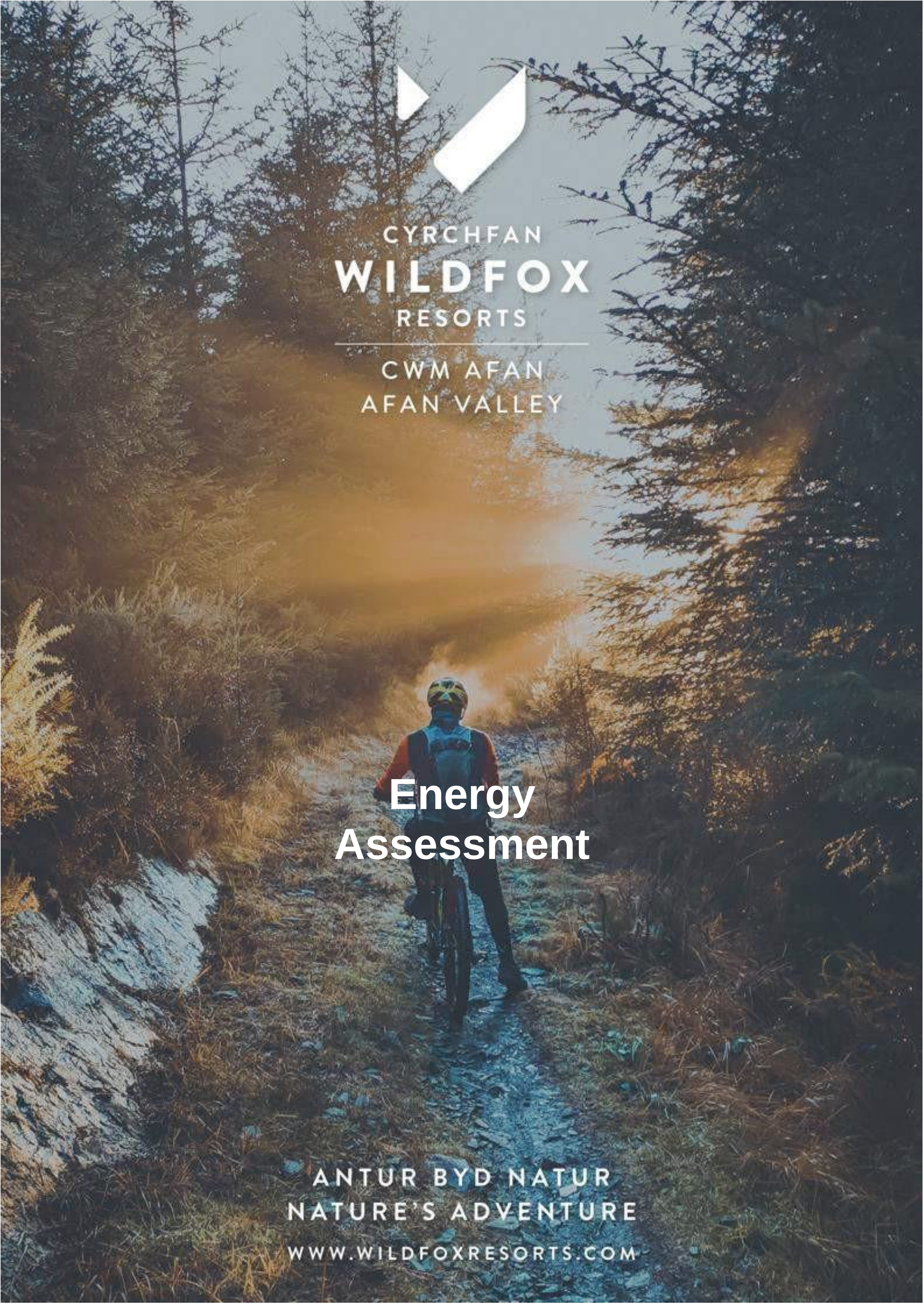

Energy Assessment

EXECUTIVE SUMMARY

INTRODUCTION

1. This Energy Assessment report supports a reserved matters application (RMA) relating to an existing outline planning permission reference P2018/0493 for the development of land at Pen Y Bryn, Croeserw Cymmer, Port Talbot. It describes the development's energy strategy, in the context of planning policy and the relevant reserved matters.

2. In accordance with supplementary planning guidance, the scope of the report covers the following.

    1. The likely energy demand of the development;
    2. The potential for renewable / low carbon energy generation on the site;
    3. The availability and potential to connect to existing sources of renewable / low carbon energy;
    4. The potential for incorporating or being part of a District Heating System; and
    5. The potential to share renewable / low carbon energy generated on the site.

3. The approach and strategy associated with developing a low carbon development Interlinked with a wider renewable energy Infrastructure has been discussed with NPT Planning Authorities and support for the concept and methodology received. Some aspects of that require further Investigation and design development which Is not applicable to this assessment reporting, but we welcome further engagement as the detail develops.

METHODOLOGY

4. At the outline planning application stage, the baseline was estimated using benchmark data applied through the Enplanner tool. The calculations presented in the report are based on the methodologies used for Building Regulations compliance.

5. Building Regulations are a devolved responsibility in Wales, Scotland and Northern Ireland. In Wales, Part L *Conservation of Fuel and Power* will soon be updated, with the 2022 editions of the Approved Documents coming into effect on 23/11/2022. However, the calculation methodologies and software are not yet available.

6. It is understood that Part L 2022 (Wales) will be much more closely aligned to Part L 2021 (England) than the current Part L 2014 (Wales). Therefore, for the purposes of this report, the calculation methodologies are those used for Part L 2021 (England) compliance and present a more realistic and appropriate carbon emission benchmark for the assessment.

ENERGY DEMAND

Baseline

7. The first step in assessing energy demand is to define the baseline against which reductions in energy consumption and GHG emissions are reported. The baseline is defined as compliance with Part L 2021 (England), which is intended to approximate compliance with Part L 2022 (Wales).

8. Table 1 shows that there are significant reductions in baseline energy consumption and GHG emissions relative to the outline proposals. This is primarily because Part L 2021 (England):

- Sets much higher standards of energy performance; and
- Uses more up-to-date emissions factors, reflecting the ongoing decarbonisation of grid electricity.

Table 1: Baseline consumption and emissions under outline and detailed proposals

Parts of development	Outline proposals: energy consumption (MWh/yr)	Outline proposals: GHG emissions (tCO_2/yr)	Detailed proposals: energy consumption (MWh/yr)	Detailed proposals: GHG emissions (tCO_2/yr)
Domestic (lodges)	6,664	3,181	6,063	887
Non-domestic (others)	7,578	2,250	4,332	588
TOTAL	14,241	5,695	10,395	1,475

Demand Reduction

9. A range of demand reduction measures is proposed, including the following.

- Insulated opaque building fabric with low air permeability
- Glazing with appropriate U-value, g-value and daylight transmittance
- Heat pumps
- Mechanical ventilation with heat recovery
- High efficacy lighting

10. Table 2 shows the impact of these measures on consumption and emissions, relative to the baseline.

Table 2: Effect of demand reduction measures on consumption and emissions

Parts of development	Detailed proposals for demand reduction: energy consumption (MWh/yr)	Detailed proposals for demand reduction: GHG emissions (tCO_2/yr)	Improvement over baseline: energy consumption	Improvement over baseline: GHG emissions (tCO_2/yr)
Domestic (lodges)	3,181	453	48 %	49 %
Non-domestic (others)	4,152	564	4 %	4 %
TOTAL	7,333	1,017	29 %	31 %

HEATING INFRASTRUCTURE

11. Heat demand density is low across most of the site. However, there is sufficient density to support a heat network within the central part of the site.

