

Devonshire Place, Port Talbot

Low & Zero Carbon Technology Appraisal Feasibility Report

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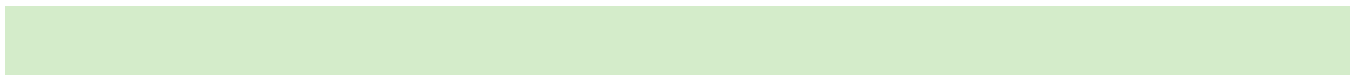
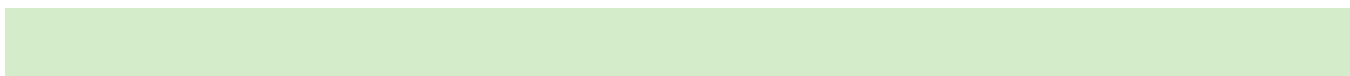
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1. EXECUTIVE SUMMARY

Lync Cymru Housing Association have appointed Services Design Solution Ltd to complete a low and zero carbon technology appraisal of the proposed domestic re-development at Devonshire Place, Port Talbot.

The technologies outlined below adhere to Neath Port Talbot County Borough Council (NPTCBC) Local development plan (2011-2026), specifically strategic policy SP18 Renewable and Low Carbon Energy, sections RE1 (Criteria for the Assessment of Renewable and Low Carbon Energy Development (paragraph 4a – 4e inclusive)), and RE2 (Renewable and Low Carbon Energy in New Development).

We find the following technologies are appropriate to achieve the required standards for the construction phase, whilst meeting the requirements of the above policies:

- ◆ Efficient, new construction fabric comprising:
 - ◆ At least 25% more thermally efficient than current approved Wales part L1(A)2014 building regulations requirements with values as set out in Appendix B
 - ◆ Thermally efficient opaque and clear constructions, for both doors and windows
 - ◆ Airtight construction junctions
- ◆ Heating and domestic hot water:
 - ◆ Air source heat pumps are recommended to provide both central heating and domestic hot water.
- ◆ Ventilation:
 - ◆ Mechanical ventilation heat recovery units with excellent heat recuperation of at least 75% will provide excellent indoor air quality throughout the year where windows need to be shut
 - ◆ Cross dwelling natural ventilation potential, from appropriate window positioning and trickle ventilators, so indoor air can be naturally diluted, where desired
- ◆ Lighting:
 - ◆ LED lamps throughout with high efficacy levels
- ◆ Renewables technologies:
 - ◆ Roof mounted mono-crystalline silicon photo-voltaic panels. Roof mounted photo-voltaic cells meeting zero carbon energy generation requirements are modelled with 8m² for each unit, of 20.1% efficient monocrystalline silicon PV cells to generate circa 1,416 kWh/year per dwelling as an estimate. These figures support the project requirements noted above, with the set up outlined below. Changes to the construction and building services specifications will impact on PV quantum required to achieve this at construction stage.

We note this document is based on our understanding the development is proceeding under the current Wales Part L1(A)2014 regulations. However, as we appreciate these are due to change soon, but haven't yet been published, this report also takes guidance from the UK building regulations, which changed on 15th June 2022, with the introduction of Part L1(A)2021 for England. These are more energy efficient standards than the current part L 2014 Wales regulations and are applied to the modelling processes underpinning this report. They are closer to where the new Welsh regulations are expected to be in terms of efficiencies.

We note the potential changes of the U.K. part L1(A)2021 building regulations are not discussed in this report.

2. INTRODUCTION

Lync Cymru Housing Association are proposing to construct circa 42 No. new dwellings on the existing Devonshire Road School site in Port Talbot. This report identifies appropriate efficient technologies which should be considered for this scheme.

This report uses Roberts Limbrick Architects (Job number 10429) drawing number SK06 revision B, for part of its source data, and we understand the development will comprise the following units:

- ◆ 18 No. 1-bedroom apartments
- ◆ 6 No. 2-bedroom apartments
- ◆ 8 No. 2-bedroom houses
- ◆ 10 No. 3-bedroom houses

The site is located in Port Talbot, to the north-east of Devonshire Place, east of Broad Street and to the south of York Place, on land which was used as the old school, which is to be demolished.



Figure 1: Drawing of the Devonshire Place, Port Talbot, development site

3. PLANNING POLICIES

The following local planning policies apply to this development.

Neath Port Talbot County Borough Council (NPTCBC)'s Local development plan (2011-2026), has two separate policies concerning low and zero carbon developments and renewable and low carbon energy in new developments.

- ◆ The first is strategic policy SP18 Renewable and Low Carbon Energy, sections RE1 (Criteria for the Assessment of Renewable and Low Carbon Energy Development (paragraph 4a – 4e inclusive)
- ◆ The second is SP18 RE2 (Renewable and Low Carbon Energy in New Development)

For the development to achieve compliance with Neath Port Talbot County Borough Council's requirements, the following will be considered.

- ◆ Fabric first approach with low u-values with low air permeability ratings
- ◆ Appropriate economic, heating plant for this shell and core development, which has a low heating demand, but where even more efficient heating plant (such as heat pumps) can be easily retro-fitted by potential unit owners or tenants.
- ◆ Mechanical extract ventilation systems with enhanced building services insulation (ventilation ducts, and pipes)
- ◆ High efficiency LED lighting
- ◆ Zero carbon energy generation with Construction Design and Management (CDM) compliant roof mounted PV array, with hard-wired connections to each unit).

