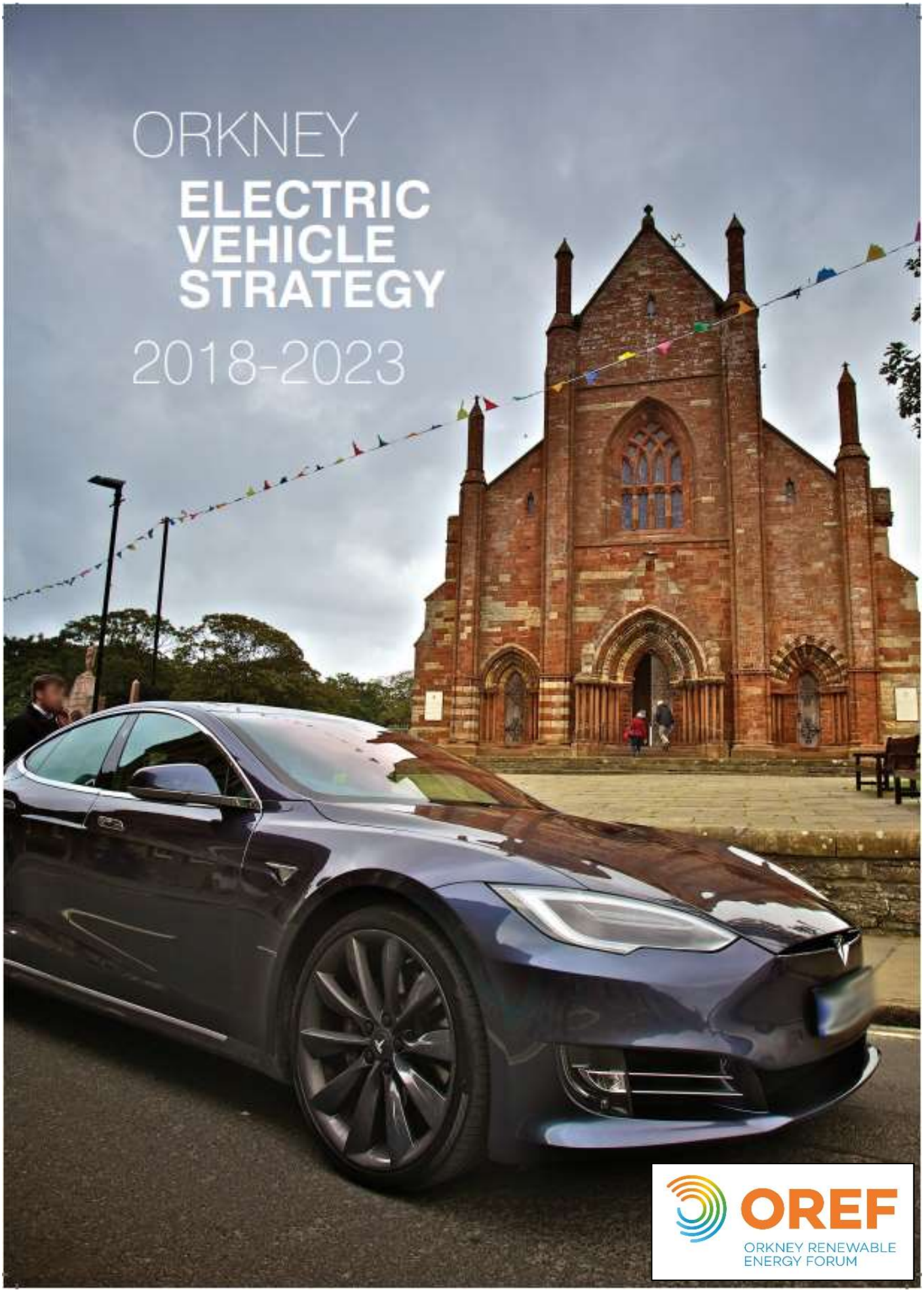

ORKNEY
ELECTRIC
VEHICLE
STRATEGY
2018-2023
OREF
ORKNEY RENEWABLE
ENERGY FORUM

Welcome

It gives me great pleasure to introduce Orkney's Electric Vehicle Strategy for the next 5 years. It's a visionary document and suggests that as many as 1,000 EVs could be negotiating Orkney's roads in a mere 5 years from now.

Like the best things in life, the EV Strategy has been compiled from the grass roots up. EV owners have come together, under OREF's wing, to suggest a way forward for EVs in Orkney. But as the document suggests, there's more to EVs than simply transport, and they could also play a pivotal role in expanding the potential of renewable energy generation through storage for the benefit of all our community. There are many other advantages, not least a huge reduction in carbon emissions, all of which are outlined in the Strategy.

To succeed, this Strategy will need the support of many partners, from central and local government, to private sector businesses, and indeed many hundreds of existing and future EV owners. All I would ask is that these potential partners consider the vision and excitement of what may be achieved in Orkney and direct their actions to help deliver the Strategy. We already have the highest proportion of our cars and vans being powered electrically in Scotland– let's all take that leadership a good deal further.

Steve Sankey, Co-convenor, Orkney Greens.

March 2018

Cover design courtesy of Colin Keldie of K4Graphics

Orkney Electric Vehicle Strategy 2018-2023

1 Description

This document was produced by electric vehicle (EV) drivers, coordinated by the Orkney Renewable Energy Forum (OREF).

It is produced to help guide the decisions makers (Orkney Islands Council, Highlands and Islands Enterprise, private businesses, investors, individuals, Scottish and UK government) to enable them to efficiently deploy their capital and efforts to help de-carbonise Orkney's road transport. It is expected that the Council will review its own *EV Infrastructure Strategy 2014* to respond to the more up to date position established in this document.

A draft of this strategy was written following Transport Scotland's publication of '*Switched on Scotland Phase 2*' action plan and sought to map activity in Orkney onto this national document. Whilst being drafted, the UK government made a statement that new conventional diesel and petrol vehicle sales will be banned by 2040; the Scottish Government have set a target to phase out the need for such vehicles by 2032; and the 2017 Queen's Speech announced a UK wide charging scheme and the enabling of autonomous vehicles.

A public consultation was undertaken on this document in late 2017 and some changes made. However, this document is substantially the same as that in the consultation due to the high levels of support received. A summary of the responses and the changes made are shown in the accompanying '*Report on EV Strategy Consultation'*.

After the consultation closed, the Scottish Government also published its Energy Strategy. It reinforced the points in Transport Scotland's documents and the UK Government announced its intention to mandate EV charge points in new buildings in its forthcoming building standards review.

This document, in seeking to map out a path for the uptake of EVs in Orkney, is therefore extremely timely. It is launched at a time when it looks as though there could be unprecedented change in the private ownership of EVs. The drafting team have therefore sought to be realistic and expect the document will have a short shelf life. The rate of change will overtake some of the items shown herein, so it is recommended that it be revised biennially.

This document therefore looks to the near future of five years when around 1,000 EVs are anticipated to be on Orkney's roads and proposes actions in that timeframe that should fit with the Envisaged Future trajectory set out in section 5.

2 Executive Summary

The end of fossil fuelled vehicles is in sight and Orkney needs to be ready to deal with the changes this will require. It is anticipated that most vehicles on Orkney's roads will become electric, but at this time this is not absolutely certain as other alternative fuels may become more feasible.

This document is intended to set Orkney off in the right direction by recommending sensible and coordinated changes and seeks to map the tasks for the next five years.

Most of the investment in this change in the way we travel will be private with individuals and businesses making separate and numerous investment decisions to go electric. This private investment in vehicles will amount to over £15M in the next five years.

There are roles, however, for the public sector to enable and facilitate this change through safeguarding two critical sites, insisting on cheap measures during development and setting some of the rules over the use of charging infrastructure. This Strategy highlights shortcomings in the maintenance of the present charging infrastructure and proposes better data flows to allow this to be tackled. It also recommends the introduction of a charging scheme to reduce the drain on public finances and shows why public investment of approximately £1M needs to be made over the same period.

In addition to specific Council actions, there are a number of cooperative tasks across the wider public, private and third sectors. These include the provision of charging points at all accommodation in the isles and tourist destinations, getting cheap chargers on the Aberdeen boats, and seeking to pilot new business models and equipment amongst others.

The document shows how the electrification of transport in Orkney can be accomplished with very little change to the existing electricity system. It also shows how early action to make Orkney 'EV friendly' will result in increased overnight tourism, and make Orkney quieter, with even cleaner air and water.

A summary of the actions proposed is shown in Table 5.

3 Contents

4 Background

Orkney presently has the highest proportion of vehicles being EVs of any county in Scotland[1] as can be seen in Figure 1.

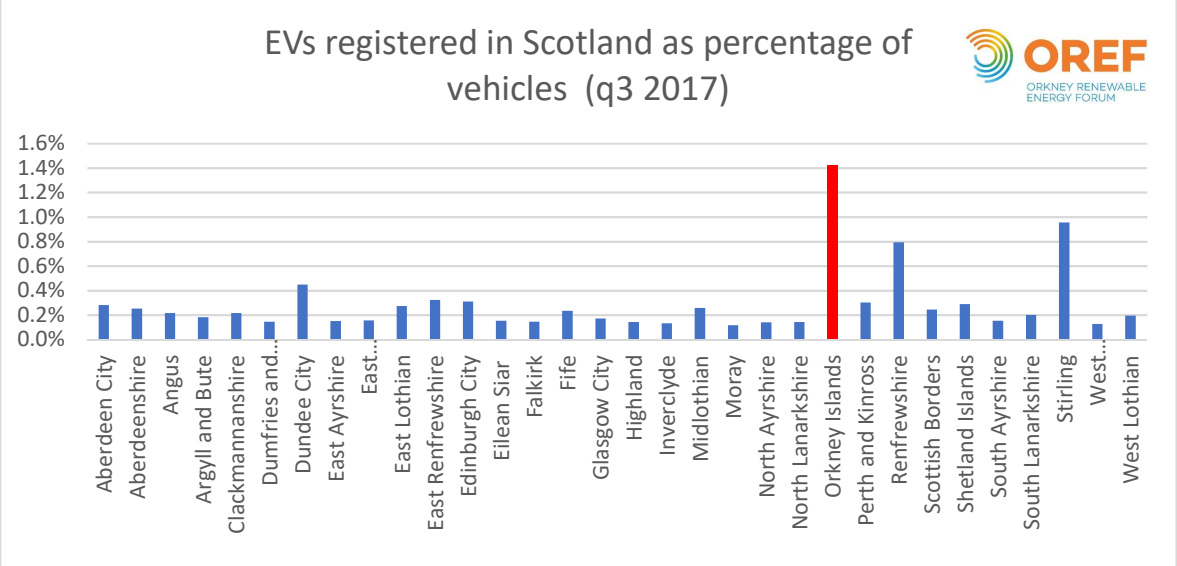


Figure 1. EVs registered in Scotland as percentage of vehicles (Quarter 3 - 2017)

EVs are now an increasingly common sight on Orkney's roads. A brief look back shows that the combination of the Council becoming an early adopter and seizing a funding opportunity, along with local enthusiasm for renewables and a population with a 'can do' attitude, have conspired to achieve the level of penetration seen to date in Figure 2.

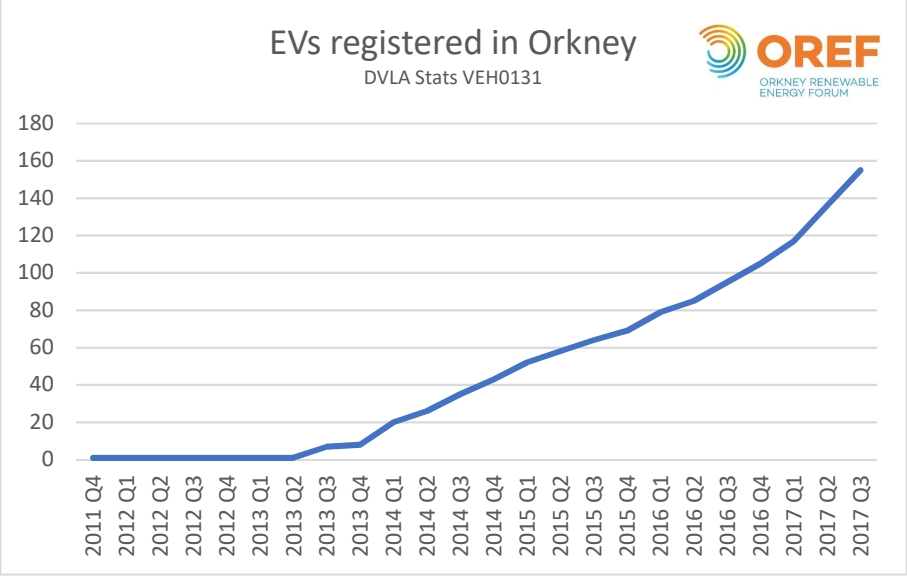


Figure 2. EVs registered in Orkney 2011 to Quarter 3 - 2017

[1] Composed from VEH0131 https://www.gov.uk/government/statistical-data-sets/all-vehicles-veh01#table-veh0131 and VEH0105 https://www.gov.uk/government/statistical-data-sets/all-vehicles-veh01#table-veh0105

4.1 Key events

Table 1. Key events (*relate to photos)

Sep 2006 *	Demo of G-Wiz Hydrogen Fuel cell vehicle at H2Orkney conference getting a charge at Aquatera in Stromness.
Aug 2007 *	Willie McEwen shows off his home modified converted Renault Kangoo at the Orkney Vintage Rally.
2011	OIC install first EV chargers in Kirkwall, Stromness and St Margaret's Hope and take on a Peugeot iOn for the car park wardens and an Allied converted litter collection van.
Dec 2011 *	OREF secures a Mitsubishi i-MiEV for a demo and test drives and gets it out to Westray, Eday, and Rousay in the space of a few days.
Aug 2012 *	OREF first displays vehicles at the Vintage Rally as 'Future Heritage'.
Early 2013	Hoy, Rousay, and Shapinsay development trusts take on four LEAFs. Aquatera and EMEC take on iOns.
May 2013 *	OREF seeks participants for 'My Electric Avenue' trial. Although unsuccessful Orkney represented 1/7th of total national applications. Jonathan Porterfield became aware of Orkney's interest & decides to move Eco-cars.net to Orkney. OREF display four EVs at Aberdeen's All-Energy conference for the first time.
May 2014	OIC publish the *EV Infrastructure Strategy 2014*.
Jul 2014	OREF does 'Show and tell' and test drives for cruise passengers.
May 2015	First electric bus arrives.
Jul 2015	Robert Llewellyn does his '*EVs are rubbish*' show in Kirkwall and records first Orkney edition of '*Fully Charged*'.
Sep 2015 *	Jonathan Porterfield and Chris Ramsay drive non-stop from John o' Groats to Land's End and back again in a weekend.
Nov 2015 *	'No CO2!' spelt out in EVs and sent as a message to COP21 in Paris.
May 2016	OREF publishes and circulates *EV Charging Infrastructure Guide* to all local authorities in UK.
Dec 2016	Orkney sees 100th EV in county.
Mar 2017	OREF convenes first EV driver strategy group.
May 2017 *	OREF holds 2nd EV show with Robert Llewellyn, Solo Energy and My-energi.
Nov 2017	Draft strategy published for consultation.
March 2018	This strategy published.