Offsite Heat Network

12. The outline proposals identified the potential for connection to the Caerau Heat Scheme (CHS). This remains a possibility but repeated attempts to initiate dialogue with the scheme's project manager have not to date been successful. Therefore, the proposals do not currently include connection to the CHS but there is a commitment to continue to investigate the technical, environmental and economic feasibility of connection.

Onsite heat network

13. The outline proposals included a heat network serving the central part of the site. The primary heat generation technology was gas-fired combined heat and power (CHP), supplemented by gas-fired boilers. Gas CHP was once viewed as a transition technology, as it burned fossil fuel in a more efficient way than other technologies. However, due to the decarbonisation of grid electricity, there is in environmental terms no merit in burning gas to generate electricity, even where waste heat from the process is captured and utilised.

14. The detailed proposals take a different and modern approach, incorporating an ambient loop heat network. This exclusively uses electric heat pump technology and facilitates recovery of heat rejected from the provision of cooling. Thermal storage optimises peak demand and infrastructure costs; since the heat generators are electric heat pumps, the thermal storage could also in effect provide electricity storage, allowing utilisation of surplus 'real-time' electricity generation and/or more favourable off-peak consumption tariffs.

RENEWABLE/LOW-CARBON ENERGY

Offsite Generation

15. The proposals do not currently include a private wire or sleeved connection from a local windfarm to the site but there is a commitment to continue to investigate the technical, environmental and economic feasibility of connection.

Onsite Generation

16. The outline proposals suggested that small-scale biomass secondary heating (e.g. log burners within lodges), photovoltaics and solar thermal *may* be suitable and should be considered in the development of the detailed proposals.

17. A further assessment of these options found that biomass and solar thermal would not be suitable but that photovoltaic (PV) systems would be. Across the site, PV systems with a total installed capacity of 373 kW_p are estimated to further reduce energy consumption and GHG emissions by 4 %.

CONCLUSION

18. This report demonstrates that the energy strategy set out in the outline proposals has been developed in to more robust and detailed proposals, which respond to regulatory change and adopt a 'net zero ready' approach, while addressing planning policy and reserved matters.

19. Table 11 shows the overall energy performance of the detailed proposals, incorporating demand reduction, heat pumps and PV systems.

Table 3: Consumption and emissions under detailed proposals

Parts of development	Detailed proposals for demand reduction: energy consumption (MWh/yr)	Detailed proposals for demand reduction: GHG emissions (tCO_2/yr)	Improvement over baseline: energy consumption	Improvement over baseline: GHG emissions (tCO_2/yr)
Domestic (lodges)	3,181	453	48%	49%
Non-domestic (others)	3,877	526	10%	11%
TOTAL	7,058	979	32%	34%

20. In addition, an energy education facility is proposed. This would be hosted in the multifunction room within the Wildfox Hotel building and would document the site's previous uses (including coal mining), its ecology, and the development's energy strategy, with reference to onsite and offsite infrastructure.

1.0 INTRODUCTION

SCOPE OF APPOINTMENT

1.1 Stantec has been instructed by Afan Valley Limited to prepare an Energy Assessment in support of a reserved matters application (RMA) relating to an existing outline planning permission reference 2018/0493 for the development of land at Pen Y Bryn, Croeserw Cymmer, Port Talbot.

OUTLINE PLANNING PERMISSION

1.2 A planning application for the following proposal was submitted and validated by the local planning authority (LPA), Neath Port Talbot County Borough Council (NPTCBC), on 25/07/2018. The LPA's reference is P2018/0493.

1.3

Outline planning application (including access) for a proposed adventure resort comprising 600 no. lodges/apartments, 100-bed hotel with associated spa, central plaza containing restaurants, leisure activities and shops, adventure activities and associated buildings (including X-sports, alpine/ski, forest activities and Trax & Trail), restaurants and associated administration and maintenance buildings and parking for approx. 850 cars, plus associated landscaping, drainage and engineering operations including re-profiling of land, boundary treatment, retaining structures, external lighting and CCTV, and diversion of public rights of way.

1.4 Outline planning permission was granted on 18/01/2022.

1.5 Chapter 9 *Climate Change Mitigation* of the Environmental Statement covered the proposed energy strategy.

PURPOSE OF REPORT

1.6 This report is for submission in support of the RMA and describes the development's energy strategy, in the context of planning policy and the relevant reserved matters. Figure 1 shows the proposed site layout and listed below Is the schedule of buildings covered by the scope of the energy statement.

RMA - reference areas and quantities		
Reference	Building	Treated floor area (m²) *
A_01a	Forest Hub	31
A_01b	Summit Hub	228
A_02	Entrance Pavilion	121
A_03	Back of House	685
A_08	Rock & Wild	9,788
A_09	Spa	2,530
A_10	Wildfox Hotel	9,360
A_11	Wildfox Mountain	3,314
masterplan	Lodges	570 units

* treated floor area is derived from thermal modelling of heated zones - reference should be made to the master accommodation schedule produced by the architect for GIA applicable to the application

Planning Policy

1.7 The following local planning policy and guidance were cited in outline application and remain current.

- Local Development Plan (2011-2026)
- Policy RE2 *Renewable and Low Carbon Energy in New Development*
- Renewable & Low Carbon Energy Supplementary Planning Guidance (July 2017)

1.8 They do not set quantitative targets in respect of energy or emissions.

Reserved matters

1.9 Condition 17 attached to the Approval of Outline Planning Permission states:

For each phase or sub phase of development as agreed under Condition 17, the first reserved matters submission shall be accompanied by an Energy Assessment which shall include, but not be limited to proposed methods of energy production and generation, including renewable energy, together with passive methods to be implemented to achieve energy reduction. The development of each phase shall thereafter be operated in accordance with the scheme as approved.

Reason:

In the interest of sustainability and to comply with the requirements of Policy RE2 of the Neath Port Talbot Local Development Plan.

Figure 1: Proposed site layout – For information only

SCOPE OF REPORT

1.10 The supplementary planning guidance states the following:

An [energy] assessment will be expected to include the following information:

1. *The likely energy demand of the development;*
2. *The potential for renewable / low carbon energy generation on the site;*
3. *The availability and potential to connect to existing sources of renewable / low carbon energy;*
4. *The potential for incorporating or being part of a District Heating System; and*
5. *The potential to share renewable / low carbon energy generated on the site.*

1.11 This report addresses these five points with content arranged as follows.

- Energy demand
- Heating infrastructure (onsite and existing)
- Renewable/low-carbon energy (onsite and existing)

OTHER CONSIDERATIONS

1.12 In developing the energy strategy for the development, other considerations have been taken in to account, as summarised in Table 4. However, it is generally beyond the scope of this report to comment further on these aspects.

Table 4: Other considerations for energy strategy

Consideration	Applicability
Building Regulations	Comply with Part L *Conservation of fuel and power (2022 edition - for use in Wales)*
Energy Performance Certification	Lodge EPC for each dwelling (i.e. each lodge) Lodge EPC for each non-domestic building (except stand-alone buildings with a total useful floor area of less than 50 m²)
Environmental ratings schemes (e.g. BREEAM, LEED)	Not applicable
Industry targets/benchmarks (e.g. LETI, Passivhaus, RIBA)	Not applicable
Client's brief/targets	None advised

2.0 METHODOLOGY

CALCULATIONS

Outline Permission

2.1 The principal tool used to estimate energy consumption and greenhouse gas (GHG) emissions from the operation of the proposed buildings was the online 'Enplanner' assessment tool, developed by the Carbon Trust and selected local planning authorities to help support the process of demonstrating compliance with local planning policies for renewable energy and/or GHG emissions reduction within new development.

