BOB COSTELLO ASSOCIATES LTD

# ROSSLEY MANOR
# CHELTENHAM

## MECHANICAL AND ELECTRICAL SERVICES

## PRELIMINARY REPORT ON ENERGY SOURCES

JUNE 2022

**CONTENTS**

## 1. INTRODUCTION

Bob Costello Associates Ltd (BCA) were contacted by Mr Darren Price of Adam Architecture to advise on new oil-fired boiler plant for Rossley Manor near Cheltenham. The Client had purchased the property in February 2022 and had appointed Adam Architecture to undertake some internal reordering of rooms to provide new facilities.

Bob Costello and Steven Bailey of BCA visited the property on 12 May 2022 and met with the Client, Mr Darren Price and Mr Warren Arnsmeyer of Solarsense Ltd.

BCA were provided with a copy of a quotation from Neptune Building Services ref. P4769 dated 11 March 2022 for replacement oil-fired boiler plant totalling £192312.84 excluding VAT. Neptune Building Services had installed the existing mechanical and electrical services for the previous owner of the property to what BCA consider to be a high standard and have undertaken routine maintenance since. In the first instance BCA were requested to review the quotation and comment on the proposals.

The Client is concerned at recent and pending increases in the price of electricity and fuel oil and had invited Solarsense Ltd to propose as large a photovoltaic (PV) array as possible. BCA were provided with a copy of a quotation from Solarsense ref. WAC14067A dated 4 May 2022 for 300 module PV array totalling £112860.52 excluding VAT.

The Client showed us around the House and identified the proposed modifications to rooms and explained which rooms are to have electric underfloor heating as part of the proposed reordering of the house. An extensive tour of the grounds included a visit to the field to the north of the property which the Client has purchased to accommodate the proposed PV array.

During discussions the Client tabled recent electricity accounts from Eon Next Energy Ltd. These were copied for BCA to analyse.

This preliminary report on energy sources is intended to collate as much information on existing installations and energy consumption as is available, to explain and assess the consequences of current proposals and also suggest alternative proposals to reduce energy costs and carbon emissions.

Appendix A, Comparative Energy Data presents costs and carbon emissions for a range of fuels for heating. It is intended to provide background information to assist discussions. The world market for gas and oil has recently been extremely volatile as a result of the recent pandemic and the war in Ukraine and it is not possible to predict the future prices of fossil fuels with any certainty.

At a further meeting at Adam Architecture's offices in London on 31 May 2022 the Client further clarified requirements as follows.

1. A reduced size of boiler plant from 6 to 4 boilers
2. The Swimming Pool complex is to be served by air source heat pumps only.
3. The proposed battery installation by Solarsense is to be optimised so that it can be charged with low cost electricity during the night during winter months when the PV system may not be generating electricity.
4. Re-designated rooms on the Ground Floor which are to have electric underfloor heating.
5. Advised that the external swimming pool is to be refurbished and heated in summer only by a new air source heat pump installation.

Photo P1.1 Rossley Manor House

Photo P1.2 Stable Range

Photo P1.3 Stable Yard

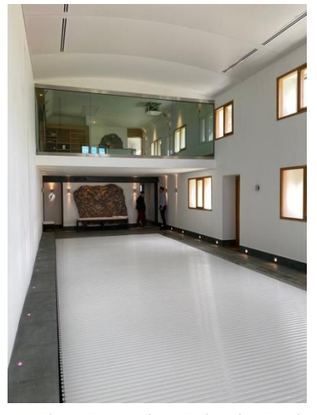


Photo P1.4 Indoor Swimming Pool

## 2. EXISTING ENERGY SOURCES

This section should be read in conjunction with drawing no. 774-ME-101 which indicates the key existing energy services.

### ELECTRICITY

The property is supplied with electricity via an overhead line from the south which terminates with a pole-mounted transformer adjacent to the Garage Block. See photo P2.1. The supply to the House is 100Amp Three Phase and Neutral (TP&N) and the service head and meters are located in a cupboard in the Utility Room on the Ground Floor of the House. See photo P2.2.

There is a 130kVA Petbow standby diesel-engine generator and oil storage tank located in the gardens. See Photo P2.3. This probably provides 100% of the electricity load currently but may not do so when additional electric heating and a heat pump is installed during the forthcoming reordering of rooms.

The Client took possession of the property in February 2022 and consequently the electricity accounts from Eon Next Energy Ltd only covers a period of 2 months. The relevant data from this is as follows.

