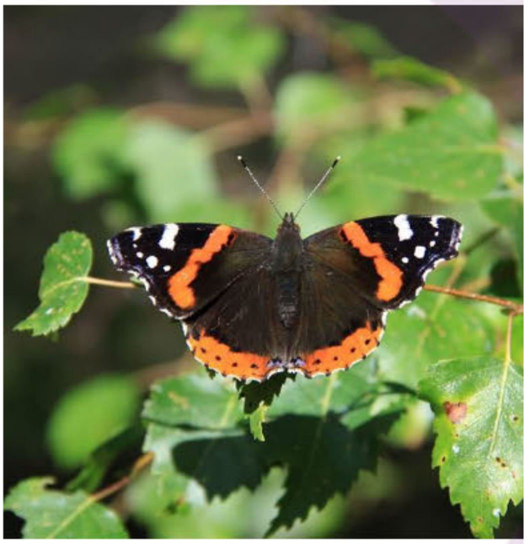
HIE/CMSL

Renewable Energy Options Appraisal

CMSL

Final Report



Wood Environment & Infrastructure Solutions UK Limited – June 2020

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Document revisions

No.	Details	Date
1	Draft Report	18/03/20
2	Final Report	30/06/20

Executive summary

Purpose of this report

This report has been produced for the purpose of providing an options appraisal for renewable energy development by Cairngorm Mountain (Scotland) Ltd (CMSL) at the Cairngorm Mountain Resort.

Prioritising Resource Efficiency

CMSL continue to explore efficiency savings across the operations at the Cairngorm Mountain Resort in order to minimise resource requirements (particularly in respect of energy and water). Ongoing work has included separate work to this study regarding energy efficiency saving opportunities. These combine both behavioural change measures and a number of potential investments that are under active consideration[1]. The focus of this report is renewable energy options for on-site generation that complement any such efficiency work.

Commercial-Scale Opportunities

Commercial scale renewable energy generation opportunities, in this case, would be generating options that provide more power output than can be used on the resort. This would therefore provide excess electricity that could be exported to the national grid or sold to a third party under a supply agreement.

There are no commercial-scale generation options considered viable at present for the CMSL site.

The greatest natural resources across the site are in the most inaccessible locations. This would make any development expensive to build and operate given the difficulty in moving personnel and materials into/away from the working site. It would also increase the risk of damage to the local environment.

Without a revenue stream from FiT, economic viability relies on supplying to local consumers (rather than export to the grid). The logistics of supplying relevant local consumers (outside of the resort) are difficult and costly, primarily due to location and the costs of linking the consumers to the generation location.

A review of known renewable energy generation, and applications within the planning process, has been undertaken. This was to identify any third-party development in the immediate neighbouring area to the resort, which could be approached to buy power from. No such opportunities have been identified.

Site-scale Opportunities

Site-scale opportunities would be those where on-site generation is reducing the amount of fuel or grid electricity bought for use on site. The size of output would not be large enough for sale to third parties.

An initial wide-ranging options appraisal looked at potential for electricity and heat generation, considering:

- Availability of local resources (wind, hydro, solar, biomass)
- Suitability of energy outputs for the operational energy needs of the resort
- Specific operational issues (e.g. damaging wind regime at Ptarmigan Restaurant, minimising infrastructure in car park areas to simplify snow clearing)

[1] Energy Efficiency Audit, CMSL, Synergie Environ (January 2020)

- Environmental and visual amenity impacts (including relevant planning guidance)
- Future impacts on energy requirements (e.g. wider uptake of electric vehicles, etc.)

The initial findings of this analysis were discussed at a stakeholder workshop. It was agreed to take forward three technology options for further investigation:

- Wind – Medium scale (likely single) turbine
- Solar PV – Opportunities for roof and/or ground-mounted arrays and a solar car port
- Boiler replacement – Replacement of existing kerosene boiler at Day Lodge Building with low carbon equivalent

Wind

Present National Park Authority (NPA) planning guidance notes a height restriction for any turbine of 30 m. However, this guidance was written, in part, to prevent large-scale commercial wind development and the associated impact on the landscape and visual amenity.

While mindful of the landscape character and natural assets of the resort, a potential site of a single turbine has been identified that is close to the existing infrastructure and outside the recreational area. Initial assessment also suggests that it would be unobtrusive to views from the surrounding area and avoid significant impacts on habitat and local birds and wildlife.

Table 1 Summary techno-economic evaluation (wind turbine options)

	Option 1	Option 2	Option 3	Option 4	Option 5
Hub Height (m)	18	23	24.5	46	46
Total Height to Blade Tip (m)	27	33.5	36.5	76.5	76.5
Rated Power (kW)	100	100	100	500	1,000
Annual Generation (MWh)	136	237	280	1,402	2,803
Annual Energy used onsite (MWh)	136	237	280	981	1,402
Annual Electricity Bill Savings (£)	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
OPEX (£/yr)	£4,305	£4,305	£4,305	£31,500	£39,690
Net Annual Savings (£/yr)	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
CAPEX (£)	£153,720	£296,888	£362,250	£1,237,530	£1,559,288
Simple Payback (Years)	10	10	10	9.4	6.5
NPV (£)	£64,770	£131,269	£154,783	£669,095	£1,848,740
IRR (%)	10%	10%	10%	11%	16%
Net Carbon Savings (tCO_{2e}/yr)	38	66	78	272	389

Note: Lecht ski centre turbine is 150 kW, hub height 32.5 m; blade tip height 43.4 m

Solar PV

Initial assessment of the Day Lodge and Base Station buildings suggests capacity of around 40 kW of roof-mounted solar PV.

A land area around the on-site wastewater treatment works offers a further 17 kW of potential capacity.

While the scale of any solar car port can potentially span large areas of the main car park, a system with capacity of around 30 kW has been reviewed.

An integrated solar PV solution linked to a Moving Carpet lift has also been reviewed. This does not look economic in energy terms based on initial capital cost and energy yield estimates.

Table 2 Solar PV Installation – Initial economic assessment

	Roof Mounted PV	Ground Mounted PV	Solar PV Carport
Estimated Potential Capacity (kWp)	44.5	16.5	28.5
Annual Energy Generation (MWh)	27	11	19
Total Capital cost (£)	£45,835	£18,810	£31,350
OPEX (£/yr)	£579	£182	£371
Estimated Net Annual savings (£/yr)	[redacted]	[redacted]	[redacted]
Simple Payback (Years)	14	13	14
NPV (£)	£1,453	£2,105	£2,267
IRR (%)	6%	7%	7%
Net Carbon Savings (tCO_{2e}/yr)	7	3	5

Wider decarbonisation of the national grid means that net carbon savings from any of the three options considered here are relatively limited.

The economics of each option are broadly similar. The roof-mounted system would offer a medium-term supporting technology if future heat pump systems were considered for the Day Lodge and Base Station buildings.

The car port option provides self-supply for EV charging points, which could be integrated into the design.

Boiler Replacement – Day Lodge

Three options have been considered.

Option 1 - A containerised biomass boiler could be installed to replace the existing kerosene boiler. This offers the benefit of decarbonising the input fuel as well as flexibility to move the boiler to suit any future renovations, refurbishment or other significant changes to existing facilities. In this case existing electric heating would be retained.

Option 2 - Extending the wet radiator system within the Day Lodge building would remove the need for additional electrical heating. It would also offer future flexibility in alternative lower temperature circuit solutions such as heat pumps or heat batteries.

Option 3 - A second circuit could be fed from the biomass boiler to replace the electric heating in the Base Station building.

Fuel costs for kerosene and wood chips are broadly similar. In the case of a direct boiler replacement there is no significant cost saving in fuel costs. This does not therefore offer a sensible investment return.

The other two options benefit from cost savings from displacement of grid electricity use. These options appear economically feasible.

All three options offer significant decarbonisation of the input fuel and sustained annual carbon savings. These were discussed at a stakeholder workshop at the end of the second phase of work.

Table 3 Biomass Boiler Installation – Initial economic assessment

	Option 1		Option 2		Option 3	
	Lower	**Upper**	**Lower**	**Upper**	**Lower**	**Upper**
Estimated Potential Capacity (kWth)	85	85	110	110	140	140
Annual Energy Generation (MWh)	82	82	340	340	500	500
Total Capital cost (£)	£76,820	£98,770	£104,300	£142,640	£131,670	£170,120
Net OPEX (£/yr)	£310	£310	-£160	-£160	-£520	-£520
Estimated Net Annual savings (£/yr)	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
Net Carbon Saving (tCO_{2e}/yr)	21	21	89	89	129	129
Simple Payback (Years)	NA	NA	5	6	4	5
NPV (£)	-£68,170	-£88,877	£226,399	£190,229	£388,065	£351,792
IRR (%)	-12%	-13%	24%	17%	29%	23%

Recommendations and next steps

The Cairngorms Mountain Estate provides a natural public amenity that is an important element of the Cairngorms National Park. Meeting the existing and future energy needs of the ski resort needs to be balanced with suitable management and protection of the habitats, species and environmentally sensitive areas that are an integral part of the National Park.

With this in mind immediate recommendations regarding on-site renewable energy are provided.

Recommendation 1 (Approach to meeting energy needs): Overall strategy to look at opportunities for on-site energy generation supporting local energy needs. This therefore addresses both decarbonisation and cost of energy while being sympathetic to maintaining the natural character and amenity of the Cairngorm Mountain Estate.

Recommendation 2 (Efficient energy use): Prioritise cost-effective energy efficiency measures and evaluation of use of HVO prior to renewable energy project implementation.

Recommendation 3 (Meeting future needs): Develop key elements of site masterplan to provide medium term view of future energy requirements.

Recommendation 4 (Solar PV development): Develop specification for solar PV installation at site and associated planning consent (ground mounted solar PV)

Recommendation 5 (Containerised biomass): Carry out detailed feasibility study to develop specification for containerised biomass heating system for Day Lodge and Base Station.

Recommendation 6 (Medium scale wind): Engage in pre-application dialogue and seek screening opinion from local planning authority in order to determine development approach for a single medium scale wind turbine at site.

Sensitively managed projects can deliver renewable energy for meeting local site needs while avoiding negative impacts on the local environment. Increasing the scale of renewable energy generation on site provides a supporting bridge to further decarbonisation actions (e.g. power for hydrogen electrolyser or EV charging points).

Contents

1. Introduction

This section provides an overview of the site and energy requirements.

1.1 Site Overview

The Cairngorm Estate comprises an area of around 1,400 Ha set within the Cairngorms National Park. The ski resort makes up approximately 600 Ha of the area within the Cairngorm Estate. The resort is operated by CMSL with a lease agreement in place with the land owner (HIE).

The resort is open all year round, with snowsports operating in winter.

1.2 Site infrastructure

Buildings and facilities

The main buildings on the resort are the Day Lodge, Base Station and the Ptarmigan Restaurant (at the mountain top). There is a mid-station building higher up the mountain, linked with operation of the (currently mothballed) funicular railway.

The main car park is adjacent to the Day Lodge and Base Station; a lower car park is also in operation.

Transport

The resort operates a number of vehicles. A summary of this inventory is provided in Appendix A.

Snow Making

A Snow Factory is operational on site. It is currently located relatively close to the Day Lodge building, though is likely to be moved further into the ski area in the near future (subject to planning authority agreement and sufficient electrical capacity). The snow factory is rated at 400 V, 3 Phase with a maximum apparent power of 336 kVA and operational apparent power of 210 kVA.

There are 13 No. snow cannon also operational on site. The canons are rated at 400V, 3 Phase with a full load current of 72A.

1.3 Existing Energy Supply and Use

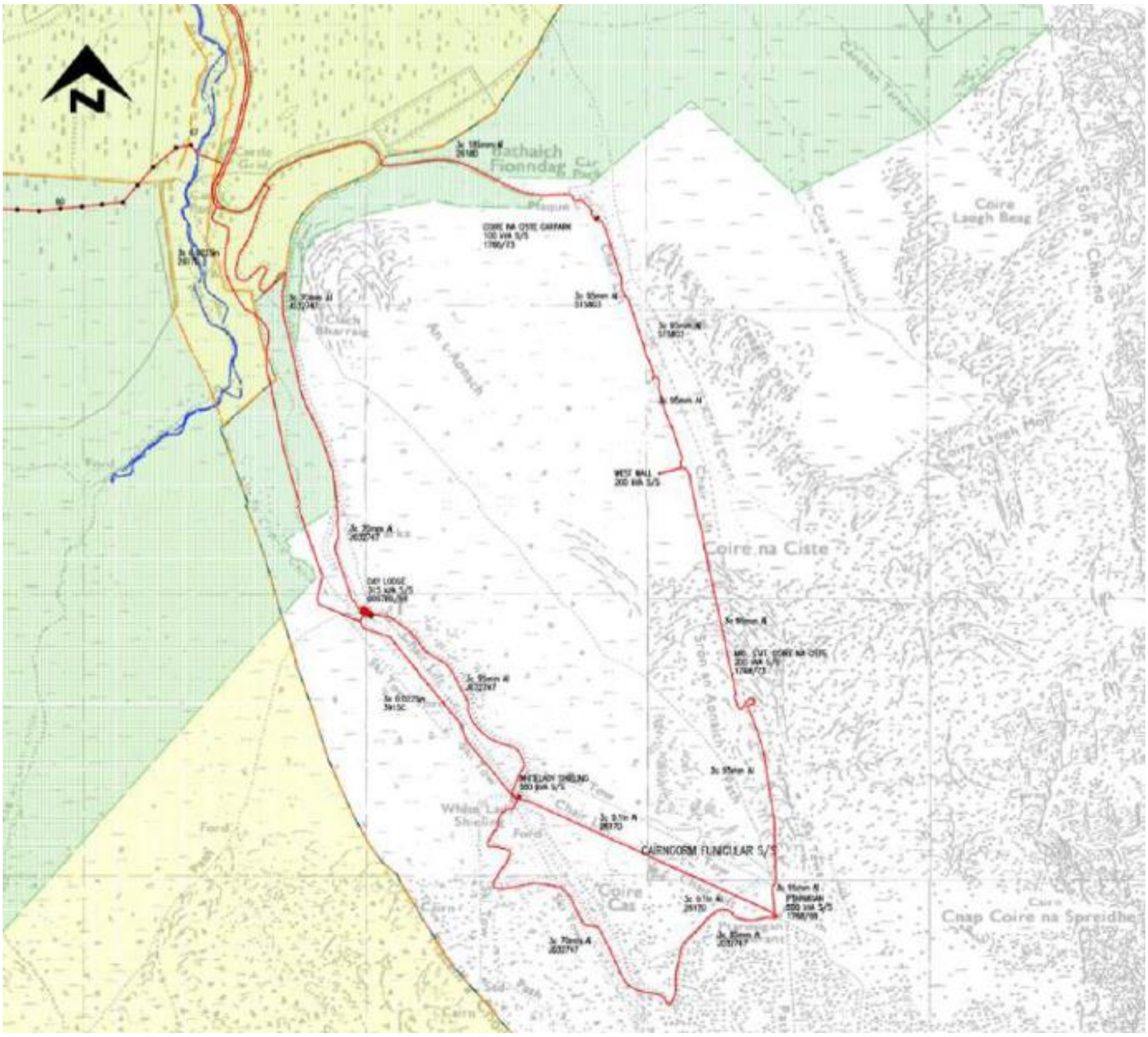
The energy consumed at CMSL is in the form of electricity imported from the local network as well as diesel consumed by generators and heating boilers. An ongoing programme of fuel switching has replaced diesel for generators with Hydrotreated Vegetable Oil (HVO). There is no current renewable energy generation on-site.