3.1. Section 4 examines Strategic Policy SP18, RE1

This policy sets out criteria for the assessment of renewable and low carbon energy development. Sections 1 to 3 focus on wind farms of different scales and are not applicable for discussion here. However, section 4 is applicable as all renewable energy or low carbon energy development proposals will be required to demonstrate that;

- ◆ Measures have been taken to minimise impacts on visual amenity and the natural environment
- ◆ There will be no unacceptable impacts on residential amenity;
- ◆ The development will not compromise highway safety;
- ◆ The development would not interfere with radar, air traffic control systems, telecommunications links, television reception, radio communication and emergency services communications; and
- ◆ There are satisfactory proposals in place for site restoration as appropriate.

The low and zero carbon proposals are listed in the sections below; all recommendations comply with RE1 requirements. Furthermore, the proposals are unlikely to cause unacceptable impacts to the environment and the amenity of local residents or communities.

3.2. Strategic Policy SP18, RE2

This policy sets out criteria for renewable and low carbon energy in new developments. These include renewable energy, such as wind or solar PV, district heating networks and incorporate on-site zero / low carbon technology (including microgeneration technologies). The policy states proposals will be required to submit an energy statement to determine the feasibility of incorporating such a scheme and, where viable, would be required to implement the scheme for;

- ◆ Residential development for 100 or more dwellings;
- ◆ Development with a total floor space of 1,000 square meters or more.

Given this development exceeds 1,000m² in floor area, this low and zero carbon report meets the requirements set out in the council's RE2 policy.

This Low and Zero Carbon report effectively constitutes an 'Energy Assessment' which investigates potential to incorporate on-site zero and low carbon equipment, and, where available, establish connections to existing sources of renewable energy. It also sets out how the proposal can contribute towards increased levels of energy generation from renewable and low carbon sources.

4. POTENTIAL RENEWABLES TECHNOLOGIES

The following technologies are considered here.

- ◆ Photo-voltaic panels (PV)
- ◆ Solar Thermal Hot Water
- ◆ Air to water or closed loop Ground Source Heat Pumps & geothermal arrays (both centralised and de-centralised)
- ◆ Wind
- ◆ Biomass boilers
- ◆ Combined Heat and Power (CHP)
- ◆ Geothermal
- ◆ Tidal

We note that, as there are no local district heat networks within the Devonshire Place neighbourhood, this technology has not been considered within this report.

Whilst not a strictly renewable technology, we would include mechanical ventilation heat recovery units as part of the solution for low and zero carbon design for this project.

4.1. Preamble

The table below, repeated in much more detail in Appendix A, identifies potential LZC technologies and scores each, determining whether they are likely to be suitable for installation on this development.

Scoring is based on the benefit of comparable carbon emissions of the fuel saved, installation simplicity, maintenance and pay-back factors, with individual advantages and disadvantages scored. These feed into a final score for the technology, with those scoring in the top two being recommended for installation in the development.

Cells identified in green are considered suitable, and cells coloured red are not thought to as economic, or appropriate, for this development. Cells coloured amber are borderline for consideration at some future point, but are not immediately recommended for consideration.

Ref.	LZC technology	Fuel Type	Fuel generation	Benefit of fuel carbon	Final Score (0 to 10)	Appropriate for site?
1.	Photovoltaic Panels	Solar energy (zero carbon)	Electricity	10	7.83	Yes
2.	Solar Thermal Heating Panels	Solar energy (zero carbon)	DHW and/or; Central heating	4	4.05	No
3.	Air Source Heat Pump	Electricity	Central heating and/or; DHW	7	6.00	Yes
4.	Ground Source Heat Pump	Electricity	Central heating and/or; DHW	4	3.75	No
5.	Water Source Heat Pump	Electricity	Central heating and/or; DHW	3	3.20	No
6.	Wind	Wind energy (zero carbon)	Electricity	8	3.80	No
7.	Biomass Heating	Wood chip or; Wood pellets or; Logs or; Briquettes.	DHW and; Central heating.	5	3.60	No
8.	Combined Heat and Power	Hydrogen or; Natural gas or; Propane	DHW and; Central heating and; Electricity.	2	3.00	No
9.	Geothermal	Geothermal energy	Electricity	5	2.80	No
10.	Tidal	Tidal energy (zero carbon)	Electricity	5	2.73	No

Figure 2: LZC technology table, showing advantages, disadvantages, and score (repeated in Appendix A)

Mechanical ventilation heat recovery units are also an important part of the design philosophy we would be suggesting for this development, but which is not scored in the table above.

4.2. Photovoltaic Panels

PV systems convert ultraviolet sunlight into electricity. This can be used to power lighting and other appliances. PV generated electricity can be used at source or fed back into the national grid. Standalone grid-tied systems exist to feed electricity to the national grid only. Off-grid systems also exist. These charge batteries of buildings sited in remote locations which the national grid does not reach.

Solar panels can be building or ground mounted. In this instance, significant roof space is available.

Adequate space to situate panels and avoid shading is critical. To gain maximum generation, panels should be orientated south, although orientations from east through south to west, (clockwise) should also be considered.

Whilst generation share can be achieved by orientating panels in both westerly and easterly directions, this will not achieve maximum yield and limits capacity the greater the angle from due south.

Advantages of Technology

- ◆ Panels do not emit any noise (although wind noise should be assessed if in sensitive locations)
- ◆ Electricity can be generated during overcast conditions
- ◆ Produces free (excluding cost of initial purchase and installation) electrical energy
- ◆ Limits reliance on fossil fuels
- ◆ Orientation is flexible but does affect yield
- ◆ Normally roof mounted (can be ground, if space permits), or integrated into the building structure

Dis-advantages of Technology

- ◆ Need to be installed in areas without shading limiting location

- ◆ Requires large area for installation
- ◆ Much reduced yield in overcast conditions or very cold weather
- ◆ No generation at night
- ◆ Orientation sensitive
- ◆ Generated electricity storage may be impractical due to local site constraints and battery technology limitations. Occasionally the regional electricity company places a cap on the peak simultaneous yield of an array.

