Urban Foresight

Low Carbon Surface Access Strategies

Inverness and Kirkwall Airports

PREPARED FOR:

HITRANS
HIAL

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Highlands and Islands Transport Partnership (HITRANS) is the statutory regional transport partnership covering Eilean Siar (Western Isles), Orkney, Highland, Moray and most of the Argyll and Bute area. HITRANS work with Councils, the Scottish overnment, Transport Scotland, HIE, transport operators and other stakeholders to improve transport services and infrastructure in the north of Scotland and on routes to the Highlands and Islands.

Highlands and Islands Airports Limited (HIAL) is the company that owns and operates 11 airports in the Scottish Highlands, the Northern Isles and the Western Isles. These airports include Inverness and Kirkwall.

The Northern Periphery and Arctic (NPA) Programme , co-funded by the European Regional Development Fund (ERDF), forms a cooperation between 9 programme partner countries: the Member States of Finland, Ireland, Sweden and the UK (Scotland and Northern Ireland) in cooperation with the Faroe Islands, Iceland, Greenland and Norway.

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Executive Summary

This study has been prepared for Highlands and Islands Transport Partnership (HITRANS) and Highlands and Islands Airports Limited (HIAL), in support of the Smart Peripheral and Remote Airports (SPARA) project.

This study has considered best practice in decarbonising surface access to and from remote and peripheral airports to inform the development of low carbon access strategies and subsequent delivery of priority programmes at Inverness airport and Kirkwall airport.

Remote and peripheral airports across the NPA region have already made good progress towards the integration of low carbon technologies. There are multiple examples where airports have demonstrated the successful integration of a mix of different low carbon technologies such as electric vehicle charging, electric buses, electric car club vehicles, electric taxis, electric bike schemes, fuel cell vehicles, use of biofuels and renewable energy generators.

Drawing upon examples of best practice across the NPA region, and consultation with a wide range of regional stakeholders, 10-point action plans for Inverness airport and Kirkwall airport have been identified to assist future master-planning and prepare for the deployment of low carbon technology in the next 5-10 years. Priority programmes have also been developed to provide a plan of action for the future roll-out of electric vehicle charging infrastructure at each airport in the coming years.

Action plans for Inverness airport and Kirkwall airport are summarised in the table below.

Airport	Actions	
Inverness	1	Undertake enabling electrical works for the provision of electric vehicle charging infrastructure
	2	Provide smart slow/trickle charging infrastructure
	3	Work with operators to provide low emission car club vehicles and enabling Infrastructure
	4	Increase awareness of low carbon travel options to and from the airport
	5	Provide rapid charging infrastructure
	6	Seek opportunities to integrate an express low carbon bus Service
	7	Explore opportunities to introduce renewable and battery technology.
	8	Explore opportunities for trialling vehicle-to-x Integration
	9	Monitor the potential to integrate biofuels at Inverness airport
	10	Explore opportunities for trialling Autonomous Vehicles

Kirkwall	1	Smart slow/trickle EV charging
	2	Trial low carbon car club vehicles
	3	Seek opportunities to develop an ebike hub and cycle path
	4	Seek opportunities to fully decarbonise the airport bus route
	5	Engage with local taxi companies to accelerate the uptake towards plug-in taxis
	6	Increase awareness of low carbon travel options to and from the airport
	7	Consider future integration of low carbon airside technologies
	8	Provide rapid EV charging infrastructure
	9	Consider wider integration of low carbon surface with other remote and peripheral airfields
	10	Explore the potential for integrating clean energy generation plant near the site

Contents

1. Introduction

This document has been prepared for Highlands and Islands Transport Partnership (HITRANS) and Highlands and Islands Airports Limited (HIAL), in support of the Smart Peripheral and Remote Airports (SPARA) project.

It sets out the findings of research into the current Electric Vehicle (EV) charging network at airports across the UK and the Northern Periphery and Arctic (NPA) area to which the SPARA project relates, with a focus on best practice for EV surface access at remote and peripheral airports in the NPA area.

Low carbon surface access action plans are presented for Inverness and Kirkwall Airports, as well as more detailed priority programmes specifically looking at the development of the charging network at these airports.

1.1 Background

SPARA is a three-year, €2.4m NPA Programme project, part-funded by the European Regional Development Fund (ERDF), and aims to address challenges faced at remote and peripheral airports.

As part of the SPARA project, HITRANS and Scottish airport partners HIAL are looking to deliver low carbon surface access strategies for Inverness and Kirkwall Airports to support the roll out of EVs and supporting charging infrastructure. A key aim of the SPARA project is to share learning between remote and peripheral airports to increase sustainability. This report acts as a learning resource that can be shared between airports in the Programme area and beyond.

HIAL are currently reviewing their commercial masterplans for their 11 airports. With the expectation of widespread penetration of low carbon vehicles and required electrical infrastructure over the coming years, they are keen to understand the short- and long-term emerging technology trends that may shape the approach to their future energy system.

1.2 Policy Drivers

In 2015, private vehicles were responsible for 43% of Scotland's greenhouse gas emissions in transport, and air travel was responsible for 16%.[1] Air travel tends to be the highest emitter per passenger kilometre, particularly domestic flights.

In June 2017, the Minister for Transport and Islands announced the activities that Transport Scotland will undertake in the second phase of its electric vehicle roadmap.[2] This places an emphasis on growth, focusing on actions that accelerate the uptake of EVs as part of both a wider sustainable transport system and a smart energy grid. Following this, the First Minister set Scotland on an ambitious path, by announcing the aim to phase

[1] Transport Scotland (2018) *Environment*. Scottish Transport Statistics. No. 36. 2017 Edition.

[2] Transport Scotland (2017) Switched on Scotland Phase Two: An Action Plan for rowth

out the need for new petrol and diesel cars and vans in Scotland by 2032[3].

In response to these national commitments, Orkney Renewable Energy Forum (OREF) and HITRANS released EV Strategies, recommending a series of actions to increase the uptake of electric vehicles and associated infrastructure in coming years. Both of these strategies identify opportunities at airports, enabling low carbon transport options for residents and tourists across the highlands and islands of Scotland.

1.3 Structure of this Document

This document has been structured according to the specific task requirements of HITRANS:

- Chapter 1 provides an overview of emerging low carbon transport technology trends, best practice in low carbon surface access to airports across the Northern Periphery and Arctic (NPA) Region, and current charging provision at airports across Scotland, the UK, and NPA;
- Chapter 2 presents a low carbon surface access action plan and a priority programme for EV charging infrastructure provision at Inverness airport.
- Chapter 3 presents a low carbon surface access action plan and a priority programme for EV charging infrastructure provision at Kirkwall airport.

[3] First Minister, Nicola Sturgeon, Statement to Scottish Parliament , 5th September 2017

Chapter 1: Review of Best Practice

1. Introduction

In order to understand the opportunities for low carbon surface access at remote and peripheral airports, this chapter provides an overview of relevant low carbon transport options, current provision and best practice across the Northern Periphery and Arctic (NPA) Region, and identification of opportunities at Inverness and Kirkwall airports.

Section 2 provides an overview of the current electric vehicle landscape in relation to vehicle numbers, targets, and vehicle charging technology. It then reviews the existing charging provision at airports in the Northern Periphery and Arctic (NPA) region, including Inverness and Kirkwall.

Section 3 describes the existing provision of a variety of forms of surface transport at the NPA remote and peripheral airports. This provides context to the existing provision and plans for Inverness and Kirkwall airports and allows the identification of potential future opportunities.

Section 4 provides an overview of existing and developing energy management technologies that could potentially be applied at Inverness and Kirkwall airports as the level of EV uptake and demand for charging infrastructure increases.

Finally, Section 5 provides an overview of the opportunities for biofuels at Inverness and Kirkwall airports. This has been informed by learnings from Swedish partners from the SPARA programme, Trafikverket and Sundsvall-Timrå airport, and a desk review of biofuel progress in the UK and Scotland.

This chapter has been informed by a comprehensive desk review and a series of stakeholder interviews.

2. Electric Vehicle Infrastructure

Charging provision at remote and peripheral airports is patchy but offers a good opportunity to contribute to the wider charging network.

This section provides an overview of the current EV landscape in relation to vehicle numbers, targets, and vehicle and charging technology. It then reviews the existing charging provision at airports in the NPA region, including Inverness and Kirkwall.

2.1 Landscape

2.1.1 Plug-in vehicle numbers

In Quarter 2 of 2018, there were 8,869 plug-in car and vans registered in Scotland, representing 0.36% of all cars.[4] This is an increase on Q2 2017 when the proportion was just 0.20%.

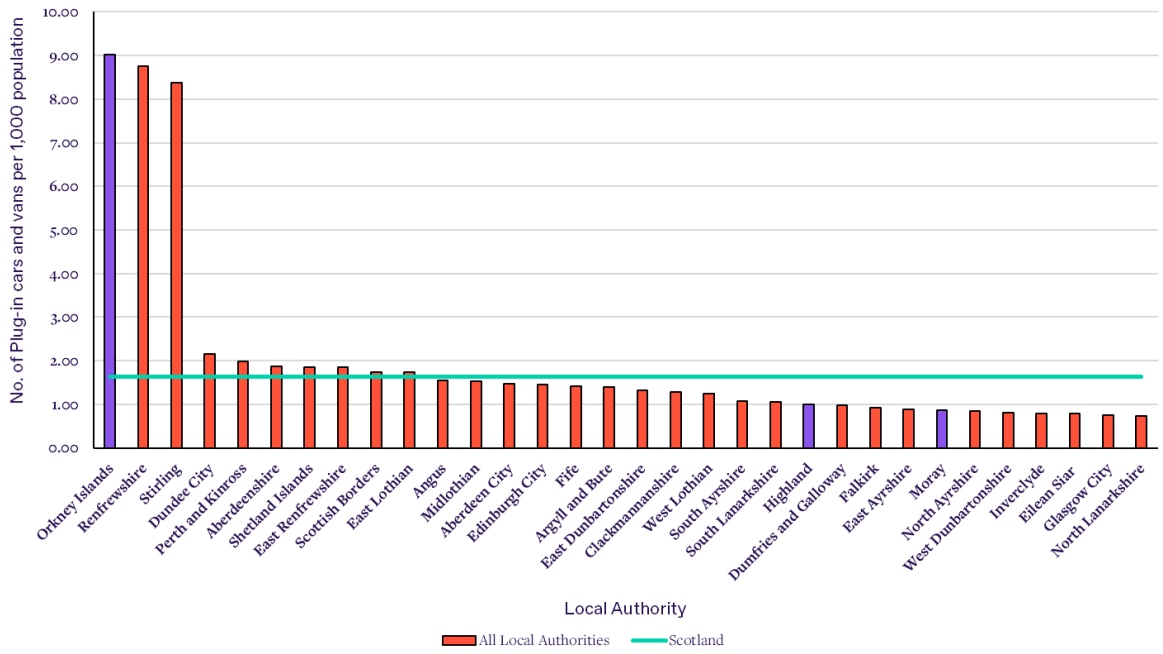

Figure 1 - Plug-in car and van registrations by Local authority area per 1,000 local inhabitants 2018 Q2

197 of these plug-in vehicles were registered in the Orkney Islands Council area, 236 in the Highland Council area and 84 in Moray Council area. As shown in Figure 1, the Orkney Islands have the highest number of plug-in vehicles per 1,000 population, while the Highland and Moray Council areas are considerably lower.

[4] Department for Transport (2018) Vehicle Licensing Statistics: January to March 2018. Plug-in vehicles. Table VEH0131: Plug-in cars, LVs and quadricycles licensed at the end of quarter by upper and lower tier local authority, 2018 Q2

Plug-in vehicle sales will need to grow around 42% year-on-year for the Highland Council to meet the Scottish government 2032 targets. For Moray, this is around 40%, but only 20% for Orkney.[5]

2.1.2 Vehicle technology

As of August 2018, there were 77 plug-in cars and vans available in the UK.[6]

There are two types of plug-in vehicles, plug-in hybrid (PHEV) and battery electric vehicles (BEV). PHEVs combine a petrol or diesel engine with an electric motor and a large rechargeable battery. Unlike conventional hybrids, PHEVS can be plugged-in and recharged from an outlet, allowing them to drive extended distances using just electricity. The Mitsubishi Outlander PHEV is the UK's top selling plug-in vehicle; it has a combined range of 532 miles, of which 33 miles can be achieved purely using the battery.

BEVs are powered completely by a rechargeable battery. The 2018 model of the best-selling fully electric vehicle in the UK, the Nissan LEAF, is reported to be capable of a range of around 158-206 miles, depending on driving conditions. Tesla vehicles achieve ranges beyond 300 miles.

Several manufacturers including BMW, Honda, Volvo and JLR have committed to producing electric models in the next few years: Volvo has stated that all models will be electric from 2019; the Volkswagen roup hopes to create more than 30 battery EVs by 2025[7]; while erman automaker Daimler has promised to invest up to €10 billion to achieve its goal of developing 10 EV models by 2025[8]. Dyson has also committed to developing a new electric car with an estimated release in 2021.[9]

PHEVs and BEVs will otherwise be referred to as electric vehicles (EVs) for the rest of this study.

2.1.3 Charging technology

Vehicle charging is a fundamental part of the experience of owning an EV. Improving the convenience of en-route charging infrastructure is very important in supporting longer distance movements by EVs.

At present, the highest speed charging unit being deployed for public access is around 50kW in power. These 'rapid chargers' can charge a typical EV from empty to 80% in around 20-30 minutes; these are usually necessary for 'topping up' on longer journeys, or short stops where the driver typically stays with or close by the vehicles. Rapids typically have three connector types, CHAdeMO, CCS and Type 2 but can only be used by one to two vehicles at a time.

'Semi rapid' 22kW, 'fast' 7kW and 'slow' 3kW chargers are also commonly available to the public, with the latter taking around 6-8 hours to charge a typical car from empty to 80%;

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[5] Urban Foresight analysis – these figures may not be wholly accurate, and are calculated on a number of assumptions.

[6] Next reen Car (2018) Electric car market statistics

[7] Volkswagen A, (2016) New roup strategy adopted: Volkswagen roup to become a world -leading provider of sustainable mobility

[8] Reuters (2016) Daimler to invest $11 billion in electronic vehicles: paper

[9] The uardian (2018) Dyson to build electric cars in Singapore – with 2021 launch planned

these are more commonly used where vehicles will be left in one place for longer periods.

In 2018, the first 'Ultra-rapid' 150kW-350kW chargers were deployed by manufacturers across Europe. Due to the intense power exchange with the vehicle batteries, no vehicles in the UK can currently accommodate this level of charging. However, it is expected that the next generation of vehicles will have the capability to do so. Theoretically, a compatible 40kWh Nissan LEAF's battery could fill from empty to 80% for in 15 minutes with a 150kW charger, and in just under 10 minutes with a 350kW.

In addition, cableless charging, otherwise known as inductive or wireless charging is emerging. While wireless charging for small cars or vans is currently available, commercial products are currently only available at lower power ratings and require the vehicle to occupy a charger unit for relatively long periods of time (4-8 hours).

Several companies, including a number of car manufacturers, are developing higher power products that could offer a more viable option to quickly recharge vehicles on the move. However, these are all still within the testing phase for cars. For example, Innovate UK announced funding in Summer 2018 for wireless charging solutions in urban areas. This may lead to the emergence of more widespread adoption of wireless technology in the coming years.

Charger manufacturers are also beginning to develop other solutions to the challenge of space constraints. For example, London based startup, Urban Electric, have developed the UEone, a smart pop-up EV charger for residential streets that retracts underground when not in use.

2.2 Charging Infrastructure Provision at Airports

A desk-based analysis has provided the following overview of the current state of EV charging infrastructure at all airports located in the Northern Periphery and Arctic Programme (NPA) area countries, and the UK.

The following section, 2.3, specifically focuses on remote and peripheral airports within the NPA region.

The NPA region covers Finland, Ireland, Northern Ireland, United Kingdom, Sweden, Faroe Islands, reenland, Iceland and Norway and the UK. Remote and peripheral airports are considered as those located within all the shaded areas in Figure 2.

