



# Royal Borough of Greenwich

## Strand Court

### Low carbon technology feasibility

Dr Gabriel Gallagher  
Omied Khakshour  
June 2020



Sustainable  
ENERGY

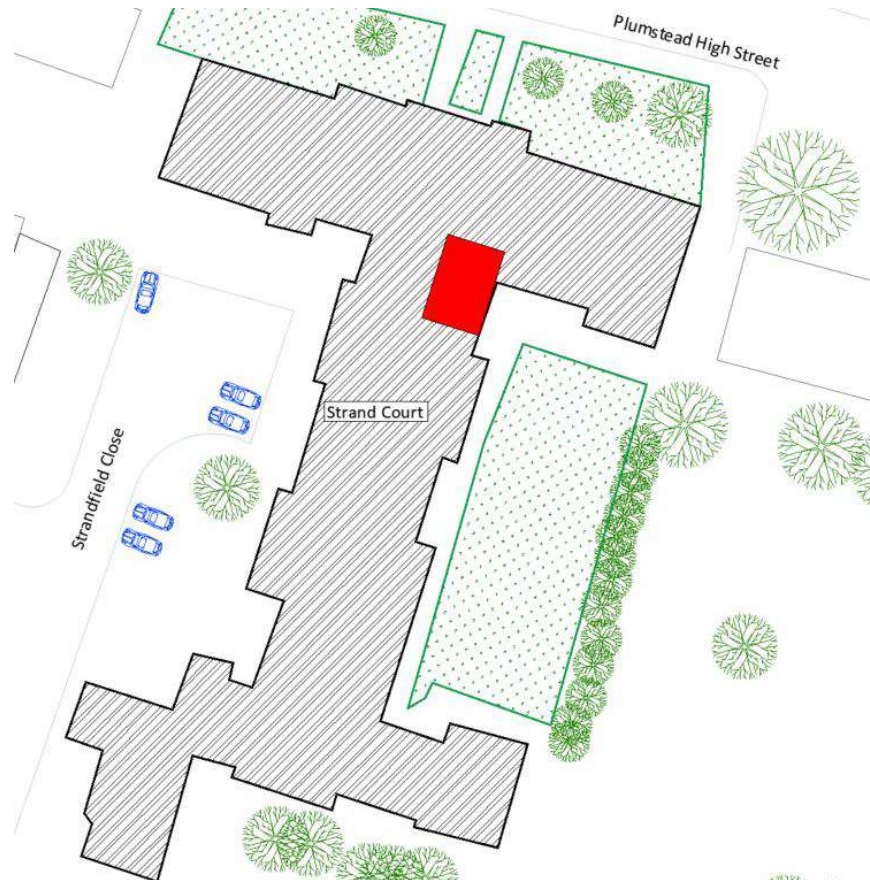
# Scope of work

- To assess low carbon / renewable heating options for social housing
- Model heat and hot water demands for different levels of fabric improvements to inform sizing of new system
- Review and propose solutions for secondary heating and hot water systems
- Develop concept designs for refurbishment of energy centre with low carbon heating



# Summary of Strand Court

- 60 dwellings in sheltered accommodation
- Central heating system plant in ground floor plant room (red)
- Existing LTHW (82°C flow / 71°C return) communal heating system supplies radiators and communal hot water cylinder provides DHW



# Design considerations



- To ensure correct specification of low carbon heating systems – flow and return temperatures must be reduced we must:
  - Reduce radiator temperatures\*
  - Increase temperature differential to reduce pipe sizes
  - Ensure peak loads are correctly estimated to prevent oversizing
  - Install heat interface units in dwellings to replace hot water cylinders
  - Maintain existing network and supply of heat to continue to provide service whilst new system is installed

\* This does not mean a reduction in the potential energy supplied to each space; although, the operating temperatures are lower than existing, the new emitters will be compatible with the operating conditions and the required set points will be achieved



# Heat demand profiling



# Current heat demand



- Existing gas consumption data – 986,978kWh per annum
- Existing heat demand modelled based on following assumptions:
  - Fabric to ~30 year old building regs
  - Unmetered heating controls with 23°C setpoint and 19°C set back
  - Communal DHW hot water storage tank
  - 1.5 occupants per apartment
- Heat losses from existing DHW cylinders and DHW pipework

# Current heat demand

- Fabric and ventilation loss inputs:

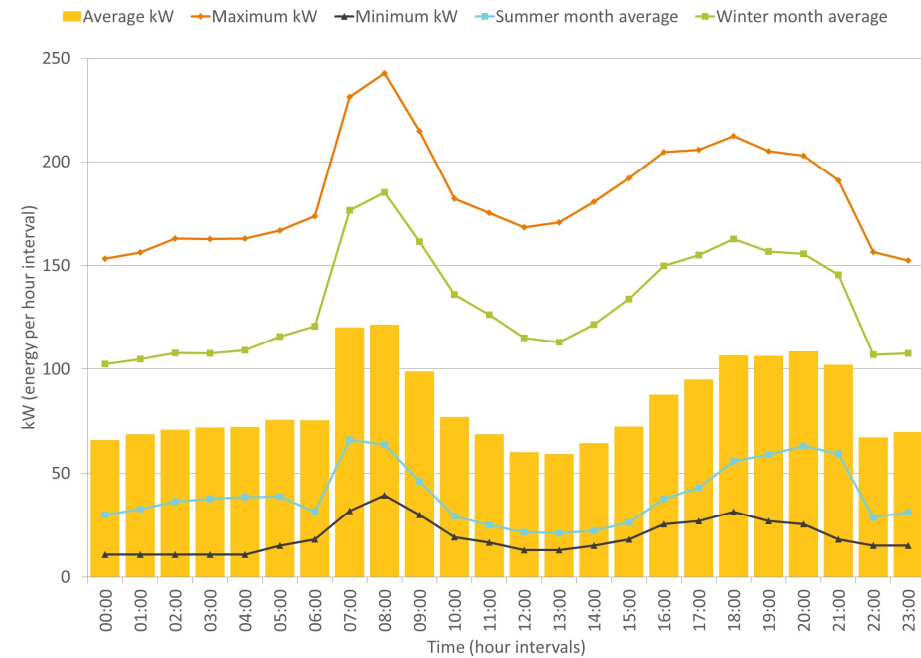
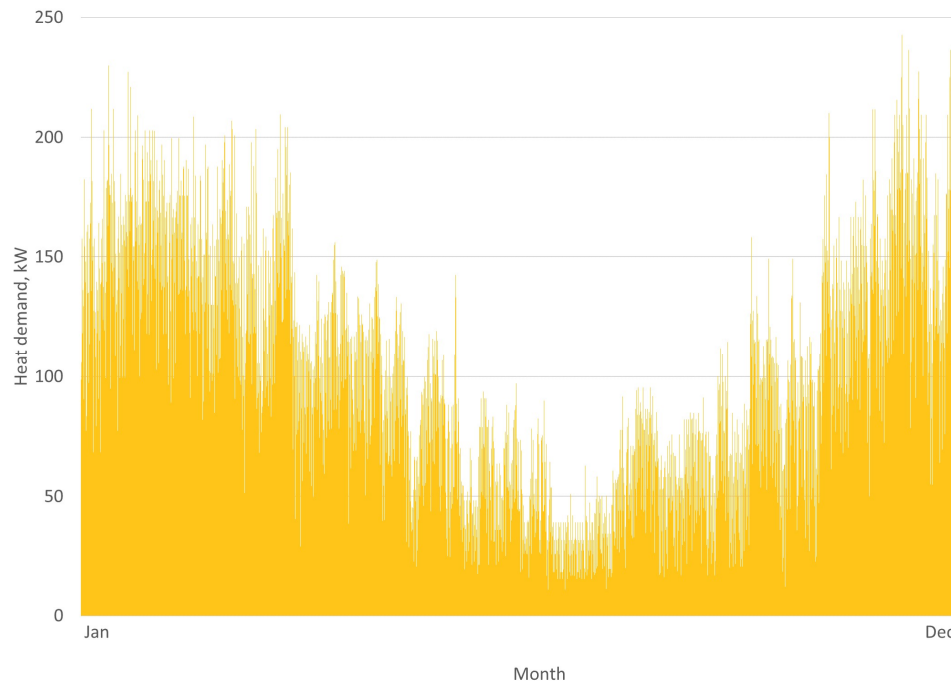
Fabric type - U-Values		
Floor	W/m <sup>2</sup> K	0.45
Walls	W/m <sup>2</sup> K	0.45
Glazing	W/m <sup>2</sup> K	2.00
Roof	W/m <sup>2</sup> K	0.25
Ventilation		
Air permeability	m <sup>3</sup> /h.m <sup>2</sup>	8

# Current heat demand

- Summary of existing heat demand

Scenario	Annual Modelled Demand kWh	Peak heat kW	kWh per flat	Total kW per flat
Existing	725,250	243	12,088	4.0

- Modelled boiler efficiency of existing system – 73%





# Scenario 1

## Upgraded heating system demand



- Scenario 1 assumes:
  - No fabric changes
  - Flat fit outs for low temperature network conditions
  - Heat interface units for local heating control, metering and instantaneous hot water
  - Upgraded pipe work for the risers and laterals in each building
- Factors that have an impact on heat demand once the new system is installed:
  - Change in behaviour and housekeeping due to individual metering of each apartment
  - Ambient temperature controls in energy centre
  - Heating controls with 23°C setpoint and 17°C set back
  - Replacement communal DHW storage tanks and 4-pipe system with instantaneous plates in HIUs

