Wood Heating Opportunities for Rampton Parish Council (site B)

A Feasibility Study

Microgen Energy

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HEADLINE RESULTS OF THE STUDY

Modern wood heating is a technically viable option for Rampton village and an economic alternative to the existing heating oil boiler systems

Utilising two 1MW modern wood heating system effectively means there would be an average saving of 20% in heating bills for each household.

- **Internal Rate of Return (IRR) of 10% for ESCO provider**
- **Payback of 10 years**
- **Net Present Value (NPV) of around £2.8m**
- **Fuel costs cut by 20% from current levels**

These results effectively make the investment positive and indicate a fair use of capital.

1. Introduction

Rampton Parish council sort to investigate the possible use of a biomass district heat network system to cut fuel costs and emissions in Rampton village. This report has therefore been commissioned by Rampton Parish council to focus on developing a biomass district heating system at Rampton village and on encouraging the utilisation, where appropriate, of local wood fuel.

The intention of the feasibility study is to assess the technical and financial viability of a wood heating boiler system. Due to the close proximity of several volume wood chip suppliers and local resources, this study will mainly consider this fuel.

The Renewable Heat Incentive (RHI) is a Government backed scheme to encourage the use of renewable heating technologies such as biomass heating. It is a key part of the Government's strategy to meet a binding European Union (EU) target to achieve a 15% renewable energy contribution by 2020. The RHI has been made available because technologies such as wood heating systems are more capital intensive than gas or oil boilers, frequently three to five times the cost. Dependent on technology and scale, owners of renewable heating equipment will be paid a tariff for the kilowatt hours (kWh) of heat they generate. The RHI therefore has the potential to be the 'game-changer' by improving the economics of renewable heat and is already leading to significantly more investment into the sector.

All the information in this report is based on the data made available, the team's expertise, best-efforts and with the Clients' interests at heart. While we note that building performance is extremely difficult to predict, especially with a distribution systems of various ages and largely undetermined detail, we built in some conservatisms as well as blind-checked the initial heat loss calculations so that the heat loss and boiler sizing assessments are realistic and sound. Back-up heat sources are also an integral part of the feasibility proposal.

It should also be noted that the capital and service costings in the study, whilst based on recent market activity and data, are not a formal quote. They hence need to be tested in the market via a fully detailed design and quotation.

2. Objectives

The objective of the study is to answer the following questions:

- Is a wood heating system, to service the space heating and DHW (Domestic Hot Water) demand of the properties at the village, technically viable via a single or twin wood boiler and a new connecting district heating network?
- If so, what is the optimum combination and sizing of boiler(s) and accumulator tank, using criteria of financial payback, technical efficiency and maximising carbon savings?
- What are the outline costs, cashflow and payback periods for a project registered under the Renewable Heat Incentive (RHI) scheme under an ESCO scheme?
- What are the main ESCO business model options for developing a wood heating scheme at Rampton village?
- Are there secure and cost-effective sources of wood chip fuel within the local area (within 30-50 miles radius)?
- Are there secure and cost-effective sources of wood chip fuel within the regional-national area (within 100-250 miles radius)?

3. Description of the site

3.1 Basic description of site and existing heating system

Rampton village consists of 265 properties including some small commercial buildings, all with either oil or LPG fuelled boilers and varying aged heating systems.

4. Heat Loads and implications

4.1 Assumed heat load for individual properties

An assumed figure of 22,000kwh per annum required for 265 properties at the Rampton site. This including 7 small commercial sites.

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The basis of this figure has been acquired at the site visit speaking with local inhabitants of the village as specific usage was not available.

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4.2 Discussion of results and boiler size estimates

Critical to the development of a successful wood heating system is hence the correct sizing of the boiler in order to match the heat load profile of the site. Wood boilers have a higher inertia than conventional systems as they cannot be turned on and off quickly like oil and gas boilers. Wood boilers also need a minimum 25% to 30% load to ensure high efficiency.

