HARLEY
HADDOW

Tocher Knowe, West Linton

Energy Statement, Rev 00

February 2024

ENGINEERING POWERED BY THE PAST
BUILDING THE FUTURE

Document Revision Control

Revisions	Date	Reason for Issue	By	Approved
Rev00	09.02.24	For Planning	AZA	SG

Contents

Executive Summary

Harley Haddow has produced this Energy Statement for the proposed dwelling, at Tocher Knowe, West Linton which summarises the proposed route to compliance approach adopted for the project. The project consists of a two-storey detached house. The proposed parameters have been assessed using the SAP 10 software to demonstrate compliance with the current Building Regulations which came into force in February 2023 and the Scottish Borders local planning policies.

The initial proposal is to achieve all compliance requirements using an Air Source Heat Pump (ASHP) providing heating and hot water to the dwelling along with Photovoltaic panels. This strategy can be used to meet Section 6 requirements and satisfy the requirements of the Scottish Borders Local Development Plan which requires to demonstrate that the carbon dioxide emissions reduction target has been met with at least half of this met through the use of low or zero carbon technology (LZC).

Through the use of improved fabric levels and a ‘zero direct emissions’ heating system the dwelling achieves a reduction of 60.6% in carbon emissions and 17.15% in delivered energy over the targets as set within Section 6 of current building regulations is predicted.

At the time of this report, the dwelling is predicted to achieve an EPC rating of ‘B’.

1.0 Introduction

1.1 General

This energy strategy report has been produced by Harley Haddow to support the Planning Application for the Tocher Knowe development in West Linton. The site consists of a two-storey detached house. The energy strategy will provide proposed parameters to allow the development to meet the carbon reduction and delivered energy targets as set out in the Scottish Building Standards.

The purpose of this report is to summarise the approach to energy conservation and the adoption of the low and zero carbon energy sources (LZC) for the project in response to the planning objectives of the Scottish Borders Council and the carbon/energy reduction requirements of Section 6 of the Scottish Building Standards.

The proposed scheme layout, engineering systems and the provision of energy services have been proposed for the development with a low carbon approach being adopted.

The assessments have been undertaken based on the preliminary scheme design information for the proposed development. As this information has not been finalised it will be subject to further design development during the scheme's progression through to the construction stage.

1.2 Compliance Targets

The proposed development will be required to meet the following objectives:

- The February 2023 Scottish Building Standards (Domestic), Section 6 requires the Dwelling Emission Rate (DER) to meet or better the Target Emission Rate (TER).
- The February 2023 Scottish Building Standards (Domestic), Section 6 requires the Dwelling Delivered Energy Rate (DDER) to meet or better the Target Delivered Energy Rate (TDER).
- The New Build Heat Standard (April 2024), all new buildings will be prohibited from using direct emissions heating systems. Instead, the use of zero direct emissions heating (ZDEH) technologies will be required.

Where there is no heat or cooling supplied to a new dwelling from 'direct emissions heating systems' and all such sources are fuelled by electricity or thermal energy from a heat network, the Target and Dwelling Emissions Rate calculation need not be undertaken. The operation of the building is deemed to produce 'zero direct emissions'. Compliance with Standard 6.1 will still be demonstrated by the building meeting the Target Delivered Energy Rate (TDER).

In this case, the heating and hot water is proposed to be served via Air Source Heat Pumps therefore, this report will only address the TDER requirements.

As the site is in West Linton, the Scottish Borders Local Development Plan Policy PMD1: Sustainability and Plan Policy PMD2: Quality Standards states the following:

- The Council will regard the sustainability principles which underpin the Local Development Plan's policies and which developers will be expected to incorporate into their development. For example, the efficient use of energy and resources, particularly non-renewable resources.
- Planning permission will only be granted for new development where it has been demonstrated that the current carbon dioxide emissions reduction target has been met, with at least half of this target met using low and zero carbon generating technologies (LZC).

We note that compliance with Section 7 Silver Standard is not currently a specific requirement for the project. However, the report will comment on the following Section 7 Aspects:

<u>Section 7 (Sustainability) Aspect 1</u>:

- **Gold**: All new dwellings that meet or improve upon the Target Emissions Rate (TER) or, where not calculated, the Target Delivered Energy Rate (TDER), will be deemed to meet the Gold level criteria in respect of CO_2 emissions.

<u>Section 7 (Sustainability) Aspect 2</u>:

- **Silver**: Maximum annual demand for useful energy for space heating should be 40 kWh/m2 for houses or 30 kWh/m2 for flats or maisonette

1.3 The Energy Strategy Approach

Harley Haddow have adopted a comprehensive strategy to address the energy and renewable technologies used on the scheme and how they will be adopted on the proposed development. The energy strategy will incorporate the following energy hierarchy:

- **"Lean"** Measures through Energy Efficiency & Passive measures including building fabric performance improvements.
- **"Mean"** Measures through energy efficiency plant, low energy lighting and heat recovery systems. Viability of CHP and connection to district heating.
- **"Green"** Measures including the inclusion of renewable technology.