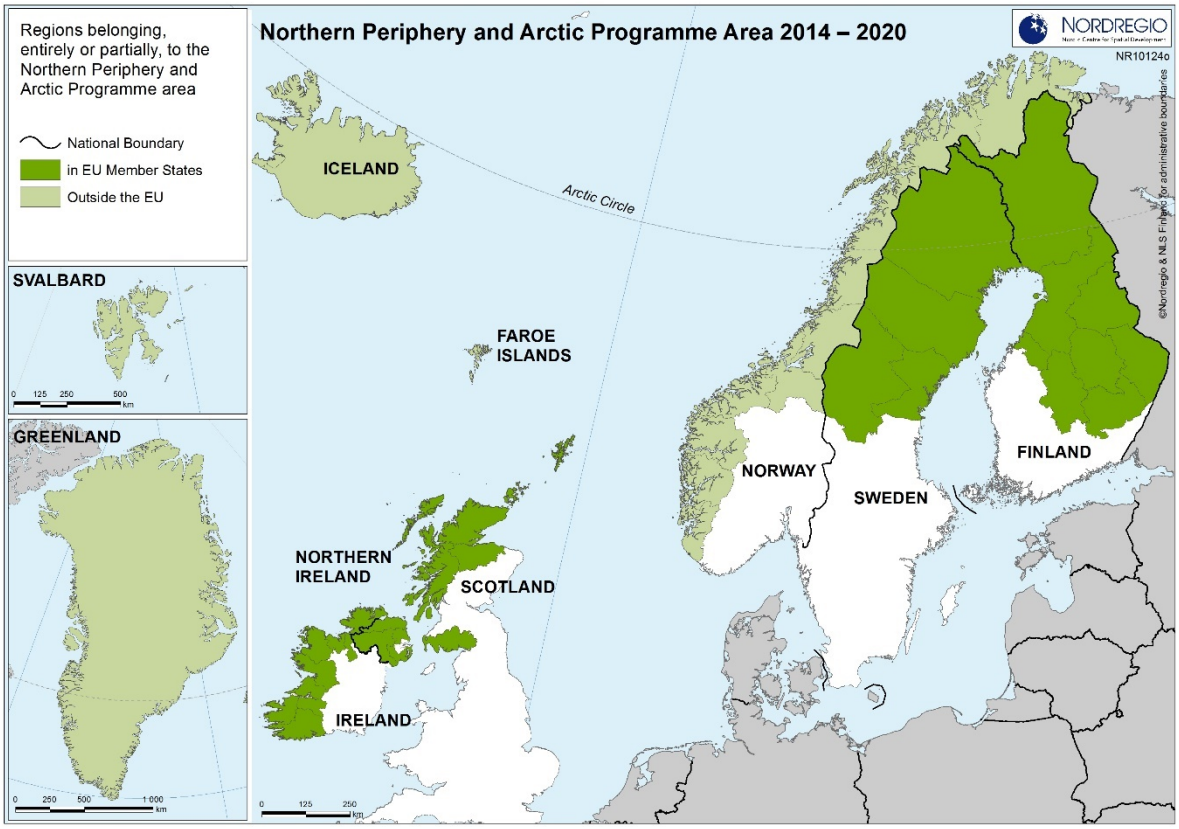

Figure 2 - Northern Periphery and Arctic Programme Area Map. Image credit: Interreg

Figure 3 provides an overview of the current locations of charging infrastructure present at all airports across the NPA area and the UK. There are currently 716 charge points[10] (96% of which are publicly accessible) located across all 60 airports. These comprise of a range of charging speeds, ranging from 2kW-135kW sockets. There are no charge points recorded at airports in reenland, Northern Ireland, Svalbard or Wales.

[10] Note: "charge point" refers to the physical connection/socket available for charging a vehicle. This does not refer to the number of posts/units. For example, a charging post/charging unit with two connection sockets, would equate to two charge points. Similarly, a rapid charger, typically with three connectors on the unit, is considered to have three charge points.

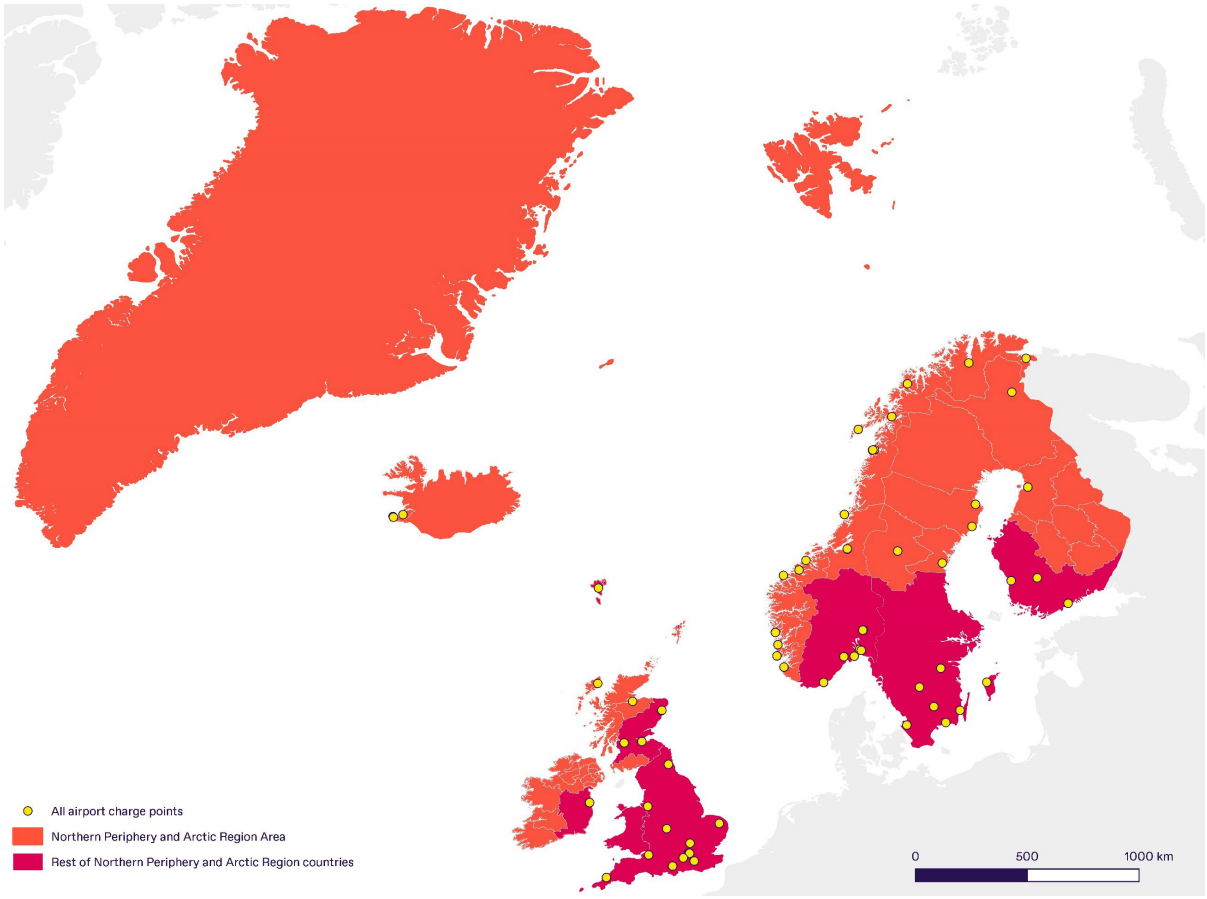

Figure 3 - Charging network recorded at passenger airports across countries in NPA area and the UK

The highest number of EV charge points are located at Norwegian airports, with 211 sockets, closely followed by Finland with 208 sockets. Since 9.5% of Norway's vehicles on the road are EVs[11], it is no surprise that they have the greatest number of charging points located at their airports. Only 0.3% of Finland's vehicles are electric, however, Oulu airport, Finland's second busiest after Helsinki, has 162 3kW public charge points in its long stay car park.

The greatest number of charge points across all airports by power type are those rated 2.0-3.7kW, suitably located in long-stay car parks for vehicle owners away for periods longer than a day. There are fewest 22kW chargers; these can typically provide around 30 miles of charge in just 20 minutes and would take around 1 hour 40 minutes to charge a new 40kWh Nissan LEAF from empty to full. They are therefore less suitable at airports, as users are more likely require quick battery top-ups after dropping off passengers, or very slow charging for long-stay trips. However, they are cost comparable to 7kW units and can be installed for a quarter of the price of rapid chargers at current market rates.

120-135kW charge points are only found in Norway and Scotland because they are Tesla Destination chargers. These chargers are only available to Tesla vehicles.

[11] European Alternative Fuels Observatory (2018) Norway

2.3 Charging Provision at Remote and Peripheral Airports

As shown in Table 2, a significant proportion – just over 50% - of the charge points located at airports in the NPA regional countries are situated at 31 remote and peripheral (R&P) airports.

Table 1 - Charge point infrastructure types: Countrywide Airports vs Remote and Peripheral airports in the NPA region

Region	≤ 3.7kW Charge points	7kW Charge points	11-22kW charge points	36kW-50kW charge points	120kW-135kW charge points	Total No. of Charge Points
Countrywide	410	118	79	101	8	**716**
R&P Airports	284	23	12	43	6	**368**

Figure 4 provides a comparison of charge points found at all airports compared to just R&P airports. This illustrates that this high proportion is largely a result of the high charging provision in Finland, Norway, and to a lesser extent Sweden and Iceland.

Finland has the largest number of charge points at R&P airports, with 164 eTolppa charge points, all of which have power outputs of ≤ 3.7kW. The eTolppa charge point is a combined system consisting of an electric charger and a heater (See Case study).

All of Iceland's airports are classified as remote and peripheral. Most of Iceland's charge points have recently been installed by the airport operator, ISAVIA, at Reykjavik airport. There is no information on the power outputs of these chargers, but 11 charge points have been installed.

The picture elsewhere, however, is patchy:

- There are currently no charge points located at R&P airports in reenland, Northern Ireland, or Svalbard;
- There is limited provision for charge points at Republic of Ireland (ROI) airports. There are no charge points at R&P airports, with all 10 locations situated at Dublin airport.
- Scotland R&P airport charge points are only situated at Inverness airport. However, these are not publicly available: Inverness is dedicated for taxis only.
- there are no charge points located at England's R&P airport, Carlisle.

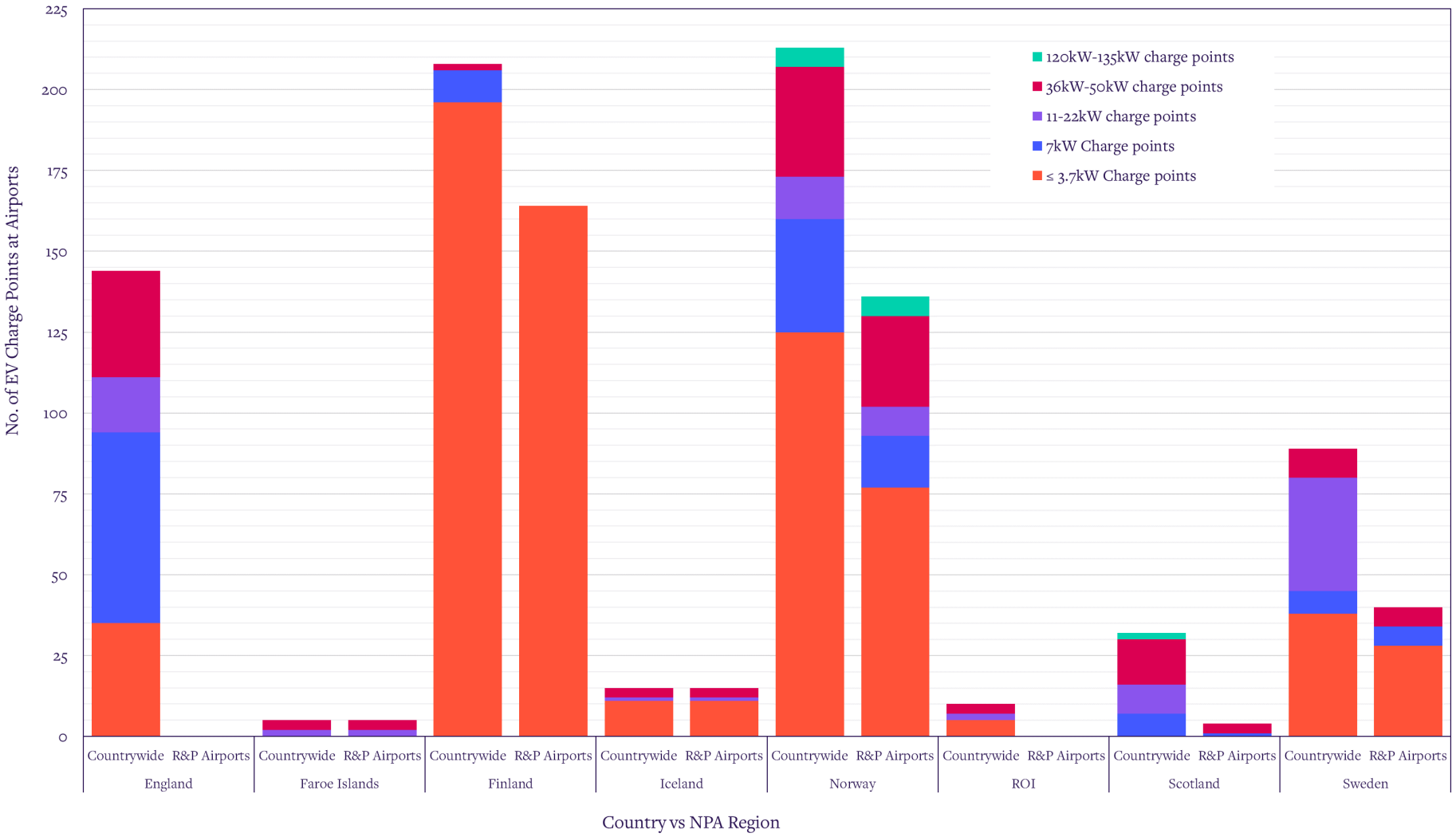

Figure 4 – Comparison of charge points at airports across the NPA region. Countrywide chargers at airports vs. chargers just at “remote and peripheral” airports

CASE STUDY

Hybrid Electric Charger and Heating System

Photo credit: Tehomen

Finnish company, Tehomen have developed eTolppa, a remote-controlled heating and vehicle charging point

Conveniently controlled via a browser or an app, users can schedule when they are due to return from their trip and notify how and when they would like their vehicle to be heated and/or charged. This optimises the scheduling and use of energy warming the car to the outside temperature and reportedly saving up to 65% of the electricity otherwise used to heat the vehicle on the road.[12]

There is access to 164 charge points across Ivalo and Oulu airports, with 162 located at Oulu airport, Finland's second most popular airport.

The €1,500 3.6kW poles are installed similarly to regular socket poles, and they are mutually radio-connected. Electricity consumption can be monitored in real-time and separately for each parking space. This also enables invoicing based on actual consumption and usage analytics in order to determine the popularity of the unit.

[12] Tehomen (2017) Charging electric and hybrid cars

2.4 Existing Provision in Inverness

There are currently 10 ChargePlace Scotland charge points publicly available in Inverness.[13] All charge points are currently free in Inverness. These consist of a mixture of 2 fast (7kW), 5 semi-rapid[14] (22kW) and 3 rapid (43-50kW) charge points.

As shown in Figure 5 there are currently no publicly accessible chargers at Inverness airport. This is situated approximately half-way between a rapid charger in Inverness City Centre (10 miles) and a rapid charger in Nairn (10 miles). Strategically, locating additional charge points within proximity to the airport may be convenient for users as EV uptake increases.

Figure 5 - ChargePlace Scotland public charge point locations between Inverness and Nairn, September 2018

2.5 Existing Charging Provision in Kirkwall

There are currently 39 ChargePlace Scotland charge points publicly available across the Orkney Islands. These consist of a mixture of fast (7kW), semi-rapid (22kW) and rapid (43-50kW) charge points. 16 of these charge points are located within Kirkwall (4 fast, 6 semi-rapid and 6 rapid charge points[15]). There are currently no publicly accessible charge points located at Kirkwall airport.

Figure 6 shows the coverage by ChargePlace Scotland charge points located the Islands. All charge points are currently free in Kirkwall apart from the rapid charge points located

[13] Data gathered from ChargePlace Scotland Online Map, September 2018.

[14] Note: There are 3 charge points located one unit. Only 2 charge points per unit can be charged at any one time.

[15] Note: There are 6 charge points available, across 2 charging units. Only 2 charge points per unit can be charged at any one time.

at Ayre Service Station, which incur a charge of £0.29/kWh.

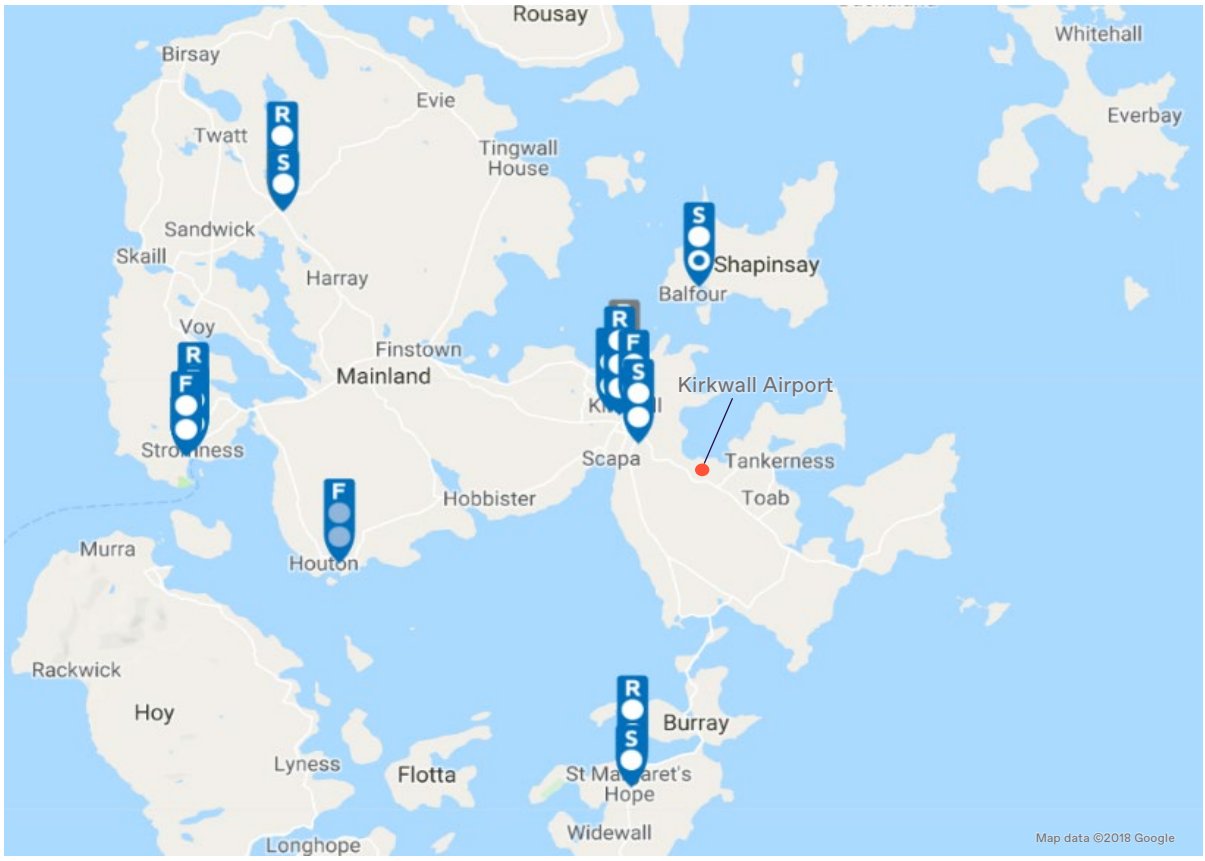

Figure 6 - ChargePlace Scotland public charge point locations across the Orkney Islands, September 2018

2.6 Charging Fees in Scotland

ChargePlace Scotland is a national network of EV charge points available across Scotland. The ChargePlace Scotland network has been developed by the Scottish overnment through grant funding of Local Authorities and other organisations to install publicly available charge points.