4.3. Solar Thermal Heating Panels

Solar thermal uses the sun's free energy as a renewable heat source typically for the generation of hot water. Although electricity is required to power the pump and controls, the primary input energy is solar, where the effectiveness of the system is dependent upon the availability of the sun and the duration of the sunshine and is therefore best suited to areas where the annual sunshine is high.

Generally, the solar thermal systems suitable for application are of the active indirect system type and comprise of either roof mounted flat plate collectors or evaporated tube collectors, solar pumping station/controller, and solar hot water cylinder with indirect heating coil. The solar hot water cylinder will require supplementary heating and backup due to interruptions in sunshine, either by utilising a secondary indirect heating coil fed from the heating system or an electric immersion heater.

Flat Plate Collectors (FPC): Generally, FPCs comprise two horizontal header pipes at the top and bottom, with smaller vertical riser pipes connecting between them. The risers have thin absorber fins connected to them to increase the surface area and encourage heat transfer. Heat transfer fluid containing anti-freeze is circulated through the collectors by the solar pumping station/controller where the available heat is absorbed into the fluid. This heat is then transferred from the fluid to potable water by means of an indirect heating coil within a hot water cylinder. Typically, the type of glass used in flat plate collectors enables them to withstand significant hail without breaking, and for this reason flat plate collectors are considered the most durable collector type. In addition, FPCs perform better in full sunshine conditions.

Evacuated Tube Collectors (ETC): Unlike FPCs the ETC's pipes are encased by two concentric tubes, and the air between the concentric tubes is evacuated to create a vacuum, where the inner tube is coated with a thermal absorbent to encourage heat transfer into the systems heat transfer fluid. As convection cannot occur across a vacuum the heat loss to the environment is reduced significantly, enabling the ETC to perform slightly better than FPCs in cloudy or cold conditions. The life of the vacuum is limited, and as a result the performance of the collector can decay over time. Generally, ETCs are susceptible to damage from hail.

Usually, the collectors are located on the roof and must be positioned so that they are southeast or southwest facing and angled to maximise the sunlight absorbed by the panel as the sun travels across the sky. When fixing to existing roofs, the weight and hence structural requirements must be carefully considered. The collectors require minimal maintenance; however, the performance of the collectors is inhibited if not regularly cleaned, and therefore access should be considered during the development of the scheme.

Pros

- ◆ Zero noise
- ◆ Produces nearly free and renewable heat thus reducing dependency on fossil fuels
- ◆ Funding grants are available for particular panel types through the Renewable Heat Incentive (RHI) and financial contribution provided for every kWh of renewable energy produced for installations

- ◆ Possible use as a zero carbon source of heating to augment the domestic hot water generation

Cons

- ◆ Sensitive to over shading
- ◆ System yield is heavily depended on external weather conditions i.e. daylight and temperature conditions
- ◆ Restriction on orientation (though this is near optimal at Devonshire Place; a roof array would face due south)
- ◆ Limited yield and therefore longer return on investment
- ◆ Heat needs to be used at point of use or stored for future use
- ◆ Some losses in renewable heat can be found where heating and hot water demand is low
- ◆ Storage calorifier vessels would be required in each unit where solar water heating is to be used in both central heating and domestic hot water generation, such vessels would take up space and would tend to reduce the net internal floor area
- ◆ Limited DHW demand within the units would tend to render these systems uneconomic

Solar thermal is considered less economic, for this development. Its installation could conceivably be completed independently of the development, post construction. Should this be the case, space would need to be allocated to suitably sized storage vessels within each unit to reduce energy demand for domestic hot water generation.



Figure 3: Solar thermal collector (roof mounted or ground anchored)

4.4. Air, Water and Ground Source Heat Pumps

Units 1 and two of Devonshire Place are both shell and core developments. As such, they are known to have relatively low heating demand, with a requirement for electric heaters within the WC and changing spaces of each unit, but no heating within the main light industrial spaces. Pragmatically, this means that installation of a heat pump system is likely to be uneconomic for such a low heating demand development.

However, this should not preclude heat pump discussion here as an option for retro-fitting of a “wet” heating system by new owners, after shell and core project hand-over. These systems are described below in that context.

Air source heat pumps (ASHP) are commercially available with Coefficient's of Performance (COP) of up to three. In energy terms, and under optimal conditions, this means that for every unit of energy input to the heat pump, the heat pump will generate three units of heat energy that can be utilised for space heating and hot water. Efficiency can be much less, and approach unitary, in colder external conditions. As the primary input energy is electricity this makes the system suitable for applications where fuel deliveries are difficult, or the utility infrastructure is limited, and natural gas is unavailable.

Devonshire Place has two number units in the development. Two possible solutions using heat pump technology are suggested below:

- ◆ Option 1: Individual ground source geothermal heat pumps, one for each unit, comprising:
 - ◆ Small unit sited ground source heat pump – sized to match unit type providing primary heat for the heating & domestic hot water of the unit (one per unit).
 - ◆ Local pipework into adjacent ground (or consideration of connection to energy piles under each unit, if these are to be utilised)
 - ◆ Individual unit sited thermal storage vessel to attenuate heating demand with regards to end user domestic hot water and central heating demand.
- ◆ Option 2: Individual air source heat pumps, one for each unit, comprising:
 - ◆ Individual air source heat pumps– sized to match unit type providing primary heat for the heating & domestic hot water of the unit (one per unit).
 - ◆ Individual unit sited thermal storage vessel to attenuate heating demand with regards to end user domestic hot water and central heating demand (one per unit).