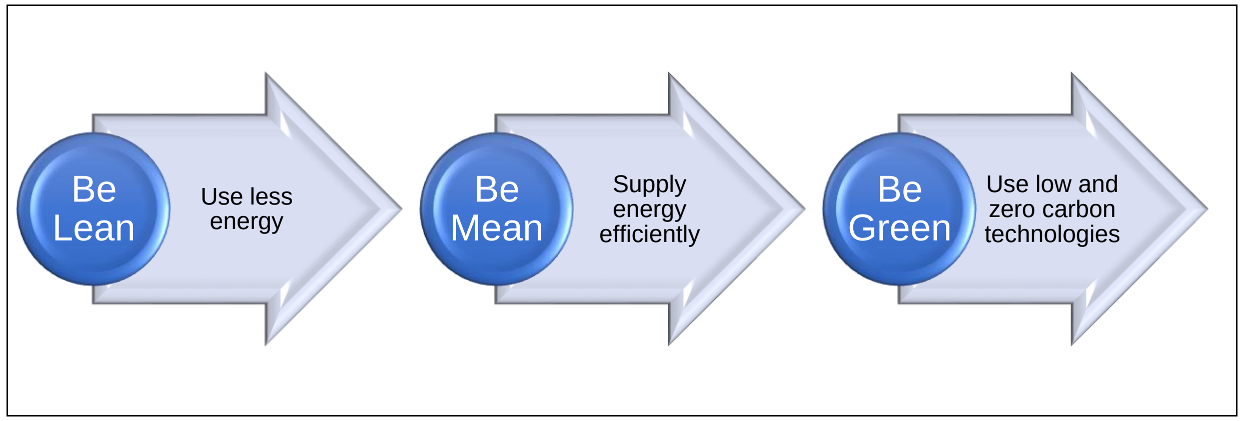


Figure 1. Energy Strategy compliance methodology

1.4 Domestic Methodology

The Standard Assessment Procedure (SAP) is the approved methodology for assessing and comparing the energy and environmental performance of dwellings. Its purpose is to provide accurate and reliable assessments of dwelling energy performances that are needed to underpin energy and environmental policy initiatives.

The SAP software works by assessing how much energy a dwelling will consume and how much carbon dioxide (CO_2) will be emitted in delivering a defined level of comfort and service provision, based on standardised occupancy conditions. This enables a like for like comparison of dwelling performance.

SAP quantifies a dwelling's performance in terms of:

- Energy use per unit floor area
- A fuel cost-based energy efficiency rating (the SAP rating)
- Emissions of CO_2.

These indicators of performance are based on estimates of annual energy consumption for the provision of space heating, domestic hot water, lighting, and ventilation. The SAP 10 software has been used as required under the current Building Regulations which came into force in February 2023.

1.5 Limitations

The project is currently at concept design stage. This report is based on preliminary information only and is therefore only valid based on this information as presented within this report. The energy strategy will be developed and refined as the design progresses. It is vital that any proposed changes are assessed through compliance.

1.6 Future Proofing

The Scottish Government currently aims to achieve the following carbon emissions reduction targets:

- 70% CO_2 reduction by 2030;
- 90% CO_2 reduction by 2040;
- Net-zero carbon by 2045.

As part of this process, there will be policies and targets put in place which will push new developments and existing buildings to move away from fossil-fuel based heating systems such as gas. Potential alternatives will include electric solutions which will be supplied by a largely decarbonised electricity grid due to the significant contribution from renewable technologies onto the network.

Using an all-electric solution for heating and hot water will future proof the development and allow it to decarbonise and reach net zero with the grid.

Figure 3. Net Zero Timeline

1.7 Grid Decarbonisation

The following fuel emissions and primary energy factors have been used in the calculations; these are based on the current NCM approved figures for Section 6 compliance as published within the approved SAP 10 document.

Fuel	CO_2 Emission Factor (kgCO_2/kWh)
Natural gas	0.210
Grid supplied/displaced electricity	0.136

Table 1 Carbon Dioxide Emissions Factors

As the electrical grid is now being produced more and more by renewable power sources rather than gas or coal fired power stations the grid is decarbonising and as such the carbon emission factor for electricity as a fuel has been revised.

