Heat Decarbonisation Plan

Queen Mary, University of London

Presentation to: Sustainability Committee

24 January 2022

Context of Study

- Strategic commitment to decarbonisation and in helping the UK achieve Net Zero by 2050
- **Six-year target of reducing emissions by 30%** and a **long-term target of achieving net zero**.
- Queen Mary has commissioned a **heat decarbonisation plan** under Salix Public Sector Decarbonisation Scheme (PSDS).
- This plan addresses:

- **Building level decarbonisation** –
- **immediate PSDS related measures** for decarbonisation of individual buildings identified as priority due to high energy consumption.
- **Campus level decarbonisation** –
- **short-term, interim, mid-term and long-term strategic proposals** for the campuses, in particular **Mile End, Charterhouse Square and Whitechapel**, and it taking into account the University`s masterplan proposals and broader development context/opportunities;
- **Plan approval internally within QMU by 31.03.22** to meet SALIX / BEIS requirements

Scope of Presentation

- Context / Scope / Status
- Salix Public Sector Decarbonisation Scheme (PSDS) related Building level measures
- Strategic options by campus:
  - Mile End
  - Charterhouse Square
  - Whitechapel
  - West Smithfield
  - Lincoln`s Inn Fields
  - Chislehurst
- Indicative timeline to Net Zero

Scope: Project Status

Project Status / Ongoing Actions

- **Building Surveys undertaken** to inform proposed PSDS measures (completed 17.12.21)
- Short term, mid term and longer term strategic **opportunities scoped and investigated**

- Ongoing internal stakeholder engagement
- **Scheduled internal stakeholder Workshop** for feedback (11.02.22)
- Opportunity quantification and costing
- Reporting

Challenges

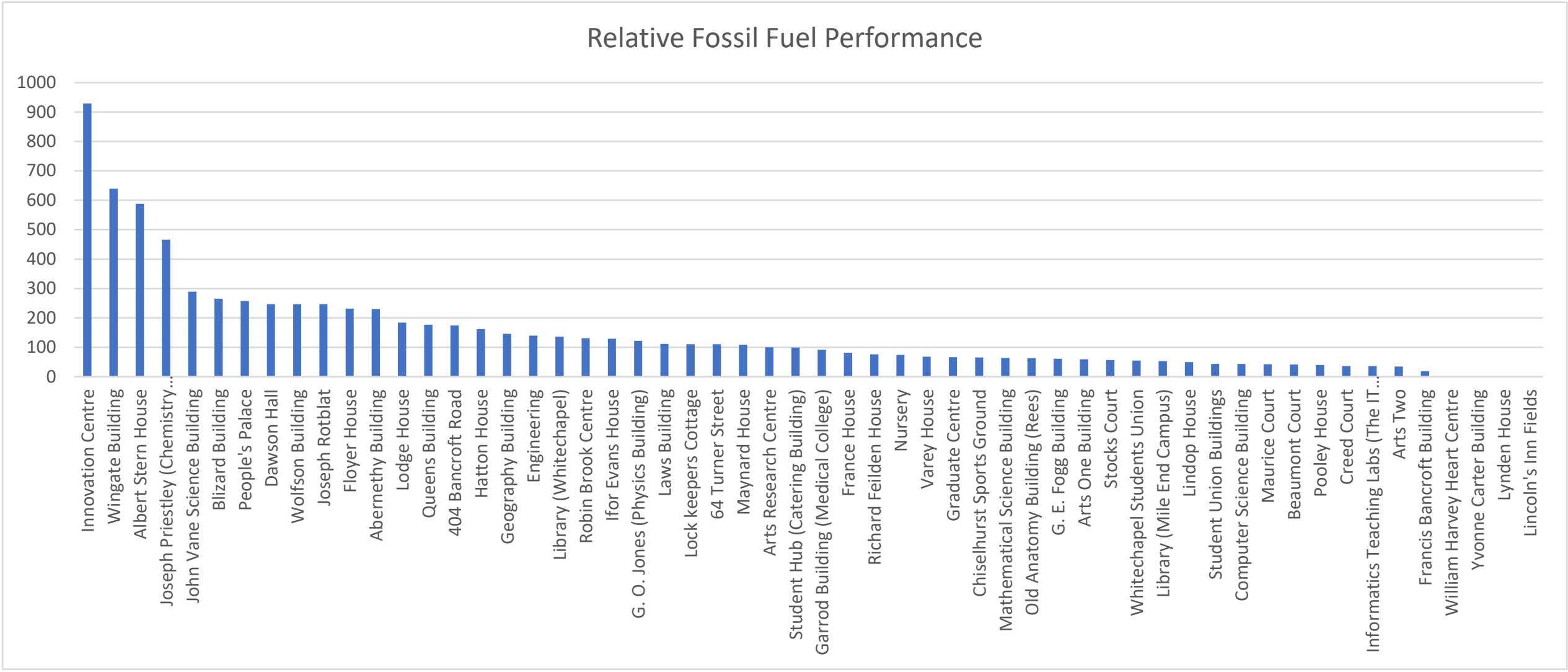
- Limited external stakeholder engagement
- Time constraints
- Gaps in record information

Strategic Perspective

- Campus masterplan - **development timescales**
- **Evolving strategy living document – periodic updating/review**

Proposed Building Level Measures under PSDS

Relative Building Performance



Mile End: Priority Buildings

- The buildings **highlighted in red have been identified as having both high fossil fuel consumption and relatively poor performance** compared to the rest of the portfolio.
- Buildings which have been identified affected by the site redevelopment plan are highlighted in yellow.

Campus	Building	Description of measure	Indicative Capital Cost	Saving Fuel type	Likely Saving kWh	Likely cost saving	Annual CO2 saving / tCO2e	Lifetime Carbon abated (tCO2e)
Mile End	Priestly	200m2 Solar PV (38kWp)	£ 45,600	Electricity	35,600	£5,340	8.2	185.1
Mile End	Priestly	Hybrid DHW (Electric Immersions)	£ 18,000	Gas	17,800	£476	2.8	63.1
Mile End	Peoples Palace	Retrofit small ASHP on roof AHUs	£ 60,750	Gas	20,487	£45	5.3	106.4
Mile End	Engineering	Glazing and wall panel upgrade on West Wing	£ 813,600	Gas	109,100	£3,273	20.0	559.5
Mile End	Queens Building	Glazing upgrade	£ 589,600	Gas	178,500	£5,355	32.7	915.4
Mile End	Queens Building	VSD Pump upgrades	£ 18,000	Electricity	31,550	£4,733	7.3	74.8
Mile End	Albert Stern	Glazing upgrade	£ 57,600	Gas	13,500	£405	2.5	69.2
Mile End	Albert Stern	Replacement radiators and pipework	£ 31,050	Gas	94,237	£27,134	6.5	98.8
Mile End	GO Jones	Glazing upgrade	£1,040,000	Gas	344,100	£10,323	63.0	1,764.7
Mile End	GO Jones	Local ASHP on ground floor AHU	£ 13,125	Gas		£0		0.0

Charterhouse Square: Priority Buildings

The buildings highlighted have been identified as priority buildings, in that they have high fossil fuel consumption and relatively poor performance compared to the rest of the portfolio.