The location of the condensing units (external heat pumps) must be considered carefully as they would need to be positioned in such a way as to ensure air movement around the unit is not inhibited. In addition, outdoor units must be located away from noise critical areas, to avoid the ingress of noise to occupied spaces, particularly when windows are opened.

Heat pumps operate using the same principles as a domestic fridge. Typically, when in heating mode the ambient air is distributed over the external condensing heat exchanger located in the outdoor unit by a fan. The available heat from the air is absorbed by a low-pressure liquid refrigerant at the evaporator; this energy transfer converts the refrigerant into a vapour. The low-pressure refrigerant is then compressed into a high pressure vapour by a compressor in the outdoor unit. The refrigerant is then distributed from the outdoor unit to the indoor module (boiler equiv.) using refrigerant pipework. Heat is then transferred from the refrigerant into a low temperature hot water circuit at the condenser heat exchanger located in the indoor module.

Using this method, low temperature hot water from +35°C to +55°C can be achieved, depending upon the manufacturer. Most modern ASHPs are suitable for both low grade heat applications such as underfloor heating, as lower operating temperatures are desirable in order to achieve higher efficiencies, and also provision of higher temperature heat applications such as domestic hot water.

Typically, these temperatures will be generated to +55°C for use at the taps, with a periodic pasteurisation cycle to raise the temperatures to +60°C. This temperature boost is required to eliminate legionella growth.

Ground source heat pumps (GSHP) are similar in operation to Air Source Heat Pumps (ASHPs). They differ in that heat is absorbed or rejected into the ground instead of the air, typically through the use of a brine or

glycol solution which is circulated through a network of pipes by the heat pump. GSHPs use the solar energy stored within the Earth. At 3m below the ground the earth's temperature remains relatively constant at around 10°C through-out the year. Due to the constant ground temperatures, a GSHP can operate at optimum efficiency in both heating and cooling, as unlike ASHPs the high summer or low winter temperatures do not influence its performance. GSHPs can offer COPs of greater than 4, but are often less than this.

Generally, GSHP systems comprise of a thermal store and heat pump (containing the refrigerant plant) connected to either vertical closed loops such as boreholes or horizontal closed loops such as slinky coils.

Either a series of bore holes are drilled down into the ground at a depth of between 50 and 130m (depending upon the geology of the site), or a pipe loop is embedded within the piles of the structure(s) (also known as energy piles), or a pipe (known as a "slinky") is installed whereby coiled pipe is overlapped and laid at the bottom of a trench dug to a depth of between 1.7 to 3m.

There are various refrigerant types used in commercially available heat pumps, where the most common of these is R32, R410a, and R134a etc. These refrigerants have insignificant ozone depletion potential (ODP), however, they still have a high global warming potential (GWP).

Pros

- ◆ High system efficiencies can reduce dependency on fossil fuels compared to other systems / fuel sources
- ◆ Funding grants are available through the Renewable Heat Incentive (RHI) for systems less than or equal to 45kWth

Cons

- ◆ System noise & condenser size can bring issues in terms of location and appearance
- ◆ Available and suitable land for ground source piping network
- ◆ Delivered hot water temperatures can be low and result in an increase in electric immersion heating, thus dependency on energy use from national grid being increased
- ◆ Some system refrigerants have a high Global Warming Potential (GWP) and are deemed bad for the environment

Only air source heat pumps are considered suitable for future investigation, as significant extra capital expenditure in excavating ground source trenches and boreholes mean ground source heat pumps have a much longer return on investment.

4.5. Biomass Heating

Biomass is a renewable energy source and can be seen as a sustainable fuel source for biomass boilers to generate heat for space heating and hot water. However, the financial and carbon cost of fuel transport to the islands, together with the additional pollution created by that transport, makes this fuel less feasible for the Devonshire Place development. Furthermore, additional costs of ash disposal and the associated negative impact on health of reduced air quality suggest strongly that biomass boilers are not appropriate for this development.

4.6. Combined Heat and Power

Combined heat and power units are typically gas fired, though a small number are biomass fueled. Similar in nature to a car engine, they are approximately 50% thermally efficient, (which would be used for heating

and domestic hot water) and are about 30-35% efficient in electricity generation. Circa 15-20% of energy input into CHP is lost.

CHP demands a constant base heating load, as they are less efficient when cold at start up. They are much more common in non-domestic buildings such as hotels, swimming pools and hospitals, which have a steady thermal demand.

4.7. Geothermal

Geothermal arrays are typically only viable in locations where hot springs are known to exist. This technology is considered unviable in Chard, with the nearest geothermal spring of adequate reliability being in Bath, north-east Somerset.

4.8. Tidal

Given the landlocked nature of this site, tidal renewables are not considered viable.

5. RECOMMENDED LZC TECHNOLOGIES FOR DEVONSHIRE PLACE

5.1. Air Source (Air to water) Heat Pumps

Air source systems are now common for new build developments around the UK, and the market is mature. Such systems are expected to form the backbone of carbon efficient heating and DHW generation systems for domestic properties in the U.K. going forward.

As such, prices of units and associated maintenance agreements tend to be lower than their ground source counterparts. This is particularly the case for decentralized units where one heat pump serves each unit.

Modern refrigerant R32, is more environmentally friendly with low ozone depletion properties. Life cycles of well-maintained units are at least 15 years.

The final siting of the external element of the heat pump needs consideration and the side of the units away from vehicular traffic seems more appropriate. Low noise units are also available.