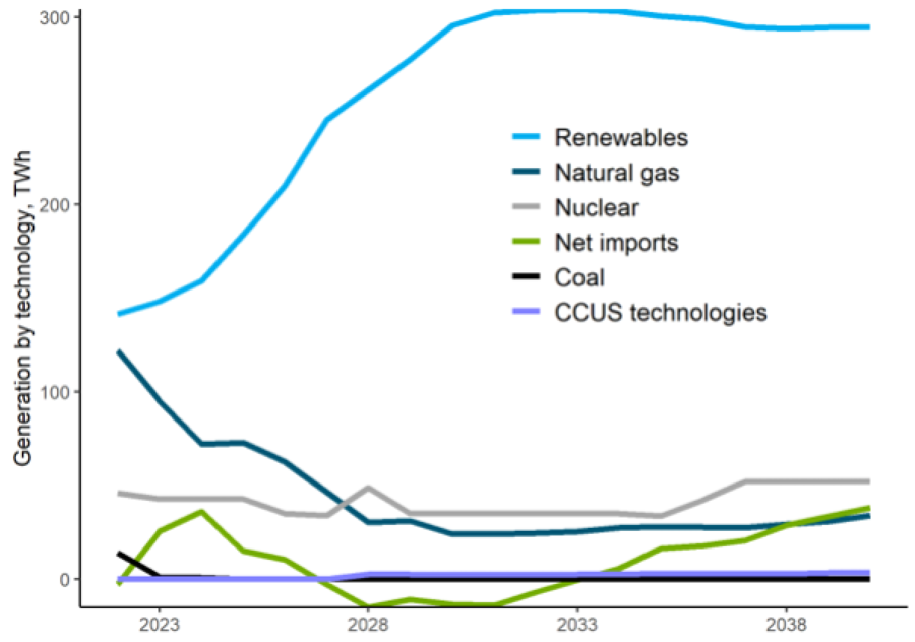


Figure 4. Grid generation breakdown – Energy and Emissions Projections 2022-2040

1.8 Thermal Bridging

There is a requirement to have the proposed construction details thermally modelled to calculate an associated and specific psi value for each detail. If this is not carried out the alternative is the use of default figures which may have a detrimental effect on the associated compliance results for the development. Harley Haddow assumes this will be carried out by the architect/contractor and details provided to input into the SAP calculation.

At detailed design/as-built stage Harley Haddow will input the associated lengths attributed to each junction as part of thermal bridging calculations but requires input relating to psi of each construction detail.

For the purpose of this study, the dwelling has been modelled with figures provided by the architect. It is predicted that generally, any junction thermally modelled will be an improvement on these figures.

1.9 Change to Building Regulations

Any estimated EPC ratings provided within this report are based on current building regulations software and methodology however at the time of project construction completion the EPC methodology may change further and potentially any completion EPC rating, as such EPC ratings are indicative only.

The proposed strategy already looks to a zero direct emission heating system, improved fabric levels and continuous mechanical ventilation with heat recovery which the new regulations will favor as a potential strategy.

2.0 "Be Lean" Energy Efficiency Measures

The 'Be Lean' measures proposed will reduce the energy consumption and CO_2 emissions for the proposed development so that a substantial reduction can be achieved without the reliance on 'Be Green' measures. The proposed development shall focus on 'lean' design measures first maximising the opportunities available in energy efficient design.

The 'Be Lean' measures shall include:

- Improved levels of fabric insulation with U-values exceeding compliance with Section 6 2023.
- Optimised glazing areas, orientations, and performance levels (both thermal and solar) which aim to maximise the benefits of passive solar gain where appropriate and limit unwanted solar gain where necessary.
- Reduced levels of air permeability to minimise uncontrolled heat gains or losses.

2.1 U-values

The proposed development will feature thermal fabric performance such that compliance with Section 6.2.1 of the February 2023 Building Regulations would be bettered.

The U-values calculated as outlined below have been used in the initial energy calculations, which exceed the minimum requirements of Section 6 Feb 2023:

Fabric Element	Minimum Section 6 U-Value ($W/m^2.K$)	Proposed Target U-Value ($W/m^2.K$)
External Wall	0.17	0.15
Floor	0.15	0.12
Roof	0.12	0.12
Cavity Separating Wall (Party wall)	0.0	0.0 (Assumed fully filled)
Glazing	1.4	0.8 (Transmittance Factor "g" 0.5, Frame Factor 0.7)
Rooflights	2.1	n/a
Doors	1.4	1.2

Table 2. Proposed U-Value Levels

2.2 Air Permeability

It has been assumed for calculation purposes that the air pressure testing will produce test certificates of no greater than the following:

- 4 $m^3/h.m^2$@50Pa

2.3 Solar Control Glazing & Overheating

Glazing areas shall be optimised with solar controlled glazing with low g-values to limit the amount of solar gain transmittance into areas with a high solar gain. Passive solar gain shall be included where possible to limit heating loads.

3.0 “Be Mean” Energy Efficiency Measures

Be “Mean” measures shall be incorporated throughout the scheme in order to reduce energy consumption and the associated carbon emissions, these will include but are not limited to the following:

- Comprehensive incorporation of heat recovery on ventilation systems.
- Utilisation of high efficiency heating plant.
- The use of low energy variable speed drives and motors.
- The installation of automated controls to limit plant and lighting operation where practical.
- Installation of low energy lighting schemes throughout.

3.1 Ventilation

It is proposed that the proposed dwelling will utilise Mechanical ventilation with heat recovery (MVHR). This type of system results in a more comfortable indoor environment maintaining good air quality whilst also minimising energy losses through the retention of energy recovered through the heat exchanging process.

3.2 Cooling

No cooling will be provided to the dwelling.

3.3 Lighting

It is recommended that all light fittings are specified as dedicated energy efficient lights only (LED or compact fluorescent – 100% of fittings).

As part of the change in building regulations and SAP methodology, a new approach has been included that means energy use from lighting can now be more accurately accounted for within the assessment. Previously, the calculation only required a percentage of how many light fittings were “low energy”. The new approach requires the following information for each light fitting.

- Power (W) – electrical power consumption of the fitting.

- Luminous efficacy (lm/W) - This is the ratio between a lamp’s output in lumens and the power it uses in Watts (The higher the value reflects a more efficient fitting).

3.4 Heating Generation and Distribution

It is proposed that the space heating and hot water requirements of the dwelling will be met using an Air Source Heat Pump (ASHP). The dwelling will have an internal domestic hot water cylinder that will be served via the main heating system.

