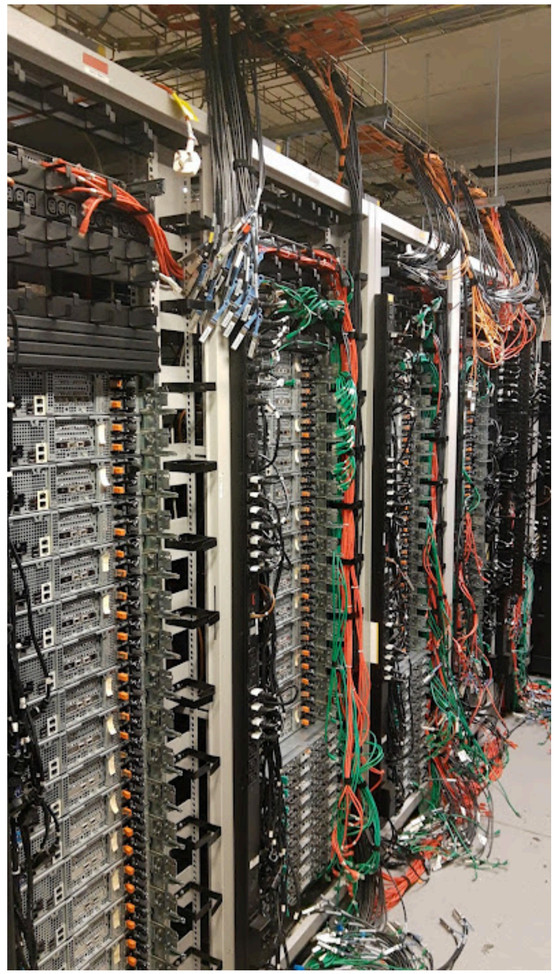
Refurnishing your Data Centre

Daniel Traynor, QMUL, CHEP2023

to reduce the carbon footprint



History

Original facility built and commissioned in ~2004.

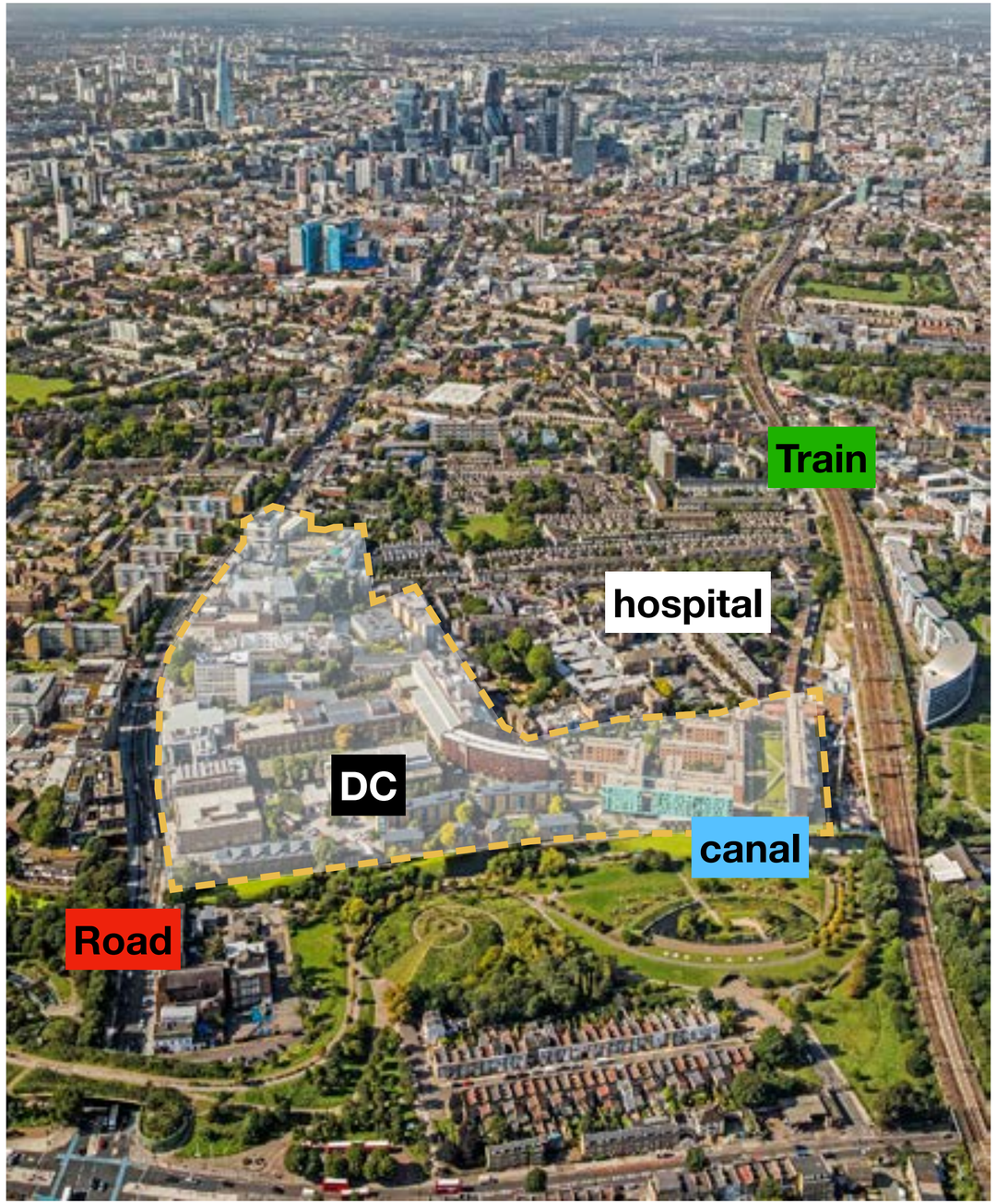
Built on a budget, with compromises and limited knowledge. Provided a 200KW facility over 22 racks on the 2nd Floor of half filled new Chemistry building. No raised floor, no hot/cold air containment, shallow depth, open racks.