NEW GARAGE BLOCK

Period 3-31 March 2022 (2 accounts)
Total electricity consumption (408 + 349kWh) = 757 kWh
Total charge including VAT and standby charges – (£92.99 + £79.83) = £172.82
Effective cost-in-use = 22.83p/kWh

Period 15-29 April 2022
Total electricity consumption = 342kWh
Total charge including VAT and standby charges = £108.51
Effective cost-in-use = 31.728p/kWh

Cost increase from March to April = 22.83p/kWh to 31.728p/kWh = 39%
Eon predicted annual energy consumption = 8384kWh/annum
Predicted annual energy cost = 8384kWh @ 31.728p/kWh = £2660.00

MAIN HOUSE

Period 2-15 March 2022
Electricity consumption at Day rate = 2282kWh @ 24.168p/kWh
Cost for Day rate electricity = £553.39
Electricity consumption at Night rate = 1097kWh @ 12.90p/kWh
Cost for Night rate electricity = £141.50
Total electricity consumption = 2282kWh + 1097kWh = 3379kWh
Total charge including VAT and standby charges = £731.70

Eon predicted annual energy consumption = 46529 + 18708 = 65307kWh/annum
Predicted annual cost = 65307kWh @ 21.654p/kWh = £14142
Anticipated cost with 39% increase = £19657

Combining the figures for the New Garage Block and the Main House provides the following data.

Predicted annual electricity consumption = 8384 + 65307 = 73691kWh/annum
Predicted annual cost-in-use = £2660.00 + £19657.00 = £22317 per annum

Photo P2.1 Pole-mounted transformer adjacent to Garage Block

Photo P2.2 Electricity meter and main distribution board in House

Photo P2.3 Standby diesel generator and oil tank located remotely from the House

Photo P2.4 Oil fill point in Garage Yard

## 2. EXISTING ENERGY SOURCES…continued

A further increase in the cost of electricity is anticipated in October 2022 when the current price cap imposed by OFGEM is lifted. Assuming a 30% cost increase the annual cost of electricity will rise to £29000.00.

**OIL**

There are no records available for oil (kerosene) consumption in the property. The Client reports that she had difficulty obtaining a delivery of oil in March 2022, eventually obtaining a limited delivery of 5000 litres for which she had to pay 179p/litre as a result of a shortage of oil due mainly to the war in Ukraine and turbulence in world oil markets. Prior to this the published price of oil was around 70p/litre and the current price (May 2022) is 94p/litre. The critical period of oil supply availability appears to have passed.

There is a single 10000 litre oil storage tank located in a chamber in the Basement of the Garage Block with an oil fill point in the Garage Yard. See photos P2.4 and P2.5. The oil tank supplies all the heating boilers in the House and the Garage Block.

The House is heated by LPHW and provided with domestic hot water (HWS) by a single Ideal Harrier GTS oil-fired boiler rated at 230kW output located in the Utility Room on the Ground Floor. See photo P2.6. There is a further small oil-fired boiler in the Stable Annex.

The Swimming Pool complex is heated and provided with hot water by 2 no. Worcester Bosch Danesmoor 32/50 oil-fired boilers each rated at 50kW output located in a roof level plant space. See photo P2.7. These boilers provide low pressure hot water (LPHW) to radiator heating, to the hot water cylinder for HWS and to the Heatstar Phoenix 3000 unit located in the Pool Plantroom (see photo P2.8). This unit incorporates a 22.9kW LPHW coil to heat the Pool Hall and a 46.2kW coil to heat the swimming pool water. The total LPHW connected load is consequently 69.1kW. Heat from dehumidification is recycled to heat pool water and contributes 11.4kW.

We have assessed the annual energy requirement of the existing boilers in the House, including the Swimming Pool to be in the order of 300000kWh/annum. The calorific value of oil (Kerosene) is 10.35kWh/litre so this equates to around 30000 litres of oil per annum.

At the current price of 94p/litre this totals £28200.00 per annum. If, as is predicted, oil prices increase by 30% in October 2022 then this cost will increase to £36600.00 per annum.