Currently, the majority of ChargePlace Scotland chargers are free, with the responsibility of the hosts to set tariffs for users. At present, Orkney Islands Council and Highland Council do not charge any fees for use on their hosted charge points. However, with pressures on local government operational budgets and rising levels of EV use, the local authorities are beginning to consider applying fees for using public charging infrastructure.

Transport Scotland are due to release tariff guidance in Autumn 2018. It is understood that this is likely to suggest an initial tariff of a £1 minimum fee and a rate of 15p / kWh. This tariff would contribute towards back office, merchant and handling fees, and not be much higher than domestic electricity costs to charge a vehicle.

It is widely acknowledged that any fees introduced to charge a vehicle must remain significantly lower than to refuel a petrol or diesel equivalent to maintain the incentive for drivers to switch to EVs.

3. Low Carbon Surface Access

With some exceptions, low carbon surface access options to remote and peripheral airports in the NPA region are very few.

This is illustrated in Figure 7, other than Inverness and Kirkwall airports, only 24 of the 112 remote and peripheral airports actively undertaking low carbon surface access activity.

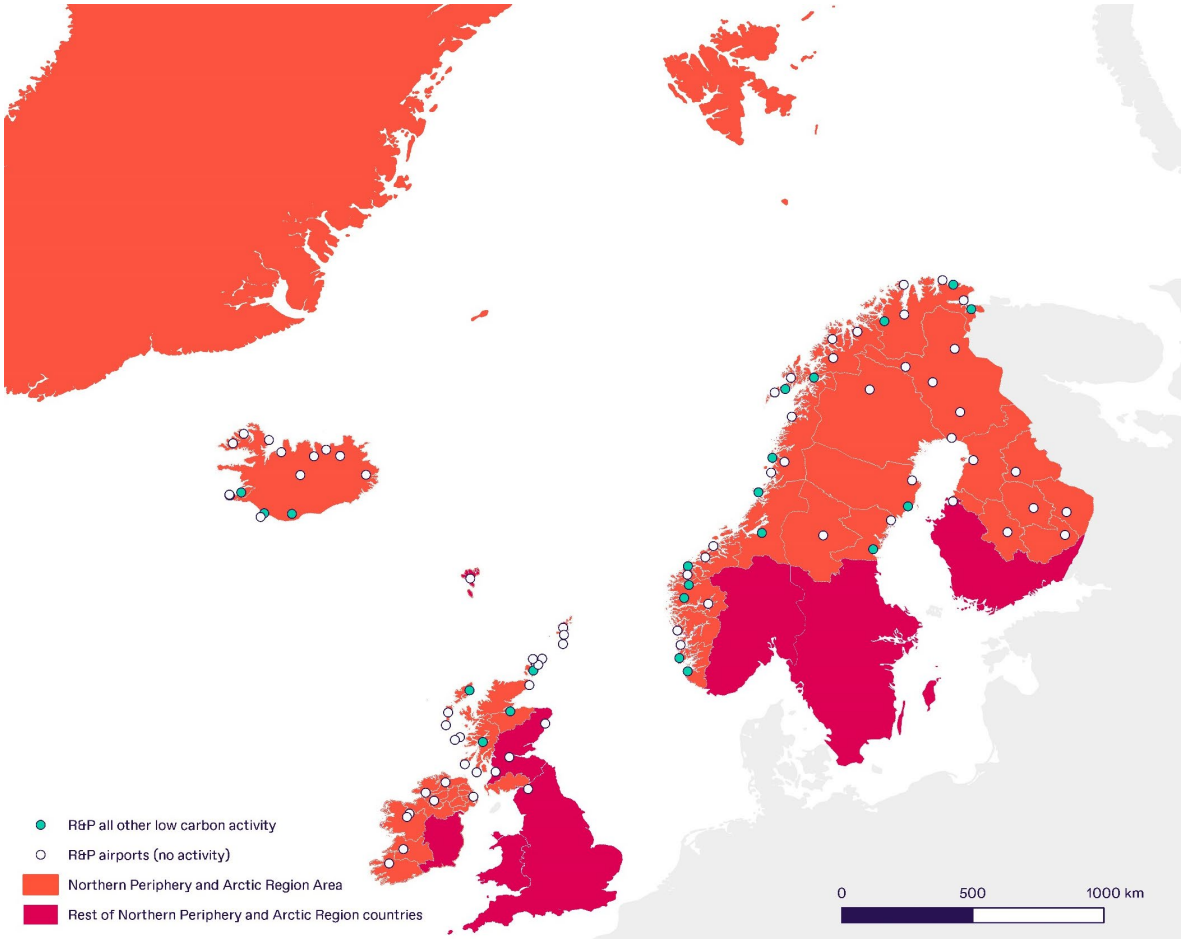

Figure 7 - Low carbon surface activity at remote and peripheral airports across the NPA region

This section describes the existing provision of a variety of forms of surface transport at NPA remote and peripheral airports. This provides context to the existing provision and plans for Inverness and Kirkwall airports and allows the identification of potential future opportunities.

3.1 Car Clubs and Rental

3.1.1 Context

Pay by the hour car clubs, allow individuals and businesses to have access to a personal

vehicle without being tied to ownership.

According to the 2017/18 Annual Survey of Car Clubs in Scotland[16], there are currently 14,200 car club members in Scotland, sharing 411 new, fuel-efficient cars. Car clubs in Scotland produced 45% less CO_2 from tailpipe emissions than the average UK car and members saved 300 tonnes of CO_2 in one year, by using car club cars rather than an average UK car.[16]

3.1.2 Provision at NPA Airports

In addition to plans at Inverness and Kirkwall airports (see section 3.1.3), only five other remote and peripheral airports have introduced or are planning to provide access to a low emission car club or car hire vehicles.

Sixt car rental firms at Svolvær-Helle Airport, Kirkenes Airport, Harstad Airport, Bodø Airport all offer BMWi3 for hire. The prices are currently around 25% more expensive than a similar-sized internal combustion engine vehicle, costing around €65-€75 per day and the first 100km for free.

The only other low carbon car club/hire option is available at Stornoway airport in the Western Isles of Scotland. There is at least one electric car club vehicle operated by E-car available.

In Finland, DriveNow includes Helsinki airport within its carsharing zone. This allows users to drive the latest BMW and Mini models, including the all-electric BMWi3, for a price of €0.57 per minute including any charging. Users can benefit from parking or leaving the vehicle anywhere within a defined DriveNow Zone, however, an additional fee of €7.90 is incurred for picking up/dropping off the vehicle at the airport.

3.1.3 Provision in Inverness and Kirkwall

Through the SPARA project, there were plans for E-Car club to provide EVs at Inverness airport, with a view to expanding to Kirkwall airport. However, there are reported to have been ongoing challenges relating to the installation of charging infrastructure.

Enterprise already has car hire facilities at Inverness airport and Inverness city centre and have expressed their interest in operating a car club at Inverness airport.

At Kirkwall airport, there is currently an informal car club model in operation. Communities from the surrounding islands have permanently parked vehicles at Kirkwall airport. Friends, families and neighbours flying into Kirkwall are then able to use the vehicles for day trips in Kirkwall or even travel to the mainland.

In July 2018, the airport introduced daily fees of £3 for parking in long-stay parking. For now, the fee has been waived for islander vehicles, however, in time this informal car club model may not be economically sustainable for island residents. This may present an opportunity to provide these users with access to low emission car club vehicles.

[16] Como UK (2018) Car clubs in Scotland 2018

3.2 Electric Taxis

3.2.1 Provision at NPA Airports

Apart from Inverness airport (see section 3.2.2), there are only three remote and peripheral airports within the NPA region with local electric taxi firms operating at airports:

- Umeå airport in Sweden has been operated by Umeå Eltaxi since 2016, operating Tesla cars;
- Haugesund Airport in Norway has a lone taxi driver who also operates a Tesla[17];
- Sundsvall-Timrå Airport in Sweden is also supplied by a local firm, Electric Taxi. They operate with one Nissan E-NV200, supplied completely by renewable electricity from wind and hydropower.

Local taxi companies in Trondheim previously included electric taxis in their operation as part of a 2-year project. This included the introduction of 6 Nissan LEAFs to operate between the airport and town centre. The taxis were considered to be very efficient and positively received by the public, however, the project found that the fleet was not profitable over the time period. A lack of appropriate supporting infrastructure and smarter trip management plans were identified as key reasons for this failure.[18]

3.2.2 Provision at Inverness and Kirkwall Airports

Inverness Taxis has recently been awarded a loan from the Energy Saving Trust (EST) and will shortly be purchasing 2 pure electric taxis. A rapid charger funded by HITRANS has been installed at Inverness airport, dedicated for use by Inverness Taxis' vehicles. A rapid charger has also been installed within Inverness city centre reserved for taxis to ensure local taxi firms can feasibly service the wider region with EVs. Upon successful implementation, Inverness Taxis aim to increase the number of electric taxis in their fleet.

There are currently no electric taxis in Orkney and discussions with key stakeholders identified that there is hesitation to pursue them: Home Energy Scotland have previously engaged with local firm Craigies Taxis and identified initial purchase cost and perceptions around vehicle versatility, specifically over long distances when compared to petrol or diesel vehicles, as particular barriers. Typically, Craigie Taxi drivers favour the purchase of a 3-year old second-hand diesel vehicle which they operate until the end of its life.

3.3 Electric Buses

3.3.1 Provision at NPA Airports

Apart from Kirkwall airport (see section 3.3.2), Umeå airport in Sweden is the only remote

[17] Fuel Included (2014) A trip by Tesla taxi in Norway

[18] Muneer, Kohle & Doyle (2017) Electric vehicles: Prospects and Challenges, Elsevier.

and peripheral airport to introduce an electric bus. The express bus service operates a 6-mile round-trip between Umeå and the airport, stopping to charge at a 400kW overhead charger between services. During a quick layover period of just 3-4 minutes, the bus is charged to operate for another hour, in -20°C temperatures.[19] Hybricon Bus System who builds the buses is currently working on developing a 500-1000kW charger to fill the batteries within 2-3 minutes at the end-of-route stations.

Sundsvall-Timrå Airport is also planning to include an electric bus serving the town and the airport.[20]

3.3.2 Provision in Inverness and Kirkwall

Stagecoach Highlands have deployed fully electric buses in Inverness, servicing routes 7 and 9 which link the city centre to the outskirts. The Highland Council and Stagecoach also included a dedicated rapid charging unit at Inverness bus station to allow the buses to be recharged during layover periods.

Orkney also has an electric bus operated by Stagecoach between Kirkwall and Kirkwall Airport. When fully charged, the bus has a range of around 70 miles. It typically makes five round trips on the 12-mile airport route before returning to the depot to recharge. During this time, the current diesel JetBus will operate.

A private rapid charger has been installed at Kirkwall Travel Centre to allow for the bus to charge up in just two-and-a-half hours, but reportedly suffers frequent downtime. According to Orkney Islands Council, this has had a profound impact on the reliability of the electric bus and has placed the addition of another electric bus in doubt at present.

3.3.3 Future bus technology

It is expected in the coming years that there will be a greater focus by manufacturers on reducing the weight and optimising the thermal management systems of electric buses to increase their efficiency. UK company Equipmake report that equipping an electric bus with a heat pump, smart control and thermal energy recovery system, can save a bus 200 kWh of battery energy per day.[21] This greatly optimises the potential to run buses on longer, or more intensely timetabled routes.

Charging technology for buses is also improving, with inductive charging, dynamic inductive charging and overhead charging all having been successfully deployed in cities around the world. These technologies offer improvements in charging downtime and hence efficiency in timetabled operations.

3.4 Electric Bikes

3.4.1 Context

With lowering costs and the development of more efficient motors, electric bikes (ebikes)

[19] The Barents Observer (2017) Umeå paves the way for green electric bus revolution

[20] reen Highway Magazine (2013) reen Highway Magazine 2013/14

[21] Equipmake (2018) The Cost Effective Electric Bus – Cheaper than a Diesel without subsidy. Presentation by Ian Foley at CENEX LCV, 13th September 2018.

are becoming an increasingly practical transport option. Current ebike models are capable of undertaking power-assisted pedalling for around 30-150 miles. This assisted pedalling is increasing accessibility to cycling as a mode. For airport passengers, there are also ecargo bikes available with space to store baggage.

Through Energy Saving Trust (EST), Transport Scotland have made available an eBike loan scheme[22] for individuals, and the eBike rant Fund[23] for local authorities, public sector agencies, colleges and universities to take the lead on the large-scale adoption of ebikes.

3.4.2 Provision at NPA Airports

Apart from Oban and Barra (see section 3.4.3), Norway is the only country with remote & peripheral airport including the provision for ebikes through the scheme Fly & Bike. Including a selection of different ebikes, the scheme allows passengers to pick up a pre-booked bike at any airport on the north Norwegian coast between Trondheim and Bodø Airports.

The scheme also offers the bikes as a one-way rental, whereby users can pick up bikes from one airport and drop at another. This has become rather popular, facilitating "island-hopping by bike", since there are many short flights required to get around the islands in Northern Norway.

3.4.3 Provision in Inverness and Kirkwall

Through the SPARA project, HITRANS will be introducing electric bike schemes at Oban and Barra Airports later this year. In Barra, this will see the operation of ebike hubs at the airport and the town centre, and the introduction of a mobile maintenance and service vehicle to retrieve ebikes and return them to the hubs. Oban is expected to operate with a similar model.

In addition, Orkney has been awarded funds from Transport Scotland's Low Carbon Travel and Transport Challenge fund[24] to operate a Multi-Modal Low Carbon and Active Travel Hub in Stromness. Situated at the Stromness Ferry terminal, the Hub will provide a combination of various transport decarbonising initiatives including the provision of bicycle charging facilities and two e-bikes.

3.5 Hydrogen Fuel Cell Vehicles

3.5.1 Context

Hydrogen fuel cell vehicles produce zero tailpipe emissions, can be refuelled within a couple of minutes and have ranges of up to 300 miles for passenger vehicles. There are currently only 62 Hydrogen Fuel Cell vehicles in the UK[25] although this number will soon

[22] EST (2018) eBike loan

[23] EST (2018) eBike rant Fund Note: Round two of this fund opens on 9th October 2018.

[24] EST (2018) Low Carbon Travel and Transport Challenge Fund Awards – Round 2, 8th August 2018.

[25] Department for Transport (2018) Vehicle Licensing Statistics: Table Veh0120: Licensed vehicles at the end of the quarter by make

rise a further 172 vehicles through projects announced in the first round of the UK government's Hydrogen for Transport Programme.[26]

Some of the main challenges with hydrogen attribute to the energy required to produce hydrogen and storing at appropriate pressures. Due to the significant advancement in EVs, there is acknowledgement that the potential of fuel cell vehicles is likely to be more applicable for larger vehicles, such as buses and lorries which undertake significant mileage. However, single-deck electric buses currently cost a quarter of the price of hydrogen fuel cell buses.

There are also opportunities for hybridisation of fuel cell and light vehicles. For example, Symbio FCell has retrofitted hydrogen fuel cell range-extenders technology to Renault Kangoo EV vans.

3.5.2 Provision at NPA Airports

There are currently no fuel cell vehicles in operation at remote and peripheral airports in the NPA region.

3.5.3 Opportunity in Orkney

Orkney's Surf 'N' Turf project utilises excess renewable energy generated through tidal and produces hydrogen for the islands. An additional €5 million of European funding secured for the "BI HIT " project will pay for the installation of a refuelling station, and 10 Symbio Renault Kangoo EVs retrofitted with fuel cells.[27]

There are plans to expand this hydrogen to shipping vessels, but there may also be opportunities to introduce other fuel cell vehicles, such as fuel-cell buses. However, this will be subject to the production and supply potential of the Orkney's fuel cell programme.

3.6 Freight and Delivery

In discussions with the Road Haulage Association and Freight Transport Association as part of this research, they stated that they consider there is still around 5 to 10 years before local hauliers will consider the mass adoption of low carbon vehicles. They consider that most of the uptake of low carbon freight and delivery vehicles have been adopted by large corporates, who have carbon standards to abide by and the capital to purchase the vehicles.

They stated that currently there is a lack of versatility on offer for EVs, and there is also a growing interest in greater uptake for Compressed Natural as (CN) vehicles for freight delivery.

However, there was acknowledgement that in the short-term there would be a greater opportunity for EVs for 'last-mile' delivery vehicles.

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and model, reat Britain, 2018 Q1.

[26] Ricardo (2018) Hydrogen for Transport Programme (HTP)

[27] EMEC (2016) Press release: BI HIT Hydrogen to Power Orkney Transport and Heating

3.7 Autonomous Vehicles

rasping the attention of large technology companies and partnerships with vehicle manufacturers, self-driving autonomous vehicles are gaining momentum as transport for the future.

