



Royal Borough of Greenwich

Jervis and Woodville Courts

Low carbon technology feasibility

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Sustainable
ENERGY

Scope of work

- 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 and back up gas boilers



Summary of Jervis and Woodville Court



- 26 dwellings in two blocks
- Central heating system plant in Woodville Court
- Existing LTHW (82°C flow / 71°C return) communal heating system supplies radiators and hot water cylinders



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

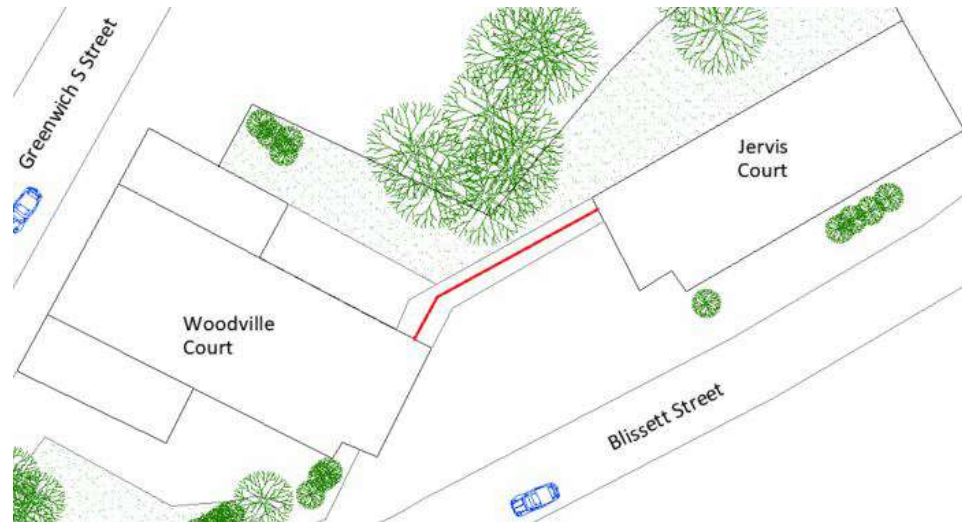
* This does not mean a reduction in the potential energy supplied to each space; although, the operating temperatures are lower than existing, the new emitters will be compatible with the operating conditions and the required set points will be achieved

Heat demand profiling



Current heat demand

- Existing gas consumption data - 417,046kWh per annum
- Existing heat demand modelled based on following assumptions:
 - Fabric to ~30 year old building regs
 - Unmetered heating controls with 21°C setpoint and 16°C set back
 - Individual DHW hot water storage tank per flat
 - 1.5 occupants per apartment
- External pipe losses from existing underground pipework
 - Red line shows assumed pipework layout
 - Calculated hourly heat loss – 0.44kW
 - Calculated annual heat loss – 3,854kWh/yr



Current heat demand

- Fabric and ventilation loss inputs:

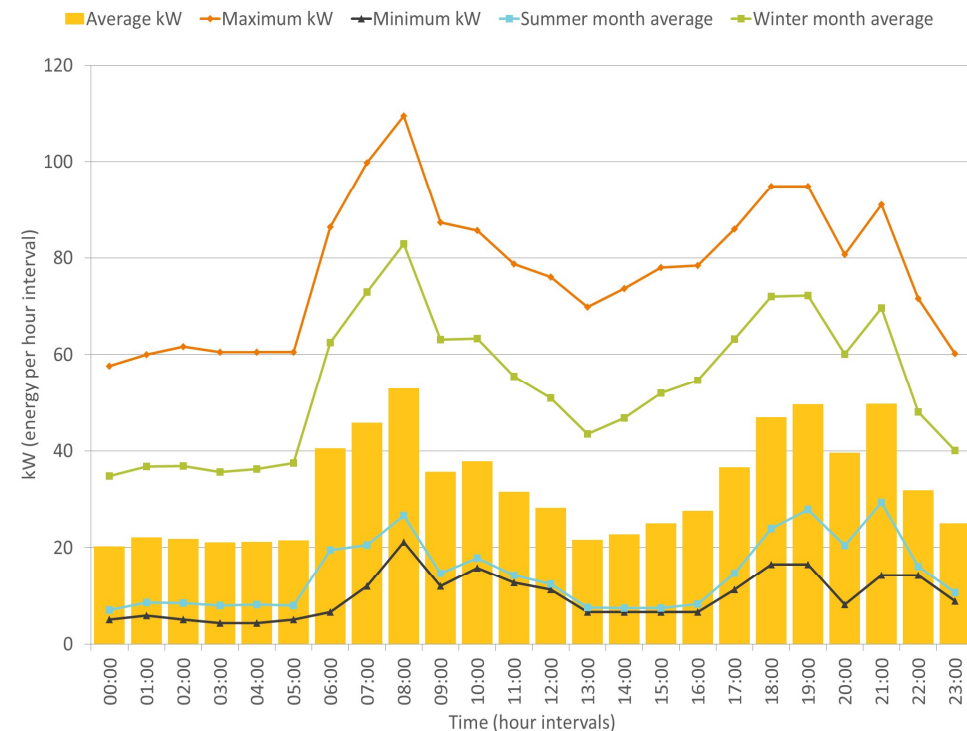
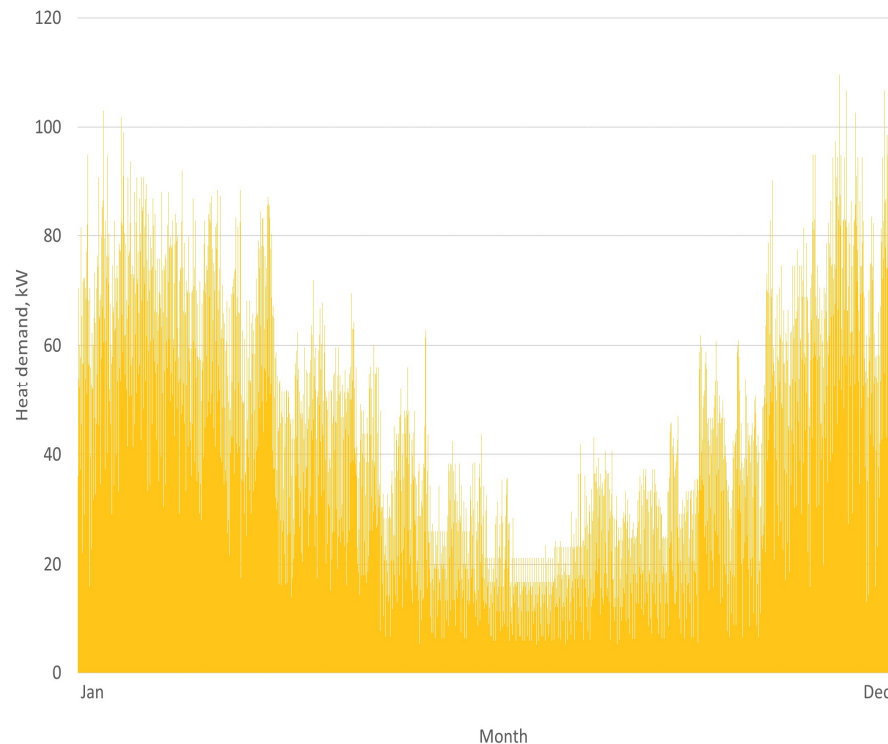
Fabric type - U-Values		
Floor	W/m ² K	0.45
Walls	W/m ² K	0.45
Glazing	W/m ² K	2.00
Roof	W/m ² K	0.25
Ventilation		
Air permeability	m ³ /h.m ²	10

Current heat demand

- Summary of existing heat demand

Scenario	Annual Modelled Demand kWh	Peak heat kW	kWh per flat	Total kW per flat
Existing	283,869	110	10,918	4.2