The existing electricity distribution network at CMSL is operated by SSEN (Scottish and Southern Electricity Networks) and is distributed around the site via a medium voltage, 11kV ring circuit from the Aviemore main substation. Electricity is distributed to the ten supply meters via six smaller transformer substations as shown in Figure 1 below. The ten electricity supply meters are as follows:

- Base Station
- Day Lodge
- Glenmore Garage

- Base 4
- Sign on ski road
- Mid Station
- Ptarmigan Restaurant
- West Wall POMA
- White Lady Shieling
- Ciste Building

Figure 1.1 Electrical infrastructure



2. Initial Options Appraisal

This section looks at initial options for renewable energy generation and evaluates the costs and benefits of each technology.

2.1 Commercial Scale Opportunities

Commercial scale renewable energy generation opportunities, in this case, would be generating options that provide more power output than can be used on the resort. This would therefore provide excess electricity that could be exported to the national grid or sold to a third party under a supply agreement.

Until April 2019 opportunities for revenue generation were available for specific technologies included within the Feed-in tariff (FiT) scheme. This scheme is no longer in operation. Commercial scale generation opportunities therefore currently rely on the revenue that can be achieved from export of power.

The present Smart Export Guarantee (SEG) provides one such revenue stream. It is useful to consider that the typical value of the SEG (£/kWh exported) is around 50% of the cost of imported grid electricity.

In the current regime it is therefore much more cost-effective to utilise generation on-site to meet the organisation's own energy needs than it is to export the power to the grid.

A review of known renewable energy generation, and applications within the planning process, has been undertaken. This was to identify any third-party development in the immediate neighbouring area to the resort, which could be approached to buy power from. No such opportunities have been identified. The following review therefore considers opportunities for CMSL to develop commercial-scale opportunities on-site.

Summary

There are no commercial-scale generation options considered viable at present for the CMSL site.

The greatest natural resources across the site are in the most inaccessible locations. This would make any development expensive to build and operate given the difficulty in moving personnel and materials into/away from the working site. Any such development would also be likely to cause significant impacts on the local environment at odds with the overarching aim of maintaining and enhancing the natural capital associated with the area.

Without a secure revenue stream from FiT, economic viability relies on supplying to local consumers (rather than a simple export to the grid). The logistics of supplying relevant local consumers (outside of the resort) are difficult and costly, primarily due to location and the costs associated with linking the consumers to the generation location.

In short, installation costs would be prohibitive given the specialist civils works that would be required in difficult to access sites. There would also need to be expensive work carried out on local grid reinforcement in order to facilitate any power flows from this scale of renewable generation. The combination of the accessibility and associated infrastructure for connection of power would lead to local environmental impacts that would also need to be mitigated resulting in further development costs. Revenue available from grid export would be insufficient to make these development costs viable; there are insufficient local consumers to provide an alternative revenue opportunity.

Table 2.1 Commercial-scale opportunities assessment

Technology	Description	Resource / Electrical Capacity	Environment	Visual Amenity	Accessibility / Orientation	Overall Viability Assessment
Wind	Large scale turbine	Wind resource is very good for wind development Existing sub-station capacity potentially insufficient to support this scale of generation	Adjacent environmental designations need to be considered in design Ornithological studies would be required to assess potential impacts	Large-scale turbines likely to be seen as negative impact on local visual amenity NPA planning guidance currently seeks 30 m height restriction and visual amenity considerations	Greatest resource is on higher slopes. These are only accessible using expensive transport (e.g. helicopters) Civils works to support turbine would be extremely difficult to implement	It is not considered feasible to pursue a commercial scale wind development at the resort
Solar	Ground-mounted solar PV array	Solar resource is reasonable for development. Albedo effects of reflection off snow potentially add to direct incident light Existing sub-station capacity on-site would need to be upgraded to support this scale of generation	Adjacent environmental designations need to be considered in design Snow loading is not an issue in respect of structural integrity of panels. However, if snow lies on panels for long periods then this will impair performance	Less impact than for wind turbines However, large scale ground array would still be subject to visual amenity assessment and concerns over preserving landscape character	Majority of land area at higher level is predominantly on North facing slopes. These are least effective from a solar design point of view. These areas are also difficult to access for movement of materials and construction	It is not considered feasible to pursue a commercial scale solar development at the resort
Hydro	Run-of-river scheme. Reservoir type scheme discounted	Hydro resource available is too small to support commercial-scale. Previous studies consider turbines with rated output of 80 kW. Water at site is prioritised for snow making; need to avoid any issues with availability Existing sub-station capacity on-site would need to be upgraded to support this scale of generation	Adjacent environmental designations need to be considered in design While planning guidance is supportive of hydro development the main issue is to ensure minimal impact on flow in the watercourse	Less impact than for wind turbines Turbine designs can be developed to limit impact on landscape character	Higher flows are inaccessible due to nature of water courses (either side of the resort). Potential generating sites are long distances from sub-stations and consumers. This means expensive cabling to connect and transport power output	It is not considered feasible to pursue a commercial scale hydro development at the resort

Technology	Description	Resource / Electrical Capacity	Environment	Visual Amenity	Accessibility / Orientation	Overall Viability Assessment
			Existing discharge consent to burn may be compromised by any large scale hydro development			
Biomass	Anaerobic digestion for production of biogas	Food waste arisings on-site insufficient for commercial scale. Planning guidance discourages import of waste arisings on to commercial sites Local distilleries are typically already using waste for their own energy generation There are no Scottish Water sites close by with availability of sewage sludge	Adjacent environmental designations need to be considered in design Planning guidance does not support import of waste arisings	Less impact than for wind turbines Commercial scale AD plant could be developed sympathetically on resort	AD plant would be built on land within vicinity of Day Lodge. Access for materials and personnel is good.	It is not considered feasible to pursue a commercial scale biomass development at the resort

2.2 Site Scale Opportunities

Site scale opportunities offer a wider variety of potential energy supply solutions. This is because the scale of generation is looked at in terms of a contribution to overall site energy demand. There could, in principle, be multiple technologies used on site in meeting a proportion of energy demand. This can also be viewed in terms of future development and how local on-site renewable generation may support such work.

There are two over-arching considerations for any such solutions:

- The balance of heat and power requirements on site. Electricity (power) demand is much higher than heating demands. It is therefore more likely to look for electricity generation opportunities in preference to space heating and domestic hot water.
- The present cost of electricity imported from the grid is more than double the achievable value of export to the grid via the Smart Export Guarantee. Using generated energy on-site is therefore more cost effective than looking at exporting a large volume of electricity

A summary of the benefits and barriers to development for a range of technology options is provided here. Each option is given a qualitative ranking (Red [1] / Amber [2] / Green [3]) to denote the suitability for further examination on site. Red [1] rates a technology as unsuitable for further consideration; Green [3] rates a technology as a preferred option to explore further.

Wind

Table 2.2 Site-Scale Wind

Parameter	Opportunities / Benefits	Barriers / Limitations	Overall Suitability
Wind Resource	Available wind resource that can sustain a medium scale turbine		3
Electrical Infrastructure		Potential sub-station upgrade required to enable use of generated electricity	
Planning / Environmental	Current NPA planning guidance enables turbines below 30 m height	Impact on ornithology needs assessment	
Visual Amenity		Need to select site closer to existing infrastructure (buildings, ski lifts, pylons) to avoid significant impact on landscape character and visual amenity	
Accessibility	Areas at lower end of resort are more accessible for materials and personnel		
Examples elsewhere	Lecht ski resort has operational 150 kW turbine (30 m hub height; 43 m blade tip height). The turbine was sited beside the car park in an area relatively obscured by neighbouring peaks.		
Other Commentary	While there is potential to export output from the array to the national grid this would attract Smart Export Guarantee (SEG) payment estimate to be around 5.5p/kWh		

Solar PV (Roof-mounted)

Table 2.3 Solar PV (Roof Mounted)

Parameter	Benefits	Barriers	Overall Suitability
Solar Resource	Annual average irradiation estimated at 820 – 980 kWh/m²		3
Electrical Infrastructure		Potential sub-station upgrade required to enable use of generated electricity	
Planning / Environmental	Roof-mounted solar PV capacity up to 1 MW would be subject to permitted development rights. No significant issues with environmental impacts		
Visual Amenity	No significant visual amenity impact		
Accessibility	Access to main Day Lodge and Base Station Buildings is easy to achieve	Access to Ptarmigan Restaurant and Mid Station Buildings more difficult	
Examples Elsewhere	Solar PV installations are already installed on a number of existing European and North American ski resorts[2]		
Other Commentary	While there is potential to export output from the array to the national grid this would attract Smart Export Guarantee (SEG) payment estimate to be around 5.5p/kWh. A roof-mounted array can be dis-assembled and re-installed on a different building (presuming that suitable electrical infrastructure is in place)		

Solar PV – Car Port

Table 2.4 Solar PV (Car Port)

Parameter	Benefits	Barriers	Overall Suitability
Solar Resource	Annual average irradiation estimated at 820 – 980 kWh/m²		3
Electrical Infrastructure	Relatively simple to integrate into existing on-site supply system	Potential sub-station upgrade required to enable use of generated electricity	
Planning / Environmental		Planning consent required for any solar car port	
Visual Amenity	No significant impact on visual amenity due to being close to		

[2] See, for example, https://www.borregosolar.com/solar-project-portfolio/gore-mountain-ski-resort-solar-project (Accessed April 2020); http://www.pvresources.com/en/pvpowerplants/highaltitudes.php (Accessed April 2020)

Parameter	Benefits	Barriers	Overall Suitability
	existing buildings		
Accessibility	Readily accessible within main car park area		
Examples Elsewhere	There are relatively few UK examples at present[3]. Larger scale examples include areas of low-level and multi-storey car parks.		
Other Commentary	Solar car ports offer a modular design so can be readily scaled for individual parking areas. A variety of frame designs are available, all of which incorporate EV charging points.		

Solar Thermal

Table 2.5 Solar Thermal

Parameter	Benefits	Barriers	Overall Suitability
Solar Resource	Annual average irradiation estimated at 820 – 980 kWh/m^2		2
Electrical Infrastructure	No significant electrical infrastructure aside from small immersion heater (< 5 kW)		
Planning / Environmental	Permitted development if roof-mounted	Planning permission required if ground-mounted	
Visual Amenity	Little impact on wider amenity given proximity to buildings		
Accessibility	Readily accessible if installed at main buildings		
Examples Elsewhere	See, for example, https://www.hotsolarwater.com/london-hospital-largest-in-roof-solar-hot-water-array/ and https://www.hotsolarwater.com/hot-solar-water-at-the-worlds-most-southerly-point/		
Other Commentary	Limited domestic hot water demands relative to power requirements on resort. Installation of solar thermal would reduce scope for Solar PV, which is replacing a more expensive energy source		

[3] See, for example, https://www.evoenergy.co.uk/case-studies/harvey-hadden-sports-village/ (Accessed June 2020); https://www.sungiftsolar.co.uk/project/exeter-car-parks/ (Accessed June 2020); http://www.windandsun.co.uk/products/PV-Mounting-Structures/Solar-Carports/Solar-CarPort#.XvC6T698CM8 (Accessed June 2020)

Solar PV (Ski lift)

Table 2.6 Solar PV (Ski Lift)

Parameter	Benefits	Barriers	Overall Suitability
Solar Resource	Annual average irradiation estimated at 820 – 980 kWh/m^2		1
Electrical Infrastructure	Likely to be relatively easy to integrate with existing sub-stations		
Planning / Environmental		Planning permission required	
Visual Amenity		Potential issues with visual amenity depending on location within ski area	
Accessibility	Modular construction means system can be built out relatively easily		
Examples Elsewhere	Moving Carpet and other variants operational at a number of resorts[4]		
Other Commentary	Any solar PV is unlikely to be oriented on the structure to optimise incident solar energy. Limited South facing orientation of PV panels means that energy output will be very low making scheme economically infeasible.		

Day Centre Boiler Replacement (Heat Battery)

Table 2.7 Day Centre Boiler Replacement (Heat Battery)

Parameter	Benefits	Barriers	Overall Suitability
Fuel consumption	Heat Battery could be supplied with electricity rather than kerosene (existing boiler)	Net fuel consumption may rise	2
Integration with existing system	System will provide hot water for space heating and domestic hot water as per existing system	Need additional secondary space heating to deliver flow temperatures of 75 °C for existing supply	
Fuel delivery	Input energy can be electricity so no issues of fuel delivery or siting of heat battery		
Other Commentary	System offers some flexibility in heat storage and potential to reduce either kerosene use by existing boiler and/or some of the electrical heating. Main issue is requirement for secondary heat source to maintain existing flow/return temperatures. This would mean having an additional supply system to increase the flow temperature of the water supplied to the heating circuit (hence a higher operating and maintenance requirement than the present single boiler-fed system). The alternative would be to re-design the system with a lower temperature circuit and replace all radiators with larger sized ones. Ideally would be combined with Solar PV to provide electrical input		

[4] See, for example, https://www.sunkidworld.com/en/moving-carpet-special-solutions (Accessed April 2020)

Day Centre Boiler Replacement (Biomass)

Table 2.8 Day Centre Boiler Replacement (Biomass)

Parameter	Benefits	Barriers	Overall Suitability
Fuel consumption	Lower carbon fuel than existing kerosene	Wood pellets cost similar to kerosene	3
Integration with existing system	Containerised unit could be readily accommodated.	Would need additional distribution system if extending heating to all of Day Lodge and Base Station buildings	
Fuel delivery	Containerised unit could be located adjacent to Day Lodge enabling ease of access fuel fuel deliveries		
Other Commentary	No visual impact or planning issues. Extension of wet heating system would offer future scope to consider lower operating temperatures for heat pump systems (or heat battery). Containerised unit can be readily re-located on site to serve any future refurbished or newly built premises.		