Photo P2.5 Oil storage tank in Garage basement


Photo P2.6 Ideal Harrier GTS boiler serving the House

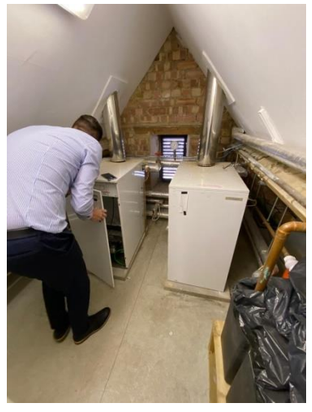


Photo P2.7 Two boilers located in roof void serving the Swimming Pool building

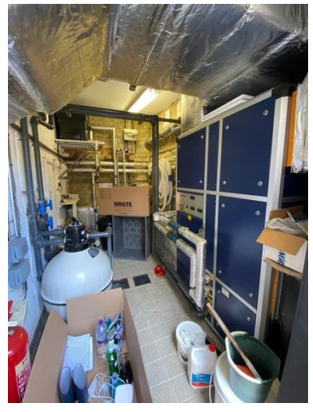
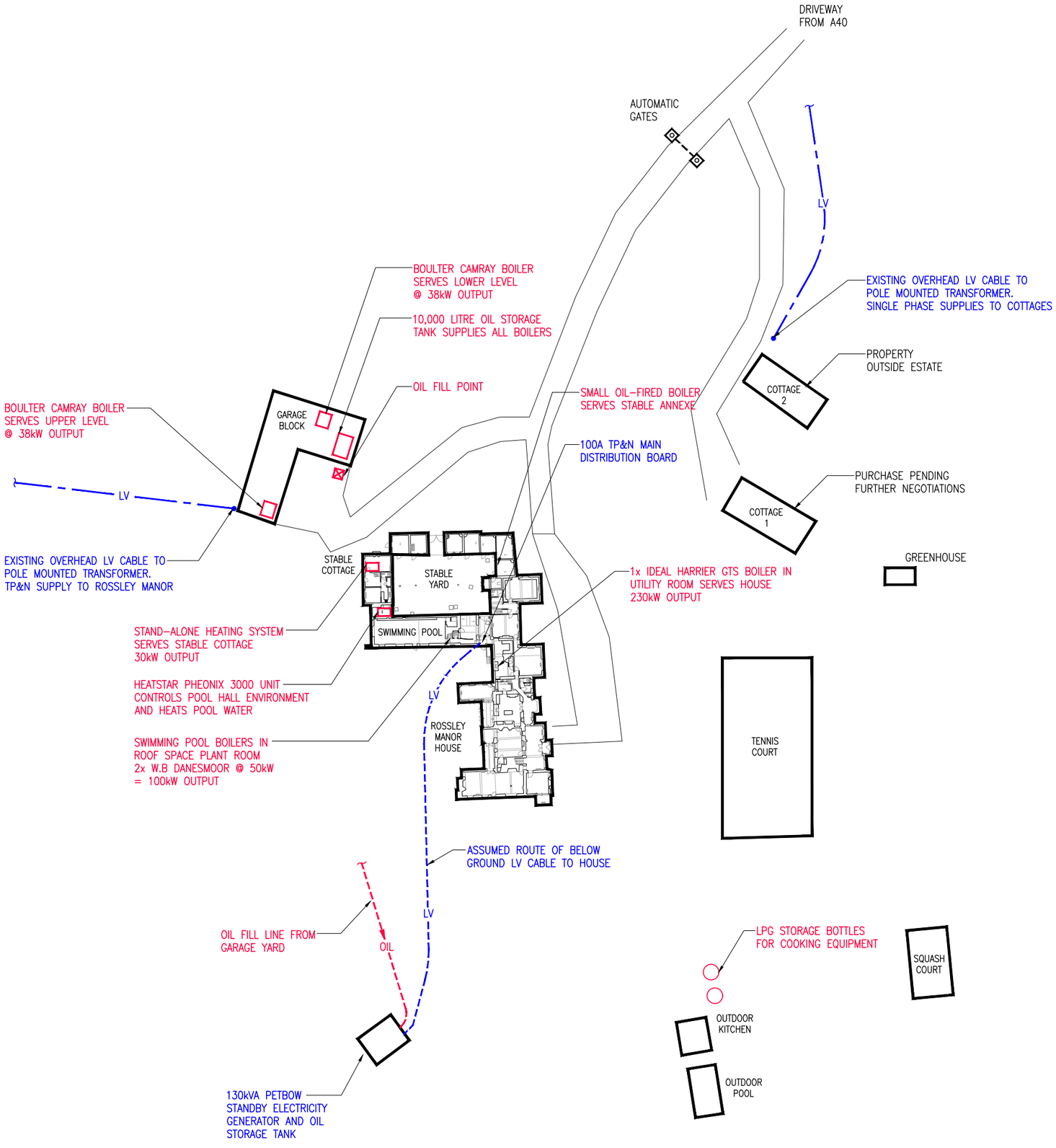


Photo P2.8 Heatstar Phoenix 3000 unit controls the Pool Hall environment and heats the pool

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AMENDMENTS

| NO. | DATE | DESCRIPTION | DRAWN | APP |
|---|---|---|---|---|
| P | 27.05.22 | PRELIMINARY ISSUE | SB | BC |
| P1 | 01.06.22 | ADDITIONAL BOILER IN STABLE ANNEXE. COTTAGE 1 NOT ACQUIRED YET | JT | BC |

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CHELTENHAM

DRAWING TITLE

M&E SERVICES
EXISTING ENERGY
FACILITIES

| | | | |
|---|---|---|---|
| N | DRAWN SB | APP BC | |
| | DATE MAY 2021 | | |
| | SCALE NTS | | |
| DRG.No.: 774-ME-101 | | REV P1 | |

## 3. OPTION A – CURRENT PROPOSALS

This section should be read in conjunction with drawing no. 774-ME-102 which illustrates the proposed schemes under consideration.