- Modelled boiler efficiency of existing system – 68%
- Heat losses – 3,854kWh



Scenario 1

Upgraded heating system demand



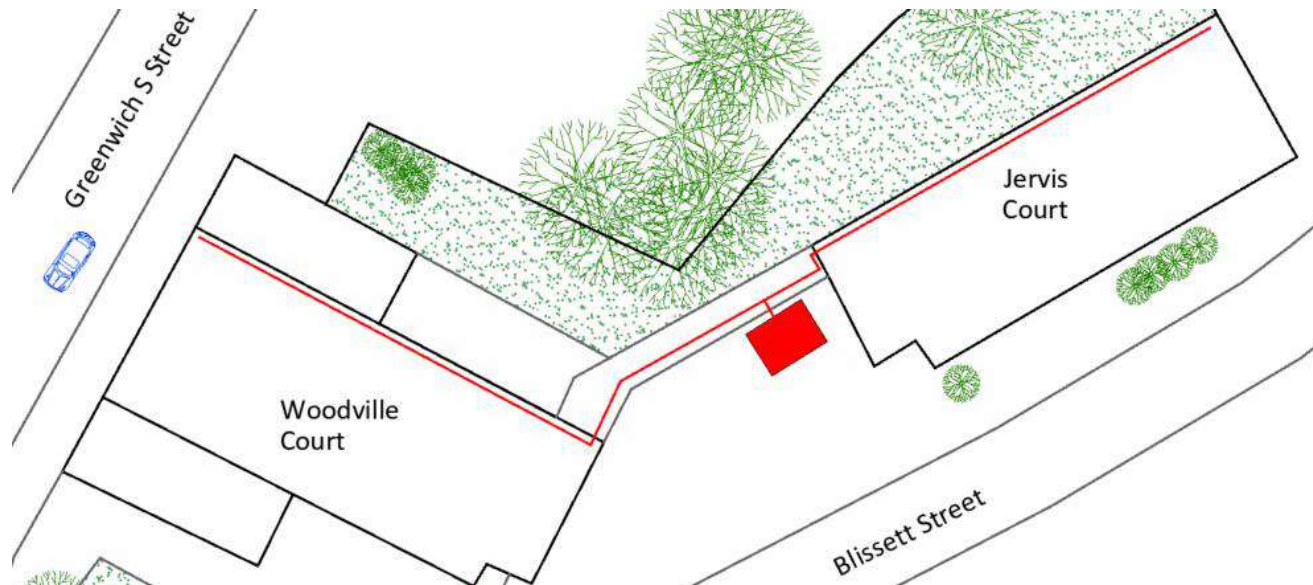
- Scenario 1 assumes:
 - No fabric changes
 - Flat fit outs for low temperature network conditions
 - Heat interface units for local heating control, metering and instantaneous hot water
 - Upgraded pipe work for the risers and laterals in each building
- The model also considers the impact of the following factors on the heat demand for the new system:
 - Assumed change in heat setting behaviour and energy usage due to the introduction of individual metering of each apartment
 - Ambient temperature controls in energy centre
 - Heating controls with a 21°C heating setpoint and 16°C set back
 - Reduction in heat losses due to the replacement of DHW storage tanks with instantaneous plates in HIUs

Scenario 1

Upgraded heating system demand



- The heat demand for the site after all the above conditions are adjusted is 221,087kWh
 - 22% reduction in current heat demand
- Pipe heat losses
 - Red square shows proposed Energy Centre location
 - Red line shows assumed pipework layout – all external to building
 - Calculated hourly heat loss – 0.3kW
 - Calculated annual heat loss – 2,628kWh/yr
 - Best practice installation assumed.
 - Total losses is circa 1% of total heat load, this is within best practice CIBSE Heat Network Code of Practice requirements.

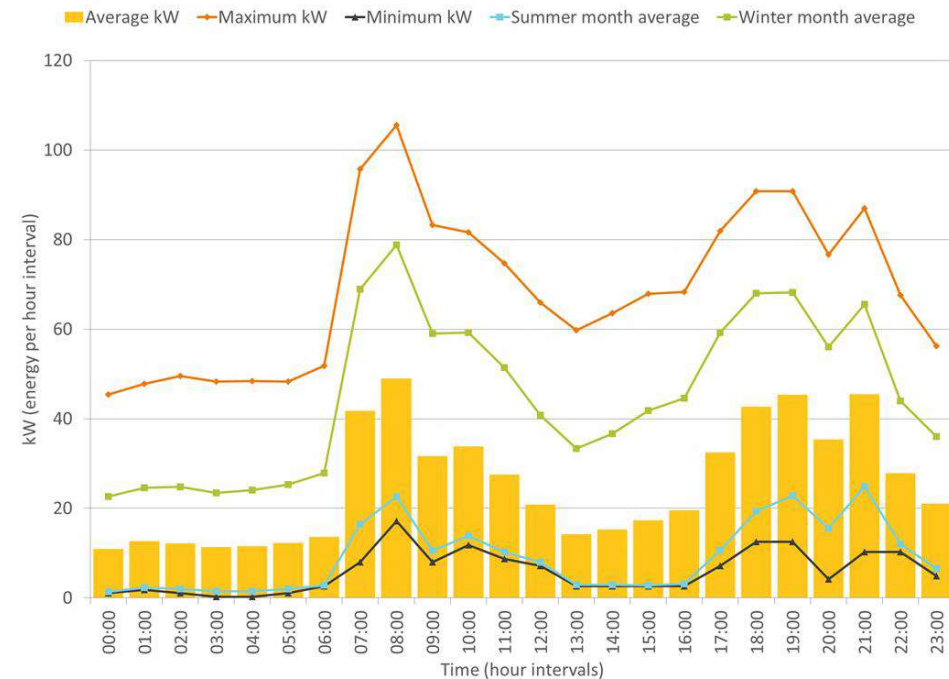
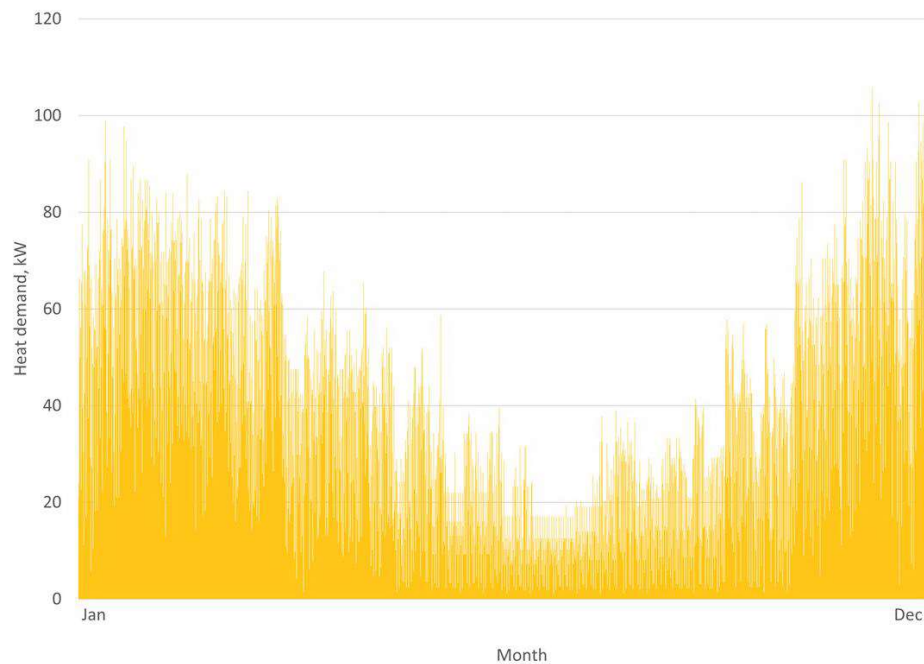


Scenario 1

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	221,087	105	8,503	4.1



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:

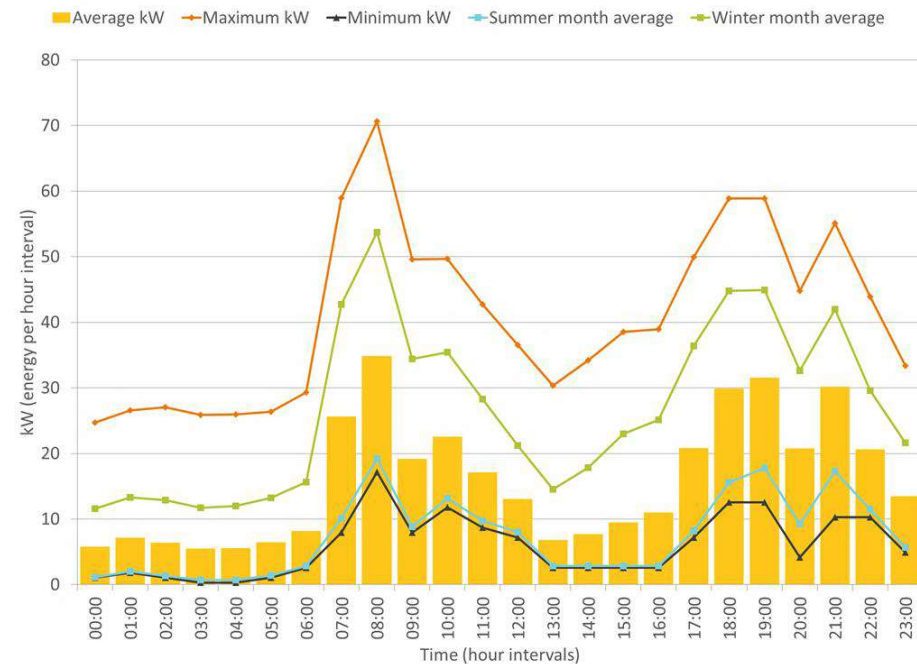
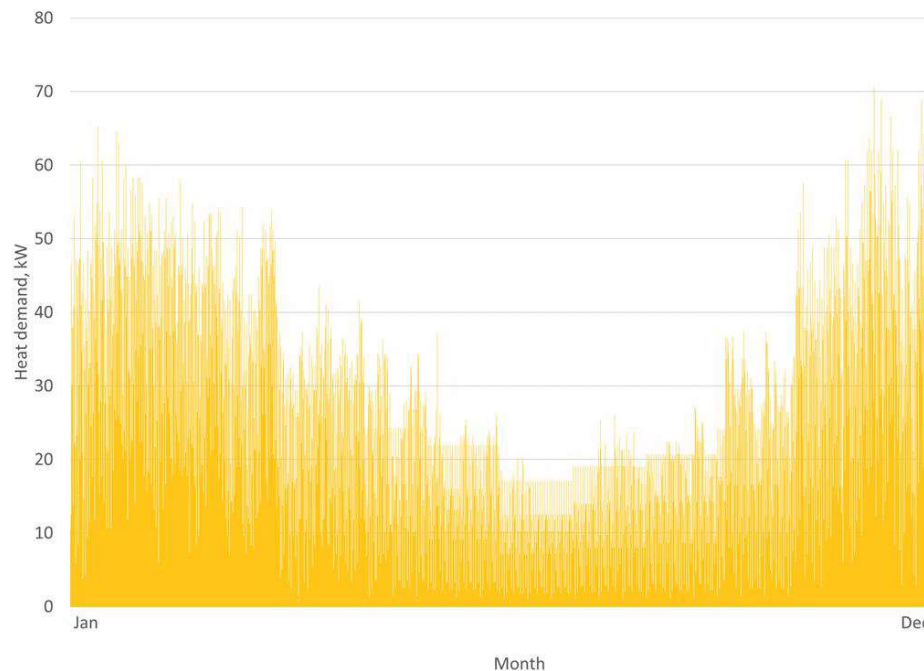
Fabric type - U-Values	Units	Scenario 1 – Existing fabric	Scenario 2 -Roof upgrade	Scenario 3 - Roof and glazing	Scenario 4 - Roof, glazing and EWI
Floor	W/m ² K	0.45	0.45	0.45	0.45
Walls	W/m ² K	0.45	0.45	0.45	0.30
Glazing	W/m ² K	2.00	2.00	1.60	1.60
Roof	W/m ² K	0.25	0.16	0.16	0.16
Ventilation					
Air permeability	m ³ /h.m ²	10	8	7	5

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	190,764	93	7,337	3.6
3	173,965	86	6,691	3.3
4	138,559	71	5,329	2.7

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



Supply options appraisal and feasibility



Supply options appraisal

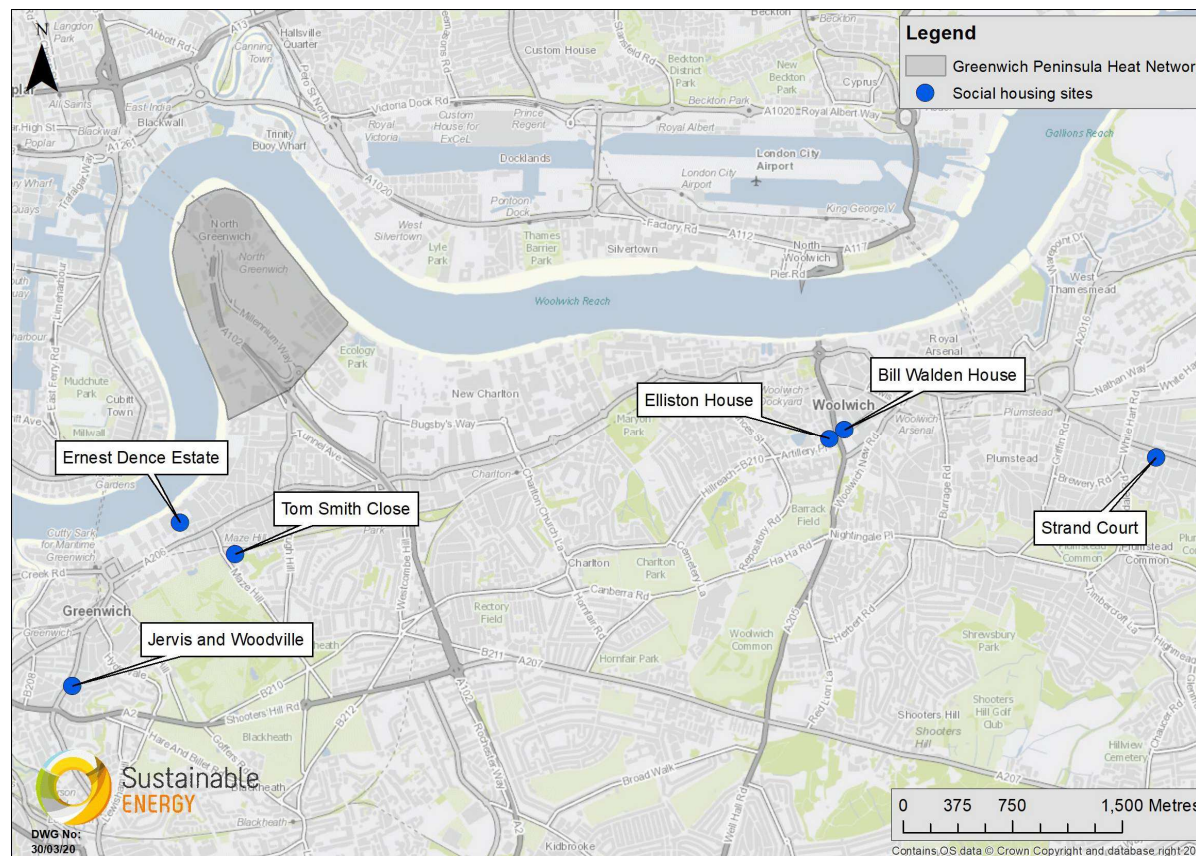


A number of different supply options were considered for the supply of heat and electricity to Jervis and Woodville Court:

- 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

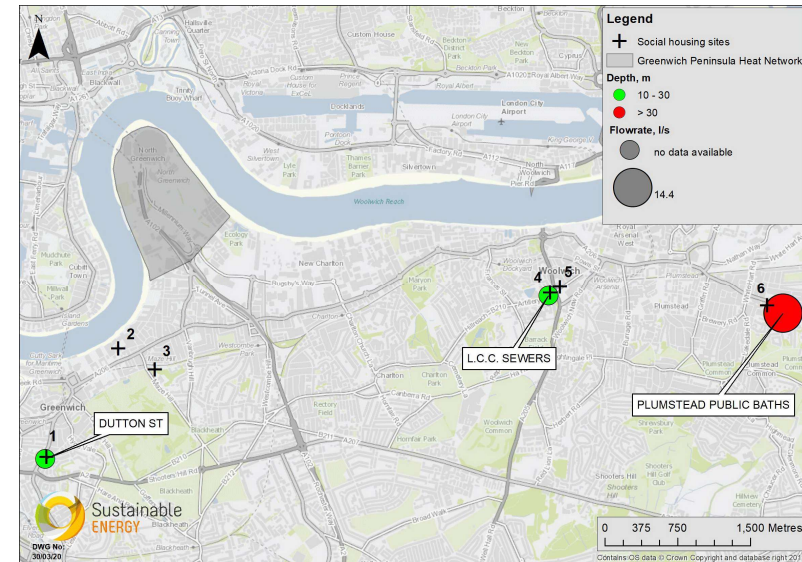
Local heat networks

- 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. Jervis and Woodville Court is shown at position 1
- Table with results of bore hole data



Location	Borehole name	Depth, m	Water depth, m	Flowrate, l/s	Strata details	Notes
Jervis and Woodville 538050,176910	TQ37NE493 — DUTTON ST GREENWICH BH1	18.29	15.85	NA	0-2.74 m: Fill, sand, bricks and stone 2.74-3.66 m: Brown sand, clay and stone 3.66 – 4.88 m: Sand and gravel 4.88 – 6.71 m: Sand and gravel with pockets of brown sandy clay 6.71 – 7.93 m: Brown clay, grey sand and stone 7.93 – 9.75 m: Brown grey sand 9.75 – 10.06 m: Brown silty clay and stone 10.06 – 10.97 m: Sand and gravel 10.97 – 11.89 m: Soft brown silty clay and stones 11.89 – 13.26 m: Dark grey silty clay 13.26 – 15.85 m: Greyish blue silty sand and thin layers of blue silty clay and chalk 15.85 – 17.07 m: Brown clayey sand and pebbles 17.07 – 18.29 m: Rock and putty chalk	Last examined in 1970

Ground source – open loop



- There is significant risk around the open loop solution.
- No flowrate data is available for Dutton Street located near Jervis and Woodville Court (site marked 1 on the image).
- A detailed hydro-geological modelling assessment would be required. This may cost in the region of £20,000.
- A trial well could be drilled into chalk aquifer but this will require significant CAPEX (upto £120,000) and there is no guarantee of a positive result.
- There is limited space for abstraction and discharge wells that are significantly separated to minimise thermal interaction. 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.
- If a sufficient flowrate was found to supply the scheme then the installation would need to be ready to apply for the RHI subsidy before March 2021.
- A high level economic case for this option is shown on the next slide.

Ground source – open loop



- A 45kW GSHP with 1,500litres thermal storage could supply 88% of the annual demand (allowing for 50weeks availability)
- A high level economic assessment is shown below:

		Current system	GSHP with Gas condensing boilers with RHI	GSHP with Gas condensing boilers without RHI
			Scenario 1	Scenario 1
Energy and carbon	Units			
Heat demand - Peak	kW	110	105	105
Heat annual demand	kWh	280,015	218,459	218,459
Heat annual demand - losses	kWh	3,854	2,628	2,628
Heat annual demand - Total	kWh	283,869	221,087	221,087
% heat demand low carbon	%	0%	88%	88%
25 year CO2e savings	tCO2e		930	930
First year CO2e savings, tCO2e	tCO2e		28	28
First year CO2e intensity of delivered heat	gCO2e/kWh		108	108
Build and run costs				
Capex of scheme + contingency	£		£333,715	£333,715
Fixed heat sales	£/day		1.31	1.31
Variable heat sales	p/kWh		7.5	7.5
Cost of heat to residence - annual	£		£1,108	£1,108
Payback period	Years		23	0
NPV	£		-£94,450	-£228,668
IRR	%		0.4%	-4.8%

Ground source – closed loop

- The available green space for the installation of ground loops is limited
 - Circa 530m² total shown below
- Potential issues with positioning of trees and tree roots
 - Red circles show x1.5 canopy ranges for each tree



Ground source – open loop



- Borehole data from the national BGS resource is summarised below
- No flowrate data is available for Dutton Street wells located at Jervis and Woodville Court (site marked 1 on the image)
- A trial well could be drilled into chalk aquifer but this will require significant CAPEX and there is no guarantee of a positive result

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

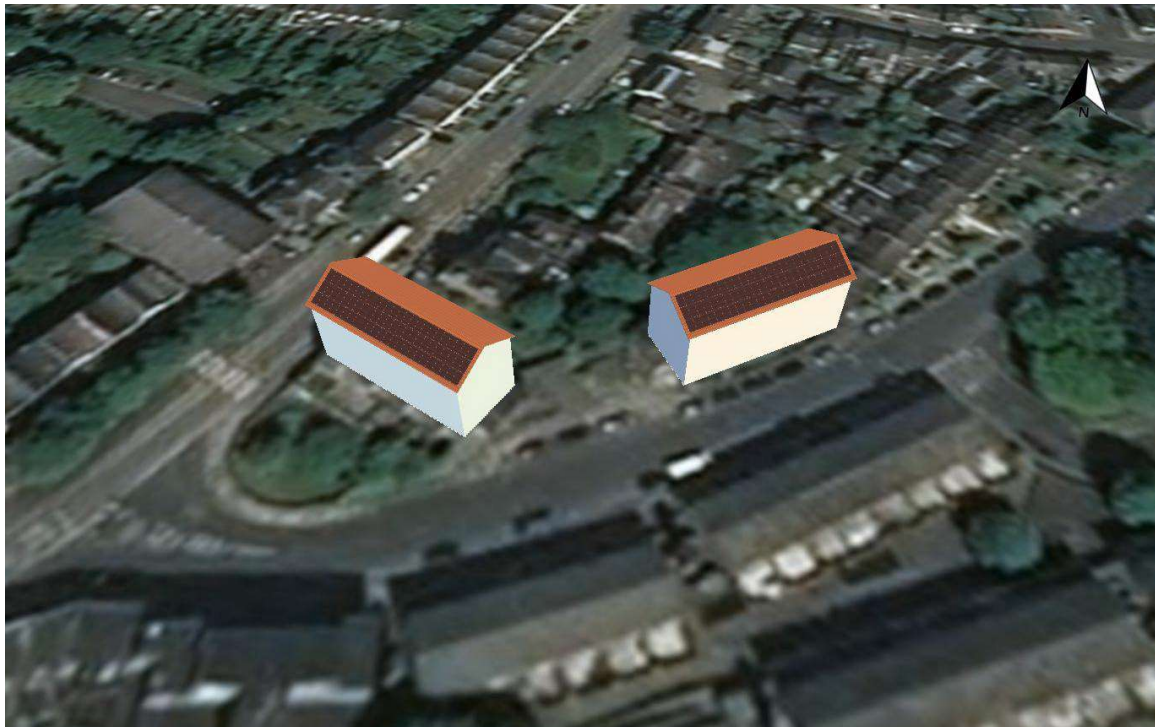
Heat source	Comments	Considered further?
Heat network connection	<ul style="list-style-type: none">• No suitable networks local to the assessment site	No
Closed Loop GSHP	<ul style="list-style-type: none">• Not viable due to land requirement for ground loops (horizontal and vertical)	No
Open Loop GSHP	<ul style="list-style-type: none">• Water source unknown• High CAPEX associated with drilling boreholes into chalk aquifer (in relation to small scheme)• No guarantee of adequate resource• RHI accreditation is time sensitive and installation of bore is time intensive	No
ASHP	<ul style="list-style-type: none">• Lower initial CAPEX than GSHP options• Potential noise restrictions close to residential developments	Yes