By 2018 having to rely on 2nd hand parts to maintain chillers. During covid all old units broke, no more spare parts, left with only 150KW of replacement, temporary chillers.

Power distribution needed to be replaced (heat damage).

Need to support LHC + SKA +LSST +,… for ~ 15 more years.

clear that >15 year old facility needed refurbishment.



Boundary Conditions

Highly constrained site with protected historic buildings, cemeteries, conservation areas, parks, transport links.

Offsite data centres are full or costly, and have increased remote management overheads.

No alternative existing space suitable for new DC

No new build space for new DC till after 2030

Only option is to reuse the existing space

Need to plan for future expansion ~400KW

Boundary Conditions(2)

Data Centre

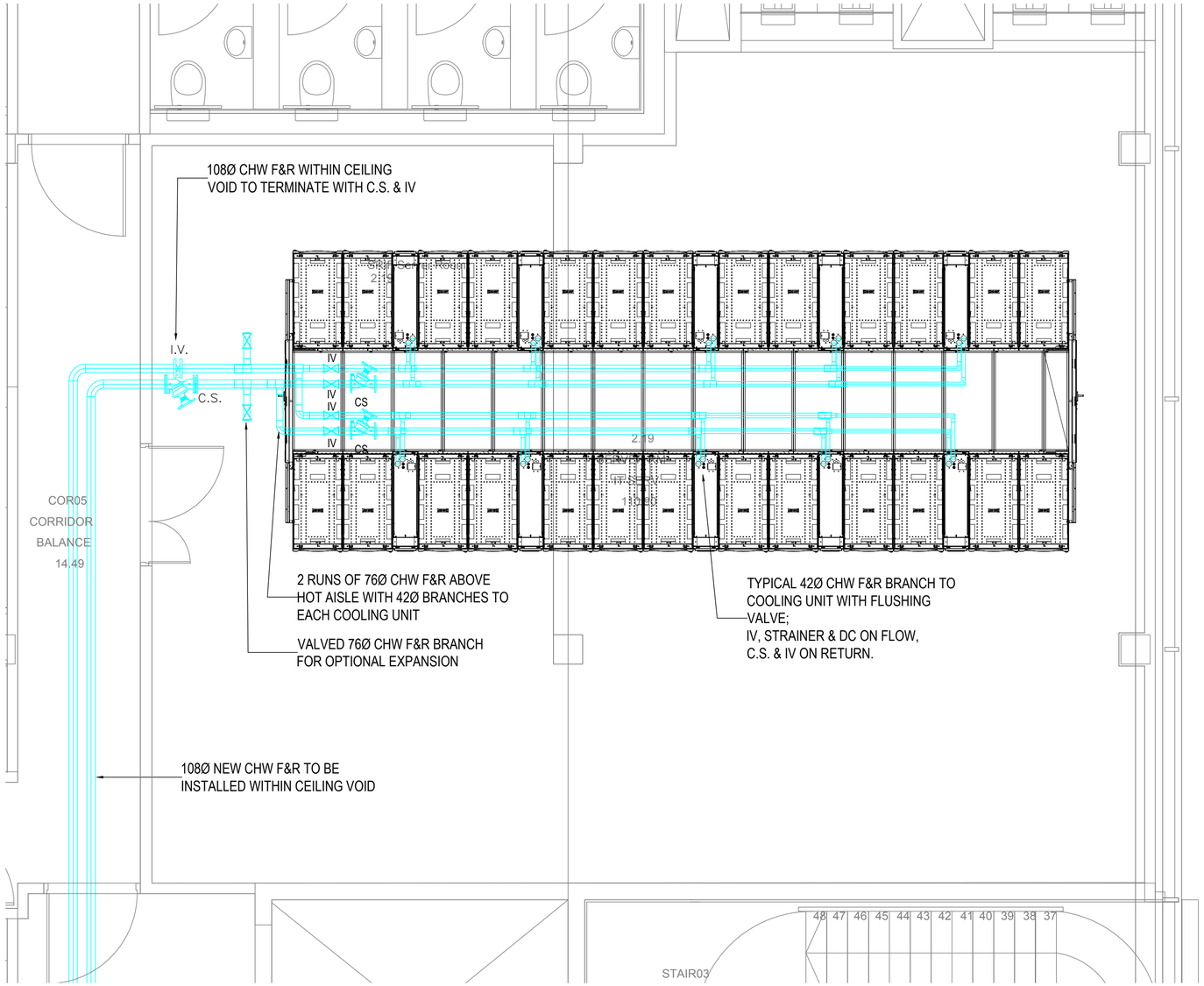
Our Data Centre is located in the Joseph Priestly (JP) building (chemistry)

Building Chillers 2* 300KW (redundant pair)

Original 6 condensers providing 200KW cooling

Electrical substation (building has plenty of electrical power capacity)

First Refurbishment Plan



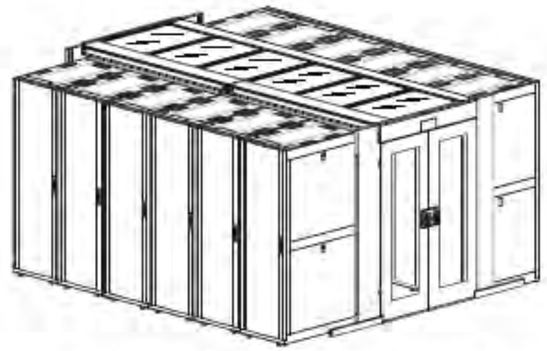
Hot aisle containment with in row coolers

10KW(average) per rack, 26 racks, 2 rows, 260 KW total.