Campus	Building	Description of measure	Indicative Capital Cost	Saving Fuel type	Likely Saving kWh	Likely cost saving	Annual CO2 saving / tCO2e	Lifetime Carbon abated (tCO2e)
Charterhouse	Dawson	Glazing upgrade	£ 770,400	Gas	516,000	£15,480	94.5	2,646.3
Charterhouse	Dawson	Heat Metering	£ 3,000	Gas	0	£0		0.0
Charterhouse	Wolfson	Heat Metering	£ 3,000	Gas	0	£0		0.0

Whitechapel: Priority Buildings

The buildings highlighted in red have been identified as priority buildings, in that they have high fossil fuel consumption and relatively poor performance compared to the rest of the portfolio.

Campus	Building	Description of measure	Indicative Capital Cost	Saving Fuel type	Likely Saving kWh	Likely cost saving	Annual CO2 saving / tCO2e	Lifetime Carbon abated (tCO2e)	Simple payback (yr)
Whitechapel	Blizzard	400m2 Solar PV (76kWp)	£ 91,200	Electricity	71,200	£10,680	16.5	460.8	8.54
Whitechapel	Wingate	Glazing upgrade	£ 64,000	Gas	29,500	£885	5.4	121.6	72.32
Whitechapel	Innovation	300m2 Solar PV (57kWp)	£ 68,400	Electricity	53,400	£8,010	12.3	345.6	8.54
Whitechapel	Garrod	VSD Pump upgrades	£ 14,400	Electricity	17,250	£2,588	4.0	40.9	5.57
Whitechapel	Garrod	Glazing upgrade	£ 396,000	Gas	273,000	£8,190	50.0	1,400.1	48.35
Whitechapel	Garrod	DHW Decentralisation	£ 9,000	Gas	38,103	-£1,352	1.2	22.2	-6.66
Whitechapel	Garrod	25m2 PV array (5kWp)	£ 6,000	Electricity	4,600	£690	1.1	23.9	8.70
Whitechapel	Floyer	Glazing upgrade (all windows)	£ 271,200	Gas	183,000	£5,490	33.5	938.5	49.40
Whitechapel	Floyer	Upgrade of in-fill panels	£ 35,000	Gas	20,000	£600	3.7	109.9	58.33
Whitechapel	Floyer	140m2 Solar PV (27kWp)	£ 32,400	Electricity	25,300	£3,795	5.8	131.6	8.54
Whitechapel	Floyer	Hybrid DHW (Electric Immersions)		Gas	12,650	£338	2.0	23.9	#VALUE!

Buildings Being Retained…

Efficiency Measures Common to all Buildings

- **BMS Controls Upgrades** including additional sensor points, resetting of time clocks, use of temperature compensation, additional metering and improved plant sequencing;
- **Introduce VFDs** Replace fixed frequency control with variable frequency control of distribution pumps with index control, where feasible
- **Address Heat Losses** Improve, replace or add insulation to building services pipework, fittings and equipment
- **Improved Field Control** Replace three-port with two-port control valves, resize coils for lower water side operating temperatures and implement heat recovery where feasible, eliminate bypasses and low loss headers
- **Calorifier Replacements** Replace or modify existing bundle calorifier packs, implementing plate and buffer arrangements specifically designed to achieve low primary return temperatures
- **Building fabric improvements**. Various
- Equivalent measures for **distributed cooling systems** should also be implemented where feasible

Strategic Objective

- **More favourable temperature regimes**
- reduced pumping costs
- **Reduced heat losses**
- **Higher operating efficiency for heat pump systems** to be installed under the interim and long term strategic plan.

Target operating temps:

LTHW 70/40ºminimum / 60/30 ºC aspiration
CHW 10/14ºminimum / 12/20 ºC aspiration

Campus Level Strategic Proposals and Options

Portfolio by Campus: Mile End

Overview

- Teaching, research, administration and accommodation buildings.
- Heating and Domestic Hot Water generally distributed gas fired boiler plant
- Mini heat network served by engine CHP and boilers, poorly utilised, undersized
- Ventilation is mostly natural. Some of the mechanically ventilated buildings have high ventilation rates due to process requirements.
- Cooling currently provided by a large number of split units and only a few number of chillers with no heat recovery
- Electrical infrastructure ~ 5/6 radial networks with distributed MPANs to serve campus