Solar PV assessment



Roof top PV installation

- Circa 230m² of available roof space for installation
 - South facing on pitched roof
 - Mounted flush to pitched roof
 - 30° inclination (assumed pitch of roof)
- Potential peak load circa 40kW
 - 144no. 330W panels



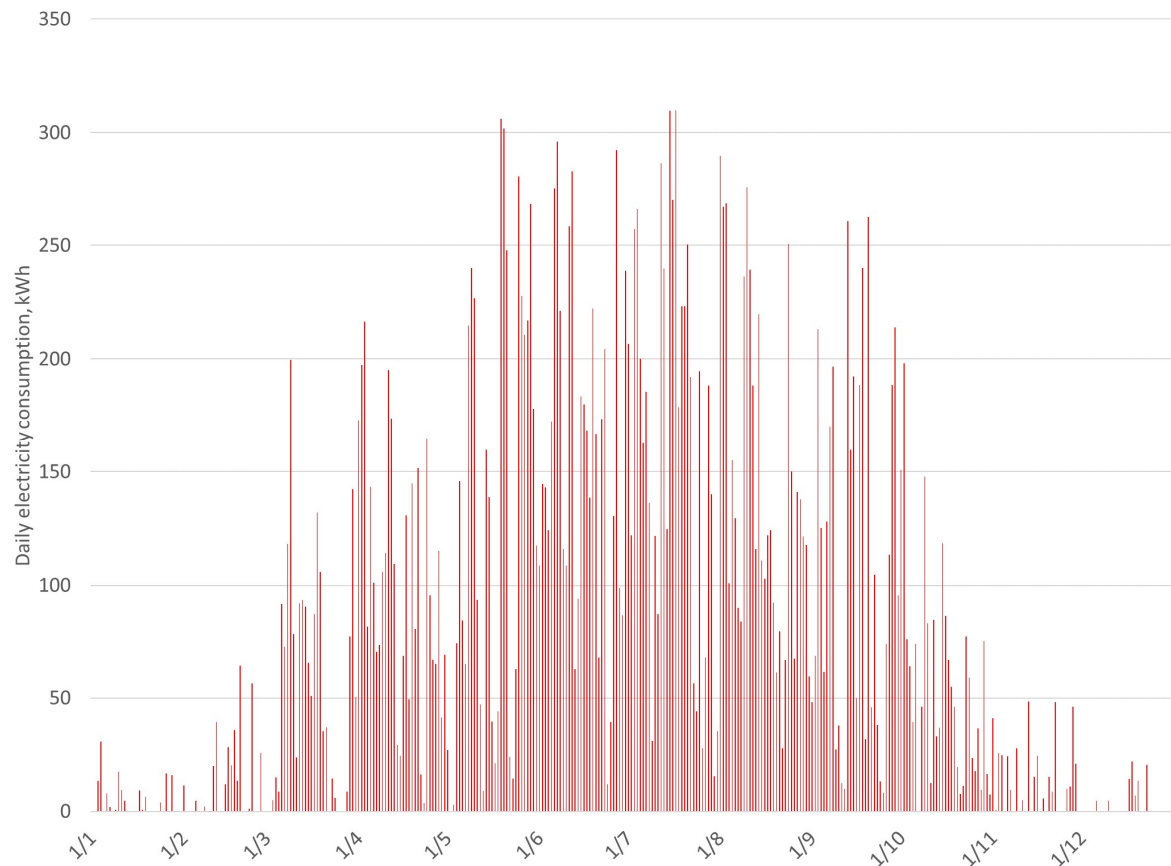
Roof top PV installation

- Potential generation 47,078kWh per annum
- Installation cost including cost of PV panels, inverters, roof mounts, cabling and installation - £42,000



Roof top PV – Battery Storage

- To recoup/store excess electricity generation on the peak day would require a discharge capacity of 311kWh
- Based on round-trip efficiency of 90% a circa 345kWh battery is required
- The income gain from storing electricity over exporting is £2,359
 - Excess kWh at high tariff minus kWh at export tariff = £4,061 - £1,702 = £2,359
- The typical lifespan of a solar battery is between 5-15years; best case scenario the battery would need to be £35,379 to pay back during its lifespan (cost of a suitable battery for this site would be in the £120,000 - £160,000 range)
- Battery storage option not currently viable



Concept design



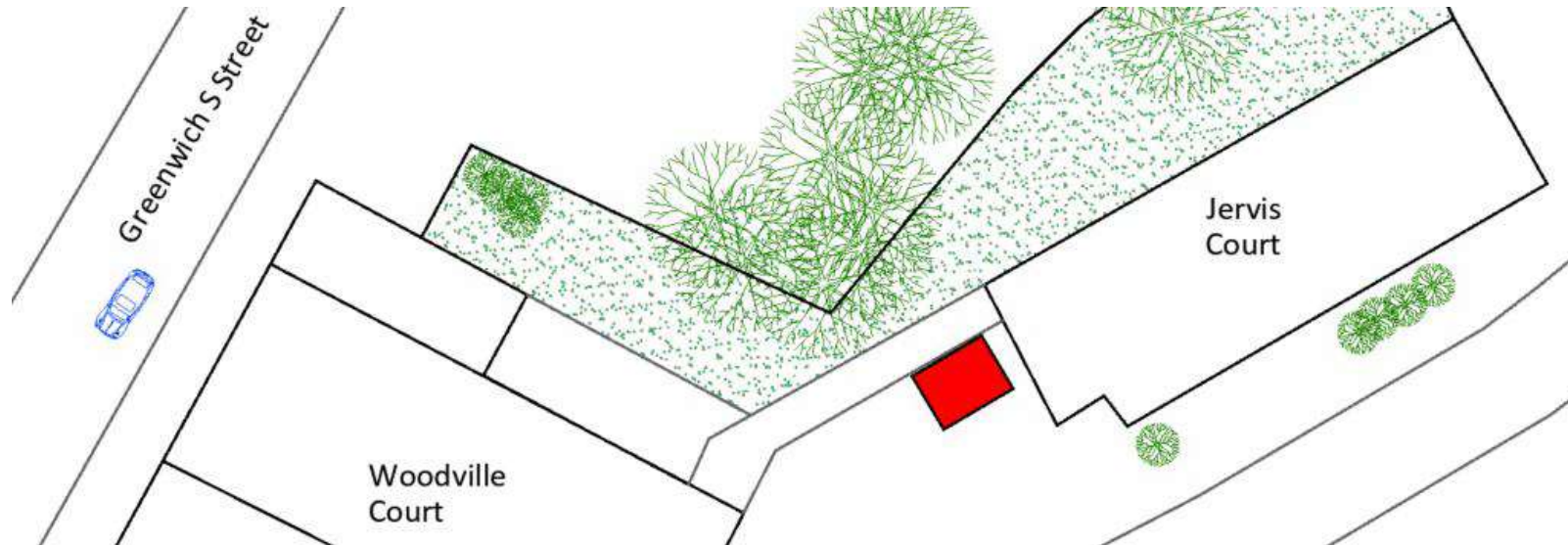
Design considerations

- The existing plant room has been deemed unsuitable by RBG for the installation of new plant due to concerns over the phasing of works
 - Plans have been made for a New Energy Centre for the condensing gas boiler option with a footprint of 4 x 3m
- The low carbon solutions will also include gas boilers sized to provide 100% back up
- New Energy Centre for low carbon solution using ASHP with separate dry air coolers requires a footprint of 5 x 3.5metres plus some additional space for the dry air coolers and attenuation (an extra 5 x 4m)
 - Requires more space and more CAPEX than the 4 x 3m energy centre
- New Energy Centre for low carbon using Monobloc ASHP requires a footprint of 4 x 3m with the ASHP positioned externally. Monobloc solution can be installed external to plant room (example of unit shown below)
 - Slight reduction in COP compared to ASHP with separate dry air cooler
- The Monobloc ASHP with the smaller Energy Centre footprint will be used in the following economic cases



