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The Highland Council
Comhairle na Gàidhealtachd

EES:ABS 2023/24 – Case Study 3

Munlochy, Highland

Installation of Loft Insulation, Flat Roof Insulation, Air Source Heat Pump and Solar Photovoltaic Panels with Battery Storage

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1. Introduction

This report details efforts to improve the energy performance of a two-bedroom semi-detached bungalow in Munlochy, Ross and Cromarty, focusing on the flat roof, loft, and the installation of renewable technologies. The project aimed to demonstrate effective methods and materials for enhancing the building's thermal performance, increasing energy efficiency, and reducing costs for the homeowner. Highlighting the property's energy performance before and after the upgrades, as well as the resulting benefits for both the property and its occupants.

2. The Site

The property is a two-bedroom semi-detached bungalow built before 1919, situated in Munlochy, a village in Ross and Cromarty. Given its location, the property is exposed to harsh weather conditions, especially during the winter months, with frequent heavy rainfall and snow. The property consists of solid walls with a pitched slate roof. The loft contained 150mm of insulation, which was increased to 300mm as part of the energy efficiency measures. The house is heated by an oil-fired boiler, and the windows are PVC double-glazed, providing some existing insulation against heat loss.

3. Pre-Intervention Performance

Prior to the installation of the energy efficiency measures, the property had an Energy Performance Certificate (EPC) rating of E53, indicating low energy efficiency. The environmental impact rating stood at E45, highlighting the property's significant carbon emissions. These low scores underscored the need for substantial improvements to reduce energy consumption and improve the environmental footprint of the property. The full pre-installation EPC report can be reviewed in Appendix 1.

4. Implemented Improvements

To enhance the property's energy efficiency, a combination of solar power, a modern air source heat pump, and flat roof insulation was implemented. These improvements were selected to address both the specific energy needs of the property and the challenging climate in the area. By introducing a renewable energy source, upgrading the heating system, and improving insulation, the project aimed to deliver a comprehensive energy-saving solution. The following interventions were carried out to optimise the property's thermal performance.

4.1 Solar

The goal of installing the solar photovoltaic (PV) array was to reduce the overall energy consumption of the property. With heating, lighting, and cooking comprising the bulk of energy usage in most homes, solar panels offer a clean, renewable energy source to help meet these demands. The typical family home consumes around 3,500 kWh of electricity annually. Energy trend of the property since install can be seen in figure 1 below, this highlights the systems production and consumption.

