

Sustainability / Energy Statement

Heating and Domestic Water Energy Consumption / Carbon Footprint

Heating, domestic hot water and CAT 5 hot water energy consumption for George Begg and John Garside Buildings was unavailable from the original from the north campus steam district heating system, to ascertain the load profile of the of the building the gas consumption of the temporary boiler plant has been logged twice daily against the ambient temperature in the Princess Street carpark from December 2024 to March 2024, observations of the plant activity were also made to validate the data.

A sample data set is detailed below.

University of Manchester MIB Plantroom Gas consumption											
DAY	Date	Time	Temp	Meter Reading m3	10.7945333	KWh Total	KW	Time	Time	KW	Daily Cost
Thurs	07/12/2023	10:00	9°C	0045227.8	488212.99	488212.99	Daily Ave	Clock	Decimal	Peak	£0.064 kW/h
	07/12/2023	15:30	6°C	0045604.5	492279.30	492268.50					
Fri	08/12/2023	09:45	9°C	0046724.3	504367.01	16154.0	673.1	04:05	4.08	675.7	
	08/12/2023	13:50	9°C	0046979.9	507126.10	14846.8	618.6				£950.20
Mon	11/12/2023	09:40	9°C	0051216.4	552857.14	48490.1	673.5	05:40	5.67	761.4	
	11/12/2023	15:20	10°C	0051616.1	557171.71	50045.6	695.1				£1,067.64
Tue	12/12/2023	09:30	8°C	0052713.8	569020.87	16163.7	673.5	05:50	5.83	637.9	
	12/12/2023	15:20	9°C	0053058.5	572741.75	15570.0	648.8				£978.17
Wed	13/12/2023	09:00	7°C	0054129.7	584304.85	15284.0	636.8	06:00	6.00	745.0	
	13/12/2023	15:00	6°C	0054543.8	588774.87	16033.1	668.0				£1,197.38

The data is being utilised to evaluate the energy cost for the buildings, the carbon footprint and to validate that the capacity of proposed replacement plant solution is appropriately selected to support the building load.

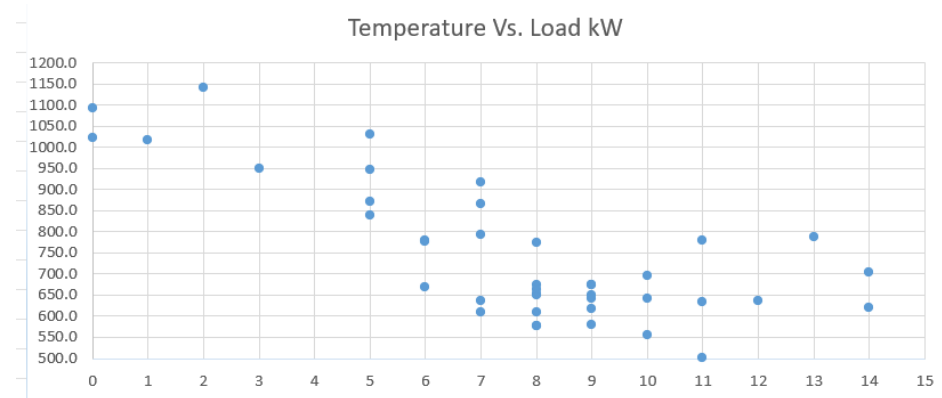
UoM – North Campus – Energy Centre

RIBA STAGE 3

The data set has been filtered and reordered to profile the plant energy consumption against daily temperature in lieu of the date recorded.

A scatter graph to the right indicates the typical range of daily average consumption vs. ambient temperature. The graph indicates a spread of energy consumption, the range of values will be accounted for by a combination of factors: Wind effect on the building, the activity of users within the building and the utilisation of process equipment.

October 2024 Rev 01



To establish energy consumption the average value of the profile will be interpolated, for plant capacity the extreme values are considered.

The interpolated data shows that at the demand profile for daily average gas consumption is:

1,500kW at -5.0°C tapering off to 250kW at 20.0°C.

It should be noted that the figures represent the gross gas input to the plant and not the delivered energy, the boilers installed would have a nett efficiency of circa 80%, this would give a building load profile of:

1,200kW at -5.0°C tapering off to 200kW at 20.0°C.

The taper doesn't tend towards zero as the domestic water load remains outside the heating season alongside distribution losses from the plant and pipework.

Regional Met office weather data gives an annual daily average temperature of 9.0°C, with a range of 5.55°C to 12.79°C.

To evaluate the likely energy consumption the average figure of 9.0°C will be taken, this against the average load for this temperature of 660kW.