There are currently no autonomous vehicles in operation at Inverness and Kirkwall airports. However, British autonomous vehicle companies Oxbotica and Westfield Autonomous Vehicles believe that fully autonomous (level 5) vehicles are ready for commercial environments such as airports where conditions need to be strictly controlled.[28]

Landside, autonomous vehicles offer the opportunity to transfer passengers between terminals and car parks and for 'last-mile' applications. Airside, autonomous vehicles offer the opportunity to search and collect foreign object debris (FOD) along runways and help in the ongoing logistics vehicles, such as tugs and baggage handlers.

CASE STUDY

Autonomous Vehicles at Gatwick Airport

Photo credit: Oxbotica

Gatwick becomes the first airport in the world to trial autonomous vehicles, shuttling staff across the airfield

British autonomous vehicle software firm Oxbotica has been commissioned to trial autonomous pods at atwick airport . According to atwick Airport, its 300 airside

[28] Oxbotica and Westfield Autonomous Vehicles (2018) CAV Technology and Market Development. Panel Q&A session at CENEX LCV, 13th September 2018.

vehicles are often stationary and unused by staff up to 90% of the time.[29]

In a bid to reduce the fleet, operations costs and emissions, the airport launched a trial in summer of 2018, using Oxbotica's electric driverless pods to provide shuttle services for workers on airside roads between the airport's North and South terminals.[30]

If the technology is proven in an airfield environment and following further trials, this project may be the precursor to a wide range of other autonomous vehicles being used on airport, including aircraft push back tugs, passenger load bridges, baggage tugs and transportation buses.

[29] atwick Airport Media Centre (2018) atwick to be the first airport in the wor ld to trial autonomous vehicles to shuttle staff across the airfield

[30] Airport Technology (2018) How airports can act as testbeds for autonomous vehicles

4. Energy Management

Energy management technologies bring a wide range of benefits to transport and energy systems at airports.

During site visits held on 6th and 7th September 2018, HIAL noted that managing the costs of electricity supply and affect to the local grid is a concern with regard to increasing the uptake of EVs. HIAL expressed specific interest in opportunities to optimise the management of energy at their airports.

This section therefore provides an overview of existing and developing energy management technologies that could potentially be applied at Inverness and Kirkwall airports as EV uptake increases.

4.1 Vehicle-to-X

V2X technology provides opportunities for EVs to be utilised as mobile energy systems, helping to balance local and national grid loads and creating additional revenue generating opportunities for EV users. In the case of airports, V2X could provide direct energy savings through optimised and scheduled energy exchange between EVs and terminal buildings.

There are trials ongoing across the globe to advance the potential of Vehicle-to-X (V2X) technology. There is currently only one commercial V2X facility in operation (See Case Study).

Currently, CHAdeMO is the only charging standard that supports V2X applications. For vehicles without CHAdeMO compatibility and equipped with the European standards of Type 2 and CCS chargers, it will be a few years before these vehicles are supported.

There are currently no V2X applications in proximity to Inverness or Kirkwall, and these are not expected to be commercially available for a few years. However, Solo Energy is set to offer free installation of battery storage and Vehicle-2-rid (V2) technology for Orkney households in the first half of 2019.

In addition, as part of an Innovate UK study, "Vehicle-to-rid Britain" , energy company Ovo Energy and vehicle manufacturer partners are currently assessing and trialling how significant V2 revenues could be , and the extent to which they could influence EV uptake within the wider market and policy environment.[31] Upon completion of the project in 2019, it is hoped that Ovo's VCharge hardware will cost around £1,000, to justify a reasonable payback period for customers.[32]

[31] Digital Catapult (2018) Catapult modelling to support Vehicle-to-rid electric car project

[32] Ovo Energy (2018) Making V2 a Reality. Presentation by Tom Pakenham at CENEX LCV, 12 th September 2018.

CASE STUDY

World's First Commercial V2G Fleet

Photo credit: Nuvve Corporation

Danish utility installs the world's first commercial V2G hub

Collaboration between Nissan, Enel and Nuvve has helped to develop the world's first commercially V2 hub. Danish utility Frederiksberg Florsyning installed 10 Enel V2 units and purchased 10 electric Nissan e-NV200 vans to integrate with its headquarters in Copenhagen.[33]

When not in use, the Nissan vans can be plugged into the V2 units , acting as mobile energy solutions, providing energy to and from the national grid. With all ten vans plugged in the total capacity amounts to approximately 100kW.

Nuvve provides the platform which controls the energy flow to and from the vans. The software ensures that the driver's mileage needs are always met and optimises the power available to the grid.

4.2 Renewable Energy

The surrounding areas of Inverness and Kirkwall are major contributors to Scotland's renewable energy generation. With some of the UK's highest mean annual wind speeds[34] and an extensive coastal area, there is an abundant natural resource for renewable energy generation. For example, Scotland's island communities total practical resource potential is estimated at 12.9W .[35]

[33] Nuvve (2016) Nuvve operate world's first fully commercial vehicle-to-grid hub in Denmark

[34] Met Office (2015) Where are the windiest parts of the UK

[35] Baringa (2013) Scottish Islands Renewable Project: Final Report

Integration of renewable energy generation at HIAL airports can play a role in reaching the Scottish overnment's target of 100% renewable energy generation by 2020 , and help to offset carbon emissions from aviation emissions.

At Kirkwall airport, the local grid capacity is constrained by the provision of an overhead cabling line and limited ground-level electricity supply. Upgrading or reinforcing the capacity would be very costly. The installation of a local Solar PV array and/or wind turbine could provide a solution, providing free energy, a boost to energy security for the airport, and offsetting emissions.

CASE STUDY

Helsinki Airport Achieves Carbon Neutral Status

Photo credit: Finavia

In 2017, Finavia, operator of 21 of Finland's airports received the international Airport Carbon Accreditation (ACA) certificate, awarding the airport for achieving carbon neutral status.

To reach the accreditation Finavia has implemented continuous improvements to emissions efficiency and residual emissions. Key enablers have also been the use of renewable diesel fuel for buses and the generation of electricity from solar PV panels.

Finavia started using renewable diesel fuel in vehicles operating at the airport. The buses travelling between the terminal and aircraft are fuelled by biodiesel produced entirely from waste and residue.[36]

[36] International Airport Review (2017) Helsinki Airport is now carbon-neutral

They have also installed the largest solar power plant in the Nordic area. With a total capacity of more than 500 kWp. It will supply almost 10 per cent of all the electricity required by the new terminal extensions at Helsinki Airport.

Finavia is a key partner to the joint commitment of European airport companies under which there should be 100 carbon-neutral airports in Europe by the year 2030. As part of its wider Climate Programme, Finavia is aiming to make all of its 21 airports carbon-neutral by the year 2020.

4.3 Energy Storage Systems

It is expected that significant grid reinforcement will be required to cope with the predicted uptake of EVs and greater provision of charging infrastructure. Due to the high cost of conventional grid reinforcement, energy storage systems are emerging as potential solutions that can accommodate these power demands without significant and costly upgrades, whilst optimising the integration of intermittent renewable energy in EV charging.

Orkney has experience with energy storage systems, as a 2 MW lithium-ion battery at Kirkwall Power Station is currently capturing the vast intermittent renewable energy being generating across the islands.

In addition, Solo Energy's scheme mentioned in Section 2.2 is also offering the installation of a 'smart' battery system across Orkney households or businesses – with no upfront cost. Solo uses their proprietary software to charge up customers' batteries when wind turbines and solar panels across the country are generating clean energy. When deployed at scale, these technologies can also be used to take the pressure off the grid by shaping demand and removing the peaks and troughs of intermittent renewable generation –lowering costs across the system as a whole.

4.4 Microgrids

It is possible to combine all of the above energy management technologies to ultimately form a micro-grid.

A microgrid is a discrete energy system consisting of distributed energy sources (including demand management, storage, and generation) and loads capable of operating in parallel with, or independently from the main power grid. In such a set-up, EV charging is one of several easily controllable loads that can be integrated with other electrical loads, energy storage and localised generation sources in a way that acts as a single controllable entity.

This can ensure local, reliable, and affordable clean energy security for urban and rural communities, as well as for commercial and industrial consumers. It can also help to minimise the stress on the grid of additional charging infrastructure.

This set-up can be particularly suitable for the business case of EV charging in remote areas, where the network is at capacity and/or where the cost or complexity of extending

the network is prohibitive. Lowering costs, coupled with increasing performance of solar and wind energy generation alongside smaller energy storage systems are also helping increase the practicality and cost efficiency of integrating energy generation into charging infrastructure.

CASE STUDY

Micro-grid at EUREF Campus

Photo credit: inno2grid

Real estate developer EUREF A has developed the EUREF campus [37], a 5.5 hectare campus situated in the heart of Berlin-Schöneberg. Comprising of companies in the fields of energy, sustainability, and environmental protection, the site is designed as a model project for the future, an "Intelligent Urban Quarter" with the objective of utilising urban technologies to generate carbon-neutral energy and optimise energy use.

To enable these objectives, the site's companies have developed an intelligent micro-grid for controlling the distribution and storage of the assets on-site. The site comprises energetically optimised green buildings, battery storage technology, and a test platform of vehicle-to-grid and self-driving technology for electromobility with the use of EVs. By installing on-site wind, solar and a biomass heating and power unit, and together with the intelligent control of these components, the site achieved its carbon-neutral status in 2014. As such, the full site can function without the back-up of the national grid.

[37] EUREF - Note that this website is in erman

Being a scalable campus, the system and its components can grow in-line with increases in energy use. In addition, the intelligent use of the control and management technology also permits energy exchange between other neighbouring micro-grids where required and prevent reliance on the national grid. For example, the campus currently works in tandem with neighbouring Südkreuz railway station.

5. Biofuel Opportunities

Integrating biofuels represents a short-term solution to decarbonisation of the transport system but requires suitable material supply.

As part of the SPARA programme, Swedish partners, Trafikverket developed a report appraising the applicability of biofuel transportation in Sweden. To understand the opportunity for biofuels at Inverness and Kirkwall airport, a conference call was held with both Sundsvall Airport and Trafikverket.

This section provides a summary of biofuels in the UK, lessons learned from Sweden and the extent of the opportunity for biofuel integration at Inverness and Kirkwall airports.

5.1 Context

In 2015, air travel was responsible for 16% of transport emissions in Scotland and the highest emitter per passenger kilometre – especially domestic flights in Scotland. The International Air Transport Association (IATA) recognises the need to address the global challenge of climate change and stipulates the need for a reduction in net aviation CO_2 emissions of 50% by 2050[38].

Although sustainable and clean alternative propulsion technologies for aviation are in development, such as electric or solar-powered aircraft, it is widely accepted that these are unlikely to be commercially available until after 2050.[39] In the short-term, achieving the H emissions reduction targets proposed by the aviation industry and by organisations such as the IATA will need a significant increase in biofuel production and consumption.

In April 2018, changes were made to the UK's Renewable Transport Fuel Obligation (RTFO), compelling owners of transport fuel who supply at least 450,000 litres a year or more to make sure the mix is at least 12.4% biofuel by 2032. The changes also qualify jet biofuel for credits under the RTFO, giving aviation the same incentives for biofuel use as road transport.

In June 2018, renewable fuels company Velocys plc was awarded £4.9m funding b The Department for Transport to develop the first waste to jet biofuel in the UK. The project is supported by Shell and British Airways.

[38] IATA (2018) Climate Change

[39] International Renewable Energy Agency (2017) Biofuels for Aviation: Technology Brief

5.2 Lessons from Sweden

The Swedish aviation sectors have set targets that imply that domestic aviation in Sweden will be fossil free in 2030.

Biofuel for aviation is currently 2-4 times as expensive as fossil-based jet kerosene, based on the prices paid for delivering fuel to the Swedish market. This is due to all aviation biofuel used in Sweden being sourced from AltAir in California, produced using cooking oils. This increased cost has been identified as Sweden's main obstacle to transitioning to a sustainable aviation industry.

To overcome this barrier, Sundsvall-Timrå (SDL) Airport have been working with Swedish timber, pulp and paper manufacturer, Svenska Cellulosa AB (SCA) to potentially create a national biofuel refinery, supplying SDL and Sweden with transport-readied biofuel.

Before a biofuel refinery could be established there were a number of key challenges identified:

- Legislative - The need for 8 different permissions to allow production to begin. SCA is currently about 80% the way through the process, with a final decision expected in the next 12-18 months.
- Resource - Biofuel production would require 1 million tonnes of wood to feed the mill.
- Finance & National supply – SCA would need to spend €300 million capital to create a centralised biofuel production plant, however, shareholders are yet to be fully convinced of the Return on Investment for biofuels.
- Price – flights using biofuels are more expensive. For a typical domestic trip in Sweden, e.g. Stockholm to Sundsvall, which takes 50 minutes, paying for biofuels would add one third to the ticket price.
- Awareness – there is a lack of awareness of biofuels in aviation amongst customers.

Having the autonomy to make decisions on fleet fuelling, SDL has been using biofuels in its ground operations vehicles and machinery that has led to an 80% reduction in carbon emissions at the airport. SDL Airport is also looking to invest in solar panels or a ground source heat pump, pending the results of a feasibility study.

5.3 Use at NPA Airports

There are only four remote and peripheral airports to currently use biofuels: Sundsvall-Timrå Airport in Sweden, and Norwegian airports Alesund, Bergen and Trondheim.

The first deliveries of synthetic biodiesel were made at Alesund Airport in July 2018 to be used by heavy vehicles across the airport and reduce carbon emissions by 90% compared to previous fuels.[40]

[40] Sunnmørsposten (2018) Brukt frityrolje er miljøsatsing på Vigra – Content in Norwegian

Biofuels are also in use at Trondheim Airport, where they demand that airport express coaches and buses use bio-diesels. Bergen Airport began refuelling planes with Air BP's bio-jet fuel in August 2017.[41]

The number of Norwegian airports using biofuels is likely to increase over the next 12 years, with Avinor setting a target for 30% of all aviation fuel sold at its airports to be sustainable biofuel by 2030. This is equivalent to a volume of approximately 400 million litres of jet fuel per year.[42]

5.4 Opportunities at Inverness and Kirkwall

A significant challenge to biofuel adoption at Inverness and Kirkwall airports is that there are currently no large biofuel facilities in proximity to Kirkwall and Inverness airports.

Argent Energy is Scotland's only large commercial biofuel plant, with a plant-based in Motherwell. However, since the revision of the RTFO in April 2018, and more UK government-led challenge funds for biofuel production emerge, there may be future opportunities for biofuels.

For Kirkwall, it was determined there are limited opportunities for the integration of biofuel vehicles. Orkney's well-established expertise in generating surplus renewable energy and production of green hydrogen may provide greater opportunities to integrate electric and fuel cell vehicles at Kirkwall airport. In the long-term, there may be opportunities to develop third-generation micro-algae applications, if it were to become commercially viable.

[41] BP (2017) Air BP announces third biojet-supplied location at Bergen Airport, Norway

[42] Avinor (2017) Avinor and Norwegian Aviation 2017

Chapter 2: Inverness Action Plan & Priority Programme

1. Inverness Airport Low Carbon Action Plan

1.1 Context

1.1.1 Overview

Receiving just under 900,000 passengers in 2017[43], Inverness airport offers a range of daily flights to and from key destinations and interconnectivity hubs including London, Amsterdam, Bristol, Manchester, Birmingham, Dublin, Belfast City, Stornoway, Kirkwall and Sumburgh (Shetland).

There are 1,001 parking spaces at Inverness airport, combining a comprehensive pricing strategy for short- and long-term stays.

1.1.2 Tourism

There are a variety of opportunities for electric vehicle penetration into the local context:

- Electrification of the North Coast 500 (NC500) and announcement of the upcoming Electric A9 represent opportunities for tourists to discover the surrounding landscapes in an electric vehicle. There are currently no advertised car hire/rental facilities promoting the NC500 at Inverness Airport[44].
- In 2017, the Cairngorms National Park attracted 1.85m Tourism Visits to the park, up 7.1% on the previous year. If electric vehicle market penetration continues in line with Scottish targets, there is likely to be a marked increase in the number of electric vehicles travelling through the national park.
- As well as the need for electric vehicle infrastructure across the Cairngorms National park, there will be an onus for car rental and car hire firms to include the option for visitors to hire low carbon vehicles. Inverness airport would be a suitable terminal point for these vehicles.

1.1.3 Future Developments

There are major infrastructure projects in proximity to Inverness that may have an impact on opportunities for low carbon surface access in the coming years.

Inverness Airport Railway Station

The Inverness Airport Railway Station is scheduled to open in 2020 and will mainly serve Inverness Airport and the new town of Tornagrain. The Station will be a 1.2-mile drive from the airport terminal along the Airport Access Road.

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[43] lobal Tourism Solutions (UK) Ltd (2017)

[44] North Coast 500 (2018) North Coast 500 – Interactive Map

Tornagrain will be situated 0.6 miles from the station and is expected to house 10,000 people. 200 homes have already been built and are occupied. There are opportunities to develop low carbon transport solutions that connect Tornagrain and Dalcross Railway station to the airport.

Inverness Business Park

There are plans to develop a new business and retail park, adjacent to the airport. This may generate the requirement for additional transit, serving commuters and passengers travelling to the business park and the airport. Moreover, depending on the access to the airport, there may be a market for shuttle services between the business park and the airport. This could be facilitated by small-medium sized low carbon or autonomous vehicles.

Dualling of the A96

Transport Scotland has approved the dualling of the A96, upgrading 86 miles of single carriageway between Inverness and Aberdeen. This will include improved journey time and reliability, delivering economic growth, improved connectivity and reduce the rate and severity of accidents. As well, as providing an additional lane, there will also be a non-motorised access lane between the airport and Inverness city centre. Inclusion of electric bikes, and assisted pedalling technology, may make the 10-mile journey more accessible for commuters or passengers that are currently reluctant to cycle to the airport.