# Scenario 1

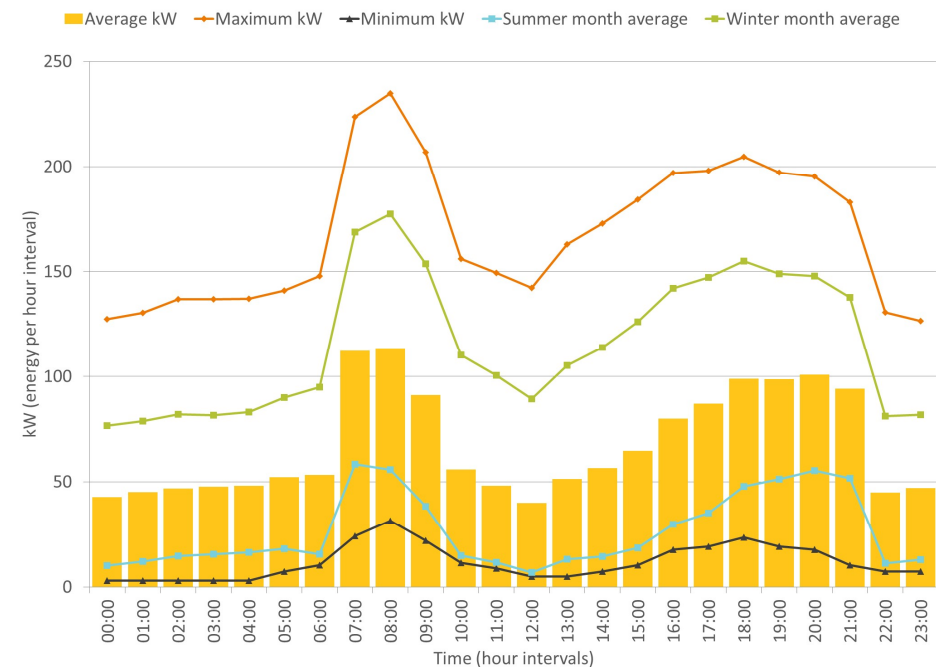
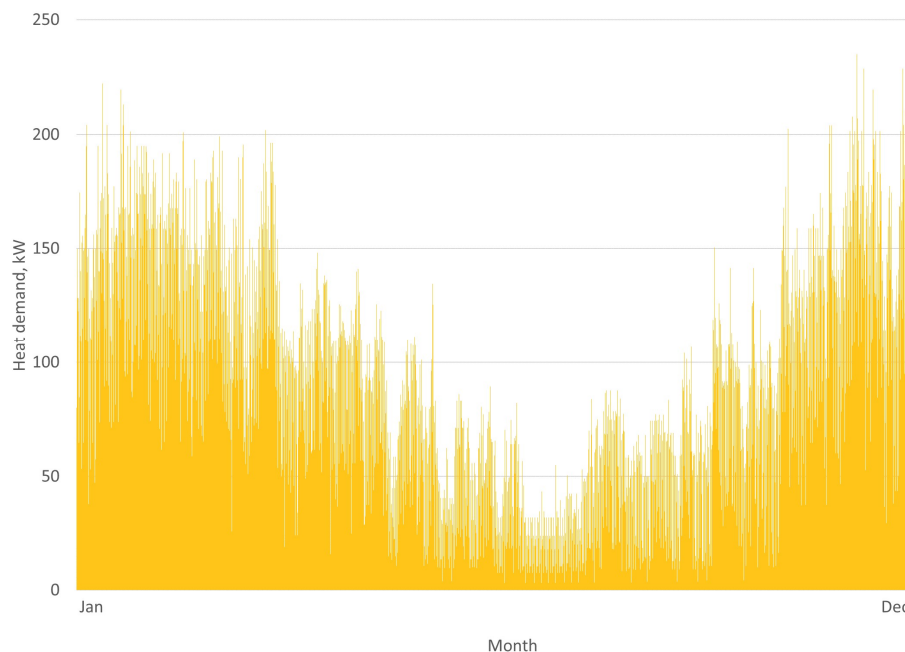
## Upgraded heating system demand



- Scenario 1 heat demand summary

Scenario	Annual Modelled Demand kWh	Peak heat kW	kWh per flat	Total kW per flat
1	591,639	235	9,861	3.9

- The heat demand for the site after all the above conditions are adjusted is 427,320kWh
  - 18% reduction in current heat demand



# Scenarios 2,3 and 4

## Fabric improvements



- As with scenario 1, scenarios 2, 3 and 4 all assume:
  - Flat fit outs for low temperature network conditions
  - Heat interface units for local heating control, metering and instantaneous hot water
  - Upgraded pipe work for the risers and laterals in each building
- With the addition of varying levels of fabric improvements as follows:
  - Scenario 2 – roof insulation improvements
  - Scenario 3 – roof insulation improvements and glazing upgrades
  - Scenario 4 – roof insulation improvements, glazing upgrades and external wall cladding

# Scenarios 2,3 and 4

## Fabric improvements



- Fabric improvements are to bring each element up to current retrofit/refurbishment Part L levels as below:

Fabric type - U-Values	Units	Scenario 1 – Existing fabric	Scenario 2 -Roof upgrade	Scenario 3 - Roof and glazing	Scenario 4 - Roof, glazing and EWI
Floor	W/m <sup>2</sup> K	0.45	0.45	0.45	0.45
Walls	W/m <sup>2</sup> K	0.45	0.45	0.45	0.30
Glazing	W/m <sup>2</sup> K	2.00	2.00	1.60	1.60
Roof	W/m <sup>2</sup> K	0.25	0.16	0.16	0.16
<b>Ventilation</b>					
Air permeability	m <sup>3</sup> /h.m <sup>2</sup>	8.0	7.5	7.0	5.0

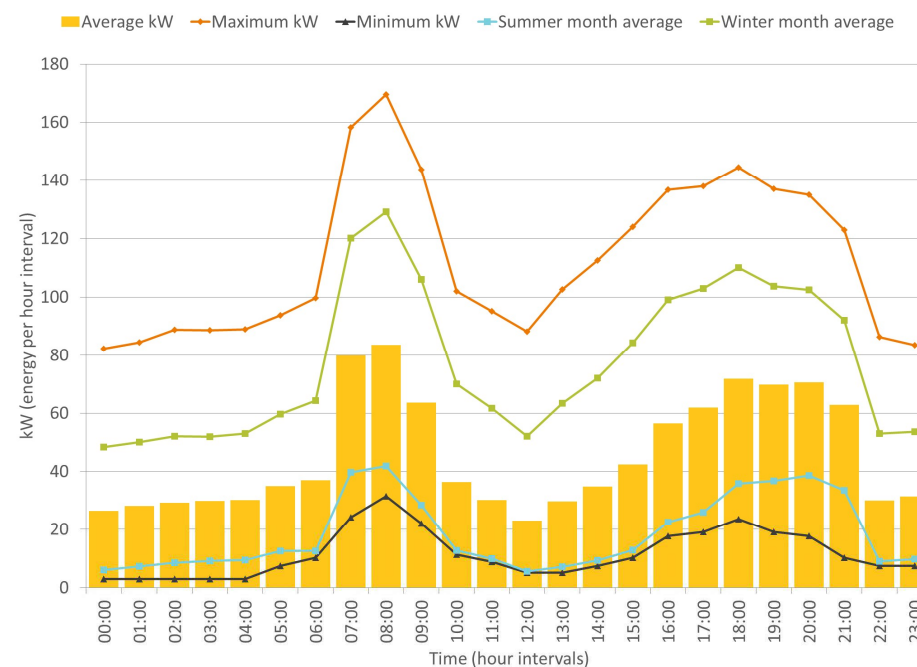
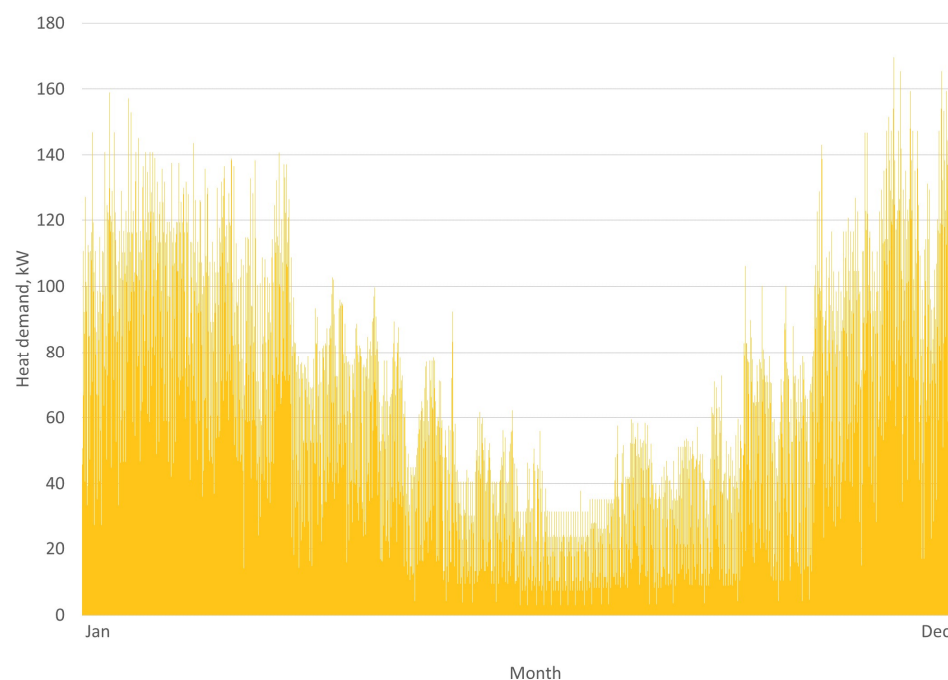


# Scenario 2,3 and 4 Fabric improvements

- Summary of heat demands

Scenario	Annual Modelled Demand kWh	Peak heat kW	kWh per flat	Total kW per flat
2	556,982	223	9,283	3.7
3	525,994	213	8,767	3.5
4	399,302	170	6,655	2.8