The resultant annual energy input to the building is:

660kW x 24hrs x 365days = 5,781,613 kWh.

The energy cost and carbon footprint of the heating and domestic water system can be considered in four scenarios:

- 1, Served from the original district steam system.
- 2, Served from modern gas fired boilers.
- 3, Served from heat pumps.
- 4, Served from heat pumps with heat recovery from cooling systems.

Region: England N

Climate period:

1991-2020

Month	Maximum temperature (°C)	Minimum temperature (°C)
January	6.41	1.09
February	7.05	1.11
March	9.21	2.16
April	12.03	3.77
May	15.17	6.35
June	17.82	9.17
July	19.91	11.18
August	19.52	11.15
September	16.92	9.15
October	13.10	6.47
November	9.26	3.51
December	6.76	1.24
Annual	12.79	5.55

Sustainability / Heating / Domestic Hot Water Energy Use

Steam District Heating

The original steam system considering distribution losses is likely to have a nett efficiency to the building of circa 60%.

kWh energy input 5,781,613 kWh / 60% = **9,636,022 kWh** (Input)

4.4p/kWh gas x 9,636,022 kWh = £423,985.00 annual gas cost.

1763 T CO₂ x £45 UKETS cost = £79,322.00

Total Energy + UKETS cost = £503,307.00

The carbon emissions from the gas consumption based on current UK data are:

CO₂ 0.18293 kg / CO₂ per kWh x 9,636,022 kWh = **1763 T CO₂**

New Gas Fired Plant

New gas fired boiler plant is likely to have a nett efficiency to the building of circa 80%.

kWh energy input 5,781,613 kWh / 80% = **7,227,016 kWh** (Input)

4.4p/kWh gas x 7227016.25 kWh = £317,989.00 annual gas cost.

1763 T CO₂ x £45 UKETS cost = £59,492.00

Total Energy + UKETS cost = £377,481.00

The carbon emissions from the gas consumption based on current UK data are:

CO₂ 0.18293 kg / CO₂ per kWh x 7,227,016 kWh = **1322 T CO₂**

Air Source / Water Source Heat Pumps

The seasonal efficiency of an ASHP / WSHP heating and domestic water solution is likely to deliver a COP ratio of circa 2.5 to 1.

The resultant electricity consumption will be:

$5,781,613 \text{ kWh} / 2.5 = 2,312,645 \text{ kWh}$

$19.7\text{p/kWh electricity} \times 2,312,645 \text{ kWh} = \text{£455,591.00 annual electricity cost.}$

$\text{CO}_2 0.1360 \text{ kg} / \text{CO}_2 \text{ per kWh} \times 2,312,645 = 314 \text{ T CO}_2$

Air Source / Water Source Heat Pumps with Heat Recovery

A simple case study has been carried out looking at the potential heat recovery from the George Garside / MIB chiller plant to establish the viability of recovering waste heat energy on to the ambient loop heat network.

The following data was applied:

Peak cooling load: 1,200kW

Average cooling load factor: 20% (Average annual cooling load during daylight hours)

Average recoverable energy: 240kW

Annual heat network energy saving kWh: 1,051,200 (240kW x 365 days x 12 hours)

Primary heat network COP: 4

Annual electricity consumption offset kWh: 262,800 (1,051,200kWh / 4)

Annual energy cost saving @ 19.7p/kWh = £51,772.00

Annual Carbon Saving Tons @ 0.136 kgCO₂e/kWh: 36

Heat network energy cost with heat recovery £403,819.00

This demonstrates that the introduction of partial waste heat recovery to the ambient heat loop very quickly closes the heating energy cost of electricity with that of efficient gas fired boiler plant. Should process cooling heat recover be added to the ambient loop network cost parity could easily be realised.

Energy Costs

The energy cost comparison identifies that all renewable energy solutions will have a lower operating cost than the original steam system that served the buildings. However, compared to new gas fired plant the renewable energy solutions will moderately increase the energy cost until waste heat recovery is incorporated. The heat pump option with heat recovery does not form part of the current scope of the project, this is indicative of the resultant efficiency if cooling plant within the building was integrated with the energy centre, this option can be integrated in the future.

Carbon Footprint

The heat pump solution will deliver in all scenarios a very significant CO₂ reduction, this will typically be over 70%, this figure will increase as the electricity grid decarbonises.

1763 T CO₂ (original peak) 279 T CO₂ (heat recovery option) = **1484 T CO₂ (Potential saving) or a 84% reduction.**

1763 T CO₂ (original peak) 315 T CO₂ (standard heat pump) = **1448 T CO₂ (Potential saving) or a 82% reduction.**