The Main House is to be internally remodelled and electric underfloor heating is to be installed in the following rooms.

GROUND FLOOR

| | | | | | |
|---|---|---|---|---|---|
| Kitchen – stone floor | = | 22.0m$^2$ x 75W/m$^2$ | | = | 1650W |
| North Loggia – stone floor | = | 10.0m$^2$ x 75W/m$^2$ | | = | 750W |
| Breakfast Room – stone floor | = | 21.0m$^2$ x 75W/m$^2$ | | = | 1575W |
| Lobby- wooden floor | = | 15.0m$^2$ x 55W/m$^2$ | | = | 825W |
| Music Room - wooden floor | = | 26.0m$^2$ x 55W/m$^2$ | | = | 1430W |
| Study – wooden floor | = | 24.0m$^2$ x 55W/m$^2$ | | = | 1320W |
| North Stair Hall – wooden floor | = | 10.0m$^2$ x 55W/m$^2$ | | = | 550W |
| Library – wooden floor | = | 24.0m$^2$ x 55W/m$^2$ | | = | 1320W |
| | | | Total | = | 9420W |

FIRST FLOOR

| | | | | | |
|---|---|---|---|---|---|
| Bathroom 1 – tiled/marble floor | = | 13.0m$^2$ x 135W/m$^2$ | | = | 1755W |
| Bathroom 2 – tiled/marble floor | = | 5.0m$^2$ x 135W/m$^2$ | | = | 675W |
| Bathroom 3 – tiled/marble floor | = | 7.0m$^2$ x 135W/m$^2$ | | = | 945W |
| Bathroom 4 – tiled/marble floor | = | 3.0m$^2$ x 135W/m$^2$ | | = | 405W |
| New Bathroom 5 – tiled/marble floor | = | 8.0m$^2$ x 135W/m$^2$ | | = | 1080W |
| Bathroom 6 – tiled/marble floor | = | 10.0m$^2$ x 135W/m$^2$ | | = | 1350W |
| Bathroom 7 – tiled/marble floor | = | 2.0m$^2$ x 135W/m$^2$ | | = | 270W |
| Guest Suite Bathroom – tiled/marble floor | = | 6.0m$^2$ x 135W/m$^2$ | | = | 810W |
| | | | Total | = | 7290W |

The reordering includes the creation of a Gym, Sauna and Hamman for which there will be additional electrical loading.

The Client proposes to have the Heatstar Phoenix 3000 unit serving the swimming pool modified to be heated by an air-source pump instead of the oil-fired boiler plant. Initial discussions with Mr John Meijer of Heatstar (tel. 01983 521465) have confirmed that this is possible but the heat pump would need to generate low temperature hot water (LTHW) at 60°C flow temperature. This is a relatively high temperature for a heat pump and results in a reduced coefficient of Performance (CoP or efficiency). Mr Meijer has since advised that further checking of design data shows that by extending the warm-up period the LTHW flow temperature can be reduced to 55/45°C. The installed unit would need to have the existing heat exchangers replaced plus other modifications in order to operate in conjunction with a heat pump. We have requested a quotation for this work. It may be more economic to replace the Heatstar unit with a new unit designed to work in conjunction with a heat pump. We have asked Heatstar to provide an alternative quotation for this.

Without firm engineering proposals it is not possible to estimate costs with accuracy. Provisionally we assess the cost of the Heatstar unit modifications and the air-source heat pump system as £40000 and the increased electrical load as 25kW. We also suggest that the air-source heat pump installation would consume an additional 30000kWh per annum plus perhaps another 10000kWh for other heating totalling 40000kWh per annum. These figures will be reviewed when more information is available. Given that the present predicted annual electricity consumption is some 74000kWh/annum this represents a considerable increase of some 50%.

The Client has advised that she intends to eliminate oil-fired heating from the Swimming Pool complex altogether and a further air-source heat pump will be required. Provisionally two large air source heat pumps located at the end of the Garage Block are to be incorporated into the planning and LBC applications.