2.2 It was considered particularly useful for outline planning applications, where limited design information and energy performance specifications preclude energy modelling using Building Regulations methodologies. Enplanner applied benchmark data based on planning use class and floor area for each building.

2.3 The Enplanner tool is no longer available.

Detailed proposals

2.4 The design proposals have been developed to a level commensurate with the preparation of the RMA, which allows the Building Regulations methodologies to be used for a more robust estimate of energy consumption and greenhouse gas (GHG) emissions.

2.5 Building Regulations are a devolved responsibility in Wales, Scotland and Northern Ireland. In Wales, Part L *Conservation of Fuel and Power* will soon be updated, with the 2022 editions of the Approved Documents coming into effect on 23/11/2022. However, the calculation methodologies and software are not yet available.

2.6 It is understood that Part L 2022 (Wales) will be much more closely aligned to Part L 2021 (England) than the current Part L 2014 (Wales). Therefore, for the purposes of this report, the calculation methodologies are those used for Part L 2021 (England) compliance, implemented through accredited software, as outlined below. This approach was agreed in principle with NPTCBC's Energy Manager, Chris Jones.

- Dwellings
  - Calculation methodology: SAP 10.2
  - Accredited software: Stroma FSAP 10 version 1.0.32
- Non-dwellings
  - Calculation methodology: dynamic simulation modelling (DSM)
  - Calculation engine: Apache (version 7.0.15)
  - Interface: IES Virtual Environment (version 7.0.15)
  - BRUKL compliance check: version v6.1.b.0

2.7 The software has only recently been accredited and released. There have been significant issues affecting the Stroma FSAP software for dwellings. It is understood that these now primarily affect functionality available to users rather than calculation of regulated metrics. One of the key limitations is that energy consumption by regulated end use is not currently available for data export from the software.

2.8 Part L 2021 (England) regulates the following end uses: heating; hot water; cooling; fans, pumps and controls ('auxiliary'); and lighting. The following unregulated end uses have been accounted for:

- Dwellings: cooking and appliances (calculated in accordance with SAP 10.2 Appendix L)
- Non-dwellings: equipment (calculated in accordance with DSM)

2.9 Other unregulated end uses, such as external lighting and other processes such as leisure swimming pool heating and spa functions are not accounted for. These would in due course be assessed in accordance with Part L 2021 (England) requirements for energy forecasting or the Part L 2022 (Wales) equivalent.

EMISSIONS FACTORS

2.10 Paragraph 9.40 of the Environmental Statement notes that Enplanner tool uses out-of-date emissions factors that, in particular, do not reflect decarbonisation of grid electricity over the last decade or so.

2.11 The Part L 2021 (England) compliance calculations uses more up-to-date emissions factors and are therefore likely to show lower GHG emissions for a given level of energy consumption.

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- Non-dwellings: equipment (calculated in accordance with DSM)

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2.14 The Part L 2021 (England) compliance calculations uses more up-to-date emissions factors and are therefore likely to show lower GHG emissions for a given level of energy consumption.

3.0 ENERGY DEMAND

Baseline

3.1 The first step in assessing energy demand is to define the baseline against which reductions in energy consumption and GHG emissions are reported.

Outline Proposals

3.2 The baseline was defined using benchmark data, applied through the Enplanner tool. Table 5 summarises the likely operational energy consumption and GHG emissions as calculated for the outline planning application (refer to Table 9.2: *Building Energy Demand & GHG Emissions (Prior To Mitigation)* in the Environmental Statement.

Table 5: Baseline consumption and emissions under outline proposals

Parts of development	Energy consumption (MWh/yr)	GHG emissions (tCO_2/yr)
Domestic (lodges)	6,664	3,445
Non-domestic (others)	7,578	2,250
TOTAL	14,241	5,695

Detailed Proposals

3.3 The baseline is defined as compliance with Part L 2021 (England), which is intended to approximate compliance with Part L 2022 (Wales).

3.4 Table 6 summarises the revised likely operational energy consumption and GHG emissions, through the calculation of target CO_2 emission rates (TERs). More detailed calculations showing energy demand and GHG emissions by building and by end use are appended,

3.5 There are significant reductions in baseline energy consumption and GHG emissions relative to the outline permission, primarily because of Part L 2021 (England) being used as a more appropriate and current baseline. The new Part L :

- Sets much higher standards of energy performance; and
- Uses more up-to-date emissions factors, reflecting the ongoing decarbonisation of grid electricity.

3.6 Therefore, there is little relevance in comparing the estimated consumption and emissions savings for the detailed proposals in the RMA with those for the outline permission that utilised outdated carbon emission and assessment methodology.

Table 6: Baseline consumption and emissions under detailed proposals

Parts of development	Energy consumption (MWh/yr)	GHG emissions (tCO_2/yr)
Domestic (lodges)	6,063	887
Non-domestic (others)	4,332	588
TOTAL	10,395	1,475

Demand Reduction

Outline Permission

3.7 The following demand reduction measures were identified, with an assumed reduction in energy consumption relative to the benchmark

- Low energy lighting (e.g. LED): 5.00 % saving
- Building fabric insulation: 3.75 % saving
- Energy efficient appliances and equipment: 5.00 % saving

3.8 This 13.75 % reduction in energy consumption achieved a resultant reduction in GHG emissions of 15.1 %.

3.9 Further, relatively modest savings were also identified in connection with the use of heat pumps in buildings other than those connected to a heat network.

Detailed Proposals

3.10 The use of compliance calculations has allowed more comprehensive proposals for demand reduction to be developed. These measures include the following; more detailed information is appended.

- Domestic accommodation (i.e. lodges),
  - Insulated opaque building fabric with low air permeability
  - Glazing with appropriate U-value, g-value and daylight transmittance
  - Heat pumps for space heating and domestic hot water
  - Mechanical ventilation with heat recovery
  - High efficacy lighting
- Non-domestic accommodation
  - Insulated opaque building fabric with low air permeability
  - Glazing with appropriate U-value, g-value and daylight transmittance
  - Heat pumps for space heating, space cooling and hot water
  - Distributed hot water generation to reduce storage and distribution losses
  - Mechanical ventilation with heat recovery
  - Power factor correction
  - High efficacy lighting

- Lighting controls including occupancy and daylight detection

3.11 It is anticipated that the Future Homes and Buildings Standard will be adopted in 2025. Its key objective is for all new homes and buildings to be 'net zero ready', i.e. not requiring retrofitting and dependent only on grid electricity decarbonisation to ultimately achieve net zero operational GHG emissions.

3.12 Ahead of the 2025 target date, the detailed proposals adopt a 'net zero ready' approach through high levels of demand reduction and full electrification of heat. There are three variants of electric heating proposed.

