St Mary's Church - Portsea

Assessment of Energy Savings Opportunities

EMphasis3 CO_2 Reductions
2,000 tonne reduction in CO_2 emissions

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ENERGY ENVIRONMENT TRAINING

Contents

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This service is provided as part of the "EMphasis3 CO2 Reductions" project which is partially funded by the 'European Regional Development Fund'.

EMphasis3 CO_2 Reductions
2,000 tonne reduction in CO_2 emissions

1 Executive Summary

Opportunities for reducing energy use have been investigated at St Mary's Church as part of a wider Building Energy Audit program through the EMphasis3 project. The following table summarises the opportunities identified during the site energy audit.

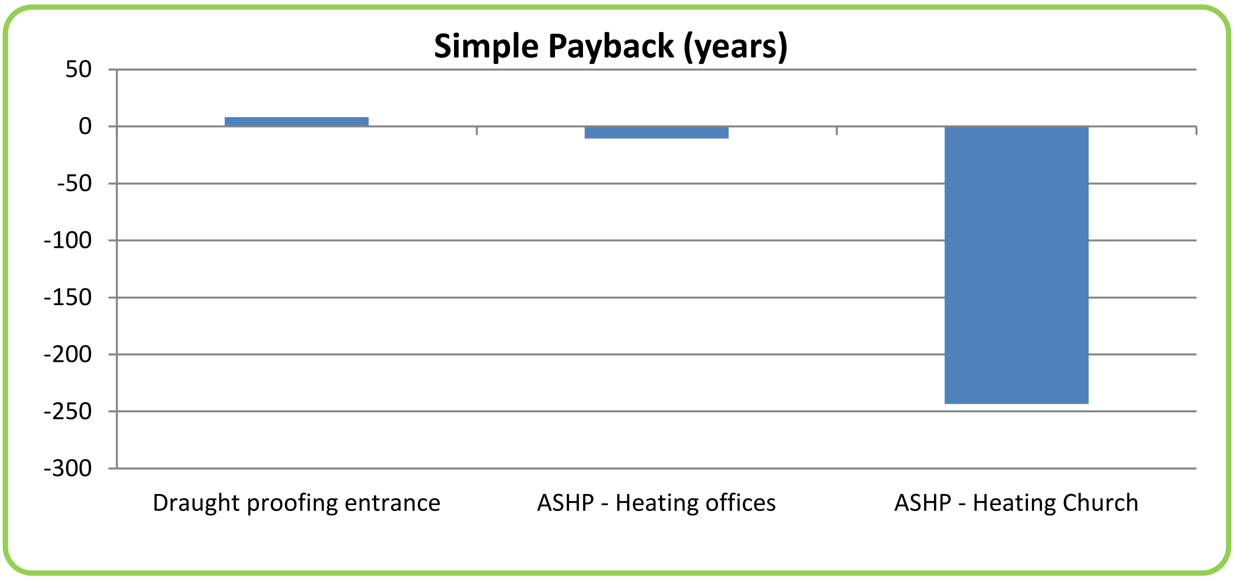
Project Name	Utility Saved	Annual Consumption saving (kWh)	Annual Total £ saving[1]	Annual tCO_2e saving	Capital Expenditure £	Simple Payback (years)	Lifetime tCO_2e savings	£capex per lifetime tCO_2e savings
Draught proofing entrance	Kerosene	1,148	84	0.3	700	8.3	8.3	84.5
ASHP - Heating offices	Natural Gas	32,099	-2,430	4.8	25,340	-10.4	51.5	492.0
ASHP - Heating Church	Kerosene	10,932	-1,046	2.7	254,800	-243.6	28.8	8838.6
Total ('Core' projects only)		**44,179**	**-3,391**	**7.7**	**280,840**	**-82.8**	**88.6**	**3,169.2**