Figure 3. EV promotional activity by Orkney since 2006

5 Envisaged Future

This section outlines a vision of how one will travel in Orkney in 2050.

> *By 2050 it is anticipated that there will be no fossil fuelled vehicles on Orkney's roads other than "vintage specimens"[2]. Not all vehicles will be electric, some will be fuelled with hydrogen either through a fuel cell or as conventional internal combustion diesels running on synthetic diesel made through electrolysis.[3]*
>
> *Most EVs will charge at home, in the street, at work or in 'Charge Parks' which will essentially be cabled up car-parks in the present locations.*
>
> *EVs will have greater battery capacity than present (or at least greater range) requiring less frequent charging. Few will be hybrid.*
>
> *Some vehicles will be in joint ownership and transport may be seen more of as a service than a capital investment. Disruptions of the 20th century ownership model represented by Uber and self-driving vehicles may result in fewer vehicles parked on the road as there will be better utilisation. Traffic levels are unlikely to be significantly different from now although they may be higher.*
>
> *Our towns will be quieter, our air and water quality will be better and less money will leave the islands to pay for fuel.[4]*
>
> *The Orkney electricity supply system will be entirely supplied by renewables and storage.*

Realising this vision requires significant change to the way in which vehicles are fuelled and the way transport is paid for.

Note that the vast majority of the change will be accomplished by private investment in vehicles. If an average price of £15,000 is anticipated for a vehicle then the 1,000 vehicles envisaged will represent a private investment of £15M by 2020. By 2050 this will be over £150M. The changes proposed in this document to public infrastructure (two DC charge parks, public 7kW charging points at tourist destinations, and flexible public AC charging at Kirkwall airport and some harbours) will cost in the order of £1M and is largely comprised of strategic enabling works and very localised electricity system upgrades.

5.1 Fuel Types

There is to be a move away from fossil fuelled vehicles. But just as there are presently diesel and petrol cars, so in the future we anticipate a diversity of fuel types. This Strategy focusses on the most likely form of alternative to fossil fuels; electricity. More specifically it looks to cater for the needs of battery electric vehicles.

This Strategy does not look to cater for hydrogen or other fuelled cars as they are unlikely to be a significant road user in the lifetime of this document (five years). In addition, this Strategy does not seek to address the needs of hybrid vehicles (or plug in hybrids) as they can use both the existing fossil-based infrastructure as well as the charge points to be installed for 'pure battery electric vehicles' See Appendix 6 for details of other fuel types.

[2] Scottish Govt target is for 40% of new cars and vans registered in 2032 will be Ultra Low Emission.
[3] See Appendix 6 –*Alternate Fuel Vehicles*
[4] See Appendix 3 – *Ancillary benefits*

6 Convention

There is not yet an agreed naming convention for the various ways in which to charge an EV, this is in part because there are many ways to deliver power not all of which have been trialled yet.

Historically, in the UK chargers have been named based on the relative speed in which a particular EV can be fully charged. However as larger batteries with longer ranges are developed, the time in which to fully charge an EV is inconsequential to most and varies greatly between EV models. The relative speed of the chargers is also becoming an issue as what was once considered fast is now considered normal or slow by some. In an attempt to avoid these problems, and reduce confusion or misunderstanding amongst readers, it has been decided that a combination of the charging method and rated power output will be used in this Strategy.

This section of the document explains in more detail what each of the charging powers mean and where they might be seen. It should also be recognised that each EV also has limits on how fast it can charge with AC connections based on the vehicle's onboard charging circuits. With some early EVs this was a maximum of 3.3kW and this rate is still the maximum supported on the cheapest EVs such as the Peugeot iOn, Citroen C-Zero, and some Nissan LEAFs. Many EVs also support DC charging where the conversion of AC to DC is done in the charger external to the EV and charge rates can be much higher, up to 50kW, with current EVs but expected to go to 150kW within a short time and higher later.

Figure 4. Illustration of different charger types.

Charging at home was often the only option in the early days of EV uptake. It has since evolved and much has been learnt. 2.3kW charging using a 3-pin socket 13A supply (often known as 10A due to the current draw being limited and therefore power) are no longer recommended for regular use as they have been known to be prone to overheating and failure through mistreatment. This charging rate was described as slow charging by many. 3.6kW, 16A single phase charging using wall mounted sockets is often used and has been called medium speed charging. Finally, 7.2kW, 32A single phase is the largest charging option open to most people at home; these were referred to as FAST charging.

The term PRIVATE charger is used within this document to describe a charger without any method for metering the electricity used. They may also be used at guest houses, hotels and work places where the electricity is provided as part of some other service or as a benefit to the employees/ visitors. The slow, medium and fast charging rates described above are often deployed as PRIVATE chargers.

Few households have three phase AC supplies. An upgrade or new connection can be provided by the local Distribution Network Operator (SSEN in Orkney) at a cost to the householder. The cost is likely to be at least £2,000 and often much more, therefore upgrading domestic supplies in Orkney is not normally expected to be undertaken.

Existing public charging infrastructure can be broadly split into two categories:

- AC supplies which can deliver a range of power depending on the network connection and the EV model from 3.3kW to 22kW on dual socket charge points.
- 43kW three-phase AC and DC combined units which, with existing EVs in Orkney, provide between 40kW and 50kW. These are often termed RAPID chargers in the UK.

The main difference between private and public charging is that public charging has a mechanism in place to only allow a charge to start following authorisation; the charger records the energy used; and allows the owner/operator to be paid for the charge provided. PUBLIC charging in this document is defined as charging provided for the use of anyone and it is expected that this will normally be paid for at an appropriate rate. Discussion on appropriate charging is in section 10.4 *Charging for charging*.

The three main charging types currently in use are shown in blue in Fig 5.

This document identifies three future options which are expected to be required, two of which are shown in red and for which deployments are proposed within Orkney during the period covered by this Strategy. The third future option of DC charging above 150kW is not expected to be needed within Orkney during the next 5 years, if ever, and is shown in green.

Faster DC charging presently uses above 50kW and up to 150kW and hence is faster than the existing DC RAPID charging. This type of charging is being deployed in Europe and is already a commercially available product. EVs able to utilise charge rates above 50kW are currently limited to those produced by Tesla Motors. However, it is expected that other EVs will come to market in 2018 capable of utilising above 50kW charge rates and that by the end of this strategy EVs capable of charging at 150kW will be relatively common. Proposals to use faster DC charging within Orkney are outlined in section 10.1.1 *Public DC charge parks.*

FLEXIBLE AC charging in this document is used to describe a charging system where people are expected to leave their EVs plugged in for longer periods than is required to fully charge them. It is expected to be a subset of Public charging in most cases and is explained in section 10.5.1.

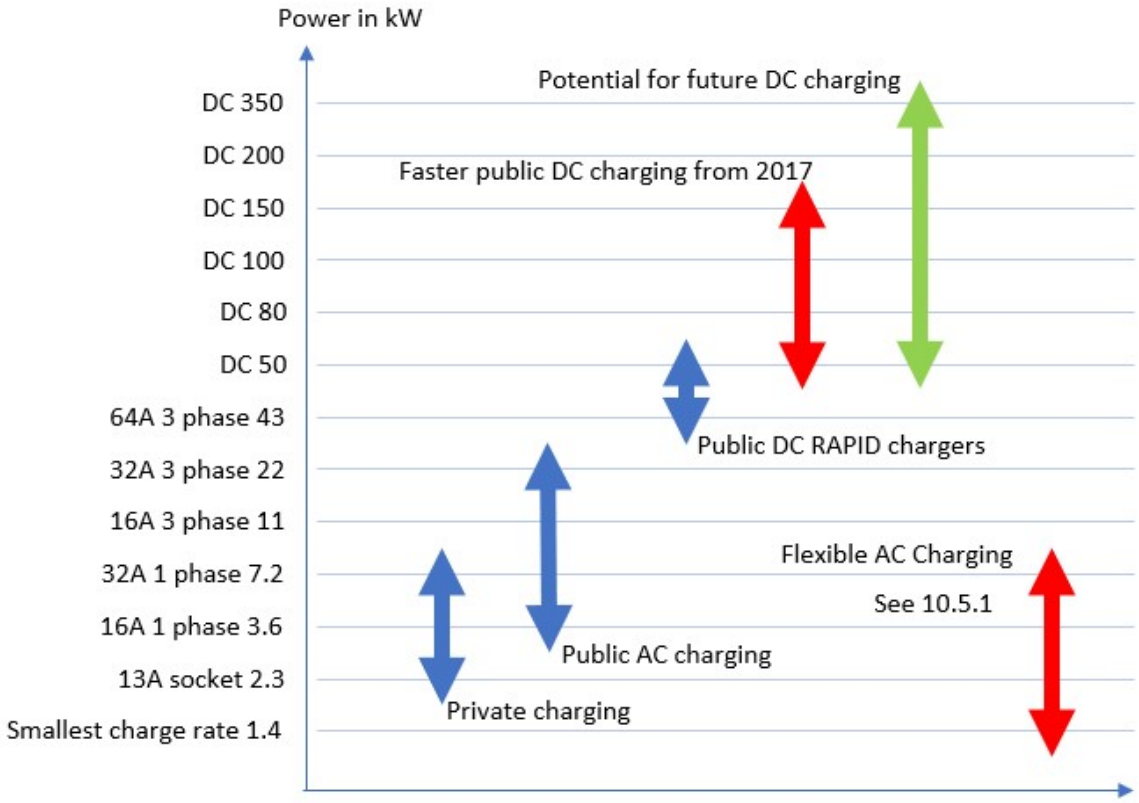


Figure 5. Illustration of types of chargers, their capacity and availability

The higher the power rating of the charger, the faster a given mileage can be delivered, but the higher the cost to install and maintain. There is therefore a balance to be found between time spent charging for a given mileage and installation and running cost of the charger. This Strategy takes this into account along with charging behaviour to date and concludes that faster chargers, while they have a role to play, are not always what is required in Orkney.

7 Present situation

Public chargers have been installed across much of the Orkney mainland. All but two of them (indicated by an * in Table 2 below) have been installed by OIC. Only one island has a publicly funded 7kW public charger (Shapinsay).

In addition, an unknown number of private chargers have been installed.

Table 2. Public charger locations and types

Public chargers	7kW	22kW	50kW
Picky Centre (Kirkwall)		2	
Tickety-Boo * (Kirkwall)			1
Great Western Road (Kirkwall)	2	2	1
School Place (Kirkwall)	4		
Lynnfield* (Kirkwall)	2		
St Rognvald's House (Kirkwall)	2		
Old Academy (Stromness)	2	2	
Ferry Road (Stromness)		2	1
Houton Ferry terminal		2	
Dounby	2		1
St Margaret's Hope	2		1
Shapinsay*	2		

Figure 6. Locations of public chargers in Orkney August 2017

8 Decision makers

A wide range of organisations, groups and individuals will play parts in delivering this Strategy. Table 3 below lists the anticipated participants.

Table 3. Decision makers

Assorted local groups	Orkney has numerous community groups and branches of national organisations.
Back office providers	Payment for EV charging is expected to be via back office providers such as Charge Place Scotland who already provide this service.
Corporate bodies	Their employees will come to work in EVs and they will send staff and products out in EVs.
COSLA	Confederation of Scottish Local Authorities – the joint voice of the Scottish Public Sector.
Development Trusts	Many areas or islands in Orkney have bodies dedicated to developing that area. They may have funds available for local use.
Electricity suppliers	The traditional incumbent 'Utility' is SSE, however the market is changing with multiple small companies both providing services and electricity. In addition; individuals are now generating their own power and peer-to-peer supplies are likely in future.
Equipment suppliers	Equipment will interface between the generator and the EV and will become more sophisticated over time. These may allow storage aboard the vehicle or for the vehicle at home. The 'Internet of Things' will also permeate EVs and the charging process so data will be ubiquitous.
Garages and car dealers	The skills to sell, service and maintain EVs are similar to present skills, but there will be additional training required to allow efficient roll out.
Government bodies	Will provide policy direction to drive behavioural change and will subsidise or grant fund key activities and charge for others.
HITRANS	The regional transport partnership.
Individual EV drivers	The vast majority of those using EVs will be owner drivers unless there is a shift to 'car clubs' or some other disruptive ownership model.
Non-EV driving public	Drivers who have yet to transfer to an EV or those with no need. Their needs will have to be factored into plans to ensure equity of treatment.
Orkney Islands Council (OIC)	Will provide public estate for EV parking and some charging. OIC are tasked by Government with carbon reductions and are likely to still be responsible for internal ferry services. They are the planning authority and enforcement authority for a range of activities including parking.
Researchers	The change from traditional transport will need to be understood and lessons learned and disseminated from its roll out. Orkney's leading position will continue to make it of interest to the research community and organisations who may be able to bring funding to the county.
Retail outlets	It is anticipated that charging will become something done whilst other things are going on such as shopping or visiting tourist sites. The owners of these activities may seek to attract foot-fall by offering charging.
Scottish Southern Electricity Networks (SSEN)	SSEN is the distribution network operator in Orkney. Charging points in Orkney are connected to the network they manage and maintain.
Transport providers	The main bus service is presently provided by Stagecoach. Several private companies provide taxi services and coach services.
Vehicle manufacturers	Will provide suitable products. These will vary over time in the light of customer demand.

This Strategy therefore concentrates on the steps needed to deliver the Envisaged Future and seeks to identify which decision maker is best placed to take the lead. The Strategy is written with an orientation towards practical action. It calls upon all decision makers to play whatever part they can. The majority of the proposed actions fall to those in Orkney.

8.1 Outline of the charging philosophy:

1. The vast majority of homes out-with Kirkwall and Stromness have off street parking available to the occupiers and these will become the place where most 'routine' charging takes place. This applies as equally to 'Mainland' Orkney as it does to the rest of the county.
2. Payment will be needed on all public charging points which will be at least as expensive as domestic standard rate electricity. This will remove the incentive to charge for free in public, so reducing the burden on infrastructure.
3. Almost all new EVs have ranges of greater than 100 miles and this is expected to increase to 150 miles during the life of this Strategy.
4. Owners of EVs in Orkney can access government grants to enable them to install a 32A charger at home.

9 Switched on Scotland Phase 2

Transport Scotland published a refreshed version of their *Switched on Scotland EV Action Plan* on the 13th of June 2017. The document laid out 10 key areas of work and priorities and grouped them into three areas, see Table 4.

Table 4 Switched on Scotland EV Action Plan

	Action	Area
1	Support increased deployment of public charging infrastructure by developing the Charge Place Scotland network.	Infrastructure and support
2	Provide financial support for the purchase of EVs and installation of private charging infrastructure.	
3	Work with partners on procurement approaches that encourage investments in EVs.	
4	Continue to work with partners to promote EVs as an alternative to fossil fuelled vehicles.	
5	Embed support for EVs in strategies for transport, energy, climate change, air quality and the built environment.	
6	Improve the user experience of the Charge Place Scotland network.	Electric Mobility Services
7	Support the development of innovative EV charging hubs across Scotland.	
8	Support local authorities in deploying measures that encourage adoption of EVs.	
9	Consider the impact of emerging technologies and business models on EV adoption and infrastructure deployment.	
10	Support improvements in the collection, analysis, interpretation and dissemination of data and evidence on the economic, environmental and social benefits of EVs.	Benefits

By inspection it can be seen that one of these areas is exclusively within Government's purview (Item 2); of the others most require local action to varying degrees.