- Annual heat demand profile and average, max, min daily profile for scenario 4



# Supply options appraisal and feasibility



# Supply options appraisal

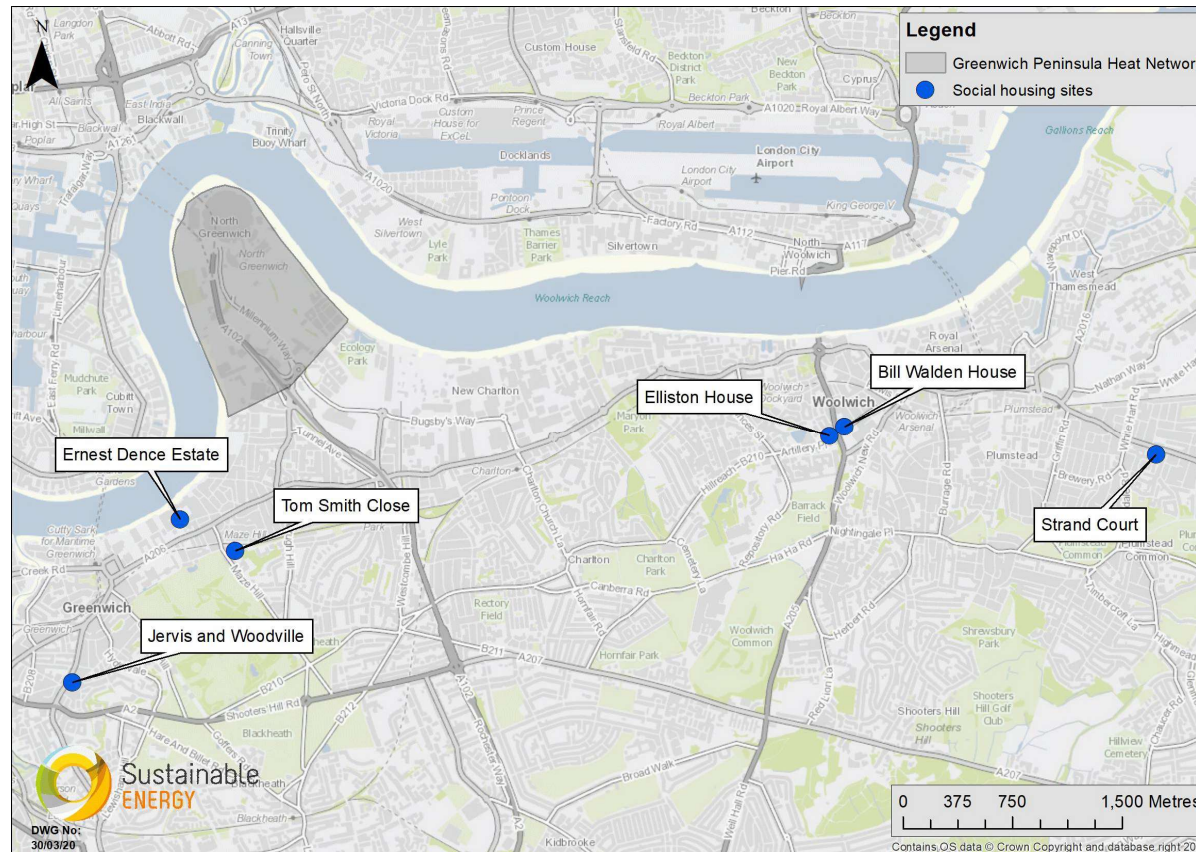


A number of different supply options were considered for the supply of heat and electricity to Strand Court:

- Connection to local district heat networks
- Heat pump technologies
  - Ground source – closed loop
  - Ground source – bore hole
  - Air source
- Solar PV
- Energy storage
  - Thermal
  - Electrical

# Local heat networks

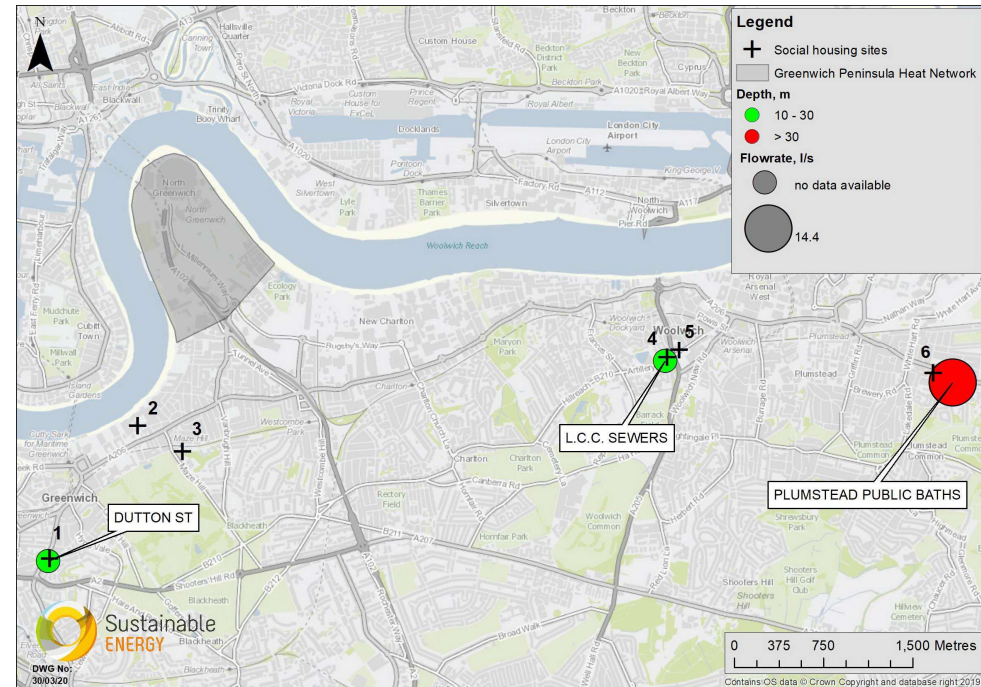
- The image below shows the position of the RBG low carbon assessment sites and the location of the Greenwich Peninsula heat network
- At present there are no suitable connection points for heat supply from the existing network
- The design of the new heating systems will be compatible with connection to a large heat network if a suitable one was to become viable in the future





# Ground source

- Borehole data from the national BGS resource is summarised in the GIS and table below
- Positions of gathered data is shown in the GIS
  - Colour indicated depth of bore holes
  - Width indicates flowrates measured in the bore holes
  - The assessment sites are numbered. Strand Court is shown at position 6

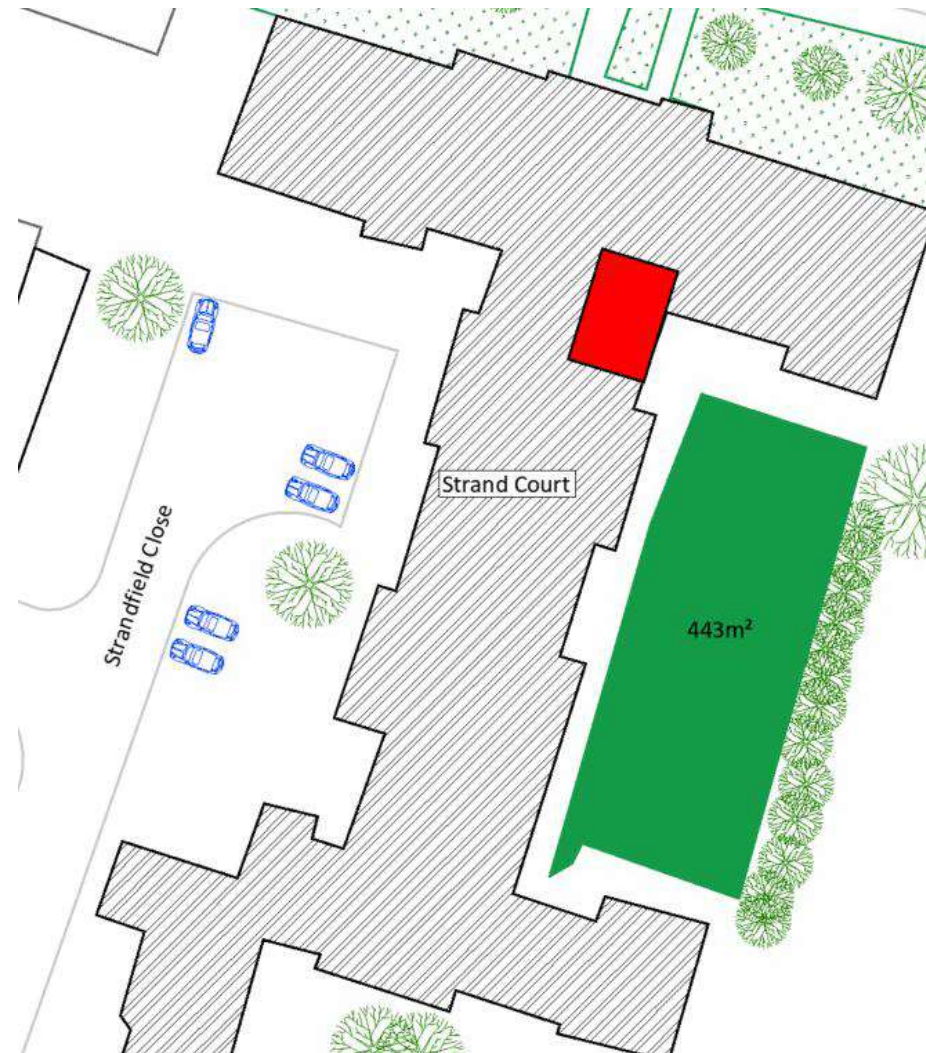


- Table with results of bore hole data

Location	Borehole name	Depth, m	Water depth, m	Flowrate, l/s	Strata details	Notes
Strand Court 545660,178410	TQ47NE5 — PLUMSTEAD PUBLIC BATHS WOOLWICH	128		14.4	0 – 3.05 m: Sand 3 – 5.2 m: Hard sand 5.2 – 32 m: Chalk and flints 32 – 37.5 m: Hard chalk and flints 37.5 – 79.3 m: Chalk and flints 79.3 – 81.7 m: Grey chalk and flints 81.7 – 83.2 m: Chalk and flints 83.2 – 95.7 m: Hard chalk and flints 95.7 – 109.2 m: Chalk and flints 109.2 – 111.9 m: Very hard chalk 111.9 – 114.3 m: Chalk and flints 114.3 – 116.1 m: Hard chalk 116.1 – 122.8 m: Chalk and flints	Last examined in 1961

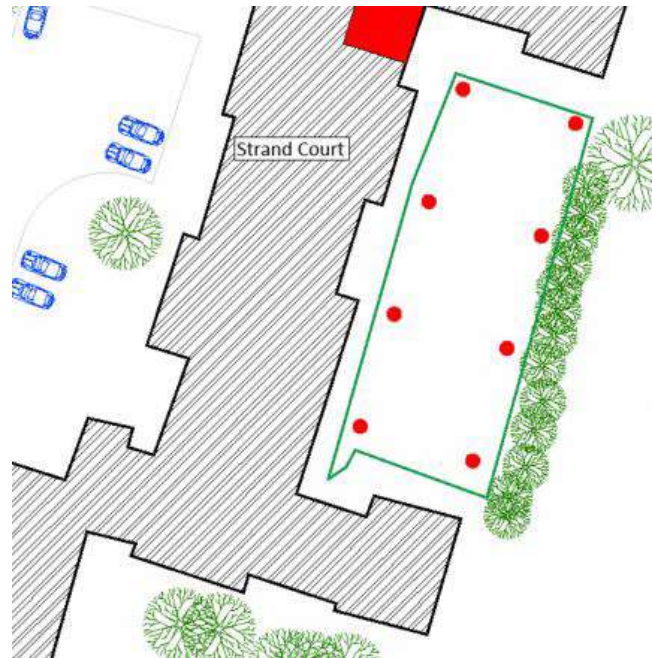
# Ground source – closed loop

- The available green space for the installation of ground loops is limited
  - Circa 443m<sup>2</sup> total shown below
- Potential issues with loss of recreation space for the sheltered accommodation