Space Heating (Heat Pumps)

Table 2.9 Heat pump options summary

Parameter	Benefits	Barriers	Overall Suitability
Fuel consumption	Decarbonise fuel for heating	Increase electricity demand	1
Integration with existing system	Offers lower temperature flow/return	Would need to replace radiators to provide larger surface area for heat emission	
System Performance	Ground source heat pump likely to offer most efficient performance but is expensive to install	Performance efficiency lower at low temperatures so system sizing would be crucial	
Other Commentary	Heat pumps would only be effective if combined with extensive building fabric works to improve overall thermal efficiency and air tightness. System design would be crucial to ensure adequate temperature distribution. Retrofit systems are more difficult to install than when designing to meet needs of any new building since the total area of heat emitter is critical to its effective performance (in combination with overall thermal efficiency of the building).		

Combined Heat and Power (CHP)

Table 2.10 Combined heat and power options summary

Parameter	Benefits	Barriers	Overall Suitability
Fuel consumption	Could look to use biodiesel/HVO or biomass wood chip as low carbon fuel sources	Diesel would offer most cost effective fuel, but not attractive from GHG emissions viewpoint	1
Integration with existing system	Would reduce grid electricity demand	Substation upgrade would be required to accommodate a CHP engine	
Market availability	Biodiesel/HVO engines available	Limited market availability of biomass CHP and fuel cell CHP at a scale suitable for the site	
Other Commentary	Ratio of heat and electrical demand on site is not readily met with a CHP solution. Summer heat loads would be particularly difficult to manage with potential for significant excess heat. This would reduce overall system efficiency		

Electrolyser – hydrogen production

Table 2.11 Electrolyser option summary

Parameter	Benefits	Barriers	Overall Suitability
Scale	Electrolyser is size of standard ISO freight container so could be readily located on site		2
Fuel use	Ideally needs renewable electricity source as well as potable water input	Potential competition for water use in snow making	
Integration with existing system	Hydrogen could be used to generate electricity, heating fuel or as vehicle fuel	No known existing hydrogen fuelled ATV or similar vehicles	
Other Commentary	Hydrogen for heating would require a new boiler and distribution pipework. Technology is in relatively early stage of development with proven examples predominantly in industrial operations.		

Heat Recovery (Snow Making)

Table 2.12 Heat recovery from snow making

Parameter	Benefits	Barriers	Overall Suitability
Capacity to recover heat	Snow Factory uses heat exchanger in snow production. Could recover heat in this process		1
Use of recovered heat	Recovered heat could feed a hot water tank or provide contribution to space heating		
Integration with existing system		Needs to be close to heat demand. Difficult to recover heat at a temperature close to current flow/return temperatures in space heating. Limited use therefore in contributing to domestic hot water needs. Snow Factory will be moved further from building making heat recovery impractical	
Other Commentary	Snow cannon use compressed air/water so no heat recovery options		

3. Wind Turbine

This section looks at the potential for wind development at the site.

3.1 Wind Resource

In assessing the wind resource available at the site there are two main characteristics to consider. The first is the mean average wind speed at the given location. The second is the direction of wind, measured using the frequency of occurrence in a given direction.

The Global Wind Atlas developed by the Technical University of Denmark (DTU)[5] provides the wind rose for both, wind frequency and wind velocity, for the specific location (Figure 3.1 and Figure 3.2).

Figure 3.1 Wind Frequency Rose

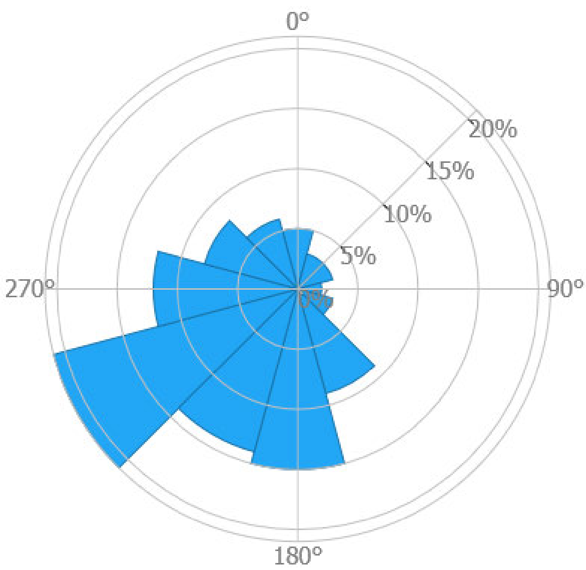
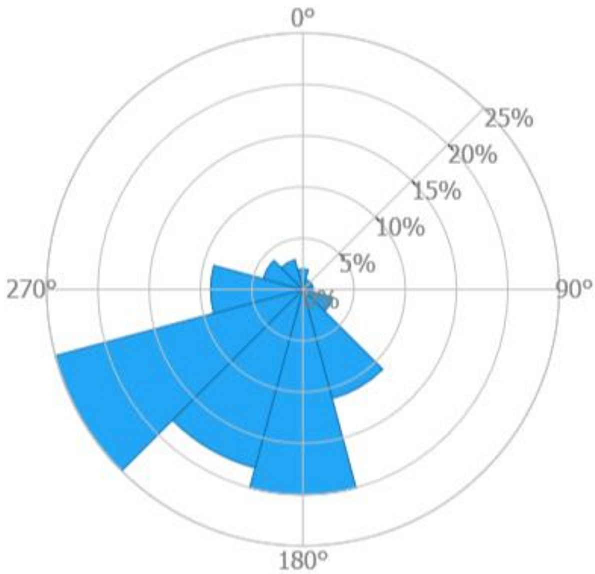


Figure 3.2 Wind speed Rose



As is common for UK wind turbines, the prevailing wind direction in South-West.

No specific anemometry data is available for the CMSL site.

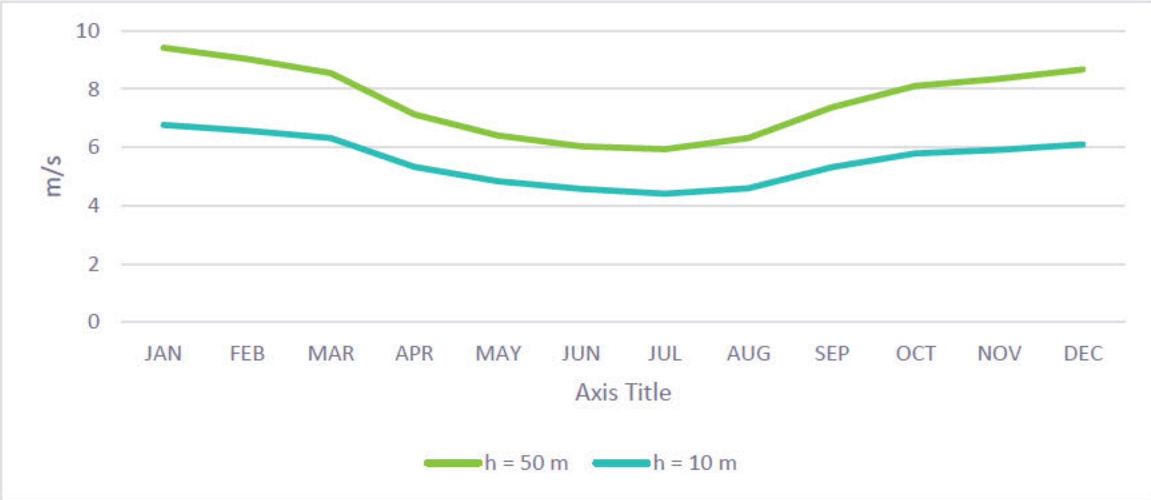
Initial data has therefore been obtained via the NASA Wind Database[6]. This provides mean average wind velocities per month at heights of 10 m and 50 m respectively.

Given this level of detail it is possible to provide an estimate of the annual energy generation available for a given turbine design. It is assumed, as a first approximation, that the monthly energy output will track the mean average wind velocity in line with the distribution profile shown in Figure 3.3.

[5] Source: DTU, WAsP. Global Wind Atlas. [Online] March 2020. https://globalwindatlas.info/.

[6] NASA. POWER Data Access Viewer. [Online] [March 2020] https://power.larc.nasa.gov/data-access-viewer/.

Figure 3.3 Monthly mean wind velocity



Source: NASA. POWER Data Access Viewer. [Online] [March 2020] https://power.larc.nasa.gov/data-access-viewer/.

3.2 Planning

A summary of national planning policy regarding renewable energy, as well as existing Cairngorms National Park Local Development Plan policies relevant to the current study, is provided in Appendix B.

Cairngorms National Park Local Development Plan 2020 Proposed Plan

The Local Development Plan 2020 (LDP2020) will guide development in the Cairngorms National Park over the period 2020-2025 and into the longer term. The proposed plan is currently at the examination stage and once adopted will replace LDP2015 in its entirety. The LDP2020 Proposed Plan is currently undergoing an examination by a Reporter appointed by Scottish Ministers and is expected to be adopted by the end of 2020. Given that the LDP2020 Proposed Plan has reached public examination stage, it is considered a material consideration in the determination of applications.

The LDP2020 will continue to support the four statuary aims of Scottish National Parks and states:
"The Cairngorms National Park Authority (CNPA) must work to deliver these aims collectively. However, if when carrying out any of our functions it appears to us that there is a conflict between the first aim and any of the others, we must give greater weight to the first aim. This is a sustainable development approach in which conservation of the natural and cultural heritage underpins the economic and recreational value of the National Park."

Policy 2: Supporting Economic Growth

Within LDP2020, a number of policies seek to support the use of renewable energy. Policy 2 will be used to *"support appropriate economic development which encourages sustainable economic growth whilst protecting communities from inappropriate development and helping to keep them vibrant and sustainable. All proposals must be appropriate and compatible with their surroundings and contribute to supporting a year-round economy."*

Policy 3: Sustainable Design

Policy 3 outlines that all developments must be designed to:

- *"minimise the effects of the development on climate change in terms of siting and construction;*
- *make sustainable use of resources, including the minimisation of energy, waste and water usage…;*
- *enable the storage, segregation and collection of recyclable materials and make provision for composting…"*

In addition: *"design and placemaking policy will contribute to the Partnership Plan's long-term Rural Development outcome and is consistent with its Rural Development policy framework. It will specifically support Partnership Plan Policies 3.3 and 3.5, which are aimed at:*

b) promoting a high standard of sustainable design, energy efficiency, sustainably sourced materials and construction in new development;

g) increasing renewable energy generation, especially biomass and hydro, that is compatible with conserving the special qualities of the National Park and maintaining the integrity of designated sites;

h) supporting businesses and communities to use less energy, reduce emissions, improve the energy efficiency of existing buildings, generate low impact renewable energy, reduce, reuse and recycle resources, and plan for a changing climate;

i) maximising the benefits to communities through direct use of locally generated energy or, where sold to the grid, reinvesting income to support community development; and

j) promoting high standards of sustainable design and efficient use of energy and materials in construction."

Points (a) and (c-f) are not of relevance with regards to renewable energy.

Policy 5: Landscape

A presumption against development that does not conserve and enhance the landscape character of the park. Any proposed development should therefore complement and enhance the landscape character of the park and that development will only be permitted where:

- *"any significant adverse effects on the special landscape qualities of the National Park are clearly outweighed by social or economic benefits of national importance; and*
- *all the adverse effects on the setting of the proposed development have been minimised and mitigated through appropriate siting, layout, scale, design and construction to the satisfaction of the planning authority."*

Policy 7: Renewable Energy

All Proposals for renewable energy generation will be considered favourably where:

- *"they contribute positively to the minimisation of climate change;*
- *they complement the sustainability credentials of the development;*
- *they conserve and enhance the special qualities of the Park;*
- *they include appropriate means of access and traffic management including appropriate arrangements for construction areas and compounds;*
- *they adequately minimise all cumulative effects; and*
- *they adequately minimise detrimental impacts on local air quality, particularly for proposals including combustion plants such as biomass."*

In addition, all hydropower proposals must have no detrimental impact on:

- *"the water environment;*
- *the recreational use of the water environment."*

The following sections of the proposed plan are similar to the current adopted plan. Section 7.3 relates to wind energy and proposals should minimise noise impacts, shadow flicker and impacts on aviation interests.

Section 7.4 states that all biomass proposals must include sufficient storage capacity in order to minimise the need for the delivery of fuel on to the site.

Section 7.5 outlines that any energy from waste proposals must maximise energy production by utilising locally sourced waste and minimise the transport of waste.

In addition, section 7.7 states that development of heat networks will be encouraged.

"Heat networks should utilise renewable or low carbon heat sources, although networks that are initially reliant on carbon-based fuels may be supported where there is potential to convert them to run on renewable or low carbon sources of heat in the future. Opportunities for co-location of a heat source or connection into an existing or planned local heat network are encouraged to maximise opportunities for the reuse of waste heat in a new development."