This Strategy seeks to focus Orkney's attention on what it can do. It recognises that it can contribute and shape other outcomes and will continue to do so by providing input to key actions through OIC and others. See *Table of Actions* within section 12 for draft proposed local actions.

10 Topic Areas

Based on present Orkney EV drivers' experiences[5] a number of changes are proposed to enable an electric future. These changes are inter-related; however, they have been grouped into six main topic areas:

1. Charging Infrastructure
2. Tourism
3. Electrical Vehicle Transport
4. Charging for Charging
5. R&D
6. Planning Policy

10.1 Charging Infrastructure

Sufficient, reliable, and appropriate EV charging infrastructure is essential for the uptake and continued use of EVs within Orkney as well as the UK as a whole. The Scottish Government has stated in *The Government's Programme for Scotland 2017-18* that they will "*expand our electric charging infrastructure between now and 2022, whether in rural, urban or domestic settings. Easy access to smart and rapid charge points will mean 'range anxiety' will be a thing of the past in Scotland*".

Developing further charging infrastructure within Orkney is going to be a challenge. This is because the needs of the charging public are not yet clear, the technology is changing and the timescale for demand is unclear. Whatever is installed within the next five years will likely not be perfect and a degree of iteration and pragmatism will be essential. However, infrastructure will need to be improved to be able to cope with the predicted 1,000 EVs within the time scale of this Strategy. Some pieces of the complex jig-saw can be foreseen and the elements within this section can be adopted with confidence.

Increased battery size may mean that cars will not have to be charged every night and may go several days between charges. This is already the case with some 30kWh battery LEAFs and ZOEs in Orkney being able to drive over 100 miles between charges. This is anticipated to become the norm.

Some people may charge using public DC chargers in very much the same manner that petrol and diesel drivers re-fuel now i.e. an occasional trip to the 'pump' to gorge on fuel. It is anticipated that this approach will be a minority activity for locals as most will routinely plug in whenever they park overnight however tourists are likely to require, and be comfortable with, faster DC charging.

10.1.1 Public DC charge parks

Accommodating multiple public 50kW (and up to 150kW) DC chargers at one location is a better solution than seeking to distribute them evenly. This is similar to the way petrol stations have multiple pumps so dramatically increasing the chance of an available pump. Groups of multiple 50kW+ chargers will provide similar flexibility of use without the risk of having to drive around looking for one in a more evenly distributed model. If adopted, this approach will require a site with a significant electrical connection and the space for such a site should be safeguarded against development now.

[5] Collected over time and through the OREF EV workshop in March 2017

Two such sites are proposed for these faster public DC charge parks:

- Great Western Road in Kirkwall, and
- Ferry Road in Stromness.

Depending on the size of the DC charge station it will require the installation of new cables and feeder transformer. The sites proposed are both relatively close to large substations and will therefore be less costly to connect.

It is recognised that the money to build such facilities is beyond present budgets and it is possible that any emerging commercial charging model might mean this is no longer an OIC responsibility. Notwithstanding these uncertainties; the locations are clearly strategically important and should be safeguarded through the planning process.

Action: *OIC to safeguard, design, permit, and enable these public DC charge parks.*

10.1.2 Ownership of chargers

In response to the consultation, the question of whether the ownership and operation of charge points should continue to be an OIC responsibility was raised. The Council has been instrumental in initiating the infrastructure, but it is highly unlikely that it will own it all in the long term. It was pointed out that the Council does not own and run petrol stations, so why should it own charge points?

There is an argument that the assets being installed could become a community owned resource. Another argument is that they can be seen as a national piece of infrastructure and therefore could be Government owned. This model requires further development with input from a local and national perspective.

Action*: OIC consider its 'exit strategy' and the application of the Community Asset Transfer regulations on any existing or future installations.*

10.1.3 Public AC charging locations

Taking into account the greater ranges and the planned ubiquity of private charging, the provision of multiple 7kW to 22kW public chargers at these destinations will allow 20 miles of charge to be taken on in an hour[6]. Given that most tourists visit these destinations for more than an hour this will give sufficient charge to get them back to a town or their next tourist destination. It is therefore proposed that two 7.2kW public charge outlets are installed, with provision of electrical supplies and installation of ducts to extend to four or six public charge outlets at each site. This should be kept under review to enable appropriate expansion with appropriate technology.

The following locations are proposed for 7.2kW public chargers as a matter of course:

- Birsay Tea-rooms
- Broch of Gurness
- Finstown
- Fossil and Vintage Centre Burray
- (Highland Park)[7]
- Hoxa Tea- rooms
- Lyness[8]
- Rackwick Bay[8]
- (Scapa Distillery)[7]
- Sheila Fleet Jewellery
- Skara Brae
- Tomb of the Eagles
- Quoyloo Brewery

It is believed to be possible to get suitable electrical connections at all these sites. The impacts of EV charging on the Orkney grid are outlined in Appendix 5

Note: All these locations are destinations. The charging model will probably move to people expecting to charge whilst they are doing something else. They are unlikely to want to just sit in the car whilst charging.

Note too that the use of the sites listed may well increase peak electrical demand fractionally as they will be supplying power during the day and not over-night.

***Action**: OREF or OIC to approach land-owners of the above locations and seek to cooperatively install appropriate chargers.*

10.1.4 Community hall charging.

The popularity and use of community halls throughout the county has led to a suggestion that they could be the centre of any rural charging. This Strategy does not recommend this approach as this may cause problems as detailed below.

Although the halls are the centre of the social web of many local communities (not just on the isles[9]), the use of the halls is extremely periodic. i.e. users tend to arrive and leave in bursts, as activities start and finish, before being replaced by other groups who arrive and leave. A popular hall may also involve people arriving before the last group has left to use a subsequent 'slot' in the hall. This makes it extremely hard to provide sufficient chargers for all those coming to the hall if that is to be their preferred charging location. Additionally, the halls are often not necessarily near houses and when they are shut there is little else to do there.

[6] Most present EVs travel approximately 4 miles per kWh of electricity.
[7] Bracketed sites may be too close to Kirkwall and may be regarded as marginal and lower priority if the rest of the infrastructure is in place.
[8] The EV model for islands (see section 10.1.9 and appendix 4) is unlikely to be suitable for Hoy due to its length therefore is included in the list for destination charging while other isles are not.
[9] Isles: Inhabited Orkney Islands excluding mainland Orkney and the linked south isles.

So although it is initially appealing to see the provision of charging at the hall as a solution this model quickly runs into the problem of 'how many chargers do we need?'

It is likely that most people in the community do not visit the hall every day. Indeed, it is likely that many only visit weekly or less often. In which case they will have had to make alternative charging arrangements for their 'non-hall' periods. The model proposed throughout this Strategy is that most charging will be done at home, particularly in rural areas, so it is likely that those arriving at the hall will have driven from home and will have charged there. Alternatively, they will be going home afterwards and can charge at that point. The Strategy therefore recommends that the optimum model will be for there to be inexpensive domestic chargers at every suitable house/parking area (£500 each and grant aided). In doing so the need for a hall charger practically disappears.

There is, however, an advantage in having a domestic charger at a hall. It can give the odd charge for those caught out, but it is not worth putting in an expensive 'public' type charger and should be avoided.

Having considered a 'hall-centric' model it would only work if enough 50kW (£50k) and 22kW (£10k each) chargers were installed there to satisfy all demand AND for everybody to only charge at the hall. This latter point is unrealistic. In addition, the cost of installing a bank of several expensive chargers would not be cost effective.

Finally, it is also worth pointing out that vehicles will come and go after charging, so creating traffic. It is unlikely that putting the equivalent of a petrol station forecourt into the middle of the community hall car-park would be an optimum solution from a road safety point of view.

It does not make sense to make the hall the charging hub for a community. There is, however, an advantage in having a domestic charger at the hall.

***Action**: OREF to produce and OIC to circulate information to Community Councils on likely charging needs at halls.*

10.1.5 Private charging

At present 66 %[10] of Orkney's EV owners charge their vehicle at home and at night and there are two conditions needed to enable this:

1. For those with off road parking, a private charge point will be needed. The design of this point can be simple, however conventional 13A 3 pin sockets are no longer recommended for regular use as experience has shown them to be prone to over-heating (even when limited to 10A[11]) and failure through mistreatment. EV sockets which provide 3.6kW or 7.2kW are preferred and can be accommodated at most homes. The fixed Type 2 (Mennekes) socket which is used by most sub 22kW public chargers and for flexibility is preferable to the tethered options, as these cannot be used by all EVs.
2. For those without off road parking, it will be necessary to consider enabling most night-time parking spots to become EV charge points. Some form of on street charging point in the public realm will be required.

***Action:** OIC investigate 'on street' charging options for overnight parking and attract a supplier for an R&D project.*

[10] See Appendix 1 for results of survey undertaken of Orkney EV drivers in 2018.
[11] The 10A limiter needs to be hung from a hook to avoid putting strain on the 13A socket.

All public charging points should be labelled appropriately including an identifier, a help line number, and the type and power rating of the unit (to help users to estimate how long it will take to charge their EV).

10.1.6 Tourist accommodation

Some tourists staying in Orkney who drive or own EVs at home may bring their cars on holiday with them. To be able to use their EV during the day they will expect to charge at night. It follows that hotels, B&B and self-catering establishments will need to provide charging for their overnight guests. Evidence from conversations with many EV drivers over several years has shown that this is their number one priority when choosing accommodation for the following reasons.

1. The need to charge during an outing is reduced by plugging in overnight.
2. The day is started with a 100% full battery rather than filling it to 80% in half an hour at a rapid charger.
3. The charger can be pre-booked, this reduces issues with queueing.

A campaign to enable tourist accommodation providers to offer charging is also needed.

***Action**: Orkney Tourism Group to assess scale of present tourist offering on the isles and mainland Orkney.*

10.1.7 Airport charging

Kirkwall Airport is considered an ideal location to install a flexible AC charger as defined in section 10.5.1. Furthermore, it will allow allocating energy to pre-condition[12] the car in the hours before the driver's return time. See 10.1.11 *Islander car club*s.

In addition to the use of Flexible AC charging at the airport, taxi services may need to take on charge rapidly whilst waiting for fares. A public DC 50kW or faster public DC charger capable of providing 150kW should be anticipated at the airport to complement the proposed faster DC chargers in Kirkwall and Stromness if there is sufficient demand towards the end of the five years this Strategy covers.

10.1.8 Workplace charging

Some drivers may choose to charge at their place of work; particularly those unable to charge at home or where the commute distance is greater than the vehicle range. To facilitate this, chargers will need to be provided for a proportion of the car-parking spaces at the employer's premises. Over time this proportion will need to increase in response to demand as more EVs are on Orkney's roads.

Charging at work could take various forms depending on the kind of parking available to employees (dedicated or not). Public flexible charging as outlined in section 10.5.1 is proposed for parking areas that are commonly used by multiple employees. Simpler, cheaper, charging solutions may also be appropriate for large dedicated employee parking where cars will be parked for the conventional 8 working hours.

[12] Pre-conditioning allows the battery to be brought to within its optimum temp range either by heating in winter or cooling in summer and it also allows the car to heat up, demist, or cool down using the air conditioning so that the occupants can get into a comfortable car and be ready to drive off. While not available on all EVs it is likely that this will become common across all new EVs as part of the minimum expectation and a unique selling point for EVs compared to internal combustion engine vehicles.

10.1.9 Charging on the Isles

Most islands are small enough to mean that charging at home will generally be enough for most EV drivers.

The provision of a public DC charger on each island in the short term should be kept under review to see if demand exceeds accommodation-based charging. The preferred location for any public DC charger should be where most potential users will pass by it as part of a regular journey or not have to detour too far from their route. For visitors to Orkney's isles; every B&B, hotel and holiday let should provide a private charge point. See 10.1.6 *Tourist accommodation*.

This will mean that drivers know there will be charge points on the isles if they visit. It will encourage drivers to stay overnight too.

There seems to be no need to install public chargers (the types normally presently installed in car-parks of 7kW single-phase or 22kW three-phase). These will presently fully charge an empty EV in 4-6 hours, but on islands it is hard to see when this charger type will be needed. These chargers are also around ten times the cost of private units of up to 7.2kW, so ten properties could be served by putting in the cheaper units rather than the public ones. Other significant advantages include:

1. Even the smallest island accommodation provider can take part for example on Wyre or Graemsay.
2. Private AC chargers are easy to repair and can easily be replaced using local labour with the unit sent away for repair if possible.
3. Repairs could be carried out on a next day basis rather than waiting for a specialist technician which could take weeks or even months after a failure.
4. Many more visitors can be catered for on larger islands.
5. The potential for queueing at chargers is significantly reduced if not eliminated.
6. A single failure is not a disaster; if a unit fails only one guest is impacted. An alternative charger at another accommodation provider on the island could possibly be used, or the portable 10A charger supplied with most EVs could be used.

Note too that there is no need to install chargers at Community Halls on islands if the above model is followed. There will be better utilisation of charge points at home than at a public space that is used infrequently by the majority of EV drivers. See 10.1.4 *Community hall charging*

This is covered in more detail in Appendix 4 *Isles Charging*.

Action: *This island model should be adopted as in Appendix 4. See action under 10.2.4 Tourist accommodation.*

10.1.10 Charging on ferries

The short sea-crossings across the Pentland Firth and between the isles should not be regarded as charging opportunities because, at present, the electricity aboard is provided by diesel engines and is therefore not a green supply. Additionally, the crossings are short and sufficient on-shore charging facilities should be made available. (See Appendix 4 *Isles Charging*.)

Although the ferries from Aberdeen are similarly diesel powered, the trip is long enough to make a 1kW to 7kW charge worthwhile. Furthermore, the late-night arrival times of the ferries from Aberdeen and Shetland in Orkney are antisocial. Having to find charge in Kirkwall late at night would be difficult and unpopular. It is recommended that single-phase chargers of less than 7.2kW be provided on the Aberdeen ferries. The scale of present generation plant aboard some of the ferries

is huge compared to EV's needs so it is possible to manage the additional loads of cars from the spinning reserve without undue extra emissions during the journey.

As a result of the consultation it has become apparent that the Maritime and Coastguard Agency have yet to recognise the need for this service. As at the time of writing they are unwilling to issue guidance that would enable charger installation.

***Action**: Northlink Ferries to continue to press to be permitted to fit charging points in relevant ships and provide charging as a chargeable service.*

Note: There is debate as to the usefulness of chargers at ferry terminals. There tend to be electrical supplies and they are locations where people wait for vessels when travelling from one island to another. However, many are also locations where there is nothing else to do, meaning that charging time is dead time. They can be considered as chargers 'en-route' and on many of the smaller isles the route to the pier is very short, meaning they may get rarely used and may not be a good investment.

It was suggested that 50kW chargers should be placed at ferry terminals, however the Strategy does not recommend this as it would not be a good use of public investment if the 'home charging' model recommended is adopted. See Appendix 4 *Isles Charging*.

10.1.11 Islander car clubs

Chargers at ferry terminals could enable car-pooling to be established leading to islands having an EV (or EV fleet) on the mainland that could be used by islanders. This would allow islanders to travel as foot passengers so saving the cost of taking the car on the ferry.