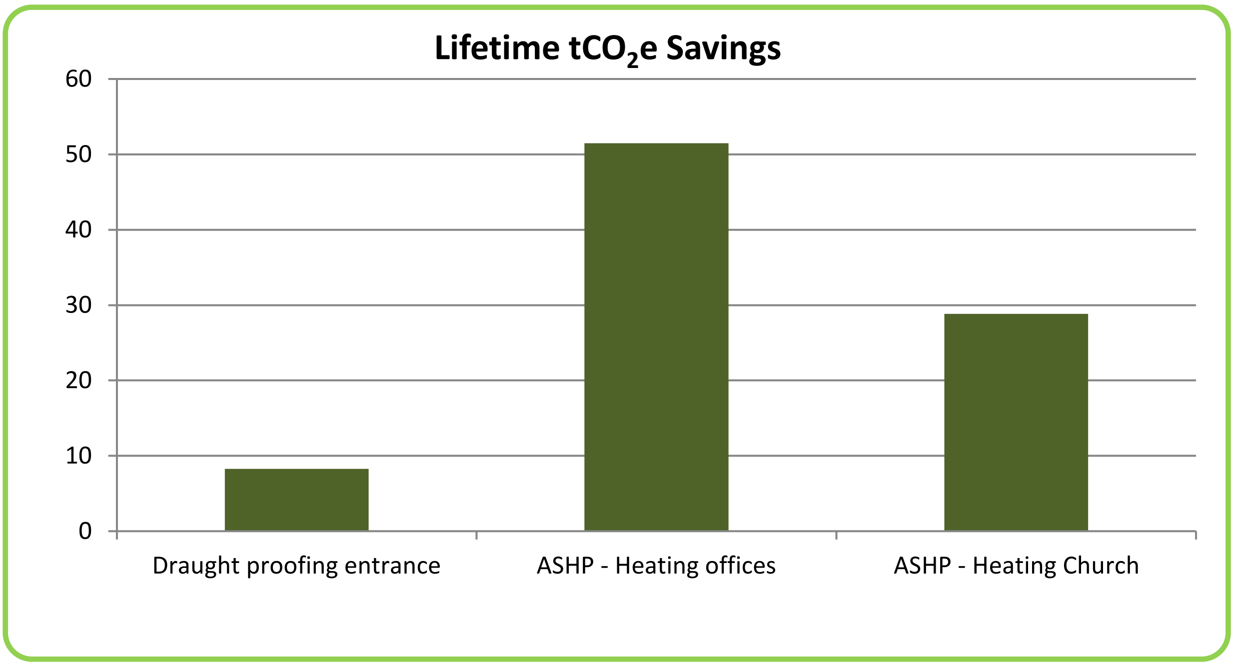
Note that the total Capital Expenditure may be reduced through an application to The EMphasis3 project which looks to part-fund SME energy efficiency projects through its grant scheme, up to an intervention rate of 36%.

The table below summarises the estimated CO_2e emissions before and after the implementation of the above projects:

Current Annual tCO2e	19.9
Estimated Annual tCO2e Savings	7.7
Estimated Future Annual tCO2e	12.2

Simple payback and Lifetime tonnes CO_2e savings for each project are represented in the following graphs:




Lifetime tCO_2e Savings
60
50
40
30
20
10
0
Draught proofing entrance
ASHP - Heating offices
ASHP - Heating Church

2 Project Details

Consultant Name:	Isabel Romero
Email address:	IsabelR@gepenv.co.uk
Site Address:	Fratton Rd, Fratton, Portsmouth PO1 5PA
Site Visit Date:	9th November 2021

2.1 Site Description

St Mary's Church is the oldest church in the area. It is a category II Listed Building built between 1887 and 1889. The church is primarily built externally with flint and Bath stone (non-insulated). It has pitched, tiled roof and all the windows are single glazed. It features a west tower, an aisled nave of six bays, north and south porches, chancel, and lady chapel. The church uses 3 different accesses. All of them have draught issues, which are addressed in this report.

The heating in the church is provided by different systems. The main area is heated by 2 very old red diesel boilers of around 120kW each (Riello B10 40). The heat is distributed via water pipes that run underneath the Nave's floor. These boilers are only used during services (a couple of times per week). Each of the boilers have a programmer in the office where they are be switch on and off manually. No further paperwork was available detailing the boiler systems.

The offices and the community room heating are served by a gas boiler of 10-15kW (Potterton) and distributed via traditional radiators with TRV valves and double panel and a Temca Kestrel 55 gas heater.

The Domestic Hot Water is provided via localised electric water heaters (PoU) of around 3kW each (in toilets and kitchen).
All the lighting has been upgraded to LED.

For the recommendations in this report the following factors have been used:

Electricity Cost #	17.72 p/kWh
Electricity Carbon Factor*	0.25319 kgCO_2e/kWh
Gas Cost #	4 p/kWh
Natural Gas Carbon Factor*	0.18387 kgCO_2e/kWh
Kerosene Cost #	7.36 p/kWh
Kerosene Factor*	0.24666 kgCO_2e/kWh

*Based on 2020 DBEIS carbon factors.
Based on latest available bill.