Policy 8: Open Space, Sport and Recreation

Policy 8 seeks to preserve areas of open space and sites that are used for sport and recreation. The re-development of existing sites should only take place where:

- *"the proposed development is ancillary to the principal use of the site as an outdoor sports facility; or*
- *the proposed development involves a minor part of the facility which would not affect its use and potential for sport and training."*

Policy 8 also states the relationship with the Cairngorms National Park Partnership Plan and *that "open space sport and recreation policy will contribute to the Partnership Plan's long term Visitor Experience outcome… It will specifically support:*

- *Partnership Plan Policy 2.3, which looks to provide high quality opportunities for access and recreation while maintaining the integrity of designated sites; and*
- *Priority 5, which aims to support the delivery of Scotland's Natural Health Service and in doing so encourage residents and visitors to responsibly enjoy the National Park for physical activity as part of daily life."*

Policy 10: Resources

Policy 10 seeks to reduce consumption of limited resources and help communities adapt to a lower carbon way of living. In particular, section 1 of Policy 10 seeks to minimise the use of treated and abstracted water and section 4 states that development should:

- *"safeguard existing strategic waste management facilities and all sites required to fulfil the requirements of the Zero Waste Plan; and*
- *ensure the minimisation of waste from the construction of the development and throughout the life of the development as defined in a site waste management plan or statement."*

Policy 10 also relates to Development affecting carbon sinks and stores, particularly soil and peat and it should:

- *"protect all soil and peat from commercial extraction; and*
- *minimise disturbance of soils, peat and any associated vegetation; and c) include an assessment of the likely effects of development on carbon dioxide (CO2) emissions and identify appropriate mitigation measures to minimise the release of stored carbon as a result of disturbance."*

Commentary

It is clear that a wind farm of any scale (i.e. multiple turbines) would be highly unlikely to be viewed favourably by planning authorities within the National Park. This implicitly considers a development situation where any such development is proposed on a purely commercial model, i.e. energy output from the wind farm would be sold on via power purchase agreement or similar with third parties or the DNO.

As noted in Section 2.1, large scale turbines are not viable at the site since areas with greatest wind resource are highly inaccessible with steep gradients unsuitable for turbine foundations. It would also be prohibitively expensive to connect any such turbines with the main resort electrical infrastructure.

In this case, therefore, the proposal would be for a wind turbine to provide self-supply. On this basis it is meeting an operational need and supporting a more sustainable position for a local business activity. Given the sensitivity of local habitats the area of consideration for any wind turbine would not be optimised for energy output, since this would require it to be located at the top of the mountain.

Instead, a location close to the existing infrastructure is considered more in keeping with the balance of energy generation capacity and minimising local environmental (and visual amenity) impacts.

3.3 Constraints Map

In any initial site screening for wind turbine locations there are several key constraints to review, including:

- Identification of statutory national environmental and cultural designations.
- Hydrological features
- Identification and buffer of technical constraints
- Terrain slope

Identification of statutory national environmental and cultural designations.

These designations are specified by two organisations in Scotland, they are Historic Environment Scotland (HES) and Scottish Natural Heritage (SNH).

The forest legal boundaries market by the Forest Stewardship Council (FSC) have been included in this analysis. The datasets from HES and SNH included in this analysis are summarise in the table below:

Table 3.1 Statutory national environmental and cultural designations datasets

Historic Environment Scotland (HES)	Scottish Natural Heritage (SNH)
Battlefield	Biosphere Reserves
Conservation Areas	Council of Europe Diploma sites
Gardens and Designated Landscapes	Country Parks

Historic Environment Scotland (HES)	Scottish Natural Heritage (SNH)
Historic Marine Protection Areas	National Nature Reserves (NNR)
Listed Buildings	Sites of Special Scientific Interest (SSSI)
Properties in Care	SNH Nature Reserves
Scheduled Monuments	Special Areas of Conservation (SAC)
World Heritage Sites	Special Protection Areas (SPA)
	Wetlands of International Importance (Ramsar)
	World Heritage Sites

Hydrological features

For watercourses, the minimum separation distance considered reasonable to expect the Local Planning Authority and the consultee to accept, is 15 m from the turbine. It is important to note that:

1. The results of the Feasibility Study, in terms of turbine numbers, predicted annual energy production and costs are based on the minimum separation distances to identified constraints, unless the maximum separation distance can be achieved without reducing the installed capacity of the site
2. These buffers are to be treated as guidance only, since it is not possible to stipulate separation distances for every site-specific eventuality.

Identification and buffer of technical constraints

Technical constraints include any rails, road routes, paths and buildings present in the area. Minimum buffer requirement for the elements present in the ski resort surroundings are:

Table 3.2 Technical constraints. Minimum Buffer requirements

	Minimum Buffer	Buffer Applied
A Road	Blade tip fall over measured to the edge of the highway boundary	50 m
B Road	50 m form centre point of turbine tower	50 m
Minor Road	50 m form centre point of turbine tower	50 m
Private/Staff car parks	No buffer. But ideally 50 m buffer from centre of the turbine	50 m
11.33 kW lines (Poles)	No buffer. Require to trenching the 11/33kV cables through the 1.5 x blade tip fall over zone. Consultation with DNO to be undertaken	No buffer applied
Commercial Buildings	No over sailing of building by blades i.e. 45m buffer for N90 (90 meters rotor diameter)	50 m
Permanent Structures which are not buildings i.e. water tanks	If there is no public access, no buffer should be applied. account needs to be taken of construction activities which may require that a 15m buffer is applied for the foundation.	50 m
Ski rails	No specific buffer identified. Conservative buffer applied for this project	50 m

Terrain slope

A review of terrain slope mapping was carried out. As an initial rule of thumb, it is not advisable to install wind turbines on slopes of greater than 9 degrees. This is due to the additional complexity of installation regarding access and underpinning civils works, and therefore increased capital costs. In limited situations, 9 to 12 degrees slope may be an acceptable solution.

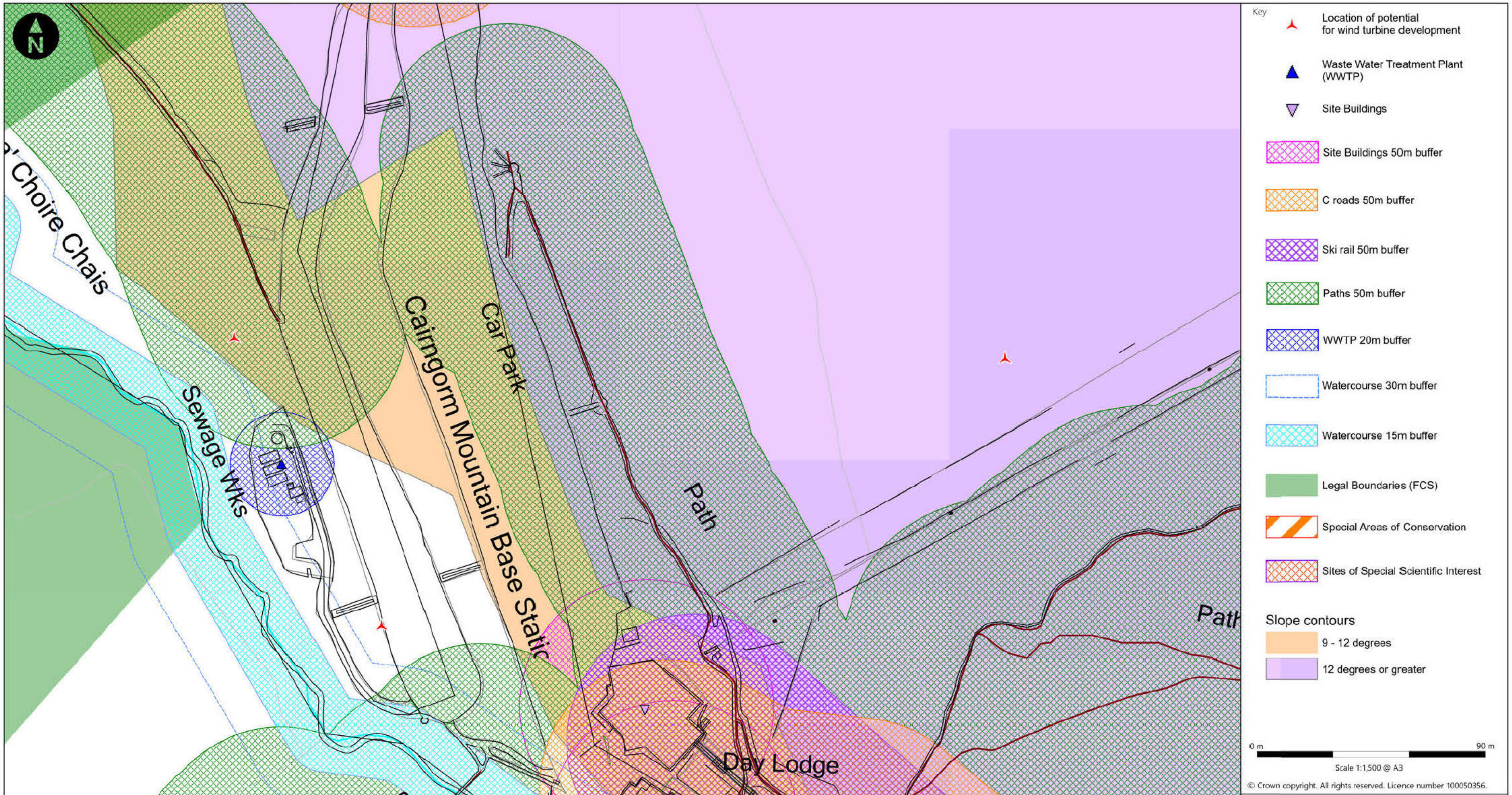
Constraint mapping summary onsite

The figure below shows all the elements identified above that are present on site. On this basis, 3 potential options have been identified.

- Option 1 – Available area located to the East of the parking area. The slope of the terrain is estimated to be just above 12 degrees. Further studies would be required to analyse the actual viability of this location.
- Option 2 – Available area located South-East of the WWTP. The slope of this area is lower than 9 degrees. The turbine could be potentially situated in the lower area of the car park; this would mean ready access to the road for ease of transportation and installation as well as being relatively close to the loads it would supply. The disadvantage would be a reduction in available space for parking and associated uses.
- Option 3 - Available area located North of the WWTP, East side of the watercourse. The slope of this area is lower than 9 degrees. The turbine will be located close to the parking area, which could generate some additional constraints. The main advantage is the proximity to the road, which will facilitate the transportation and installation.

The fences surrounding the ski resorts have not been initially considered as technical constraints. Paths have an initial buffer of 50 m, which may be reduced depending on specific considerations such as if they are categorised as core paths.

For a better understanding of the visual effects of each location, a map showing the Zone of Theoretical Visibility (ZTV) for the 3 options has been developed. These figures have been generated for a turbine with a total height (Height to blade tip) of 80 m. As noted in the section on Planning, we are aware that the current Planning Policy Framework, does not look favourably on turbines with a height to blade tip greater than 30 m. However, as noted earlier the context of development here is in support of site operational energy needs, rather than a commercial scale development. On that basis the potential for a larger turbine has been explored, essentially as a 'worst case' scenario regarding visual impact.



Client

Highlands and Islands Enterprise

Cairngorm Mountain (CM)
Highlands & Islands Enterprise (HIE)
Renewable Energy Options Appraisal

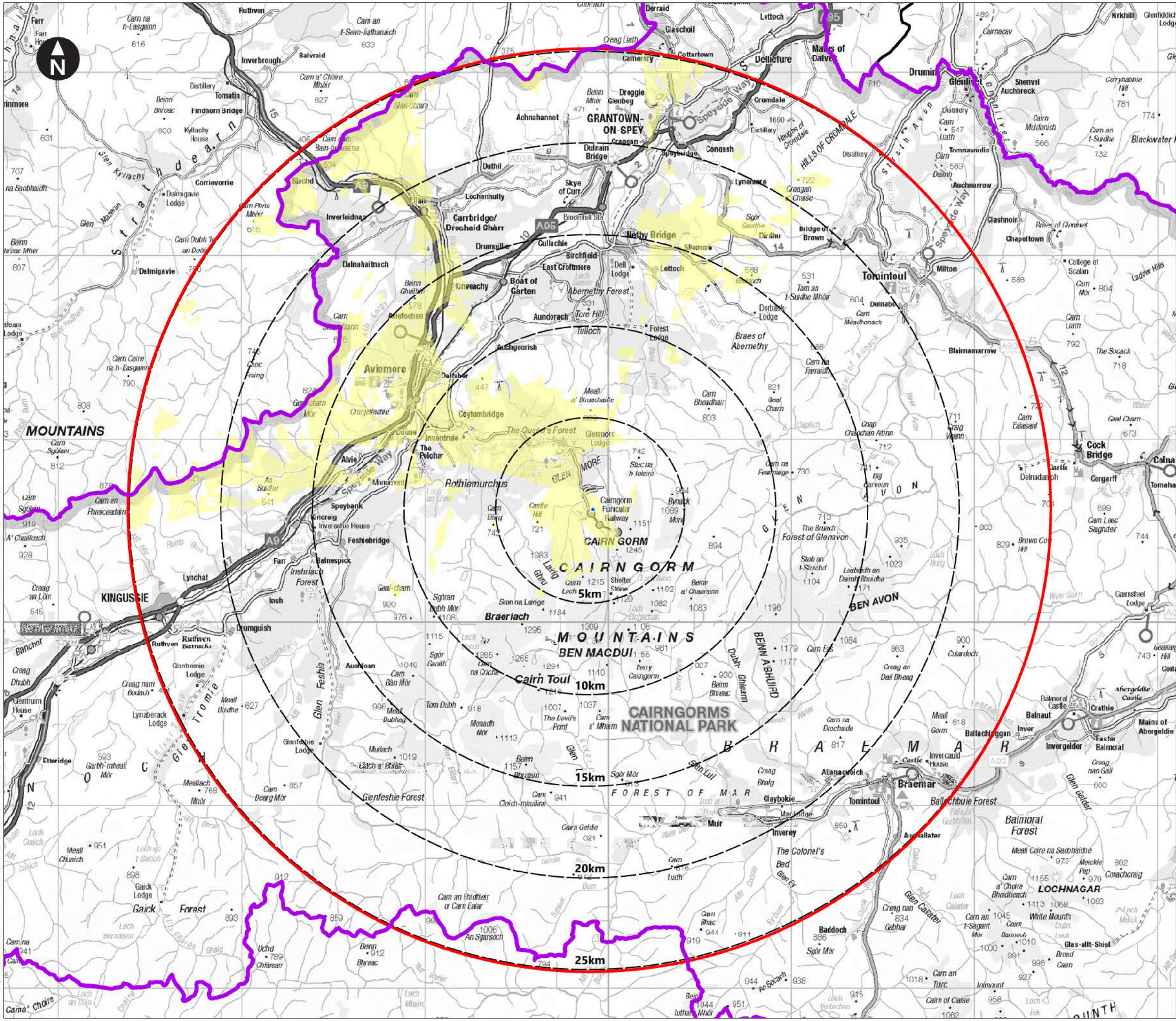
Figure 2.5

Constraints Map (Wind Development)

June 2020

wood.