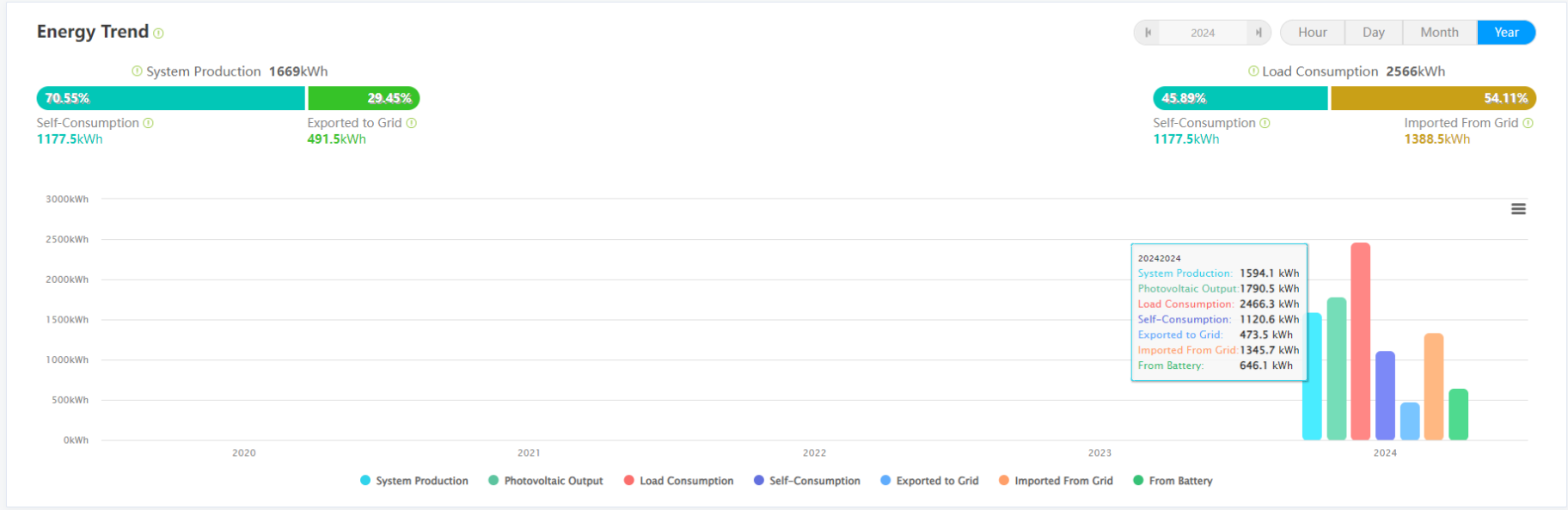


Figure 1 – Energy Trend

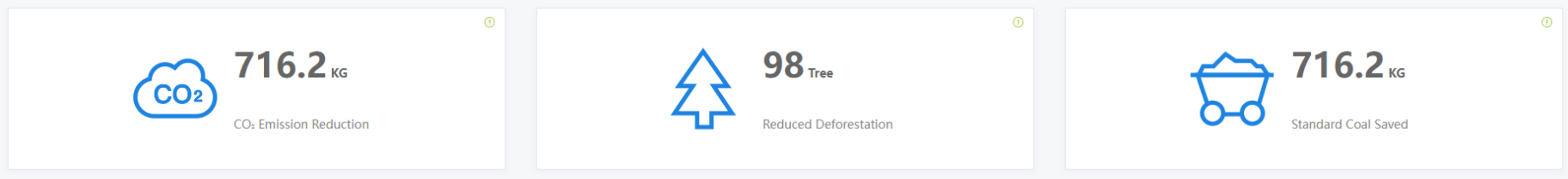


Figure 2 – Social Contributions

A solar PV system comprising an 8-panel array, hybrid inverter, and battery storage was planned and installed. This system is expected to generate approximately 2,000 kWh of energy annually. Any surplus energy generated during the day is stored in the battery for later use, which helps to reduce dependency on grid electricity,

especially during peak hours. Immediate reductions in the customer's energy bill are anticipated following the installation with considerable social contributions illustrated in figure 2. Most solar PV installations can be completed within a day, although more complex installations may take longer.

Figure 3 – Solar PV on property

4.2 Air Source Heat Pump

To modernise the heating system and reduce the property's reliance on oil-based heating, a Grant Aerona HPID10R32 Air Source Heat Pump (ASHP) was installed as seen in figure 4, along with a 201L Pre-Plumbed Hot Water Cylinder. The ASHP cited in the rear garden of the property, and the system provides consistent heating through new radiators and pipework. A programmable thermostat was installed to allow the homeowner to control the heating schedule, ensuring it only operates, when necessary, further reducing running costs.

All areas of the property were insulated to the highest standard before the heat pump installation to prevent heat from escaping. Detailed heat loss calculations were carried out for each room to size the radiators appropriately, ensuring that each room can achieve the desired temperature while minimising energy wastage.

Figure 4 – Air Source Heat Pump

4.3 Flat Roof Insulation

The flat roof insulation system comprised a 50mm PIR thermal board bonded to a 12.5mm plasterboard (63mm total thickness). This insulation board was mechanically fixed through the existing plasterboard into the timber beams above, preventing heat from escaping through the roof. Upon completion of the installation, all joints and edges were taped, filled, and sanded to create a seamless finish. The entire surface was then coated with two layers of paint for a clean and polished final appearance.

Figure 5 – Before and after install of IWI prior to taping and painting

4.4 Loft Insulation

To further enhance the thermal efficiency of the property, we upgraded the loft insulation from 150mm to 300mm, meeting current building standards. Loft insulation is one of the most cost-effective energy efficiency measures available, as a poorly insulated loft can account for up to 25% of a home's heat loss. By increasing the depth of insulation, we aimed to reduce this heat loss, ensuring that the property retains heat more effectively, especially during the colder months.