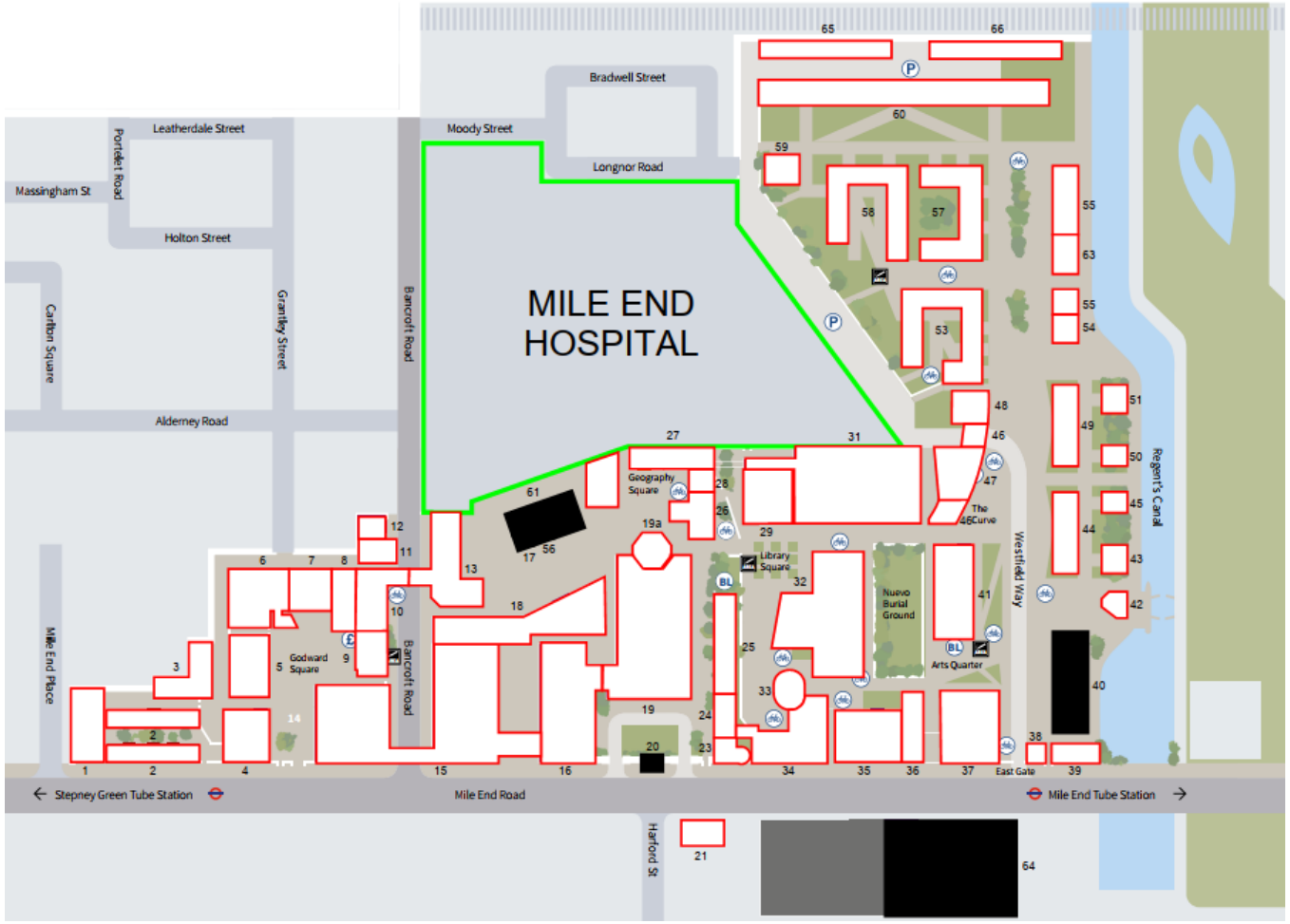


Figure: Mile End campus

Mile End: Interconnectivity

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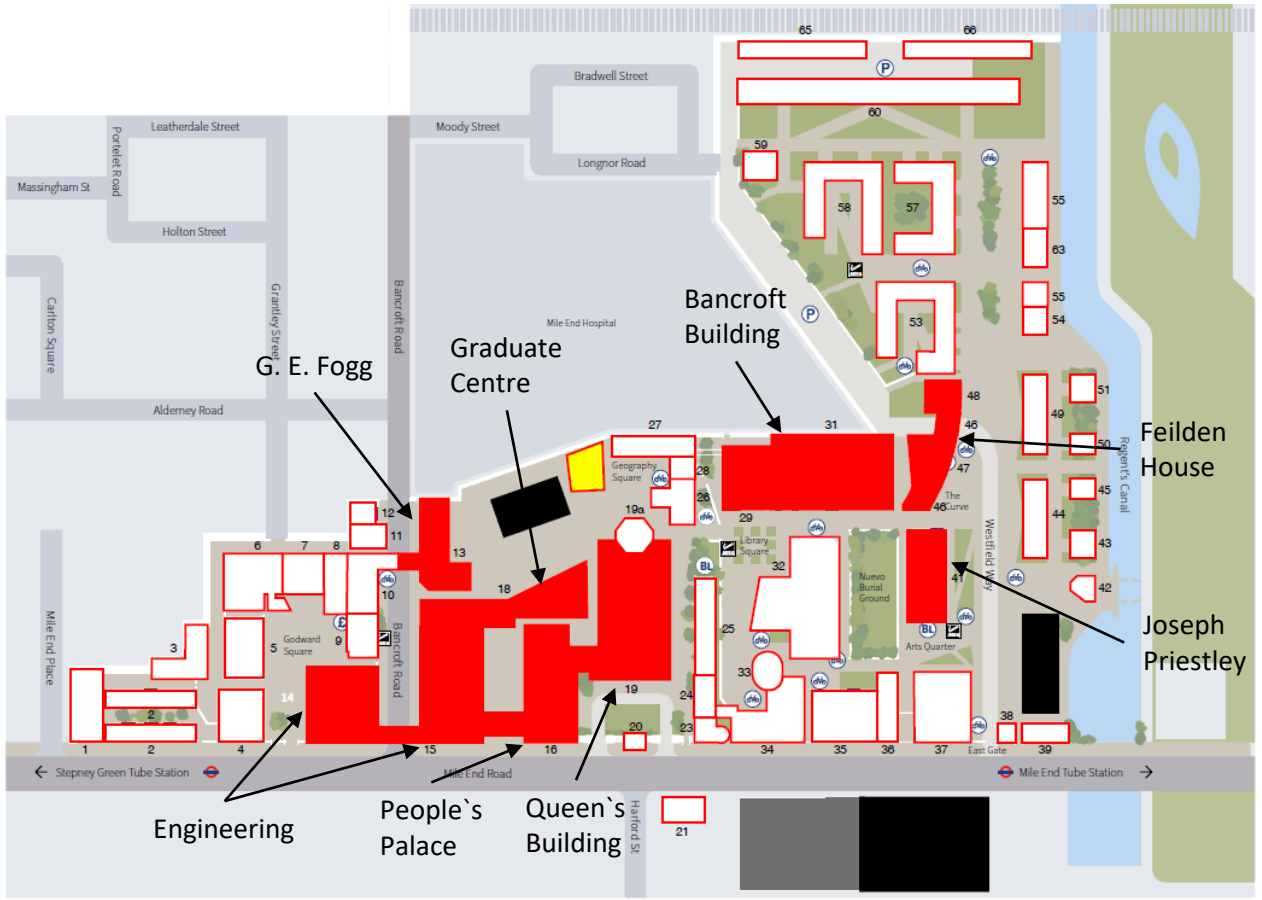
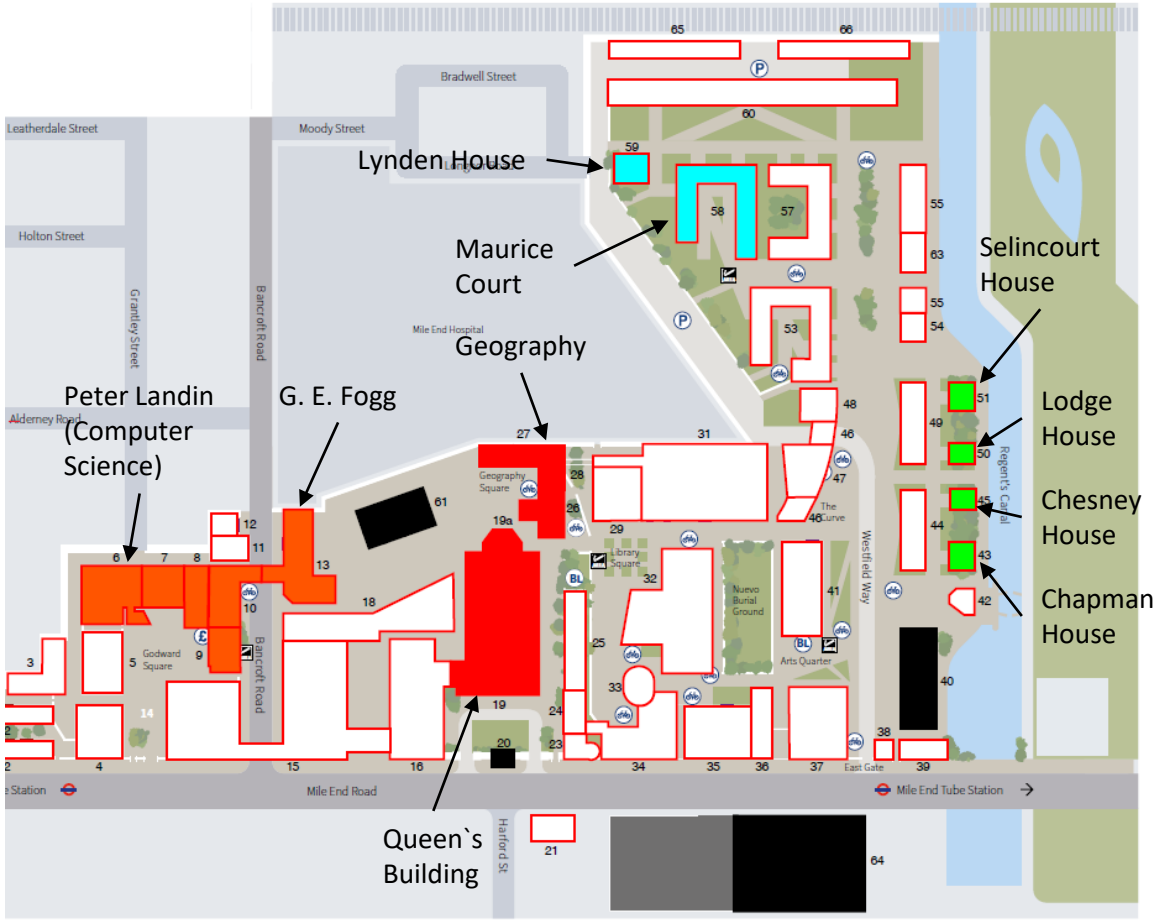