It is proposed that the heating system will be controlled using time and temperature zone control by arrangement.

These systems have been selected with consideration given to the futureproofing of the proposed development while also maximizing efficiency to reduce the amount of energy being consumed within the dwelling therefore, reducing potential energy bills.

3.5 Hot Water Demand

Since building regulations have emphasised the important of building fabric and reducing the space heating demand, hot water energy will now have a much more significant impact on a dwelling’s total energy use. Therefore, improvements in this aspect may now offer significant energy savings overall.

Within the assessment, the software now accounts for the cold-water source whether that be from mains or a header tank and now also requires more detailed information relating to showers regarding the shower type and the flow rate (l/min) or rated power (kW) for an instantaneous electric shower.

3.6 Daylighting

Daylighting levels should be optimised to ensure good levels of natural daylight within the dwellings while not increasing solar gains which may increase the overheating risk.

A daylighting assessment is not included as part of this Energy Statement.

4.0 District Heating and CHP

4.1 District Heating

The Scottish Borders Council planning requirements require the viability of the installation of new or connection to existing district heating networks and the viability of local generation technologies, such as Combined Heat and Power (CHP).

These type of heating systems are favoured because they offer:

- Potential economies of scale in respect of efficiency and therefore reduced carbon emissions.
- Better economic life cycle costs through efficiencies associated with planning and maintenance requirements.
- Increased opportunities for future proofing the development to react to energy supply market factors.
- Greater potential for further replacement with LZC technologies.

District heating works by the supply of hot water distributed from a central source, typically a CHP / Boiler.

Research has been undertaken considering the viability of utilising district heating for the site.

The Scotland Heat Map have developed a Heat Opportunities map which identifies potential heat sources and district heating connections.

Using this tool, it has been determined that there is no district heating centre within the local area of the site. Therefore, is not deemed to be a viable solution in this instance but can be considered in the future if there is a system in place.

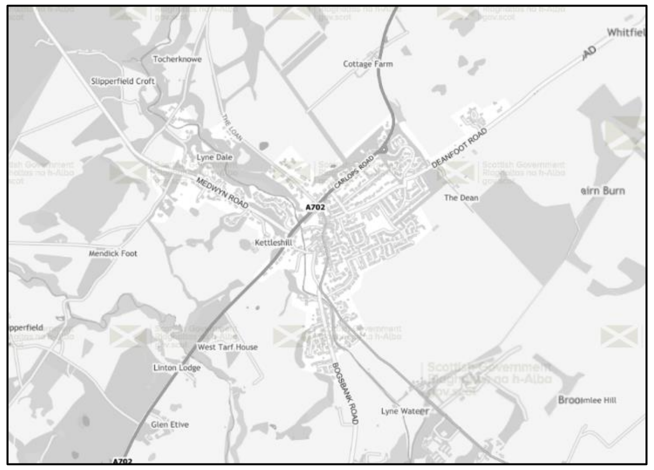


Figure 5. Scotland Heat Map – West Linton

4.2 Combined Heat and Power (CHP)

The feasibility of Combined Heat and Power (CHP) as a 'clean' measure shall be carefully assessed and requires taking consideration of a wide range of factors and influences.

CHP is considered a 'clean' technology because it is a cogeneration of heat and electricity which increases the overall utilisation efficiency of primary energy.

CHP generates electricity and captures heat that is produced in this process. The captured heat can be used to pre-heat Domestic Hot Water used for a centralised heating network.

To be economical a CHP unit generally needs to operate for a minimum of 4,000 hours per year, around 14 hours per day. Furthermore, CHP units cannot be easily switched off and on to reflect loading variations and doing so dramatically affects its operation and efficiency.

To overcome these limitations CHP units are sized on the base heat load, for this development it would be therefore proposed that it will be sized on the domestic hot water (DHW) load, which has a constant annual profile.

With the de-carbonisation of the electrical grid once the fuel carbon emission factors are re-set the production of electricity via gas will not provide the same level of carbon saving.

Due to the above, it has been determined that CHP is not feasible for the proposed development.

5.0 “Be Green” Energy Efficiency Measures

5.1 General

A range of technologies have been appraised in order to generate renewable energy in relation to the development. These include:

- Site mounted wind turbines
- Roof mounted wind turbines
- Solar Photovoltaics (PV)
- Solar Hot Water
- Ground Source Heat Pumps
- Biomass
- Biomass CHP
- Direct Air Source Heat Pumps
- Fuel cells

A renewable energy options assessment has been undertaken to evaluate which of these technologies would be most feasible in terms of economic, political, environmental, and practical considerations.

5.2 Unfeasible Renewable Technologies

A desktop study has discounted the following technologies for this project:

5.2.1 Biomass

Biomass systems differ from other renewable sources because they emit carbon dioxide when they burn fuel. However, the amount is equal to the carbon absorbed when the biomass material was growing. For large scale projects there are three types of wood fuel that are generally used: logs, pellets, and woodchip.

A biomass boiler is not considered appropriate for this scheme for the following reasons:

- High cost of heat generation and distribution system.
- Air quality / pollution issues.
- Fuel delivery and storage issues.
- The New Build Heat Standard

5.2.2 Biomass Combined Heat and Power (CHP)

Although CHP is not strictly a renewable source of energy, it produces both heat and electricity from a single heat source using a highly efficient process. CHP generates electricity and captures heat that is produced in this process. The captured heat can be used to pre-heat Domestic Hot Water used for a centralised heating network.

