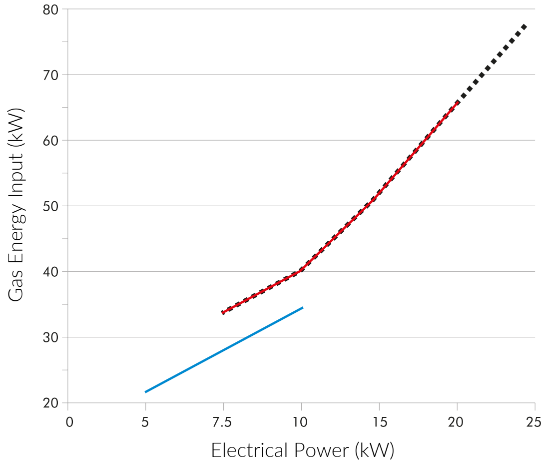
Electrical Efficiency vs. Electric Load



Thermal Power vs. Electric Load



Input Power vs. Electric Load



TOTEM 10 @ 35°C   TOTEM 20 @ 35°C   TOTEM 25 @ 35°C
TOTEM 10 @ 70°C   TOTEM 20 @ 70°C   TOTEM 25 @ 70°C

TOTEM 10 @ 35-70°C   TOTEM 20 @ 35-70°C   TOTEM 25 @ 35-70°C

* Values from independent testing at Milan Technical University and verified by TÜV Rheinland. Unit certified by TÜV Rheinland.

** Heat to Power ratio must be input into SBEM calculations alongside Maximum Gross (HHV) Total Efficiency. For normally stated net efficiencies, divide by 1.1 to calculate gross efficiency.

† As defined by EU No. 811/2013, EN 50465/2015

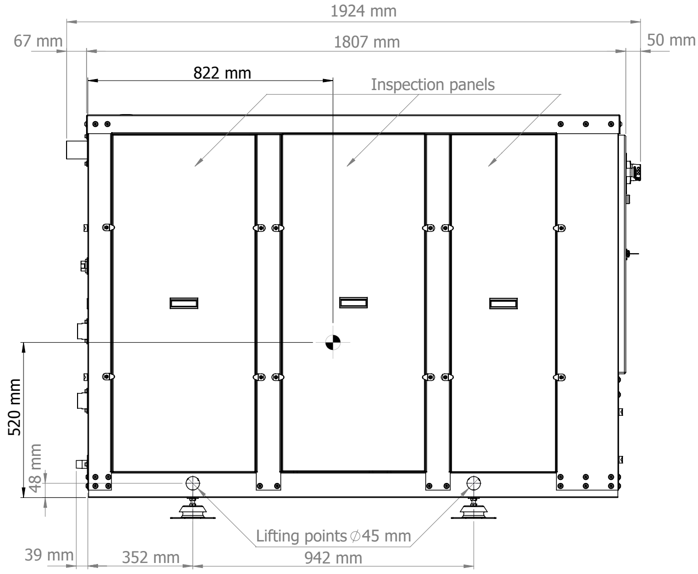
MODEL		T10	T20	T25	T50
OUTPUT air inlet @ 25°C and 101.3 kPa, natural gas (G20) @ 20 mbar					As 2× T25
Modulating 40/50% Output:					
Rated Electrical Power	kW	5	10	10	10
Electrical efficiency (net of machine consumption)*	% LHV (HHV)	23.7 (21.4)	25.5 (23.0)	25.5 (23.0)	25.5 (23.0)
Thermal output (35°C return temperature) *	kW	16.4	30.9	30.9	30.9
Thermal output (70°C return temperature)*	kW	14.1	27.0	27.0	27.0
Thermal efficiency (35°C return temperature)*	% LHV (HHV)	77.9 (70.5)	79.4 (71.7)	79.4 (71.7)	79.4 (71.7)
Thermal efficiency (70°C return temperature)*	% LHV (HHV)	70.0 (60.5)	69.2 (62.5)	69.2 (62.5)	69.2 (62.5)
Total efficiency (35°C return temperature)*	% LHV (HHV)	101.5 (91.6)	105.0 (94.8)	105.0 (94.8)	105.0 (94.8)
Total efficiency (70°C return temperature)*	% LHV (HHV)	90.3 (81.5)	94.4 (85.2)	94.4 (85.2)	94.4 (85.2)
DIMENSIONS AND WEIGHTS					
h x w x l (rigged up with panels - standard version without feet)	mm	1,280x795x1,924			1,280x2,390x1,924
Weight Full	kg	720	780	780	1560
HYDRAULIC CIRCUIT					
Maximum inlet water temperature	°C	70			
Maximum outlet water temperature	°C	80			
Rated water flow	l/h	2,500	4,000	5,000	10,000
Maximum pressure drop through unit	kPa	60			
Maximum working pressure	bar	10			
ASYNCHRONOUS GENERATOR					
Operation		In parallel with grid			
Three phase voltage/Frequency	V/Hz	400/50			
Engine starter		Starter motor			
Electrical generator connection		3 phase and neutral			
WORKING CONDITIONS					
Max Ambient Conditions (temperature/relative humidity)	°C/RH	40/75%			
Acoustic impact Lp					
@ 1 m distance in open field	dB(A)	56.7	61.1	61.1	64.1
Exhaust emission					
NO_X Emissions @ 5% O_2	mg/Nm^3	<10	<10	<10	<10
NO_X Emissions @ 0% O_2	mg/kWh	<12	<12	<12	<12
CO Emissions @ 5% O_2	mg/Nm^3	<10	<10	<10	<10
Max flue gas temperature (normal conditions)	°C	77			
Max flue gas temperature (fault condition)	°C	100			
Flue gas mass flow rate	kg/h	55	100	125	250
Condensate mass flow rate (35°C return temperature)*	kg/h	1.37	3.04	3.14	6.28
Max flue system pressure drop	Pa	500			
Max flue run (80mm PP flue) Total Equivalent Length*	m	32	23	23	23
Flue material specification		T120 and H1			
Asynchronous three-phase alternator					
Rated power*	kW	10.10	20.09	25.06	50.12
Frequency	Hz	50			
Rated voltage	V	400			
Poles		4	2	2	2
Insulation Class		F			
Efficiency Class		IE3			
Power Factor		0.962			