Energy Centre

Buildings which are connected to the heat network

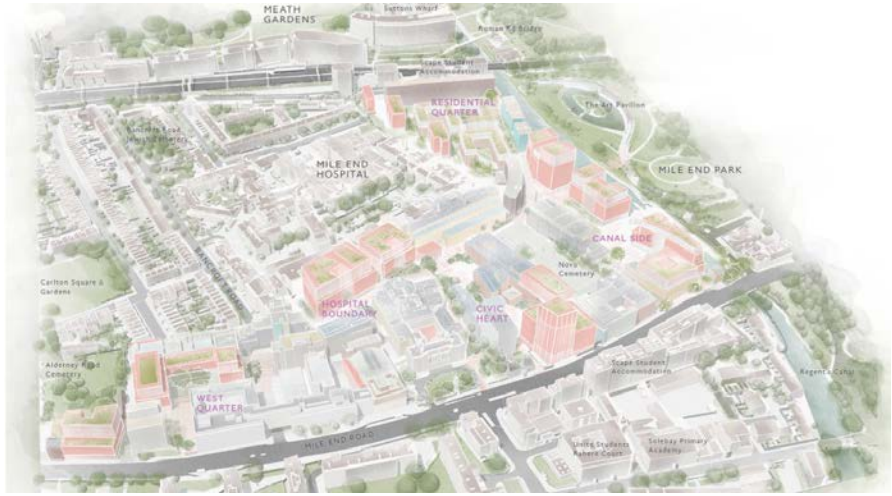
Buildings which have shared domestic hot water generation

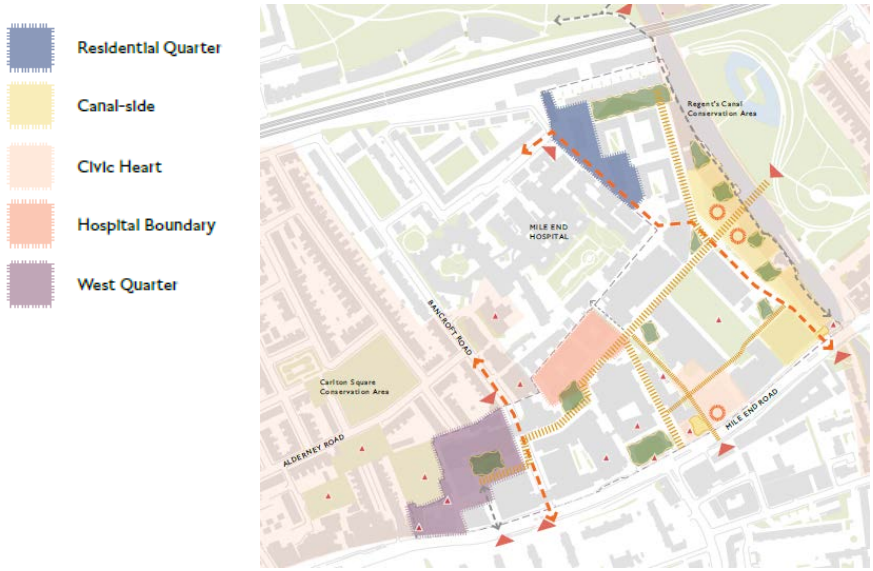
Buildings which have shared heating systems

Mile End: Current Development Plans

Summary of Current QMU Proposals

- **Major campus development masterplan underway** with strategic ambition of doubling of student capacity 50,000 by 2030. Additional residential accommodation and academic buildings on site.
- Some building level re development underway**: Building 40 (Hatton House): (near term), Buildings 42-45 and 49-51 (mid term).** All other sites in campus masterplan subject to uncertainty around redevelopment timescales
- **SRIFF Room** IT load increasing to 600kW within 5 years. **200 kW heat pump planned**
- **Avoided chiller replacement at Joseph Priestly (41)** ~ supplied via SRIFF Room heat pump
- DHW services to France house and business school / Hatton house site via **extension to DHN**
- Electrical infrastructure ~ **improving capacity and resilience with 11kV ring main** under Phase 1 (Hatton House) redevelopment. Incoming supply at Hatton House/Business School
- **Retaining newly installed CHPs** whilst developing strategic opportunity. Mothballing to coincide with 5 year development horizon for Business School