Dual 32 amps power feeds per rack

Chilled water circuit. 4+1 in row cooling per row, 17C water in, 23C out. High level piping. 26C cold / 41C hot aisle air temperature!

Reuse existing building chillers +dry (free) air cooler



DUAL-AISLE CEILING CONTAINMENT

QM has a what?

SILVER
Energy Management Solutions

Queen Mary
University of London

Queen Mary, University of London

Heat Decarbonisation Plan

March 2022

Silver Energy Management Solutions Ltd
St Clare House, 30/33 Minories
London EC3N 1DD
T: 020 3900 1509

Plan

Six year 30% carbon reduction target

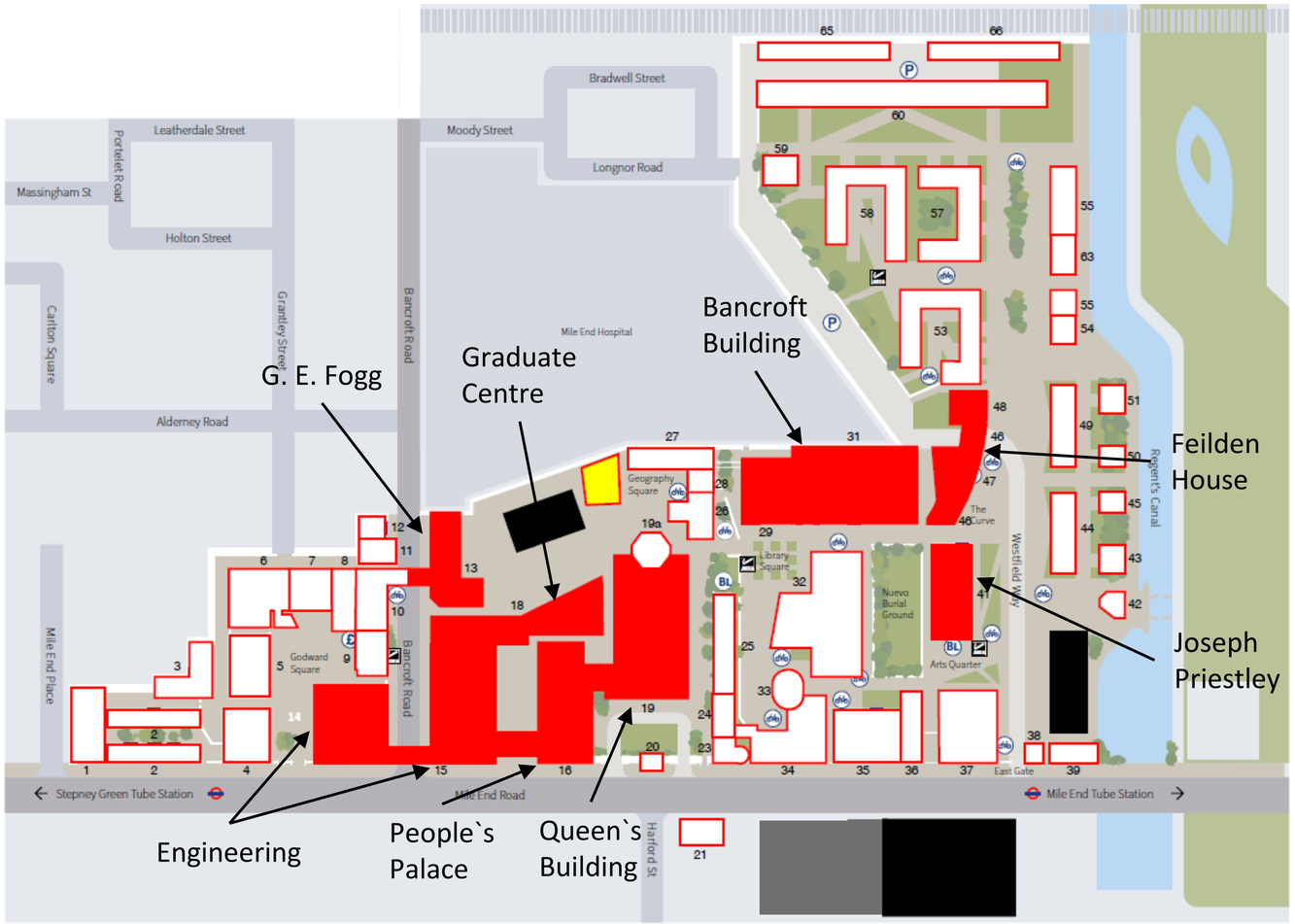
Energy use: 30,610,159 kWh electricity; 25,762,996 kWh gas

Electricity is slowly becoming dominated by wind, solar, nuclear, hydro electric (i.e. becoming decarbonised

J.P building largest consumer of power (natural gas+electricity) on campus
(Chemistry building has lots of ventilation).

Use heat from DC to replace Gas heating.

QM has a what?