This system can be used in a centralised plant network serving multi-residential units. However, it is not considered feasible due to the fuel delivery, storage issues and air quality issues.

5.2.3 Fuel Cells

Fuel cells could potentially have a massive impact on the future UK energy market. Current research indicates that although the technology is developing commercially, viable equipment and reliable sources of non-fossil fuel hydrogen are not yet available, on a commercial scale.

5.2.4 Site mounted large wind turbines

Due to the scheme’s location, the proximity to residential development and poor associated wind speeds, the technology is deemed unsuitable in this instance.

The associated noise with large scale wind turbines could have a potential impact with adjacent residential development. A 300kW turbine could potentially reach a sound level of 100 dBa at 8 m/s wind speed.

5.2.5 Roof mounted wind turbines

The feasibility of roof mounted wind turbines has been studied in terms of:

- Size and visual impact on the building
- Power output
- Noise generation

Wind turbines extract energy from the wind using a rotor which usually comprises of two or three blades similar in profile to the wing of an aeroplane. Most small wind turbines generate direct current (DC) electricity. Systems that are not connected to the national grid require battery storage and an inverter to convert DC electricity to AC.

Wind systems can also be connected to the national grid. A special inverter and controller convert DC electricity to AC at a quality and standard acceptable to the grid, hence no expensive battery storage is required. Any unused or excess electricity may be able to be exported to the grid and sold to the local electricity supply company.

The average on site wind speed is 7.3 m/s at 10m. For a turbine to be feasible a wind speed of at least 6m/s is required to produce a satisfactory energy output.

But due to the aesthetic impact and potential detrimental impact on wildlife, roof mounted wind turbines are not considered suitable for this application.

5.3 Feasible Renewable Technologies

An initial desktop study has appraised and has considered the following technologies as potentially suitable technologies.

5.3.1 Solar Hot Water

Solar hot water uses a heat collector, usually as panels on the roof, in which liquid is heated by the sun.

In a typical system, a heat transfer medium (generally a water/antifreeze mixture) travels through a series of heat conducting tubes known as a heat collector. During its circulation through the tubes, the fluid picks up heat from the sun which is then transferred to the domestic hot water supply as it passes through a coil in an appropriate storage cylinder.

These systems do not generally provide space heating and are often described as 'solar thermal' systems. They are among the most cost-effective renewable energy systems that can be installed to developments in urban environments. A basic solar thermal collector comprises of a translucent cover, an absorption plate, and the heat transfer system. In the UK, there are two main types of collectors, known as evacuated tube and flat plate.

The dwelling will have a relatively high DHW demand therefore solar hot water is a potential solution for this development.

However, consideration must be given to the final plant solution for the development for example if PV is deemed an appropriate solution, the carbon benefit from PV may be more beneficial to the development compared to solar hot water.

5.3.2 Solar Photovoltaics (PV)

The incorporation of Solar Photovoltaic (PV) panels has been assessed as a possible renewable technology to reduce the carbon emissions for the proposed development.

PV uses energy from light to create electricity for the running of appliances and lighting. The PV cell consists of one of the two layers of a semi conducting material, usually silicon (normally Monocrystalline, Polycrystalline and Amorphous silicon).

When light shines on the cell it creates an electric field across the layers causing electricity to flow. The greater the light intensity, the greater the flow of electricity.

Individually PV cells only provide a small amount of electricity, they are generally grouped together into a module for convenience and higher output.

PV is most suitable where electricity is generated at the point of use and the energy loss and costs with transmission and distribution are avoided.

A key advantage of PV in the urban environment is their potential to be integrated into the fabric of the building. No extra land space is required, and the visible aesthetics of a building can be altered – either to be unobtrusive, or to give a clear indication of 'green' credentials.

5.3.3 Air Source Heat Pumps (ASHP)

An Air Source Heat Pump (ASHP) could be installed to meet the building's space heating demands. It is considered a renewable only on heating mode. The technology works by extracting available heat from the air and boosting this to a higher temperature which can be used in the building for heating using compressor technology. ASHPs are more cost effective to install than ground source systems as they do not involve expensive ground works.

Figure 6. Example ASHP System

ASHPs require evaporator units to be exposed to ambient air. This is most effectively achieved by mounting the units external to the building. Any planning implications would have to be assessed prior to installing external units. The ASHP Coefficient of Performance (CoP) is 3 therefore assuming that each 1 kW of electricity used to drive the ASHP, generates 3 kW of heat energy from the outside air to heat the building.

An ASHP installation would be appropriately sized and designed to meet the heating requirements of the building. The domestic hot water load of the buildings may also be met by the ASHP but the CoP of the system may reduce due to the higher temperatures required for DHW. However, newer technologies with high temperature heat pumps can help to reduce the impact on performance with seasonal efficiencies between 3 and 4 now possible.

Colder climates will result in a reduction in efficiency and the achievable seasonal coefficient of performance (SCoP) of Air Source Heat Pump technology. However, ASHP technology has advanced in recent years and through consideration of the specification of a system with key design features so that the negative impact on their performance when the outside air is cold can be reduced.