# Ground source – closed loop

- Vertical bore positions



- Potential yield\*

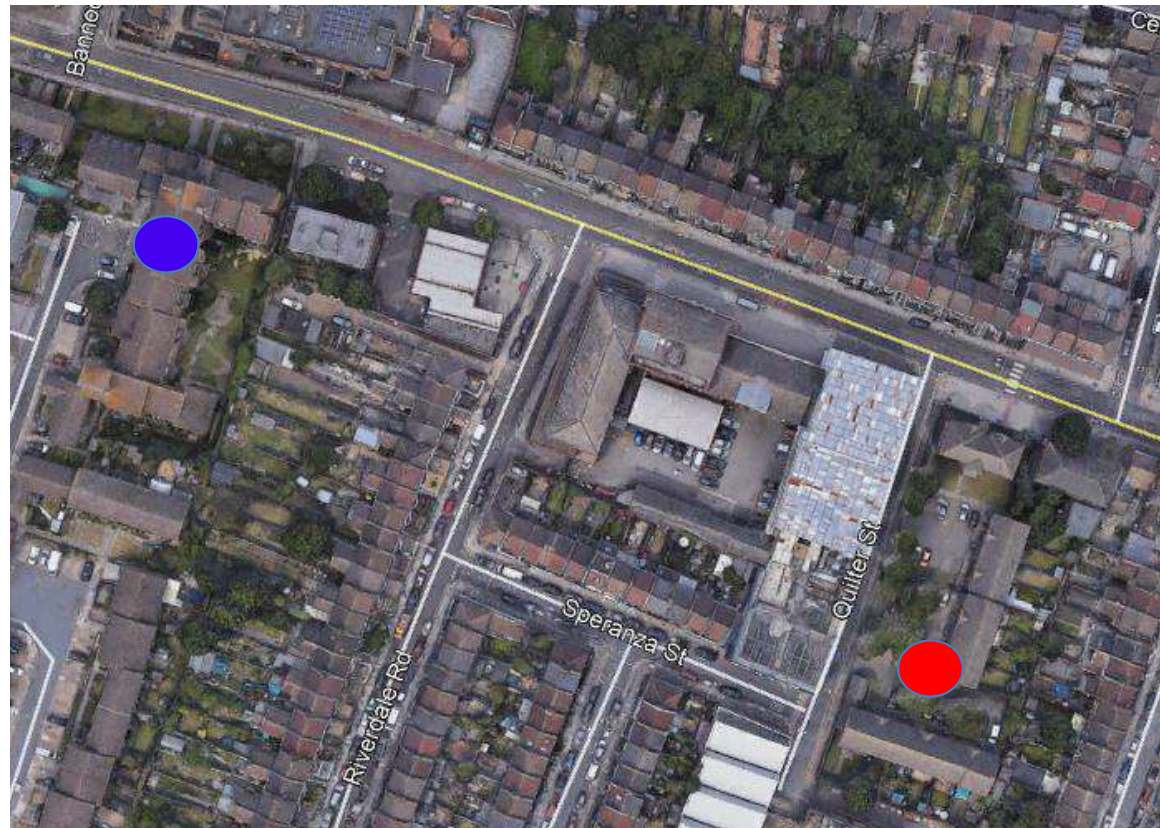
Array type	Heat extraction rate – figures from BS EN 15450	Installation details	Potential Capacity
Horizontal –slinky pipe	<ul style="list-style-type: none"> <li>• 16 - 24W/m<sup>2</sup></li> <li>• Figure for moist cohesive soil</li> <li>• 2400h p.a operation</li> </ul>	<ul style="list-style-type: none"> <li>• 443m<sup>2</sup> green space</li> </ul>	7 – 10.6kW
Vertical	<ul style="list-style-type: none"> <li>• 50W/m</li> <li>• Figure for normal underground and water saturated sediment</li> <li>• 2400h p.a operation</li> </ul>	<ul style="list-style-type: none"> <li>• 8 boreholes</li> <li>• 0.6m diameter with 10metre spacing</li> <li>• 100m depth</li> </ul>	40kW

\*Numbers shown assume all existing trees are removed and all available green space could be utilised



# Ground Source– open loop

- Borehole data is taken from a source (red) which is approximately 190m from Strand Court (blue)
- Flowrate from bore of 14.4l/s
  - Heat pump output potential of circa 270kW per bore hole ( $\Delta T - 3^{\circ}\text{C}$ )





# Ground Source– open loop



- There is some risk associated with the open loop solution.
- There is limited space for abstraction and discharge wells on site.
  - Without significant separation the ability to minimise thermal interaction will be limited
  - If land area cannot be found to significantly separate the wells, it is unlikely abstraction and discharge wells will be viable and so it may be possible to drill a single well where water is abstracted from one aquifer horizon and injected back to another. However, this approach is not tried and tested and detailed hydro geological modelling will be required to further assess viability as will the drilling of a test well.

# Air source



- Available resource with lower installation requirements
- Potential risks of noise to residents and cold plumes can be mitigated with suitable attenuation

# Technology assessment summary

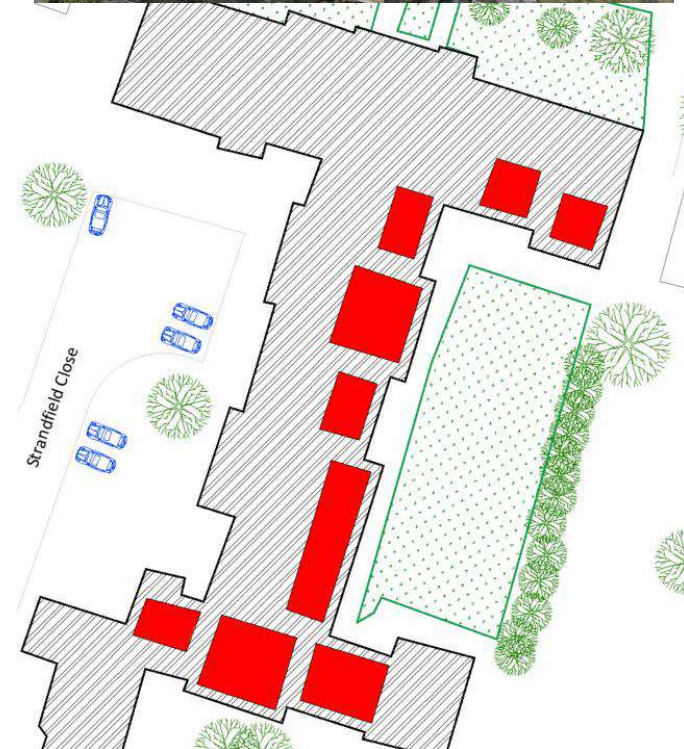
Heat source	Comments	Considered further?
Heat network connection	<ul style="list-style-type: none"><li>• No suitable networks local to the assessment site</li></ul>	No
Closed Loop GSHP	<ul style="list-style-type: none"><li>• Low yield potential from available land</li><li>• Not viable due to land requirement for ground loops (horizontal and vertical)</li></ul>	No
Open Loop GSHP	<ul style="list-style-type: none"><li>• Potential yield to supply full load</li><li>• High CAPEX associated with drilling boreholes into chalk aquifer</li><li>• RHI accreditation is time sensitive and installation of bore is time intensive</li></ul>	Yes
ASHP	<ul style="list-style-type: none"><li>• Lower initial CAPEX than GSHP options</li><li>• Potential noise restrictions close to residential developments</li></ul>	Yes

# Solar PV assessment



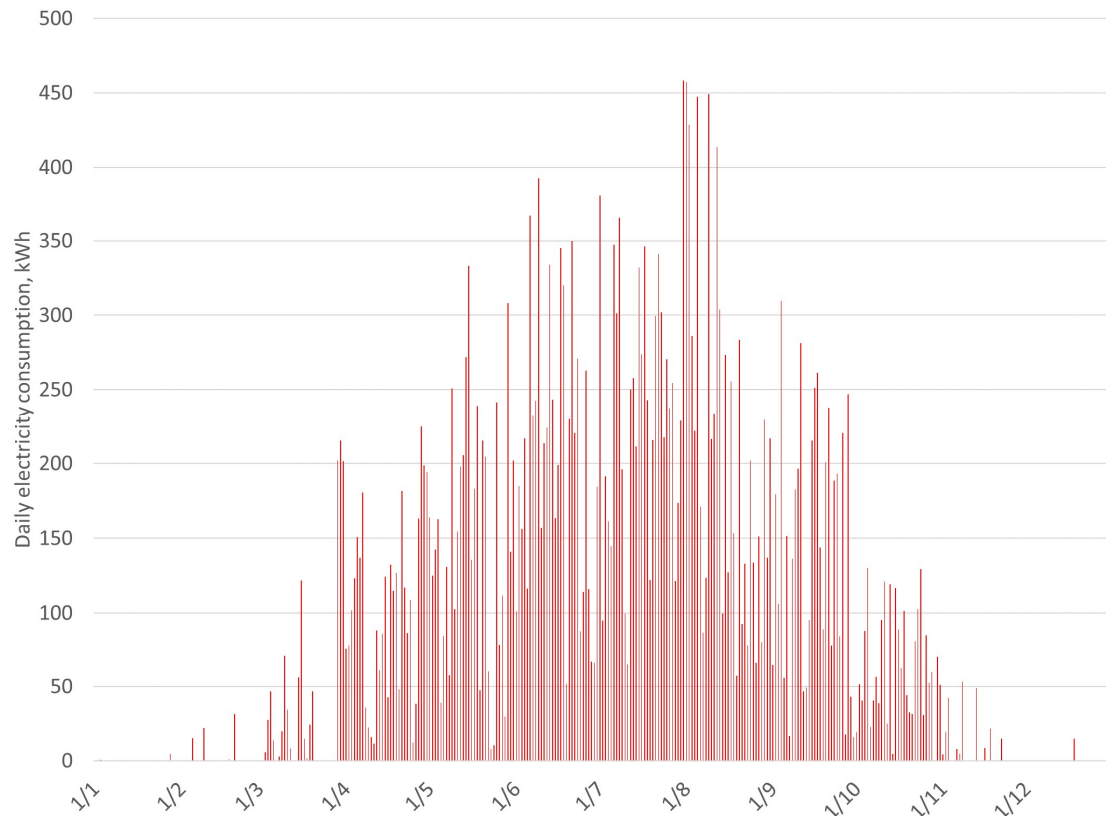
# Roof top PV installation

- Circa 340m<sup>2</sup> of available roof space for installation (red)
  - South facing on pitched roof
  - Mounted flush to pitched roof
  - 30° inclination (assumed pitch of roof)
- Potential peak load circa 70kW
  - 213xno. 330W panels
- Potential generation 67,752kWh per annum
- Installation cost including cost of PV panels, inverters, roof mounts, cabling and installation - £72,000
- Additional surveys required to determine structural suitability of existing roof for housing the PV array