Mile End: Strategic Opportunity

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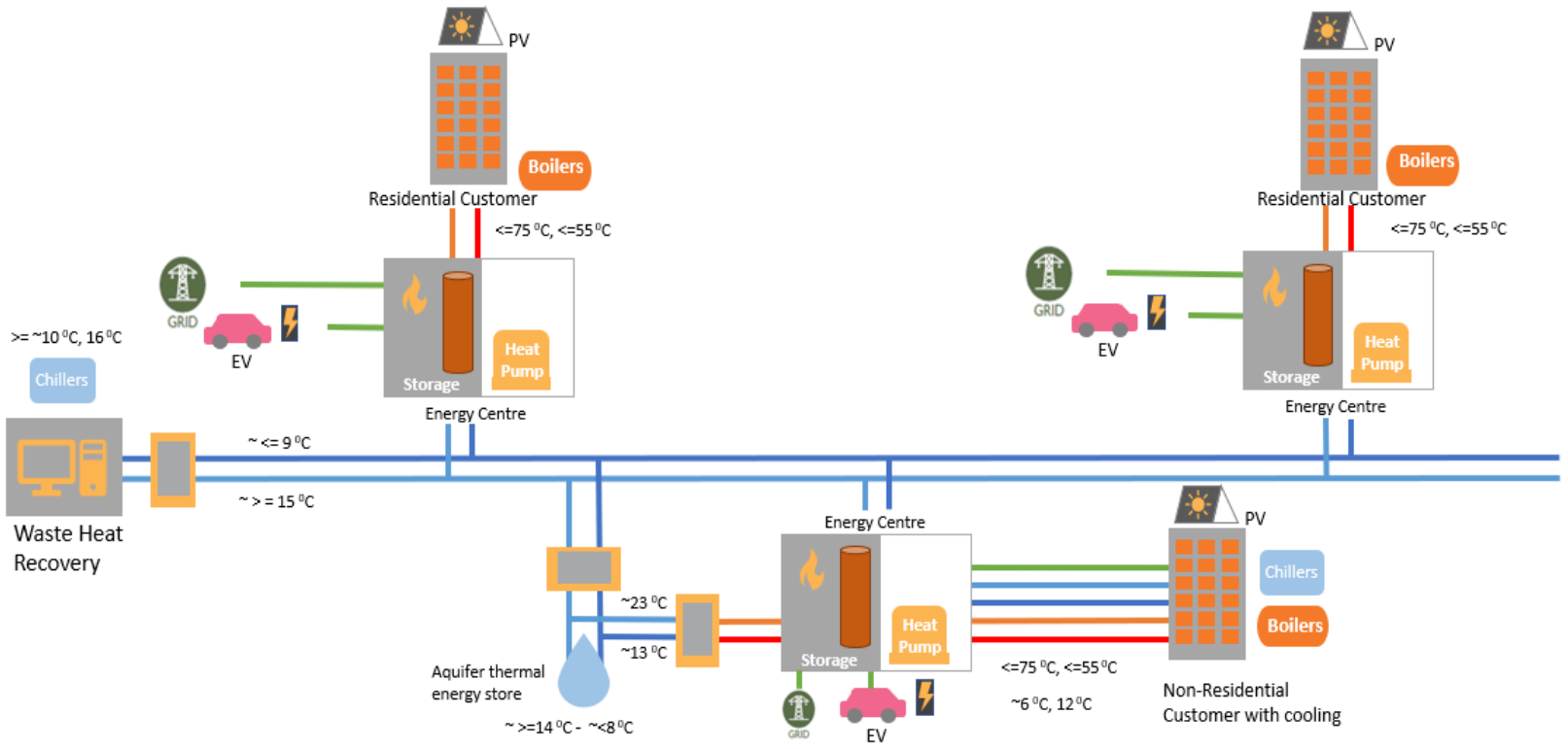
- Low energy buildings
- Campus based integrated energy system
- R**ecycling / prosuming energy** between buildings
- **Renewable heat / waste heat recovery**
- Unlocking value through **energy storage, electricity market participation** (FFR,STOR) and Integrated Electric Vehicle charging
- **Strategic delivery partner** to realise opportunity commercially



Mile End: Strategic Proposal

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Overview

- **Decarbonising new masterplan districts** as they emerge through cluster networks
- **Energy centres** situated within new developments, phased w.r.t strategic masterplan
- **Network configuration to be determined** ~ 5th Generation Network: ambient loop/two stage temperature lift?
- Hybrid arrangement, **decarbonising increasingly over time**
- Retrospective integration of interim proposals
- Coordination with electrical infrastructure upgrading plans
- Capitalising on improved site wide efficiency measures

Critical that campus utilities infrastructure aligns with strategic plan/topology