Air source heat pump technology is considered *potentially* viable in this instance as a cost-effective means of providing heating where the new users of the units install the systems, if the heating demand increases.



Figure 4: Typical air source heat pump, Mitsubishi Electric Ecodan unit

5.2. Photovoltaic Panels

The PV installation proposed will be ineligible for a feed-in-tariff. However, a PV array is considered appropriate and feasible, and less prone to overshadowing if mounted on the roof.

Consideration of how the panels will integrate with the proposed roofing systems would be required, particularly with respect to loading and how this can be supported by the structure. An on-roof system with suitable interfaces to the structure for the installation of the panel support system to be considered further by the Architect and Structural Engineer as the design is developed.

This technology is considered viable and preferable as a cost-effective means to achieve local planning and BREEAM requirements.



Figure 5: Domestic PV array image

5.3. Mechanical ventilation heat recovery units

MVHR units are recommended to provide filtered fresh air which is pre-conditioned by the exhaust air within the unit prior to entering the rooms. This reduces air source heat pump energy demand, reducing energy bills and carbon emissions.

6. LZC TECHNOLOGY RESULTS ASSESSMENT

6.1. Technology suitability

The table below is an extract taken from Appendix A, where the advantages and disadvantages of different technologies for the Devonshire Place development are assessed and scored, with the most appropriate for inclusion having the highest score and the least suitable, the lowest score. A score of above 5.0 is considered appropriate for inclusion in the development, and below 5.0 is not.

Roof mounted PV panels feature strongly for the new development and are considered an important part in improving the on-site, zero carbon power generation capacity of the development. With increasing electricity demand, they will serve a very important part in reducing building running costs for landlords and tenants alike.

Air source heat pumps are considered the second most important element in the new development, with individual heat pumps serving each dwelling. Single bed apartments may be served by heat pumps within mechanical ventilation heat recovery units, whereas larger dwellings will need the more standard external condensing units, capable of generating both central heating and domestic hot water, together with mechanical ventilation heat recovery units for the dwellings too.

As noted above, there is no local district heating system within economic reach of this development, so this solution has not been scored here,

Devonshire Road, Port Talbot - LZC synopsis		
Renewable / LZC Technology	Final score / 10	
Photovoltaic Panels	7.83	Feasible LZC technologies for Devonshire Road, Port Talbot
Air Source Heat Pump (Post construction, for consideration by prospective shell and core fit-out responsible tenant)	6.00	
Mechanical Ventilation Heat Recovery units	>5.00	
Solar Thermal Heating Panels	4.05	LZC technologies not recommended Devonshire Road, Port Talbot
Ground Source Heat Pump	3.75	
Water Source Heat Pump	3.20	
Wind	3.80	
Biomass Heating	3.60	
Combined Heat and Power	3.00	
Geothermal	2.80	
Tidal	2.73	
Local District heating (not available or considered)	<5.00	
* For further LZC description refer to Appendix A.		

Table 1 - Low and zero carbon technology breakdown

6.2. Carbon emissions

The regulated carbon emission figures for the development will be examined under separate energy modelling, which is reliant on detailed drawn plans, sections and elevations.

An initial assessment, by way of a route map and comparator for dwellings, is included within Appendix B showing the progressive improvements of dwellings to get to zero carbon, should this become a requirement.

7. INITIAL PV ASSESSMENT

7.1. Photovoltaic Panel Proposal

Based on the review of available LZC technologies, a roof array of photovoltaic panels is recommended as a viable means of achieving compliance with Neath Port Talbot Council.

Using the Photovoltaic Geographical Information System (PVGIS) energy calculator the electricity generation of the proposed PV system has been predicted using empirical climate data for the site. The results and data inputs are shown below.

As an initial assessment, and before detailed plans, sections and elevations are available, the proposed installation coupled with passive and energy efficiency measures has a DRAFT annual yield of circa 33,700 kWh + / - 1800kWh / annum, to help offset the developments carbon emissions.

A DRAFT PV array for the development, which falls within local electricity District Network Operator (DNO) export is shown below and suggests initial quantum for site PV area, peak output and annual yield.

The figures identified herein are purely for information and are applicable for this early stage of the development only. We would recommend a more detailed design analysis is undertaken at subsequent RIBA stages to provide greater certainty on quantum of PV and yields.

Table 2 – RIBA stage 2 PV Yield

All Devonshire Place Buildings	Photovoltaic Peak Power (kWp)	Approximate Photovoltaic Area per dwelling (m ²)
Typical rooved dwelling (average over the development)	1.136	8
42 No. dwellings	42 x 1.136	42 x 8
Total	47.712	336