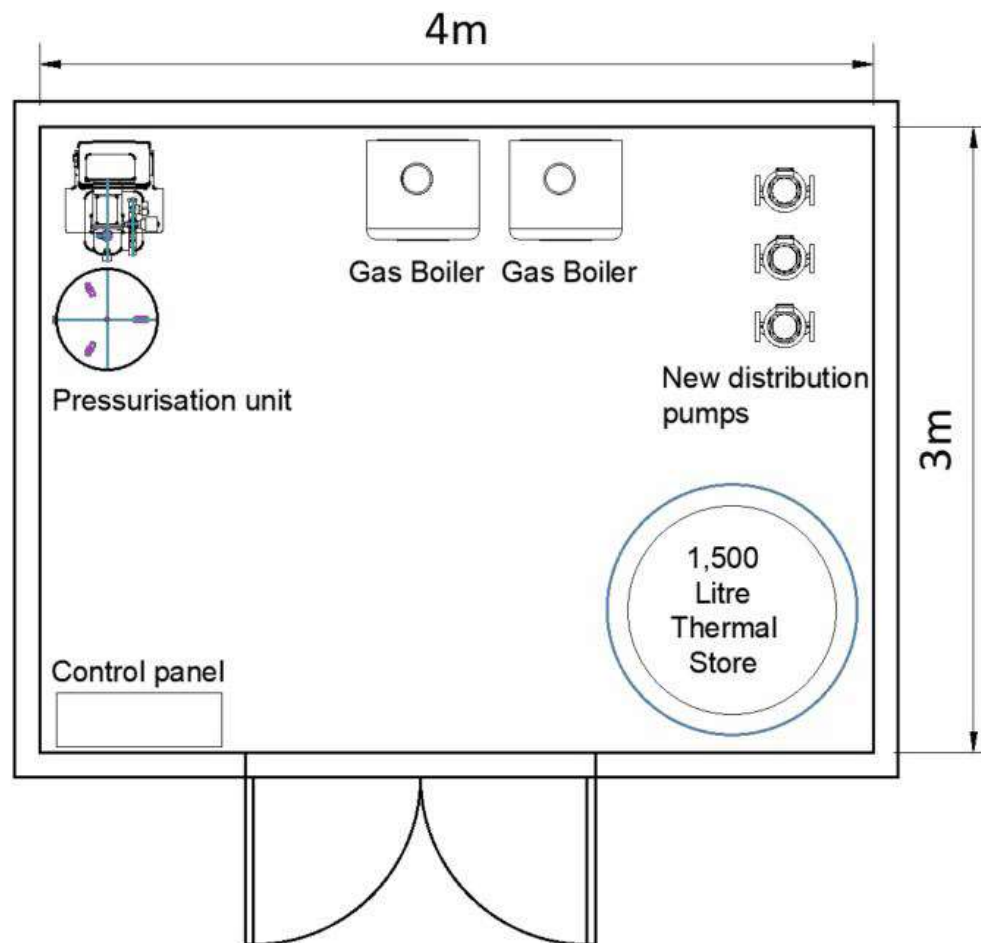
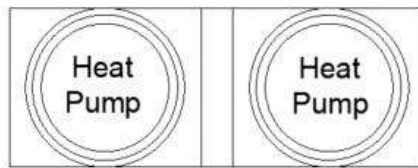
Energy Centre – Location

- The new energy centre is positioned between Jervis and Woodville Court (red)

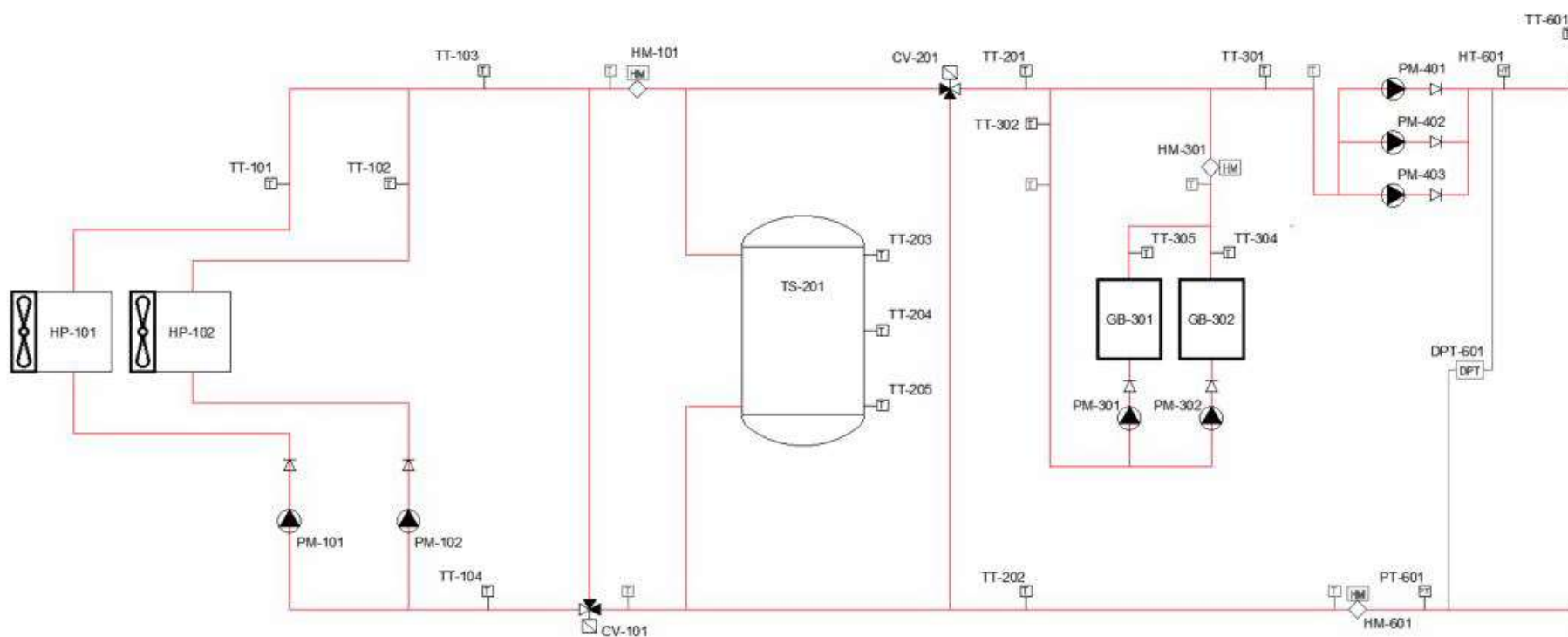


Energy Centre

- New heating plant consists of:
 - 2 x 45kW Air source heat pumps,
 - 2 x 50kW gas boilers,
 - 1,500litre thermal store