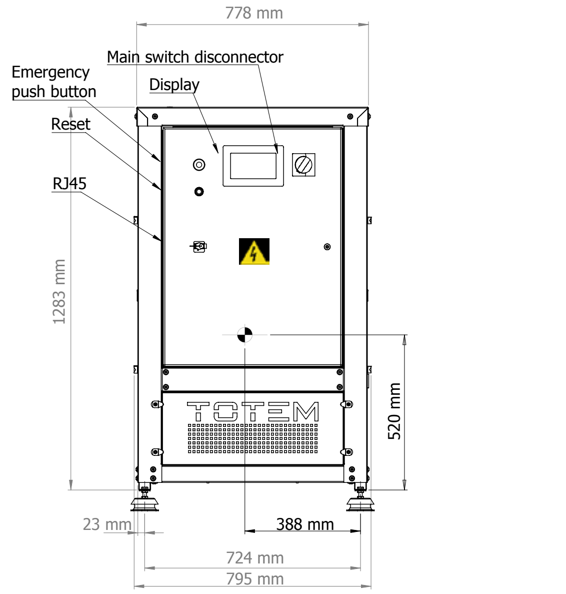
* Values from independent testing at Milan Technical University and verified by TÜV Rheinland. Unit certified by TÜV Rheinland.