- Lodges: individual monobloc hydronic air-source heat pumps
- Wildfox Mountain: reverse-cycle hydronic air-source heat pumps
- Standalone buildings: reverse-cycle variable refrigerant flow (VRF) air-source heat pumps
- Buildings connected to onsite heat network: refer to following section for details

3.13 Table 7 summarises the estimated effect of the demand reduction measures, including heat pumps, on operational energy consumption and GHG emissions. More detailed calculations showing energy demand and GHG emissions by building and by end use are appended.
Table 7

Table 7: Consumption and emissions under detailed proposals for demand reduction

Parts of development	Detailed proposals for demand reduction: energy consumption (MWh/yr)	Detailed proposals for demand reduction: GHG emissions (tCO_2/yr)	Improvement over baseline: energy consumption	Improvement over baseline: GHG emissions (tCO_2/yr)
Domestic (lodges)	3,181	453	48 %	49 %
Non-domestic (others)	4,152	564	4 %	4 %
TOTAL	7,333	1,017	29 %	31 %

3.14 The results show significant differences in energy performance between the domestic and non-domestic parts of the development, despite similar demand reduction measures being applied in both cases. The primary explanation for this is as follows.

3.15 For the domestic calculations, the notional dwelling used to calculate the baseline always has heat generated by a gas-fired boiler (except where the actual dwelling is connected to an existing heat network). If the actual dwelling uses an efficient electric heat pump, the GHG emissions for heat generation are much lower in comparison. For the non-domestic calculations, this is not the case as the notional building used to calculate the baseline generally mirrors the heating fuel used in the actual building, so there is less inherent comparative benefit to using heat pumps (though doing so reduces the provision of photovoltaics in the notional building).

3.16 Figure 2 and Figure 3 show annual energy consumption by building and by end use respectively.

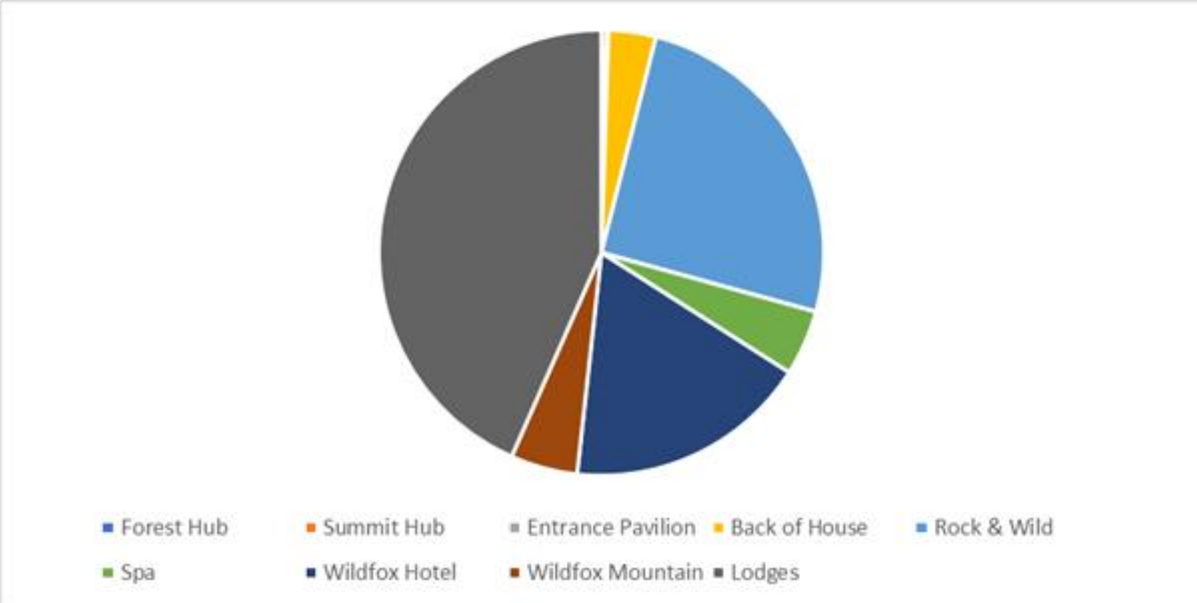

Figure 2: Annual regulated energy consumption by building

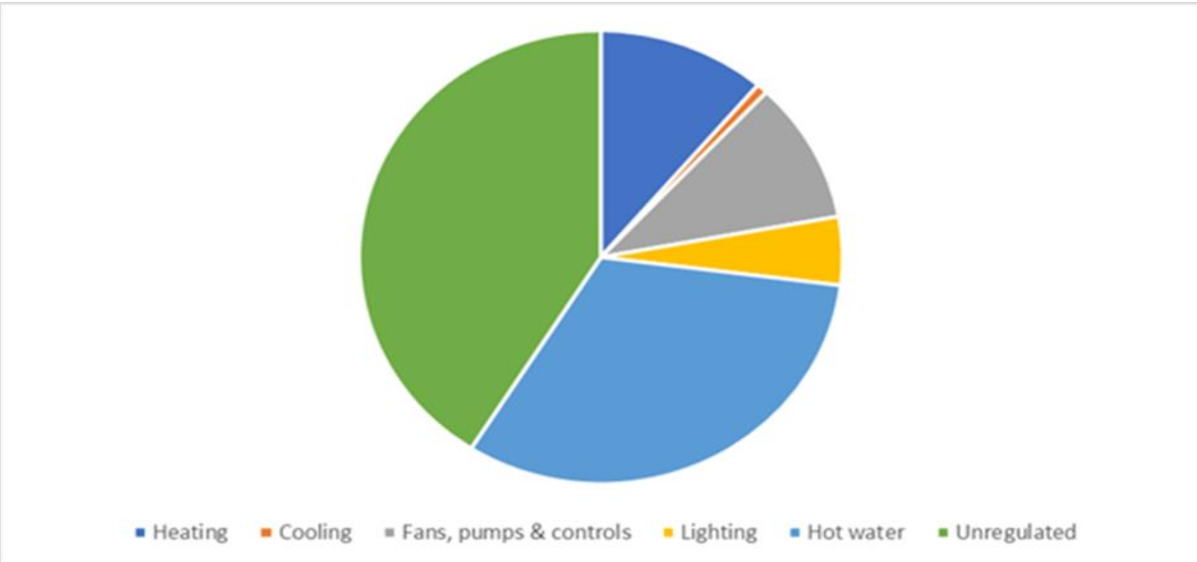

Figure 3: Annual regulated energy consumption by end use

4.0 HEATING INFRASTRUCTURE

HEAT DEMAND DENSITY

4.1 The technical, environmental and economic feasibility of district heating is contingent on heat demand density, for the following reasons.

- Distribution losses from pipework

- Parasitic energy consumption for circulating pumps
- Cost of Installing pipework, particularly given the site topography In this case

4.2 Heat demand density is low across most of the site. However, there is sufficient density to support a heat network within the central part of the site, as illustrated in Figure 4. Other buildings including all the lodges have individual, building-level heating infrastructure. This conclusion is consistent with the outline proposals.