It is also important to look at the base-load of heat demand in summer. For long periods of the summer the boiler load will consist of the DHW only. We estimate that this could be as low as 600-700kW. If the boiler capacity is too great it would not be possible to run the boiler efficiently during the summer which in turn would reduce the potential carbon savings and extend the financial payback.

The use of a large accumulator tank which balances the heat output of the wood boiler is therefore important in allowing greater flexibility of a large single wood heating boiler. Opting for twin boilers, also with a large accumulator tank, would further improve the ease of operation in summer months, a recommendation we look at in more detail in the following sections.

Text Box 1: The importance of boiler sizing

If a modern wood heating system is solely designed for the winter peak load, then for much of the year it will be running at low load factors which will affect its efficiency levels.

While modern wood heating systems can modulate down to 30% load with little loss in efficiency, below this load level the efficiency levels fall off and the boiler can be found 'cycling' on and off for long periods in response to low heat loads.

The use of accumulator (hot water) tanks is one important way of ensuring that wood boilers operate efficiently. Such tanks allow fluctuations in demand to be managed relatively simply. In summer low load conditions, the boiler can simply charge up the accumulator tank with heat for use later and then switch off. In high demand situations (e.g. the winter morning peak load) a charged up accumulator tank can support the boilers and provide a higher peak load for several hours.

4.3 Boiler sizing options

We took the estimated peak load across the entire heating season and then adjusted the wood boiler size downwards to reflect the use of a large accumulator tank. In conclusion we opted for:

- Either a single or twin wood heating boiler solution for Rampton at 100% of the estimated 2,000kW peak load.
- The twin boiler approach would more easily allow summer *and* winter peak load to be managed
- A single boiler with a 35,000 litre accumulator tank would also allow good controllability and ease of use
- A large accumulator tank has been included in both configurations, to ease load management and control, as well as giving a higher morning peak load in winter.

4.4 Optimising boiler size

We now need to look at appropriate boiler sizes for the heat demand that exists. Sizing wood heating boilers needs to take account of:

- **The higher thermal inertia in biomass boilers**: even with an accumulator tank they are not 'instant on' like gas and oil boilers.
- **The need to run the boilers with at least 30% load to ensure high efficiency:** Low loading on wood boilers (i.e. below 30%) leads to lower efficiency levels and is not recommended as it leads to frequent 'cycling' of the boiler.
- **Summer base-load**: If the boiler is sized too high it would not be possible to run the boiler in summer, hence reducing the carbon reduction potential.
- **High winter load factors**: This may impact on longevity and servicing. Hence opting for a smaller boiler may lead to greater servicing costs, faster parts replacement, and possible reduced lifetimes.

Small commercial biomass	Solid biomass including solid biomass contained in waste	Less than 200 kWth Tier 1	3.05

Tariff name	Eligible technology	Eligible sizes	Tariffs

Tariff name	Eligible technology	Eligible sizes	Tariffs
Small commercial biomass	Solid biomass including solid biomass contained in waste From 20 September 2017 the tiering threshold for small and medium biomass changed from 15% to 35% of heat load. Large biomass moved from a single, untiered tariff to a tiered tariff with the same 35% threshold.	Less than 200 kWth Tier 1	3.05
		Less than 200 kWth Tier 2	2.14
Medium commercial biomass		200 kWth and above & less than 1MWth Tier 1	3.05
		200 kWth and above & less than 1MWth Tier 2	2.14
Large commercial biomass		1MWth and above Tier 1	3.05
		1MWth and above Tier 2	2.14
All commercial biomass	Solid biomass boilers	0-1MWth & Above – tier 1	3.05p
All commercial biomass		Tier 2	2.14p

Given the above issues and criteria, we looked at two possible boiler sizing approaches:

- **Option A: Maximising carbon savings and RHI income**
  - 2MW boiler system (twin boilers) with a large 25,000 litre accumulator tank. This produces a potential 2000kWh of heat energy in the accumulator tank when fully charged. This produces the maximum RHI income and should cover c.100% of the total heat load
- **Option B: Middle ground option**
  - 2MW boiler system (single boilers) with 30,000 litre accumulator tank. Covering approximately 100% of the annual heat load

Table 4: Summary of boiler sizing options

Option	Boiler Size	Technical Constraints and Issues	Estimated Annual heat load coverage	RHI tariff consideration and capital costs
A	**2000kW**	• Use large accumulator tank • Use good control system • If twin boilers used a single boiler can be used in summer months • Retain oil boiler for back up	100%	• Highest RHI income • c.Higher capital costs versus single 2000kW boiler option
				•
B	**2000kW**		100%	• Provides a balance between capital costs, RHI income and carbon savings • 100% of the summer heat load can be covered • Approximately 100% of winter heat load • c.100% of annual load

As a result of the above, we have focussed our financial analysis on the following boiler sizing strategies as all other configurations fall short of investment ROI expectations. Wood chip is our recommended fuel for Rampton

- **Option A:**
  - 2 x 1MW boiler system with 25,000 litre accumulator tank.

As a result of the site visit and discussions with the client, the location of a new wood heating boiler room and fuel store quickly settled on a single site. The site agreed was the field next to the playing field on the outskirts of the village.

5. Technical assessment of wood heating options

Wood heating can be provided from a wood chip boiler or wood pellet boiler. As was the intention of the project, we have focussed almost entirely on the wood chip option due to the availability of wood chip locally.

5.1 Wood fuel availability

The potential wood chip fuel demand for Rampton village under this project is:

- **Wood chip**:
  - Around 1767 tonnes per year
  - Based on the estimated heat load and calorific value of 3,300kWh/tonne

Using this report we have assumed a central cost of £100/tonne with a +/-15% sensitivity. At 30% moisture content (MC) this is equivalent to a central cost of 2.9p/kWh and a variation between 2.45 and 3.2p/kWh.

While there has been an escalation of wood fuel prices over the past four years, prices have been much less volatile than gas and oil prices. They are currently cost competitive even with low commercial gas prices. Wood pellet fuel by comparison tends to be around 0.5p to 1.0p/kWh more expensive than equivalent wood chip fuel, but is still considerably cheaper than heating oil (at around 5.8p/kWh. Overall wood chip fuel, should provide a major hedge against rising natural costs in future.

6. Financial Appraisal

6.1 Introduction

We carried out a detailed cost-benefit analysis for our central case of a twin wood boiler system at 1MW each capacity. This includes:

- New boiler room and fuel store
- Insulated heat pipework system connecting up to each property
- Controls
- Heat exchangers and heat meters

- Heat main run throughout village including civils

6.2 Cost and Savings data

We looked at the capital costs of the proposed wood heating scheme, the costs of financing this and set this against the likely fuel savings when using wood fuel as against heating oil. Finally we estimated the potential RHI income based on data available to us as reviewed through our own RHI screening model.

6.2.1 Financial Analysis

In summary the financial analysis measured the following costs to ESCO supplier and savings to end users:

- **Costs:** capital costs of the new scheme, costs of financing the project, extra wood boiler servicing costs, wood fuel costs and residual heating oil costs
- **Savings:** costs of wood fuel costs less the costs of heating oil equivalents