Energy Centre

Buildings which are connected to the heat network

District heating system

QMUL has a district heating system linking several buildings
(This is unusual in the UK)

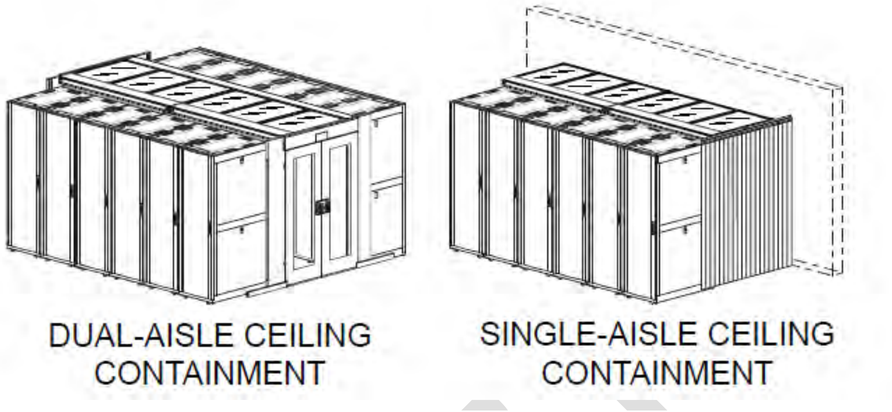
Plans to extend to student residencies

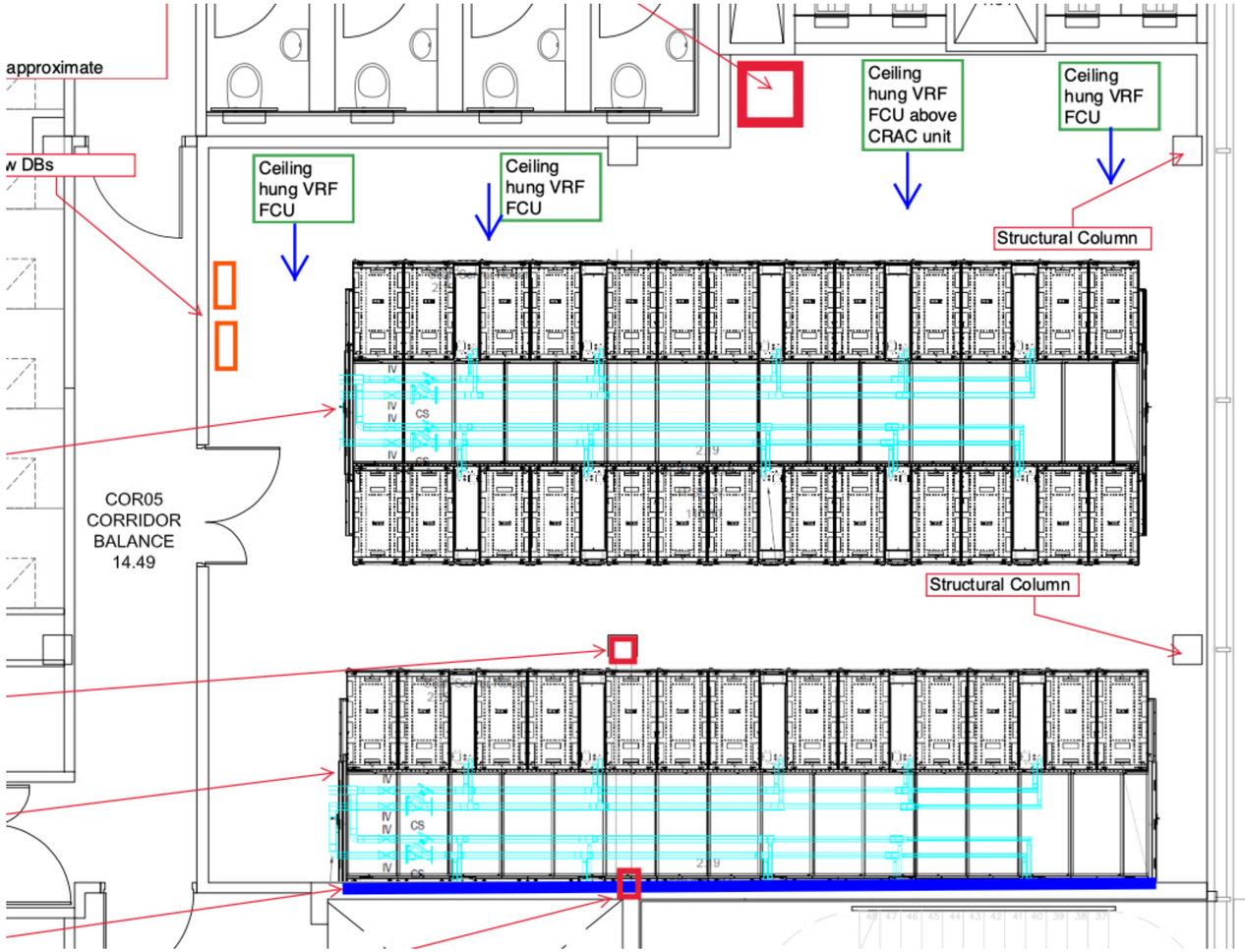
Gas fired boilers provide the heating

Use heat from DC to replace some of the gas heating.

Second Refurbishment Plan

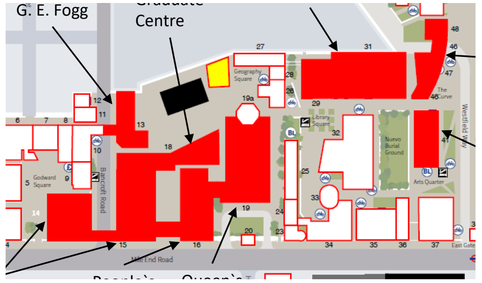
- New power, floor, lighting, cable management
- 10KW(average) per rack, 39 racks, 3 rows, 390KW
- Redundant dual 32 amps power feeds per rack.