# Roof top PV – Battery Storage

- To recoup/store excess electricity generation on the peak day would require a discharge capacity of 460kWh
- Based on round-trip efficiency of 90% a circa 510kWh battery is required
- The income gain from storing electricity over exporting is £2,712
  - Excess kWh at high tariff minus kWh at export tariff = £4,683 - £1,971= £2,712
- The typical lifespan of a solar battery is between 5-15years; best case scenario the battery would need to be £40,682 to pay back during its lifespan (cost of a suitable battery for this site would be in the £180,000 - £220,000 range)
- Battery storage option not currently viable



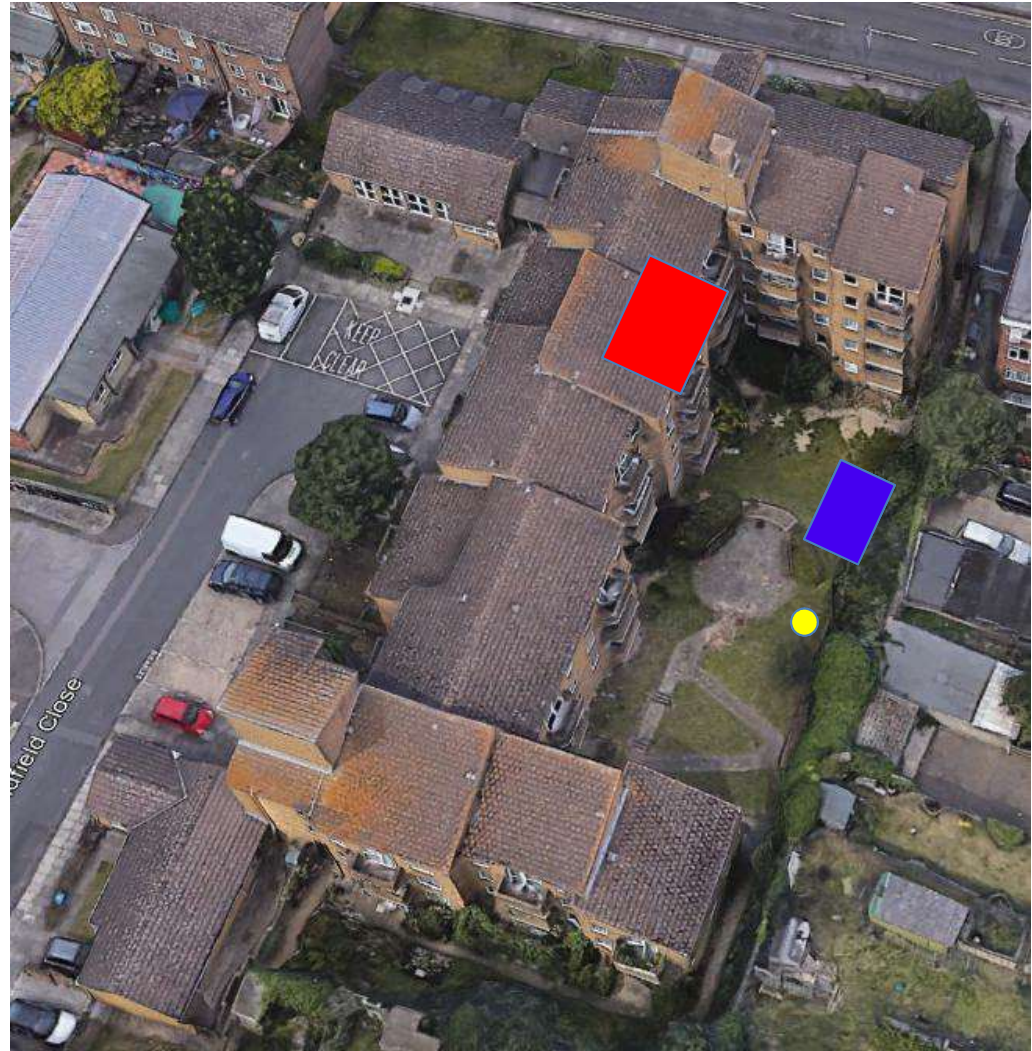
# Concept design





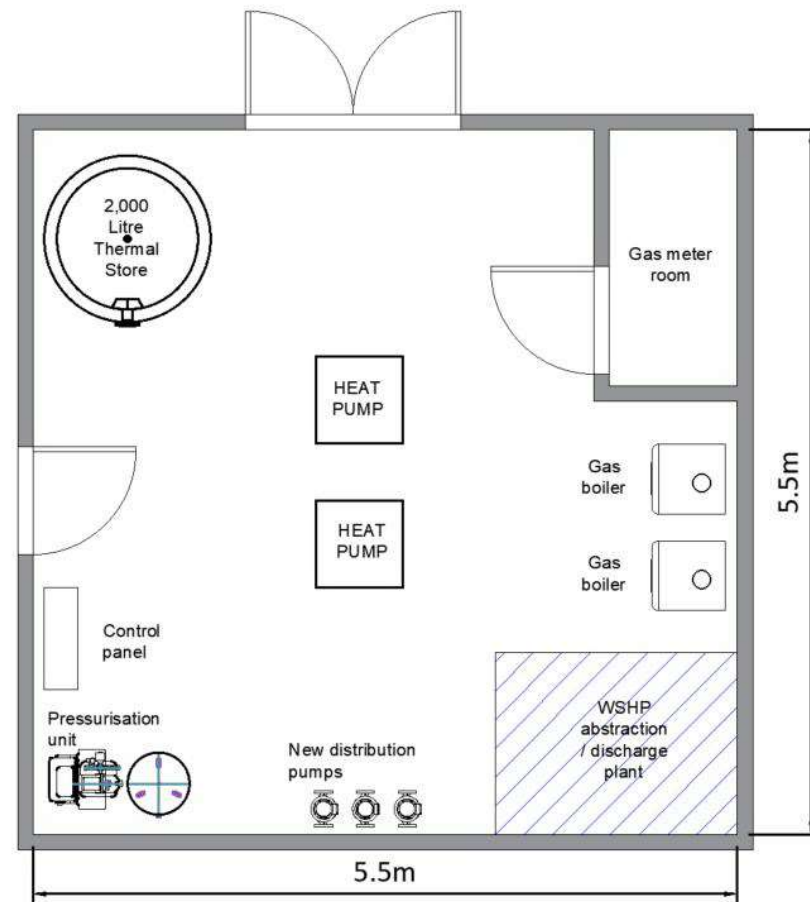
# Design considerations

- Existing available plant room space = 5.5 x 5.5metres
- Plant room space limits the selection of new heating plant
- The existing plant room is positioned on the ground floor (red)
- Dry air coolers can be placed on the green outside the existing plant room. Additional attenuation required to mitigate any sound issues
  - Potential position for dry air coolers (blue)
- Bore hole can be drilled on the green outside the existing plant. To reduce the risk of interaction between abstraction and discharge and CAPEX for drilling , a bore that allows for abstraction and discharge from the same hole can be used
  - Potential position for bore hole (yellow)



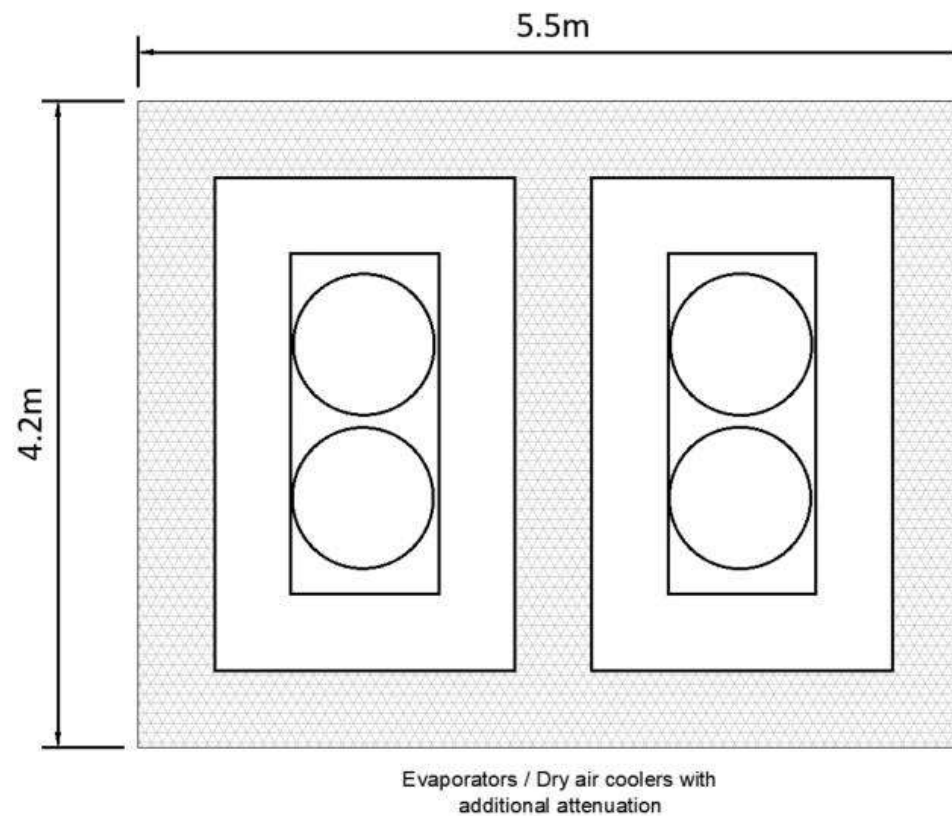
# Energy Centre

- New heating plant to be installed in existing plant room
- ASHP solution consists of 2no. 80kW air source heat pumps and 1no. 2,000litre thermal store
- GSHP solution consists of 2no. 95kW water source heat pumps and 1no. 2,000litres
- 2no. 120kW Condensing gas boiler back-up for both solutions