For this to work the 'pool cars' would need to be ready to use. The adoption of the 'airport charging' model above would therefore seem appropriate and cost effective.

Furthermore, this would enable people to leave their car on their island and there may be an advantage in it being charged whilst they are away, so requiring the 'airport charging' approach on the island.

Similarly, there may be tourist opportunities in having a pool of charged EVs on the isles that could encourage foot passengers to the isles who would then pick up a car upon arrival.

OIC have indicated a willingness to consider use of the parking at ferry terminals for this sort of model.

***Action**: Island specific opportunities should be kept under review and enabled by OIC/Marine Services if demand can be established.*
***Action**: An 'island car club' model should be piloted by a Development Trust.*

10.1.12 Charge point maintenance

Chargers are unmanned and so the 'back office' reporting mechanism needs to be able to pick up faults and rapidly react to them. Recent improvements in the Charge Your Car and Charge Place Scotland service whereby out of hours faults can be logged and sometimes rectified are welcome. However, there remain significant issues with overall response to repeated faults and correspondence. The inadequate handling of e-mails and the inability to receive texts or leave messages remains a shortcoming.

Overall there is considerable dissatisfaction with the present responses to reported faults. It would not be acceptable to go to a petrol station and be told that it was broken, that there was no

indication as to when it was to be fixed and there was no alternative provision. This is exactly what some EV drivers are told today when a charge point is not working. Improvements in the overall service should be a high priority.

At present OIC are unable to allocate an owner to the task of ensuring the existing public infrastructure remains fit for purpose. It is hard to see how the present situation will improve without a suitable allocation of resource.

***Action**: OIC to seek funding to allocate an 'owner' to the service of charge delivery and set performance measures.*

There appear to be three main problems with charge points:

1. Inadequate installations
2. Communication with chargers
3. Damage/repairs

The first problem was identified by OREF in 2014 and after finding no guidance on the subject OREF produced the *EV Charging Infrastructure Guide in 2016*[13]. The positive response from Local Authorities who received the document means that a 2nd edition is planned for 2018. In Orkney's case it is anticipated that further installations in the county will adhere to the good practice featured in it and OIC have committed to use the Guide

***Action**: OREF to publish 2nd edition of guide.*
***Action:** OIC to use the EV Charging Infrastructure Guide as standard.*

The second problem of communications with chargers needs to be resolved by removing the dependency on good communications before a vehicle can be charged. Following discussions with OIC as charge point owner, Siemens and EVolt as charger suppliers, technical work-arounds were installed in late 2017 and early 2018. This intervention by OREF members showed the effectiveness of partnership working and removed a long standing intractable problem for OIC. This is further explored in 10.4.2 Back office.

The third problem of repairs has become prominent with some key chargers being off line. It is understood that a supply of critical spares will now be held locally. If suitable personnel are trained in maintenance then the present delays could be reduced.

Note: This issue could become critical if the 'home charging' model is not followed. If an alternative model of 'all public' charging leads to a proliferation of sophisticated public chargers, there will be a need to have public maintenance. If a more 'home charging' model is adopted then the simpler chargers will require less maintenance and their ubiquity will remove the time pressures that critical 'public chargers' will create.

***Action**: Charge point owner(s) to ensure critical parts are locally held and that warranty options are taken up when any new public infrastructure is installed.*
***Action**: OIC and Development Trusts to work together to train sufficient local people to undertake simple maintenance and identify the means to deliver more sophisticated servicing for 'public charging' locations and infrastructure.*

[13] http://www.oref.co.uk/wp-content/uploads/2016/07/20160726-Charging-Infrastructure-Design-Guide-V1.3.3.pdf

10.1.13 Enforcement

EV public chargers are valuable public investments and need to be optimised. They are also as necessary to EV drivers as disabled spaces are to the disabled. Equally diligent levels of enforcement should be applied.

Establishing coherent enforcement policy along with other Local Authorities through working groups by COSLA is desirable over unilateral and uncoordinated action. Key principles should include:

- Public education as to the use of EV charge points
- Ensure enforcement against ICE (Internal Combustion Engine) and non-battery electric vehicle drivers who misuse/block charge points.
- Ensure action against EV drivers who do not plug in and just use the chargers as parking spaces.
- A means to ensure EV drivers do not over-stay the time needed to obtain sufficient charge on public charge points.
- Provide effective signage and bay marking to prevent a defence of ignorance being offered.
- Encourage the drivers to display a time to show when charging is planned to finish.

Note: Number-plate recognition cameras may be able to provide automated enforcement in some locations.

***Action**: OIC to establish appropriate Traffic Regulation Orders and charging mechanisms. See10.4 Charging for charging.*

10.2 Tourism

In the short term, the novelty of driving an EV on holiday may represent a Unique Selling Point (USP) for Orkney if grasped. This may take two forms:

1. People bringing their cars away on holiday with them up the A9 or 'North Coast 500' and by ferry. See 10.2.1 *Getting to Orkney*
2. People hiring an EV car locally as the preferred 'normal' form of vehicle.

The former will be reassured to come if they know they can get to Orkney and that they will be able to charge when here. Charging at all accommodation is therefore regarded as an essential part of the Orkney service offering. See sections 10.1.3 *Private Charging* and 10.1.6 *Tourist accommodation*

In both cases above the EV drivers will be in an unfamiliar environment. The issue of 'range anxiety' will return if they are unsure how far they will be able to travel and where and when they can get a charge. It should also be noted that the high winds in Orkney will also reduce range on some occasions meaning that on-board range calculators may be unreliable.

Although the distances to be travelled in Orkney are generally commensurate with present range, and ranges in future are anticipated to be greater, 'range confidence' will be considerably enhanced if there are sufficient chargers at popular destinations. Knowing that a range boosting charge can be taken if needed will remove anxiety.

***Action**: OIC and partners to enable/support provision of private or public 7kW charge points at holiday accommodation.*
***Action**: OIC/Hitrans ensure the roads and ferries that bring people to Orkney are suitably provided with charging infrastructure.*

10.2.1 Getting to Orkney

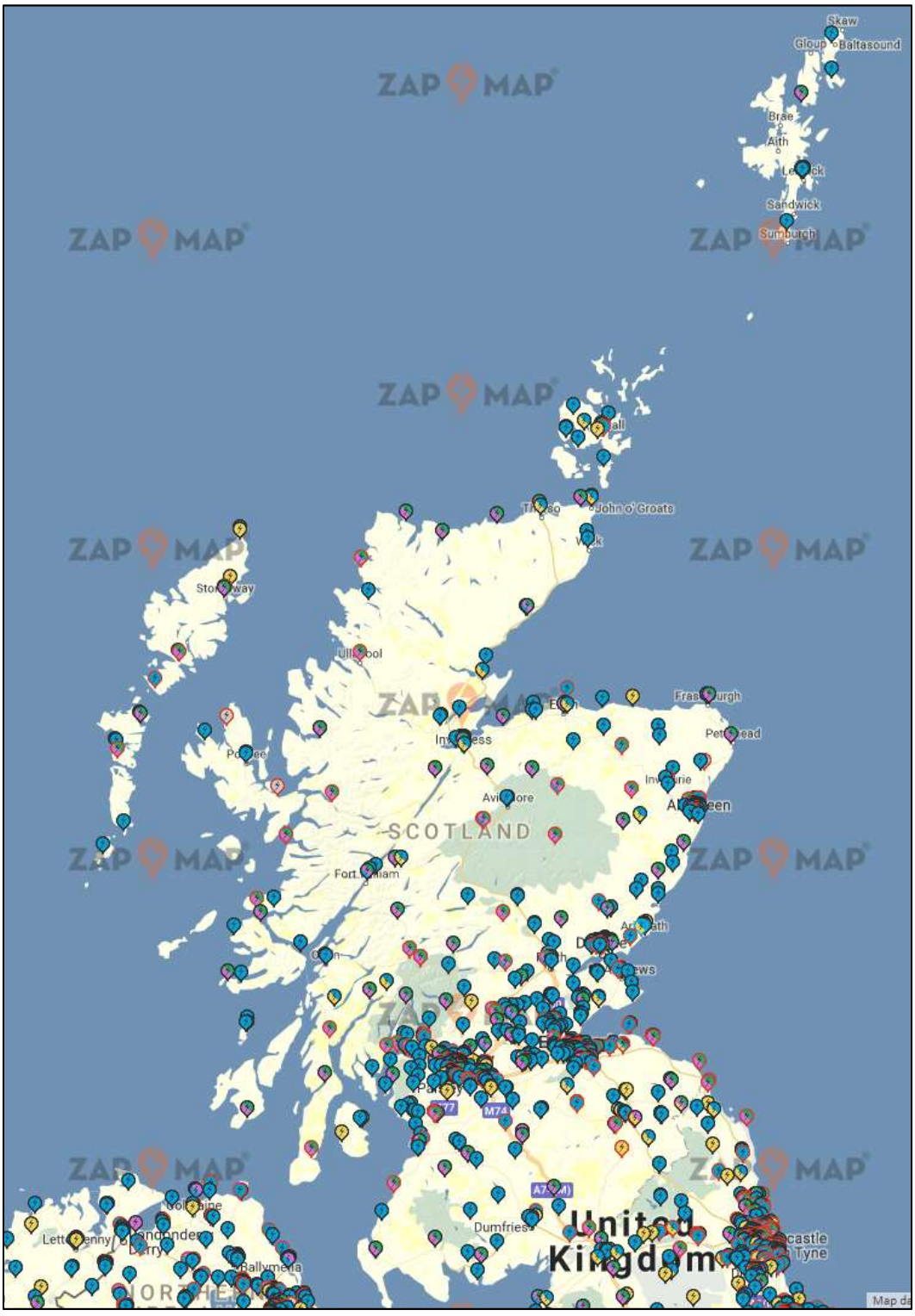


Figure 7. Chargers in Scotland from Zap-Map - 2017

The Scottish Government have laid out ambitions in their programme for Scotland 2017-18 to create Scotland's first 'electric highway' on the A9. Scotland has already developed a chain of 50kW chargers extending up the A9 and other trunk roads. These chargers are, as originally envisaged, essential to enable long distances to be travelled.

However, there are emerging problems with the unpredictability of the chargers which is beginning to impede more long-distance trips.

The unpredictability is caused by five things:

1. Single 50kW chargers at locations introducing single point modes of failure. i.e. no backup/redundancy. Multiple chargers are needed at these and intermediate locations.
2. Inherently poor communications in some locations are unnecessarily preventing charges.
3. Poor/inaccurate data on mapping systems failing to report problems or availability. (Note: No competing maps have been found to be complete or accurate!)
4. Repair to chargers is not treated as a priority.
5. Driver behaviours are sub-optimal with chargers being blocked or inappropriately used.

These are all addressable but require a strategic and coordinated approach. This requires Transport Scotland to work with the relevant Local Authorities and ensure progress is made. This appears to be alluded to in their Action Plan (Item 7. *Support the development of innovative EV charging hubs across Scotland*). It also requires OIC to work with Highland Council through HITRANS and others to ensure the network is in place to enable EV drivers to pass through to Orkney.

***Action**: OIC to work with HITRANS to engage with Transport Scotland ensure points above are monitored and resolved.*

To enable tourism to Orkney and Caithness it is important that the electric highway on the A9 extends north of Inverness.

***Action**: Orkney Tourism Group and partners to build EV tourism as a market segment into the 'Destination Orkney' tourism planning process.*

10.3 Electric vehicle transport in Orkney

Electric vehicles in Orkney are not solely owned for private use by householders. Several businesses use electric vans and an electric bus already exist in Orkney. It is expected that EVs will be increasingly used as taxis, goods vehicles, buses and coaches and will be leased.

10.3.1 EV hire

EV hire will become inevitable with the phasing out of diesel and petrol vehicles both in Orkney and elsewhere. At present, it is hard to make this attractive since the capital cost of the vehicles is recouped through the daily rate and the fuel costs are the responsibility of the hirer.

***Action**: Await changes to the car rental model and consider any enabling actions.*

10.3.2 Taxi

The load profile of taxis will mean that running them on electricity may be a challenge in this predominantly rural community unless high mileage vehicles are more readily available/affordable, or dramatically improved 50kW+ charging is possible. The vehicles tend to be heavily used in burst periods, but also do large mileages in these rural communities. More work is needed before a clear model becomes apparent.

***Action:** Await emergence and test of the rural EV taxi model elsewhere.*

10.3.3 Bus & coaches

Orkney has one electrically powered bus and the rest of the bus fleet is provided by Stagecoach. Electric busses are available but have limited range and may have diesel powered supplemental

heating to maximise battery range. In congested urban environments with slow average speeds and short distances travelled this short range may not be a problem. In uncongested Orkney, the distances travelled by buses are likely to be longer and at higher speed, therefore challenging battery capacity. It is likely that, due to Orkney's bus fleet's predominantly rural usage, hydrogen fuel cell busses may offer a better fit with the additional bonus of heating from the fuel cell as a biproduct.

Coaches on the other hand tend to have longer dwell times at destinations and may be better suited to electrification if suitable models become available. This might require public charging as per 10.1.2 to top up charge en-route. However, it is important that contention between coach range and car use at these locations does not become an issue.

***Action**: OIC press for alternate fuelled buses through Transport Scotland.*

***Action**: OTG/OIC If coach provision begins to become electric then ensure suitable destination charging is considered.*

10.3.4 Goods vehicles

Some light goods vehicles/vans are already electric, and this number will continue to increase. The number of heavier goods vehicles is low and unlikely to be easily satisfied with existing technical solutions. This should be kept under review. If national organisations, such as the Post Office seek to roll out EVs then Orkney is ideally placed to participate.

Note however that a significant amount of material is moved by tractor and trailer, and the electrification of farm equipment may well drive some key charging locations such as the Auction Mart.

10.3.5 Public sector vehicles

The uptake of EVs in parts of the public sector now lags behind private ownership. Concern has been expressed that EVs do not have the range needed to deliver the duties required of them by the public sector, however this does not seem to be backed by evidence of present duty cycles. Since EVs are now cheaper to run, and their whole life costs per mile are lower than fossil fuelled vehicles, there appears to be no reason why all public sector vehicles should not be required to be EV unless proven to be unsuitable[14].

The data that exists in OIC, NHSO, HIE and others on mileages travelled by staff should provide sufficient evidence to show when EVs would be capable of delivering present needs (if they do not do so already). A data mining exercise of existing mileage claims, and pool car records, should determine if this saving is available to the public sector already.

***Action**: OIC, NHSO, HIE to mine existing travel records to determine present usage patterns and plan for the electrification of vehicles as the standard.*

10.4 Charging for charging

The initial introduction of free public charging was a useful stimulus to get the first tranche of vehicles on the roads. It is, however, difficult to justify why the public purse should continue to shoulder the burden of supplying the fuel for free. It is noted that OIC is facing substantial budget cuts and charging will need to be introduced in due course.

[14] Alternative green fuels may be suitable for some public sector vehicles.

It is important that there is a nationally coherent process for charging for public charging. OIC should therefore work with the Scottish Government and COSLA, ideally through HITRANS, to develop an equitable EV charging process. See Appendix 2 *Draft EV Charge Schema* which sets out a recommended schema.