6.2.2 Costs

- Cost to the end users is zero with little to no financial risk

6.2.3 Savings

- Savings to each household would be circa 20% off current heating costs

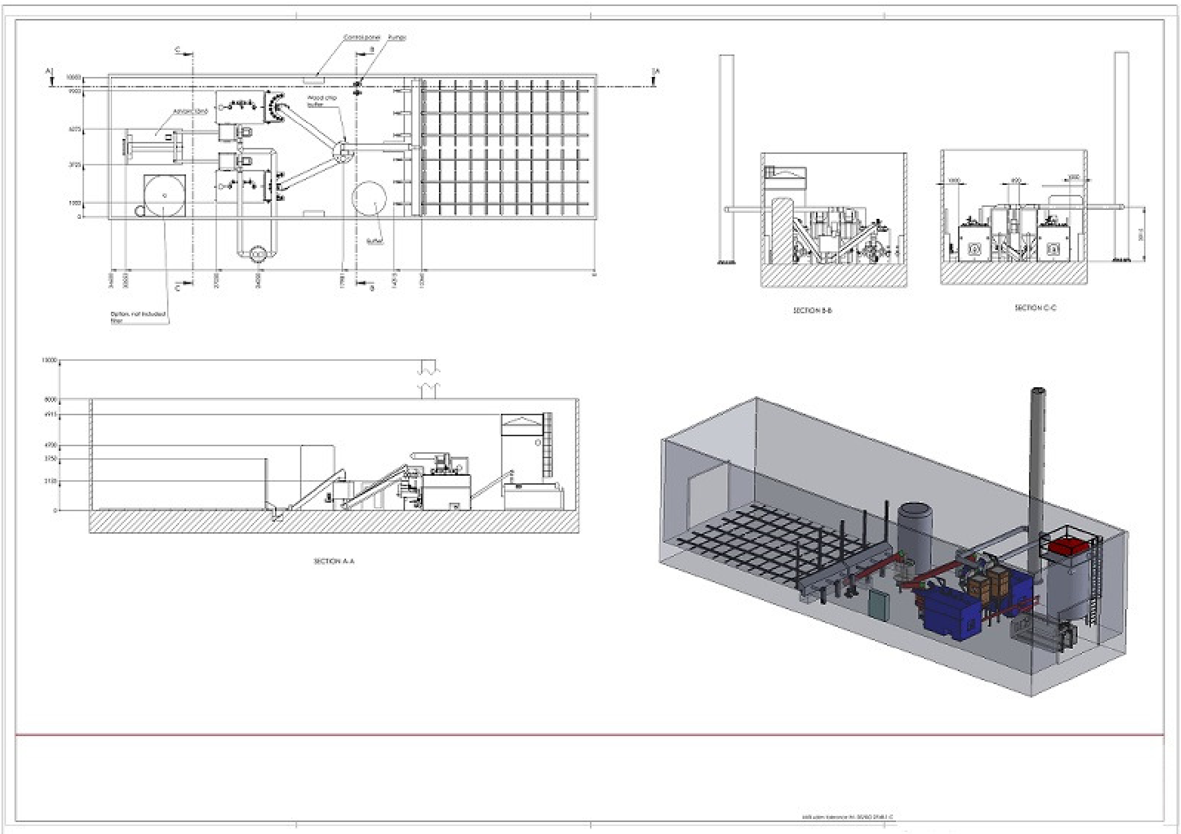

Table 5: Capital Costs of wood heating System (Chip)

Item	Cost (£)
2MW boiler system	775,000
Flue	10,000
New Boiler room	110,000
Fuel store	40,000
Heat Pipework, inc. excavation	963,000
Electricals	60,000
Consultants/planning	200,000
Heat meters	90,000
Prelims, general, Connecting up to water and 3-Phase	500,000
Total	**2,748,000**

6.2.4 Savings

The main savings for the village are the potential fuel savings in switching from heating oil to wood chip. For our central case this is a saving of around 1p/kWh – a significant margin.

6.3 Key assumptions for 2MW twin central case modelling

The following were used as inputs to our modelling and sensitivity testing. A print-out of our central case analysis is shown Appendix 1.