The insulation material used was mineral wool, which is both durable and environmentally friendly. Mineral wool insulation has excellent thermal properties, providing a high level of heat retention, and its fibrous structure helps to prevent air movement through the material, further improving the thermal performance of the loft space.

The additional insulation not only improves the energy efficiency of the property but also contributes to the overall comfort by creating a more consistent indoor temperature. As a result of

the upgrade, the homeowner can expect reduced heating bills, a lower carbon footprint, and a more comfortable living environment throughout the year.

5. Post-intervention Performance

Following the implementation of these energy efficiency measures, the property's energy performance improved dramatically. The Energy Performance Certificate (EPC) rating increased from E53 to an impressive B91, indicating a highly efficient energy system. The environmental impact rating also rose significantly, from E45 to A92, reflecting the property's substantially lower carbon emissions. These improvements not only make the home more comfortable and cost-effective to run but also significantly reduce its environmental footprint. The full post-installation EPC report can be found in Appendix 2.

6. Conclusion

The energy efficiency measures installed at the home in Munlochy provide a clear demonstration of how a combination of renewable energy, modern heating systems, and improved insulation can dramatically enhance the thermal and energy performance of a property. By integrating solar panels, an air source heat pump, and high-quality roof insulation, the project highlights the benefits of a comprehensive approach to energy savings, offering immediate cost reductions and long-term environmental benefits.

Appendix 1 – Pre Energy Performance Certificate Extract

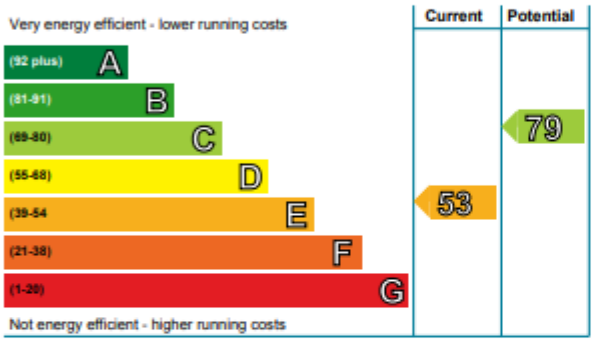
Dwelling type:	Semi-detached bungalow	**Reference number:**	[redacted]
Date of assessment:	30 January 2024	**Type of assessment:**	RdSAP, existing dwelling
Date of certificate:	30 January 2024	**Approved Organisation:**	Elmhurst
Total floor area:	74 m²	**Main heating and fuel:**	Boiler and radiators, oil
Primary Energy Indicator:	299 kWh/m²/year		

You can use this document to:

- **Compare current ratings of properties to see which are more energy efficient and environmentally friendly**
- **Find out how to save energy and money and also reduce CO_2 emissions by improving your home**

Estimated energy costs for your home for 3 years*	**£4,350**	See your recommendations report for more information
Over 3 years you could save*	**£1,299**	

* based upon the cost of energy for heating, hot water, lighting and ventilation, calculated using standard assumptions

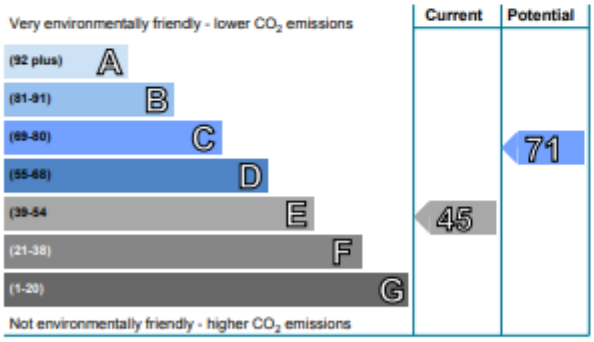


Energy Efficiency Rating

This graph shows the current efficiency of your home, taking into account both energy efficiency and fuel costs. The higher this rating, the lower your fuel bills are likely to be.

Your current rating is **band E (53)**. The average rating for EPCs in Scotland is **band D (61).**

The potential rating shows the effect of undertaking all of the improvement measures listed within your recommendations report.



Environmental Impact (CO_2) Rating

This graph shows the effect of your home on the environment in terms of carbon dioxide (CO_2) emissions. The higher the rating, the less impact it has on the environment.