It should be noted that Orkney has successfully piloted many other initiatives and is in a good setting to be able to trial charging for public charging schemes if this is deemed appropriate. (See also 10.2.10 *Enforcement*.) Any successful scheme should be nationally introduced.

Note: A consultation was undertaken by Charge Place Scotland on charging across Scotland in 2017. At the time of writing this Strategy in Q1 2018 it has yet to report.

***Action**: OIC/COSLA and HITRANS/Transport Scotland to decide on a national EV 'charging for charging' process and use local experience to assist with implementation.*
***Action**: OIC to offer to pilot a national 'charging for charging' scheme.*

10.4.1 Hours of use

The precise model for the use of charge spaces has yet to evolve. This is in part due to understanding how charging behaviours will evolve. In turn, this will be affected by the nature and extent of charging infrastructure. In order to move the process forward it is recommended that the blanket '*Max use of space for 3 hours*' rule recently introduced is replaced with '*Max use of space for 4 hours if charging*'. This appears to be a more reasonable limit during the day for newer EVs on 7kW to 22kW public chargers. It is however too long on public 50kW chargers which should be limited to 60 minutes if charging. Furthermore, the 4-hour limit should only apply from 08:00 to 20:00 with vehicles left overnight removed by 08:30 at the latest. This will allow some urban users to charge overnight on public chargers, but not block them for commuters. It is recognised that this scheme will require polishing if more urban locations are provided.

Any scheme should seek to ensure there is maximum use made of charge points by encouraging drivers to move on as soon as practical, driving high levels of reliability and all with the minimum amount of back office cost.

Action: *OIC to revise EV charging signs.*
Action: *OIC/Charge Your Place Scotland to change DC charging software so it stops after 60 minutes.*

10.4.2 Back office

The following principles should be applied to back office charging systems:

To prevent drivers being stranded due to mobile communication network shortcomings the supply of power should not be communication dependent. Since the first draft of this Strategy, a work-around solution has been deployed to most chargers in Orkney and Scotland. These sites default to 'vend' if communications fail rather than 'no vend'. They also log use and later re-integrate the charge history into the database.

Action: *OIC to insist and ensure that <u>all</u> new charge points are set to default to 'vend' when communication is lost.*

Public charging at all rates of power should be at a flat rate per kWh supplied with monthly billing. More sensitive time of use /resource availability charging may come in over time, but this should not be introduced at present due to the complexity it will introduce. This may change over time, but during the life of this Strategy it seems unnecessary. It is expected that private charging will be

influenced by time of day tariffs as smart meters are rolled-out but this need not apply to public charging in the first instance.

The ability for those responsible for the chargers to interrogate back office systems is now critical and has great opportunities for improvement. The data available on Charge Place Scotland's web site for an individual user is adequate if rudimentary. The data routinely provided to charger owners is non-operational and urgently requires attention to enable better maintenance. This is also an item in the *Switched on Scotland* action plan (Item *10. Support improvements in the collection, analysis, interpretation and dissemination of data and evidence on the economic, environmental and social benefits of EVs*)

***Action**: OREF, OIC and HITRANS to work with CPS to seek data from existing chargers to determine optimum data flow.*

10.4.3 Information systems

Most EVs have on-board mapping systems that show charge points. In addition, there are several 'Apps' to show their location and status. Unfortunately, these systems are demonstrably unreliable/ incomplete. This must be corrected as a matter of urgency if we are not to see a plethora of work arounds being inefficiently developed.

There is a tension between accurate status reporting on one hand and the problems with mobile data communication to some locations. This Strategy recommends that the priority should always be to make charge available. If communications are lost then chargers should default to 'vend' and the information systems should record the charger as an 'unknown' status.

Action: *Transport Scotland to improve accuracy and consistency of mapping and seek to avoid a plethora of competing maps being developed.*

10.4.4 Advice to potential EV owners on selection of an appropriate vehicle.

It has been suggested that a short guide be produced to allow potential EV owners to work out what they need to consider when purchasing a vehicle to avoid people purchasing unsuitable vehicles. The use of EVs with faster 6.6kW and 7.4kW chargers coupled with 32A home charging units can make a considerable difference to the ability to recharge during the day. Further opportunities for providing up to date information will also be sought.

***Action:** OREF to produce a purchasing guide for Orkney EVs.*

10.5 Research & Development

The scale of change in transport as fossil fuelled vehicles are retired will need a huge R&D effort. Orkney is well placed to effectively engage with EV manufacturers, charge kit suppliers and others to understand and pilot new behaviours, grid interactions and business models. However, it is likely that the results of R&D introduced now will only significantly affect the EV driving public towards the end of this Strategy's life. The following elements are therefore included here in order to set out possible projects that could be of use post 2020.

The Scottish Government have stated in their programme for 2017-18 that they will, "*provide financial support for local solutions and small scale research and development to address the particular challenges to expanding the charging infrastructure in Scotland, such as charging in tenement properties, and capitalising on opportunities such as better linking electric vehicles with renewable energy and energy storage and systems in Scotland*".

To be able to identify the impact of new schemes or technologies it is important to have data from before and after those changes were made. The present collection of mileage data by OREF will aid in this and help demonstrate carbon dioxide savings.

Action: *OREF continue to log mileages to detect changes in use patterns and also demonstrate CO2 savings.*
Action: *OIC and OREF to explore options for more data gathering and data mining of existing travel patterns.*

10.5.1 Flexible AC charging / dynamic AC charging

Some locations present problems when it comes to the speed of charging and the time which an EV will be left there for. We have identified three main areas where this is a problem:

- at work places where an EV owner would like to plug in and leave the vehicle for 8 to 9 hours (at work or overnight) and
- at the airport where an EV may be left for periods from 8 to 12 hours if someone has been away on a day trip, to periods of over two weeks when they have flown away on holiday.
- at ferry terminals where an island 'car share' model may be possible.

Flexible AC charging could provide a simple solution to allow many EVs to be plugged in at the same time but allow the charging to be spread over time without having to provide many high powered dedicated chargers. In most cases the EVs plugged in to such a scheme could wait for several hours before any charge is required (or several days at the airport). This would allow EVs to be charged at suitable times to ensure maximum use of renewable energy and minimising the amount of curtailment of renewables on the Orkney grid. This is known as dynamic AC charging.

Flexible AC charging could be made up of multiple 7.2kW public chargers that could each connect four or more EVs and have a central controller to decide which EV is charged, at what time and, at what rate (up to 7.2kW). The central controller would aim to give each EV the required charge before the return time, and could allow pre-conditioning of the vehicle and battery so that the EV can be at the optimum temperature when picked up by the driver. This is particularly useful in winter and means the driver can safely jump in and drive the car straight away.

This type of charger is not commercially available and Orkney could look to partner with a manufacture to develop the idea and install it at Kirkwall Airport and possibly other locations.

Action: *OREF/Dev trust to seek a project to prove the merit of Flexible AC /Dynamic charging.*

10.5.2 Vehicle design

Orkney can have little or no effect on the design or supply of mass market vehicles. It will therefore need to accommodate what it gets. However, in the early stages of roll out there will be lessons to be learnt. Orkney, with its well-established track record of public engagement and willingness to try new technology, is well placed to be a test bed for innovative approaches. Orkney should therefore offer itself to the EV manufacturers and equipment suppliers in order to secure R&D activity in the county and so aid early deployment.

Action*: All to promote Orkney's success to date and look for R&D deployment opportunities.*

10.5.3 Vehicle to grid (V2G)

V2G allows the vehicle's battery to interact with the grid by both receiving/storing electricity, but also of returning it, in part, to the grid if required to supply grid balancing. Such charging requires

more complex chargers than those in use today. However, EVs will represent a huge electricity storage pool, that can be accessed if the EV is connected to the grid appropriately. It is therefore likely that many EVs will be plugged in whenever they are parked, not just to charge the car, but also to support the grid by making their battery available to the grid. This will not be altruistic but will be a service provided by the EV owner. This service may be paid for by the grid operator, or in some other arrangement whereby, for example, the driver gets a rebate on electricity costs or vehicle lease costs. This market is yet to be developed.

From studies by OREF and Ofgem it is known that most EV cars are presently used for only 1 hour a day and take up to 3 hours to charge. The battery capacity of an EV is expected to double to around 50kWh, so in the Envisaged Future of Orkney's 10,000 vehicles being electric this will represent 500MWh of battery storage sitting about unused for 20 hours per day.

To enable V2G, it is likely that large groups of vehicles will make their batteries available, so car parks (both private and public) may well be enabled to allow all vehicles to plug in when they park. Likely examples will be public car parks, the hospital, Council Offices, schools, Orkney College, Kirkwall airport and the Old Academy in Stromness.

Action: *OREF members to seek to attract a V2G project/supplier.*
Action: *NHS Orkney. Plan for EVs through the installation of ducts in car-park works in new builds such as the hospital.*
Action: *OIC. Plan for the uptake of EVs and V2G through the installation of ducts in car-park works in new builds such as the new Stromness Innovation Campus*

10.5.4 Autonomous Vehicles

It is unlikely that autonomous vehicles will be first deployed in Orkney due to the rural location and the prevalence of single track roads with poor line markings. Similarly, it is unlikely that there will be many 'vehicles on demand' as taxis (Uber etc) due to the low population density. In cities it is anticipated that both will come together to provide driverless vehicles on demand. However, these changes should be anticipated to come to Orkney after the lifespan of this strategy. It is presently unclear how this would impact overall parked vehicle numbers or traffic patterns.

Action: *All to keep autonomous vehicle development under review under review.*

10.5.5 EVs connected to the internet

The introduction of the 'Internet of Things' is anticipated to result in ubiquitous connection of vehicles. It is likely that road pricing will be introduced that will involve the vehicles' position being known and monitored, so there may be no need for electrical charging infrastructure to connect to the internet; the EV will be connected and it will be able to communicate with the charger. There will therefore be no need for separate cards carried by the drivers, the interaction will take place between the car and the charge point.

Action: *Internet of Things demonstration project to be offered by OIC/ CPS as a potential solution to the communications problems experienced by existing EV users in Orkney.*

10.6 Planning policy

OIC as the planning authority in Orkney can influence elements of building provision across the county and future proof present development. This is encouraged in items in the *Switched on Scotland* action plan[15].

It is noted that OIC is starting the review of the *Orkney Development Plan* and has indicated that measures recommended in this Strategy will be considered for incorporation in all documents at the earliest opportunity.

The following items are proposed:

- Single properties with off road parking: Given that the majority of charging will take place at home, all new properties with off road parking should be required to ensure there is provision to enable the provision of EV charging. This should involve the provision of ducts/identified cable routes from suitably sized distribution boards to future private charge point locations. It would be desirable if charge points were provided with all new properties, but this may represent a presently unacceptable additional cost on the builder/purchaser.

  Note: Charge points are 'Permitted Development' and do not require subsequent planning permission.

- Groups of properties with shared parking (car courts); Communal charging arrangements should be planned into new developments. This too should involve the provision of ducts to areas in which charging can take place. It would be advisable to follow the published OREF guidance[16] of the locations of charge points, so avoiding trip hazards and inefficient siting of chargers in corners.

  A threshold based on the number of housing units should be established whereby the provision needs to move from just the ducts to the actual installation of the charge post and switchgear when parking arrangements exceed a certain size.

- Groups of properties with on-road parking; Ducts should be provided to each car park space and a scheme proposed by the designer as to how to connect them to the electricity supply.

- A contribution should be sought from developers towards public charging infrastructure if this is not provided by the development[17].

Note too that OIC can deliver on some aspects through their own building programme. It is recommended that OIC adopt best practice and continue to be an exemplar of charging provision as it has to date with the first tranches of chargers.

***Action**: OIC to audit its current plans and identify active planning measures to be undertaken.*

[15] Switched on Scotland: Item *5. Embed support for EVs in strategies for transport, energy, climate change, air quality and the built environment.* Item *8. Support local authorities in deploying measures that encourage the adoption of EVs.*

[16] Electric Vehicle Infrastructure – A design guide (www.oref.co.uk)

[17] Section 105 of the Town and Country Planning Act

11 Recommendations

This strategy needs to be bought into by a wide group of stakeholders and has already received support during the consultation.

The opportunities for Orkney to seize the public relations agenda by exploiting its unique reputation are here now but may not last. The opportunity needs to be exploited.

Urgent action should be taken to provide charging at accommodation throughout Orkney by providing encouragement immediately.

There are a number of elements where research projects, pilots and demonstrations can be attracted to the county. A concerted effort to secure these should be made.

OREF's Electric Vehicle Infrastructure – The Design Guide has been well received within and out-with Orkney. A second edition should be progressed by OREF.

This strategy, *Orkney Electric Vehicle Strategy 2018-2023*, needs revisiting in 2020.

Next steps:

This Strategy will be maintained by OREF and a plan drawn up with and by the identified parties to set timebound actions and deliverables.

Action: *OREF to draw up a plan with the identified parties and seek commitment from all to execute it.*
Action: *OREF to update this Strategy in 2020*

12 Conclusions

EVs are coming and the way we travel is going to change as a result. Orkney has the opportunity to continue to show itself as a pioneering and innovative community through the enthusiastic adoption of EVs.

By adopting EVs Orkney will save money, improve air/water quality and reduce our CO_2 emissions. They will make our county quieter, healthier and more prosperous whilst also showing our visitors how the future can be.

Through cooperative action Orcadians can seize the initiative and deliver the next big decarbonisation revolution to meet our needs.