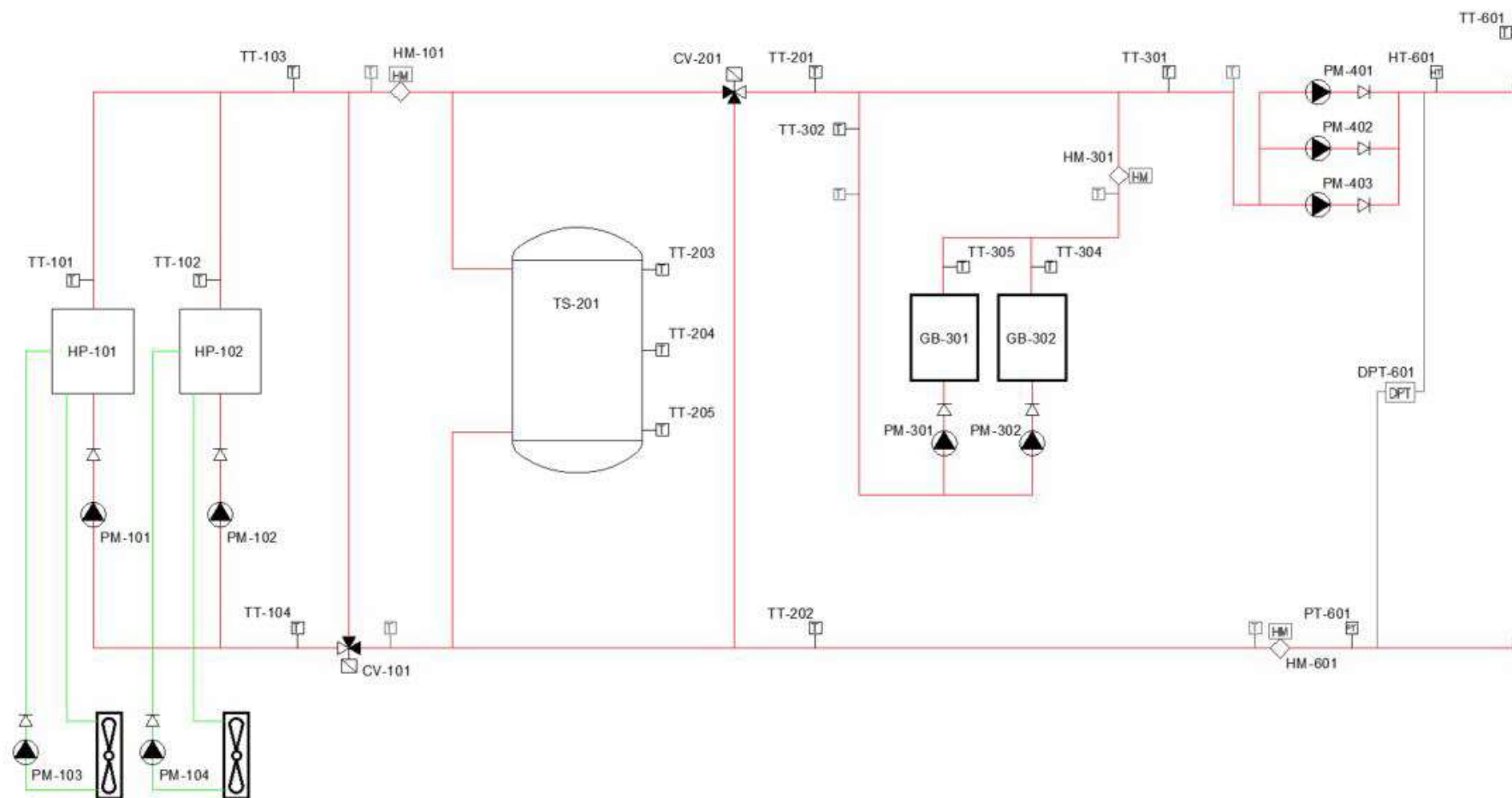


# Energy Centre

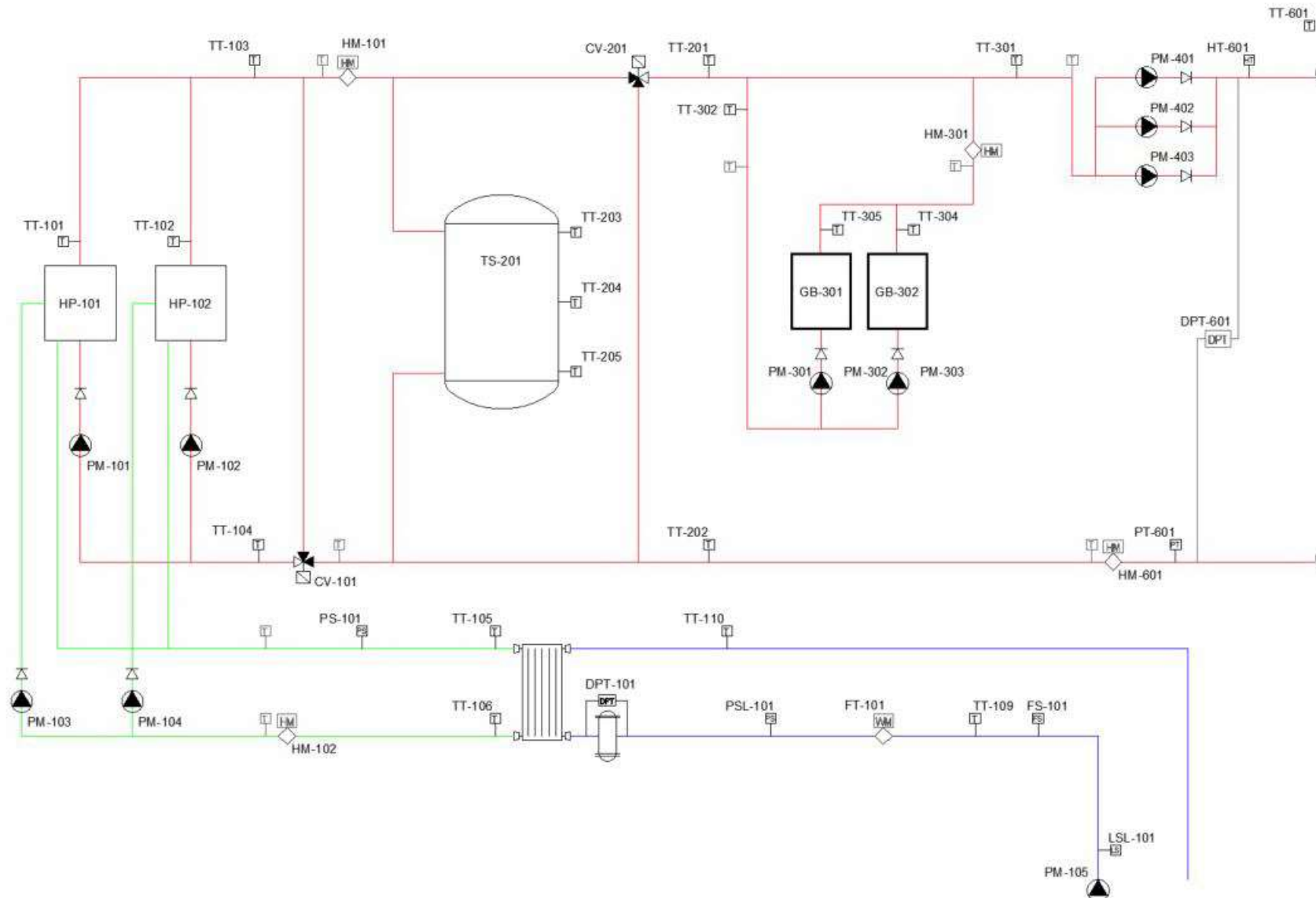
- ASHP solution – Dry air coolers with attenuation



# PFD Schematic - ASHP



# PFD Schematic - GSHP



# Economic Assessment





# Condensing gas boiler - full scheme CAPEX



	CAPEX	CAPEX inc. contingency
<b>Preliminary</b>		
Contractor prelims including welfare and storage	£45,000	£54,000
<b>Energy Centre works</b>		
Peak and reserve gas boilers	£12,500	£13,125
Peak and reserve gas boiler flues	£5,000	£5,750
Pressurisation	£5,000	£5,250
Water treatment, flushing and testing	£6,500	£7,475
Electrical connection upgrade	£19,000	£23,750
Plantroom controls	£40,000	£48,000
Cabling and electrical housing blocks	£25,000	£30,000
Other energy centre M&E (pipework, pumps, temporary PHE)	£79,449	£95,339
Builders works	£10,000	£11,500
<b>Network - Usual</b>		
Customer HIUs and flat fit out	£240,000	£276,000
Risers and laterals	£225,000	£281,250
<b>Planning, design and management</b>		
Resident liaison officer	£10,000	£11,000
Professional, design and contracting fees	£50,000	£52,500
Clients Engineer - technical support for construction and commissioning	£30,000	£33,000
<b>Total</b>	<b>£802,449</b>	<b>£947,939</b>



# Condensing gas boiler - gas boiler only CAPEX



	CAPEX	CAPEX inc. contingency
Energy Centre works		
Peak and reserve gas boilers	£12,500	£13,125
Peak and reserve gas boiler flues	£5,000	£5,750
Electrical connection upgrade	£19,000	£23,750
Plantroom controls	£40,000	£48,000
Cabling and electrical housing blocks	£25,000	£30,000
Other energy centre M&E (pipework, pumps, temporary PHE)	£79,449	£95,339
Planning, design and management		
Professional, design and contracting fees	£50,000	£52,500
Clients Engineer - technical support for construction and commissioning	£30,000	£33,000
Total	£260,949	£301,464