For the avoidance of doubt, energy prices include CCL where appropriate but exclude delivery charges, VAT and other fixed elements.

3 Energy Audit Methodology

Electricity consumption data has been sourced for the 12-month period from August 2020 to July 2021 based upon quarterly energy data provided by the client. The Gas consumption data is sourced from quarterly bills provided by the client. However, there is missing data and consumption from previous quarters have been used. Annual Kerosene consumption has been calculated based on the approximate volume delivery and the cost per litre provided by the client.

4 Analysis of Current Energy Consumption

The energy consumption at St Mary's Church was for the 12-month period between August 2020 to July 2021 is summarised below:

	Electricity (kWh)	Natural Gas (kWh)	Kerosene (kWh)
TOTAL	27,307	48,635	16,221

5 Action Plan

The following table provides a summary of the measures identified. A detailed analysis of each measure is shown in section 6.

Project Name	Utility Saved	Annual Consumption saving (kWh)	Annual Total £ saving[1]	Annual tCO_2e saving	Capital Expenditure £	Simple Payback (years)	Lifetime tCO_2e savings	£capex per lifetime tCO_2e savings
Draught proofing entrance	Kerosene	1,148	84	0.3	700	8.3	8.3	84.5
ASHP - Heating offices	Natural Gas	32,099	-2,430	4.8	25,340	-10.4	51.5	492.0
ASHP - Heating Church	Kerosene	10,932	-1,046	2.7	254,800	-243.6	28.8	8838.6
Total ('Core' projects only)		**44,179**	**-3,391**	**7.7**	**280,840**	**-82.8**	**88.6**	**3,169.2**

[1]The total cost saving includes all cost savings (energy, renewable income) and is adjusted for any additional annual costs (e.g. maintenance, staff costs).

Note that the total Capital Expenditure may be reduced through an application to The EMphasis3 project which looks to part-fund SME energy efficiency projects through its grant scheme, up to an intervention rate of 36%.

6 Detailed Recommendations

Recommendation 1:

Description	Draught proofing entrance	
Technology Type	Insulation - Draught proofing	
Project Description	The main entrance has an internal glass door as shown in the picture below. New seals and draught strip can be fitted to reduce the cold air infiltration in winter months.  Implementing new door seals will reduce the fuel consumed to heat the spaces and portable electric heaters will be less likely to be required during colder periods. Additionally, by working on the inner's doors the external protected building fabric is not required to be changed.	
Costs	Capital Costs:	£700
	Additional Annual Operating Costs:	£0
Annual Savings	Utility saved	Kerosene
	Consumption Saving	1,148
	Units	kWh
	Running Costs:	£84
	Greenhouse Gas (GHG) Emissions (tonnes CO_2 equivalent)	0.3
	Other Cost savings:	£0
	Potential RHI/ FiT Income:	£0
	Total £ Savings:	£84
	Simple Payback (years)	8.28
Lifetime Emissions savings	Lifetime GHG emission savings (tCO_2e)	8.3

Calculations and assumptions Refer to Appendix 1 of this report for savings calculations. Pricing is aligned to domestic doors; commercial or safety aspects that are required will increase costs. Expected that due to the bespoke nature of the clear glass doors there may be a compromised required or for specialist equipment to be procured. Approximate dimensions were taken for doors to allow for estimation and financial modelling. Quoting suppliers should take their own measurements to ensure the correct size for the install work.
Risks and Issues: Working at height from ladders/platforms will be invasive and put staff and site visitors at risk - it is likely that when work is in progress then it will affect the usability of the affected spaces. Full RAMS will be required when quotations are submitted.
Implementation of Energy Saving Opportunities: Invite suppliers to quote for supply and fit with accompanying RAMS. Schedule the installation with the agreement of the site users. Monitor for and make any changes to the heating system as the need for heat should change.