H:\Projects\update.WOR Steven Fitzpatrick.



Key

Proposed Turbine 1 location

Co-ordinates: 299142, 806134

Landscape and Visual Study Area

Note: The study area is based on a 25,186m radius circle that allows a minimum of 25km distance from each of the proposed turbine locations

Cairngorms National Park boundary

Local authority boundaries

Lines indicating the distance from proposed turbines

Turbine 1 may be theoretically visible

Notes: This drawing is based on a computer generated Zone of Theoretical Visibility (ZTV). The areas shown indicate the maximum theoretical visibility of the proposed turbines using OS Terrain 50 data only and do not take account of any screening from vegetation or bui t-form. The ZTV also includes an adjustment that allows for the Curvature and Light Refraction of the Earth.

This figure has been based on the following parameters:

Turbine layout file:	CAIRNGORMS OPTION 1.WFL
Hub height:	56m
Rotor diameter	48m
Height to blade tip:	80m

0 2 4 6 8 10 12 km

Scale at A3: 1:200,000

Client

HIE
Highlands and Islands Enterprise
Iomairt na Gàidhealtachd 's nan Eilean

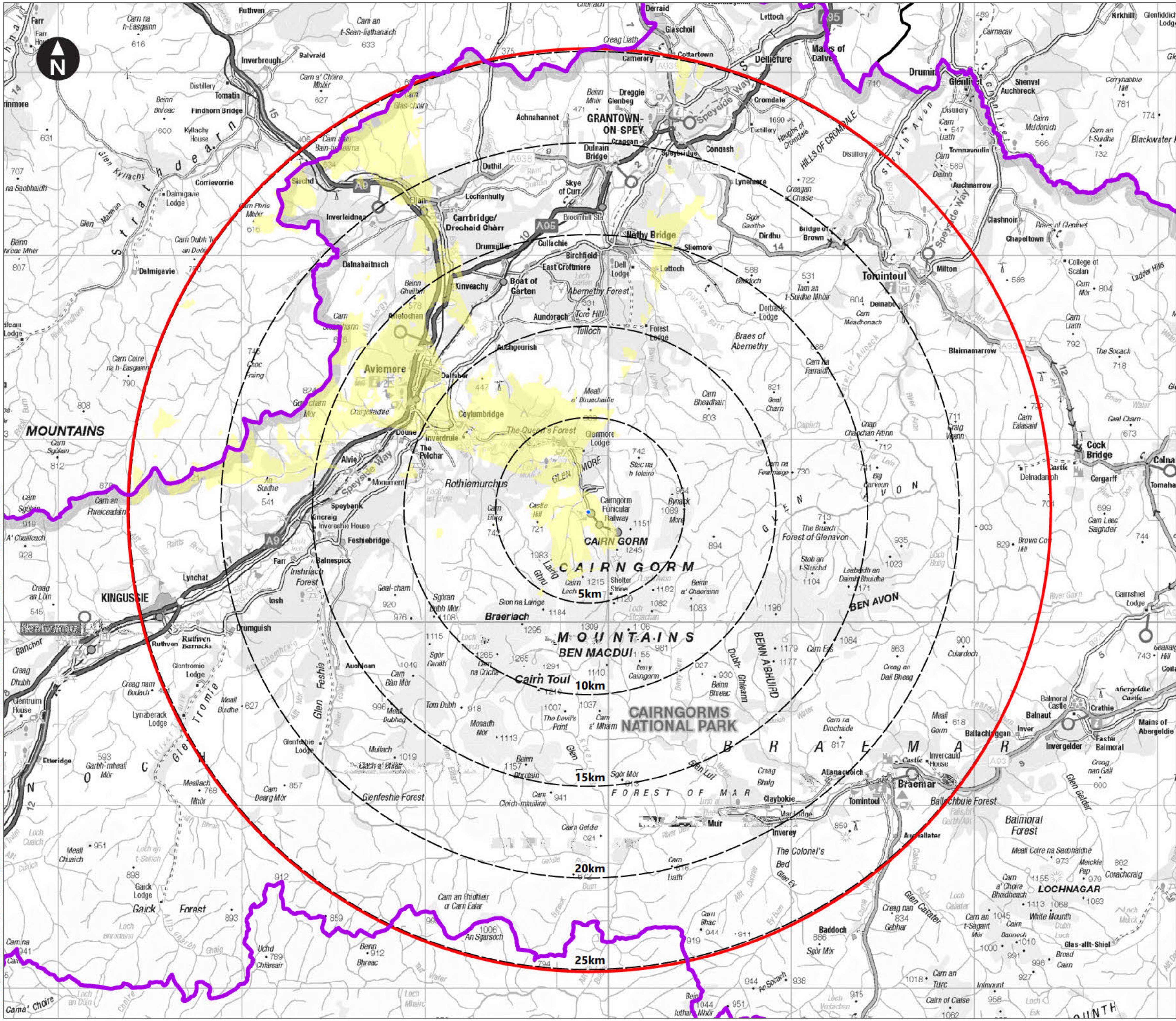
Cairngorms Ski Centre
Feasibility Study

Figure 5
Option 1 Blade Tip ZTV

February 2020

wood.

H:\data\Projects\SUB 42575 Cairngorm Ski Resort - Wind Turbine Coordinates\ArcGIS\42575-ED1005.mxd Originator: wilsc03



Key

Proposed Turbine 2 location

Co-ordinates: 298897, 806028

Landscape and Visual Study Area

Note: The study area is based on a 25,186m radius circle that allows a minimum of 25km distance from each of the proposed turbine locations

Cairngorms National Park boundary

Local authority boundaries

Lines indicating the distance from proposed turbines

Turbine 2 may be theoretically visible

Notes: This drawing is based on a computer generated Zone of Theoretical Visibility (ZTV). The areas shown indicate the maximum theoretical visibility of the proposed turbines using OS Terrain 50 data only and do not take account of any screening from vegetation or bui t-form. The ZTV also includes an adjustment that allows for the Curvature and Light Refraction of the Earth.

This figure has been based on the following parameters:

Turbine layout file:	CAIRNGORMS OPTION 2.WFL
Hub height:	56m
Rotor diameter	48m
Height to blade tip:	80m

0 2 4 6 8 10 12 km

Scale at A3: 1:200,000

Client

HIE Highlands and Islands Enterprise
Iomairt na Gàidhealtachd 's nan Eilean

Cairngorms Ski Centre Feasibility Study

Figure 6
Option 2 Blade Tip ZTV

February 2020

wood.

H:\data\Projects\SUB 42575 Cairngorm Ski Resort - Wind Turbine Coordinates\ArcGIS\42575-ED1006.mxd Originator: wilsc03

3.4 Turbine selection

To examine the site potential for wind generation a number of turbine designs have been considered as summarised here:

- Option 1 is a WES100 which has a rated power of 100 kW and tip height of 27 m
- Option 2 is a XANT M21 which has a rated power of 100 kW and tip height of 33.5 m
- Option 3 is an ED100 which has a rated power of 100 kW and tip height of 36.5 m
- Option 4 is an EWT61 which has a rated power of 500 kW and tip height of 76.5 m
- Option 5 is an EWT61 which has a rated power of 1 MW and tip height of 76.5 m

Option 1 is compliant with current NPA planning guidance, while Options 2 and 3 are higher than the current 30 m guidance but lower than 40 m.

Option 4 and Option 5 have been calculated to be able to compare the increment in the efficiency and annual energy generation if higher turbine heights were deemed acceptable by the planning authority.

As noted previously there is no specific anemometry for the site. An estimate of energy yield has therefore been derived using the power curve information for the specific turbines in combination with the wind resource data outlined in Section 3.1.

The table below summarises the annual behaviour of each turbine being considered.

Table 3.3 Wind Turbine Performance

	Option 1	Option 2	Option 3	Option 4	Option 5
Turbine	WES100	XANT M21	nED100	DW61	DW61
Power Rate (kW)	100	100	100	500	1,000
Hub Height (m)	18	23	24.5	46	46
Total Height (m)	27	33.5	36.5	76.5	76.5
Annual Generation (MWh)	136	237	280	1,402	2,803
Capacity Factor (%)	16%	27%	32%	32%	32%

Note: results are approximative values calculated using the annual mean average velocities from different well-known sources and further studies for the area such as: wind farm developments planning consents (Hillhead of Acquihire and GLENSHERO Wind Farm), and Savills research 'Onshore Wind in Aberdeenshire: Growth and Performance'[7].

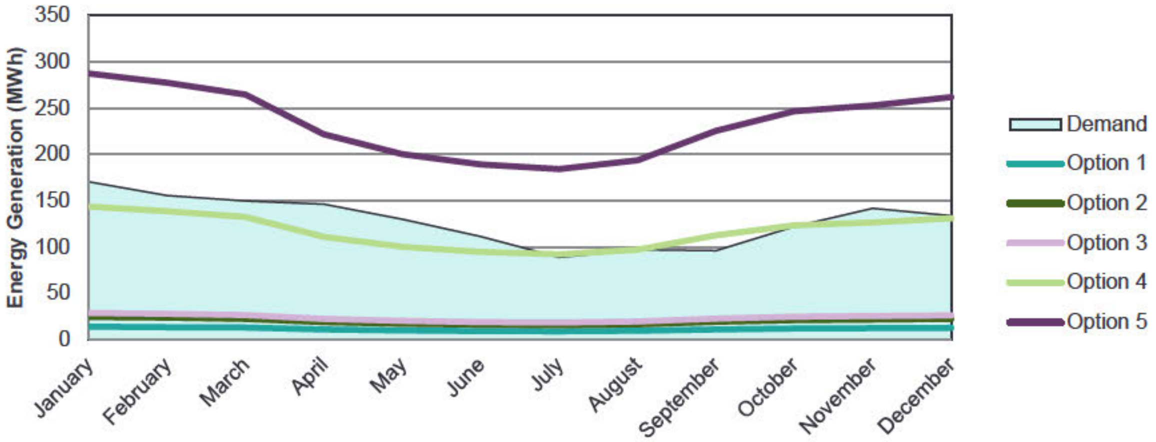
[7] Source: Savills World Research. UK Rural. Onshore Wind in Aberdeenshire: Growth and Performance. Savills, 2017

In order to get actual performance values for a turbine located onsite, it would be required to monitor the wind regime for at least a 12-month period. Installation of anemometry would require prior planning consent, and would enable real time monitoring data of:

- Wind speed and direction
- Wind shear (or wind gradient)
- On-site turbulence levels
- Ambient air temperature
- Atmospheric pressure

As an initial estimate of the benefit of any on-site wind turbine generation in displacing grid-supplied electricity, a monthly output profile has been derived using input wind regime data as outlined previously. This is then compared with the current CMSL baseline grid electricity demand to assess the net benefit of displaced grid electricity demand.

Figure 3.7 Monthly Wind Energy Generation and Demand



It can be seen that the output from the larger turbines potentially offers a significant contribution to current overall site demand (Option 4), or indeed exceeds it (Option 5).

As would be anticipated, the contribution from smaller turbines is much less significant.

Wind Turbine Economic Analysis

From initial enquires, EWT provided an average price range for the EWT61 turbine of 855,000-1,1000,000 euros. On this basis, the total CAPEX applied to the EWT61 turbine is £1,178,600, which includes £852,600 for the wind turbine and £326,000 of other expenses related to the construction (civil works, grid connection costs, foundations and civil infrastructure)

Regarding the Norvento turbine nED100, Renewables First engineering consultants provide a general project price of £345,000 that includes the prices of the wind turbine and all expenses related with the construction.

The capex of the remaining two turbines (turbine models WES100 and XANT M21) has been estimated based on UK government published data[8]. The same source is used to estimate the operating costs for the 5 turbine options.

Given the high level nature of the current cost estimate, and to account for ongoing fluctuations in currency exchange rates, a 5% contingency has been included in both capex and opex figures.

Table 3.4 Summary techno-economic evaluation (wind turbine options)

	Option 1	Option 2	Option 3	Option 4	Option 5
Turbine	WES100	XANT M21	nED100	DW61	DW61
Rate Power (kW)	100	100	100	500	1,000
Annual Generation (MWh)	136	237	280	1,402	2,803
Capacity Factor	16%	27%	32%	32%	32%
Generation used onsite (%)	100%	100%	100%	70%	50%
Annual Energy Exported (MWh)	-	-	-	420	1,402
Annual Energy used onsite (MWh)	136	237	280	981	1,402
Annual Electricity Bill Savings (£)	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
Electricity Export Income (£)	£-	£-	£-	£23,547	£78,490
OPEX (£) + 5% contingency	£4,305	£4,305	£4,305	£31,500	£39,690
Net Annual Savings (£)	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
CAPEX (£) + 5% contingency	£153,720	£296,888	£362,250	£1,237,530	£1,559,288
Payback (Years)	10	10	10	9.4	6.5
NPV (£)	£64,770	£131,269	£154,783	£669,095	£1,848,740
IRR (%)	10%	10%	10%	11%	16%

Notes:
NPV calculated based on 25 year asset lifetime and a discount rate of 6%
[redacted]

3.5 Evaluation

Option 1 provides a turbine that is compliant with current planning guidance within the National Park. It would contribute around 10% of current grid electricity demand.

Options 2 & 3 offer a higher energy yield, though are slightly taller than the current guidelines. There is a limited benefit in terms of the scale of energy generation.

[8] Source: Department of Energy and Climate Change. Review of Renewable Electricity Generation Cost and Technical Assumptions ARUP, 2016

Options 4 and 5 offer larger turbines with much higher energy yields. While the current analysis has considered revenue opportunity from export to grid, there is also scope therefore to meet additional load on site in the event of expanded facilities or future load (e.g. batteries, heat pumps or electrolyser).

Further dialogue would be needed with the Park and other stakeholders to consider the viability of any larger turbine. The current study has not carried out any extensive ecology or ornithology studies and these topics would also need to be addressed vis specific site surveys if this option is pursued further.

4. Solar PV

This section looks at solar PV opportunities in the resort.