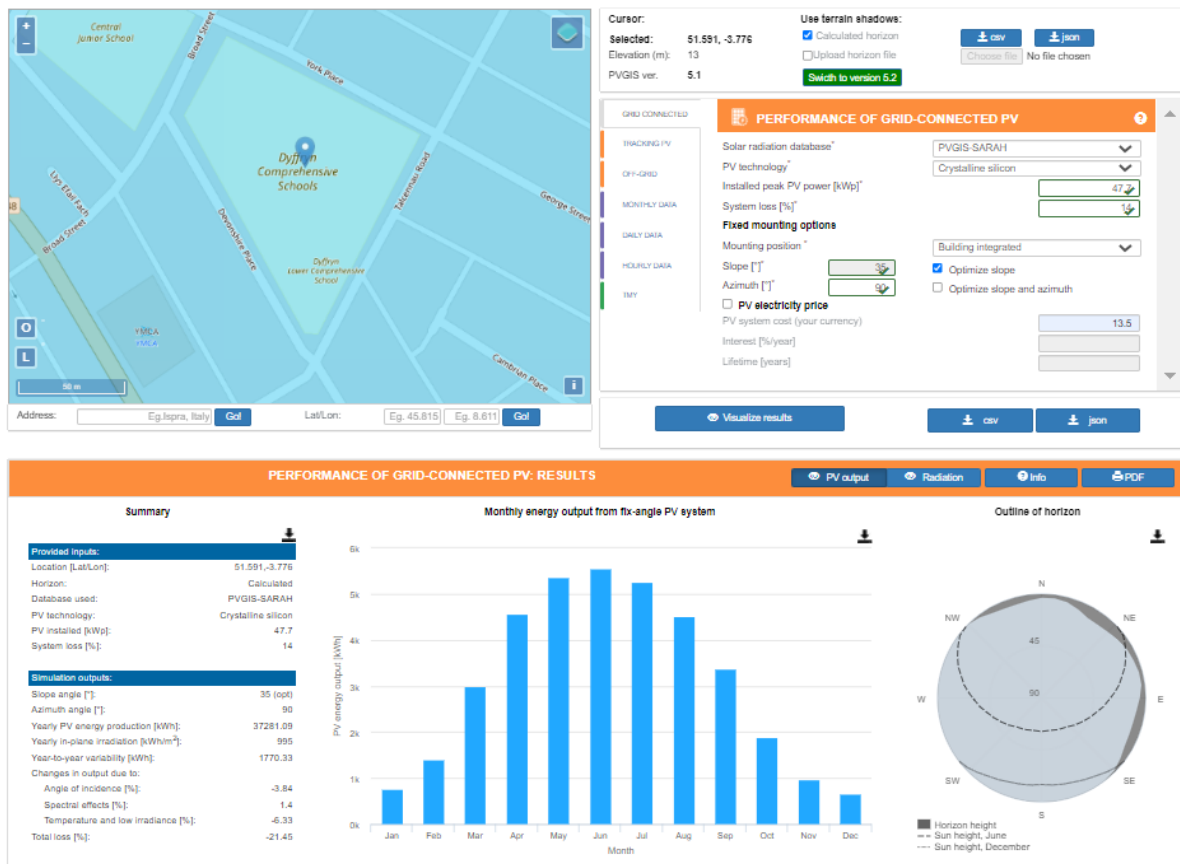


Figure 3 details calculation breakdown photovoltaic area and approximate available array area (8m² per unit)

7.2. Additional LZC Technologies

Please refer to the table in Appendix A for the results calculation table assessing appropriate low and zero carbon renewables technologies.

8. CONCLUSIONS

We conclude this document is based on our understanding the development is proceeding under the current Wales Part L1(A)2014 regulations.

We appreciate these are due to change soon, but haven't yet been published, so this report takes guidance from the UK building regulations for England, which changed on 15th June 2022, with the introduction of Part L1(A)2021 for England.

We conclude these are more energy efficient standards than the current part L 2014 Wales regulations, are closer to where the new Welsh regulations are expected to be in terms of efficiencies applied to the modelling processes underpinning this report.

We conclude the use of air tight, thermally efficient construction fabric, with openable windows to enhance cross flow and single sided ventilation, roof mounted photo-voltaic panels, air source heat pumps and MVHR units are all sensible, economic solutions in the drive to deliver energy efficiency and a net zero carbon economy.

9. RECOMMENDATIONS

We recommend the following inclusion with this shell and core development:

- ◆ Individual air source heat pumps serving each dwelling's central heating and domestic hot water requirements
- ◆ Thermally efficient, airtight building fabric with constructions, as set out in the architect's report.
- ◆ Mechanical ventilation heat recovery units with heat recuperation efficiencies of at least 75%, to assist compliance with part F and part O of the building regulations.
- ◆ Completion of a detailed PV energy design and assessment at RIBA stage 3 to provide the District Network Operators (DNO's) with more refined development peak and annual generation yields. This will become very important under the new U.K. part S regulations where electric car charging needs to be accommodated.

We do not advise comparison between design stage carbon emission figures and this feasibility report due to different calculation details.

We recommend consideration is given to the specifications detailed in this report and summarized above, as these will assist with gaining compliance with Part L of Building Regulations, and Local Plan Policies (NPTCBC...SP18...RE1...RE2).

10. REFERENCES

The Building Regulations 2010: Conservation of Fuel and Power Part L1A. Conservation of fuel and power (New buildings other than dwellings) (2013 edition incorporating 2016 amendments, with reference to the new 2021 edition, valid from 15th June 2022). HM Government. ISBN 978-1-85946-512-7.

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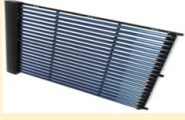
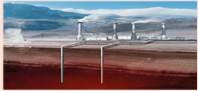
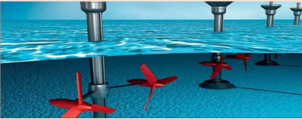
Met Office National Meteorological Library and Archive Fact Sheet 7 – Climate of South-West England