Second Refurbishment Plan

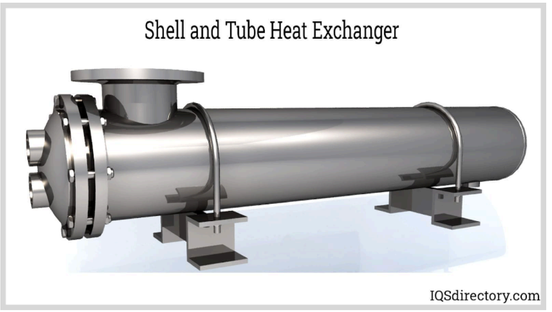
- To connect the low grade waste heat (26C) from the DC we need to
  - Redundant heat pumps to turn heat in to 75C high grade hot water (water to water more efficient than air to water).
  - Heat exchanger to put heat into district heating system.
  - Water tanks to hold reservoir of hot and cold water + other works needed
- Extra row of 13 racks (+130KW capacity),
- Strip out then add new power, lights, floor, cable management.
- Double the cost of original plan - needs to be justified to get the investment.



District heating

Hot water store

75C



Cluster

26C

Heat pump

75C

Heat exchanger

17C

17

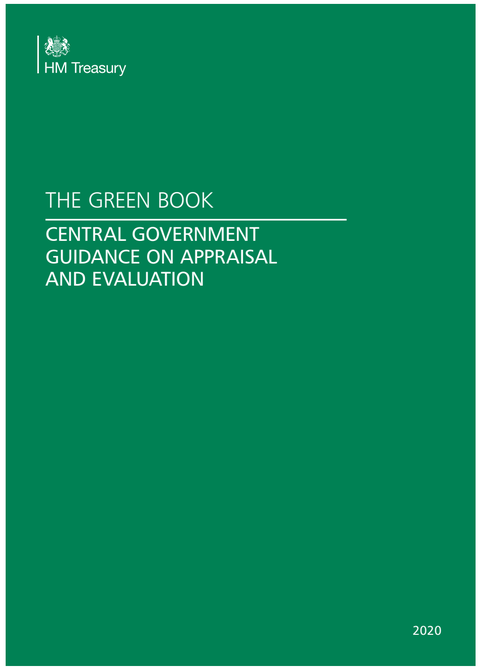
75C

Cold water store

Hot water store

Dry air cooler

Justification



Using UK Government "Green book" guide lines on project evaluation

Provides best practice to quantify the impact of a project - social, economic, environmental

We have used this "tool kit" to work out impact on CO2 emissions

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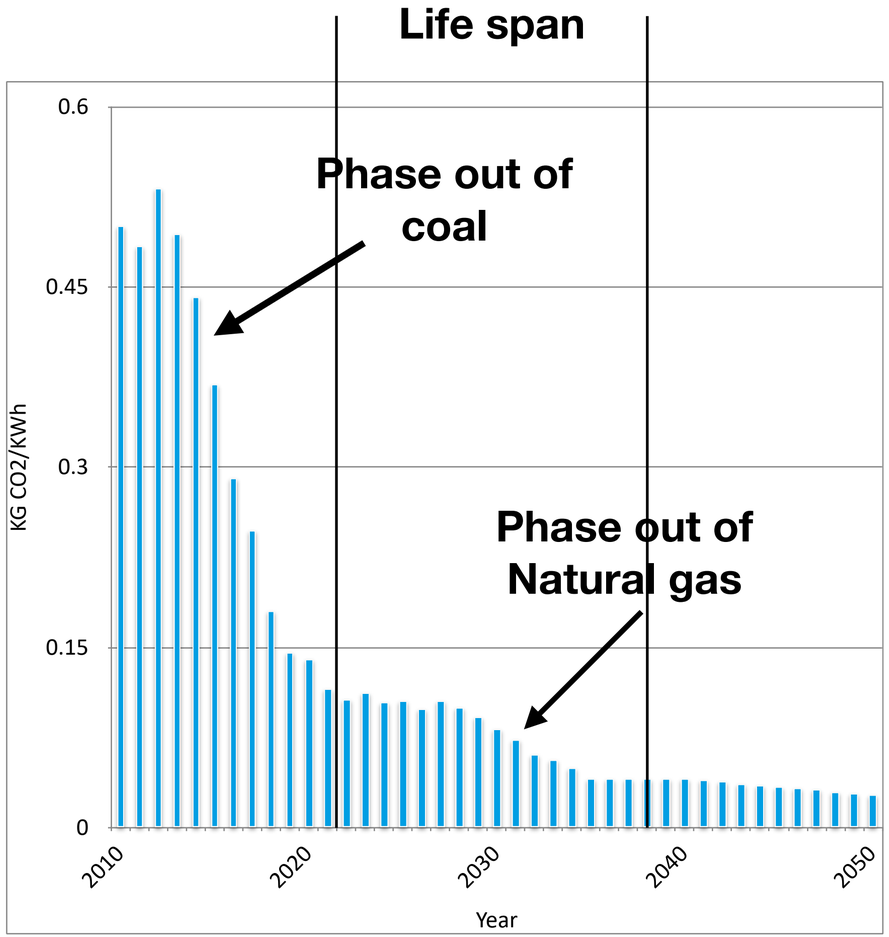
Unfortunately electricity is 2-3 times more expensive than natural gas

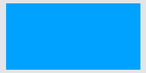
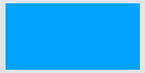
For every 1KWh of heat pumped we consume an additional .3KWh for the heat pump! (~PUE1.3)