Recommendation 2:		
Description	ASHP for offices	
Technology Type	Heating - Heat Pump (Air source)	
Project Description	The site can take advantage of renewable Air-Source Heating to reduce carbon emissions. Such systems produce up-to 3 units of heat for each unit of electricity consumed. Air Source Heat Pump (ASHP) systems with thermal buffer tanks can provide the heat needed in the offices and community hall. New Low Temperature radiators would be required to replace the existing ones (i.e. increased surface area and/or fan assisted). This will allow the ASHP to maximise its operational efficiency.	
Costs	Capital Costs:	£25,340
	Additional Annual Operating Costs:	£500
Annual Savings	Utility saved	Natural Gas
	Consumption Saving	32,099
	Units	kWh
	Running Costs:	-£1,930
	Greenhouse Gas (GHG) Emissions (tonnes CO_2 equivalent)	4.8
	Other Cost savings:	£0
	Potential RHI/ FiT Income:	£0
	Total £ Savings:	-£2,430
	Simple Payback (years)	-10.43
Lifetime Emissions Savings	Lifetime GHG emission savings (tCO_2e)	51.5

Calculations and assumptions

Refer to Appendix 1 of this report for savings calculations.
The driver for this project is the Carbon Saving rather than pure financial saving.
The model has 100% of heat being provided by the ASHP systems; detailed scoping and sizing will more closely determine what is possible and the costs entailed.
A COP of 2.5 has been assumed for the calculations.
It is assumed that existing radiators will be replaced by Low Temperature radiators with large surface.
Financial calculations have assumed that all electricity used by the ASHP has been sourced from the National Grid.
Service costs are assumed to be £500 per annum. This discounts the annual cost saving of gas boiler service.

Risks and Issues:

The sizing of the ASHP systems is critical if correct operating regimes are to be achieved. A more granular analysis of the site's heating profile should be undertaken as a feed into both the physical and financial modelling of the ASHP systems.
The site is considered secure and the external elements of the ASHPs are not seen to be at risk from vandalism.
Obtain contractor work schedule including at least a generic RAMS which includes methods for internal and external work.

Implementation of Energy Saving Opportunities:

Capture heat demand data for the site at an hourly or half-hourly resolution.

Build a heat profile for the site and extend this to 12 months.

Model ASHP performance against the heat profile to determine the optimal install specification.
Conduct a procurement exercise based upon the developed ASHP System Specification and bill of materials.

Select the most suitable quotation and schedule the installation.

Recommendation 3:		
Description	Install High Temperature Air Source Heat Pump	
Technology Type	Heating - Heat Pump (Air source)	
Project Description	The site can take advantage of renewable Air-Source Heating to reduce carbon emissions. Such systems produce up-to 2.3 units of heat for each unit of electricity consumed. A two-stage High-Temperature Air Source Heat Pump (ASHP) will significantly reduce the consumption of gas at the site and has been modelled using a seasonal COP of up to 230%. An air to water heat pump will capture renewable heat from within the ambient air from external thermal collectors in the back garden. This raises the temperature of water in the intermediate thermal store to 35°C and the second stage water-to-water heat pump will raise the temperature in the final thermal store to up to 70°C. The existing heating distribution system and heat emitters which are bespoke and integral to floor will therefore be able to be retained. The system will incorporate automatic controls to optimise such that reasonably high Heat Pump Coefficient of Performance (COP) values are maintained.	
Costs	Capital Costs:	£254,800
	Additional Annual Operating Costs:	£1,000
Annual Savings	Utility saved	Kerosene
	Consumption Saving	10,932
	Units	kWh
	Running Costs:	-£46
	Greenhouse Gas (GHG) Emissions (tonnes CO_2 equivalent)	2.7
	Other Cost savings:	£0
	Potential RHI/ FiT Income:	£0
	Total £ Savings:	-£1,046
	Simple Payback (years)	-243.56
Lifetime Emissions Savings	Lifetime GHG emission savings (tCO_2e)	28.8

Calculations and assumptions

Refer to Appendix 1 of this report for savings calculations.
The driver for this project is the Carbon Saving rather than pure financial saving.
The model has 100% of the total annual heat being provided by the ASHP systems; detailed scoping and sizing will more closely determine what is possible and the costs entailed.
It is assumed that existing heat emitters will be retained, and a High Temperature Heat Pump System be installed.
Financial calculations have assumed that all electricity used by the ASHP has been sourced from the National Grid.
Service costs are assumed to be £1000 per annum discounting the avoided cost of oil boiler service.
It is assumed that there is enough space for all the equipment required for the new system.