Table of actions

Table 5 Actions

Ref	Actions	Who	When
10.1.1	Safeguard, design, permit, and enable two public DC charge parks.	OIC	
10.1.2	Consider its 'exit strategy' and the application of the Community Asset Transfer regulations on any existing or future installations	OIC	
10.1.3	Approach land-owners of identified locations and seek to cooperatively install appropriate chargers.	OREF and OIC	
10.1.4	Produce and circulate information to Community Councils on likely charging needs at halls.	OREF and OIC	
10.1.5	Investigate 'on street' charging options for overnight parking and attract a supplier for an R&D project.	OIC	
10.1.6	Assess scale of present tourist accommodation offering on the isles and mainland Orkney.	OTG	
10.1.9	Adopt the island model for the delivery of charging infrastructure.	OIC	
10.1.10	Continue to press to be permitted to fit charging points in relevant ships and provide as a chargeable service.	Northlink	
10.1.11	Island specific opportunities should be kept under review and enabled by OIC/Marine Services if demand can be established for charging.	OIC	
10.1.11	An 'island car club' model should be piloted.	A Dev Trust	
10.1.12	Seek funding to allocate an 'owner' to the service of charge delivery and set performance measures.	OIC	Now
10.1.12	Publish 2nd edition of EV Charging Infrastructure Guide.	OREF	2018
10.1.12	Use the EV Charging Infrastructure Guide as standard	OIC	Now
10.1.12	Ensure critical parts are locally held and that warranty options are taken up when any new public infrastructure is installed.	Charge point owner (OIC)	

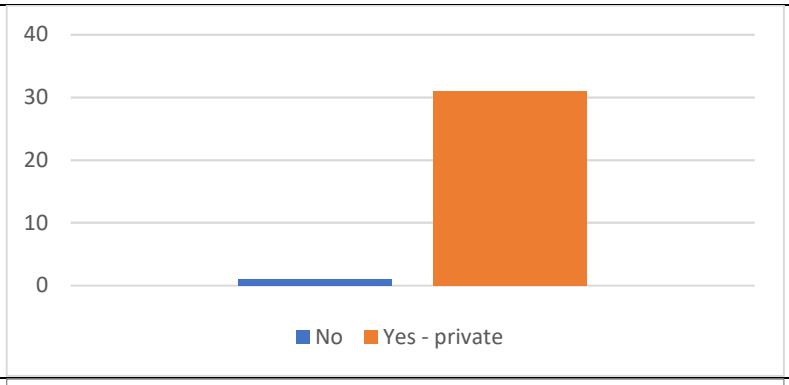
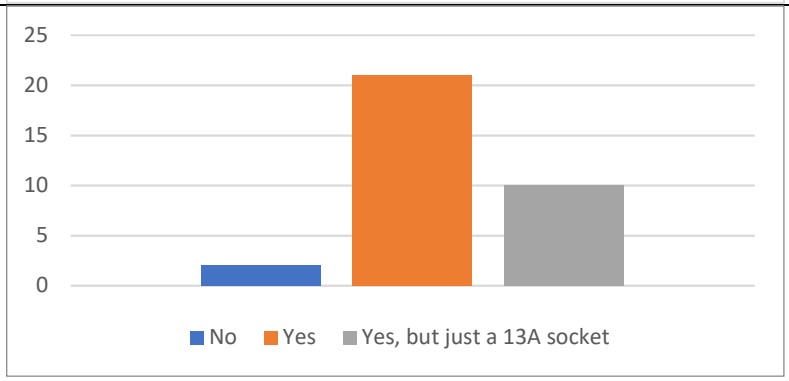
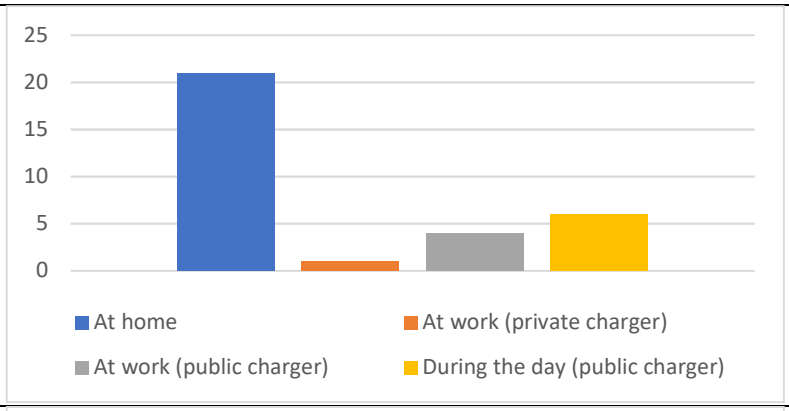
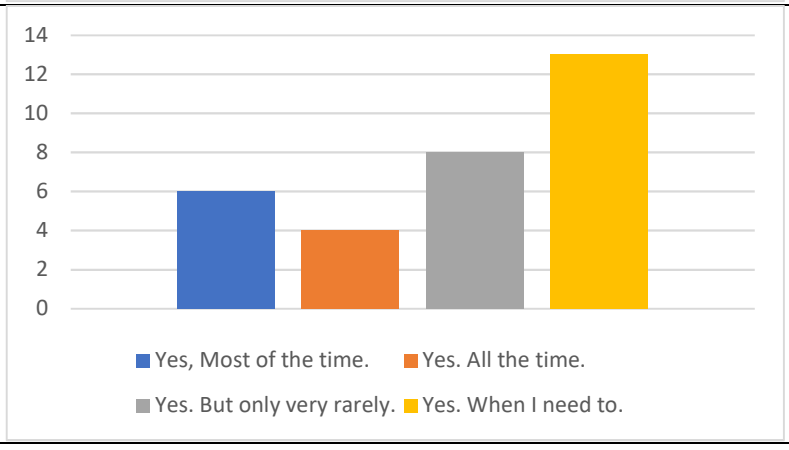
10.1.12	Work together to train sufficient local people to undertake simple maintenance and identify the means to deliver more sophisticated servicing for 'public charging' locations and infrastructure.	OIC and Dev Trusts	
10.1.13	Establish appropriate Traffic Regulation Orders and charging mechanisms.	OIC	Now
10.2	Enable/support provision of private or public 7kW charge points at holiday accommodation.	OIC and partners	
10.2	Ensure the roads and ferries that bring people to Orkney are suitably provided with charging infrastructure	OIC and HITRANS	
10.2.1	OIC to work with HITRANS to engage with Transport Scotland ensure 5 points of issue are monitored and resolved.	OIC, HITRANS, and Transport Scotland	
10.2.1	Build EV tourism as a market segment into the 'Destination Orkney' tourism planning process.	OTG and partners	
10.3.1	Await changes to car rental model & consider any enabling actions.	All	Ongoing
10.3.2	Await emergence and test of the rural EV taxi model elsewhere.	All	Ongoing
10.3.3	Press for alternate fuelled buses through Transport Scotland.	OIC	
10.3.3	If coach provision begins to become electric then ensure suitable destination charging is considered.	OTG and OIC	
10.3.5	Mine existing travel records to determine present usage patterns and plan for the electrification of vehicles as the standard.	OIC, NHSO, and HIE	
10.4	Decide on EV 'charging for charging' process and use local experience to assist with implementation.	OIC, COSLA, HITRANS, and OREF	
10.4	Offer to pilot a national 'charging for charging' scheme.	OIC	
10.4.1	Revise EV charging signs.	OIC	
10.4.1	Change DC charging software so it stops after 60 minutes.	CYC, and OIC	

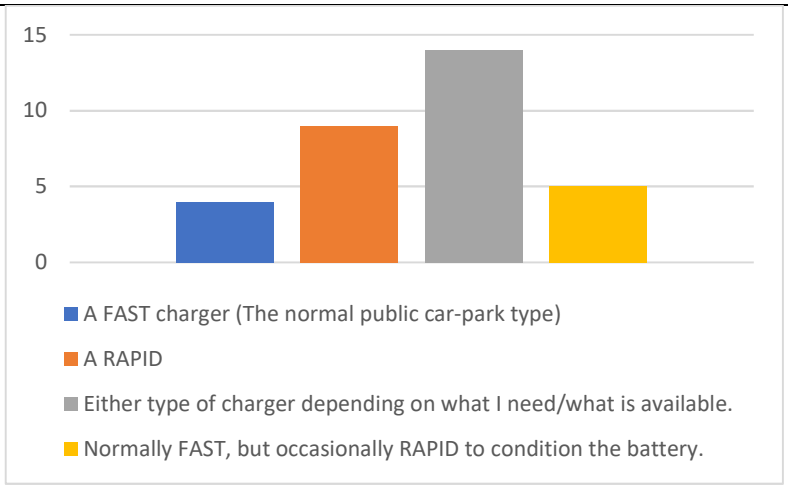
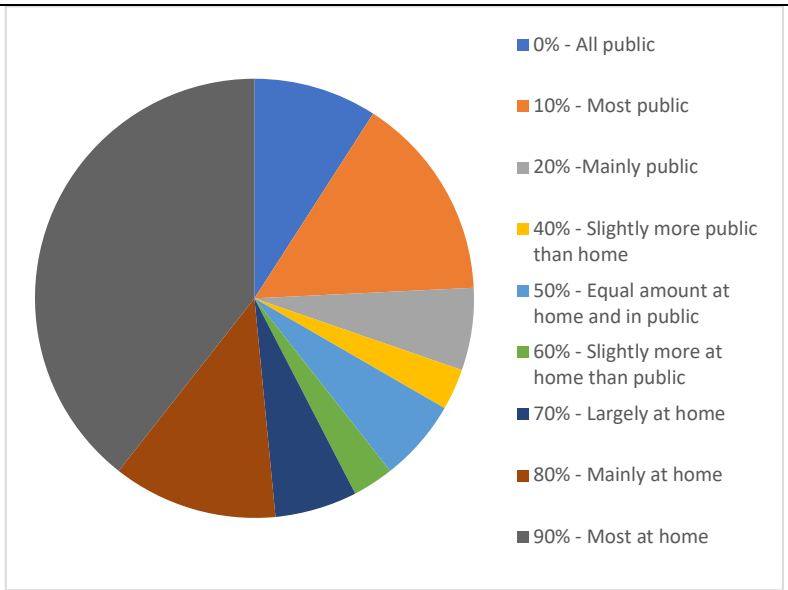
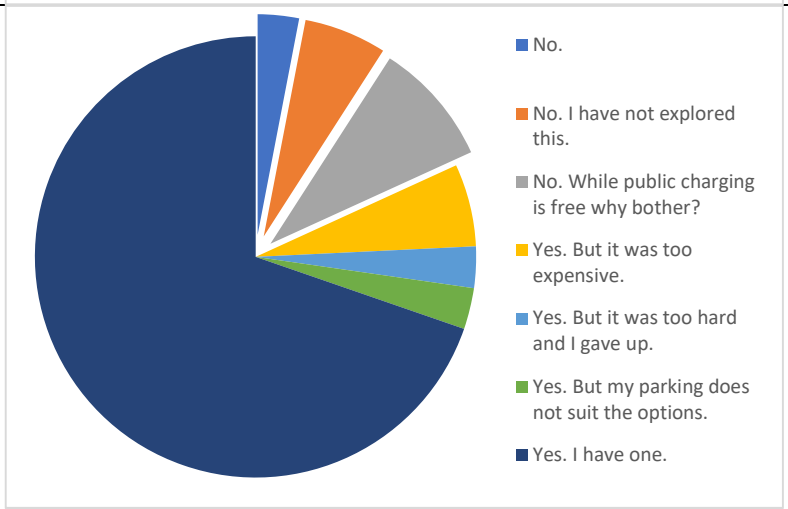
10.4.2	Insist and ensure all new charge points are set to default to 'vend' when communication is lost.	OIC	Now
10.4.2	Work with CPS to seek data from existing chargers to determine optimum data flow.	OREF, OIC, and HITRANS	Ongoing
10.4.3	Improve accuracy and consistency of mapping and seek to avoid a plethora of competing maps being developed.	Transport Scotland	
10.4.4	Produce a purchasing guide for Orkney EVs.	OREF	Spring 2018
10.5	Continue to log mileages to detect changes in use patterns and also demonstrate CO2 savings	OREF	
10.5	Explore options for more data gathering and data mining of existing travel patterns.	OIC and OREF	
10.5.1	Seek a project to prove the merit of Flexible AC /Dynamic charging.	OREF and Dev trust	
10.5.2	Promote Orkney's success to date and look for R&D deployment opportunities.	All	Ongoing
10.5.2	Seek to attract a V2G project/supplier.	OREF members	
10.5.3	Plan for EVs though the installation of ducts in car-park works in new builds such as the Hospital	NHSO	
10.5.3	Plan for the uptake of EVs and V2G through the installation of ducts in car-park works in new builds such as the new Stromness Innovation Campus	OIC	
10.5.4	Keep autonomous vehicle development under review	All	Ongoing
10.5.5	Internet of Things demonstration project to be offered with CPS as a potential solution to the communications problems.	OIC	
10.6	Audit its current plans and identify active planning measures to be undertaken.	OIC	
11	Draw up a plan with the identified parties and seek commitment from all to execute it.	OREF	Now
11	Update this Strategy in 2020.	OREF	2020

13 Appendices

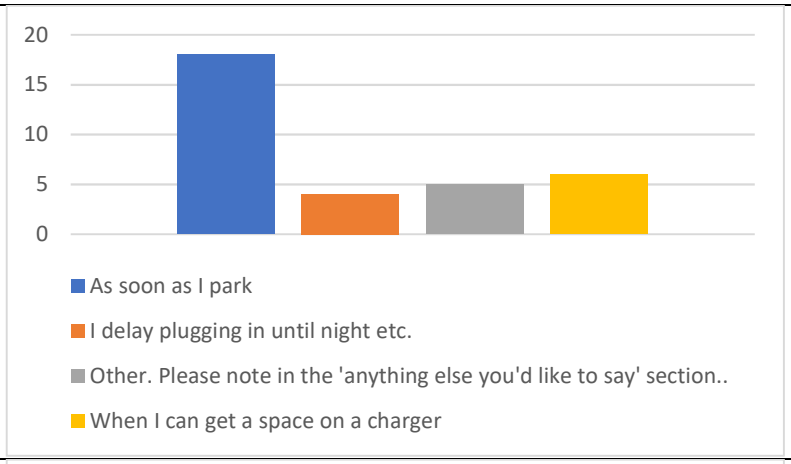
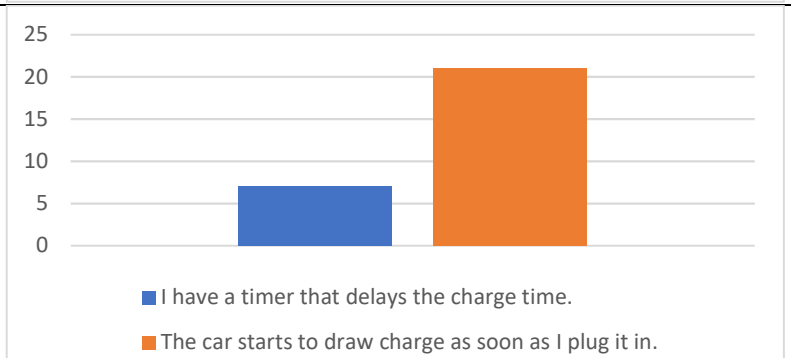
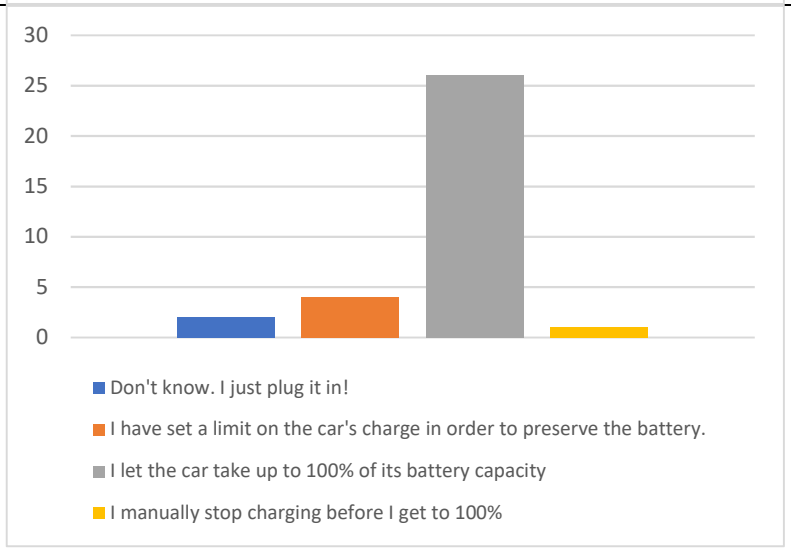
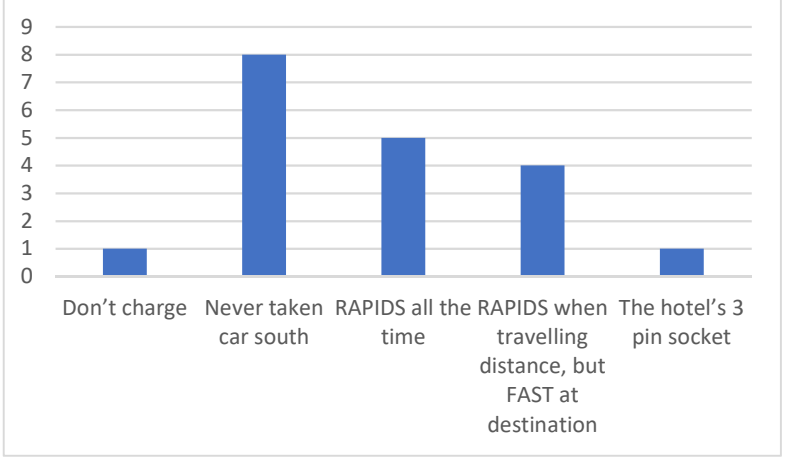
13.1 Appendix 1 Analysis of charging habits