We have used this "tool kit" to work out payback time (inc discount rate)



Since 2018 the CO2 produced per KWh of electricity below that for KWh of natural gas

Justification

SCOPE	Minimum scheme: No Heat recovery	Full scope: Heat recovery & dry air cooler
Racks	26	39
Cooling Capacity	260KW	390KW
District Heating connection	No	Yes
APX cost		
15 Year carbon saving (2/3 capacity) Metric Tons	0	8,172
Pay back years	NAN	7

1,819 years or driving a car, 135,000 trees after 10 years, 8 seconds of world CO2 production

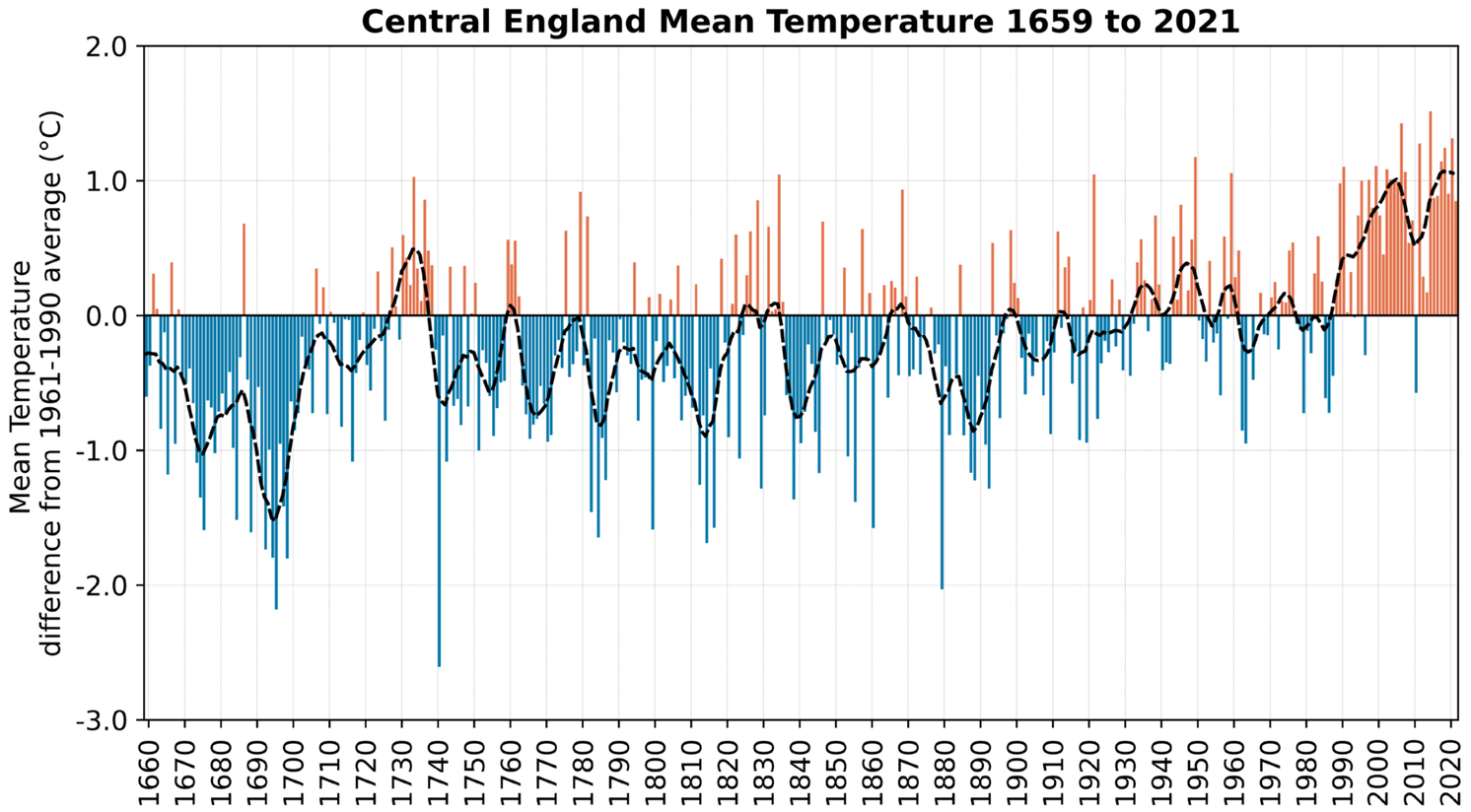
https://www.epa.gov/energy/greenhouse-gas-equivalencies-calculator