Your current rating is **band E (45)**. The average rating for EPCs in Scotland is **band D (59).**

The potential rating shows the effect of undertaking all of the improvement measures listed within your recommendations report.

Top actions you can take to save money and make your home more efficient

Recommended measures	Indicative cost	Typical savings over 3 years
1 Flat roof or sloping ceiling insulation	£850 - £1,500	£162.00
2 Floor insulation (suspended floor)	£800 - £1,200	£447.00
3 Add additional 80 mm jacket to hot water cylinder	£15 - £30	£144.00

Summary of the energy performance related features of this home

This table sets out the results of the survey which lists the current energy-related features of this home. Each element is assessed by the national calculation methodology; 1 star = very poor (least efficient), 2 stars = poor, 3 stars = average, 4 stars = good and 5 stars = very good (most efficient). The assessment does not take into consideration the condition of an element and how well it is working. 'Assumed' means that the insulation could not be inspected and an assumption has been made in the methodology, based on age and type of construction.

Element	Description	Energy Efficiency	Environmental
Walls	Granite or whinstone, with internal insulation Timber frame, as built, insulated (assumed)	★★★★☆ ★★★★☆	★★★★☆ ★★★★☆
Roof	Pitched, 150 mm loft insulation Flat, limited insulation (assumed)	★★★★☆ ★★☆☆☆	★★★★☆ ★★☆☆☆
Floor	Suspended, no insulation (assumed)	—	—
Windows	Fully double glazed	★★★☆☆	★★★☆☆
Main heating	Boiler and radiators, oil	★★★☆☆	★★★☆☆
Main heating controls	Programmer, room thermostat and TRVs	★★★★☆	★★★★☆
Secondary heating	None	—	—
Hot water	From main system	★★★☆☆	★★★☆☆
Lighting	No low energy lighting	★☆☆☆☆	★☆☆☆☆

The energy efficiency rating of your home

Your Energy Efficiency Rating is calculated using the standard UK methodology, RdSAP. This calculates energy used for heating, hot water, lighting and ventilation and then applies fuel costs to that energy use to give an overall rating for your home. The rating is given on a scale of 1 to 100. Other than the cost of fuel for electrical appliances and for cooking, a building with a rating of 100 would cost almost nothing to run.

As we all use our homes in different ways, the energy rating is calculated using standard occupancy assumptions which may be different from the way you use it. The rating also uses national weather information to allow comparison between buildings in different parts of Scotland. However, to make information more relevant to your home, local weather data is used to calculate your energy use, CO_2 emissions, running costs and the savings possible from making improvements.

The impact of your home on the environment

One of the biggest contributors to global warming is carbon dioxide. The energy we use for heating, lighting and power in our homes produces over a quarter of the UK's carbon dioxide emissions. Different fuels produce different amounts of carbon dioxide for every kilowatt hour (kWh) of energy used. The Environmental Impact Rating of your home is calculated by applying these 'carbon factors' for the fuels you use to your overall energy use.

The calculated emissions for your home are 77 kg $CO_2/m^2/yr$.

The average Scottish household produces about 6 tonnes of carbon dioxide every year. Based on this assessment, heating and lighting this home currently produces approximately 5.7 tonnes of carbon dioxide every year. Adopting recommendations in this report can reduce emissions and protect the environment. If you were to install all of these recommendations this could reduce emissions by 2.5 tonnes per year. You could reduce emissions even more by switching to renewable energy sources.

Appendix 2 – Post Energy Performance Certificate Extract

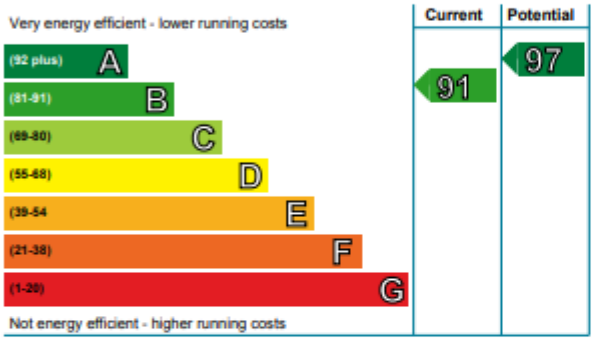
Dwelling type:	Semi-detached bungalow	**Reference number:**	[redacted]
Date of assessment:	26 June 2024	**Type of assessment:**	RdSAP, existing dwelling
Date of certificate:	27 June 2024	**Approved Organisation:**	Elmhurst
Total floor area:	74 m²	**Main heating and fuel:**	Air source heat pump, radiators, electric
Primary Energy Indicator:	86 kWh/m²/year		

