

**Consultation : Provisional specification and emissions analysis
 (for discussion)**

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Northshore
40 Sinah Lane
Hayling Island
Hampshire
PO11 0HH

Project Name :

PO11 0HH - Northshore

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Site address : Northshore, 40 Sinah Lane, Hayling Island, Hampshire PO11 0HH

Initial Project Analysis

Northshore is a proposed replacement dwelling project on a plot with tidal frontage directly onto the sea.

The project includes the replacement of both an ancillary accommodation annexe to the rear of the house and a pavilion down by the shoreline.

The instruction is to optimise the provision of high quality mechanical services and to maximise any return on investment based on carbon emissions reductions (against the default of natural gas-fired boilers because Kerosene for heating is to be withdrawn by 2030 under the Clean Growth Strategy) and any accessible subsidy income from the Renewable Heat Incentive (RHI).

Taking the above into account, having considered multiple options, and having listened to the views expressed by the client's representatives, the recommended approach is to deploy ground-source heat pump technology. Ground-source systems, once deployed, leave no visible surface trace, thus minimising the visual impact on the surrounding environment which is a key client's requirement.

The alternative deployment of air-source heat pumps would require consideration for potential noise pollution in a quiet setting and the corrosive coastal environment would shorten the working life of any external air-source unit. For these reasons, an air-source heat pump solution is not considered to be suitable for this project.

Having considered all of the possible heat pump scheme variations, including hybridisation, an initial analysis has been run on a 100% ground-source system (with capacity to meet the peak thermal load of the dwelling, annexe and pavilion and the full potable hot water demand). A DHW storage capacity will be included with capacity to meet the demands of the house during full occupancy. Ideally, all the systems would be co-located in a dedicated plant room, potentially located in the annexe building. The ground-source heat pump system will be coupled to a closed-loop borehole array sized to suit the physical limitations of the site, the local geological conditions and the total annual energy demand. A cascade of compressors in any heat pump arrangement delivers system resilience.

The expectation is that the scheme will be designed to meet the eligibility criteria for the Renewable Heat Incentive subsidy which has recently been extended to accept applications for accreditation out until 31st March 2022. The dwelling demands would potentially be eligible for the Domestic RHI (7-year term) with payments made quarterly against the data contained in a new EPC, up to the Heat Demand Limit of 30,000kWh/annum.

There is additional potential to deploy a small solar PV array on the highest flat roof level. The PV output will contribute to additional reduction in greenhouse gas (GHG) emissions from the site and to reduced operational costs for the ground source heat pump systems. The full value of solar PV deployments in domestic settings is realised when 100% of the output is utilised on site. This may require consideration of some form of battery storage. This is likely to be a seasonal requirement because in winter, the heat pump system is likely to use 100% of the generated electricity.

It should be remembered that the investment in the borehole ground array should be valued differently because of the long term value of the asset. The ground array has a life expectancy of around 100 years or more, being very similar to a water or gas main. Therefore, its costs and residual value should be accounted for taking this into account. If this is coupled to the consideration that the life expectancy of any new condensing fossil-fuel-fired plant room is likely to be 8-12 years, whilst that of a high quality ground-source plant room is likely to be 18-22 years, then the total lifetime cost of ownership equation changes significantly. The models that BBH Energy Strategies provide at the first high level feasibility stage do not have the sophistication to take all these factors into account but they could be modelled in due course if required.

Indicative Specification

Site description :	Replacement dwelling Replacement annexe and pavilion
GIA :	580m ² - new construction (heated space) (from architect's calculations) 116m ² - renovated existing fabric (heated space) (from architect's calculations)
Height above sea level :	4m
Design external temperature :	-4 °C
Service targets :	spatial heating to the principal dwelling, annexe and pavilion domestic hot water (DHW) supply to all bathrooms and the usual kitchen and utility requirements
Construction :	based on Building Regulations minimum standard U-values in place at the time of the construction or renovation until the provision of any architect's data confirming higher levels of insulation, etc. BBH Energy recommends installing the highest levels of insulation achievable as this represents the best possible value for money when preparing any property for a renewable energy solution
Bathroom configuration :	allowance for 6 no. shower rooms, 1 no. bathroom and 2 no. ancillary showers (as the scheme design develops, consideration will be given as to whether it's appropriate to include the pavilion potable hot water demand on the core systems because of asymmetric usage pattern)
Sub-surface soil conditions :	River Terrace Deposits, sand, silt & clay (BGS record)
Geology conditions :	Portsmouth Sand Member, Whitecliff Sand Member over London Clay over Upper Chalk (rest water level unknown)
Technology :	cascade ground-source heat pump system coupled to a drilled closed-loop borehole array
Estimated peak loads :	26.1kW (principal dwelling – 45W/m ²) 3.6kW (annexe – 50W/m ²) 2.3kW (pavilion – 50W/m ²) 2kW (in-ground distribution losses)
Estimated annual energy demand :	81,600kWh/annum (2,400FLEQhrs to allow for relatively high HWS) Note that SAP tends to underestimate heating and HWS loads so the final EPCs may show lower figures There is a tendency for occupants to under-heat, so these figures may not be borne out in practice
Seasonal Performance Factor (SPF) :	ground source estimated at 3.7
RHI heat demand limits :	30,000kWh/annum, ground-source (use of additional heat does not disqualify a site from the DRHI but any demand over the heat demand limit is not subsidised)