4.1 Overview

The output from the phase 1 workshop identified solar PV as one option to consider for the resort. This offers a short term development opportunity for on-site energy generation. It also offers a degree of flexibility, since any solar PV panels installed could be relocated to other suitable roof space if refurbishment or new build activity is subsequently undertaken at site.

Recognising the penetrating nature of the typical wind regime at the mountain top it was decided not to evaluate options for the Ptarmigan Restaurant building.

The focus of analysis here is therefore the potential for roof-mounted solar PV installed on the Day Lodge and Base Station buildings.

More broadly there are three other solar opportunities considered:

- Ground-mounted array on land surrounding the water treatment works
- Solar car port (within vicinity of the Day Lodge)
- A ski lift design incorporating solar PV integrated into the system

These are addressed in turn.

The annual solar irradiation at the site was obtained via the European Commission tool PVGIS[9].

4.2 Roof-mounted solar PV

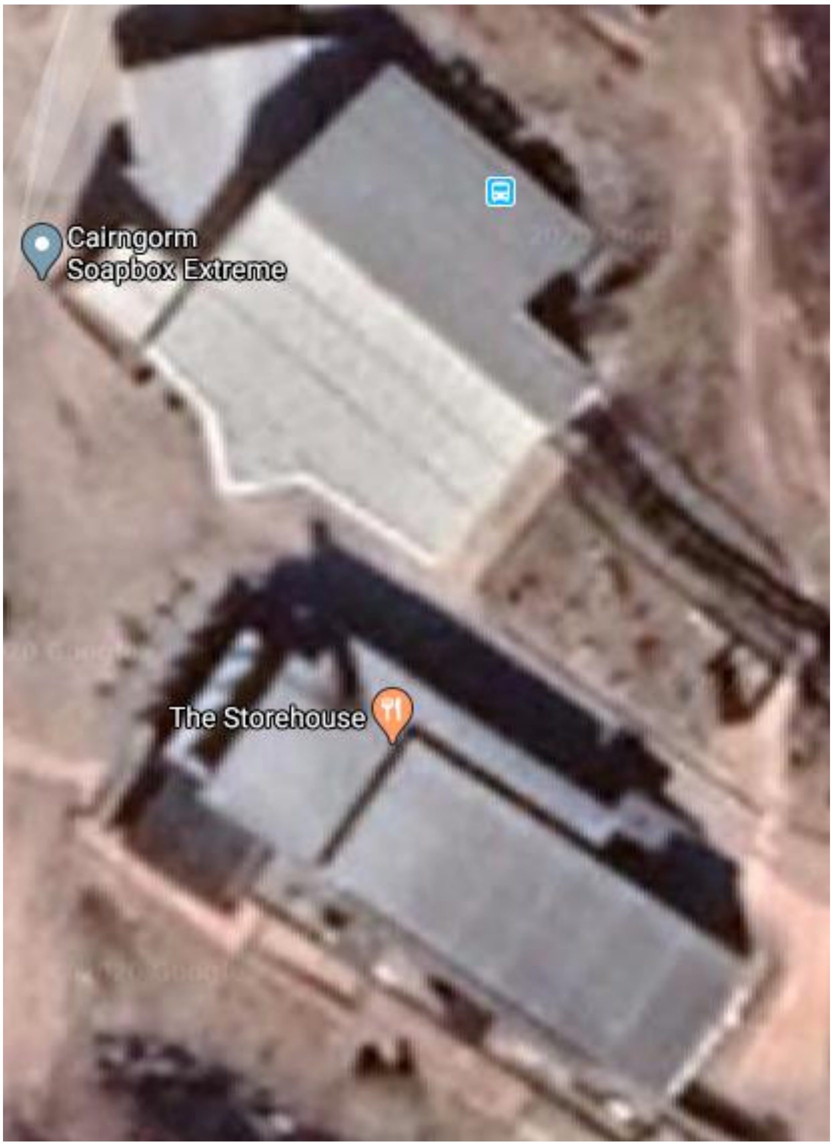
Initial review of the roof of the base station and Day Lodge buildings has been completed using aerial imagery. The relevant roof areas are shown in Figure 4.1.

The Day Lodge building has a total roof area of approximately 176 m^2; 86 m^2 north-east facing and 90 m^2 South-west facing.

The Base Station building has a lower roof area that has been excluded from analysis due to the overshading that would result if solar panels were placed in this area. The available roof area is therefore estimated at 92 m^2 and it is north-west oriented.

[9] Source: European Commission. EU Science Hub. PVGIS. [Online] (Accessed February 2020)

Figure 4.1 Roof areas considered for solar PV



Estimated Energy Yield – Working Assumptions

To calculate the potential PV energy generation of the roof mounted installations, it is assumed that 80% of the roof will be covered by PV panels. This accounts for a combination of compliance with permitted development requirements (planning guidelines) and ease of access for maintenance.

It is assumed that PV panel efficiency and capacity power are fixed at 18% and 250 W respectively, in line with industry benchmarks.

4.3 Ground-mounted solar

The land areas of interest are shown in Figure 4.2.

Figure 4.2 Land areas considered for ground-mounted solar PV

The upper image shows a banked area of land with an area of 143 m^2; the lower image shows a flatter land area of approx. 68 m^2.

In calculating the potential ground mounted PV generation south facing panels with 35 degrees tilt (optimum angle) have been considered in order to optimise energy yield.

4.4 Solar Car Port

The opportunity to install a solar PV carport in the parking area nearby to the Base Station is reviewed here. A large structure is not proposed, in order to avoid disruption to snow clearing in the main car park (and associated maintenance requirements). The size of system reviewed here is a double row structure 15 m long covering 12 parking spaces. The model chosen is in line with that available from Flexisolar[10]. In this instance the tilt of the car port panels is estimated as 12 degrees; the optimum angle for the location is 35 degrees.

4.5 Estimated Energy Yields

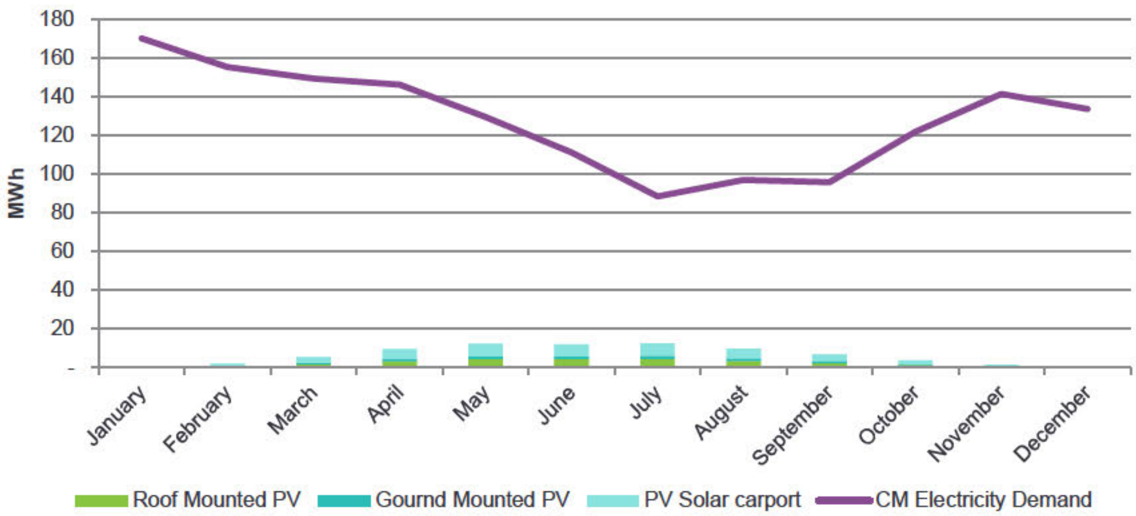
A summary of the estimated annual energy yields from each system is provided in Table 4.1.

Table 4.1 Solar PV Installation: Estimated annual generation and capacity factor

	Roof Mounted PV	Ground Mounted PV	Solar PV Carport
PV Area (m^2)	203	200	138
PV Panels (number)	178	66	-
Annual Energy Generation (MWh)	27	11	19
Total Capacity (kW)	44.5	16.5	28.5
Capacity Factor (%)	6.8%	7.8%	7.5%

This scale of generation can be viewed in the context of current site electricity demand as shown in Figure 4.3.

Figure 4.3 PV Solar Energy Generation and CMSL electricity demand



Overall site demand is well in excess of the capacity that has been reviewed here. On this basis all generation will be utilised on site without the need for any grid export.

[10] Source: Flexisolar. Integrated Solar Carport Solutions. https://www.flexi-solar.com/ (Accessed March 2020)

wood.

Initial Economic Analysis

The estimated CAPEX for the solar PV installations considered are listed in Table 4.2, along with estimated operating costs. A summary of the initial economic analysis is provided in Table 4.3.

Table 4.2 Estimated capital and operating costs (£/kW)

	Roof Mounted PV	Ground Mounted PV	Solar PV Carport
CAPEX (£/kW)	1,030	1,140	1,100
OPEX (£/kW)	13	11	13

Notes:
Data sourced from: International Renewable Energy Agency. Renewable Power Generation Costs 2018 (2019); Department for Business, Energy & Industrial Strategy BEIS. Solar PV cost data (2019); Department of Energy and Climate Change. Review of Renewable Electricity Generation Cost and Technical Assumptions, ARUP, 2016. Carport figures from Flexisolar https://www.flexi-solar.com/

Table 4.3 Solar PV Installation – Initial economic assessment

	Roof Mounted PV	Ground Mounted PV	Solar PV Carport
Total Capital cost (£)	£45,835	£18,810	£31,350
OPEX (£)	£579	£182	£371
SEG Export Income (£)	-	-	-
Estimated Net Annual savings (£)	[redacted]	[redacted]	[redacted]
Simple Payback (Years)	14	13	14
NPV (£)	£1,453	£2,105	£2,267
IRR (%)	6%	7%	7%

4.6 Solar PV and Ski Conveyor

One further option to consider is the installation of an outdoor conveyor within the ski resort area. There are a number of potential designs for these conveyors, one of which integrates solar PV panels in a 'tunnel' design. Such conveyors, or moving carpets, are suitable for the movement of people and materials, and can be used to assist in snow clearing.

Initial analysis has been carried out looking at two potential options available from Sunkid[11]. Solar resource has been estimated using the PVGIS tool[12].

[11] https://www.sunkidworld.com/en/sonderloesungen (Accessed March 2020)
[12] https://re.jrc.ec.europa.eu/pvg_tools/en/tools.html?lat=&lon=&startyear=&endyear=&raddatabase=&angle=&browser=&userhorizon=&usehorizon=1&select_database_month=PVGIS-CMSAF&mstartyear=2007&mendyear=2007&optrad=1&selectrad=1&mangle=39
(Accessed March 2020)

- Option 1 – Moving Carpet (99 m). Either double row PV modules or single row PV modules
- Option 2 – Moving Carpet (54 m). Either double row PV modules or single row PV modules

Summary details are provided here.

Table 4.4 Solar PV Moving Carpet – Initial Analysis

		Option 1 Sunkid Moving Carpet 99 m		Option 2 Sunkid Moving Carpet 54 m	
Parameter	**UOM**	**Two Rows Modules incl. installation material/cable tray**	**One Row PV Modules incl. installation material/cable tray**	**Two Rows Modules incl. installation material/cable tray**	**One Row PV Modules incl. installation material/cable tray**
Capacity	kWp	11.2	5.6	6.0	3.0
Annual Energy Production	MWh	7.2	3.6	3.9	1.9
Capacity Factor	%	7%	7%	7%	7%
% Energy use on-site	%	100%	100%	100%	100%
Capital Cost	£	£25,845	£13,200	£12,900	£7,050
Annual Energy Cost Saving	£/yr	[redacted]	[redacted]	[redacted]	[redacted]
Annual Opex Costs	£/yr	£123	£62	£66	£33
Net Cost Savings	£/yr	[redacted]	[redacted]	[redacted]	[redacted]
Simple Payback	yrs	29	29	27	29

Note: Capital costs based on Sunkid information; opex based on typical costs for PV arrays

The energy yield here is based on the most efficient output.

Initial capital cost estimates are from initial supplier documentation.

It can be seen that the energy yield available from this system is low and is a much higher capital cost than other available solutions for solar PV output (either roof or ground mounted or indeed a solar car port).

This option is not considered economic (in energy terms) given the high capital cost and low renewable energy output.

This assessment is purely on energy yields and associated on-site energy demand. It has not considered any wider benefits or replacement cost assessment relative to existing ski lifts on site.

5. Heating System – Day Lodge

This section looks at opportunities to decarbonise the heating system within the Day lodge and Base Station buildings.

5.1 Overview

Space heating and domestic hot water is currently supplied to the Day Lodge building via a kerosene-fuelled boiler and wet radiator system. Additional electrical heating provides space heating requirements in areas of the building where radiators are not present.

The Base Station building is currently fully electrically heated.

An estimate of the associated heating energy requirement, based on the finding of a recent energy audit[13], is provided here.