Appendix A

Devonshire Place Fabric and LZC Solutions

Devonshire Place, Port Talbot

Low & Zero Carbon Technology Appraisal

Ref.	LZC technology	Image	Description*	Fuel Type	Fuel generation	Benefit of fuel carbon	Installation costs (score)	Payback time	Advantage	Score	Disadvantage	Score	Final Score (0 to 10)	Appropriate for site?
1.	Photovoltaic Panels		Photovoltaic (PV) systems convert energy from the sun into electricity that can be used to power lighting and other electrical appliances.	Solar energy (zero carbon)	Electricity	10	10	8	Zero noise Electricity can be generated during overcast conditions Produces free (excluding cost of initial purchase and installation) electrical energy Orientation is flexible but does affect yield Can be building or ground mounted, or integrated into the building structure Limits reliance on fossil fuels	8 8 10 7 6 10	Orientation sensitive Need to be installed in areas without shading limiting location Requires large area for installation No generation at night Reduced yield in overcast conditions Reduced yield in very cold weather Generated electricity storage may be impractical due to local site constraints and battery technology limitations.	5 2 4 0 3 4 3	7.83	Yes
2.	Solar Thermal Heating Panels		Solar thermal uses the sun's free energy as a renewable heat source typically for the generation of hot water.	Solar energy (zero carbon)	DHW and/or; Central heating	4	4	4	Zero noise Produces nearly free and renewable heat thus reducing dependency on fossil fuels Orientation is flexible but does affect yield Possible use as a zero carbon source of heating to augment the domestic hot water generation	6 6 6 6	Sensitive to over shading System yield is heavily depended on external weather conditions i.e. daylight and temperature conditions Heat needs to be used at point of use or stored for future use Orientation sensitive	2 2 2 3	4.05	No
3.	Air Source Heat Pump (Post construction, for consideration by prospective shell and core fit-out responsible tenant)		Air-source heat pumps take their heat from ambient air, so utilise a fan to suck air into a heat exchanger to extract the heat and evaporate the refrigerant inside the heat pump.	Electricity	Central heating and/or; DHW	7	7	7	This type of system is likely to become more favorable considering future decarbonisation of the grid. High system efficiencies can reduce dependency on fossil fuels compared to other systems / fuel sources.	7 7	System noise. Condenser size can bring issues in terms of location and aesthetics. Not always effective at providing heat during cold periods (<10°C). Most system refrigerants have a high Global Warming Potential (GWP) and are deemed bad for the environment.	3 3 2 0	6.00	Yes
4.	Ground Source Heat Pump		Ground-source heat pumps benefit from the steadier and warmer temperatures available from the ground compared to ambient air. They use boreholes or buried coils of tubing to extract the heat and this is piped back to a the heat pump.	Electricity	Central heating and/or; DHW	4	4	4	High system efficiencies can reduce dependency on fossil fuels compared to other systems / fuel sources. This type of system is likely to become more favorable considering future decarbonisation of the grid. Low noise. No aesthetic issues as the system is installed under the ground.	6 6 6 6	Potential problems associated with installing pipework deep underground, as a result of leaks or blockages. Available and suitable land for ground source piping network High capital cost linked to the excavation process and might result in a long-term payback. Most system refrigerants have a high Global Warming Potential (GWP) and are deemed bad for the environment.	3 0 0 0	3.75	No
5.	Water Source Heat Pump		Water-source heat pumps use a static or flowing water source as the heat source, so typically a river, canal or lake, though wells and the sea can also be used. The amount of heat that can be extracted from water is much higher than the ground, and in the case of flowing water there is no risk of depleting the resource of heat because it is being continuously replenished.	Electricity	Central heating and/or; DHW	3	2	2	Low noise. The site is located close to a water source	6 6	Special planning permissions needed to install water heat pumps The site must be located close to a water source Most system refrigerants have a high Global Warming Potential (GWP) and are deemed bad for the environment.	3 3 3	3.20	No
6.	Wind		Wind power is the process of harnessing energy from the movement of the wind and converting it to useful forms of mechanical power and electricity.	Wind energy (zero carbon)	Electricity	8	3	1	Produces nearly free and renewable energy thus reducing dependency on fossil fuels. Lends itself to energy storage resulting in clean energy being used when demand is high.	6 6	System noise. System maintenance and relatively short battery life of around six to ten years. Dangerous to some wildlife Wind turbines need to be free from strong turbulence and obstructions such as large trees, houses or other buildings.	1 1 1 1	3.80	No
7.	Biomass Heating		Biomass heating systems burn wood pellets, chips or logs to provide warmth to power central heating and hot water boilers. It releases carbon dioxide when burned, but considerably less than fossil fuels.	Wood chip or; Wood pellets or; Logs or; Briquettes.	DHW and; Central heating.	5	3	3	Reduced dependency on fossil fuels compared to other systems / fuel sources. Can be used for both heating and hot water generation and can form part of a Combined Heat and Power or trigeneration system to produce low carbon heat and electricity. Smaller or large scale systems are available giving opportunity for localised or centralised / district systems.	6 6 6	System noise. Regular system maintenance required. Wood chip storage and plant size needs careful consideration. Fire risk and consideration needed for the same. One of the by-products of biomass material after incineration is carbon dioxide which is bad for the environment. Biomass logistics puts onus on storage layout, size and access and increased carbon dioxide emissions to be considered in delivery of biomass material to site.	1 1 1 1 1 1	3.60	No
8.	Combined Heat and Power		Combined Heat and Power (CHP) is an energy efficient technology that generates electricity and captures the heat that would otherwise be wasted to provide useful thermal energy that can be used for space heating, cooling, domestic hot water and industrial processes.	Hydrogen or; Natural gas or; Propane or; Methanol.	DHW and; Central heating and; Electricity.	2	2	2	Reduced dependency on fossil fuels compared to other systems / fuel sources. Can be used for both heating and hot water generation to produce low carbon heat and electricity. Smaller or large scale systems are available giving opportunity for localised or centralised / district systems.	6 6 6	System noise. Regular system maintenance required. Design of the system needs careful consideration to ensure the building heating and / or hot water demand is sufficient for the CHP to run for the optimum number of hours. Under sizing or oversizing the CHP plant will result in lesser number of running hours, and as a result, electricity yield reduced.	3 3 3	3.00	No
9.	Geothermal		Geothermal energy is the heat that comes from the sub-surface of the earth. It is contained in the rocks and fluids beneath the earth's crust and can be found as far down to the earth's hot molten rock, magma. To produce power from geothermal energy, wells are dug a mile deep into underground reservoirs to access the steam and hot water there, which can then be used to drive turbines connected to electricity generators.	Geothermal energy	Electricity	5	1	1	Reliable source of power Relatively small land footprint Usable for large and small-scale installations Geothermal infrastructure has long lifespan	6 6 6 6	Location dependent Geothermal reservoirs above 100°C are usually necessary High construction costs Can lead to surface instability	1 1 1 1	2.80	No
10.	Tidal		Tidal energy is produced by the surge of ocean waters during the rise and fall of tides. Underwater turbines use this movement of water to harness kinetic energy and convert it into electrical energy.	Tidal energy (zero carbon)	Electricity	5	1	1	Tides are predictable and reliable (cyclic) Tidal energy systems have long lifespans Effective at low speeds	6 6 6	Tidal generators under water can wreak havoc on aquatic ecosystems (environmental impact) High construction costs Scarcity of suitable locations. The system requires a very specific set of factors in order to operate effectively and efficiently.	1 0 1	2.73	No