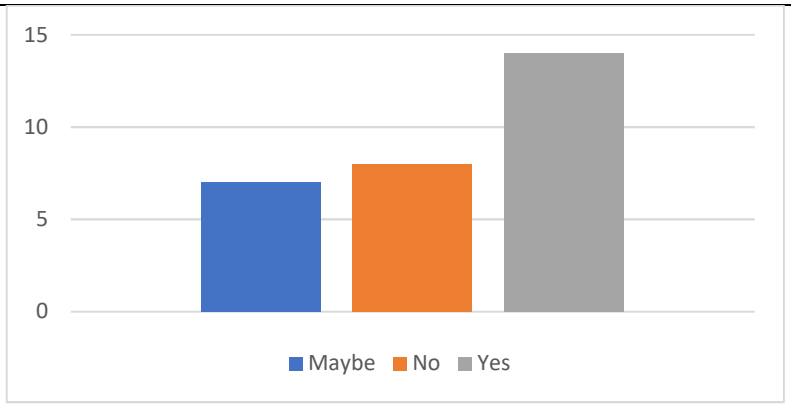
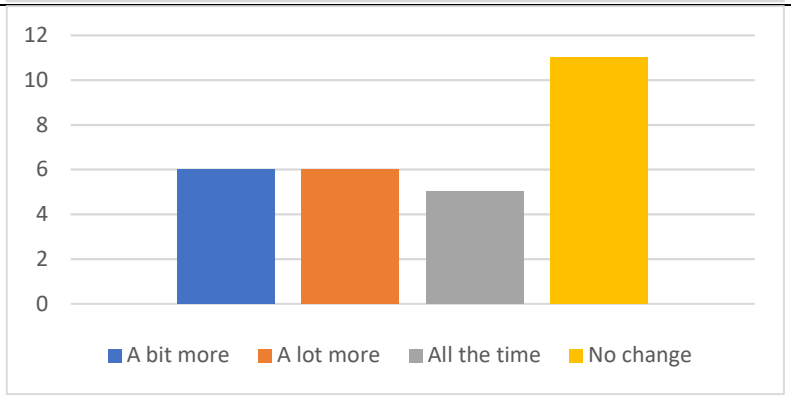
A Google poll of Orkney EV drivers was undertaken in March 2018 to look at their charging habits by asking 13 questions. 29 responses were received:

1. Do you have off road parking?	
2. Have you got an EV charge point?	
3. Where do you mainly charge?	
4. Do you ever use a public charger?	

5. What sort of public chargers do you use?[18]	
6. Please give an estimate of how much of your charging you do at home.	
7. Have you considered having a home charger?	

[18] Public chargers that can deliver between 3.6kW and 22kW have historically been known as FAST chargers.

8. When do you plug in?	
9. When do you charge at home?	
10. How much do you charge?	
11. When you travel outside Orkney, how do you mainly charge? Click the most applicable option(s)	

12. Would you use public chargers less if it was cheaper to charge at home/work?	
13. How much would you charge at home if public FAST chargers cost 20p/kWh and RAPID chargers cost 25p/kWh?	

13.2 Appendix 2 Draft EV Charge Schema

13.2.1 Objectives:

1. Supply income to charger owners/operators from EV drivers to cover the cost of electricity and contribute to the cost of maintaining facilities but keeping the fuel cost of EVs below that of petrol and diesel vehicles.
2. Encourage optimal use of public charge facilities.

13.2.2 Application:

1. All public charge points.
2. May be adopted by other organisations with private parking, but this is outside this schema.

13.2.3 Principles:

1. Home or private charging is to be encouraged through a slight premium for energy supplied by public chargers.
2. Public charging used by urban residents unable to charge at their own private charger is driven by routine need to charge.
3. Other public charging is driven by routine need. E.g. charging whilst at work.
4. RAPID charging (50kW and above) is driven by urgent need. It will be slightly more expensive than public charging.
5. Appropriate chargers will be used by drivers wherever possible.
6. Cost recovery shall be based upon the quantity of energy supplied plus a contribution to maintenance.
7. There will be a disincentive for drivers who fail to move from chargers after an appropriate time.
8. The majority of the charge is delivered before the final hour(s) of charging; roughly according with the following model.

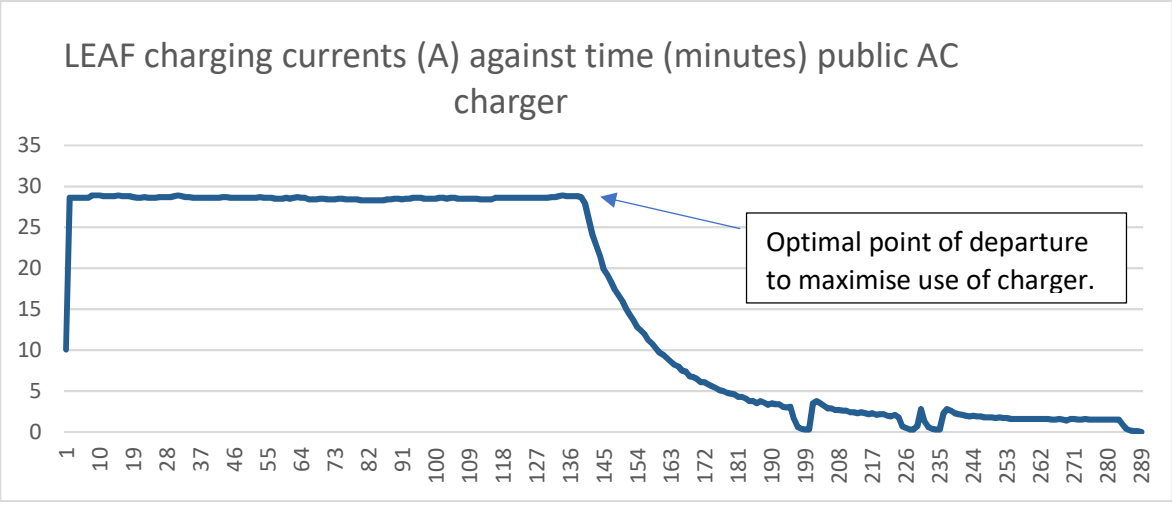


Figure 8 Example of charge rate of 6kW Nissan Leaf charging on a 7kW public charger [19]

[19] The chosen Nissan LEAF's onboard charger limits it to 6.6kW. Other EVs have other onboard charger limits.

13.2.4 Description:

Low rate charging (1kW – 6kW) will be provided by simple charge points.

The chargers will result in a lower line than that shown in the Figure 8. The end of the flat portion of the charge will be later, however the tail will remain a similar length.

The costs of installing these chargers will be low and coordinated control will be centrally provided to charge overnight or during working hours. See section 10.5.1 for a description of Flexible AC charging and dynamic charging. It is anticipated that the cars will plug in for a minimum of 8 hours although this will not be a mandatory minimum.

Public charging will use present 'council' style charge posts and deliver up to 7kW and follow the line shown in the graph.

The charge posts are anticipated to be grant aided, or secured though other means such as *'S105'* agreements/contributions. It is anticipated that the chargers will become relatively rare as charging processes become more polarised into very slow and very fast forms although they may be used to provide long charges for vehicles with larger batteries than those presently available. No vehicle is anticipated to <u>need</u> to be plugged into a 7kW public charger for more than 8 hours unless flexible charging is being undertaken.

The 50kW+ chargers will be used in a manner akin to petrol pumps. A surge of electricity will be taken on board in a short period and this service is likely to be rarely used outside of town dwellers in Orkney. It will have a place for those doing extended mileages, those who, get 'caught short' of charge, or for those in towns without adequate private overnight charging options.

50kW+ chargers are expensive to provide and place considerable strain on the electricity network. The costs of using these are therefore likely to be the highest and provided as a premium service (assuming the slower, smaller chargers are in place). The charge graph will be taller and narrower with the plateau dropping off at 30 minutes for present batteries and proportionally later as battery sizes increase. Note too that there will be little need to occupy the charger beyond the flat area and an incentive to avoid seeking 100% charging may become necessary to optimise the use of the chargers.

13.2.5 Payment:

All payments will be made through back office systems. There is no anticipated on-site cash handling.

13.2.6 Electricity costs:

There are grid benefits in seeking charging to be made off-peak/times of low demand or high supply and it is likely that in due course market signals will be sent to users. The cost of charging <u>could</u> reflect the cost of the electricity supplied which may well vary over the day, however this may not be available within the life of this strategy. A flat electricity cost per kWh should therefore initially be charged.

In order to encourage best use of the charge point it is recommended that the price of the electricity is to be higher than that paid by householders, so encouraging home charging. In addition, a premium should be charged on 50kW + chargers to reflect the additional value of the time saved. A price of 18p/kWh is recommended for most chargers and 20p/kWh for the more rapid chargers.

Note: This scheme could be altered for chargers on strategic routes where taking on board the last few miles might be important for big journeys, however this is unlikely to be the case in Orkney. Similarly, if 'Flexible AC charging / Dynamic charging' does evolve for overnight charging then a different model will be needed.

With appropriate back-office systems this variable cost can be accommodated.

13.3 Appendix 3 Ancillary benefits of the Envisaged Future:

As the uptake of EVs grow to replace Internal Combustion Engine vehicles the following ancillary benefits to Orkney will increase:

- The towns and countryside will be **quieter** than now with the removal of most of the internal combustion engines. Road noise in the countryside will be less affected than the towns as the tyre noise is the predominant element in present noise signatures for vehicles at high speeds.
- Inland **water quality will improve**. With little diesel and petrol and the implicit simplicity of EVs, the 'run-off' of hydrocarbons to the surface water system will practically disappear. Similarly, there will be less platinum being lost from catalytic converters and less dust from brake-pads. Waste rubber from tyres will, however, remain a pollutant.
- **Air quality will improve**. The absence of the emissions of particulate matter from exhausts will improve air quality as will the removal of assorted oxides. (SOx, NOx etc.)
- **Revenue will be retained**. More people will make their own electricity to charge their vehicles. They will therefore spend less on buying transport fuels. However, it would be naïve to assume that the road infrastructure will be provided for free, so there will be some other form of road pricing. It is likely, however, that there will be incentives to charge at home using domestically generated power as this reduces the burden on public infrastructure.
- **EVs will be more than just cars**. The batteries in the 10,000 EVs expected under the Envisaged Future scenario together represent an enormous electrical storage capacity. It is likely that this capacity will be mobilised on occasions to ensure grid supplies are maintained. It is expected that drivers will receive credit from making their battery available to the grid. See section 10.5.3 *Vehicle to Grid (V2G*).

13.4 Appendix 4 Isles Charging

A proposal to make Orkney's isles[20] 'EV ready' and in doing so increase tourism to the isles and maximise the use of EVs on them.

13.4.1 Background

At the Orkney EV strategy meeting on the 4th of March 2017 the question of how to make the isles more EV friendly was asked. This was in response to interest shown in EV tourism and the opportunity to build on Orkney's profile as a go-ahead county leading the uptake of EVs.

It was recognised that uncertainty as to whether one can charge on the isles is probably a disincentive to taking an EV there. In fact, most of the isles are ideally suited to the range of EVs due to their small size (Hoy being an exception due to its length). On the other hand, making the isles welcoming to EVs would provide a marketing point and might encourage green tourism to the isles.

13.4.2 The proposition

Every B&B, hotel and holiday let should be provided with a '**private** EV charge point', so that drivers know there will be charge points on the isles if they visit. It will encourage drivers to stay overnight too.

In addition, a '50kW **DC'** charger could be provided on each island if it can be justified. However, it is thought this is unlikely to be a good investment due to the generally smaller ranges travelled on the isles. If justified, the preferred location should be where the majority of journeys on the island pass by with minimal additional mileage required to access the charger.

13.4.3 What is not needed

There seems to be no need to install public 7kW chargers (the types normally installed in car-parks). These will fully charge an empty car in 4-6 hours, but on islands it is hard to see when this middle rate charger will be needed. These chargers are also around ten times the cost of private units of up to 7kW, so ten properties could be served by putting in the cheaper units rather than the public ones.

13.4.4 What should not be encouraged

Whilst it is claimed that EVs can charge from 13A sockets there is evidence that the plug and socket arrangement is not ideal and are at their operational limits, particularly if they are misused. Plugs have burnt out. A more robust arrangement is available that is designed for EVs as highlighted in the next section and which allows faster charging than the use of 13A sockets.

[20] Isles: Inhabited Orkney Islands excluding mainland Orkney and the linked south isles.

13.4.5 Technical Matters

The private charge points are available for around £300. Fitting will be extra and probably double this cost to £5-600. They are wall mounted externally on the property and supplied with a 16A fuse which allows up to a 3.6kW charge (7 to 10 miles range per hour) or where the supply is adequate a 32A fuse which allows for up to a 7.2kW charge (14 to 20 miles range per hour) depending on the EV's charging capabilities. They are normally easily accommodated in domestic settings. They are a 'permitted development' and therefore do not require planning permission.

If a present EV (such as a Nissan LEAF) is empty and fully charges then it may take on 25kWh or so of electricity, but generally less. Intelligence and control can be applied to the chargers to power them off-peak, or at times of high wind. They could fractionally contribute to reducing curtailment seen by local generation but the location of the charging will affect this significantly; this will get more significant as more cars arrive. The cost of the electricity could be under £5 for a full charge, and less if off-peak or if less than a full charge is required.

A DC 50kW charger will require a 70A three-phase electricity supply or an alternative. The costs for such a connection may be considerable, although this sort of supply may well be able to be supported by Scottish Hydro Electric Community Trust grant money. (http://www.shect.org/)

13.4.6 Possible other locations

Community Halls. Although they represent places of communal gathering they are unlikely to be priority locations for chargers other than an odd slow 7kW charger. Most people will come to the Hall from home (where they could have charged) and then be at the hall for a few hours. See 10.1.4 *Community halls*

Ferry terminals. Most people arrive at the ferry a few minutes before departure. Few people are there for longer than they must as there is little of interest at the terminals. Although public estate, and often with three-phase supplies for the link-spans, there is likely to be lower utility of chargers here than elsewhere. See 10.1.11 *Islander car clubs*

On board ferries. Ferry trips are dead time, so the opportunity to charge is initially appealing. However, the electricity supply on the ferries is provided by diesel generators aboard and so is not at all green. This should therefore not be encouraged. One exception would be the Aberdeen ferries as discussed in section 10.1.10 *Charging on ferries*.