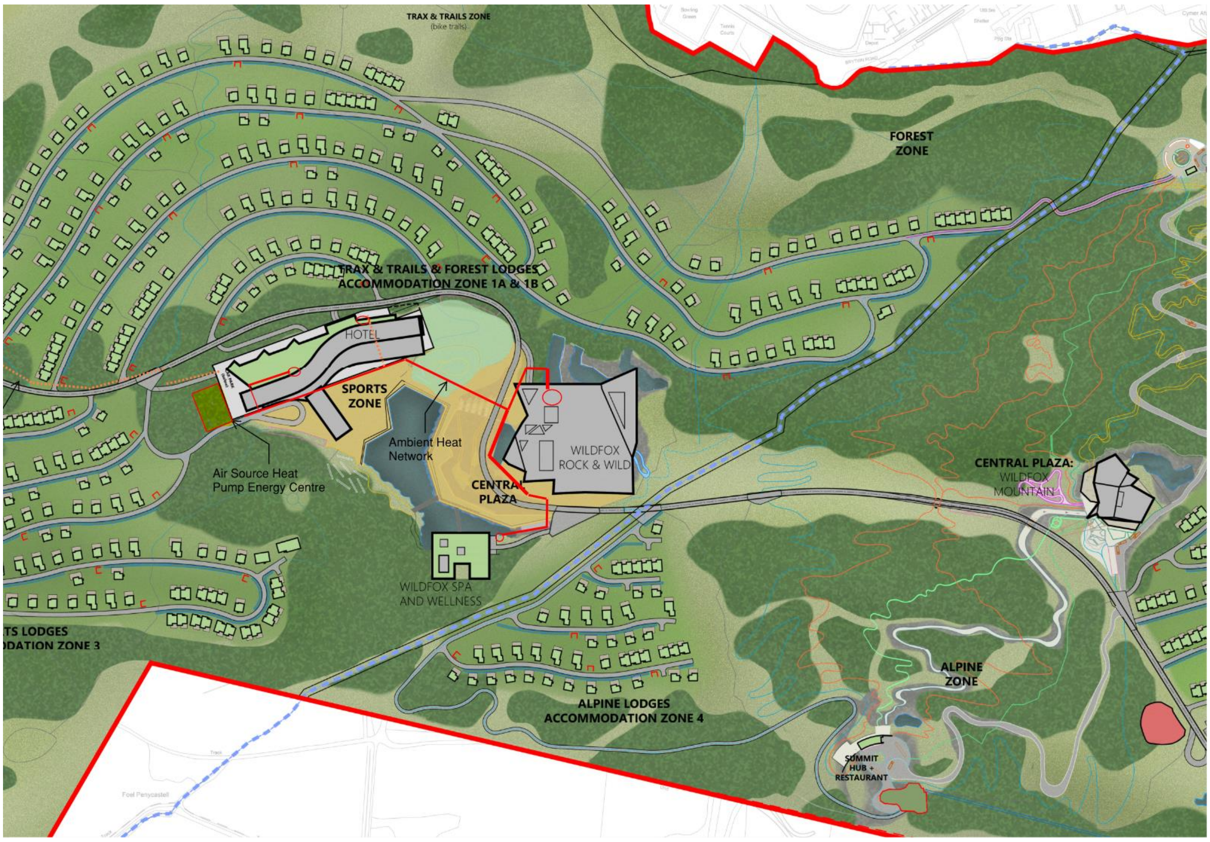

Figure 4: Extent of proposed heat network - For information only

4.3 The proposed network supplies approximately 88 % of heat demand in the non-domestic buildings and 56 % of site overall with the lodges taken in to account.

OFFSITE HEAT NETWORK

4.4 The outline proposals identified the potential for connection to the Caerau Heat Scheme (CHS). The settlement of Caerau lies approximately 1 km to the south of the site boundary as the crow flies.

4.5 Bridgend County Borough Council's website describes the scheme as follows:

The Scheme originally proposed to extract heat from water contained within flooded former coal mine workings to provide the heat resource for heating and hot water for properties within Caerau.

In June 2021, Bridgend County Borough Council's Cabinet voted to take forward plans for a set of small-scale low-carbon heat demonstrator projects in Caerau. This followed a six months options appraisal into the project after a report outlined the challenges of using mine water for an expanded scheme, including increasing costs for investigation work.

The project's proposals now involve delivering a smaller mine water heating scheme for Caerau Primary School and a district heat scheme for at least 70 homes on the Tudor Estate.

Homes on the Tudor Estate which take part will be connected to a district heat pump while a private connection will supply electricity for the scheme from the wind farm at Llynfi Afan Renewable Energy Park, providing low-cost, low-carbon power.

As a demonstrator project, Caerau Heat Scheme has a large number of stakeholders including; Welsh Government, Valleys to Coast Housing, Cardiff University, BGS, Energy Systems Catapult, Natural Resources Wales and The Coal Authority.

Table 8: Potential advantages and disadvantages of connection to the Caerau Heat Scheme

Advantages	Disadvantages
Development could be a good 'anchor load' for the future development of the CHS	At present the CHS comprises a small pilot scheme that is unlikely to be able to support the development
CHS is net zero and should therefore not compromise 'net zero ready' approach	Given 'net zero ready' approach and similar technology mix GHG savings could be modest
A bidirectional connection could be feasible, particularly given the proposed change to an ambient loop system	Applicants' expectations with respect to resilience could lead to duplication of plant

4.6 In summary, the applicant remains interested in the potential for connection to the scheme. However, repeated attempts to initiate dialogue with the scheme's project manager have not to date been successful.

4.7 The proposals do not currently include connection to the CHS but there is a commitment to continue to investigate the technical, environmental and economic feasibility of connection.

ONSITE HEAT NETWORK

Outline Permission

4.8 The outline proposals included a heat network serving the central part of the site. The heat generators were

- Gas-fired combined heat and power (CHP), meeting 65 % of annual heat demand; and
- Gas-fired boilers, meeting 35 % of annual heat demand.

4.9 Gas CHP was once viewed as a transition technology, as it burned fossil fuel in a more efficient way than other technologies. However, due to the decarbonisation of grid electricity, there is in environmental terms no merit in burning gas to generate electricity, even where waste heat from the process is captured and utilised.

4.10 This type of technology usually supports a conventional, fourth generation (4G) operating at relatively high temperatures, typically 70 °C flow and 40 °C return. The distribution losses across these networks is usually significant, with 10 % considered to be good practice.

4.11 Consequently, the emissions factor for heat supplied from this kind of network is now typically in excess of 0.400 $kgCO_2$/kWh, far in excess of the good and best practice factors of 0.100 and 0.150 $kgCO_2$/kWh respectively.

4.12 (Good and best practice refers to the guidance provided in CIBSE and ADE's *Heat networks: Code of Practice for the UK*.)

Detailed Proposals

4.13 The detailed proposals take a different and modern approach, incorporating an ambient loop heat network, also referred to as 'fifth generation' (5G), though this term is contentious. The ambient loop operates at low temperatures, typically 25 °C flow and 20 °C return. The distribution losses across these networks are therefore very low, typically circa 2%

4.14 A centralised energy centre hosts reverse-cycle heat pumps that are used to maintain the ambient loop within the required temperature range. In heating mode, they pump heat from ambient air into the network and in cooling mode they reject heat from the network into the ambient air.

4.15 Within each building, distributed reverse-cycle water to water heat pumps provide heating, hot water and, where required, cooling. In heating mode, they pump heat from the network into low temperature hot water circuits and in cooling mode, they pump heat from chilled water circuits in to the network. This arrangement allows heat rejected from chilled water circuits to be recovered and used as a heat source.

4.16 The system meets all the space heating and space cooling demand within the buildings connected to the heat network, along with most of the domestic hot water demand; electric point-of-use water heating is proposed in relatively isolated locations having a low level of demand, where distribution losses would otherwise be disproportionate.

4.17 The energy centre would also accommodate thermal storage to optimise peak demand and infrastructure costs. Since the heat generators are electric heat pumps, the thermal storage could also in effect provide electricity storage, allowing utilisation of surplus 'real-time' electricity generation and/or more favourable off-peak consumption tariffs.

4.18 There are provisionally two large-capacity thermal stores, providing circa 875 kWh of storage capacity assuming a temperature difference of 5 K.