1.1.4 Electrical Supply

Key to the development of electric vehicles and associated infrastructure is the provision of electrical supply. As shown in Figure 8, there is a cluster of substations with large capacities located around the airport car park. The airport also benefits from the presence of a primary substation nearby (highlighted in red) This is the main electrical supply point and is likely to have significant capacity if any future substation or supply upgrades were required.

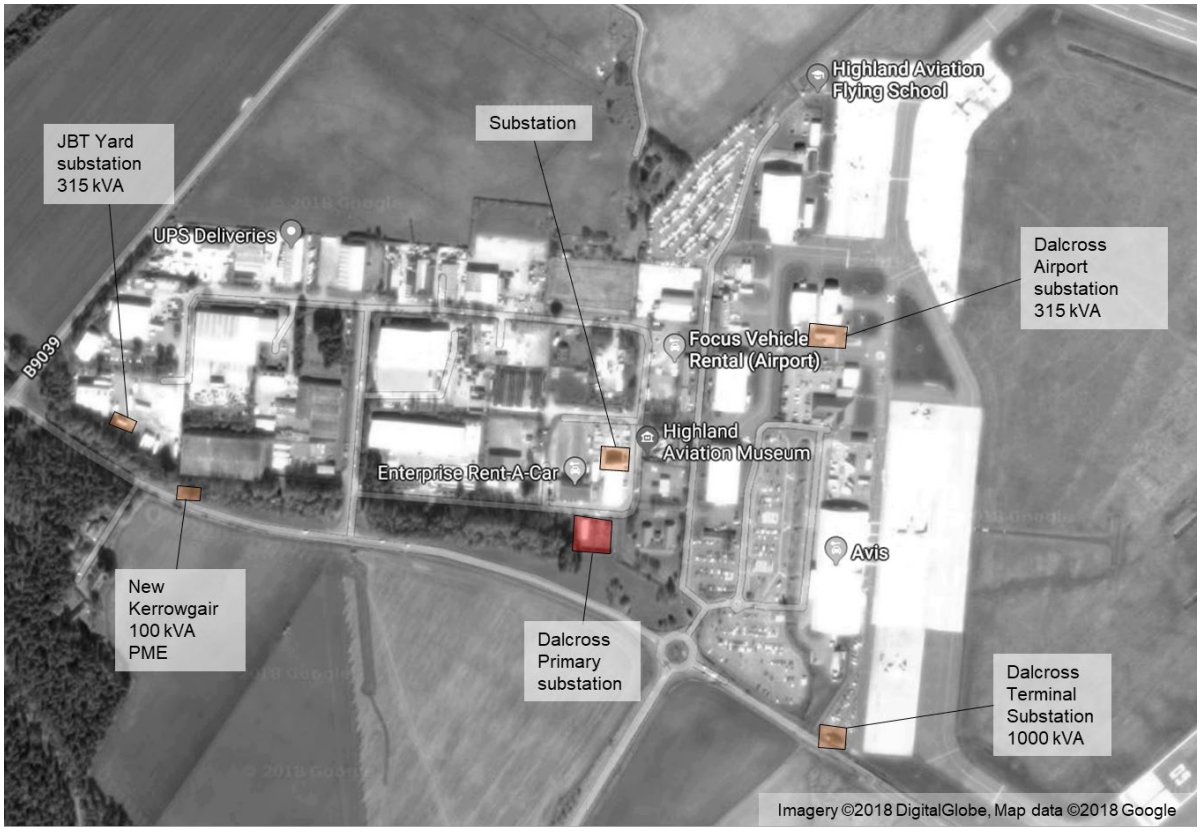

Figure 8 - Inverness Airport Layout and Electrical connection points

1.2 Action Plan

Building on information gathered through desk-based research, stakeholder interviews and a site visit held on the 6th September with HIAL and HITRANS representatives, three key aims of this action plan were identified:

- Aim 1: Improve access and knowledge for low carbon travel options at the airports
- Aim 2: Reduce and off-set carbon emissions at the airports
- Aim 3: Support future energy management of the airports

The following sections set out a 10-point action plan to increase the uptake and integration of low carbon surface activities at Inverness airport.

Action 1 – Undertake enabling electrical works for the provision of electric vehicle charging infrastructure

The Scottish government is expecting the widespread adoption of electric vehicles on the roads over the next 20-30 years. HIAL are currently undertaking a review of their masterplans and internal energy strategy. To futureproof for widespread EV uptake and requirement for charging infrastructure, there is an opportunity for HIAL to futureproof their car parks.

Electric ducting work should be undertaken where appropriate to prepare for the future penetration of electric vehicles and demand for EV charging infrastructure.

Action 2 - Provide smart slow/trickle charging infrastructure

Inverness receives a high proportion of passengers travelling to international destinations. EVs are therefore expected to be left for periods of a couple of days up to several weeks.

Allowing multiple EVs to plugged into chargers with the lowest ambient power outputs, and functionality for passengers to schedule time of arrival could enable charging to be spread over time without the need for unnecessary installation of multiple high powered chargers.

It is suggested that implementing slow/trickle EV charging is a priority for the airport. Solutions such as the eTolppa hybrid chargers in Finland, with their remote scheduling functionality, may be appropriate.

Action 3 – Work with operators to provide low emission car club vehicles and enabling Infrastructure

There is evidence from the lack of parking capacity for car hire that there is a demand for car hire vehicles, and thus an opportunity to introduce car club vehicles.

Work should continue with car club operators to establish their plans. Enterprise has also expressed their interest in forming a car club at the airport. Further engagement with Enterprise is recommended to maximise the outcomes for the airport.

Action 4 – Increase awareness of low carbon travel options to and from the airport

It was identified that to improve the uptake of low carbon travel modes at the airport, a comprehensive programme of promotional activity is required. For example, this may include an increase in digital and marketing content across the airports, wider advertisement of the electrified NC500 route, along with provision for online booking and scheduling applications.

Working with Visit Scotland, and other local tourist firms may bring about opportunities to offer discounted/VIP experiences for those using low emission transport modes.

Action 5 – Provide rapid charging infrastructure

Users may be dropping other passengers off or require a quick top-up for onward journeys. In addition, car club vehicles may need quick top-ups if hired back to back from a previous user.

It is suggested that if a financial opportunity arises, providing one rapid charger may help to support the needs of emergency charging and user confidence in switching to electric.

Action 6 – Seek opportunities to integrate an express low carbon bus Service

Currently, there is only an hourly bus service running between Inverness centre and the Airport. Stagecoach are due to introduce an express bus servicing Inverness-airport-

Nairn. With a potential round-trip distance of 40 miles, there may be future opportunities to include a low carbon bus on the route.

It is recommended that opportunities are sought to work with Stagecoach on further expansion of their Nairn/Inverness Express bus service to incorporate a low carbon bus.

Action 7 – Explore opportunities to introduce renewable and battery technology.

HIAL are keen to understand the potential for integrating on-site renewable energy and battery storage technology to help support and manage the airport's energy system. As the level of EV infrastructure increases, there will be increased pressures on the airport's electricity supply capacity. Solar canopies offer an additional form of electrical resilience and boost the green credentials of the electricity. Combined with batteries, charging could be effectively taken completely off-grid.

However, there are health and safety challenges in implementing renewables near to aviation runways.

HIAL should seek to understand the potential of installing a renewable energy and storage system, supporting the energy exchange between stationary vehicles, EV infrastructure and their terminal buildings.

Action 8 – Explore opportunities for trialling vehicle-to-x Integration

There are currently no airports that are operating with Vehicle-to-X technology, but with vehicles parked for long periods and knowledge of passenger departure, there is an opportunity to explore the benefits of energy exchange with these vehicles.

The technology is still very much in its trial phase but would complement the integration of renewable and battery storage technology. HIAL would need to identify technology and solution partners to demonstrate such a solution.

Action 9 – Monitor the potential to integrate biofuels at Inverness airport

In the short-term, biofuels offer opportunities to cut emissions as zero-emission fuel-cell and electric vehicle technology are developed for more commercial applications. Integrating biofuels may present opportunities for a small number of surface access and airside vehicles to operate on biofuel blends. However, there is a lack of current access to a supply of biofuels in Scotland and UK region.

HIAL should monitor the potential for future biofuel suppliers in Scotland. If biofuels become practically and economically feasible, HIAL should consider including competitive weighting for vehicles that have a provision for biofuels, and or other low carbon technologies in future procurement processes.

Action 10 – Explore opportunities for trialling Autonomous Vehicles

If appropriately implemented, autonomous vehicles offer the potential to increase the efficiency of transport around the airport and improve safety for airside vehicles. In

addition, with the development of a new business park, and Dalcross train station situated only 1.2 miles from the airport, there is an opportunity for on-demand and flexible autonomous vehicles to transfer passengers to and from the station.

HITRANS should consider opportunities to trial autonomous last-mile vehicles between Dalcross train station and Inverness airport.

2. Priority Programme – Inverness Airport

2.1 Overview

During a site visit held on the 7th September 2018, it was identified that there was significant potential to develop "Charging Zones" dedicated for the parking of electric vehicles. It was concluded that each zone would be developed with appropriate barrier access. Parking tariffs could then be levelled to the type of infrastructure. For example, rapid chargers would incur short-stay fees and slow chargers, long-stay fees. These would be tailored differently to those charged for conventional vehicles, to encourage vehicles turnover.

A significant barrier to installing electric charging infrastructure is the lack of or proximity to electrical supply points. Figure 9 presents an overview of the car parks that could potentially be developed as Charging Zones on the land-side of the airport.[45]

Upon successful implementation of Zone 1, there is an opportunity to replicate the approach to Zones 2 and 3. It must be noted that due to the rapid emergence of new and disruptive technologies, the technological solutions available at the time of Phases 2 and 3 may change. It is highly recommended that the uptake of electric vehicles and subsequent use of the chargers are heavily monitored on an annual basis to approach the phasing of infrastructure in a considered manner.

[45] Note: This priority programme only considers the implementation of charging zones at Inverness airport

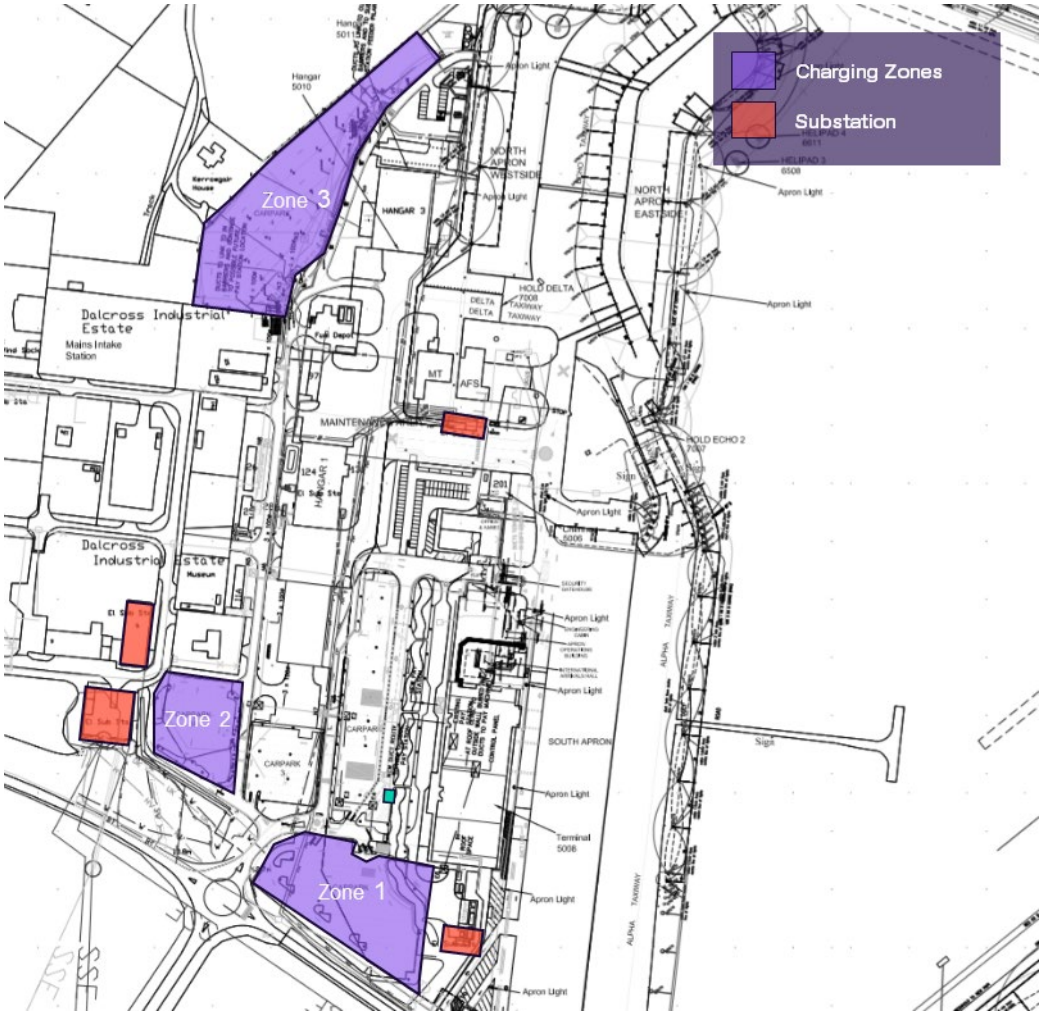

Figure 9 – Potential charging zones at Inverness airport

2.2 Zone 1

Figure 10 outlines the potential configuration of the first EV Charging Zone, to be located in what is currently a car park dedicated for use by car hire vehicles. There are currently 250 spaces in this car park.

This was identified as the primary location during the site visit to reconfigure the EV charging area due to its proximity to the airport terminal's substation, with a capacity of 1,000 kVA. In addition, this presents the greatest opportunity for integrating future energy management technologies to support the energy exchange between customer vehicles, renewable energy, and from the airport terminal.

It is expected that given current levels of electric vehicle adoption, initially, the Zone will only need to support a small number of charge points. As the uptake of vehicles increases, the number of charge points should increase.

It is therefore suggested that each zone is designed and developed in a phased approach. As a high-level guide, it is expected that Phase 1 implemented in years 1-2; Phase 2 in years 2-5, and Phase 3 in years 5-10+.

Figure 10 - Potential Phased layout of Charging Zone 1 at Inverness airport

2.2.1 Phase 1

It is expected that this Phase will be implemented within the first 1-2 years, providing a mix of short and long stay parking. This will include:

- Ducting across the entire car park
- 10 slow/trickle chargers
- 2-4 plug-in car club vehicles
- Access through the use of barriers
- Requires approximately 36 kVA

It is suggested that each charger is configured as Layout A (Figure 10) along the kerbed edges of the car park boundaries, with rapid chargers prioritised near the substation.

Each charger shall supply two bays, i.e a total of 22 bays. It is suggested that 2 of the slow-trickle chargers (4 bays) are designated for car club vehicles only.

To not disrupt the uptake of electric vehicles, parking fees, or charging tariffs should be appropriate for HIAL to recoup some revenue, but lower than the cost incurred by petrol

or diesel vehicles staying for similar periods of time.

2.2.2 Phase 2

It is anticipated that Phase 2 will be implemented over the next 2-5 years, depending on the levels of EV uptake. This could include the expansion and provision of the following elements:

- 10 slow/trickle chargers – long stay
- 8 V2 -enabled smart chargers – long stay
- 1 rapid (50kW) charger – short stay
- 5-10 plug-in car club vehicles
- Requires approximately 225 kVA
- **Optional**: 1 Ebike storage & lockers - 4 ebikes (subject to A69 Dualling)
- **Optional**: 1,500m cycle path from the airport to A69.

A rapid charger is likely to be required as the battery sizes for vehicles increase and a greater demand on the EV charging infrastructure. The existing car club vehicles could also be provided with access to the rapid charger if this is necessary between vehicle exchange.

It is suggested that the car parking tariffs should be set into different lengths of stay to encourage vehicle turnover. The length of stay for charging would need to be understood and determined. However, it is suggested that short-stay parking (suitable for rapids) will be available for up to 45 minutes and long-stay parking for periods above two hours (suitable for slower units). Overstay charges could be phased in towards the end of this phase, depending on abuse of the system. For example, a £5 overstay charge could be levied on rapid charging units after a vehicle has been connected for more than 1 hour.

It is expected V2 -enabled chargers are likely to only serve one connector and will therefore only serve one bay per post. These chargers will be positioned along the edge of the car park boundary, as Layout B is more suitable for multi-headed posts.

Towards the end of this phase, it is expected that parking fees, or charging tariffs will increase slightly and maybe at a level in line with petrol and diesel vehicles, as a measure for paying back some of the costs associated with an investment in the capital infrastructure.

There may also be greater penetration of electric taxis by this point. iven the limited space availability for a rapid charger in the existing taxi rank, there may need to be an agreement for Inverness taxis (or other operators) to charge within zone 1.

2.2.3 Phase 3

It is projected that Phase 3 will be implemented over the next 5-10+ years. This will include the provision of more sophisticated infrastructure and complete the electric vehicle transition across the car park. It is expected that this could include the provision of:

- 25 V2 -enabled smart slow/trickle chargers
- 1 Ultra-Rapid charger – Ultra-short stay

- 15-20 plug-in car club vehicles
- Requires approximately 575 kVA
- **Optional:** Additional 12 ebikes
- **Optional:** Energy Management System (EMS): PV-canopy and battery storage system

Through the inclusion of an Ultra-rapid charger, there may need to be the introduction of an ultra-short stay tariff, of no longer than 20 minutes, to encourage users to move on. This charger should be positioned in the Phase 1 zone in proximity to the battery storage system to minimise cabling costs from the substation.