Photo P3.1 Proposed field for photovoltaic array

Photo P3.2 Solarsense photovoltaic array


Photo P3.3 Proposed Grant Vortex condensing oil-fired boilers

Photo P3.4 Pre-insulated below ground heating pipework

**3. OPTION A – CURRENT PROPOSALS…continued**

Neptune Building Services have provided a proposal for removing the existing oil-fired boilers in the House and the Swimming Pool complex and replacing them with a cascade arrangement of 6 no. 70kW Grant Vortex condensing oil-fired boilers in a new Boiler Room. They have quoted a price of £192312.84 plus VAT for this which includes various modifications to the existing heating and hot water systems and controls. We have discussed the proposal with Mr Mark Hanlon of Neptune and he has advised that costs will have increased since March when the quotation was submitted. There will also be additional costs for the revised location of the boiler room from that originally envisioned and for routing heating pipes below the floor of the Stable Yard. At a meeting on 31 May 2022 the Client advised that she wants a reduced boiler plant of 4 not 6 boilers and believes the additional heat pumps and electric underfloor heating being installed compensate for this. Neptune will provide an amended proposal but a budget cost of £200000.00 excluding VAT should be allowed for this work.

The new condensing boilers would be more efficient than the existing conventional boiler in the House and the output from 4 x 70kW boilers will be less than the existing boilers. Some reduction in oil consumption in future can be anticipated. Perhaps 20% in which case oil consumption would reduce on a pro-rata basis from 30000 to 24000 litres per annum.

The proposed modifications to the mechanical and electrical services in the House are extensive and will necessitate considerable redesign of the existing installations. This needs to be undertaken in conjunction with Neptune. It is not possible to establish the cost of this with any certainty at this stage. A provisional budget of £80000.00 may be appropriate.

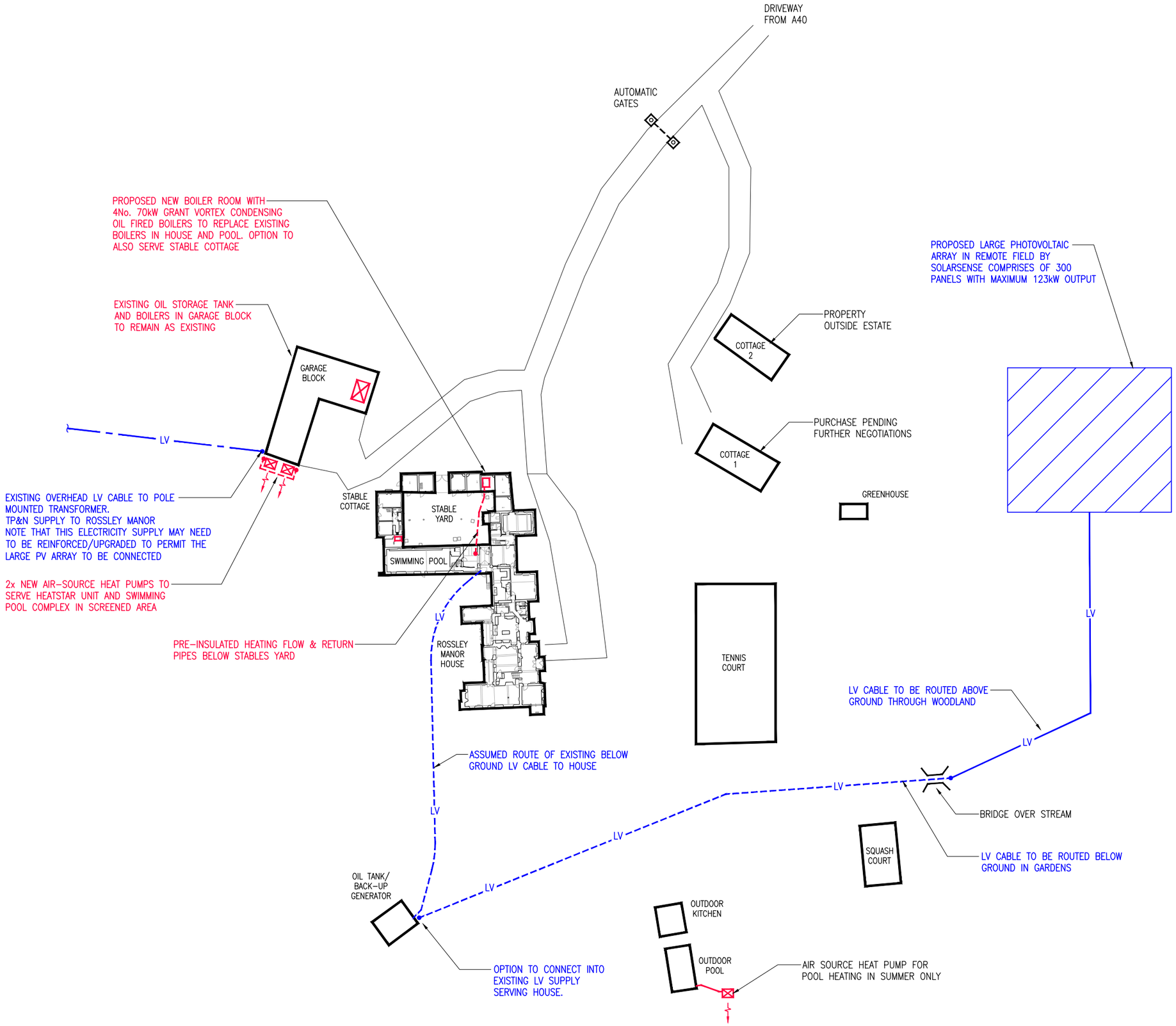
Solarsense have provided proposals for a large photovoltaic array and associated works and Mr Warren Arnsmeyer has been particularly helpful in clarifying their proposals and anticipated costs. Warren has explained that Solarsense normally survey the existing electrical system and establish a load profile for the property to ascertain the anticipated demand for electricity throughout the year prior to formulating proposals and submitting a quotation. In this instance they have not had the opportunity to do this. The Client has asked for as large a PV array as possible, has already purchased a field to accommodate this and has commissioned Solarsense to undertake initial design and make DNO and planning applications to expedite the installation work. The costs quoted and anticipated additional costs are as follows.