Additional Options

4.19 As noted in the preceding section, connection to the CHS has also been considered. However, without more detailed information on the scheme, there is a lack of clarity as to how future connection might be facilitated. In principle, a two-way connection could be technically feasible.

- Heat could be drawn from the CHS network to help regulate the ambient loop operating temperatures
- The CHS heat pump could utilise the ambient loop as an alternative or supplementary heat source.

4.20 Consideration has also been given to alternative onsite sources/sinks for the heat pumps. The most applicable alternative is groundwater, specifically water drawn from redundant mine workings. As evidenced by the Caerau Heat Scheme demonstrator project, this a challenging technology that is not yet fully mature. The applicant is keen to understand more about the CHS and whether mine-water-coupled heat pumps could be feasible for the development. Three key issues have been identified.

- Whereas the CHS is a heating-only scheme, the proposed ambient loop network provides both heating and cooling. Elevated groundwater temperatures would benefit heat generation efficiency but could be problematic where heat rejection is required. If so, separate heat rejection equipment (e.g. dry air coolers) would be required.
- There could be scope to use groundwater for inter-seasonal storage, to take advantage of any net heat rejection during the summer (notwithstanding the preceding point) and/or periods of more cost-effective heat generation.
- It is understood that the typical arrangement utilises separate seams for abstraction and reinjection respectively, due to concerns regarding limited groundwater mobility. While there are sufficiently deep mine workings below the western part of the site, there is only a single seam, which could be vulnerable to temperature creep over the medium to long term.

4.21 In summary, the proposals do not currently include either the use of groundwater heat pumps or connection to the CHS but do provide the flexibility to accommodate these options. There is a commitment to continue to investigate the technical, environmental and economic feasibility of these potential or future connections.

5.0 RENEWABLE/LOW-CARBON ENERGY

TECHNOLOGIES

5.1 The supplementary planning guidance lists various renewable/low-carbon energy technologies. Of these, heat pumps, combined heat and power and district heating are covered in the preceding section of the report (heat infrastructure). They are therefore not also covered in this section.

OFFSITE GENERATION

Outline Permission

5.2 The outline proposals did not identify any opportunities for connection to existing sources of renewable/ low-carbon energy. Nonetheless, a further assessment has been undertaken.

Wind & Renewable Electrical Infrastructure

5.3 The site is in fairly close proximity to a number of windfarms including Llynfi Afan and Ffynnon Oer, both of which host turbines that lie within approximately 2 km of the site as the crow flies. In addition, there is planning permission for a windfarm on land at Foel Trawsnant, approximately 2 km to the southwest of the site.

5.4 The possibility of directly supplying the development from one of these windfarms, either via a private wire or sleeved arrangement, has been considered. In terms of GHG emissions, there are no significant direct benefits, i.e. no additional renewable energy generation capacity is created.

5.5 It is understood that the local Caerau Primary Substation operated by the distribution network operator (DNO) Western Power Distribution (WPD) has no reverse power headroom, i.e. capacity to accept additional electricity generation, so there could be wider benefits to a direct supply from an existing or proposed windfarm. This Is being further Investigated with the DNO and local generation operators in addition to a more expansive option to source renewable generated electrical supplies for the development.

5.6 The proposals Identified in this assessment however do not currently include a private wire or sleeved connection from a local windfarm to the site but there is a commitment to continue to investigate the technical, environmental, and economic feasibility of connection.

Other Technologies

5.7 There are no other renewable/low-carbon electricity generation installations within close proximity to the site. There are no renewable/low-carbon heat sources such as waste heat available within close proximity to the site. While renewable/low-carbon fuels such as biomass, biofuels and/or biogas may be locally available, these are not compatible with the proposed heat infrastructure or the 'net zero ready' approach.

ONSITE GENERATION

Outline permission

5.8 The outline permission identified that the following *may* be suitable and should be considered in the development of the detailed proposals.

- Small-scale biomass secondary heating (e.g. log burners within lodges)
- Photovoltaics
- Solar thermal

5.9 Nonetheless, a further reassessment of all options has been undertaken.

Biomass

5.10 The provision of a log burner (or similar) in a lodge would require provision of an flue for the exhaust gases. The energy efficiency of the building fabric is compromised by the penetration of the flue.

5.11 The emissions factor for biomass varies from 0.023 to 0.053 kgCO_2/kWh depending on the fuel type (chips, logs or pellets). Therefore, in compliance terms and over the shorter term, biomass heating is likely to achieve CO_2 savings relative to heat pumps. However, over the longer term, as grid electricity decarbonises the position is reversed. Therefore, the use of biomass does not support the 'net zero ready' approach and is not proposed

Photovoltaics

5.12 While the site has very little woodland cover at present, extensive tree planting is proposed, which has the potential to overshadow photovoltaic (PV) arrays, as noted in the outline proposals. The site is sloped, generally in a north-facing orientation, which could also cause some generally modest overshadowing. The contoured terrain also requires the visual impact within the site to be considered.

5.13 A further constraint is that, as noted above, the local primary substation has no reverse power headroom, which suggests that PV systems need to be sized such that in real time output does not exceed site demand. The onsite electrical infrastructure would take the form of a smart-grid, allowing energy flows to and from the site to be actively managed using energy storage and load shedding.

5.14 The possibility of ground-mounted PV arrays was raised by NPTCBC's Energy Manager, Chris Jones. In general, this is precluded by the nature of the terrain and the development proposals. However, there is an area in the southeast part of the development, close to the Back of House building that could be suitable, for solar carports or ground-mounted arrays.

5.15 The proposals do not currently include ground-mounted PV arrays but there is a commitment to continue to investigate the technical, environmental and economic feasibility of this option.

5.16 For building-mounted PV arrays, the risk of overshadowing is likely to be highest at the lodges, as these are detached, small, low-rise buildings, mostly arranged on north-facing slopes.

5.17 The non-domestic buildings are more suited to hosting PV arrays. The detailed proposals include the provision and design intent for PV systems summarised in

5.18

5.19 Table **9**.

5.21 **Table 10** shows their combined effect on sitewide energy consumption and GHG emissions. The proportions of PV on each building may be affected subject to further design development, overshadowing analysis and Integration with roof materials and profiling.

Table 9: Photovoltaic systems – design intent but the proportions of PV per building may vary subject to design development

Part of development	PV system rating (kW_p)	Energy generation (MWh/yr)	GHG emissions (tCO_2/yr)
Forest Hub	2	1	0
Summit Hub	6	5	1
Entrance Pavilion	7	5	1
Back of House	19	14	2
Rock & Wild	136	100	14
Spa	31	23	3
Wildfox Hotel	130	96	13
Wildfox Mountain	42	31	4
TOTAL	373	276	37

Table 10: Consumption and emissions under detailed proposals for renewable/low-carbon energy

Parts of development	Detailed proposals for demand reduction: energy consumption (MWh/yr)	Detailed proposals for demand reduction: GHG emissions (tCO_2/yr)	Improvement attributable to PV: energy consumption	Improvement attributable to PV: GHG emissions (tCO_2/yr)
Domestic (lodges)	3,181	453	0 %	0 %
Non-domestic (others)	3,877	526	7 %	7 %
TOTAL	7,058	979	4 %	4 %

Solar Thermal

5.22 While the high levels of hot water demand across the site could support solar thermal, the use of heat pumps to meet domestic hot water demand is a more flexible and robust approach for the following reasons.