Risks and Issues: The sizing of the ASHP systems is critical if correct operating regimes are to be achieved. A more granular analysis of the site's heating profile should be undertaken as a feed into both the physical and financial modelling of the ASHP systems. The site is considered secure and the external elements of the ASHPs are not seen to be at risk from vandalism. The building existing electrical supply capacity was unable to be assessed from the information provided. A request to the electricity DNO should be made before commencing design work to establish if an additional ~60KVA capacity to operate the heat pump is available and if not what the upgrades costs would be. Obtain contractor work schedule including at least a generic RAMS which includes methods for internal and external work.
Implementation of Energy Saving Opportunities: Capture heat demand data for the site at an hourly or half-hourly resolution. Build a heat profile for the site and extend this to 12 months. Model ASHP performance against the heat profile to determine the optimal install specification. Conduct a procurement exercise based upon the developed ASHP System Specification and bill of materials. Select the most suitable quotation and schedule the installation.

7 About GEP Environmental

Our Service Offering

GEP Environmental are leading providers of environmental and energy consultancy services to clients across the United Kingdom & Ireland. We support organisations to identify, implement and maintain environmental, energy and training solutions. Our highly qualified project teams consist of environmental consultants, energy engineers and trainers with expertise in carbon management, ISO management systems, sustainable resource and waste management, energy efficiency, building surveying, low carbon building design and renewables.

Further information is available from http://www.gepenv.co.uk/

Our Technical Capabilities

We pride ourselves on our ability to deliver practical long-term solutions that create financial benefits and add value to our clients' services, buildings, portfolios and credentials. Our technical capabilities include:

- ISO 14001 Environmental Management Systems, ISO 50001 Energy Management Systems and ISO 9001 Quality Management Systems;
- Legislation & Compliance Services (Energy, Waste, Pollution Control, Buildings Operations, Permitting);
- Sustainability Reporting (FTSE4Good, CDP, GRESB, EPRA, CRC, ESOS, SECR);
- Waste Management Auditing and Compliance Support;
- IEMA Certified Training (IEMA Approved and IEMA Certified Training Courses);
- Feasibility Studies and Energy Efficiency Auditing;
- Implementation support including design, specification, evaluation and project management;
- Measurement and Verification (M&V);
- Programme Management and Technical Advisory.

Our teams maintain membership with professional bodies including the Institute of Environmental Management and Assessment (IEMA), the Institute of Environmental Sciences (IES) and the Energy Institute (EI).

Our Certifications

We are committed to service excellence and developing first class client relationships. Our quality and environmental standards are underpinned by our ISO 9001:2015 (QMS) and ISO 14001:2015 (EMS) certification.


SOCOTEC

CERTIFICATE

N° SCUK004138Q

GEP Environmental Ltd

ISO 9001 : 2015

for the scope of activities:

Consultancy in Environmental Management, Energy and Energy Efficiency, Management Systems: Provision of Expert Advice and Project Delivery in Support of Environmental Initiatives and Energy Projects: Training in Support of the above.


SOCOTEC

CERTIFICATE

N° SCUK003390E

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ISO 14001 : 2015

for the scope of activities:

Consultancy in Environmental Management, Energy and Energy Efficiency, Management Systems: Provision of Expert Advice and Project Delivery in Support of Environmental Initiatives and Energy Projects: Training in Support of the above.

8 About "EMphasis3 CO_2 Reductions" Project

EMphasis3 CO_2 Reductions (known as EMphasis3) is a European Regional Development Fund (ERDF) funded SME support project, led by the University of Portsmouth and delivered through the cleantech cluster Greentech South (GTS) based at the University of Portsmouth, in partnership with the University of Winchester.

EMphasis3 CO_2 Reductions aims to support the shift towards a low carbon economy in the Enterprise M3 (EM3) region and beyond, by promoting energy efficiency and renewable energy use in SMEs and promoting research and innovation in, and adoption of, low carbon technologies.

EMphasis3 will enable SMEs to reduce CO_2 emissions by using four funded interventions:

- Energy Efficiency Audits
- Energy Efficiency Grants (EEG) to part-fund energy saving/efficiency equipment or implement the recommendations of the audit
- Innovation Audits
- Innovation (Research and Development) Grants to enable SMEs to take low carbon innovations closer to commercialisation

The EMphasis3 project will run from 1st July 2019 - 30th June 2022 and will part-fund SME energy efficiency projects through its grant scheme, up to an intervention rate of 36%.