PFD Schematic



Economic Assessment



Condensing gas boiler - full scheme CAPEX



	CAPEX	CAPEX inc. contingency
Preliminary		
Contractor prelims including welfare and storage	£30,000	£36,000
Energy Centre works		
Energy Centre Construction	£17,000	19,550
Peak and reserve gas boilers	£6,400	£6,720
Peak and reserve gas boiler flues	£1,000	£1,150
Pressurisation	£2,000	£2,100
Water treatment, flushing and testing	£3,000	£3,450
Electrical connection upgrade	£11,500	£14,375
Plantroom controls	£20,000	£24,000
Cabling and electrical housing blocks	£12,500	£15,000
Other energy centre M&E (pipework, pumps, temporary PHE)	£38,725	£46,470
Builders works	£5,000	£5,750
Network - Usual		
Customer HIUs and flat fit out	£104,000	£119,600
Risers and laterals	£150,000	£187,500
Planning, design and management		
Planning application and fees	£7,500	£9,375
Resident liaison officer	£7,500	£8,250
Professional, design and contracting fees	£30,000	£31,500
Clients Engineer - technical support for construction and commissioning	£20,000	£22,000
Total	£466,125	£552,790

Condensing gas boiler - gas boiler only CAPEX



	CAPEX	CAPEX inc. contingency
Energy Centre works		
Peak and reserve gas boilers	£6,400	£6,720
Peak and reserve gas boiler flues	£1,000	£1,150
Electrical connection upgrade	£11,500	£14,375
Plantroom controls	£20,000	£24,000
Cabling and electrical housing blocks	£12,500	£15,000
Other energy centre M&E (pipework, pumps, temporary PHE)	£38,725	£46,470
Planning, design and management		
Professional, design and contracting fees	£30,000	£31,500
Clients Engineer - technical support for construction and commissioning	£20,000	£22,000
Total	£140,125	£161,215

ASHP plus condensing gas scheme – full scheme CAPEX



	Total	Total inc. contingency
Preliminary		
Contractor prelims including welfare and storage	£40,000	£48,000
Energy Centre works – common to ASHP and gas options		
Energy Centre Construction	£17,000	19,550
Peak and reserve gas boilers	£6,400	£6,720
Peak and reserve gas boiler flues	£1,000	£1,150
Pressurisation	£2,000	£2,100
Water treatment, flushing and testing	£3,000	£3,450
Electrical connection upgrade	£11,500	£14,375
Plantroom controls	£30,000	£36,000
Cabling and electrical housing blocks	£12,500	£15,000
Other energy centre M&E (pipework, pumps, temporary PHE)	£38,725	£46,470
Builders works	£5,000	£5,750
Network – common to ASHP and gas options		
Customer HIUs and flat fit out	£104,000	£119,600
Risers and laterals	£150,000	£187,500
Energy Centre works – ASHP only		
Heat pump	£38,000	£41,800
Heat pump M&E works	£15,000	£16,500
Thermal store	£2,000	£2,200
Energy centre civils works	£15,000	£17,250
Planning, design and management – common to ASHP and gas options		
Planning application and fees	£12,500	£15,625
Resident liaison officer	£7,500	£8,250
Professional, design and contracting fees	£40,000	£42,000
Clients Engineer - technical support for construction and commissioning	£30,000	£33,000
RHI Application	£4,500	£4,725
Total	£585,625	£687,015

ASHP plus condensing gas scheme – ASHP only CAPEX



	Total	Total inc. contingency
Energy Centre works – common to ASHP and gas options		
Peak and reserve gas boilers	£6,400	£6,720
Peak and reserve gas boiler flues	£1,000	£1,150
Electrical connection upgrade	£11,500	£14,375
Plantroom controls	£30,000	£36,000
Cabling and electrical housing blocks	£12,500	£15,000
Other energy centre M&E (pipework, pumps, temporary PHE)	£38,725	£46,470
Energy Centre works – ASHP only		
Heat pump	£38,000	£41,800
Heat pump M&E works	£15,000	£16,500
Thermal store	£2,000	£2,200
Planning, design and management – common to ASHP and gas options		
Professional, design and contracting fees	£10,000	£10,500
Clients Engineer - technical support for construction and commissioning	£10,000	£11,000
Total	£175,125	£201,715

Parasitic electricity BAU and saving assumptions



- Annual kWh for Jervis and Woodville – 14,492kWh
- Calculated/estimated usage split:
 - Residential usage – 7,786kWh
 - Lift and circulation ancillaries – 2,651kWh
 - Energy centre usage – 4,054kWh
- Existing energy centre usage equates to circa hourly 0.5kW base load
- Installation of new inverter driven pumps for variable speed and additional modern modulating equipment results in an annual 4,422kWh of parasitic electricity usage

Fuel Tariffs

- Tariff inputs

Gas tariff (excl. CCL)	2.166	p/kWh
Gas standing charge	6.41	£/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	13.12	p/kWh
Energy centre electricity tariff - night	9.01	p/kWh
Electricity standing charge	0.36	£/day

OPEX and REPEX assumptions

OPEX

- Annual cost for O&M of £1225.84 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 £2,860
 - Using estimated of 70% of total costs for maintenance contract from spares and repairs
- Metering and billing cost - £2,340 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 sized to provide 100% of the heat demand
- 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	221,087kWh	190,764kWh	173,965kWh	138,559kWh
Peak heat demand	105kW	93kW	86kW	71kW
Heat pump capacity	90kW	90kW	90kW	90kW
Thermal store capacity	1,500litres	1,500litres	1,500litres	1,500litres
% heat demand potentially met by low carbon / renewable technology				
52 weeks availability	100%	100%	100%	100%
50 weeks availability	98.9%	98.8%	98.7%	98.4%
48 weeks availability	98%	97.7%	97.5%	96.9%

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 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 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)

		Current system	Option 1: Gas condensing boilers	Option 2: Gas condensing boilers and ASHP	Option 3: Gas condensing boilers, ASHP and PV
Energy and carbon	Units				
Heat demand - Peak	kW	110	105	105	105
Heat annual demand	kWh	280,015	218,459	218,459	218,459
Heat annual demand - losses	kWh	3,854	2,628	2,628	2,628
Heat annual demand - Total	kWh	283,869	221,087	221,087	221,087
% heat demand low carbon	%	0%	0%	98.9%	98.9%
25 year CO2e savings	tCO2e		125	983	1,032
First year CO2e savings, tCO2e	tCO2e		5	27	31
First year CO2e intensity of delivered heat	gCO2e /kWh		212	113	93
Build and run costs					
Capex of scheme	£		£140,125	£175,125	£217,125
Capex of scheme + contingency	£		£161,215	£201,715	£247,915
OPEX – Fuel costs	£		£9,378	£14,169	£11,983
OPEX – (O&M + fuel/elec costs)	£		£15,804	£22,596	£20,409
Fixed heat sales	£		£12,432	£12,432	£12,432
Variable heat sales	£		£16,384	£16,384	£16,384
Potential annual Income - RHI	£		-	£5,942	£5,942
Potential annual Income – PV export	£		-	-	£1,721
Economic indicators – 25 year case					
Fixed heat sales	£/day		1.31	1.31	1.31
Variable heat sales	p/kWh		7.50	7.50	7.50
Cost of heat to residence - annual	£		£1,108	£1,108	£1,108
Payback period	Years		16	21	18
NPV	£		£13,692	-£49,710	-£28,137
IRR	%		4.3%	0.9%	2.4%
Assumptions	Capital costs excludes heating systems, water treatment and ancillaries Fixed tariff of £1.31/day Variable tariff of 7.5p/kWh (in line with Heat Trust costing)				

Economic assessment (heat demand scenario 1)