- Buildings connected to the ambient loop heat network benefit from the recovery of heat rejected from chilled water circuits.
- In spatial terms, solar thermal arrays compete directly with PV arrays. Electricity is a more flexible energy vector than heat.
- The use of solar thermal is not likely to lead to reduction in installed heat pump capacity

5.23 Therefore, solar thermal technology is not proposed.

Other Technologies

5.24 The further reassessment of all options did not identify any other technologies for consideration.

6.0 CONCLUSION

6.1 This report demonstrates that the energy strategy set out in the outline permission has been developed in to more robust and detailed proposals, which respond to regulatory change and adopt a 'net zero ready' approach, while addressing planning policy and reserved matters.

6.2 A wide range of demand reduction measures, including heat pumps, are proposed. These are estimated to achieve energy consumption and GHG emissions reductions of 29 and 31 % respectively, relative to the baseline of new Part L. It should be recognised that applying this benchmark as a new baseline as apposed to the original outline permission performance has been a sensible approach given the development will be subject to new legislation. Additionally, had this assessment used the original outline performance as a baseline, the reported exceedance on carbon emission reduction would be significantly higher than that reported in this assessment.

6.3 Various technologies for heating infrastructure have been considered, culminating in the proposal for an ambient loop heat network serving the central area and decentralised heat pumps elsewhere. Options for connection to the Caerau Heat Network and the use of mine-water as heat source/sink are retained.

6.4 Various technologies for renewable/low-carbon energy have been considered, culminating in the proposal for building-mounted PV systems on the main buildings across the site. These are estimated to achieve further energy consumption and GHG emissions reductions of 4 %. Options for connection to a local windfarm via private wire or sleeving along with connectivity with smart grids and wider renewable energy Infrastructure are retained.

6.5 Table 11 shows the overall energy performance of the detailed proposals, incorporating demand reduction, heat pumps and PV systems.

Table 11: Consumption and emissions under detailed proposals

Parts of development	Detailed proposals for demand reduction: energy consumption (MWh/yr)	Detailed proposals for demand reduction: GHG emissions (tCO_2/yr)	Improvement over baseline: energy consumption	Improvement over baseline: GHG emissions (tCO_2/yr)
Domestic (lodges)	3,181	453	48%	49%
Non-domestic (others)	3,877	526	10%	11%
TOTAL	7,058	979	32%	34%

6.6 Finally, in response to a suggestion from NPTCBC’s Energy Manager, Chris Jones, an energy education facility is proposed. This would be hosted in the multifunction room within the Wildfox Hotel building and would document the site’s previous uses (including coal mining), its ecology, and the development’s energy strategy, with reference to onsite and offsite renewable/low-carbon infrastructure.

APPENDIX A DEMAND REDUCTION MEASURES

DOMESTIC

1 The energy performance specification for the domestic parts of the proposed development is summarised in Table 12. The notional dwelling specification is as specified in SAP 10.2 Appendix R.

Table 12: Domestic demand reduction measures

Element or system	Notional dwelling specification	Actual dwelling specification
Climate data	UK average	UK average
Size and shape	Same as actual dwelling	As designed
Opening areas (windows, roof windows, rooflights and doors)	Same as actual dwelling up to a maximum for total area of openings of 25% of total floor area. If the total area of openings in the actual dwelling exceeds 25% of the total floor area, reduce to 25% as follows: 1) Include all opaque and semi-glazed doors with the same areas as the actual dwelling (excluding any doors not in exposed elements, e.g. entrance door to a flat from a heated corridor). 2) Reduce area of all windows and roof windows/rooflights by a factor equal to [25% of total floor area less area of doors included in 1)] divided by [total area of windows and roof windows/ rooflights in actual dwelling].	As designed
External walls including semi-exposed walls	U = 0.18 W/m²K	U = 0.18 W/m²K
Party walls	U = 0	U = 0
Floors	U = 0.13 W/m²K	U = 0.11 W/m²K
Roofs	U = 0.11 W/m²K	U = 0.13 W/m²K
Opaque door (<30% glazed area)	U = 1.0 W/m²K	U = 1.2 W/m²K
Semi-glazed door (30%-60% glazed area)	U = 1.0 W/m²K	U = 1.2 W/m²K
Windows and glazed doors with >60% glazed area	U = 1.2 W/m²K Frame factor = 0.7 Solar energy transmittance =	U = 1.2 W/m²K Frame factor = 0.7 Solar energy transmittance =

Element or system	Notional dwelling specification	Actual dwelling specification
	0.63 Light transmittance = 0.80 Orientation same as actual dwelling Overshading same as for compliance calculation (average if actual dwelling has very little or average overshading; same as actual dwelling if greater overshading)	0.63 Light transmittance = 0.80 Orientation: as designed Overshading: average or more than average
Roof windows	U = 1.2 W/m²K when in vertical position (for correction due to angle see Table 6e) Overshading factor 1.0 Other parameters as for windows	Not applicable
Rooflights	U = 1.7 W/m²K when in horizontal position (no correction applied as tested in horizontal position) Overshading factor 1.0 Other parameters as for windows	Not applicable
Curtain wall	Curtain walling to be treated as standard glazing and opaque wall with the same areas as the actual dwelling. When the total opening area exceeds 25% of floor area the glazed area to be reduced to 25% as for opening areas above. U-value of opaque wall = 0.18 W/m²K U-value of glazing = 1.3 W/m²K (which includes an allowance of 0.1 for thermal bridging within the curtain wall)	Not applicable
Thermal mass	Same as actual dwelling	Calculated
Living area	Same as actual dwelling	As designed
Number of sheltered sides	Same as actual dwelling	As designed
Allowance for thermal bridging	Thermal bridging allowance is calculated using the lengths of junctions in the actual dwelling and the 'Option 2' psi values in Table R2. Note. Where the area of openings in the actual dwelling is > 25% of the total floor area the lengths of junctions in the	Psi-values by junction present (ACD denotes equivalent to accredited construction detail - now withdrawn) E2 assumed 0.05 W/m.K E3 ACD 0.04 W/m.K E4 ACD 0.05 W/m.K E5 assumed 0.067 W/m.K E6 ACD 0.07 W/m.K

Element or system	Notional dwelling specification	Actual dwelling specification
	notional dwelling remain the same as the lengths in the actual dwelling, even though window area is reduced as described for 'Opening areas' above. If lengths of thermal bridges are not specified, use a y-value of 0.05 to determine heat losses from thermal bridges.	E20 default 0.32 W/m.K E21 default 0.32 W/m.K E8 ACD 0.000 W/m.K E24 default 0.15 W/m.K E14 ACD 0.04 W/m.K E16 ACD 0.09 W/m.K E17 ACD -0.09 W/m.K E25 default 0.24 W/m.K P1 assumed 0.000 W/m.K P7 default 0.48 W/m.K P5 ACD 0.04 W/m.K
Ventilation system	Natural ventilation with intermittent extract fans	Mechanical ventilation with heat recovery Manufacturer Vent Axia Model Sentinel Kinetic Plus BS Ductwork insulated
Air permeability	5 $m^3/h \cdot m^2$ at 50 Pa	3 $m^3/h \cdot m^2$ at 50 Pa
Chimneys and open flues	None of any type - i.e. worksheet (6a) to (6f) are zero	None of any type
Extract fans / passive vents	2 extract fans for total floor area up to 70 m^2, 3 for total floor area > 70 m^2 and up to 100 m^2, 4 for total floor area > 100 m^2	None of any type
Main heating fuel (space and water)	Where space heating is provided by an existing heat network*, same as actual dwelling. Otherwise: Mains gas	Electricity
Heating system	Where space heating is provided by an existing heat network*, same as actual dwelling. Otherwise: Boiler and radiators Central heating pump 2013 or later, in heated space Design flow temperature = 55°C	ASHP and radiators Central heating pump 2013 or later, in heated space Design flow temperature = 45°C
Boiler	Where space heating is provided by an existing heat network, not applicable. Otherwise: If gas or liquid fuel combi boiler performing space heating in actual dwelling, mains gas instantaneous combi boiler; otherwise mains gas regular boiler.	Dwelling types: A1-C2 Mitsubishi PUZ-WM85YAA Dwelling type: D1 PUZ-WM112YAA Dwelling type: E1 PUZ-HWM140VHA