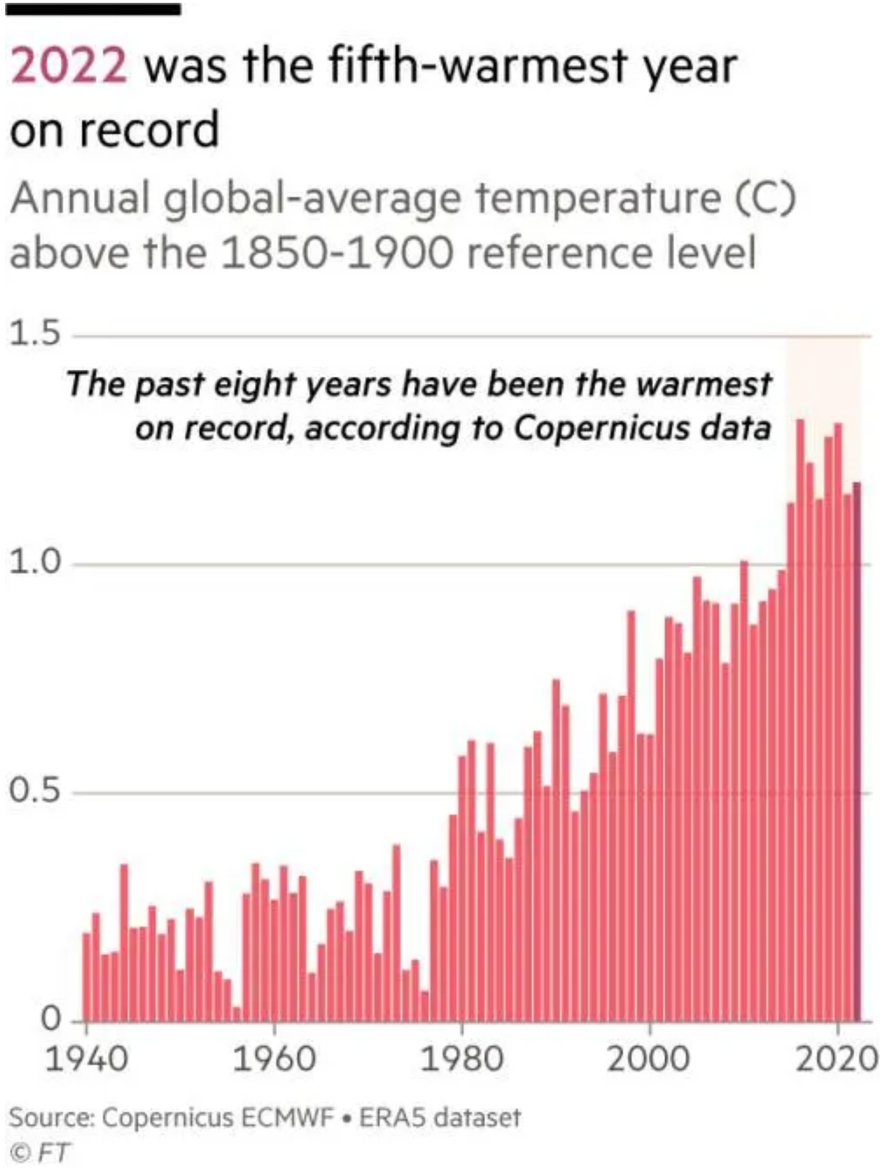
Notes

- Project awaiting official sign off from senior management.
- Project has taken over two years (still waiting).
- Needed a project manger that understands building infrastructure, heating, electricity. Knows how to talk to the suppliers and can drive the project vitally important. Before we had one the project limped along.
- Needed to justify extra spending in a way that was easy to understand.
- Air cooling only of computers, i.e. Do not have on chip water cooling option, may limit future computing options.