The MCS MIS Standard for heat pump system design demands that peak load is met 100% by the heat pump compressor capacity unless a bivalent or covalent system (where the heat pump is formally coupled to a fossil-fuel-fired boiler) is specified.

Based on the criteria above, BBH Energy Strategies suggests the following specifications to establish the potential budgets :

Ground-source heat pump system indicative specification :

34kW three-phase, twin-compressor ground-source heat pump system (or potential single compressor inverter-driven three-phase alternative)

Buffer cylinder capacity (heating) :	800 litres nominal
DHW cylinder capacity :	1,000 litres nominal (subject to tapping flow rate analysis)
Plant room location :	dedicated annexe plant room
Heating buffer immersion :	6kW (not available above design external temperature)
DHW cylinder immersion :	6kW (periodic Legionella sterilisation and emergency only)

Energy source :	960m active borehole array potentially configured in 6 no. 160m boreholes with 10m centres subject to geological condition considerations
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Flow & return distance :	80m approximately (subject to route and topography)
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Power Supply

The proposed heat pump solution would be configured against a suitable capacity three-phase electricity supply, subject to DNO consents. Three-phase compressors are likely to be more robust in the long term. There appears to be a three-phase electricity supply already on site. The capacity will need to be confirmed and additional consents will be required to connect any EV charging solution.

Pipework Insulation

It is mandatory that all plant room pipework be insulated to meet the MCS MIS 3005 v5.0 Standard.

Advice on insulation standards can be provided upon request.

The philosophy of high quality pipework insulation should be carried across to all distribution circuits to Building Regulations standards as a minimum. Minimising losses in both heating and DHW distribution is an essential part of any energy reduction strategy. Heat losses in DHW secondary return circuits and in towel rail circuits, in particular, are frequently underestimated.

Attendances

Power supply :	as discussed above subject to DNO consents
Trenches :	borehole array headering trenches, flow & return trench, spoil management
Sand-blinding :	requirement to be confirmed (subject to site survey)
Penetrations :	to agreed location and design
Plant room preparation :	plinths & ply-lining as required
Making good :	builders' works
Landscaping :	including reinstatement and spoil removal (if required). Special consideration may have to be given under any hard landscaping to avoid heave and sinkage
Cold water supply :	finished production supply and to support drilling works
Emitters :	UFH & radiators
Distribution :	Emitters to agreed specification (sized for maximum 40°C flow at design external conditions)
Drilling contract :	recommended to be placed separately (not in mechanical package, or specialist heat pump installer package) and direct, subject to project procurement strategy

Warranty

It is reasonable to anticipate the following :

a twelve-month defects period with a three-month system surveillance visit after commissioning

all manufacturers' warranties to fully supported by factory trained heat pump engineers

extended manufacturers' warranties where available

any additional installer's workmanship guarantees

insurance backed workmanship warranty. For private clients who contract directly with an MCS certified installer (domestic residential properties only) such cover is mandatory under the MCS standard and the Renewable Energy Consumer Code (RECC)

Additional Considerations

MCS certification for the installer (as a minimum) and a preference for a Ground Source Heat Pump Association member

Domestic Renewable Heat Incentive (DRHI) subsidy scheme compliance

electricity tariff selection (tariffs vary considerably, due diligence in agreeing a supply contract is essential)

remote access (Internet) to heat pumps can contribute to lower service and trouble-shooting costs over the lifetime of the system. This is likely to require an Ethernet port in the plant room

cold water pressurisation – deployment of a break tank and booster set if mains pressure is deemed to be insufficient to support reasonable shower operation

towel rail requirements – recommended all electric towel rails with programmable timers or dual fuel equivalents if bathroom space is at a premium

Potential Carbon Emissions Reduction

The following reduction in CO2 equivalent emission levels is predicted for spatial heating and DHW using Carbon factors taken from Defra figures for 2020.

kWh/annum Energy demand	KgCO2/annum Gas-fired boiler	KgCO2/annum heat pump system	KgCO2/annum potential reduction
81,600 (GSHP)	16,685	5,140	11,545 (69%)

The emissions reduction will be approximately the same as taking 6.5 average family cars, doing average annual mileage, off the road (using DVLA and RAC data).