The seasonal efficiency of the heat pump is greatly affected by the building/heating system it serves, thus efficient levels of fabric insulation and the specification of a heating system which can operate effectively at lower temperatures will improve the performance of the unit throughout the year. Good quality heat pumps are capable of providing hot water above 52°C when the outside air is as cold as -16°C.

A key consideration for an ASHP system is the acoustic performance of the external unit. The typical noise rating of a domestic external unit is up to 60dBA at 1m which equates to a similar noise level of a conversation or background music. Depending on the location of the heat pump, acoustic measures such as an acoustic enclosure will be required to minimise noise pollution to nearby occupied spaces or dwellings. However, the current market also offers ultra-quiet ASHPs for the domestic market and the noise rating is around 50dBA at 1m.

5.3.4 Ground Source Heat Pumps (GSHPs)

A Ground Source Heat Pump (GSHP) system provides extracted heat from the ground during the winter months via a heat pump and circulate hot water into a building to provide space-heating and pre-heated domestic hot water. In the summer months the process can be reversed to provide cooling.

The Coefficient of Performance (CoP) for these systems is typically 3 to 4 (i.e., for every 1kW of electricity consumed to drive the heat pump system, 3 to 4 kW of energy would be transferred from the ground to heat the building).

Ground source heat pump systems can take various forms. The most common are borehole installations where the energy is transferred from the ground to a pipe loop down to a depth of approximately 100-150 meters.

This type of system collects both solar energy and geothermal energy for use within the building through the heat pump. Alternatively, a horizontal 'slinky' system can be installed which is designed to cover a large area of ground and collect solar energy absorbed by the ground near the surface. The 'slinky' system is less efficient than the borehole system however the cost of excavation for 'Slinkys' can be less than drilling boreholes.

It is expected that a borehole installation should achieve an efficiency of approximately 4.0 to 4.5 i.e., 4.0 kW of heat for 1.0 kW of electricity consumed over the annual heating season while a horizontal 'slinky' would tend to deliver a CoP in the range of 3.0 to 3.5 hence careful consideration should be given before deciding the optimum solution.

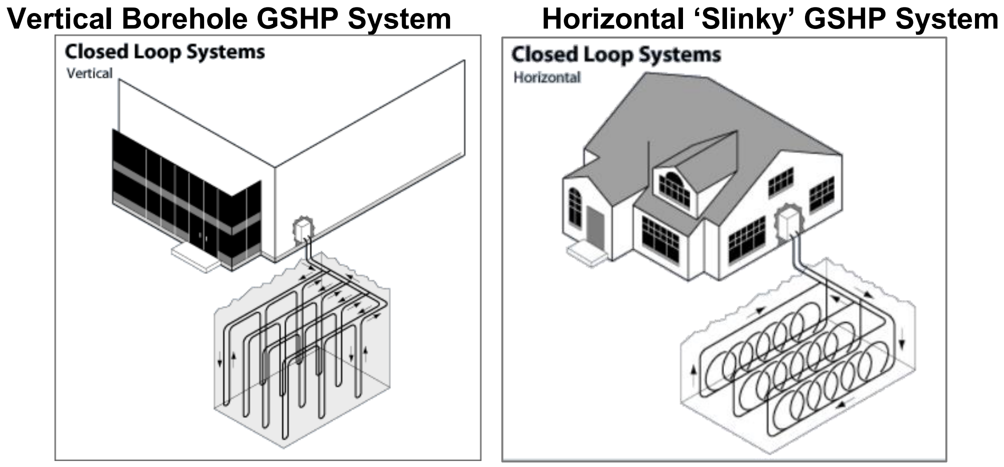


Figure 7 Typical GSHP Configurations

The GSHP installation would be designed to meet the space heating requirements of the building. The domestic hot water load of the building may be met by the GSHP, but the CoP of the system may reduce due to the higher temperatures required for domestic hot water.

A GSHP system is heavily dependent on having adequate external space to be viable and given the availability of land adjacent to the site, this technology has been determined to be feasible for this project.

5.4 Preferred Renewable Energy Options

This assessment has identified that the technically viable technologies recommended for further study that can provide some of the development's energy from a renewable source are:

- Solar Photovoltaics (PV)
- Air Source Heat Pumps (ASHPs)

These technologies have been classified as most suitable for the proposed development based on what they can provide for the development and the technical feasibility associated in relation to space and siting as well as cost implications.

The ASHP system is deemed feasible for the building as a potential route to move to an electrically driven heating system served by a decarbonising electricity grid which helps to future proof the development in line with upcoming government targets.

The Photovoltaics can be utilised as a supplementary technology to further reduce energy consumption seen throughout the development and drive down energy bills of each dwelling.

6.0 Results Summary

6.1 Proposed Parameters

The key performance parameters applied within the SAP calculations are summarised in the table below, these standards are utilised for the analysis.