13.4.7 Conclusion

EVs are going to come to the isles, and if Orkney moves quickly it can make a PR splash about this and be ahead of the game. Many islands have only a handful of accommodation properties, so installing charging across the whole island would be cheap and get PR value greater than the cost of the private chargers.

13.5 Appendix 5. Electric Vehicle charging and its impact on the Orkney grid.

Charging of EVs can be done anywhere a 13A socket can be found, using the cable with a 13A plug supplied with most cars at a rate of 10A. Whilst the 13A socket is not an encouraged format, it does show the ubiquity of electrical energy if needed. However, there is a complex interaction of charge rate, cost of chargers and any changes that may be required for the electricity network.

A private 10A charger installed at home may only cost pounds to install, will deliver about 2.3kW and will have relatively little impact on the grid, however it will only gain about 7 miles of range for each hour plugged in. A 50kW charger may cost £50,000 plus grid upgrade costs and deliver 40kW to 50kW initially.

There are a variety of chargers between these extremes, including faster home charging solutions that can range from rates of 3.6kW to 7.2kW on single phase supplies, or up to 22kW on a three-phase supply with some cars such as the Renault ZOE.

There are also chargers which allow faster charging at 43kW for some Renault ZOEs, and higher for cars fitted with either a CHAdeMO connector or larger connector option on the Combined Charging System (CCS). These are often quoted as 50kW chargers but the cars may limit the charge rate and often only work at around 40kW and start to reduce the charge rate at somewhere between 50% and 85% full. The Mitsubishi Outlander can use CHAdeMO but is limited to a charge rate that peaks at 18kW and drops off rapidly shortly afterwards.

Understanding the needs of those charging is critical to putting in the right sort of charger. The bigger the charger the higher the unit cost of the installation. In addition, the electricity can either be used in one large public charger (50kW to 150kW) or else used to supply several public smaller chargers (3.6kW to 22kW) or a wall full of private chargers (2.3kW to 7.2kW). Selecting the best charger for any given site is the first challenge.

13.5.1 Electricity supply requirements for public charging points.

Most existing public charge posts (7kW to 22kW) have two sockets to allow two cars to charge at once. There is no technical problem in getting a supply for such 7.2kW posts in any part of Orkney.

The cost of this sort of connection may vary considerably from a few hundred pounds to several thousand pounds depending on the length of cable required, the type of ground it must cross, whether there is already a suitable transformer in place, or if a transformer needs to be changed to a larger one, or a new transformer is required altogether.

While faster 22kW posts could be provided on every island the cost in some cases would be prohibitive. Where three-phase power is not currently available, the costs may range from a few thousand pounds to replace a single-phase pole mounted transformer with a three-phase transformer, with costs of ten thousand pounds or more per km to upgrade the high voltage network. Furthermore; if the total power required triggers the need to replace other equipment in the network then costs can rise to hundreds of thousands of pounds.

Where a location has three-phase power available then a three-phase 32A supply is a better option as it allows many types of EVs to charge at faster rates or it can allow more single-phase chargers to be installed and charge more EVs simultaneously as shown in Table 6.

Table 6 Charger types, power supply requirements and energy delivered.

Charger type		**Number of chargers able to be served by the following electrical supplies**					
	(kW)	(13A) 1phase	(16A) 1phase	(32A) 1phase	(32A) 3phase	(64A) 2phase	(100A) 3phase
TRICKLE	~1.5	>1	>2	5	15	20	45
SLOW	2.3	1	1	3	9	12	30
MEDIUM	3.6	-	1	2	6	8	18
FAST	7.4	-	-	1	3	4	9
MEDIUM 3ph	11	-	-	-	2	-	6
FAST 3ph	22	-	-	-	1	-	3
RAPID	40 - 50	-	-	-	-	1 but limited to about 25kW	1
RAPID+	50 - 150	-	-	-	-	-	1 but limited to about 60kW

The 50kW+ chargers need a three-phase supply of at least 55kW for the supply to the car and to cover the losses in the charger itself. Typically, a 66kW supply will be available i.e. 100A, and this will be able to supply one DC 50kW charger.

While a standard 66kW supply will be able to supply one 50kW charger, the same supply could support three dual plug 22kW chargers, or if special arrangements are made it could supply 9 dual plug 7.4kW chargers. This would allow up to 18 cars to charge at 3.6kW.

Thus, the same supply can have the potential to charge between one and 18 cars at the same time depending on the choices made of charger type.

13.5.2 Impact of Electric Vehicle charging on the Orkney Grid

In common with most electricity networks, the Orkney grid sees changing quantities of power flowing through it at different times. Most of the time the power flowing through the separate parts of the network is much less than the peak capacity of that part of the network.

The network can be split into separate components as follows:

- 33kV interconnections to Scotland. These are used to both bring electrical energy into Orkney and export it. While the power flow changes all the time, Orkney has been a net exporter of electrical energy every year since 2012.
- 33kV internal network. This connects to the 33kV interconnectors at the main intake substation where the voltage for the internal network is controlled and feeds 14 primary sub stations. It also provides connections directly to a number of larger wind turbines.
- Primary substations. These are where the voltage is changed from 33kV to 11kV and fed out on 11kV circuits.

- 11kV circuits. These cover all the populated parts of Orkney. In built up areas, they are made up of underground cables and, in rural areas, overhead lines. The back bone of the 11kV network is three-phase but in areas with lower population density the network is single phase in order to reduce the cost of providing supplies.
- Secondary substations. These reduce the voltage further from 11kV to 400V three phase or 230V single phase and in some areas 230-0-230V split phase[21]. Secondary substations can be ground mounted and are normally the size of a shed or mounted on poles.
- Low voltage networks. These are either overhead lines or underground cables.

Each of these components can see power flowing in either direction because of the large amount of renewable generation operating in Orkney. However, not all the existing 11kV circuits, secondary substations, and LV networks in Orkney see this. The charging of EVs will always take additional energy from the grid. This will increase load flows at times when Orkney is importing energy and will reduce load flows when Orkney is exporting energy.

Viewed at the 33kV level, the use of EVs will reduce some of the potential limits on exporting electricity from Orkney. It should be recognised though that most of the curtailment of generation is due to limits on parts of the internal 33kV network and to a lesser extent the 11kV network so that some EV charging may not make much difference.

Increasing the number of EVs charging at any given time will affect the Orkney grid. There are no known issues with capacity at Primary substations and therefore the chargers suggested in this five-year plan are not expected to increase load sufficiently to cause any issues.

There are potential impacts of the additional charging expected under this plan. This may affect the peak load of the Orkney grid as follows:

A) An increase in total EVs over the life of the plan from around 130-150 to 1,000. Owners of EVs will choose a mix of domestic charging options ranging from 2.3kW to 11kW. However, because of the large number of EVs which will be expected to charge at home, diversity will mean that the actual extra load on the network at peak time will be much less than the sum of the charge points installed. The use of smart charge points and flexible charging, able to delay charging away from peak load times, is likely to result in a decrease in the peak load on the network.
B) Provision of private charge points at tourist accommodation. The impact of this is going to be like another home owner having an EV, but as tourist numbers are low at peak load times (which occur in winter) the impact will be negligible.
C) Provision of multiple 7.2kW public charge points at tourist locations around the mainland, linked south isles and Hoy. At peak tourist times, these are likely to add just a few hundred kW to the network load however these times do not coincide with network peak load times. Some tourist and general public use of cafes and eateries during peak network load times may result in some tourist locations adding to network strains. The choice of four 7.2kW single phase charge points (two posts) keeps loads within acceptable values on the 11kV and 33kV networks and limits expenditure to the reinforcement of secondary substations and the provision of LV supplies from them.

[21] Split Phase allows higher power devices to be connected in areas where the 11kV network is only single phase.

D) Provision of a flexible AC charger at Kirkwall Airport. This is envisaged to be actively managed so that it provides the energy required by the parked EVs outside the early evening peak load. This will require a new supply.
E) Provision of faster (up to 150kW) public DC chargers in Kirkwall and Stromness. Use in summer by tourists will not impact on peak load but use by locals at the end of the working day can be expected to increase total network load by as much as 1,000kW (1MW). Most of the time this will not be a problem as there will be sufficient energy available from renewables to allow the chargers to operate at full output. It might be necessary to limit charge rates during the 5pm to 7pm peak load time in winter when it is cold and windless.

There may be a small number of secondary substations and LV networks which need reinforcing in order to cope with local loads but the effects on 11kV and 33k networks is expected to be minimal.

Impacts C, D, and E will each be associated with the provision of new supplies from the SSEN network. These need only be 30kW split phase for the 7kW public chargers, though where three phases are available then 66kW supplies should be taken so allowing future expansion. The airport flexible AC charger could similarly be limited to 66kW.

However, the faster 150kW+ DC chargers will need large power supplies. Perhaps 350kW for Stromness and 600kW for Kirkwall, however as a new secondary substation will be required at Kirkwall, it would make sense to plan for future expansion and install a substation rated at 1,000kW.

In summary, the plan laid out will increase peak demand by perhaps 1MW over the period 2017-2022. Most of the time this increased demand will not present any problems and at times of high renewable output will potentially reduce the amount of curtailment of generation required. During the rare event of peak load occurring at times with very low or zero renewables output then the Rapid+ chargers may need to be restricted until the 33kV interconnectors to Scotland are reinforced. The exact time scale for interconnector reinforcement is not known but earliest estimates suggest 2022 which is outside of the life time of this plan.

13.5.3 Future developments

Faster 150kW chargers are already available in some areas and will become increasingly important as cars with larger batteries start to appear in 2018. It would make sense to not install any further 50kW rapid chargers in Orkney but to wait and start to install 150kW chargers in 2018 so that they are available for tourists who may come to Orkney from the summer of 2018 onwards. It's not clear what these chargers will be called but for this document they are referred to with the term faster DC chargers.

Even faster charger options up to 350kW are being discussed. While these may develop in the early 2020s, there would not appear to be a compelling case for ever having chargers of this capacity in Orkney. This is because across the range of car types, they will be able to drive between 2 and 4 miles per kWh of energy. At the suggested 150kW rate this is 300 to 600 miles of range gained per hour or between 10 and 20 minutes to gain 100 miles of range which is sufficient to do a tour round the Orkney mainland.

There are some places where three phase 22kW chargers make sense as well. First as back up to a 50kW+ charger where low usage rates don't justify installing multiple 50kW+ chargers. Second at places you might visit for a couple of hours such as sports centres, cinemas, shopping centres.

13.6 Appendix 6. Alternative Fuelled vehicles

This strategy document recognizes that there are alternative low fossil energy sources which could be used in road vehicles. The immediate technologies are:

- Renewable hydrogen
- Cryogenic liquids (liquid air or liquid nitrogen)
- Compressed bio-gas
- Synthetic liquid hydrocarbon fuels

For the timeframe under consideration, renewable hydrogen and cryogenic liquids are the only two viable options for Orkney. We will however continue to monitor the others.

13.6.1 Hydrogen

Renewable hydrogen can be generated by the electrolysis of water using renewable electricity, or from bio-gas using a reforming system.

Electrolysis is a technique that uses a direct electric current (DC) to drive an otherwise non-spontaneous chemical reaction. When the method is used on water, oxygen is produced at the anode, and hydrogen at the cathode. Each gas can then be collected separately.

Reforming generally involves the breakdown of methane contained in bio-gas at high temperature (generally above 800C) over a catalyst to produce carbon dioxide, carbon monoxide and hydrogen through chemical synthesis with oxygen. This gas is often referred to as “syngas” and has wide manufacturing applications. The reaction is highly endothermic requiring large amounts of energy to maintain the temperature. There are various reforming technologies commercially available. The supply of oxygen is either done using elemental oxygen or oxygen contained in the water compound. The carbon monoxide component is then converted by adding steam over another catalyst (at about 300 to 400 0C) allowing the water-gas-shift reaction to take place yielding a gas containing carbon dioxide and hydrogen. The reforming system finally separates the carbon dioxide from hydrogen, the carbon dioxide is generally vented, but could form part of a carbon capture scheme.

As there is little bio-gas in Orkney, renewable hydrogen from electrolysis is the only practical manufacturing solution. In September 2017, the first hydrogen was made from tidal power in Orkney by EMEC.

When hydrogen is used in vehicles, it is converted to power using either an internal combustion engine or a fuel cell. Hydrogen cars and trucks are commercially available and there are options to combine with other energy sources such as dual fuel hydrocarbon engines and batteries with or without hybrid/plug-in options.

13.6.2 Cryogenic Liquids

Cryogenic liquids (liquid air or liquid nitrogen) are manufactured by compressing and chilling air. The temperatures achieved are below -194C. The heat extracted during the chilling process is generally low grade and can be used to heat buildings. The liquids can be stored at atmospheric pressure in insulated containers and shipped as required. During storage, there is some small amount of heat exchange with the environment, and this causes boil-off, so it is best if the liquids can be stored long term in large storage vessels to minimise energy loss.

The boil-off and the required expertise in handling cryogenic liquids will mean that their use is limited to industrial vehicles where battery power is not a practical solution.

In the UK, cryogenic liquids are currently on test in commercial buses and refrigeration units using a Dearman engine. It does offer an opportunity in Orkney to de-carbonise large engines (tractors, shipping, trucks) however a cryogenic plant would have to be built locally. This cryogenic plant could also be part of an energy storage scheme and should be powered by renewable energy, therefore a carbon free fuel.

13.6.3 Compressed bio-gas

Bio-gas may be compressed and stored on-board a vehicle for fuel. In a number of European cities, buses operate on bio-gas. However, the supply of bio-gas in Orkney is limited as animal waste is poor for bio-gas yield. Although there is potential for some higher yielding bio-gas food/crop waste, the quantities are low compared to the other alternatives. Compressed bio-gas is more suited where there are dense populations.

13.6.4 Renewable Synthetic Liquid Hydrocarbon Fuels

A synthetic liquid hydrocarbon fuel is often described as not being derived from fossil sources. However, some do accept that this can include natural gas. Historically, synthetic fuels could also be derived from coal! Synthetic fuels could also come from carbon dioxide which has been captured from the air or by the burning of fossil fuel. To align with government carbon reduction targets, the fuels should not contain direct fossil carbon hence we define the product as renewable synthetic liquid hydrocarbon fuels and these could include:

- Petrol (gasoline)
- Diesel
- Kerosene e.g. Jet A1
- Liquid Petroleum Gases (LPG's) e.g. propane, butane
- Methanol
- Dimethyl ether
- Other middle distillates (e.g. naphtha)

There are many chemical pathways (e.g. Fischer-Tropsch, alcohol to distillate) for the synthesizing of the above products, however fundamentally you need large quantities of renewable (or recycled) carbon and renewable hydrogen. Although renewable hydrogen is now available, there is not enough renewable carbon on Orkney.

The Flotta terminal does have small volumes of waste carbon which could be recycled with renewable hydrogen to make low carbon synthetic liquid hydrocarbon fuels. However, it would be better to make low carbon synthetic aviation fuel as there are no other energy technologies certified which can be used in commercial aircraft.

14 Feedback

This Strategy has been written by EV driving OREF members during 2017 and following public consultation.

OREF are therefore interested in views and comments about this document and they can be sent to Office@oref.co.uk