As an optional add-on, the installation of the battery storage system and renewable energy is hoped to reduce the burden of integrating the ultra-rapid charger, as the total capacity of the terminal substation becomes more constrained.

Towards the end of this phase, it is expected that an express electric bus route may be integrated. A 500-1000kW overhead charger could be installed to enable ultra-fast opportunity charging during route and driver layovers. The location of this charger is included in Figure 10.

It is hoped at this stage that V2 enabled smart slow/trickle chargers can supply 2-bays and that these chargers will be configured as a mixture of Layout A and Layout B configurations, so they can be in the centre of the car park.

After the initial implementation of Phases 1-3, it is expected that in total 57 bays will be enabled for electric vehicles. Since the car park area is ducted throughout in Phase 1, there is an opportunity to expand the provision of charge points until all spaces have been occupied.

2.2.4 Optional Add-ons

2.2.4.1 Energy management system

If all phases are to be implemented, there would be an electrical requirement of approximately 850kVA capacity. iven that the airport substation has a rated total capacity of 1,000kVA, but not known on what is currently remaining, there is potential to include an energy management system on site. Integrated with the array of smart chargers, an energy management system, offers optimal integration of the EV charging infrastructure and may reduce the need for costly network upgrades and potentially support wider activities on the site. The energy management system could comprise of the following:

- 50-bay Solar PV canopy array (covering ¼ of zone 1 bays)
- 150 kWh Battery Storage System

Further investigation of the battery storage solution will need to be commissioned. However, it has been assumed that a total of 150kWh of battery storage may be sufficient to support the initial elements described within the zone.

2.2.4.2 Cycling Infrastructure

It is likely that cycling infrastructure could possibly be added within the first instance of

the phasing of infrastructure, but this would be subject to the dualling of the A69.

It may also be that e-bikes and a cycle path can be funded under a separate funding programme, as part of the potential A69 dualling.

2.3 Capital Cost Estimate

An analysis has been undertaken to consider the likely magnitudes of capital costs incurred for a phased implementation plan at Inverness airport.

iven the high-level nature of this report, the innovative nature of the facilities proposed and the lack of design, this analysis should be treated as a very rough guide only.

Significant further work will be required to develop a robust design that can be priced with confidence.

2.3.1 Capital Cost

It is estimated that all three phases of the charging zone, without optional add-ons, could cost in the region of £690,000 to build at today's prices.[46] These costs do not include vehicles, such as plug-in car club vehicles, or any costs relating to access measures. It is also recommended that at this stage a contingency of around 20% be applied to the construction cost to recognise the high-level nature of the scope/design work undertaken. Each charging unit is costed to include 5-year maintenance and warranty periods.

Design, planning, management and procurement activity associated with the build has been assumed to be 15% of the construction cost. It should be noted that when proceeding with planning that full feasibility and outline design stage should be undertaken to fully assess such things as internet connectivity for communications, electrical and groundworks for infrastructure.

Including design and contingencies, it is estimated that the total infrastructure cost could be in the region of £955,000.

A breakdown of the estimated capital costs to deliver the infrastructure is included in Table 3.

Table 2 - the Capital cost of infrastructure delivery for Charging Zone 1 at Inverness airport

Equipment	Phase 1	Phase 2	Phase 3
Ducting	£90,000	£0	£0
EV infrastructure	£50,000	£180,000	£140,000
Energy System	£0	£935,000	£320,000
Information Kiosks	£10,000	£10,000	£15,000
Cycling Infrastructure	£0	£370,000	£5,000

[46] Urban Foresight calculation. These costs are estimated and derived from desk analysis only. Urban Foresight take no responsibility for the accuracy of these costs. Further feasibility work, engagement with industry and the distribution network operator, SSE are required to develop more accurate costings.

Civils & Additional Electrical works	£10,000	£130,000	£175,000
Subtotal	£160,000	£190,000	£340,000
Design and Management (15%)	£25,000	£30,000	£50,000
Contingency (20%)	£35,000	£45,000	£80,000
Phase Total	£220,000	£265,000	£470,000
All Phases Total	**£955,000**		

If optional add-ons were to be included within Zone 1, the costs would increase the project total to approximately £2.16 million after contingencies and design and management fees.

Integration of an energy management system could help to alleviate some of the potential capital costs and improve the green credentials of the airport. For example, the average electricity savings of implementing an array of Solar PV canopies could optimally generate an estimated £14,000 in electricity savings per annum, assuming a standard electricity price of £0.10/kWh.

Table 4 provides an overview of the optional add-on costs of including an energy management system and cycling infrastructure at the airport.

Table 3 - the Capital cost for additional infrastructure for Charging Zone 1 at Inverness airport

Equipment	High-level cost
PV System	£235,000
Battery Storage system	£250,000
Cycling Infrastructure	£385,000
Subtotal	£870,000
Design and Management (15%)	£130,000
Contingency (20%)	£200,000
Optional Add-ons Total	£1,200,000
Project total (incl. all phases)	£2,160,000

2.4 Funding Opportunities

Due to the potential size of the project, there will need to be a medium-high level of capital funding to facilitate the level of infrastructure.

Discussions with Highlands and Islands Enterprise identified that this approach to infrastructure at Inverness airport would also be suitable for the Low Carbon Infrastructure Transition Programme (LCITP). The call for projects for 2018 has just ended, but there is likely to be an open call in 2019.

In addition, the LCITP “catalyst” phase is open, which provides development support of up to £100,000 to help projects complete Investment rade Business Cases.

For capital ready projects, and when the next call opens in 2019, there is financial

assistance for up to 50% of the total capital value of a project and up to a maximum of £10 million per project where capital value covers financial costs associated with the build and installation of an exemplar project (i.e. purchasing of physical assets). Applications are more likely to be successful with a detailed business model for implementation, demonstrating economic, social and low carbon benefits for Scotland.

HIE also offer free Low Carbon Energy Systems Technical Advice Framework, to support early-stage/concept development of a low carbon energy systems project.

There are several business models for installing infrastructure, which are not just available through capital funding. Further information on a variety of funding that could be sought to develop such a project is included in Appendix C.

Chapter 3: Kirkwall Action Plan & Priority Programme

1. Kirkwall Airport

1.1 Context

Situated 4 miles from Kirkwall town centre, Kirkwall airport is the air transport hub for the Orkney Islands, providing access from Scotland's major cities, Shetland and Norway. Kirkwall attracted 195,982 passengers in 2017, up from 153,000 in 2016.

Orkney's natural environment offers significant potential for the generation of electricity from renewable sources, particularly wind, wave and tidal stream, and the community is embracing it. The development of community-owned wind turbines and generation of surplus energy, and also consequently hydrogen, has set Orkney up as flagship low carbon community.

Electric vehicles and infrastructure are well-placed to play an increasing role in the island's transport system. A key challenge for Kirkwall airport in the provision of charging infrastructure is electricity supply. As shown in Figure 11 the site is currently supplied by an overhead line, with a ground-level substation with a total capacity of 315 kVA. This figure includes the maximum capacity supplying the airport terminal building, so realistically the available capacity for charging infrastructure is likely to be less than 250kVA.

Due to these constraints, it is suggested that there is a significant focus on technologies that enable smart energy management of the EV charging infrastructure. If successfully implemented, Kirkwall airport could demonstrate for other remote airport locations with even less grid capacity that provision of EV infrastructure is possible.

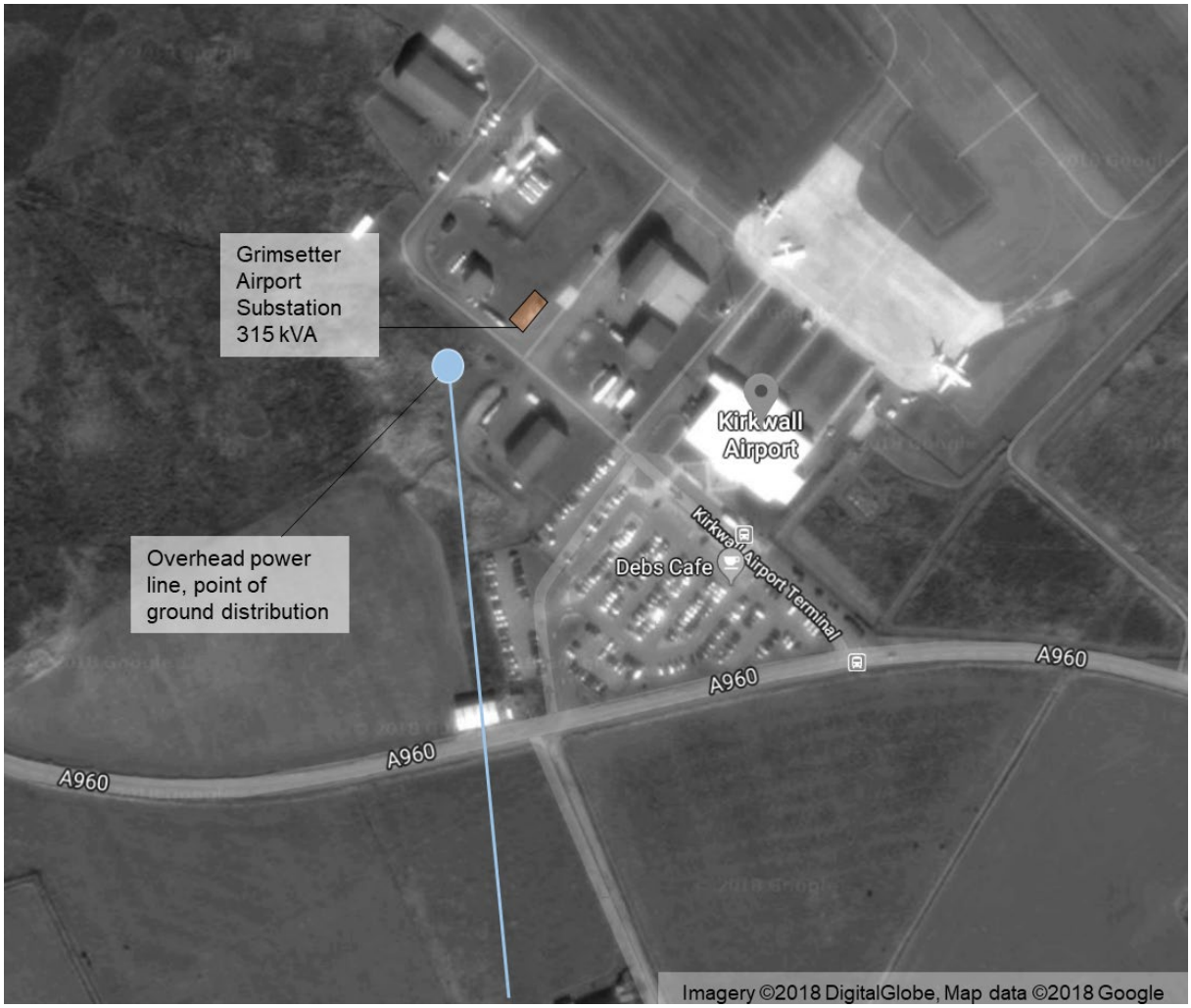

Figure 11 - Aerial view of Kirkwall Airport and the electricity supply

1.2 Kirkwall Airport Action Plan

A site visit carried out on the 6th September 2018 with HIAL, HITRANS, and Orkney Islands Council, identified three key aims of this action plan:

- Aim 1: Improve access and knowledge for low carbon travel options at the airports
- Aim 2: Reduce and off-set carbon emissions at the airports
- Aim 3: Support future energy management of the airports

The following sections set out a 10-point action plan for increasing the uptake and integration of low carbon surface activities at Kirkwall airport.

Action 1 - Smart slow/trickle EV charging

Kirkwall receives a high proportion of passengers who frequently take day trips to the surrounding islands and the Scottish mainland. EVs may be left for periods from just a few hours up to 12 hours, or several weeks when they have flown away on holiday.

Allowing multiple EVs to be plugged into chargers with the lowest ambient power outputs, and functionality for passengers to schedule time of arrival could enable

charging to be spread over time without the need for unnecessary installation of multiple high-powered chargers. It is suggested that implementing slow/trickle EV charging is a priority for the airport. Solutions such as the eTolppa hybrid chargers in Finland, with their remote scheduling, may have applicability in being installed at Kirkwall airport.

Action 2 – Trial low carbon car club vehicles

Kirkwall receives a high number of passengers from the surrounding island communities for day trips, or shorter trips to the Orkney mainland for a variety of purposes. Some islanders will even allow friends and relatives to use their vehicles located on the mainland when not in use.

Since the introduction of parking fees at the airport, there is an opportunity for the integration of low carbon car hire/car club to serve the requirements of these communities and for tourists visiting the islands.

Discussion will need to be established with the current agents at Kirkwall airport for Avis, Europcar and Ford Rental, WR Tullock, to understand the potential to assist in the operation of a car club service at the airport. In addition, the possibility of flexible "drop-off anywhere" models should be considered.

Other EV car clubs are been considered in Orkney, and there would be an opportunity to connect and create a single user platform.

Action 3 – Seek opportunities to develop an ebike hub and cycle path

Orkney Island Council were awarded funding in June 2018, to develop a Low Carbon Travel and Transport Hub in Stromness. HITRANS should work with HIAL, and CycleOrkney to consider the feasibility and desirability of deploying an electric bike hub at Kirkwall airport. This could provide a suitable connection for passengers travelling to and from Kirkwall town centre and wider integration with the Stromness hub.

iven the airport's proximity to the 60mph single carriageway, partners should instead consider investigating upgrading the bridleway that skirts the airport and linking to quieter roads that derive from Kirkwall town centre, out to Inganess Beach.

Focus may be required on the purchase of cargo ebikes to provide storage for passengers travelling with baggage or shopping whilst they ride.

Action 4 – Seek opportunities to fully decarbonise the airport bus route

It was also noted by stakeholders that there is currently a gap in the afternoon schedule of the bus Monday to Thursday during the school term time. This limits the number of passengers using the bus, particularly in between flight connections.

Introducing a fleet of electric (shorter range) and hydrogen fuel cell (longer range) buses may complement one another in the operation of the route. Orkney's hydrogen refuelling projects may also provide infrastructure for the integration of a fuel cell bus. Refuelling at the BI HIT refuelling station in Kirkwall will eliminate the requirement for electric charging- or refuelling- infrastructure at Kirkwall Airport. Currently, a JET diesel bus

replaces the electric bus whilst it is recharging. Instead, this could be replaced by a fuel cell bus powered by green hydrogen.

The feasibility of replacing the JET diesel bus with a second fully electric or fuel cell bus should be considered. A portion of revenue through car parking chargers could potentially form a contribution to a new bus.

Action 5 – Engage with local taxi companies to accelerate the uptake towards plug-in taxis

Orkney currently has no existing electric taxi fleet. There is an opportunity to trial electric taxis between the town centre and the airports.

HITRANS and Home Energy Scotland/Energy Saving Trust should seek opportunities to engage with local taxi firms, highlighting the benefits of plug-in taxis and potential support to facilitate vehicle uptake. HIAL could seek to learn best practice from other local authority areas, such as the 50+ fleet of electric taxis in Dundee.

Action 6 – Increase awareness of low carbon travel options to and from the airport

It was identified that to improve the uptake of low carbon travel modes at the airport, a comprehensive programme of promotional activity is required. For example, this may include an increase in digital and marketing content across the airports, along with provision for online booking and scheduling.

Working with Visit Scotland and Visit Orkney, and other local tourist firms may develop opportunities to offer discounted/VIP experiences for those using low emission transport.

Partners should seek to engage with Loganair for opportunities to develop wider integration with low carbon travel options, such as an online booking platform offering a selection of low carbon travel options.

Action 7 – Consider future integration of low carbon airside technologies

There are several land-based vehicles, operating airside that are not low emission vehicles. iven the predictability of their movements, it may be necessary to replace them with cleaner vehicles. In addition, there are opportunities for electric planes at Kirkwall airport, with a high number of short-haul, island-hopping flights.

HIAL should consider how their airside transport procurement can be competitively weighted towards the integration of low carbon transport. HIAL should also consider engaging with Loganair, to share and learn from best practice in Norway, who are committed to introducing fully electric planes by 2040.

Action 8 – Provide rapid EV charging infrastructure

In the event of the electrification of taxis, or the possibility that users will require a quick top-up of their vehicles for onward destinations, rapid chargers may be required. In addition, car club vehicles may need quick top-ups if hired back-to-back with another

user.

It is suggested that if a financial opportunity arises, providing one rapid charger may help to support the needs of emergency charging and user confidence in switching to electric.

Action 9 – Consider wider integration of low carbon surface with other remote and peripheral airfields

Orkney Islands Council own and operate six island airfields, with similar and in most cases, more challenging environments for supporting low carbon vehicles, due to more constrained electrical networks.

Opportunities to link low carbon activities at each side of the airports, such as the Fly & Bike scheme in Norway, should be considered.

Action 10 – Explore the potential for integrating clean energy generation plant near the site

As the level of EV infrastructure increases, there is likely to be a challenge in the limited electricity supply via an overhead power line to the site.

The land surrounding Kirkwall airport is vast, with limited obstructions for the installation of renewable generation technologies, such as Solar PV and Wind turbines. Orkney Islands Councils are looking into opportunities to develop a wind based private network.

Although there is sufficient generation in Orkney to meet the needs in the next few years, opportunities to integrate the Council's private wire network should be considered, in facilitating additional EV infrastructure.