This includes allowances for the fact that electricity is considered to be a "dirtier" fuel due to transmission losses, etc. Carbon savings can be significantly increased if electricity is purchased from a supplier specialising in renewable electricity generation. If the grid electricity procurement is based on 100% renewable generation tariffs, then the carbon emissions reduction would, of course, be 100%.

The carbon emissions reductions will increase year on year as the national grid is increasingly decarbonised.

Again, the performance of microgeneration heat pump systems is impossible to predict with certainty due to the variability of the climate and its subsequent effect on both energy supply and heating demand. The estimates provided are based upon the best available information and theoretical modelling but are

provided for guidance only and should not be considered as a guarantee of performance.

Projected Carbon Emissions (alternative build strategies)

An early consideration is understood to have been to remodel and improve the existing dwelling as far as is possible within feasible value constraints. One of the value KPIs is the potential emissions reductions (heating & potable hot water) offered by various development options on the site. The table below sets out the potential options, together with the best available estimates for the emissions reductions that each routes might deliver.

	External wall insulation	Gas-fired boiler + UFH	Ground-source heat pump + UFH	Emissions KgCO ₂ e/ann um	Improvement over existing baseline	Equivalent average vehicle displacement
Existing dwelling + annexe				38,450		
Existing dwelling + annexe	X			27,830	28%	6
Existing dwelling + annexe		X		21,440	44%	9.7
Existing dwelling + annexe	X	X		15,620	59%	13
Replacement dwelling + annexe			X	5,140	86.6%	19

Baseline estimate data provided by Beat Solutions, replacement dwelling estimate data by BBH Energy.

It is evidential that the replacement dwelling provides an opportunity for emissions reduction that is highly compelling and which would be impossible to match through improvements to the existing dwelling. It should also be noted that continued decarbonisation of the national grid will result in the replacement dwelling being close to carbon neutral by 2050, when HM Treasury Red Book and National Grid Future Energy Scenarios forecasts show the national grid reaching effective zero emissions.

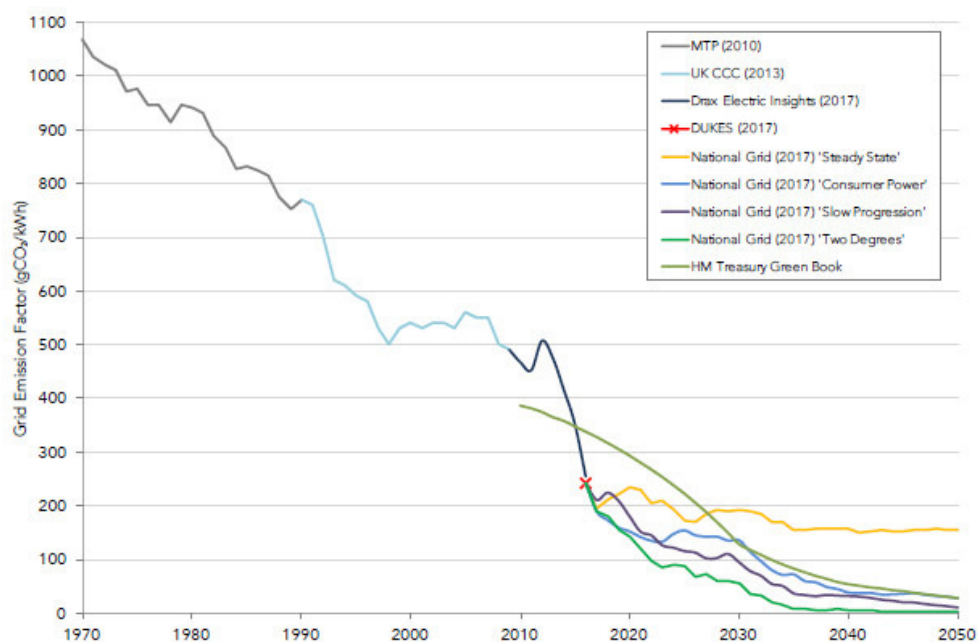


Figure 1.01 – Historic and projected carbon content of electricity

Solar PV Contribution

The section of flat roof identified will support approximately 3.96kWp of solar PV panels. Total annual generation would be approximately 3,565kWh. This represents approximately 16% of the electricity required to run the ground-source system set out in this initial specification document.

Solar generation will peak in summer and will be significantly reduced in winter when the heat pump will be principally operational. Therefore, it may be preferable to balance off capital cost against maximising the solar PV output. One option would be to investigate operating the pavilion solely on direct electrical systems. This will require information from the client on the likely usage patterns for this building. If the space heating load is effectively zero, because of summer use only, then providing potable hot water for the sinks and shower could be done with electric point-of-use solutions. This would reduce the total load on the heat pump, the cost of the pre-insulated connection to the pavilion and the losses incurred across that connection. Whilst this would not reduce the likely capacity of the heat pump system, it would have some impact on the cost of the drilling contract because of the reduced total active borehole requirement.