		Current system	Option 1: Gas condensing boilers	Option 2: Gas condensing boilers and ASHP	Option 3: Gas condensing boilers, ASHP and PV
Units					
Resident costs – Fuel only					
Cost of heat to residence – Fuel (variable)	p/kWh	5.98	4.29	6.49	5.49
Cost of heat to residence - annual	£	£503	£361	£545	£461
Resident costs – Fuel + O&M					
Cost of heat to residence – O&M (fixed)	£/day	0.68	0.68	0.89	0.89
Cost of heat to residence – Fuel (variable)	p/kWh	5.98	4.29	6.49	5.49
Cost of heat to residence - annual	£	£750	£608	£869	£785
Subsidy requirement per apartment					
Cost of heat, savings per apartment (fuel only)	£/year			-£42	£42
Cost of heat, savings per apartment (fuel + O&M)	£/year			-£119	-£35
Remaining RHI income (whole scheme - fuel + O&M)	£/year			£2,848	£5,032
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			4.8%	4.3%	5.1%
Social NPV			£23,214	£20,171	£46,546
Assumptions	Fixed tariff of £1.31/day Variable tariff of 7.5p/kWh (in line with Heat Trust costing)				

Economic assessment (heat demand scenario 4)

		Current system	Option 1: Gas condensing boilers	Option 2: Gas condensing boilers and ASHP	Option 3: Gas condensing boilers, ASHP and PV
Energy and carbon	Units				
Heat demand - Peak	kW	110	71	71	71
Heat annual demand	kWh	280,015	135,931	135,931	135,931
Heat annual demand - losses	kWh	3,854	2,628	2,628	2,628
Heat annual demand - Total	kWh	283,869	138,559	138,559	138,559
% heat demand low carbon	%	0	0	98.4%	98.4%
25 year CO2e savings	tCO2e		77	614	648
First year CO2e savings, tCO2e	tCO2e		3	17	20
First year CO2e intensity of delivered heat	gCO2e /kWh		214	114	91
Build and run costs					
Capex of scheme	£		£140,125	£175,125	£217,125
Capex of scheme + contingency	£		£161,215	£201,715	£247,915
OPEX – Fuel costs	£		£6,802	£9,770	£8,229
OPEX – (O&M + fuel/elec costs)	£		£13,228	£18,196	£16,655
Fixed heat sales	£		£12,432	£12,432	£12,432
Variable heat sales	£		£10,195	£10,195	£10,195
Potential annual Income - RHI	£		-	£3,677	£3,677
Potential annual Income – PV export	£		-	-	£1,978
Economic indicators – 25 year case					
Fixed heat sales	£/day		1.31	1.31	1.31
Variable heat sales	p/kWh		7.50	7.50	7.50
Cost of heat to residence - annual	£		£870	£870	£870
Payback period	Years		21	0	0
NPV	£		-£31,567	-£105,559	-£90,719
IRR	%		1.6%	-2.7%	-0.4%
Assumptions	Capital costs excludes heating systems, water treatment and ancillaries Fixed tariff of £1.31/day				

Economic assessment (heat demand scenario 4)

		Current system	Option 1: Gas condensing boilers	Option 2: Gas condensing boilers and ASHP	Option 3: Gas condensing boilers, ASHP and PV
Units					
Resident costs – Fuel only					
Cost of heat to residence – Fuel (variable)	p/kWh	5.98	5.00	7.19	6.05
Cost of heat to residence - annual	£	£503	£262	£376	£317
Resident costs – Fuel + O&M					
Cost of heat to residence – O&M (fixed)	£/day	0.68	0.68	0.89	0.89
Cost of heat to residence – Fuel (variable)	p/kWh	5.98	5.00	7.19	6.05
Cost of heat to residence - annual	£	£750	£509	£700	£641
Subsidy requirement per apartment					
Cost of heat, savings per apartment (fuel only)	£/year		-	£127	£186
Cost of heat, savings per apartment (fuel + O&M)	£/year		-	£50	£109
Remaining RHI income (whole scheme - fuel + O&M)	£/year		-	£3,677	£3,677
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			2.0%	0.5%	1.8%
Social NPV			-£25,723	-£61,935	-£43,712
Assumptions	Fixed tariff of £1.31/day Variable tariff of 7.5p/kWh (in line with Heat Trust costing)				

Increased gas tariff



- The gas tariff for Jervis and Woodville 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 to 2.79p/kWh (the point at which the economics are similar for the gas condensing case and the ASHP case)

Economic assessment (heat demand scenario 1)

		Current system	Option 1: Gas condensing boilers	Option 2: Gas condensing boilers and ASHP	Option 3: Gas condensing boilers, ASHP and PV
Energy and carbon	Units				
Heat demand - Peak	kW	110	105	105	105
Heat annual demand	kWh	280,015	218,459	218,459	218,459
Heat annual demand - losses	kWh	3,854	2,628	2,628	2,628
Heat annual demand - Total	kWh	283,869	221,087	221,087	221,087
% heat demand low carbon	%		0%	98.9%	98.9%
25 year CO2e savings	tCO2e		125	983	1,032
First year CO2e savings, tCO2e	tCO2e		5	27	31
First year CO2e intensity of delivered heat	gCO2e /kWh		212	113	93
Build and run costs					
Capex of scheme	£		£140,125	£175,125	£217,125
Capex of scheme + contingency	£		£161,215	£201,715	£247,915
OPEX – Fuel costs	£		£10,911	£14,186	£11,999
OPEX – (O&M + fuel/elec costs)	£		£17,337	£22,612	£20,426
Fixed heat sales	£		£12,432	£12,432	£12,432
Variable heat sales	£		£16,384	£16,384	£16,384
Potential annual Income - RHI	£		-	£5,942	£5,942
Potential annual Income – PV export	£		-	-	£1,721
Economic indicators – 25 year case					
Fixed heat sales	£/day		1.31	1.31	1.31
Variable heat sales	p/kWh		7.50	7.50	7.50
Cost of heat to residence - annual	£		£1,108	£1,108	£1,108
Payback period	Years		19	21	18
NPV	£		-£17,966	-£50,055	-£28,483
IRR	%		2.4%	0.9%	2.4%
Assumptions	Capital costs excludes heating systems, water treatment and ancillaries Fixed tariff of £1.31/day Variable tariff of 7.5p/kWh (in line with Heat Trust costing)				

Economic assessment (heat demand scenario 1)

		Current system	Option 1: Gas condensing boilers	Option 2: Gas condensing boilers and ASHP	Option 3: Gas condensing boilers, ASHP and PV
Units					
Resident costs – Fuel only					
Cost of heat to residence – Fuel (variable)	p/kWh	5.98	4.99	6.49	5.49
Cost of heat to residence - annual	£	£503	£420	£546	£462
Resident costs – Fuel + O&M					
Cost of heat to residence – O&M (fixed)	£/day	0.68	0.68	0.89	0.89
Cost of heat to residence – Fuel (variable)	p/kWh	5.98	4.99	6.49	5.49
Cost of heat to residence - annual	£	£750	£667	£870	£786
Subsidy requirement per apartment					
Cost of heat, savings per apartment (fuel only)	£/year			-£43	£41
Cost of heat, savings per apartment (fuel + O&M)	£/year			-£120	-£36
Remaining RHI income (whole scheme - fuel + O&M)	£/year			£2,822	£5,006
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			3.0%	4.3%	5.1%
Social NPV			-£8,444	£19,825	£46,200
Assumptions	Fixed tariff of £1.31/day Variable tariff of 7.5p/kWh (in line with Heat Trust costing)				

Summary and next steps



Summary



- Under current assumptions, the economics of the gas condensing boiler are more favourable than the heat pump options but offer far lower CO₂e savings
- ASHPs are the only technically viable renewable heating option with an acceptable level of risk
- Solar PV improves economics and increases CO₂e savings
- Low gas prices support the economics of the gas boiler option, when gas prices reach 2.79p/kWh then economics reach parity with the ASHP option and the social IRR of the ASHP is higher in each case

Next Steps

- Detail dimensions for full energy system and network
- Draft tender specification for energy centre and phased works