You can use this document to:

- **Compare current ratings of properties to see which are more energy efficient and environmentally friendly**
- **Find out how to save energy and money and also reduce CO_2 emissions by improving your home**

Estimated energy costs for your home for 3 years*	**£4,077**	See your recommendations report for more information
Over 3 years you could save*	**£882**	

* based upon the cost of energy for heating, hot water, lighting and ventilation, calculated using standard assumptions

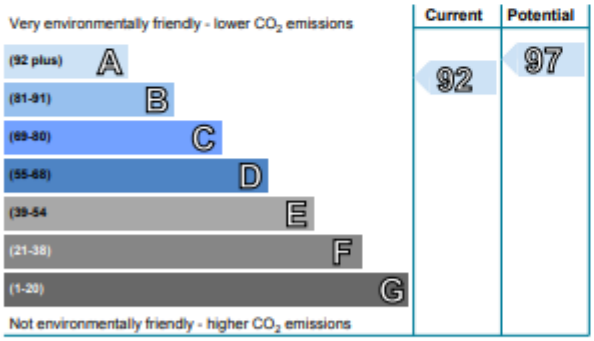


Energy Efficiency Rating

This graph shows the current efficiency of your home, taking into account both energy efficiency and fuel costs. The higher this rating, the lower your fuel bills are likely to be.

Your current rating is **band B (91)**. The average rating for EPCs in Scotland is **band D (61).**

The potential rating shows the effect of undertaking all of the improvement measures listed within your recommendations report.



Environmental Impact (CO_2) Rating

This graph shows the effect of your home on the environment in terms of carbon dioxide (CO_2) emissions. The higher the rating, the less impact it has on the environment.

Your current rating is **band A (92)**. The average rating for EPCs in Scotland is **band D (59).**

The potential rating shows the effect of undertaking all of the improvement measures listed within your recommendations report.

Top actions you can take to save money and make your home more efficient

Recommended measures	Indicative cost	Typical savings over 3 years
1 Floor insulation (suspended floor)	£800 - £1,200	£249.00
2 Low energy lighting	£40	£264.00
3 Solar water heating	£4,000 - £6,000	£372.00

Summary of the energy performance related features of this home

This table sets out the results of the survey which lists the current energy-related features of this home. Each element is assessed by the national calculation methodology; 1 star = very poor (least efficient), 2 stars = poor, 3 stars = average, 4 stars = good and 5 stars = very good (most efficient). The assessment does not take into consideration the condition of an element and how well it is working. 'Assumed' means that the insulation could not be inspected and an assumption has been made in the methodology, based on age and type of construction.

Element	Description	Energy Efficiency	Environmental
Walls	Granite or whinstone, with internal insulation Timber frame, as built, insulated (assumed)	★★★★☆ ★★★★☆	★★★★☆ ★★★★☆
Roof	Pitched, 300 mm loft insulation Flat, insulated	★★★★★ ★★★☆☆	★★★★★ ★★★☆☆
Floor	Suspended, no insulation (assumed)	—	—
Windows	Fully double glazed	★★★☆☆	★★★☆☆
Main heating	Air source heat pump, radiators, electric	★★★★★	★★★★★
Main heating controls	Programmer, TRVs and bypass	★★★☆☆	★★★☆☆
Secondary heating	None	—	—
Hot water	From main system	★★★☆☆	★★★★☆
Lighting	No low energy lighting	★☆☆☆☆	★☆☆☆☆

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The calculated emissions for your home are 15 kg $CO_2/m^2/yr$.

The average Scottish household produces about 6 tonnes of carbon dioxide every year. Based on this assessment, heating and lighting this home currently produces approximately 1.1 tonnes of carbon dioxide every year. Adopting recommendations in this report can reduce emissions and protect the environment. If you were to install all of these recommendations this could reduce emissions by 0.6 tonnes per year. You could reduce emissions even more by switching to renewable energy sources.