| | |
|---|---|
| Quoted cost for 300 PV solar modules, meters, inverters and connection | £112860.52 |
| Anticipated cost of cable from PV array to property | £20000.00 |
| Cost of trenching and reinstatement of ground – say 200 metres @ £50 per metre | £10000.00 |
| Batteries (capacity to be adequate for overnight charging in winter) | £20000.00 to £50000.00 |
| Provisional budget cost (excluding VAT) | £200000.00 |

The PV array is expected to generate in the order of 112000kWh per annum. At a current cost of 21.65p/kWh this equates to £24000.00 per annum if it can be usefully consumed on the property.

However it is not possible to predict how much of the generated electricity will be consumed and how much will need to be exported to the grid. A reasonable assessment is 50%/50%. Warren has said that Eon are currently only paying between 4p and 6p per kWh for exported electricity to the grid but he is confident that Solarsense can negotiate a figure of 10p per kWh for this large PV installation. On this basis we anticipate the following.

| | | |
|---|---|---|
| Value of consumed electricity<br>112000kWh x 50% x 21.65p/kWh | = | £12124.00 per annum |
| Value of exported electricity<br>112000kWh x50% x 10p/kWh | = | £5600.00 per annum |
| | Net cost benefit = | £17724.00 per annum |

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|---|---|---|---|---|
| P | 27.05.22 | PRELIMINARY ISSUE | SB | BC |
| P1 | 01.06.22 | 2x ASHP UNITS INDICATED ADJACENT TO GARAGE BLOCK. NOTE ADDED ABOUT ELECTRICITY SUPPLY | JT | BC |

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DRAWING TITLE

M&E SERVICES
ENERGY FACILITIES
CURRENT PROPOSALS
OPTION A

| | | | |
|---|---|---|---|
| N | DRAWN SB | APP BC | |
| | DATE MAY 2021 | | |
| | SCALE NTS | | |
| DRG.No.: 774-ME-102 | | REV P1 | |

## 4. OPTION B – ALTERNATIVE PROPOSALS

This section should be read in conjunction with drawing no. 774-ME-103 which illustrates key features of alternative proposals.

BCA are fully committed to reducing energy consumption and carbon dioxide emissions on all our projects but are aware that proposals for appropriate measures need to be practical, affordable and not undermine the amenity value of the property.

We are in complete agreement with the proposal to adopt photovoltaics to generate electricity on site. However we share Warren's view that more further consideration needs to be given to assessing loads in order to optimise the capacity of the PV array installed and the associated battery sizes. The capital cost of the system is high and the benefits in terms of cost and carbon reduction need to be optimised.

We are not in complete accord with the proposal to replace existing oil-fired boilers with new oil-fired boilers. The new boilers would be condensing type and consequently more efficient but new boiler plant should not be utilising a fossil fuel if it is avoidable. Burning oil generates enormous quantities of carbon dioxide and although the price of oil has reduced slightly from the peak price of 170p per litre during the recent crisis the cost of oil will continue to rise in future.

As demonstrated in Appendix A, Comparative Energy Data, the logical choice of fuel for a large boiler plant is item 10, Biomass Boiler plant burning commercially purchased woodchips.

The Clients initial response to this suggestion during our meetings on 12 and 31 May 2022 was negative based on an opinion that the boiler house would be unsightly, dirty and messy and difficult to maintain. This is not the case as the photographs indicate. A well-engineered and designed boiler house need not be an eyesore and should not detract from the amenity of the property. We would be happy to take the Client to a modern biomass boiler plant and let her judge for herself.