# ASHP and Condensing gas boiler scheme – full scheme CAPEX



	Total	Total inc. contingency
Preliminary		
Contractor prelims including welfare and storage	£55,000	£66,000
Energy Centre works – common to ASHP and gas options		
Peak and reserve gas boilers	£12,500	£13,125
Peak and reserve gas boiler flues	£5,000	£5,750
Pressurisation	£5,000	£5,250
Water treatment, flushing and testing	£6,500	£7,475
Electrical connection upgrade	£25,000	£31,250
Plantroom controls	£60,000	£72,000
Cabling and electrical housing blocks	£25,000	£30,000
Other energy centre M&E (pipework, pumps, temporary PHE)	£79,449	£95,339
Builders works	£15,000	£17,250
Network – common to ASHP and gas options		
Customer HIUs and flat fit out	£240,000	£276,000
Risers and laterals	£225,000	£281,250
Energy Centre works – ASHP only		
Heat pump	£90,000	£99,000
ASHP attenuation	£10,000	£11,000
Heat pump M&E works	£30,000	£33,000
Thermal store	£2,200	£2,420
Energy centre civils works	£20,000	£23,000
Planning, design and management – common to ASHP and gas options		
Planning application and fees	£6,000	£7,500
Resident liaison officer	£10,000	£11,000
Professional, design and contracting fees	£65,000	£68,250
Clients Engineer - technical support for construction and commissioning	£40,000	£44,000
RHI Application	£4,500	£4,725
Total	£1,031,149	£1,204,584

# ASHP and Condensing gas boiler scheme– ASHP and Condensing gas boiler only CAPEX



	Total	Total inc. contingency
Energy Centre works – common to ASHP and gas options		
Peak and reserve gas boilers	£12,500	£13,125
Peak and reserve gas boiler flues	£5,000	£5,750
Electrical connection upgrade	£25,000	£31,250
Plantroom controls	£60,000	£72,000
Cabling and electrical housing blocks	£25,000	£30,000
Other energy centre M&E (pipework, pumps, temporary PHE)	£79,449	£95,339
Energy Centre works – ASHP only		
Heat pump	£90,000	£99,000
ASHP attenuation	£10,000	£11,000
Heat pump M&E works	£30,000	£33,000
Thermal store	£2,200	£2,420
Planning, design and management – common to ASHP and gas options		
Professional, design and contracting fees	£65,000	£68,250
Clients Engineer - technical support for construction and commissioning	£40,000	£44,000
Total	£444,149	£505,134

# GSHP and Condensing gas boiler scheme – full scheme CAPEX



	Total	Total inc. contingency
Preliminary		
Contractor prelims including welfare and storage	£65,000	£78,000
Energy Centre works – common to GSHP and gas options		
Peak and reserve gas boilers	£12,500	£13,125
Peak and reserve gas boiler flues	£5,000	£5,750
Pressurisation	£5,000	£5,250
Water treatment, flushing and testing	£6,500	£7,475
Electrical connection upgrade	£25,000	£31,250
Plantroom controls	£60,000	£72,000
Cabling and electrical housing blocks	£25,000	£30,000
Other energy centre M&E (pipework, pumps, temporary PHE)	£79,449	£95,339
Builders works	£15,000	£17,250
Network – common to GSHP and gas options		
Customer HIUs and flat fit out	£240,000	£276,000
Risers and laterals	£225,000	£281,250
Energy Centre works – GSHP only		
Heat pump	£90,000	£99,000
Bore hole	£120,000	£138,000
Heat pump M&E works	£45,000	£49,500
Thermal store	£2,200	£2,420
Energy centre civils works	£20,000	£23,000
Planning, design and management – common to GSHP and gas options		
Planning application and fees	£6,000	£7,500
Resident liaison officer	£10,000	£11,000
Professional, design and contracting fees	£65,000	£68,250
Clients Engineer - technical support for construction and commissioning	£40,000	£44,000
RHI Application	£4,500	£4,725
Total	£1,166,149	£1,360,084

# GSHP and Condensing gas boiler scheme– GSHP and Condensing gas boiler only CAPEX



	Total	Total inc. contingency
Energy Centre works – common to GSHP and gas options		
Peak and reserve gas boilers	£12,500	£13,125
Peak and reserve gas boiler flues	£5,000	£5,750
Electrical connection upgrade	£25,000	£31,250
Plantroom controls	£60,000	£72,000
Cabling and electrical housing blocks	£25,000	£30,000
Other energy centre M&E (pipework, pumps, temporary PHE)	£79,449	£95,339
Energy Centre works – GSHP only		
Heat pump	£90,000	£99,000
Bore hole	£120,000	£138,000
Heat pump M&E works	£45,000	£49,500
Thermal store	£2,200	£2,420
Planning, design and management – common to GSHP and gas options		
Clients Engineer - technical support for construction and commissioning	£40,000	£44,000
RHI Application	£4,500	£4,725
Total	£569,149	£648,634

# Fuel Tariffs

- Tariff inputs

Gas tariff (excl. CCL)	2.166	p/kWh
Gas standing charge	14.86	£/day
CCL - natural gas (2021)	0.406	p/kWh
CCL - natural gas (2022)	0.568	p/kWh
CCL - natural gas (2023 onwards)	0.672	p/kWh
CCL - electricity	0.775	p/kWh
Energy centre electricity tariff - day	13.07	p/kWh
Energy centre electricity tariff - night	8.8	p/kWh
Electricity standing charge	0.18	£/day

# OPEX and REPEX assumptions

## OPEX

- Annual cost for O&M of £2,522 used, which covers the following:
  - Annual servicing for communal heating and hot water (gas only, current maintenance contract only covers gas based systems)
  - HIUs (presumed HIUs for all below estates based on rate receiving for some estates which already have HIUs)
  - Service of BMS with annual servicing of heating and hot water
  - Pressurisation units and expansion vessels
  - Quarterly water treatment
- Annual spares and repair costs £5,884
  - Using estimated of 70% of total costs for maintenance contract from spares and repairs
- Metering and billing cost - £5,400 per annum

## REPEX

- Pro-rata cost added per year based on the cost of the asset and its economic life
- Economic lifetime of the technologies used:

Technology	Useful economic lifetime (years)
Heat pump	20
Gas boilers	20
Heat network connections	25



# Assessment scenarios - ASHP



- Heat pump solutions sized to provide maximum % of heat demand capable given the limitations on plant room space
- For the assessment cases it is assumed that the availability of the ASHP to supply the heat demand is 96% (2 weeks for maintenance and repairs)
  - The techno economic model has a function to compare 100% (52 weeks), 96% (50 weeks) and 92% (48 weeks) availability
- Table below shows the contribution of the ASHP against the different heat demand scenarios

	Scenario 1	Scenario 2	Scenario 3	Scenario 4
Total heat demand	591,639kWh	556,982kWh	525,994kWh	399,302kWh
Peak heat demand	235kW	223kW	213kW	170kW
Heat pump capacity - ASHP	160kW	160kW	160kW	160kW
Thermal store capacity	2,000litres	2,000litres	2,000litres	2,000litres
% heat demand potentially met by low carbon / renewable technology				
52 weeks availability - ASHP	96%	97%	98%	100%
50 weeks availability - ASHP	95%	96%	97%	98%
48 weeks availability - ASHP	94%	95%	96%	98%

# Assessment scenarios - GSHP



- Heat pump solutions sized to provide maximum % of heat demand capable given the limitations on plant room space
- For the assessment cases it is assumed that the availability of the GSHP to supply the heat demand is 96% (2 weeks for maintenance and repairs)
  - The techno economic model has a function to compare 100% (52 weeks), 96% (50 weeks) and 92% (48 weeks) availability
- Table below shows the contribution of the GSHP against the different heat demand scenarios

	Scenario 1	Scenario 2	Scenario 3	Scenario 4
Total heat demand	591,639kWh	556,982kWh	525,994kWh	399,302kWh
Peak heat demand	235kW	223kW	213kW	170kW
Heat pump capacity - GSHP	190kW	190kW	190kW	190kW
Thermal store capacity	2,000litres	2,000litres	2,000litres	2,000litres
% heat demand potentially met by low carbon / renewable technology				
52 weeks availability - GSHP	99.7%	99.9%	99.9%	100%
50 weeks availability – GSHP	98.7%	98.9%	98.9%	98.8%
48 weeks availability - GSHP	98%	98.1%	98.2%	97.8%

# Assessment scenarios



- Two CAPEX scenarios are presented:
  - **CASE 1** – installation of condensing gas boiler and energy centre upgrades
  - **CASE 2** – installation of condensing gas boiler, installation of ASHP/GSHP and energy centre upgrades
  - These cases include the CAPEX associated with installation of the heat generation technology systems only
- Two heat demand scenarios are presented:
  - Scenario 1 – existing fabric with upgraded heating system
  - Scenario 4 – upgraded fabric (roof, glazing and EWI) with upgraded heating system
- Additional economic assumptions:
  - ASHP/GSHP cases will include income from RHI
  - Impact of PV array installation will also be presented
    - Electricity generation to offset the energy centre requirements at electricity day rate
    - Excess generation exported at 5.5p/kWh

## Economic assessment (heat demand scenario 1)

[illegible]

## Economic assessment (heat demand scenario 1)

		Current system	Option 1: Condensing gas	Option 2: ASHP / Condensing gas	Option 3: ASHP / Condensing gas / PV	Option 4: GSHP / Condensing gas	Option 5: GSHP / Condensing gas / PV
<b>Units</b>							
<b>Resident costs – Fuel only</b>							
Cost of heat to residence – Fuel (variable)	p/kWh	7.44	4.04	5.59	4.85	5.21	4.48
Cost of heat to residence - annual	£	£734	£399	£552	£479	£514	£441
<b>Resident costs – Fuel + O&amp;M</b>							
Cost of heat to residence – O&M (fixed)	£/day	0.63	0.63	0.77	0.77	0.77	0.77
Cost of heat to residence – Fuel (variable)	p/kWh	7.44	4.04	5.59	4.85	5.21	4.48
Cost of heat to residence - annual	£	£963	£629	£832	£759	£794	£721
<b>Subsidy requirement per apartment</b>							
Cost of heat, savings per apartment (fuel only)	£/year			£182	£255	£220	£293
Cost of heat, savings per apartment (fuel + O&M)	£/year			£131	£204	£169	£242
Remaining RHI income (whole scheme - fuel + O&M)	£/year			£15,388	£15,388	£33,401	£33,401
<b>Assumptions</b>		No accounting has been made for initial capital costs or replacement costs over lifetime. Capital for energy centre and network are part of the building and therefore will be part of the rent rather than in the energy bills.					
<b>Social Economics – 25 year case</b>							
Social IRR			4.7%	4.1%	4.6%	6.1%	6.3%
Social NPV			£41,882	£35,955	£76,469	£198,448	£238,948
<b>Assumptions</b>	Fixed tariff of £1/day Variable tariff of 7p/kWh (in line with Heat Trust costing)						

## Economic assessment (heat demand scenario 4)

[illegible]