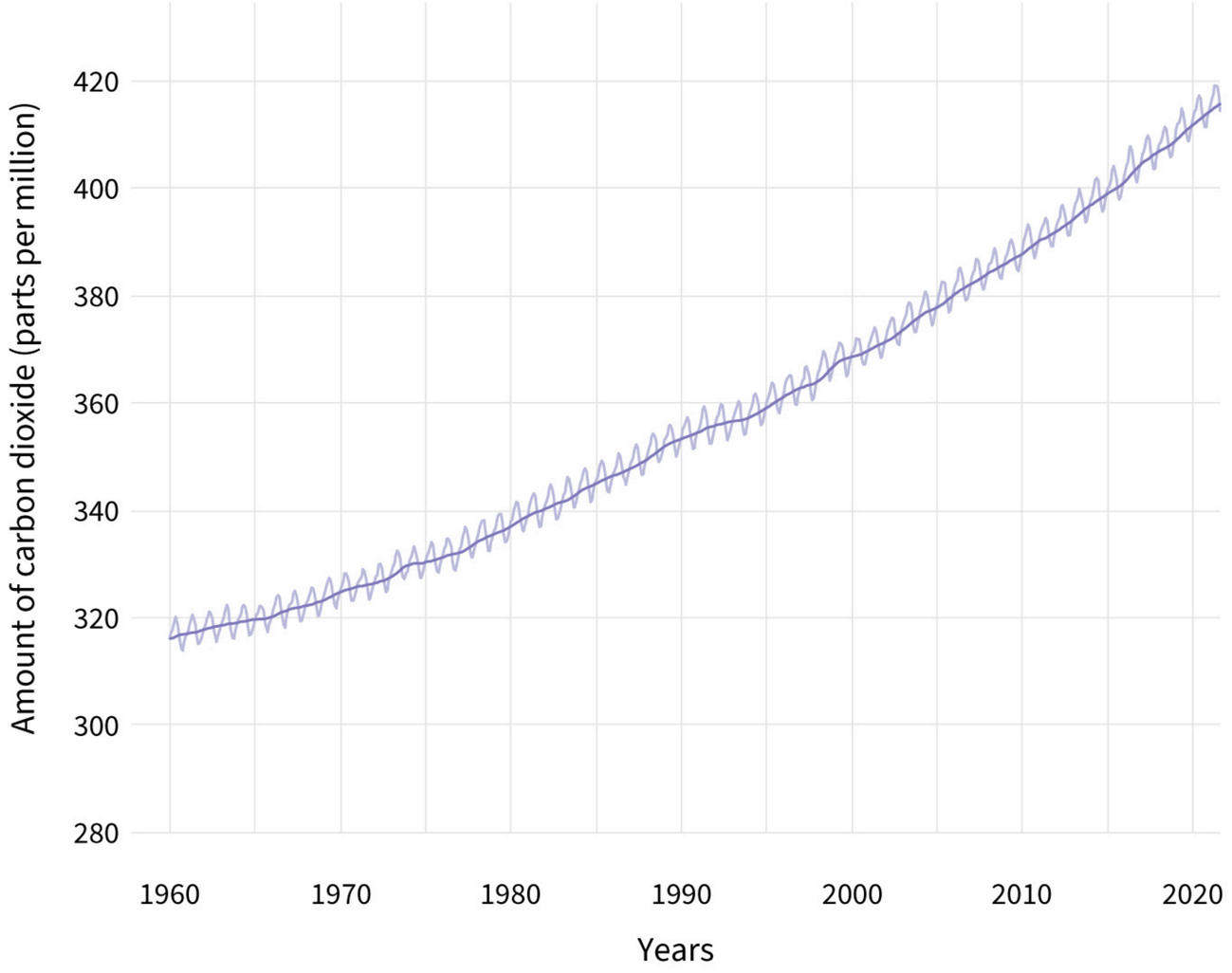
Met Office

Source: HadCET Creation Date: 23/08/2022 11:11 © Crown copyright



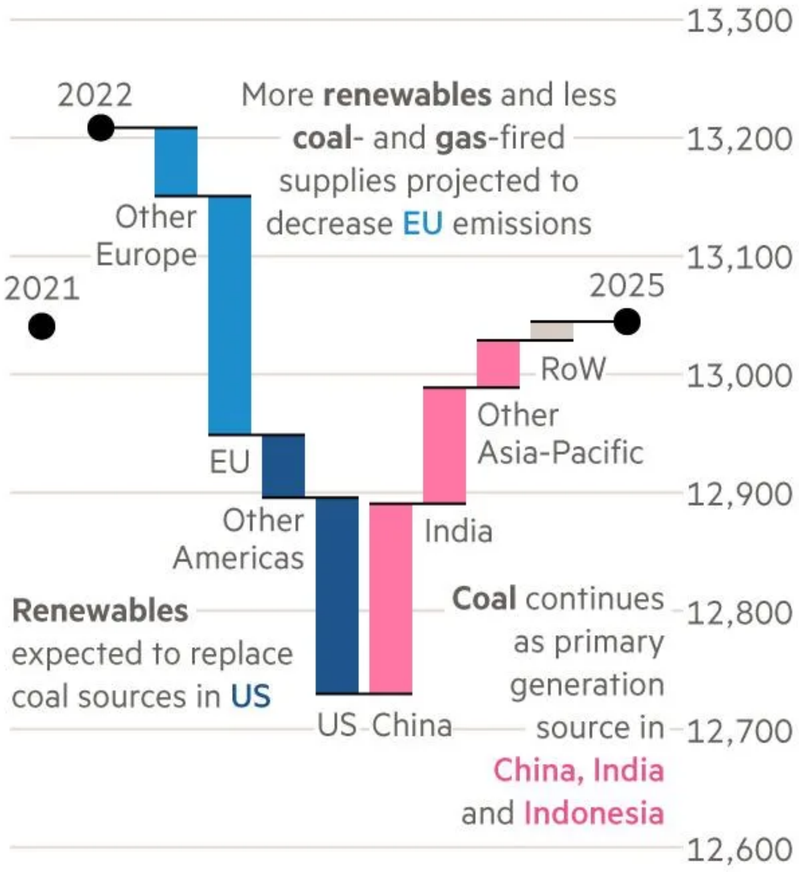


ATMOSPHERIC CARBON DIOXIDE (1960-2021)



Asia's projected increase in emissions is offset by decreases in EU and US

Power generation global emissions changes by region (million tonnes of CO_2)



Source IEA Electricity Market Report 2023

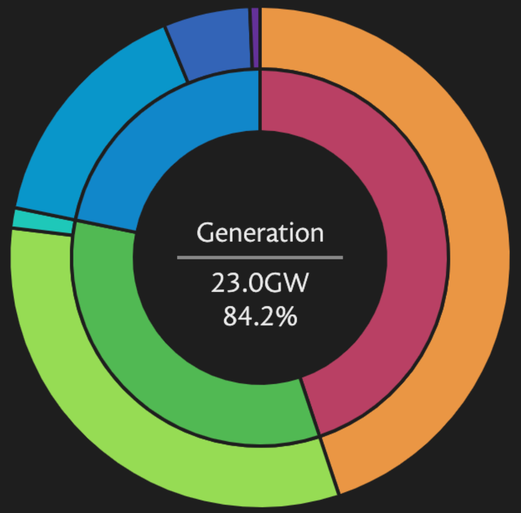
National Grid: Live

The National Grid is the electric power transmission network for Great Britain

Time	Price	Emissions
9:55pm	£116.73/MWh	150g/kWh

Demand	=	Generation	+	Transfers
27.3GW		23.0GW		4.3GW

Generation



Note: percentages are relative to demand, so will exceed 100% if power is being exported

37.8% fossil fuels

Coal	0.00GW	0.0%
Gas	10.31GW	37.8%

28.1% renewables

Solar	0.00GW	0.0%
Wind	7.35GW	27.0%
Hydroelectric	0.30GW	1.1%

18.4% other sources

Nuclear	3.58GW	13.1%
Biomass	1.28GW	4.7%
Other	0.15GW	0.6%

15.8% transfers

Imports and exports

Belgium	−0.08GW	−0.3%
France	3.77GW	13.8%
Ireland	−0.98GW	−3.6%
Netherlands	−0.10GW	−0.4%
Norway	1.30GW	4.8%

Storage

Pumped storage	0.39GW	1.4%