2. Priority Programme - Kirkwall Airport

2.1 Overview

During the site visit held on the 6th September 2018, it was determined that there are three key opportunity areas for the development of charging infrastructure at Kirkwall Airport. These have been determined as "charging zones" consisting of:

- Zone 1 – Long and short-stay car parking/charging
- Zone 2 – Smart long-stay car parking/charging
- Zone 3 – Taxi and Bus charging

Potential locations of each zone are presented in Figure 12.

Figure 12 – Kirkwall Airport Charging Zones

2.2 Zonal Configurations

As the undeveloped and overflow car parks, Zones 1 and 2 were identified as a priority. In the first instance, it is suggested that electrical ducting work is carried out across both car parking areas.

Due to the limited electric connectivity at the airport, two possible points of connection have been identified. These could be connected from the existing ground-level substation (north in Figure 12), or the provision of an additional transformer (south in Figure 12). An additional transformer would enable shorter cabling routes and minimal impact on the site. It must be noted that the feasibility of the transformer is subject to discussions with SSE.

The following sections, 2.2.1 to 2.2.3 detail a plan of infrastructure that could be implemented within these areas.

It must be noted that due to the rapid emergence of new and disruptive technologies, the technological solutions available at the time of Phases 2 and 3 may change. It is highly recommended that the uptake of electric vehicles and subsequent use of the chargers are frequently monitored to weigh up the feasibility of phasing in new infrastructure.

2.2.1 Zone 1

This zone currently supports the capacity for around 40 parking spaces. The following charger elements are suggested as an initial approach for the area:

- Electrical ducting ~150mm across all spaces
- 10 flexible slow/trickle chargers (dual outlet)
- Requires at least 36 kVA capacity

Flexible dual post, slow/trickle chargers will be enabled with scheduling and flexible functionality, optimising the time at which they charge, therefore minimising simultaneous demands on the local grid network.

As shown in Figure 12, the charging infrastructure will be configured in the format of Layout A. There is an opportunity to divide the car park into short-stay and long-stay parking. A larger proportion of the car park would be dedicated to long-stay parking, due to the nature of vehicles being stationary at airports for longer periods of time.

It is suggested that to encourage the use of the chargers and not disrupt the uptake of electric vehicles, that parking fees, or charging tariffs are appropriate for HIAL to recoup revenue but lower than the cost incurred by petrol or diesel vehicles staying for similar periods of time.

If there is an opportunity to extend the car park, due to higher penetration of electric vehicles and lower electrical connection costs, this could include:

- Ducts to all bays, approximately an additional 22 bays
- 10 flexible slow/trickle chargers (dual outlet)
- Requires at least 36 kVA capacity

Due to there being a mirrored extension to the car park, the bays could be configured as Layout B.

2.2.2 Zone 2

Situated nearby to the terminal building, this zone has the potential to include smart energy management technology. The following charger elements are suggested as an initial approach for the area:

- Electric ducting across all 40 spaces (same time as Zone 1)
- 2 V2 -enabled chargers (to begin with)
- 18 flexible slow/trickle chargers (dual outlet)
- 5 plug-in car club vehicles
- 1 ebike storage and bike locker (optional)
- Requires at least 90 kVA capacity

2 V2 -enabled smart chargers could be installed to provide smart scheduling and energy exchange between the vehicles and the terminal building.

The inclusion of a solar PV canopy is unnecessary, as it may be more effective to connect to Orkney Island Council's plans of installing a private wire network of wind turbines.

The addition of plug-in car club vehicles may be well suited in this area, as the current location for car hire vehicles. Five of the EV bays will be dedicated for plug-in car club/car hire only. Assuming the development of a DriveNow type carsharing model, where users can drop off their vehicles within certain zones, the inclusion of further infrastructure in Kirkwall town centre will help to facilitate this.

E-Bike storage and bike locker have been included as an optional extra if there is desire.

2.2.3 Zone 3

Zone 3 will be developed to support opportunity charging for enabling electric taxis and fully electrified bus route. Due to the constraints of the substation, this may require the integration of a battery storage facility before it can be successfully implemented. This will require further modelling and may be able to be funded by another project that is under development. The configuration of this zone will include the installation of:

- Ducting enabled for several rapid chargers, but the implementation of 1 rapid charger for a taxi or general user access to begin with.
- 6 flexible smart/trickle chargers (dual outlet) supporting blue badge parking.
- 100 kWh battery storage system
- Requires at least 122 kVA
- Optional: 1x rapid charger for bus

The implementation of this zone will also depend on the likelihood of local taxi firms taking up electric taxis. As well as providing a rapid charger at the airport, the installation of another taxi charger in Kirkwall town centre may be required to incentivise the switch.

If taxis are yet to make the switch, a rapid charger could also supply any car club vehicles or other users needing an emergency charge or quick top-up charge for their onward

journey. It is expected that this charger will be used less frequently than the slow/trickle chargers given the location of the airport but, if feasible, may provide user confidence.

The electrification of the bus fleet may also depend on the potential to solve the ongoing challenges with the existing bus charger and the progress of Orkney's hydrogen fuel cell projects. If an electric bus is to be implemented, there will likely need to be an additional rapid charger installed at the Travel Centre. This will be subject to available capacity at both locations. A hydrogen fuel cell bus could be entered without the need for additional charging infrastructure at the airport. Note: A rapid charger for the bus has not been in included in the capital cost estimate (Section 2.3).

2.2.4 Battery Storage Systems

If all the initial approaches to the zones are implemented, there would be an electrical requirement of approximately 285kVA capacity. iven that the airport is limited to 250kVA, there is potential to include a battery storage system on-site. Integrated with smart chargers, a battery storage system offers optimal integration of the EV charging infrastructure and may reduce the need for costly network upgrades by trickle charging from the existing network connection.

Further investigation of the battery storage solution will need to be commissioned. However, it has been assumed that a total of 100kWh of battery storage would be enough to enable the initial elements described for Zone 3.

2.3 Capital Cost Estimates

An analysis has been undertaken to consider the likely magnitudes of capital costs incurred for each zone at Kirkwall airport.

iven the high -level nature of this report, the innovative nature of the facilities proposed and the lack of design, this analysis should be treated as a very rough guide only.

Significant further work will be required to develop a robust design that can be priced with confidence.

2.3.1 Capital Cost

It is estimated that implementation of all the zones, with the initial implementation of infrastructure, could cost in the region of £525,000 to build at today's prices.[47] These costs do not include vehicles, such as plug-in car club vehicles and ebikes, just the facilitating infrastructure, but do include, 100kWh battery storage and potential electricity reinforcement.

It is also recommended that at this stage a contingency of around 20% be applied to the construction cost to recognise the high-level nature of the scope/design work undertaken. Each charging unit has been costed to include 5-year maintenance and warranty periods.

[47] Urban Foresight calculation. These costs are estimated and derived from desk analysis, only. Urban Foresight take no responsibility for the accuracy of these costs. Further feasibility work, engagement with industry and the distribution network operator, SSE are required to develop more accurate costings.

Design, planning, management and procurement activity associated with the build has been assumed to be around 15% of the construction cost. It should be noted that when proceeding with planning that full feasibility and outline design stage should be undertaken to fully assess such things as internet connectivity for communications, electrical and groundworks/segregation for infrastructure.

Including design and contingencies, it is estimated that the total infrastructure cost could be in the region of £720,000.

A breakdown of the estimated capital costs to deliver the infrastructure is included in Table 5.

Table 4 - the Capital cost of infrastructure delivery for charging zones at Kirkwall airport

Equipment	Zone 1	Zone 2	Zone 3	Zone 1 (Ext)
Ducting	£20,000	£20,000	£20,000	£20,000
EV infrastructure	£40,000	£85,000	£50,000	£40,000
Energy System	£0	£0	£125,000	£0
Cycling Infrastructure	£0	£30,000	£0	£0
Civils & Electrical works	£10,000	£30,000	£20,000	£15,000
Subtotal	£70,000	£165,000	£215,000	£75,000
Design and Management (15%)	£10,000	£25,000	£35,000	£10,000
Contingency (20%)	£15,000	£35,000	£50,000	£15,000
Zone Total	£95,000	£225,000	£300,000	£100,000
Project Total	**£720,000**			

2.4 Funding Opportunities

Due to the potential size of the project, there will need to be a medium-high level of capital funding to facilitate all levels of infrastructure.

Discussions with Highlands and Islands Enterprise (HIE) identified that this approach to infrastructure at Kirkwall airport would be suitable for the Low Carbon Infrastructure Transition Programme (LCITP) and support their HIE's wider understanding of energy systems across even more remote islands across the Orkney's. The call for projects for 2018 has just ended, but the "catalyst" phase is open, providing development support of up to £100,000 to help projects complete Investment rade Business Cases.

For capital ready projects, financial assistance for up to 50% of the total capital value of a project up to a maximum of £10 million per project, where capital value covers financial costs associated with the build and installation of an exemplar project (i.e. purchasing of physical assets).

It is noted that applications are more likely to be successful with a detailed business model for implementation, demonstrating economic, social and low carbon benefits for Scotland. HIE also offer free Low Carbon Energy Systems Technical Advice Framework, to support early stage/concept development of a low carbon energy systems project.

There are several business models for installing infrastructure, which are not just

available through capital funding. Further information on a variety of funding that could be sought to develop such a project is included in Appendix C.

Appendix A – Charging at NPA Airports

Table 6 presents an overview of the charge points located at all airports in NPA countries compared with those at remote & peripheral airports.

Table 5 - Charge points located at NPA airports: Countrywide airports vs. Remote and Peripheral airports

Country	Region	≤ 3.7kW Charge points	7kW Charge points	11-22kW charge points	36kW-50kW charge points	120kW-135kW charge points	Total No. of Charge Points
England	Countrywide	35	59	17	33	0	**144**
	R&P Airports	0	0	0	0	0	**0**
Faroe Islands	Countrywide	0	0	2	3	0	**5**
	R&P Airports	0	0	2	3	0	**5**
Finland	Countrywide	196	10	0	2	0	**208**
	R&P Airports	164	0	0	0	0	**164**
Greenland	Countrywide	0	0	0	0	0	**0**
	R&P Airports	0	0	0	0	0	**0**
Iceland	Countrywide	11	0	1	3	0	**15**
	R&P Airports	11	0	1	3	0	**15**
N. Ireland	Countrywide	0	0	0	0	0	**0**
	R&P Airports	0	0	0	0	0	**0**
Norway	Countrywide	125	35	13	34	6	**213**
	R&P Airports	77	16	9	28	6	**136**
ROI	Countrywide	5	0	2	3	0	**10**

Country	Region	≤ 3.7kW Charge points	7kW Charge points	11-22kW charge points	36kW-50kW charge points	120kW-135kW charge points	Total No. of Charge Points
	R&P Airports	0	0	0	0	0	**0**
Scotland	Countrywide	0	7	9	14	2	**32**
	R&P Airports	0	1	0	3	0	**4**
Svalbard	Countrywide	0	0	0	0	0	**0**
	R&P Airports	0	0	0	0	0	**0**
Sweden	Countrywide	38	7	35	9	0	**89**
	R&P Airports	28	6	0	6	0	**40**
Wales	Countrywide	0	0	0	0	0	**0**
	R&P Airports	0	0	0	0	0	**0**
Total	Countrywide	**410**	**118**	**79**	**101**	**8**	**716**
	R&P Airports	**280**	**23**	**12**	**43**	**6**	**364**

Appendix B – Low Carbon Transport at Smart and Peripheral Airports

Table 7 provides an overview of low carbon transport activity currently being undertaken across remote and peripheral airports within the NPA Region.

Table 6 - Low carbon activity at remote and peripheral airports within the NPA region

Airport	Country	EV Charge Points	Electric Car Club vehicles	Electric Taxis	Electric Buses	Fuel-cell vehicles	eBikes	Biofuel vehicles
Akureyri Airport	Iceland	-	-	-	-	-	-	-
Alesund	Norway	2	-	-	-	-	-	✓
Alta Airport	Norway	-	-	-	-	-	at least 1	-
Åre Östersund Airport	Sweden	2	-	-	-	-	-	-
Tromsø Airport	Norway	6	-	-	-	-	-	-
Bakki Airport	Iceland	-	-	-	-	-	-	-
Bardufoss Airport	Norway	-	-	-	-	-	-	-
Barra Airport	Scotland	-	-	-	-	-	Planned	-
Båtsfjord Airport	Norway	-	-	-	-	-	Planned	-
Benbecula Airport	Scotland	-	-	-	-	-	-	-
Bergen	Norway	2	-	-	-	-	-	✓
Berlevåg Airport	Norway	-	-	-	-	-	-	-
Bíldudalur Airport	Iceland	-	-	-	-	-	-	-
Blönduós Airport	Iceland	-	-	-	-	-	-	-
Bodø Airport	Norway	20	at least 1	-	-	-	-	-
Borgarfjordur Eystri Airport	Iceland	-	-	-	-	-	-	-
Brønnøysund Airport	Norway	-	-	-	-	-	-	-
Campbeltown Airport	Scotland	-	-	-	-	-	-	-
Carlisle	England	-	-	-	-	-	-	-
City of Derry Airport	NI	-	-	-	-	-	-	-
Coll Airport	Scotland	-	-	-	-	-	-	-
Colonsay Airfield	Scotland	-	-	-	-	-	-	-
Cumbernauld Airport	Scotland	-	-	-	-	-	-	-
Donegal Airport	ROI	-	-	-	-	-	-	-
Eday Airport	Scotland	-	-	-	-	-	-	-
Egilsstaðir Airport	Iceland	-	-	-	-	-	-	-

Airport	Country	EV Charge Points	Electric Car Club vehicles	Electric Taxis	Electric Buses	Fuel-cell vehicles	eBikes	Biofuel vehicles
Enniskillen Airport	NI	-	-	-	-	-	-	-
Enontekiö Airport	Finland	-	-	-	-	-	-	-
Førde Airport	Norway	-	-	-	-	-	at least 1	-
Gjögur Airport	Iceland	-	-	-	-	-	-	-
Grimsey Airport	Iceland	-	-	-	-	-	-	-
Halli Airport	Finland	-	-	-	-	-	-	-
Harstad Airport	Norway	2	at least 1	-	-	-	-	-
Hasvik Airport	Norway	-	-	-	-	-	-	-
Haugesund	Norway	2	-	1	-	-	-	-
Honningsvåg Airport	Norway	-	-	-	-	-	-	-
Hornafjörður Airport	Iceland	-	-	-	-	-	-	-
Húsavík Airport	Iceland	-	-	-	-	-	-	-
Inverness	Scotland	3	≥1 planned	2 imminent	-	-	-	-
Ireland West Knock Airport	ROI	-	-	-	-	-	-	-
Ísafjörður Airport	Iceland	-	-	-	-	-	-	-
Islay Airport	Scotland	-	-	-	-	-	-	-
Ivalo Airport	Finland	2	-	-	-	-	-	-
Joensuu Airport	Finland	-	-	-	-	-	-	-
Jyväskylä Airport	Finland	-	-	-	-	-	-	-
Kaajani Airport	Finland	-	-	-	-	-	-	-
Keflavik Airport	Iceland	-	-	-	-	-	-	-
Kemi-Tornio Airport	Finland	-	-	-	-	-	-	-
Kerry Airport	ROI	-	-	-	-	-	-	-
Kirkenes Airport	Norway	2	>1	-	-	-	-	-
Kirkwall Airport	Scotland	-	Planned	-	1	-	-	-
Kiruna Airport	Sweden	-	-	-	-	-	-	-
Kittilän Airport	Finland	-	-	-	-	-	-	-
Kokkola-Pietarsaari	Finland	-	-	-	-	-	-	-
Kristiansund Airport	Norway	2	-	-	-	-	-	-
Kuopio Airport	Finland	-	-	-	-	-	-	-
Kuusamo Airport	Finland	-	-	-	-	-	-	-
Lakselv Airport, Banak	Norway	2	-	-	-	-	-	-
Leknes Airport	Norway	4	-	-	-	-	-	-
Mehamn Airport	Norway	-	-	-	-	-	-	-
Mo i Rana Airport	Norway	-	-	-	-	-	-	-
Molde Airport	Norway	2	-	-	-	-	-	-

Airport	Country	EV Charge Points	Electric Car Club vehicles	Electric Taxis	Electric Buses	Fuel-cell vehicles	eBikes	Biofuel vehicles
Mosjøen Airport	Norway	-	-	-	-	-	-	-
Mývatn Airport	Iceland	-	-	-	-	-	-	-
Namsos Airport	Norway	-	-	-	-	-	at least 1	-
Newtownards Airport	NI	-	-	-	-	-	-	-
North Ronaldsay Airport	Scotland	-	-	-	-	-	-	-
Oban Airport	Scotland	-	-	-	-	-	Planned	-
Ørland Airport	Norway	-	-	-	-	-	-	-
Örnsköldsvik Airport	Sweden	-	-	-	-	-	-	-
Ørsta-Volda Airport	Norway	-	-	-	-	-	-	-
Oulu Airport	Finland	162	-	-	-	-	-	-
Papa Westray Airport	Scotland	-	-	-	-	-	-	-
Reykjavik Airport	Iceland	11	-	-	-	-	-	-
Røst Airport	Norway	-	-	-	-	-	at least 1	-
Rørvik Airport	Norway	2	-	-	-	-	at least 1	-
Rovaniemi Airport	Finland	-	-	-	-	-	-	-
Sandane Airport	Norway	-	-	-	-	-	at least 1	-
Sanday Airport	Scotland	-	-	-	-	-	-	-
Sandnessjøen Airport	Norway	-	-	-	-	-	at least 1	-
Sauðárkrókur Airport	Iceland	-	-	-	-	-	-	-
Savonlinna Airport	Finland	-	-	-	-	-	-	-
Scatsta Airport	Scotland	-	-	-	-	-	-	-
Selfoss Airport	Iceland	-	-	-	-	-	-	-
Shannon Airport	ROI	-	-	-	-	-	-	-
Siglufjörður Airport	Iceland	-	-	-	-	-	-	-
Skellefteå Airport	Sweden	8	-	-	-	-	-	-
Sogndal Airport	Norway	-	-	-	-	-	-	-
Sørkjosen Airport	Norway	-	-	-	-	-	-	-
Stavanger	Norway	45	-	-	-	-	at least 1	-
Stokmarknes Airport	Norway	-	-	-	-	-	-	-
Stoppustud Reykjanesi	Iceland	1	-	-	-	-	-	-
Stord Airport	Norway	2	-	-	-	-	-	-
Stornoway Airport	Scotland	1	-	-	-	-	-	-
Stronsay Airport	Scotland	-	-	-	-	-	-	-