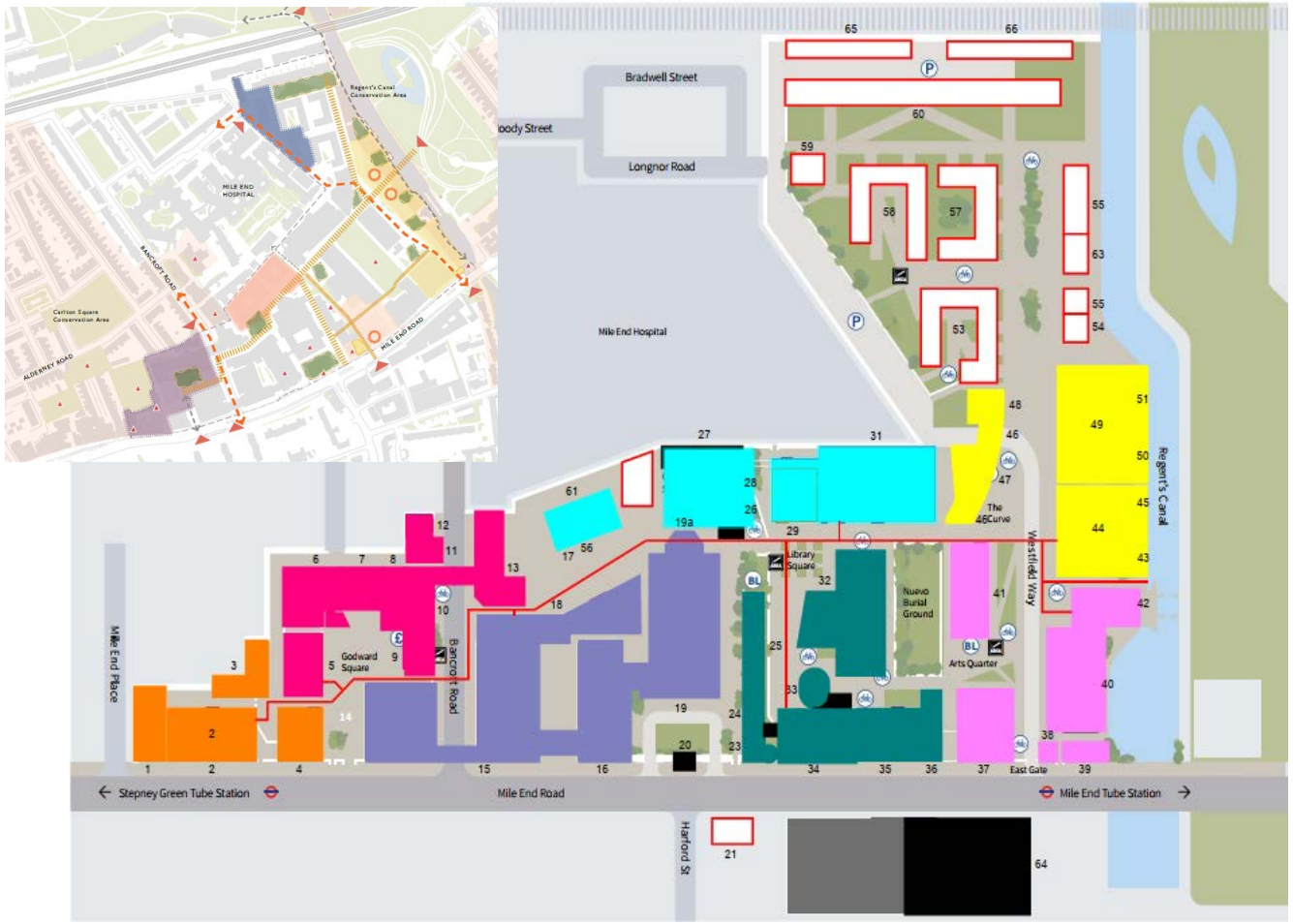

Figure: Energy network proposal

Mile End: Strategic Proposal

Low Grade, Waste / Renewable Energy Source Opportunities

- **Sewer Heat?** combined sewer along Mile End Road
- Adjacent **Mile End Hospital site ?**
- **Regent`s Canal** – Canal source heat recovery
- **Low grade waste heat recovery on site** (eg SRIFF Room IT load, other sites under masterplan redevelopment)
- **Transport for London:** Vent shaft (Bancroft Road area) and pumped water station ~ 400 kW_{th}
- **Open Loop Borehole** (pumping record for TW site in near vicinity suggests yield ~30 l/s)
- Air
- Supplementary electric boilers

Figure: Existing TW Borehole records

Mile End: Interim Proposals

Proposal 1: Decarbonising western cluster ahead of masterplan redevelopment (West Quarter)

- ➢ Redevelopment comprises new build, infill extensions
- ➢ New low carbon energy system comprising:
  - air source, ground source or waste heat recovery heat pump with supplementary thermal storage
  - Newly installed heat network
  - Existing distributed gas boilers for top up and back up
  - Safeguarding measures for future integration into long-term strategic proposals under the campus masterplan
- ➢ Potential location: Informatics Teaching Laboratories building (5) – **viability subject to masterplan** development phasing
- ➢ School of Engineering served. Opportunity to showcase innovative technology

Figure: Cluster 1

Mile End: Interim Proposals

Proposal 2: decarbonising retained campus buildings

- New energy supply/supplies to serve the buildings in red comprising:

- air source, ground source or waste heat recovery heat pump with supplementary thermal storage
- Upgrading and extending DH distribution network
- Existing distributed gas boilers for top up and back up
- Safeguarding measures for future integration into long-term strategic proposals under the campus masterplan
- Potential Location: Existing EC (in Yellow) or roof of Feilden House (46, 47, 48)
- Existing CHP decommissioned or repurposed

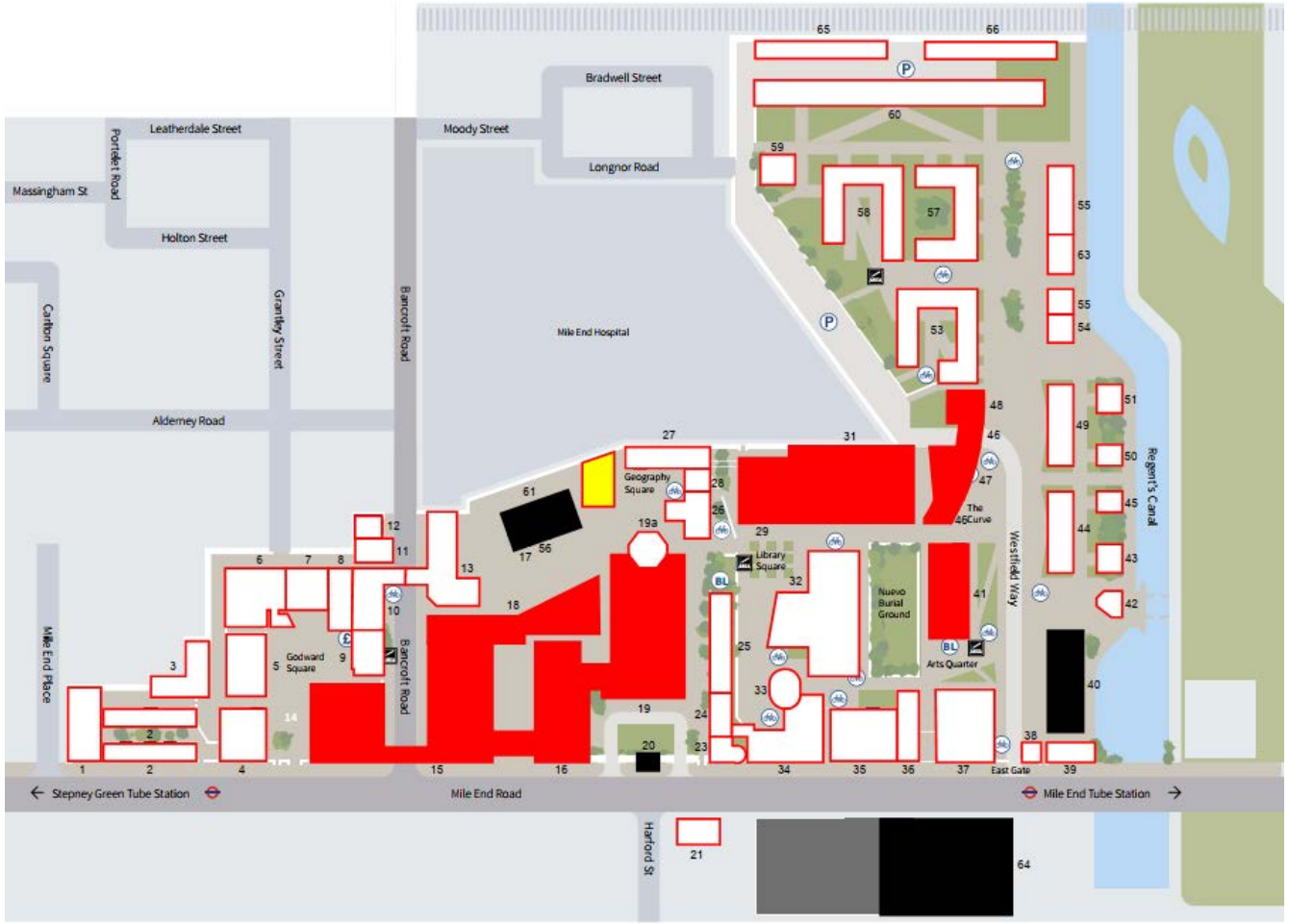

Figure: Cluster 2

Mile End: Interim Proposals

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Proposal 3: PV installation on Residential Accommodation

- Solar PV for electricity displacement (electrically heated currently)
- Solar thermal DHW generation (gas fired calorifiers currently)
- combined Solar PV-T opportunity
- Hatton Building (4) and 42-45 and 49-51 excluded
- likely area available for PV by building.