Running costs and carbon emissions would be considerably lower than for burning oil. Fuel prices are also far less subject to turbulence in world fuel markets but of course fuel costs are rising and are expected to continue rising. Never the less the benefits of adopting biomass over oil as the preferred fuel are clear.

The problem is where to locate a biomass boiler house? Following a tour of the property on 12 May 2022 we initially proposed locating it where the existing Glasshouse is located presently. The Client is trying to acquire the adjacent cottage for staff accommodation and vehicle access for fuel deliveries could be provided via the driveway to it. This suggestion was rejected by the Client on the basis of being visible from the Master Bedroom and the loss of amenity of the Glasshouse. It may be possible to allay these concerns.

No alternative site on the property for a boiler house is immediately obvious. However if the land between the property and the A40 could be purchased this would provide an ideal location for a biomass boiler house with good vehicle access and no loss of amenity at all.

Assuming a combination of two biomass boilers the capital cost of the boiler plant would be in the order of £100000.00, the building may cost £30000.00 and pipework and trenching a further £30000.00 so the budget cost of the proposed is in the order of £160000.00 plus VAT.

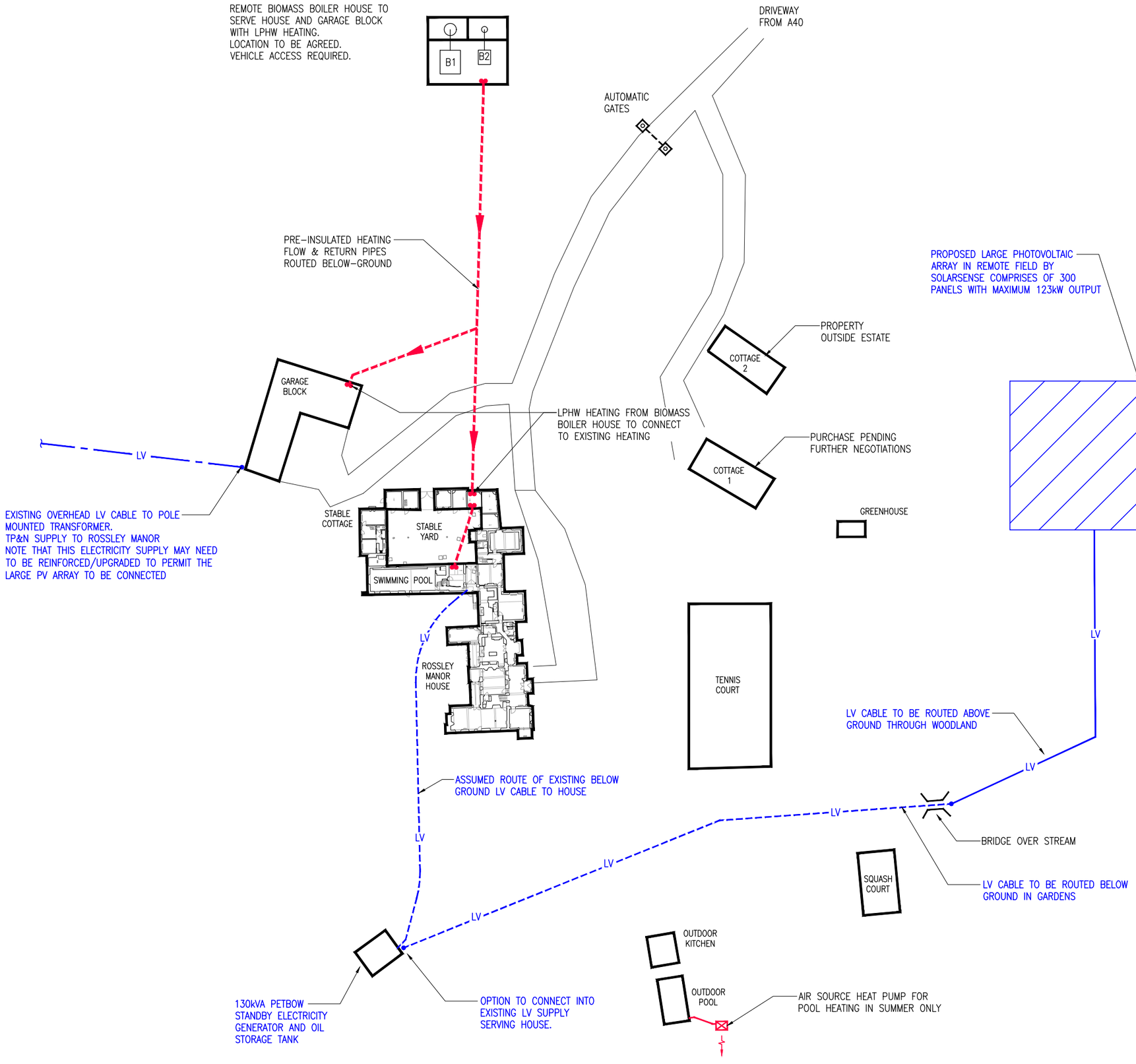
We recommend that biomass be adopted in lieu of oil as the fuel for heating in the long term but recognise that considerable problems need to be overcome to accommodate the boiler house.