Airport	Country	EV Charge Points	Electric Car Club vehicles	Electric Taxis	Electric Buses	Fuel-cell vehicles	eBikes	Biofuel vehicles
Stykkishólmur Airport	Iceland	-	-	-	-	-	-	-
Sumburgh Airport	Scotland	-	-	-	-	-	-	-
Sundsvall-Timrå Airport	Sweden	6	>1	1	Planned	-	-	✓
Svolvær-Helle Airport	Norway	2	>1	-	-	-	-	-
Þórshöfn Airport	Iceland	-	-	-	-	-	-	-
Tingwall Airport	Scotland	-	-	-	-	-	-	-
Tiree Airport	Scotland	-	-	-	-	-	-	-
Trondheim Airport	Norway	18	-	6 (Short-term trial)	-	-	at least 1	✓
Vadsø Airport	Norway	-	-	-	-	-	-	-
Vágar Airport	Faroe Islands	5	-	-	-	-	-	-
Vardø Airport	Norway	-	-	-	-	-	-	-
Vestmannaeyjar Airport	Iceland	-	-	-	-	-	-	-
Vopnafjörður Airport	Iceland	-	-	-	-	-	-	-
West Knock	ROI	-	-	-	-	-	-	-
Westray Airport	Scotland	-	-	-	-	-	-	-
Wick John O'Groats Airport	Scotland	-	-	-	-	-	-	-
Umeå Airport	Sweden	2	-	>1	1	-	-	-

Appendix C – Funding opportunities

Table 8 provides an overview of the range of funding opportunities suitable for the development of low carbon surface access transport. This list is not exhaustive.[48]

Table 7 – Potential Funding opportunities

Source	Name	Description
Scottish Government	Transport Scotland	Transport Scotland is the national transport agency for Scotland. Transport Scotland regularly issues funding for a number of transport issues, either directly to authorities, or through funding competitions. The Scottish overnment has pledged to phase out the sale of new petrol and diesel vehicles from 2032 and will be pledging various funds in coming years to help Scotland transition to a low carbon economy. In September 2018, the overnment announced an additional £16.7m that will go towards increasing the number of green buses (£1.7m) and electric vehicle charging infrastructure (£15m) in Scotland Switched on Towns and Cities Challenge Fund - The new Switched on Towns and Cities (SOTC) Challenge Fund aims to support intensive, high impact capital activity in order to incentivise, encourage and promote the use of plug-in EVs in Scottish towns and cities. This will be an annual competition after the initial round in 2018. Eligible projects should cost between £1.5m and £2m. In September 2018 the Scottish overnment announced an expansion of the SOTC programme with a view to creating 20 new 'electric towns' by 2025. Scottish reen Bus Fund - The aim of the Scottish reen Bus Fund is to support the wider roll-out of low emission buses. The 8th round of this annual funding was released in May 2018 with £1.7m made available by the Scottish overnment. Proposals from a number of local authority/ regional transport partnership areas are selected every year for funding.
	Energy Savings Trust	The Energy Saving Trust administers a number of loans and grants on behalf of Transport Scotland. The majority of these funds are long-term, with some short-term funds also made available periodically. Examples of long-term funds include: Low Carbon Transport Business Loan - Interest-free loans of up to £120,000 are available to Scottish businesses to help lower their transport and travel costs. These loans are funded by Transport Scotland and have a repayment term of up to 6 years. E-bike rant Fund - This £800k fund from Transport Scotland and

[48] Note: Some of these opportunities may no longer be open at the time of writing but may be subject to future funding rounds.

Source	Name	Description
		delivered by the Energy Savings Trust was established to encourage large scale e-bike adoption. It is expected grants will fund e-bike pools, secure cycle parking and safety equipment. The fund is aimed at local authorities, public sector agencies, community organisations, colleges & universities. Round 2 if this fund opens on 9th October 2018. eBike Business Loan - Loans of up to £30,000 are being made available to Scottish businesses to help lower transport and travel costs. The loan will cover up to £3,000 per bike for new ebikes, up to £6,000 per ecargo bike. Short-term funds: Low Carbon Travel and Transport Challenge Fund - a capital fund that aimed to facilitate the delivery of active travel and low carbon hubs and paths. Funding was provided by the European Regional Development Fund (ERDF) 2014-2020 Programme, with £3.67m made available in the second round of funding.
	European Regional Development Fund (ERDF)	ERDF makes investments on key themes including innovation & research; the digital agenda; SME support; and, the low-carbon economy. The amount of money dedicated to low carbon resources ranges from 12% to 20%, dependent on the economic development of the region. All funds allocated to Scotland are administered locally by the Scottish overnment . The second round of the Low Carbon Travel and Transport Challenge Fund was announced by Transport Scotland in October 2017. £4.4m of support is available (of which £2.25M is reserved for the H&I region), along with an additional £1, from Transport Scotland. Projects must spend a minimum of £250k. Low Carbon Infrastructure Transition Programme - Launched in March 2015, the LCITP is a working partnership between the Scottish overnment, Scottish Enterprise, Highlands & Islands Enterprise, Scottish Futures Trust and sector specialists. Projects which deliver low carbon heating solutions, integrated energy systems, and ultra-low emission vehicle charging infrastructure will be able to apply for up to £100,000 to develop investment-ready business cases or financial support of up to 50% of the total capital value of a project up to a maximum of £10 million per project is available for capital–ready projects. The call for 2018 projects has recently ended, but there is expected to be another call open in 2019. Development support of up to £100,000 is available to help projects complete Investment rade Business Cases.
	Scottish Enterprise	Scottish Enterprise is Scotland's main economic development agency and a non-departmental public body of the Scottish overnment. To deliver a significant, lasting effect on the Scottish economy, we work

Source	Name	Description
		effectively with partners in the public and private sectors to identify and exploit the best opportunities. SMART: Scotland - Providing grants to Scotland-based SMEs for feasibility studies & R&D projects that have a commercial endpoint.
	Rural Payments Agency	Rural Payments and Services are delivered by the Scottish overnment's Rural Payments and Inspections Division (RPID), with delivery partners. RPID is the accredited paying agency in Scotland for all European Commission Common Agricultural Policy (CAP) schemes. Examples of funds include: Improving Public Access – Now closed, this scheme aimed to support new and upgraded paths for public use by walkers, cyclists, horse-riders and wheelchairs/mobility scooters.
UK Government	Innovate UK	Innovate UK is a non-executive public body sponsored by the Department for Business, Energy and Industrial Strategy. They host regular funding competitions where funding is made available to promote the development and application of new technologies. Competitions are often focused on overnment priorities, which continue to include increasing the use of low carbon transport. Funding comes from specifically allocated budgets such as the Office for Low Emission Vehicles (OLEV) and the Small Business Research Initiative (SBRI). • Open grant funding competition: round 2 – up to £20m available for cutting-edge or disruptive ideas from any area of technology, science or engineering. Open calls are periodically issued by Innovate UK throughout the year. • Faraday Challenge - Part of the Industrial Strategy Challenge Fund, the overnment will invest £246m in battery technology over 4 years for the design, development and manufacture of electric batteries. The programme's funding is administered by Innovate UK. • UK Aerospace Research and Technology Programme – The Department for Business, Energy and Industrial Strategy (BEIS), through the Aerospace Technology Institute (ATI) and Innovate UK have opened Expressions of Interest for a fund of up to £8m for collaborative R&D, as well as a fast-track competition. Proposals must fit with the UK Aerospace Technology Strategy or with one of ATI's technical priority areas including machines and electronics to enable more electric aircraft. The deadline for EoIs is the 5th of December. Competition for full applications will open on January 2019, as well as a separate competition for feasibility studies.
	Office for Low	The Office for Low Emission Vehicles has periodically run funding

Source	Name	Description
	Emission Vehicles (OLEV)	competitions aimed at stimulating the uptake of ULEVs across the UK. • Electric vehicle charging for public spaces: feasibility studies – This 2-stage funding call was looking for innovation projects to develop business cases and deploy new approaches to electric vehicle (EV) charging. Funding is from OLEV and administered through Innovate UK. • Wireless electric vehicle charging for commercial users: feasibility studies - This 2-stage funding call was looking for innovation projects to develop technology and business cases for wireless charging for electric vehicles (EVs) for commercial users such as taxis, service vehicles and delivery fleets. Funding is from OLEV and administered through Innovate UK. • The Hydrogen for Transport Programme (HTP) sets out the next steps to develop the UK hydrogen vehicle market, with up to £23m of new grant funding available annually until 2020 to support the growth of refuelling infrastructure alongside the deployment of new vehicles. Stage 1 of the competition awarded nearly £8.8m to a project that is set to bring 200 fuel cell vehicles to the UK, whilst Stage 2 (open August-November 2018), will give up to £14m to fund up to ten refuelling stations and their associated vehicles. • Ultra Low Emission Taxi Infrastructure Local authorities can bid for grants in the second round of the Ultra Low Emission Taxi Infrastructure Scheme - closing date 26 October 2018. This second round competition is now available to other local authorities who can bid for the remaining £6 million.
	Department for Transport (DfT)	Transport-Technology Research Innovation rants (T -TRI) - The T-TRI competition provides seed funding to early -stage science, engineering or technology innovations that have the potential to advance the UK's transport system. Recent projects funded have included an integrated platform for booking and allocating recharging slots for electric taxis and a proof of concept for electric roads.
	UK Research & Innovation	This overarching body brings together seven Research Councils and Innovate UK amongst others, with a combined budget of over £6bn. Research councils include the Economic and Social Research Council (ESRC) whose priorities include climate change, and the Engineering and Physical Sciences Research Council (EPSRC) which seeks to address the scientific and technological challenges facing the nation. Examples of previous calls include: • Decarbonising Transport Network+ - This call form the EPSRC that seeks to fund a number of proposals using a technological

Source	Name	Description
		approach to tackle carbon emissions in transport. Strength in Places Fund - a new competitive funding scheme that takes a place-based approach to research and innovation funding, to support significant regional growth. The fund is open to any technological area, sector or research discipline focus
	Small Business Research Initiative (SBRI)	SBRI brings together government challenges and ideas from business to create innovative solutions. It is aimed at public sector organisations that might benefit from running an SBRI competition and how to get help to do so. Early in 2018, SBRI ran a competition on behalf of City of Edinburgh Council to identify an integrated innovation energy solution for its off-street EV chargers that can cater for future mass-market potential.
Private Sector	SSE	SSE is involved in producing, distributing and supplying electricity and gas as well as providing other energy-related. Examples of funds: SSE Sustainable Development Fund - SSE has established a fund for more significant projects which seek to deliver transformational social, economic and/or environmental changes in the community and develop sustainable ventures for the future. Applications for funding are invited on a periodic basis.
	SP Energy Networks	reen Economy Fund - The fund focuses on helping communities invest in low-carbon heating and transport technology, building the infrastructure and the learnings needed for the changes in heating and transport expected over the next decade. The transport element focuses on 'promoting the uptake and infrastructure provision of Electric Vehicles or other low carbon solutions.
European Commission	UK uarantee for EU funded projects extended	In July 2018, HM overnment announced that it would guarantee any funding secured BY UK organisations through EU programmes, from now until the end of 2020, even in a no deal scenario.
	Connecting Europe Facility (CEF)	The CEF supports the development of highly sustainable, efficient trans-European networks in transport (€22.4bn), telecoms (€0.3bn) and energy (€4.7bn). The fund is worth €27.4bn over 2014 and 2020; projects should incorporate work over 3 participating states.
	Horizon 2020 (H2020)	H2020 is a 7-year programme running from 2014-2020. Calls are listed in work Programmes, of which draft work programmes for 2018-2020 are currently available listing call criteria, the total funding available. Once work programmes are adopted, they will also indicate the expected schedule of calls. Of particular interest will be Societal Challenge 4 which covers Smart, reen and Integrated Transport.

Source	Name	Description
		• User-centric charging infrastructure - this project will aim to support the accelerated deployment of recharging infrastructure. Opening December 2018; EUR8 -15 million available per project.
	Interreg	Interreg is a Cohesion Policy instrument aimed at reducing disparities between regions. It is funded by the European Regional Development Fund (ERDF) and has a budget of EUR10.1BN for the period 2014-2020. Interreg has three types of programmes: cross-border cooperation programmes; transnational cooperation programmes; and, interregional programmes. The HITRANS region is eligible for funding from the following programmes: Interreg Northern Ireland – Ireland – Scotland; Northern Periphery and Arctic 2014-2020; North-West Europe; North Sea Region; Interreg Atlantic Area; Urbact; Espon; Interact; and Interreg Europe. This interactive map can be used to determine which regions are eligible for which funds.
	Interreg North-West Europe (NWE)	Interreg NWE is a transnational programme with €370M funding for the 2014-2020 period and has regular calls for funding. All parts of the UK are eligible for this funding. Projects involving partners from at least 3 different participating states will be funded. The deadline for Call 7 was the 26th April and the deadline for Call 8 (when it opens), will be 22nd November. Calls are open with project proposals on a wide variety of topics welcome to apply.
	Interreg North Sea Region	This programme seeks to support development and foster sustained economic growth across the region, with a budget of €167m. The programme has a particular focus on pilots, demonstrations and trials. Calls for applications are opened periodically every year with a two-stage application process. The first stage involves an expression of interest, with successful EOIs then being invited to present a full application in a later call. Projects will be considered from 4 priority areas which include green transport & mobility. Calls are open with project proposals on a wide variety of topics welcome to apply.
	Northern Periphery and Arctic Programme 2014-2020	The Northern Periphery and Arctic 2014-2020 form cooperation between 9 programme partner countries. The NPA 2014-2020 is part of the European Territorial Cooperation Objective, supported by the European Regional Development Fund (ERDF) and ERDF equivalent funding from non-EU partner countries. Calls for applications are issued regularly, with around two calls published annually.
	Interreg Europe	This programme seeks to support public & managing authorities, agencies and research institutes implement better policies and supports actions in a number of areas, including low carbon economy. Calls for projects are issued annually, with the 2018 call having run between 7 May & 22 June. All areas in the UK are eligible

Source	Name	Description
		for funding under this programme.
	Interreg Northern Ireland – Ireland – Scotland	This programme encompasses Northern Ireland as well as parts of western Scotland including Argyll and Bute and the Western Isles. A funding call was issued in August 2018 for the creation of a cross-border Electric Vehicle (EV) network with a deadline of 31 October 2018.
Charities	Nesta UK	Nesta seeks to champion innovation with a specific focus on areas where the combination of digital technology, empowered individuals, and better use of data and evidence can have the biggest impact. Funding is periodically available on a number of challenges throughout the year. • Sharelab Scotland – A partnership with the Scottish overnment to find and support early-stage projects that build and/or use collaborative digital platforms to tackle challenges around sustainable energy and transport; focusing on the most vulnerable consumers.
	Cycling UK	Big Bike Revival - The Big Bike Revival in Scotland is an initiative to support the Scottish overnment's vision of 10% of journeys by bike by 2020. They are looking for 100 organisations across Scotland to run a range of Big Bike Revival events and led cycle rides that engage locals during May and June. Small grants of £1000 available to help deliver cycle workshops Cycle Friendly Employer Development Fund - The fund is aimed at encouraging and supporting organisations and workplaces across Scotland to take a leading role in increasing the number of journeys by bike. The main focus of this fund is to improve cycling facilities and physical infrastructure – such as cycle parking, signage, changing facilities, etc.
	Sustrans Scotland	Examples of previous funding calls include: Community Links PLUS – This project is funded by the Scottish overnment and is an opportunity to conceptualise, design and deliver exemplary and inspirational walking, cycling and placemaking projects in Scotland. rants of up to £100k available. Community Links – This programme provides funding for the creation of infrastructure that makes it easier for people to walk and cycle for everyday journeys. This year, they will prioritise ambitious, inclusive projects that make our towns and cities friendlier and safer places for people to walk and cycle. rants of up to £2m available; applications for 2018/19 close in March 2018.
	Paths for All	Paths for All is a Scottish charity that seeks to champion everyday walking. The charity also supports cycling and other activities, to help make Scotland a more active, more prosperous, greener country.

Source	Name	Description
		Smarter Choices, Smarter Places Open Fund - The Smarter Choices, Smarter Places Open Fund aims to encourage behaviour change towards walking and cycling (active travel) for shorter journeys, and more sustainable choices for longer journeys. The fund provides grants between £5,000 & £50,000 that must be match funded. Previously funded projects include a campaign to grow the city's car club, as well as supporting the Angus, East Ayrshire and Ayr Active Travel Hubs.
	Big Lottery Fund	The Big Lottery Fund is the charitable arm of The National Lottery, awarding grants, bringing communities together, and sharing its learnings with communities, other funders and the government. National Lottery Awards for All Scotland - The programme is a partnership between the Big Lottery Fund Scotland, sportscotland and Creative Scotland. The programme offers funding from £300 to £10,000 to support what matters to people and communities.

Appendix D – Acknowledgements

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