UNIVERSITY OF PORTSMOUTH
GREENTECH SOUTH THE TECHNOLOGY AND INNOVATION CLUSTER
UNIVERSITY OF WINCHESTER
European Union European Regional Development Fund

EMphasis3 CO_2 Reductions
2,000 tonne reduction in CO_2 emissions

Appendix 1 – Savings Calculations

Recommendation 1:

Description	Technology Type	Capital Cost	Additional Annual Operating Costs	Other Costs (e.g. staff)	Utility Saved	Consumption Saving	Units	£ Saving	tCO2e Saving	Other Cost Savings	Potential RHI/ FiT Income	Simple Payback
Draught proofing entrance	Insulation - Draught proofing	700			Kerosene	1,148	kWh	84.49	0.28			8.28
						7%						

Temperature Differential	12	° C
Heating system efficiency	75%	

Type		Height (m)	Width (m)	Number of doors	Area m²	Old U-Value (W/m²K)	New U-Value (W/m²K)	Saving kW	Cost	Hours	Saving kWh
1	Glass door entrance	5	2	1	10.00	4	2.6	0.168	300	2,500	560
2	Side doors	3.5	1.5	2	10.50	4	2.6	0.176	400	2,500	588
			Total	3	20.50			0.344	700		1,148

Recommendation 2:

Boiler fuel replacement

Description	Technology Type	Capital Cost	Additional Annual Operating Costs	Other Costs (e.g. staff)	Utility Saved	Consumption Saving	Units	£ Saving	tCO2e Saving	Other Cost Savings	Potential RHI/ FiT Income	Simple Payback
ASHP - Heating offices	Heating - Fossil Fuel to Heat Pump (Air source)	£25,340	£500		Natural Gas	32,099	kWh	-£1,930	4.76		£0	-10.43

Existing boiler efficiency	85%	
Heat Requirement	41,340	kWh
Present Fuel Usage	48,635	kWh
% replaced by new ASHP	100%	
New ASHP Capacity	15	kW
Heat generated by new ASHP	41,340	kWh
New ASHP efficiency	250%	
New electricity requirement	16,536	kWh
New electricity cost	£3,877	
New electricity emissions	4,187	kgCO2e
Residual boiler fuel usage	0	kWh
Residual boiler fuel cost	£0	
Residual boiler emissions	0	kgCO2e
Present fuel cost	£1,947	
Present fuel emissions	8,943	kgCO2e
Emissions Saving	4,756	kgCO2e
RHI annual income		

Existing Gas boiler:
Potterton (around 10kW)
Radiators double panel with TRV
Temca Kestrel 55 gas heaters

New System:		Unit Cost	Total
ASHP (kW)	15	£1,000	£15,000
LT Radiators	6	£350	£2,100
Thermal Tank	1	£1,000	£1,000
Installation		40%	£7,240
			£25,340

Recommendation 3:

Boiler fuel replacement

Description	Technology Type	Capital Cost	Additional Annual Operating Costs	Other Costs (e.g. staff)	Utility Saved	Consumption Saving	Units	£ Saving	tCO2e Saving	Other Cost Savings	Potential RHI/ FiT Income	Simple Payback
ASHP - Heating Church	Heating - Fossil Fuel to Heat Pump (Air source)	£254,800	£1,000		Kerosene	10,932	kWh	-£46	2.66		£0	-243.56

Existing boiler efficiency	75%	
Heat Requirement	12,166	kWh
Present Fuel Usage	16,221	kWh
% replaced by new ASHP	100%	
New ASHP Capacity	120	kW
Heat generated by new ASHP	12,166	kWh
New ASHP efficiency	230%	
New electricity requirement	5,290	kWh
New electricity cost	£1,240	
New electricity emissions	1,339	kgCO2e
Residual boiler fuel usage	0	kWh
Residual boiler fuel cost	£0	
Residual boiler emissions	0	kgCO2e
Present fuel cost	£1,194	
Present fuel emissions	4,001	kgCO2e
Emissions Saving	2,662	kgCO2e
RHI annual income		

Existing Gas boiler:

2 x Red Diesel boilers - 120 kW each (assumption)

Hot air ducts on the floor to heat up church space

Very old - 75% efficiency (approx)

Used only during service

One is not working

New System:		Unit Cost	Total
HT ASHP	120	£1,500	£180,000
Thermal Tank	2	£1,000	£2,000
Installation		40%	£72,800
			£254,800

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