Building	Pooley House	Lynden House	Maurice Court	Creed Court	Beaumont Court	France House	Feilden House
Roof Area for PV (m^2)	180	10	50	50	50	60	100

Table: Likely area available for PV by building

Figure: PV, ST or PV-T electrically heated buildings with DHW

Portfolio by Campus: Charterhouse Square

Overview

- Clinical research, onsite accommodation in Dawson Hall (4)
- **No major redevelopment plans**
- Heat network with **gas engine CHPs** (bldgs. 1,2), outliers~ **local gas fired boilers** and calorifiers
- Natural ventilation generally, mechanical ventilation in one building
- Cooling via **split units** and a small number of chillers
- Electrical infrastructure ~ distributed MPANs at each building
- Dawson Hall HV supply limits ability of CHP_1 to operate, connect to JVSC to increase load?
- Recently **upgraded incoming 1.5 MVA electrical supply to John Vane** also supports Wolfson Building
- **Spatially constrained** in relation to new energy Infrastructure
- **Owned by Barts Trust, leased by QMU**. Rolling 35 year lease

Figure: Campus Aerial View

Charterhouse Square: Development Plans

Summary of Current QMU Proposals (John Vane building (1) **)**

- Replacement of life expired chiller in John Vane Science Centre (which supports BSU **)** with **Absorption Chiller**
- Connection to existing CIAT Chillers with a chilled loop to provide **heat load for existing CHP** in summer conditions
- Use of CHP to store energy and setup a UPS central network
- Ventilations system upgrades
- **Consolidate / centralised cooling systems** from VRF
- **Capital investment budget allocated: £2.5M per year for 5 years**

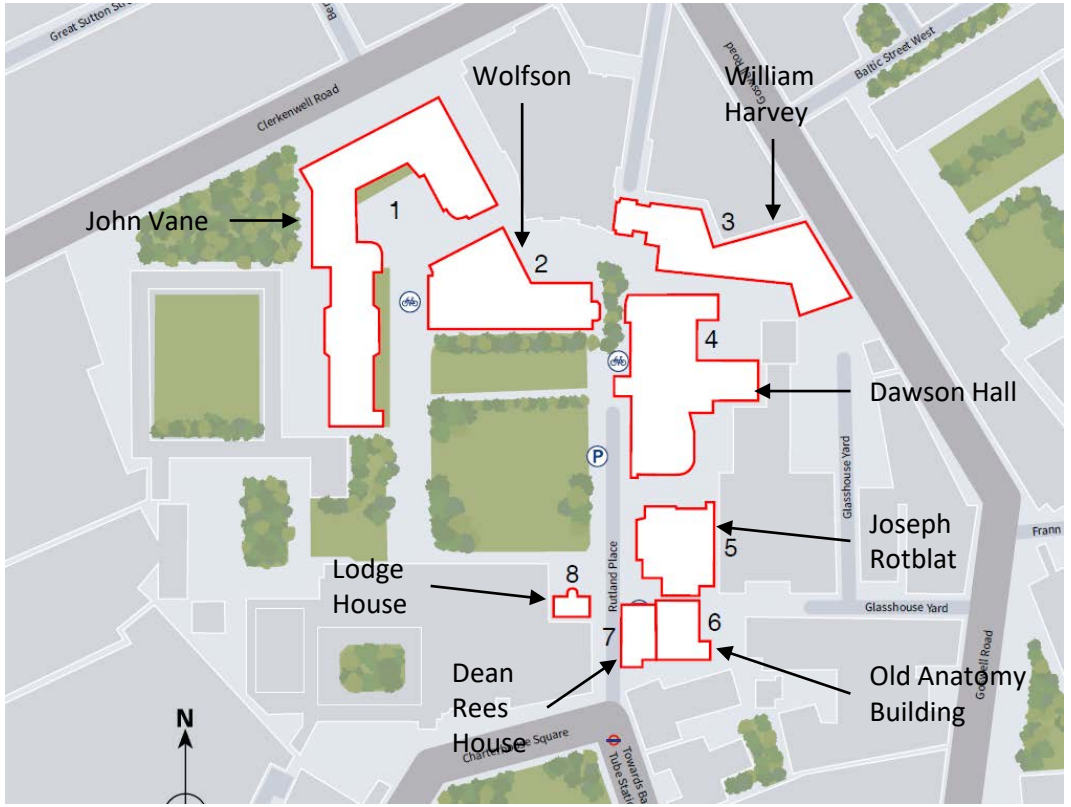

Figure: Campus layout

Charterhouse Square: Strategic Proposal

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Opportunity 1: decarbonising existing site via on site energy solution

- **Heat pump technology** situated on roof of Wolfson Institute (2), electrically fed from John Vane via recently upgraded 1.5 MVA electrical supply
- **Air source, open loop borehole** or **sewer heat recovery**?
- **Prosuming via ambient loop ~** planned centralised cooling system
- **Future proofed** for possible future offsite connection