System	Performance Parameters
Glazing	Glazing: U-Value 0.8 W/m2K Transmittance Factor “g”: 0.5 Frame Factor: 0.7
Fabric	External Wall: U-Value 0.15 W/m^{2}K Roof: U-Value 0.12 W/m^{2}K Ground/Exposed Floor: U-Value 0.12W/m^{2}K Doors: U-Value 1.2 W/m^{2}K Party Walls – assumed fully filled: U-Value 0.00 W/m^{2}K Indicative thermal mass = Precise calculation Sheltered Sides - None
Air Permeability	Assumed to be **4** m^{3}hr/m^2 @ 50Pa
Thermal Bridging	Thermal Bridging y-value set as – 0.1. (Provided by the architect)
Artificial Lighting	100% Dedicated Energy Efficient lighting throughout. Assumed typical fitting within each space: Power - 4W, Luminous Efficacy – 95lm/W.
Ventilation	Balanced whole-house mechanical ventilation with heat recovery – Nuaire MRXBOXAB-ECO2.
Heating	The dwelling includes radiators and underfloor heating served via Air Source Heat Pump. Heating served by Grant AERONA3 HPID17R32 ASHP. Time and temperature zone control by arrangement
Domestic Hot Water	Served via main heating system. Assumed 284 litres (Loss – 2.24 kwh/day). Includes cylinder stat and independent time control. Cylinder located in a heated space. Assumed showers are fed via main heating system, assumed flow of 11 l/min in all dwellings.
Low and Zero Carbon Technology	4 kWp, South-facing with assumed 30^0 incline with none or little overshading.

Table 3. Proposed Design Parameters

The SAP calculations have been run with the proposed parameters as detailed in Table 3. The parameters may change as the design progresses, the SAP calculations should also be updated to reflect the changes to ensure that Section 6 compliance is still achieved.

6.2 Results Summary

The table below summarises the TDER/DDER compliance results for the proposed flats using the proposed parameters as detailed in Table 3.

Sample Dwelling	Dwelling Delivered Energy Rate (DDER)	Target Delivered Energy Rate (TDER)	% CO_2 Reduction	EPC Rating
Tocher Knowe	20.82	25.13	17.15%	B 82

The dwelling is shown to achieve Section 6 compliance with a pass margin of approximately 17.15%. The dwelling is also shown to meet Section 7 Gold standard for Aspect 1: Carbon Reduction.

Furthermore, A **60.6**% reduction in CO_2 emissions is achieved using an Air Source Heat Pump and Photovoltaic panels (PV) which satisfies Policy PMD2: Quality Standards of the Scottish Borders Local Development Plan for LZC contribution of at least half (Refer to Appendix B).

The dwelling does not achieve a Section 7 Silver level for Aspect 2: Energy for space heating with energy for heating more than 40 kWh/m^2/year. The space heating demand for the dwelling is currently 45.32 kWh/m^2/year.

The dwelling achieves an Aspect Bronze level 3: Energy for water heating. It currently does not have heat recovery or renewable sources with little to no associated costs s (e.g. solar thermal water heating and associated storage or heat recovery from greywater) that are allocated for water heating.

The dwelling detailed within this study satisfies the requirements of the Scottish Building Regulations as well as the Scottish Borders Council.

Dwelling	Energy Efficiency Rating	Environmental Impact Rating
Tocher Knowe	82	96

It should be noted that these figures are based on the proposed parameters within Table 3 and drawings provided. The total amount of PV specified is solely for the purpose of achieving compliance and an EPC rating of ‘B’.

Any significant changes in input to the geometry, fabric and systems could significantly alter the results.

6.3 Photovoltaics

As stated the total amount of Photovoltaics panels in the analysis is only for the purpose of achieving Section 6 compliance and achieving an EPC rating of ‘B’. In case the architect/user wants to achieve an EPC rating of ‘A’, the amount of PV will need to be increased with a provision for battery storage.

The dwelling would require 15kWp of Photovoltaic panels along with 5.2kwh battery storage to achieve an EPC rating of ‘A’.

The installation of a large size PV array will have to follow either the G98 or G99 connection process, which is determined by the output of the proposed system:

- G98
  - AC output of ≤ 3.68kW/phase
  - This allows you to connect your system to the grid and inform the grid afterwards.
- G99
  - AC output >3.68kW/phase
  - This involves informing the grid of the plans to confirm in advance and awaiting their approval on if it is acceptable or there are any restrictions in place such as export limitation and is a 12-week process.

This required process will be followed during the design stage of the project and should be carried out by the PV specialist as part of their tender.

Depending on the proposed use and electrical load of the proposed development, there will be different benefits relating to battery storage or increasing the PV array. These can be investigated as the detailed design progresses.

7.0 Conclusions

The table below highlights the recommended strategy associated with the proposed Tocher Knowe development.

This preferred strategy utilises each of the ‘Be Lean’, ‘Be Mean’ and ‘Be Green’ measures.

Energy Hierarchy Stage	Proposed Measures: New Build House
“Be Lean” – Use Less Energy	Improved Building Fabric Performance and air tightness testing: External Wall: U-Value 0.15 W/m^2K Roof: U-Value 0.12 W/m^2K Exposed Floor: U-Value 0.12W/m^2K Doors: U-Value 1.2 W/m^2K Glazing: U-Value 0.8 W/m^2K Air testing assumed to be 4 m^3hr/m^2 @ 50 Pa.
‘**Be Mean’ – Supply Energy Efficiently**	• Heat recovery ventilation with efficiency of at least 86%. • 100% Dedicated Energy Efficient lighting throughout. • Energy metering. • Efficient Air Source Heat Pump serving heating and DHW. • Solar PV
‘Be Green’ – Use Renewable Energy	ASHP & Solar PV

Table 6. Final Recommended Energy Strategy

The dwelling detailed within this study satisfies the requirements of the Scottish Building Regulations as well as the Scottish Borders Council while achieving an EPC rating of ‘**B**’ for the proposed dwelling.