Table 5.1 Heating energy – current annual demand estimate

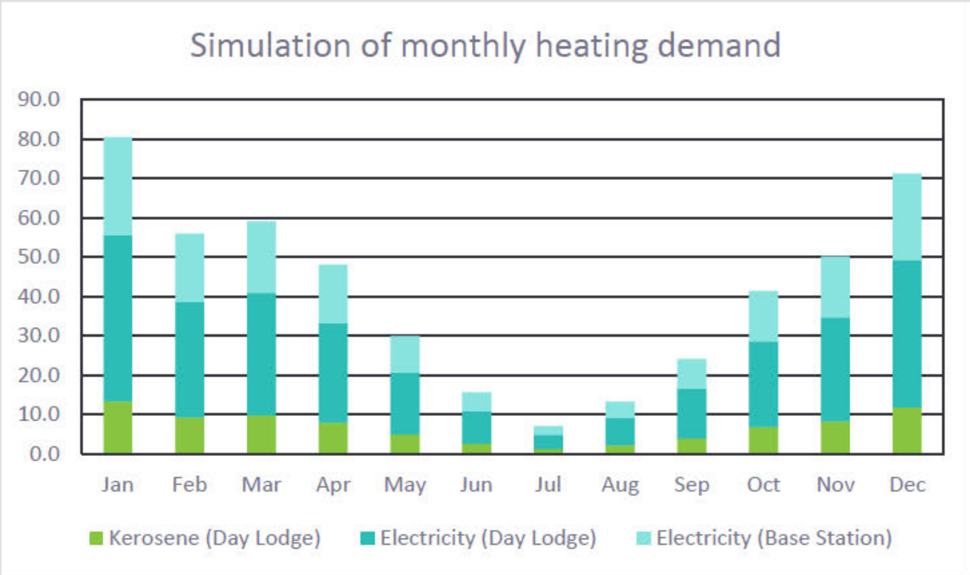
Building	Kerosene (MWh/yr)	Electricity (MWh/yr)	Sub-Total (MWh/yr)
Day Lodge	82	261	343
Base Station		153	153
Total	82	414	496

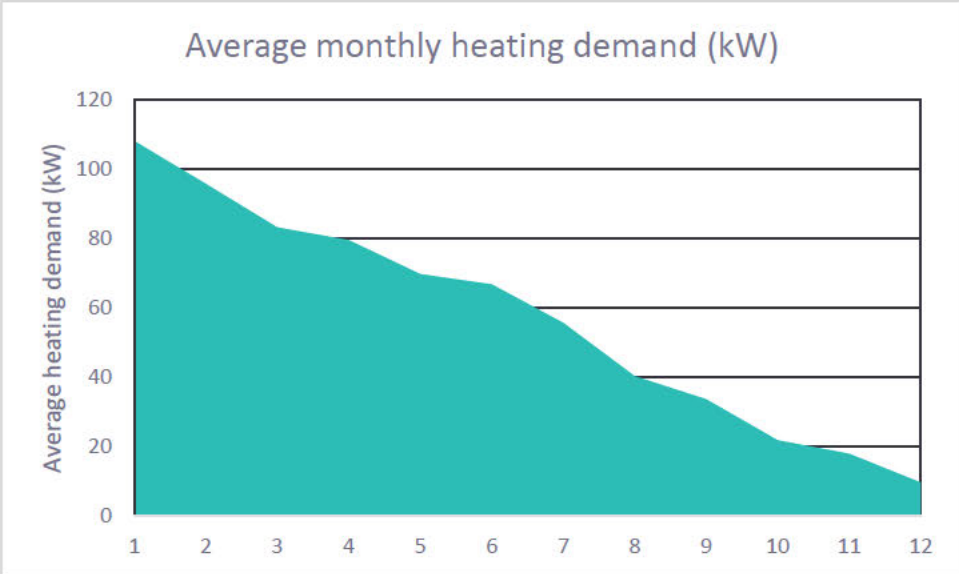
No further assessment of the monthly demand profile is available at this point. As a means of simulating the monthly demand we can use heating degree days as a means of projecting heating requirements. These provide a way of assessing the likely heating requirements based on external weather conditions over a 12-month period.

Using a heating degree day (HDD) apportioned approximation (this essentially assumes a perfect control system where heat output is modulated in line with external conditions) the simulated monthly demand profile is shown here.

[13] Energy Efficiency Audit, Cairngorm Mountain Scotland Ltd. (Synergie Environ, 2020)

Figure 5.1 Simulation of monthly heating demand profile





This data suggests that a boiler sized at about the same rating as the existing boiler in the day lodge (120 kW) would be adequate to meet the total heating needs of both the Day Lodge and the Base Station buildings. This includes the current heating requirements met by electrical heating.

To look at this in further detail, three options have been reviewed:

- Option 1 – **Day Lodge (basic)** Replacement of existing boiler serving Day Lodge building with containerised biomass unit. Existing electrical heating retained with no extension of existing heating circuit fed from boiler
- Option 2 – **Day Lodge (extend)** Replacement of existing boiler serving Day Lodge building with containerised biomass unit. Extension of existing heating circuit fed from boiler to replace existing electrical heating
- Option 3 – **Combined** Replacement of existing boiler serving Day Lodge building with containerised biomass unit. Extension of existing heating circuit fed from boiler to replace existing electrical heating in both Day Lodge and Base Station buildings

A summary of the initial techno-economic analysis is provided here.

Table 5.2 Containerised biomass options appraisal – initial summary

Parameter	UOM	1 Day Lodge (Basic)		2 Day Lodge (extend)		3 Combined	
		Lower	**Upper**	**Lower**	**Upper**	**Lower**	**Upper**
Boiler Rating	kW	85	85	110	110	140	140
Capital Costs, of which:	£	£76,820	£98,770	£104,300	£142,640	£131,670	£170,120
Boiler installation	£						
Additional distribution system	£	-	-	£16,500	£32,900	£32,900	£49,400
Operating Costs, of which:	£/yr						
Fuel costs	£/yr	£4,100	£4,100	£17,380	£17,380	£25,300	£25,300
Operating and maintenance	£/yr	£850	£850	£1,320	£1,320	£1,680	£1,680
Net Operating Costs (*cf.* existing system)	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
Simple Payback	Yrs	NA	NA	5	6	4	5
NPV	£	-£68,170	-£88,877	£226,399	£190,229	£388,065	£351,792
IRR	%	-12%	-13%	24%	17%	29%	23%

Note: NPV calculated over 25 year period with a discount rate of 6%

Fuel costs for kerosene and wood chips are broadly similar. In the case of a direct boiler replacement there is no significant cost saving in fuel costs. This does not therefore offer a sensible investment return.

The other two options benefit from cost savings from displacement of grid electricity use. These options appear economically feasible.

All three options offer significant decarbonisation of the input fuel and sustained annual carbon savings.

6. Recommendations

This section provides recommendations for next steps in taking forward renewable energy generation opportunities at the site.

6.1 Overall sustainability strategy

The Cairngorms Mountain Estate provides a natural public amenity that is an important element of the Cairngorms National Park. Meeting the existing and future energy needs of the ski resort needs to be balanced with suitable management and protection of the habitats, species and environmentally sensitive areas that are an integral part of the National Park.

CMSL, as with all other organisations across Scotland, needs to ensure that it contributes to a low carbon future and supports national targets to reduce GHG emissions and minimise environmental impacts generally. A sustainable delivery model needs to balance net benefits for people (jobs and amenity), planet (minimising environmental impacts) and profit (sustainable balance of revenue and costs).

In respect of energy, grid electricity makes up the largest current contributor to overall requirements. While it is possible for the resort to consolidate its grid electricity purchase via a single Green Tariff, backed by Renewable Energy Guarantees of Origin (REGO), this will not address the cost of energy and therefore sustainable business operations.

Large-scale commercial energy generation is not feasible given the inaccessibility of natural resources and current local electricity grid network operating regime. Development of large-scale wind or hydro generation (the most favourable resources on site) would be prohibitively expensive given the additional costs of development associated with the technical installation challenge (inaccessible geography) and grid connection upgrades. It is also difficult to align with local planning policies and therefore likely to entail a lengthy and contentious planning process with no guarantee of a successful outcome.

Recommendation 1: Overall strategy to look at opportunities for on-site energy generation supporting local energy needs. This therefore addresses both decarbonisation and cost of energy while being sympathetic to maintaining the natural character and amenity of the Cairngorm Mountain Estate.

6.2 Energy efficiency

While not within the scope of this study, separate work has looked at opportunities to improve energy efficiency at the site. These include behavioural measures and a number of aspects of building fabric and energy control systems.

Ongoing work has also replaced standard diesel with HVO as primary fuel for generators and vehicles operating on site. The net benefits of this replacement should be quantified in respect of both GHG emissions and fuel costs.

Further opportunities for short term energy efficiency (defined as savings achievable within the next 3 years) should be prioritised before any renewable energy projects are implemented. This avoids oversizing solutions for a reducing energy demand.

Recommendation 2: Prioritise cost-effective energy efficiency measures and evaluation of use of HVO prior to renewable energy project implementation.

6.3 Site Masterplan

The wider vision for the site has implications for its energy requirements in the medium term (5 – 10 years). It is therefore important that there is an understanding of any significant changes proposed. This does not require specific details – rather an understanding of what might be proposed and the order of magnitude change in energy requirements this might bring.

This enables a suitable view of how future energy needs might be accommodated in developing proposals for renewable energy on site.

Recommendation 3: Develop key elements of site masterplan to provide medium term view of future energy requirements.

6.4 Renewable energy development

Short term opportunities exist for the development of solar PV (roof and ground mounted) on the site and replacement of the Day Lodge boiler with a biomass solution.

These options provide a means of decarbonising on-site energy use and a degree of flexibility in respect of future modifications at site (roof-mounted solar panels and containerised biomass can be relocated).

Solar car ports provide an opportunity to support a wider shift from internal combustion engines to electric vehicles (particularly passenger vehicles).

Medium term, a wind turbine would provide a significant contribution to overall site energy needs. This can act as a facilitator of wider future action on site. For example, this would offer supporting generation for heat pump solutions for any retrofit/new buildings or a feed for production of hydrogen in an electrolyser.

Recommendation 4: Develop specification for solar PV installation at site and associated planning consent (ground mounted solar PV)

Recommendation 5: Carry out detailed feasibility study to develop specification for containerised biomass heating system for Day Lodge and Base Station.

Recommendation 6: Engage in pre-application dialogue and seek screening opinion from local planning authority in order to determine development approach for a single medium scale wind turbine at site.

6.5 Next Steps

There are a number of strands of work that can be taken forward at different timescales. The following table offers indicative tasks and associated costs to provide an initial view of the immediate requirements for delivery.

All costs are indicative and would need to be firmed up as the scope of works was defined.

Table 6.1 Next steps – outline tasks and indicative costs

#	Outline Task	Description	Indicative Timeframe	Indicative Cost
1	**Energy Efficiency Measures**	Review separate report and implement relevant recommendations relating to building fabric and energy control systems	6 months	TBC
2	**Evaluate net benefits of HVO fuel switch**	Benchmark HVO benefits in terms of cost of energy and GHG emissions	6 months	NA
3	**Review Masterplan**	Assess medium term energy implications of Masterplan	6 months	NA
4	**Solar PV – Roof-mounted**	Structural assessment of relevant roof areas to confirm loading capacity for solar PV	3 months	£500 - £750
5	**Solar PV – Initial Planning**	Engage with planning authority to confirm permitted development position (roof-mounted) and planning application requirements (ground-mounted and solar car ports)	3 months	£200 - £300
6	**Solar PV- Planning**	Develop planning application for ground-mounted solar PV and solar car ports	6 months	£1,500 - £2,000
7	**Solar PV – Tender Package**	Develop design brief and tender package (all solar projects)	6 months	£2,000 - £3,000
8	**Biomass boiler – survey**	Develop system requirements by review of heating system	3 months	£1,000 - £1,500
9	**Biomass boiler – Tender Package**	Develop design brief and tender package	6 months	£2,000 - £3,000
10	**Wind Turbine – Planning Engagement**	Seek pre-application advice and EIA screening opinion	3 months	£400 - £800
11	**Wind Turbine – Anemometry****	Seek planning consent for met mast (temporary structure)	6 months	£2,000 - £3,000
12	**Wind Turbine – Bird Monitoring****	Bird monitoring data	12 months	£15,000 - £20,000
13	**Wind Turbine – Planning Application (with EIA)****	Develop planning application and associated EIA	18 months	£5,000 - £10,000
14	**Wind Turbine – Planning Application (without EIA)****	Develop planning application	12 months	£3,000 - £5,000

Note: ** Wind turbine tasks are dependent on outcome of initial engagement with planning authority and agreed requirements

wood.

Appendix A
Supporting Information

Table A.1 Transport Inventory

#	Description	Quantity	Commentary
FA1	4-wheel drive utility quad bike	Vehicles	
FA2	2-stroke wide track utility snowmobile	Vehicles	
FA3	2-stroke wide track utility snowmobile	Vehicles	
FA5	Piste groomer machine with all associated attachments	Vehicles	
FA6	Piste groomer machine with all associated attachments	Vehicles	
FA7	Piste groomer machine with all associated attachments	Leased	
FA11	Rear compactor, centre roller + smoothing board attachment for KB (spare)	Plant	
FA12	Rear compactor, centre roller + smoothing board attachment for KB (spare)	Plant	
FA13	Flex tiller attachments for Kässbohrer (spare)	Plant	
FA14	Flex tiller attachments for Kässbohrer (spare)	Plant	
FA15	Flex tiller attachments for Kässbohrer (spare)	Plant	
FA16	Blade shovel grab attachment for Kässbohrer	Plant	
FA17	Snowblower attachment for Kässbohrer	Plant	
FA29	Demountable salt spreader attachment for Unimog vehicle, 2.7cu.m capacity	Plant	
FA32	Single blade snow plough attachment for Unimog vehicle	Plant	
FA41	Variable wedge snow plough attachment for JCB	Plant	
FA415	Trk 350 Dk ATV trailer	Vehicles	
FA416	Accessories	Vehicles	
FA417	Diesel driven piste groomer machine with all associated attachments 2010	Vehicles	
FA418	Lynx Yeti V800	Vehicles	
FA419	Lynx Yeti Prov-800 with Trailer	Vehicles	
FA567	Cas Motor & Invertor	Plant	
FA568	Polaris Quad SF13LDX	Vehicles	
FA575	PI / L1227 Lombard Unimog	Leased	

#	Description	Quantity	Commentary
FA607	PistenBully 600 Park SCR Standard Tier	Plant	
FA612	Lynx Snowmoblle 69 Ranger Alpine 1200	Leased	

Note: Details from asset register provided by CMSL

Other Buildings

The potential for renewable energy generation supporting the Ptarmigan Restaurant was discussed at the initial workshop. From an operational perspective the harsh weather regime, particularly mean average wind speeds make maintenance of the building challenging with significant and rapid weathering of external fabric. For this reason, the potential for solar PV was discounted.

The current heating and ventilation include a combination of air handling units (AHUs) and electric heating. Several options for refurbishment were reviewed in the separate energy efficiency audit report. It is therefore difficult to comment on the viability of alternative renewable heating solutions until decisions are made regarding any of the proposed efficiency improvements noted in the audit report.

The Mid Station building has a relatively low electricity demand throughout the year. It was therefore not prioritised for opportunities assessment given the larger loads associated with other buildings. General monitoring of metered electricity and ongoing fabric condition maintenance will assist in minimising associated electricity demand in this building. Similar concerns around damaging winds would apply here as with the Ptarmigan Restaurant.