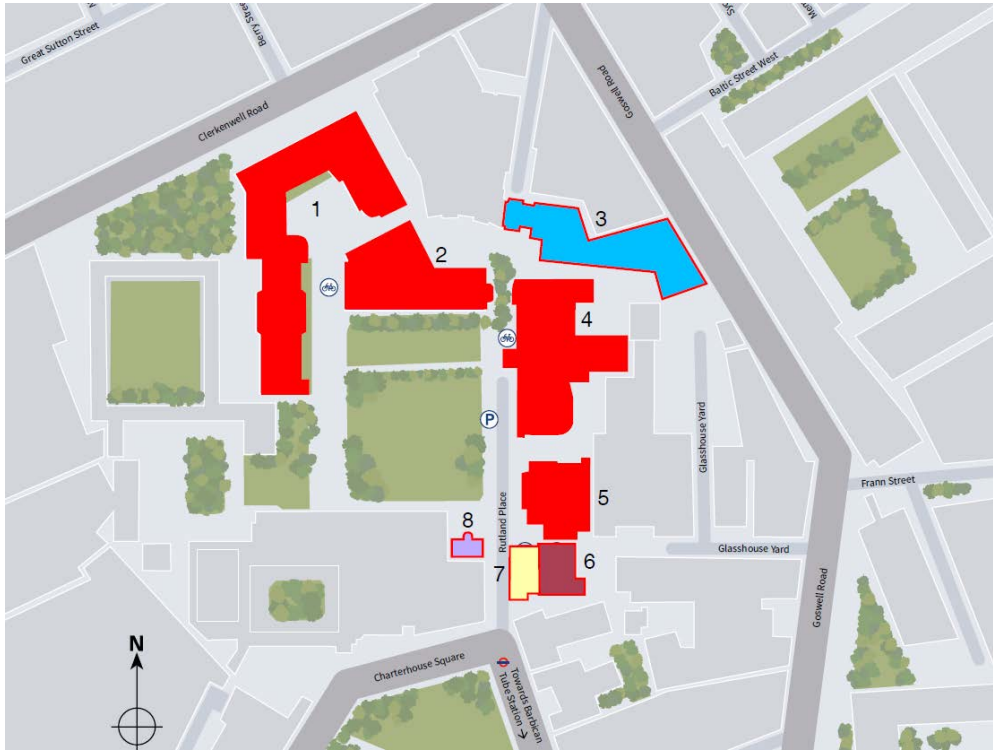

Figure: Proposed heat network

Recommended that current repurposing plans are reviewed in light of decarbonisation proposals. Residual budget could potentially be diverted for Decarbonisation Plan proposals

Charterhouse Square: Strategic Proposal

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Opportunity 2a: decarbonising existing site via off site energy solution

- Connection to **existing and planned district energy schemes**:
  - Citigen (orange), Bunhill (purple), GreenSCIES (red)
- **Prosuming ~** planned centralised cooling system?
- Potentially favourable over on-site solution (space, building ownership, available capital) but requires commercial agreement
- Initial engagement has taken place with Citigen on this basis and outline proposals are awaited from EOn.
- Network operators as **Strategic delivery partner** to realise opportunity commercially

Figure: Nearby district heating networks

Recommended that current repurposing plans are reviewed in light of decarbonisation proposals. Residual budget could potentially be diverted for Decarbonisation Plan proposals

Charterhouse Square: Strategic Proposal

Opportunity 2b – decarbonising existing site via off site energy solution

- **Volta Data Centre** situated in near vicinity
- Water cooled IT Racks
- Potential for waste heat recovery from existing roof mounted chiller plant or heat pump upgrade at next lifecycle replacement
- Currently operates ~ 50kW WSHP with heat recovery for on site DHW and space heating loads
- Data Centre as **Strategic delivery partner** to realise opportunity commercially - seeking opportunities for off-site connections

Recommended that current repurposing plans are reviewed in light of decarbonisation proposals

Figure: Volta Data Centre and Charterhouse Square Campus

Figure: Volta Data Centre

Portfolio by Campus: Whitechapel

Overview

- Medical research and teaching campus, associated with the nearby Royal London Hospital and Royal London Dental Hospital
- Each buildings operates as a standalone entity. No interconnectivity
- Main medical research buildings (Abernethy (4), Blizzard (5), Wingate(7))
  - High ventilation loads (Containment Level 2 and 3 Laboratories)
  - Process loads in the form of steam generators and autoclaves
  - High domestic hot water loads
- The Yvonne Carter Building (8) is electrically heated. All other buildings are predominantly heated by gas fired boilers
- There is limited cooling demand on campus. Served by distributed VRF systems
- The buildings highlighted in black are not strictly part of Queen Mary

Figure: Whitechapel campus

Whitechapel: Development Opportunities

Overview

- No current QMU development proposals on campus
- The area surrounding the former **Royal London Hospital site** is undergoing major redevelopment, which was sparked by the construction of the new hospital (A). The green highlight shows the proximity of the Floyer building (10) to the Pathology department of the Royal London Hospital (B).
- **Tower Hamlets Borough Council** is currently redeveloping the old Royal London Hospital site to form a new Town Hall. This is located between the Garrod building (1) and the new Royal London Hospital (A), as shown in blue.
- **Queen Mary and Barts Healthcare NHS trust** plans to redevelop the area between Newark Street and Mount Terrace, highlighted on the map, as a new life sciences hub.
- **London Newcastle development**

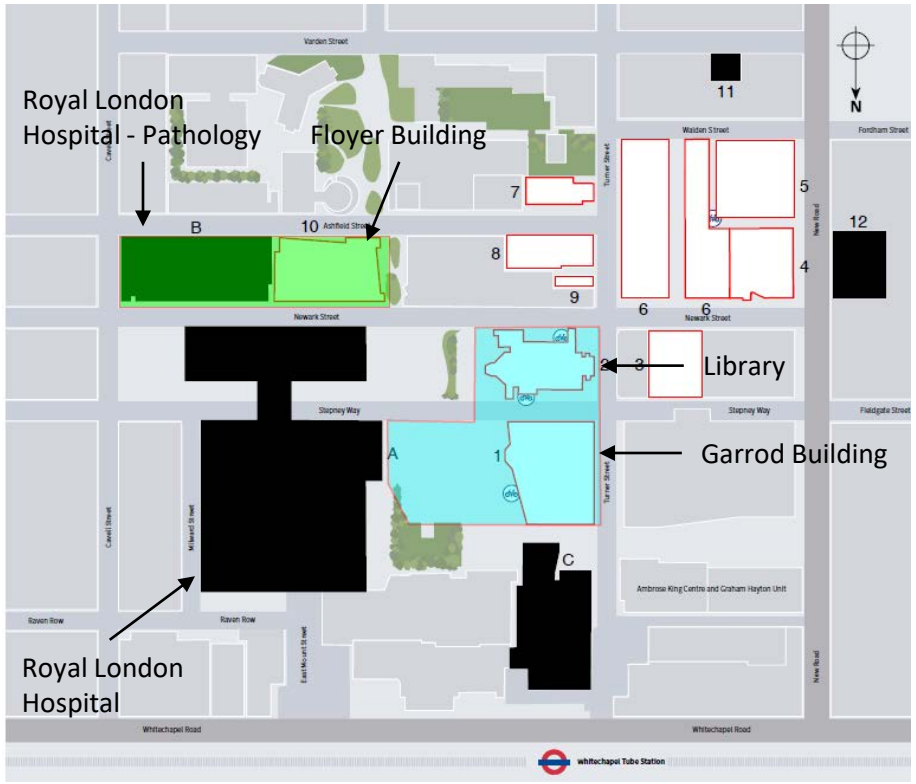

Figure: Localised heat network opportunities

Whitechapel: Strategic Opportunities

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Energy Network with Connection to Offsite Infrastructure:

- Campus based energy network connecting to **external energy supply**
- **Strategic partnering** with surrounding municipal authority developments

Figure: Localised heat network opportunities

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Thank You

Any Questions?