Relative Fuel Costs

- Wood chip: £100/tonne or 2.9p/kWh
- Heating Oil: 60p/litre or 5.8p/kWh

Boiler System Capital Costs and outputs

- Current annual primary heat load 5,830,000
- Proposed Modern wood heating Boiler size 2MW th
- Total Capital expenditure for twin boiler system £2,748,000 for twin woodchip system
- % of heat load supported by modern wood heating 100%
- Modern wood heating annual primary heat load 5,830,000 kwh
- Efficiency of modern wood heating & oil boilers 94%
- Additional heat loss from insulated heat Pipe network 15%

7 Energy Service Company (ESCO) approach

In this instance the risks of financing, installing and operating the boiler system go to another company. Under these type of contracts, the ESCO company charges an all-in heat tariff to the village which includes the costs of financing, operation and maintenance, and profit margins.

There is a good incentive for the efficient operation of the boiler system under this approach as the ESCO company does not get paid unless the boiler system operates efficiently. This approach clearly offsets the need to raise capital and manage the system.

There are benefits to this approach:

- No outlay costs
- Fully maintained system for the duration of the ESCO scheme
- Monitored system for the duration of the scheme
- Fuel cost savings per household
- Fuel ordering for system taken care of

8. Conclusions and Recommendations

In this feasibility study we have reviewed modern wood heating options for Rampton Village. The wood heating system recommended are wood chip.

8.1 Conclusions

The objective of the Feasibility Study was to answer the questions below. We have responded in turn to each:

- Q1 Is a modern wood heating system, to service the space heating and DHW demand of the main buildings on site, technically viable, via a twin modern wood heating boiler and a new connecting district heating network?
    - **A1 - yes**
- Q2 If so, what is the optimum combination and sizing of boiler(s) and accumulator tank, using criteria of financial payback, technical efficiency and maximising carbon savings?
    - **A2 – 2MW twin wood chip boilers (e.g. 2 x 1MW boilers) plus 35,000 accumulator tank. We also tested boiler options rated a**
- Q3 What are the outline costs, cashflow and payback periods for a project registered under the Renewable Heat Incentive (RHI) cashback scheme?
    - **A3 – in the central case there is an IRR of 10%, a payback of 10 years, an NPV of just over £2.3 million, a fuel saving benefit of £1.166 million over 20 years. Moving to wood fuel would reduce fuel costs by up to 20%.**
- Q4 What are the main business models for a wood heating scheme at Rampton?
    - **A4 –Options are an ESCO model**

- Q5 Are there secure and cost-effective sources of wood chip fuel within the local area (within 30-50 miles radius)?
    - **A5 – yes, between 1700 tonnes and up to around 1800 tonnes a year at an assumed cost of £100/tonne.**
- Q6 Are there secure and cost-effective sources of wood pellet fuel within the regional-national area (within 100-250 miles radius)?
    - **A6 – yes. Several suppliers with an average cost of less than £200/tonne.**

8.2 Summary of Results

- Our summary equates to the feasibility of the project as a non-viable project to ESCO providers as the ROI is too low and in turn has too much risk associated for the returns available

8.3 Summary of ESCO/Investor

- Un-viable project due to high risk and low ROI

9. Woodbeck conclusions

After researching the possibility of adding Woodbeck village to this scheme the ESCO providers have noted that the scheme would not be able to proceed any further due to the large added cost of doing so. The mere distance from the proposed boiler site at Rampton prohibits this from being an investable option as the ROI becomes less than 6%.

The extreme extra costs (noted below) far out way the additional 140 properties heat sale and RHI payments that would be added to the scheme.

Extra equipment listed to add Woodbeck

- An added 1MW in heat would be needed minimum
- 1.7 km of underground pipe just to get from Rampton to Woodbeck
- Civils for the above (1.7km)
- Planning concerns, especially road closures between the villages.
- Uplift in cost of underground pipe because of distance

The financial expenditure for adding Woodbeck does not calculate to a viable opportunity for an ESCO provider.

Conclusion

To conclude on Woodbeck village, we can see only one way of a similar scheme being viable and that is for Woodbeck to have its own separate ESCO scheme with the central boiler plant located in or in close proximity to the village. This would decrease the capital expenditure dramatically and make this a possibility.