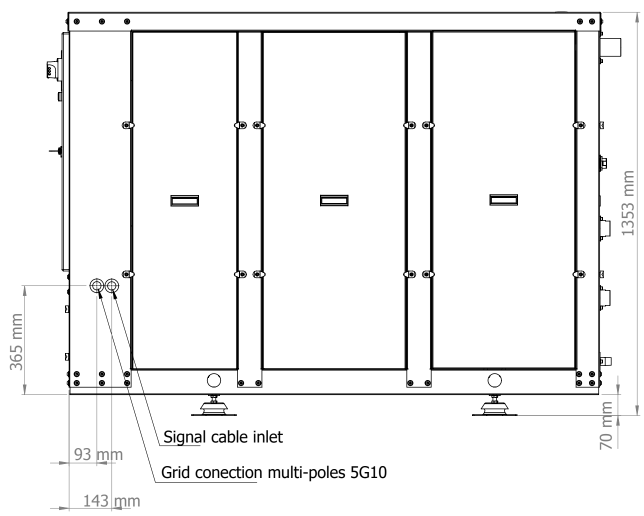
** Heat to Power ratio must be input into SBEM calculations alongside Maximum Gross (HHV) Total Efficiency. For normally stated net efficiencies, divide by 1.1 to calculate gross efficiency.

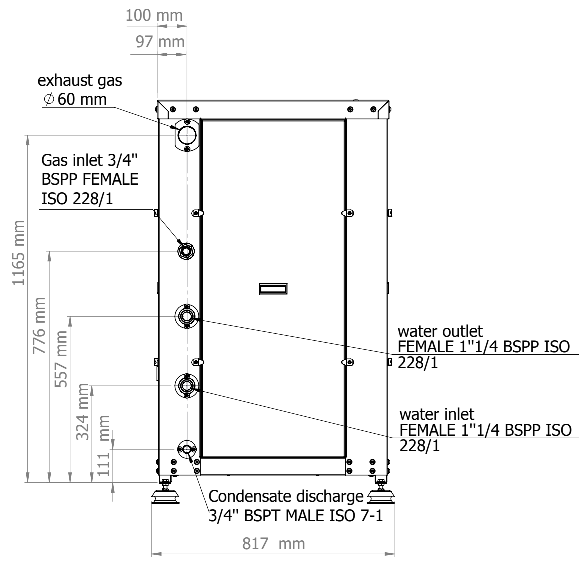
† As defined by EU No. 811/2013, EN 50465/2015

Technical drawings

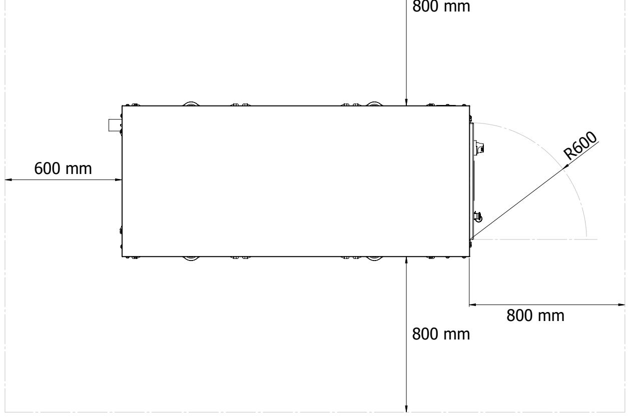








Clearances



Options and Ancillaries

- System buffer vessels
- Primary and secondary pumps: single or twin head with controls to share load
- Installation kits for the CHP system and buffer vessel accounting for all fittings and components
- Submetering available for gas, electric and heat
- Expansion vessels and pressurisation units
- G59/G83 interface protection panels
- Commissioning and witness testing
- G59 application assistance
- Maintenance plans

Buffer Vessel Options

- Carbon steel buffers from 500L to 10000L
- High and low level flow and return connections
- Extra tappings for use with multiple heat sources, low and high grade heat sources, varying return temperatures or glycol-filled primary loops.
- Vessels up to 5000L can mount up to two high-capacity internal heat exchange coils for use with indirect heat sources
- 5 bar working pressure
- 100mm flexible polyurethane insultation with removable outer PVC jacket
- Bespoke options available upon request

Adveco also offer the following products and services:

- Bespoke system design
- Maintenance and service packages
- Buffer tanks
- Indirect and direct hot water systems
- Off-site manufacturing of skids and plant rooms
- Controls systems
- Packaged plate heat exchangers
- Solar thermal systems
- Gas fired heating systems
- Combined heat & power cogeneration systems

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