## Economic assessment (heat demand scenario 4)

		Current system	Option 1: Condensing gas	Option 2: ASHP / Condensing gas	Option 3: ASHP / Condensing gas / PV	Option 4: GSHP / Condensing gas	Option 5: GSHP / Condensing gas / PV
<b>Units</b>							
<b>Resident costs – Fuel only</b>							
Cost of heat to residence – Fuel (variable)	p/kWh	7.44	4.49	6.15	5.28	5.68	4.82
Cost of heat to residence - annual	£	£734	£299	£409	£352	£378	£321
<b>Resident costs – Fuel + O&amp;M</b>							
Cost of heat to residence – O&M (fixed)	£/day	0.63	0.63	0.77	0.77	0.77	0.77
Cost of heat to residence – Fuel (variable)	p/kWh	7.44	4.49	6.15	5.28	5.68	4.82
Cost of heat to residence - annual	£	£963	£529	£689	£632	£658	£601
<b>Subsidy requirement per apartment</b>							
Cost of heat, savings per apartment (fuel only)	£/year			£325	£382	£356	£413
Cost of heat, savings per apartment (fuel + O&M)	£/year			£274	£331	£305	£362
Remaining RHI income (whole scheme - fuel + O&M)	£/year			£10,808	£10,808	£27,994	£27,994
<b>Assumptions</b>	No accounting has been made for initial capital costs or replacement costs over lifetime. Capital for energy centre and network are part of the building and therefore will be part of the rent rather than in the energy bills.						
<b>Social Economics – 25 year case</b>							
Social IRR			1.7%	0.6%	1.5%	3.2%	3.6%
Social NPV			-£56,857	-£151,571	-£122,633	-£18,538	£9,836
<b>Assumptions</b>	Fixed tariff of £1/day Variable tariff of 7p/kWh (in line with Heat Trust costing)						

# GSHP with no RHI



- The heat pump options presented benefit from the RHI subsidy
- There is risk associated with the installation of the GSHP
- The following assessment shows the economic case for the GSHP without the RHI subsidy

# Economic assessment (heat demand scenario 1)

		Current system	Option 1: Condensing gas	Option 2: GSHP / Condensing gas	Option 3: GSHP / Condensing gas / PV
<b>Energy and carbon</b>	<b>Units</b>				
Heat demand - Peak	kW	243	235	235	235
Heat annual demand	kWh	725,250	591,639	591,639	591,639
Heat annual demand - losses	kWh				
Heat annual demand - Total	kWh	725,250	591,639	591,639	591,639
% heat demand low carbon	%	0%	0%	95%	95%
25 year CO2e savings	tCO2e		341	2,757	2,857
First year CO2e savings, tCO2e	tCO2e		12	81	89
First year CO2e intensity of delivered heat	gCO2e /kWh		210	94	79
<b>Build and run costs</b>					
Capex of scheme	£		£260,949	£569,149	£641,149
Capex of scheme + contingency	£		£301,464	£648,634	£727,834
OPEX – Fuel costs	£		£23,931	£30,851	£26,476
OPEX – (O&M + fuel/elec costs)	£		£37,736	£47,656	£43,282
Fixed heat sales	£		£21,900	£21,900	£21,900
Variable heat sales	£		£41,415	£41,415	£41,415
Potential annual Income - RHI	£		-	-	-
Potential annual Income – PV export	£		-	-	£1,971
<b>Economic indicators – 25 year case</b>					
Fixed heat sales	£/day		1	1	1
Variable heat sales	p/kWh		7	7	7
Cost of heat to residence - annual	£		£1,055	£1,055	£1,055
Payback period	Years		16	0	0
NPV	£		£15,522	-£475,881	-£445,096
IRR	%		4.0%	-5.6%	-3.5%
<b>Assumptions</b>	Capital costs excludes heating systems, water treatment and ancillaries Fixed tariff of £1/day Variable tariff of 7p/kWh (in line with Heat Trust costing)				

# Economic assessment (heat demand scenario 1)

		Current system	Option 1: Condensing gas	Option 2: GSHP / Condensing gas	Option 3: GSHP / Condensing gas / PV
Units					
Resident costs – Fuel only					
Cost of heat to residence – Fuel (variable)	p/kWh	7.44	4.04	5.21	4.48
Cost of heat to residence - annual	£	£734	£399	£514	£441
Resident costs – Fuel + O&M					
Cost of heat to residence – O&M (fixed)	£/day	0.63	0.63	0.77	0.77
Cost of heat to residence – Fuel (variable)	p/kWh	7.44	4.04	5.21	4.48
Cost of heat to residence - annual	£	£963	£629	£794	£721
Subsidy requirement per apartment					
Cost of heat, savings per apartment (fuel only)	£/year		-	-	-
Cost of heat, savings per apartment (fuel + O&M)	£/year		-	-	-
Remaining RHI income (whole scheme - fuel + O&M)	£/year		-	-	-
Assumptions	No accounting has been made for initial capital costs or replacement costs over lifetime. Capital for energy centre and network are part of the building and therefore will be part of the rent rather than in the energy bills.				
Social Economics – 25 year case					
Social IRR			4.7%	-0.4%	0.6%
Social NPV			£41,882	-£276,171	-£235,671
Assumptions	Fixed tariff of £1/day Variable tariff of 7p/kWh (in line with Heat Trust costing)				

# Increased gas tariff



- The gas tariff for Strand Court at the time of this assessment is 2.166p/kWh
- This figure is relatively low and an increase in this tariff has a significant affect on economic case for the condensing gas boiler only solution
- The following table presents the cases with the gas tariff increased the point at which the economics are similar for the gas condensing case and the heat pump plus PV case
  - ASHP gas tariff increase – 2.77p/kWh
  - GSHP gas tariff increase – 2.175p/kWh

# Economic assessment (heat demand scenario 1)

		Current system	Option 1: Condensing gas against ASHP	Option 2: ASHP / Condensing gas / PV	Option 3: Condensing gas against GSHP	Option 4: GSHP / Condensing gas / PV
<b>Energy and carbon</b>	<b>Units</b>					
Heat demand - Peak	kW	243	235	235	235	235
Heat annual demand	kWh	725,250	591,639	591,639	591,639	591,639
Heat annual demand - losses	kWh					
Heat annual demand - Total	kWh	725,250	591,639	591,639	591,639	591,639
% heat demand low carbon	%	0%	0%	95%	0%	98.7%
25 year CO2e savings	tCO2e		341	2,690	341	2,857
First year CO2e savings, tCO2e	tCO2e		12	81	12	89
First year CO2e intensity of delivered heat	gCO2e /kWh		210	93	210	79
<b>Build and run costs</b>						
Capex of scheme	£		£260,949	£516,149	£260,949	£641,149
Capex of scheme + contingency	£		£301,464	£584,334	£301,464	£727,834
OPEX – Fuel costs	£		£27,902	£28,936	£23,991	£26,477
OPEX – (O&M + fuel/elec costs)	£		£41,707	£45,741	£37,796	£43,282
Fixed heat sales	£		£21,900	£21,900	£21,900	£21,900
Variable heat sales	£		£41,415	£41,415	£41,415	£41,415
Potential annual Income - RHI	£		-	£15,388	-	£33,401
Potential annual Income – PV export	£			£1,970	-	£1,971
<b>Economic indicators – 25 year case</b>						
Fixed heat sales	£/day		1	1	1	1
Variable heat sales	p/kWh		7	7	7	7
Cost of heat to residence - annual	£		£1,055	£1,055	£1,055	£1,055
Payback period	Years		22	20	16	15
NPV	£		-£66,479	-£123,782	£14,300	£29,508
IRR	%		1.3%	1.3%	3.9%	3.9%
<b>Assumptions</b>	Capital costs excludes heating systems, water treatment and ancillaries Fixed tariff of £1/day Variable tariff of 7p/kWh (in line with Heat Trust costing)					

# Economic assessment (heat demand scenario 1)

		Current system	Option 1: Condensing gas against ASHP	Option 2: ASHP / Condensing gas / PV	Option 3: Condensing gas against GSHP	Option 4: GSHP / Condensing gas / PV
Units						
Resident costs – Fuel only						
Cost of heat to residence – Fuel (variable)	p/kWh	7.44	4.72	4.89	4.05	4.48
Cost of heat to residence - annual	£	£734	£465	£482	£400	£441
Resident costs – Fuel + O&M						
Cost of heat to residence – O&M (fixed)	£/day	0.63	0.63	0.77	0.63	0.77
Cost of heat to residence – Fuel (variable)	p/kWh	7.44	4.72	4.89	4.05	4.48
Cost of heat to residence - annual	£	£963	£695	£762	£630	£721
Subsidy requirement per apartment						
Cost of heat, savings per apartment (fuel only)	£/year		-	£252	-	£293
Cost of heat, savings per apartment (fuel + O&M)	£/year		-	£201	-	£242
Remaining RHI income (whole scheme - fuel + O&M)	£/year		-	£15,388	-	£33,401
Assumptions	No accounting has been made for initial capital costs or replacement costs over lifetime. Capital for energy centre and network are part of the building and therefore will be part of the rent rather than in the energy bills.					
Social Economics – 25 year case						
Social IRR			2.2%	4.6%	4.7%	6.3%
Social NPV			-£40,119	£72,024	£40,660	£238,932
Assumptions	Fixed tariff of £1/day Variable tariff of 7p/kWh (in line with Heat Trust costing)					



# Summary and next steps



# Summary



- The economic case for the ASHP option is less favourable than the gas condensing option at the current gas price but the ASHP offers better CO<sub>2</sub>e savings.
  - When gas prices reach 2.77p/kWh then economics reach parity with the social IRR for the ASHP being higher.
- The economic case for the GSHP option is comparable to the gas condensing option at the current gas price
- There is high risk associated with the GSHP option
  - RHI subsidy application required by 31<sup>st</sup> March 2021. More difficult installation than the ASHP.
  - technical feasibility associated with the abstraction and discharge wells. Detailed hydro geological modelling will be required to further assess viability as will the drilling of a test well.
- Solar PV improves economics and increases CO<sub>2</sub>e savings.

# Next Steps

- Explore option for RHI tariff guarantee scheme for both heat pump options
  - Critical for GSHP
- Assess surrounding buildings such as Bannockburn primary school and Plumstead Library for larger network from ground source. This benefits from an improvement in local air quality and economies of scale on system installation
- Additional surveys required to determine structural suitability of existing roof for housing the PV array
- Detail dimensions for full energy system and network
- Draft tender specification for energy centre and phased works