Appendix A

Sample Energy Performance Certificates

Predicted Energy Assessment

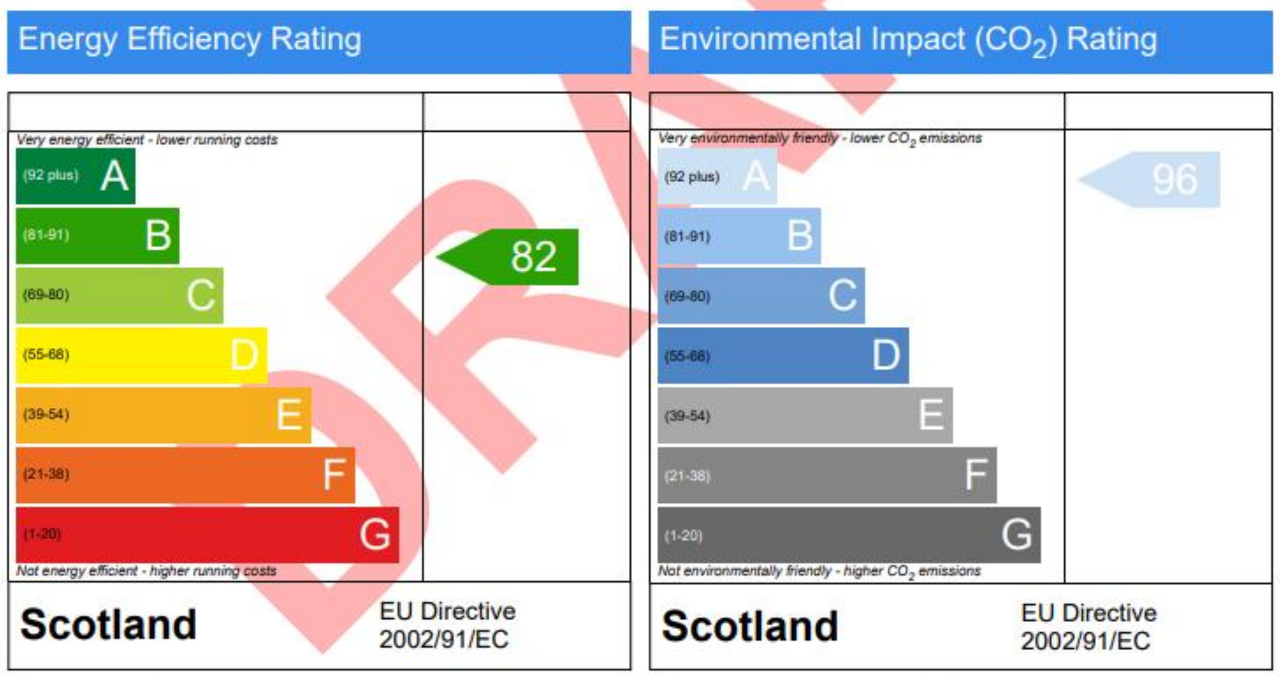
elmhurst energy

Tocher Knowe, West Linton

Dwelling type:	House, Detached
Date of assessment:	08/02/2024
Produced by:	Sean Norris
Total floor area:	544.41 m²
DRRN:	

This document is a Predicted Energy Assessment for properties marketed when they are incomplete. It includes a predicted energy rating which might not represent the final energy rating of the property on completion. Once the property is completed, this rating will be updated and an official Energy Performance Certificate will be created for the property. This will include more detailed information about the energy performance of the completed property.

The energy performance has been assessed using the Government approved SAP 10 methodology and is rated in terms of the energy use per square meter of floor area; the energy efficiency is based on fuel costs and the environmental impact is based on carbon dioxide (CO2) emissions.



The energy efficiency rating is a measure of the overall efficiency of a home. The higher the rating the more energy efficient the home is and the lower the fuel bills are likely to be.

The environmental impact rating is a measure of a home's impact on the environment in terms of carbon dioxide (CO_2) emissions. The higher the rating the less impact it has on the environment.

Appendix B

Carbon Reduction Calculations

No LZCGT

Unit	Total CO_2 TER (CO_2/yr/m^2)	Total CO_2 DER (CO_2/yr/m^2)
Tocher Knowe	10.26	8.02

To demonstrate the CO_2 emissions without LZCGT's the proposed ASHP's & solar PV's have been omitted from the calculations.

- The heating and DHW ASHP's have been replaced by direct electric sources having a seasonal gross efficiency of 100%.

With LZCGT

Unit	Total CO_2 TER (CO_2/yr/m^2)	Total CO_2 DER (CO_2/yr/m^2)
Tocher Knowe	3.81	3.16

- LZCGT's include ASHP + PV

Reduction via LZC	**60.6%**

HARLEY HADDOW

The Multi-disciplinary Engineering Consultancy

—

Edinburgh | London | Glasgow

Contact
124-125 Princes St
Edinburgh, EH2 4AD
enquiries@harleyhaddow.com