Appendix B

Devonshire Place typical new dwelling; SAP route to zero carbon results

Devonshire Place: DRAFT Pre-detailed modelling detached dwelling test case

Base_part L1a SAP 2012 compliant

Fabric	0.15u walls, 0.11u roof, 0.11u floor, 1.2u openings
Openings	1.2u openings, 0.63 g value
Air permeability	4
Ventilation	Natural and intermittent extract fans
Lighting	Low energy
Heating	Gas combi boiler SAP efficiency 90%
Water heating	Gas combi boiler SAP hot water efficiency 63.1%
Renewables	2 kWp system facing south with 30° inclination



Figure 1 The three parts of the Government's stepped policy approach to zero carbon homes. Zero carbon is achieved through:

- good fabric energy efficiency,
- inclusion of on-site low carbon heat and power technologies, and
- use of Allowable Solutions to compensate for carbon emissions reductions that are difficult to achieve on site



Built form	Fabric Standard (FEES) (max. energy demand for space heating & cooling)	Carbon Compliance (max. on-site carbon emissions from the home's design & construction)
Detached houses	46 kWh/m ² /year	10 kgCO ₂ /m ² /year
Semi-detached houses	46 kWh/m ² /year	11 kgCO ₂ /m ² /year
End of terrace houses	46 kWh/m ² /year	11 kgCO ₂ /m ² /year
Mid terrace houses	39 kWh/m ² /year	11 kgCO ₂ /m ² /year
Apartment blocks	39 kWh/m ² /year	14 kgCO ₂ /m ² /year (up to 4 storeys)

Strategy	Description	Dwelling Fabric Energy Efficiency kWh/m ² /year	Target Fabric Energy Efficiency kWh/m ² /year	Dwelling Emission Rate Kg.CO ₂ /m ² /year	Target Emission Rate Kg.CO ₂ /m ² /year	Improvement over target %	Energy Performance Rating (Rating A-G)	Compliant with future guidelines?	Comments
Base	Part L1a SAP 2012 Compliant	58.33	58.39	14.96	15.39	2.79%	C	Risk. Under 40% improvement.	Base case only
A Improved Fabric	0.1u walls_0.08u roof_0.08u floor_1.2 openings	52.03	58.39	13.41	15.39	12.87%	C	Risk. Under 40% improvement.	As base, plus this, fabric first - passive design.
B Accredited Thermal Bridging	Achieves 0.085 y-value	41.44	58.39	10.75	15.39	30.15%	B	Risk. Under 40% improvement.	As above plus reduction of heat loss through thermal bridging.
C Multi Ventilation Heat Recovery	Multi ventilation heat recovery and air permeability 3	40.62	58.39	8.82	15.39	42.69%	B	Reduced risk Over 40%	As above plus reclamation of heat from mechanical air stream OK - utilise MVHR in design.
D Direct Electric	Direct electric heating and hot water	40.62	58.39	16.91	21.6	21.71%	B	Risk. Under 40% improvement.	Do not use in design.
E Electric Air Source Heat Pump	Air Source Heat Pumps for heating and hot water	40.62	58.39	7.63	21.6	64.68%	A	Reduced risk. Over 40% improvement.	As above plus individual ASHPs to each dwelling. Reduced cap-ex & internal dwelling space requirements. Seems optimal.
E Electric Ground Source Heat Pumps	Ground Source Heat Pump heating and hot water	40.62	58.39	6.25	21.6	71.06%	A	Reduced risk. Over 40% improvement.	Do not use in design. Central ground source array and pumpset etc, which requires separate plant centre, serving multiple end heat pump units. Significant extra cap-ex (drilling) costs and maintenance costs.
PROVISIONAL FIGURES ONLY. E Additional 1.13 kWp/dwelling Total system 47 kWp Anticipated yield 33,700kWh / annum		40.62	58.39	-0.66	21.6	103.06%	A	Least risk. Carbon negative.	As above plus strategic decision required on whether to go for carbon negative development. Results dependent on clear unshaded area, & roof space, DNO compliance and more detailed stage 3 SAP analysis.
OR									Red text: Option by itself not not considered feasible going forward.
Allowable solutions to compensate for carbon emissions that are difficult to achieve on site									Grey text: Base Option not applicable on its own for this project. Green text: Option considered feasible to drive LZC strategy for this development.



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