Photo P4.1 A Biomass boiler house can be an attractive building

Photo P4.2 Modern biomass boiler plant

Photo P4.3 A Larger biomass boiler plant

Photo P4.4 Woodchip store

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|---|---|---|---|---|
| P | 27.05.22 | PRELIMINARY ISSUE | SB | BC |
| P1 | 01.06.22 | COTTAGE 1 IDENTIFIED AND NOTE ADDED ABOUT ELECTRICITY SUPPLY | JT | BC |

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DRAWING TITLE

M&E SERVICES
ENERGY FACILITIES
ALTERNATIVE PROPOSALS
OPTION B

| | | | |
|---|---|---|---|
| N | DRAWN SB | APP BC | |
| | DATE MAY 2021 | | |
| | SCALE NTS | | |
| DRG.No.: 774-ME-103 | | REV P1 | |

| | FUEL COSTS | | | | RHI SUBSIDY | | | CARBON EMISSIONS | | |
|---|---|---|---|---|---|---|---|---|---|---|
| SPACE HEATING | A Nett Cost Of Fuel | B Efficiency % or C.O.P | C Cost-in-use Pence/kWh | D Annual Cost For Heating £/year | E RHI P/kWh Tier 1 | F RHI P/kWh Tier 2 £ | G Maximum Payment £/year | H Carbon Emission Kg/kWh $CO_2$ | I Annual Carbon Emission tonnes $CO_2$/annum | J % $CO_2$ Emission Compared to gas (1) |
| 1. Gas Fired Boiler (Condensing) (British Gas) | 7.00p/kWh | 85% | 7.76 | £23280.00 | N/A | - | - | 0.203 | 60.9 | 100% |
| 2. Oil fired boiler (Condensing) | 94.0p/Litre | 85% | 10.56 | £31680.00 | N/A | - | - | 0.259 | 77.7 | 128% |
| 3. Electric-heaters on peak | 21.65p/kWh | 100% | 21.65 | £64950.00 | N/A | - | - | 0.233 | 69.9 | 115% |
| 4. LPG boiler (Condensing) | 50.33p/kWh | 85% | 7.86 | £23580.00 | N/A | - | - | 0.241 | 72.3 | 119% |
| 5. Ground-Source Heat Pump with Radiators | Electricity 21.65p/kWh | Max COP = 4.2 to 1 Seasonal = 3.7 to 1 | 5.86 | £17580.00 | N/A | - | - | 0.063 | 18.9 | 31% |
| 6. Ground-Source Heat Pump with Underfloor Heating | Electricity 21.65p/kWh | Max COP = 4.5 to 1 Seasonal = 4.0 to 1 | 5.41 | £16230.00 | N/A | - | - | 0.058 | 17.4 | 29% |
| 7. Air-source Heat Pump with Radiators | Electricity 21.65p/kWh | Max COP = 3.5 to 1 Seasonal = 3.0 to 1 | 7.22 | £21660.00 | N/A | - | - | 0.078 | 23.4 | 38% |
| 8. Air-Source Heat Pump with Underfloor Heating | Electricity 21.65p/kWh | Max COP = 4.8 to 1 Seasonal = 3.3 to 1 | 6.56 | £19680.00 | N/A | - | - | 0.071 | 21.3 | 35% |
| 9. Biomass boiler Pellet fuel | £380.00/tonne delivered | 80% | 8.00 | £24000.00 | N/A | - | - | 0.0154 | 4.6 | 8% |
| 10. Biomass Boiler Wood Chips | £115.00/tonne delivered | 80% | 4.00 | £12000.00 | N/A | - | - | 0.0154 | 4.6 | 8% |

Notes

1. Costs for fuels are generally based on Sutherland Comparative Heating Tables March 2022 plus current published prices for gas, oil and biomass fuels. The cost of electricity based on accounts from Eon for April 2022.
2. Data is based on assessed annual energy consumption of 300000kWh for heating and hot water.
3. Carbon emissions based on HM Government 'Conversion Factors for Company Reporting' 2020.
4. Renewable Heat Incentive (RHI) for Non-Domestic schemes ended March 2021 and is no longer applicable. The replacement Boiler Upgrade Scheme (BUS) is limited to installations below 45kW output.
5. Columns C and D reflect fuel costs only.

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