Appendix B
Planning Policy Overview

The National Planning Framework (NPF3)

Scotland's Third National Planning Framework (NPF3 – Scottish Government, 2014) provides the statutory national framework around which to orientate Scotland's long-term spatial development. The NPF3 represents the spatial expression of the Scottish Government's Economic Strategy (2011) and it highlights the spatial planning implications of multiple national policy documents and commitments, including opportunities for rural development as well as plans and strategies for energy, environment and climate change.

Overall the NPF3 emphasises the Scottish Government's commitment to increasing sustainable economic growth across all areas of Scotland and therefore orientates the efforts of Scotland's planning system towards this purpose. The introduction to the NPF3 notes the importance of maintaining economically active and vibrant rural areas whilst "safeguarding our natural and cultural as*sets and making innovative and sustainable use of our resources*".

The NPF3 sets out a national spatial strategy structured around four key themes. These are set below;

- A successful, sustainable place: This theme is underpinned by the objective of achieving *"a growing low carbon economy"* alongside creating "*high quality, vibrant and sustainable places…*".The Framework calls for a renewed focus on exploiting Scotland's energy resources, and in paragraph 2.7 the NPF3 identifies a need for development which "*facilitates adaptation to climate change, reduces resource consumption and lowers greenhouse gas emissions*";
- A *low carbon place: This theme relates to the legally binding target of reducing Scotland's greenhouse gas emissions by 80% by 2050 compared with 1990 levels, as set out in the Climate Change (Scotland) Act 2009. It states that "Our built environment is more energy efficient and produces less waste and we have largely decarbonised our travel"; In relation to onshore wind energy, paragraph 3.7 states that "there is strong public support for wind energy as part of the renewable energy mix", however it is noted that the social acceptability of wind farms varies in different locations. Paragraph 3.8 reiterates the Scottish Government's commitment to meeting its renewable energy deployment targets, including the aim of generating "at least 30% of overall energy demand from renewables by 2020 – this includes generating the equivalent of at least 100% of gross electricity consumption from renewables, with an interim target of 50% by 2015". To help achieve these decarbonisation targets, paragraph 3.23 confirms the Scottish Government's view that "onshore wind will continue to make a significant contribution to diversification of energy supplies"*
- A natural, resilient place: This theme is concerned with environmental protection and it is noted that Scotland's principal asset is the land, which must be managed sustainably as both an economic and dynamic resource and an environmental asset. It is noted in paragraph 4.22 of the SPP that "*rural areas have a particular role to play in building Scotland's long-term resilience to climate change and reducing our national greenhouse gas emissions*";
- A connected place: This theme is orientated around maximising physical and digital connectivity around Scotland and between Scotland and the rest of the world.

NPF3 states that rural communities will benefit from *"well-planned renewable energy development"* Paragraph 3.23 states however, that wind farm developments within Scotland's National Parks and Natural Scenic areas would not be welcomed.

The Cairngorms National Park Local Development Plan 2015 (LDP2015) was adopted on 27th March 2015. As one of Scotland's two National Parks the overarching aims for the National Parks are set out in the National Parks (Scotland) Act 2000 and the four aims are:

- *"To conserve and enhance the natural and cultural heritage of the area;*
- *To promote sustainable use of the natural resources of the area;*
- *To promote understanding and enjoyment (including enjoyment in the form of recreation) of the special qualities of the area by the public;*
- *To promote sustainable economic and social development of the area's communities."*

The vision for the National Park is set out in the Cairngorms National Park Partnership Plan 2017-2022 (NPPP) is that the Cairngorms National Park should be: *"An outstanding National Park enjoyed and valued by everyone, where nature and people thrive together"*.

Section 1.18 of LDP2015 states that the overarching vision for NPPP is that the ambition for the National Park is to become a low carbon National Park and to develop opportunities to become a low carbon economy. LDP2015 has a number of policies that seek to deliver the visions and objectives of the local plan as well as the overarching aims set out in the National Parks (Scotland) Act 2000.

Policy 2: Supporting Economic Growth

Policy 2 seeks to guide new development that will achieve growth which supports the aims of the Park as well as protecting the Park's special qualities. The policy will be used to:

"support appropriate economic development, which ensures sustainable growth and supports our communities. It is intended to protect communities from inappropriate development and loss of existing facilities and help keep them vibrant and sustainable."

Paragraph 4.12 outlines the need to balance new development with supporting and protecting existing land uses and that development which:

"facilitates diversification of existing land uses is likely to be particularly successful where the new and existing uses are complementary."

Policy 3: Sustainable Design

Policy 3 seeks to ensure that all development delivers high quality design with a focus on sustainability and ensuring the latest technology is utilised in order to reduce the demands on resources. Of particular relevance is section 1 (d) of Policy 3in that developments should:

"make sustainable use of resources, (including the minimisation of energy, waste, and water usage), within the future maintenance arrangements, and for any decommissioning which may be necessary" and to;

"enable the storage, segregation and collection of recyclable materials and make provision for composting".

Policy 4: Natural Heritage

Any development that is likely to have a significant effect on a Natura 2000 site must demonstrate that no adverse impacts will affect the integrity of the site. Any development that is likely to conflict with this policy will only be considered where:

- *"There are no alternative solutions; and*
- *There are imperative reasons of overriding public interest including those of a social of economic nature."*

Any development that may adversely affect habitats or species present on a site, or adjacent to a development site, then the developer *"the developer will be required to undertake a comprehensive survey of the area's natural environment to assess the effect of the development on it and to submit a species/habitat protection plan where necessary to set out measures to avoid, reduce or mitigate such effects."*

Paragraph 6.8 of the LDP2015 states that any development "*will not adversely affect the integrity of the site before granting any form of planning permission."* In order to protect such sites assessments under the Habitats Regulations are required.

Paragraph 6.9 emphasis the responsibility on potential developers to be aware of the position of the LPA for the requirement of robust assessments and that developers may need to: "*carry out additional research to support any development proposal. To be in accordance with the policy developments must, therefore, not adversely affect the integrity of the site, either alone, or in combination with other plans or projects."*

The Cairngorm mountain is covered by a number of policy designations aimed at protecting the natural landscape. The development site, although under no policy designation is adjacent to Sites of Special Scientific Interest and is a formal natural heritage designation.

The mountain is also covered by two International or National Designations (Natura 2000). The designated nature Reserve to the north east is a National Nature Reserve and the Cairngorm Mountain is also a National Scenic Area. Immediately south of the site there is an International Designated RAMSAR site

Policy 4 – Natural Heritage Supplementary Planning Guidance

Supplementary Planning Guidance has been adopted to provide further information and detail on how developers should comply with Policy 4. Three natural heritage principles are set out in the guidance as well as principle ensuring protection of International and National Designations. The Three principles are

- *"Ensure no net loss of natural heritage value;*
- *Enhance existing natural heritage value;*
- *Manage and maintain natural heritage value.*

All planning applications will be assessed against the impacts that any proposed development may have on the Natural Heritage of the Park. The closeness of the site to European natural heritage sites and Nationally designated sites means that any development must *"pay particular attention to notified and qualifying interest of their designation."*

Policy 5: Landscape

There is a presumption against development that does not conserve and enhance the landscape character of the park. Any proposed development should therefore complement and enhance the landscape character of the park and that development will only be permitted where:

- *"any significant adverse effects on the landscape character of the Park are clearly outweighed by social or economic benefits of national importance; and*
- *all the adverse effects on the setting of the proposed development have been minimised and mitigated through appropriate siting, layout, scale, design and construction to the satisfaction of the planning authority."*

Paragraph 7.11 is of importance in that any development will be assessed "*to consider the cumulative impact on the special qualities of the landscape and the sense of wildness found in the relevant area; how it contributes to the whole Park; and on the outcome to conserve and enhance, not simply on a local scale, but on a Park-wide basis.*"

Policy 7: Renewable Energy

The policy aims outlined in paragraph 8.2 notes "*the National Park has an abundance of natural resources which provide options to generate renewable energy, and we want to encourage this in a way which promotes the sustainable use of those resources without negative impacts on its special qualities. This includes energy from biomass, hydro, solar, heat pumps, some wind energy. Some potential for anaerobic digestion and energy from waste also exists. There are also opportunities to include integrated district heating schemes served by renewable energy*."

The policy seeks to enable renewable energy generation by harnessing the Park's natural resources to allow the Park to play a part in addressing issues around climate change and fuel poverty. Paragraph 8.5 outlines that large-scale developments, in particular wind turbines, are not compatible with the special qualities of the National Park due to the effect on landscape. However, it notes that development that seeks to increase renewable energy generation through biomass and hydro in line with Government targets.

Proposals will be considered favourably where they:

- *"contribute positively to the minimisation of climate change;*
- *they complement the sustainability credentials of the development;*
- *they conserve and enhance the special qualities of the Park*,"

Section 2 of Policy 8 relates to Hydropower and outlines that proposals should not have a detrimental impact on the water environment, recreational use and the peat and soil along the length of any development.

Section 3 relates to wind energy and proposals should minimise noise impacts, shadow flicker and impacts on aviation interests. It should be noted that large-scale commercial windfarms are not compatible with the special qualities of the National Park and are not considered appropriate development.

Section 4 states that all biomass proposals must include sufficient storage capacity in order to minimise the need for the delivery of fuel on to the site.

Section 5 outlines that any energy from waste proposals must maximise energy production by utilising locally sourced waste and minimise the transport of waste.

Paragraph 8.9 notes that "*Nationally, there is an increasing focus on small scale generation of energy and micro generation with individuals and communities realising the part everyone should play in efforts to slow climate change. The policy will be applied to assist appropriate development which achieves this end.*"

Paragraph 8.9 outlines that given the National Park's qualities the development of wind farms is not appropriate, however: "*Opportunities for the development of other forms of renewable energy schemes, including biomass, waste, and hydro which can be designed in a sympathetic way to have no adverse landscape, visual or environmental impact.*"

Paragraph 8.12 notes that any renewable energy proposal that seeks to produce electricity from biomass only, will not be permitted.

Further advice on renewable developments is provided by statutory supplementary planning guidance (see below).

Policy 9: Sport and Recreation

The development site offers opportunities for a number of recreational opportunities, both formal and informal recreation, and Policy 9 aims to protect such developments. The provision of recreational opportunities is a national strategy with the Scottish Government including *"increasing physical activity"* as a strategic objective of making Scotland a healthier nation.

Any new development, or extensions or diversification of sites will be supported where:

- *"they demonstrate best practice in terms of sustainable design, operation and future maintenance, and where there are no adverse environmental impacts on the site or neighbouring areas; and*
- *they will meet an identified community or visitor need."*

The development of existing sporting and recreational sites is addressed within the policy and re-development should not take place unless:

- *The proposed development is ancillary to the principal use of the site as a playing field; or*
- *The proposed development involves a minor part of the playing field which would not affect its use and potential for sport and training; or*
- *The playing field which would be lost would be replaced by a new playing field of comparable or greater benefit for sport and in a location, which is convenient for its users, or by the upgrading of an existing playing field in the area."*

Paragraph 9.9 outlines the importance of recreation provision within the National Park and recognise the constraints faced by sites due to their sensitive location and the plan will support development that is *"undertaken in harmony with the location; where the proposal extends the tourist season and the availability of facilities to communities; and is designed to the highest standards."*

Policy 10: Resources

Policy 10 seeks to reduce consumption of limited natural resources and help communities adapt to a lower carbon way of living. Section 1 of Policy 10 seeks to minimise the use of treated and abstracted water and section 4 states that development should:

- *"safeguard existing strategic waste management facilities and all sites required to fulfil the requirements of the Zero Waste Plan; and*
- *ensure the minimisation of waste from the construction of the development and throughout the life of the development as defined in a site waste management plan or statement."*

Supplementary Planning Guidance

The Cairngorms have adopted statutory planning guidance which forms part of the Development Plan. The applicable Supplementary Planning Guidance is detailed below.

Policy 7: Renewable Energy Supplementary Planning Guidance

The principles and justification underpinning the Park's approach to sustainable developments are contained in the adopted supplementary guidance: Policy 7 Renewable Energy. The Guidance outlines further requirements for developments including hydro, wind, energy from waste and biomass. Key considerations include:

- *"The landscape and visual impacts associated with hydro schemes are not necessarily proportionate to the size of the energy output of a scheme, but more to the degree and extent of* *disturbance and long term change. As all hydro power developments will have a landscape and visual impact, the level of this impact is a critical factor in determining any application;*

- *Many hydro power developments will have an impact on recreational interests in the National Park, and it must be ensured that this impact is minimised and/or managed. In designing your development, you must demonstrate that you have contacted the relevant interest groups, and made appropriate provision that enables recreational interests to continue alongside your development.*
- *Developments involving wind turbines over 30 metres height to blade tip are not compatible with the special qualities of the National Park and are not considered to be appropriate. Existing wind turbines can be a significant constraint to further potential wind energy development;*
- *Details of the type of biomass to be used in the development will be considered, along with any associated transportation and amenity issues. The means of transferring the biomass product from its transport into the storage facilities at the site will be an important factor in assessing any biomass development;*
- *The National Park is not near any significant sources of waste and any energy from waste plants would therefore necessitate significant transport of waste from outwith the National Park. The National Park is therefore not considered to be the place for large-scale energy from waste plants. Energy from waste schemes will only be acceptable where they make use of a local source of waste, and where the energy/heat being produced is used in the locality of the development; and*
- *Solar energy proposals are required to be assessed against all other policies."*

Appendix C
Workshop Attendee List

Phase 1 Workshop

Elaine Hanton (HIE)

Paul Dzialdowski (HIE)

Dave MacLeod (HIE)

[redacted] (HIE)

[redacted] (CMSL)

[redacted] (CMSL)

[redacted] (Scottish Government)

[redacted] (Highland Council)

[redacted] (Cairngorms National Park)

[redacted] (Scottish Natural Heritage)

[redacted] (Wood)

[redacted] (Wood)

Phase 2 Workshop

Elaine Hanton (HIE)

Paul Dzialdowski (HIE)

Dave MacLeod (HIE)

[redacted] (HIE)

[redacted] (CMSL)

[redacted] (Highland Council)

[redacted] (Cairngorms National Park)

[redacted] (Scottish Natural Heritage)

[redacted] (Wood)

[redacted] (Wood)