Element or system	Notional dwelling specification	Actual dwelling specification
	Efficiency, SEDBUK(2009) = 89.5% Room-sealed, fan-assisted flue Modulating burner control No hot water test for combi boiler	
Heating system controls	Where space heating is provided by an existing heat network: 1. For a single storey dwelling in which the living area is greater than 70% of total floor area, charging system linked to use of heating, programmer and room thermostat; 2. For any other dwelling, charging system linked to use of heating, programmer and TRVs. Otherwise: 1. For a single storey dwelling in which the living area is greater than 70% of total floor area, programmer and room thermostat; 2. For any other dwelling, time and temperature zone control, TRVs; And in all cases: Boiler interlock ErP Class V	Time and temperature zone control with delayed start thermostat Boiler interlock
Hot water system	Where the dwelling has water heating provided via an existing heat network*, same as actual dwelling. Otherwise: Heated by boiler (regular or combi as above) Separate time control for space and water heating	From main heating system Separate time control for space and water heating
Showers and baths	Number of showers and baths same as actual dwelling. If shower(s) specified, shower flow rate(s) to be 8 l/min. Shower(s) supplied by main water heating system (not instantaneous electric shower).	Number of showers and baths: as designed Shower flow rate: 8 l/min. Shower supplied by main water heating system
Waste water heat recovery	Where the dwelling has water heating provided via an existing heat network, not applicable. Otherwise:	None

Element or system	Notional dwelling specification	Actual dwelling specification
	All showers connected to WWHR including showers over baths. Instantaneous WWHR with 36% recovery efficiency (at any flow rate) and utilisation of 0.98.	
Hot water cylinder	Where the dwelling has water heating provided via an existing heat network, not applicable. Otherwise: If cylinder specified in actual dwelling: volume of cylinder in actual dwelling If combi boiler: no cylinder Otherwise: 150 litres If cylinder, declared loss factor = 0.85 x (0.2 + 0.051 V2/3) kWh/day, where V is the volume of the cylinder in litres	Volume of cylinder: 170 litres Loss factor: 1.224 kWh
Heat interface unit	Where the dwelling has water heating provided via an existing heat network, HIU data if for PCDB entry 400001 for a direct HIU, or 400002 for an indirect HIU. Otherwise, not applicable.	Not applicable
Primary water heating losses	Where the dwelling has water heating provided via an existing heat network, not applicable. Otherwise: Fully insulated primary pipework Cylinder temperature controlled by thermostat Cylinder in heated space	Fully insulated primary pipework Cylinder temperature controlled by thermostat Cylinder in heated space
Water use limited to 125 litres per person per day	Yes	Yes
Secondary space heating	None	None
Electricity tariff type	Standard tariff	Standard tariff
Lighting	Fixed lighting capacity (lm) = 185 x TFA Efficacy of all fixed lighting = 80 lm/W	Fixed lighting capacity (lm) = 185 x TFA Efficacy of all fixed lighting = 85 lm/W
Air conditioning	None	None
PV system	For houses kWp = 40% of ground floor area, including	None

Element or system	Notional dwelling specification	Actual dwelling specification
	unheated spaces / 6.5 For flats and maisonettes kWp = 40% of dwelling floor area / (6.5 x number of storeys in block) System facing SE/SW, 45° pitch. Overshading is 'none' Connected to dwelling's meter for houses Not connected to the dwellings meter for flats Export-capable meter present	

NON-DOMESTIC

2 The energy performance specification for the non-domestic parts of the proposed development is summarised in Table 13. The notional building specification is as specified in the NCM modelling guide for buildings other than dwellings in England.

Table 13: Non-domestic demand reduction measures

Element or system	Notional building specification	Actual building specification
Roof U-value (W/m²K)	0.15/0.18	0.10
Wall U-value (W/m²K)	0.18/0.26	0.18
Floor U-value (W/m²K)	0.15/0.22	0.10
Window U-value (W/m²K)	1.4	Wildfox Hotel: 1.2 Otherwise: 1.4
Window frame factor (%)	10	Wildfox Hotel: 15 Otherwise: 10
Window g-value (%)	28	28
Window light transmittance (%)	60	60
Roof-light U-value (W/m²K)	2.1	Wildfox Hotel: 1.0 Rock & Wild: 1.7
Roof-light frame factor (%)	15	20
Roof-light g-value (%)	40	Wildfox Hotel: 15 Rock & Wild: 10
Roof-light light transmittance (%)	71	60
Thermal bridging α-value (%)	10	15
Air permeability (m³/hr/m² @ 50 Pa)	3.0/5.0	3.0
Display lighting lamp (lm/W)	95	125

Element or system	Notional building specification	Actual building specification
Lighting luminaire (lm/W)	95	100
Occupancy control	yes	yes (all spaces) [Auto on/off]
Daylight control	yes	yes (all spaces with direct access to daylight)
Maintenance factor	0.8	0.8
Constant illuminance control	no	yes
Heating system efficiency (heating) (SCoP)	electric heat pump 2.6400	electric heat pump VAV 2.6554 LTHW radiators 3.0057 FCUs 2.9356 VRF 3.300
Heating system efficiency (hot water)	electric heat pump 2.860 Distribution losses: included above Storage losses: none	Varies
Central ventilation SFP (W/(l/s)	1.8	VAV systems: 0.44 MVHR systems: 0.75 Otherwise: 1.50
Terminal unit SFP (W/(l/s)	0.3	0.2
Cooling (air-conditioned) (SEER/SSEER)	4.5/3.6	SEER 5.5/4.1
Cooling (mixed mode) (SEER/SSEER)	2.7	N/A
Heat recovery efficiency (%)	76	85
Variable speed control of pumps, controlled via multiple sensors	yes	yes
Demand control (mechanical ventilation only). Variable speed control of fans via CO_2 sensors.	yes	VAV systems: yes Otherwise: no
Power factor > 0.95	yes	yes
Automatic monitoring and targeting with alarms for out-of-range values	yes	yes

APPENDIX B DETAILED ENERGY PERFORMANCE DATA

1. Regulated Energy consumption data by end use is summarised in Table 14.

Table 14:Regulated Energy consumption data (MWh/yr)

Building	Heating	Cooling	Fans, pumps & controls	Lighting	Hot water	Un-regulated	Total
Forest Hub	1	0	0	0	0	1	3
Summit Hub	3	1	2	2	2	16	26
Entrance Pavilion	1	0	1	1	0	5	9
Back of House	3	3	22	11	172	53	264
Rock & Wild	291	11	194	118	1,056	305	1,975
Spa	40	5	39	27	71	169	352
Wildfox Hotel	27	34	222	128	376	532	1,318
Wildfox Mountain	4	10	45	25	103	197	384
Lodges	1,567	0	443	429	1,898	1,727	6,063
Site total	1,938	65	969	740	3,678	3,005	10,395

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