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In the Shetland Islands tidal power provides electricity for charging points

The rise and rise of electric vehicles

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E-mobility has attracted huge attention with the government providing significant financial incentives to encourage the transition from existing fossil-fuelled vehicles to both pure electric and low emission vehicles. Over the last decade, additional government financial funding was provided to establish a robust and pragmatic EV charging infrastructure across the UK as well as contributing to further grant support towards the cost of domestic EV charging stations.

Consequently, and despite, the headwinds of rising energy prices due to the on-going Russia-Ukraine conflict, post Covid challenges and the current cost-of-living crisis, the electric car market has maintained steady growth with over 590,000 pure-electric cars on UK roads at the end of October 2022 and over 1m plug-in models (including plug in hybrids), according to NextGreenCar[1]. What's more, in November 2022 there were 36,752 charging points representing 60,701 connections at 21,906 locations countrywide according to EV charging app ZapMap[2].

Together with major advances in the proportion of renewable generation represented both within the global as well as the UK's energy industries in respect to their total generation mix, decarbonisation of transport has become a more serious contender in the transition to a net zero climate change target by 2050. The UK has stated that all new vehicles should be zero emission and the large automotive organisations have gradually directed their research and development (R&D) budgets to the production of zero carbon vehicles.

The UK has legally committed to achieving a net zero-carbon economy by 2050 and expects to fulfil this ambition by ending sales of new conventional petrol and diesel cars and vans by 2030 with hybrid vehicles only permitted until 2035.

Classifications of vehicles

The main classifications of electric vehicles (EVs) are:

- **Battery Electric Vehicles (BEVs)** which utilise electric motors powered by a rechargeable onboard battery. The latter can also generate energy through the car's own braking system to recharge the battery in a process known as 'regenerative braking';
- **Plug-in Hybrid Electric Vehicles (PHEVs)** which can be simultaneously powered by an electric motor and internal combustion engine (ICE) but which require to be charged from an external charge point;
- **Hybrid Electric Vehicles (HEVs)** which employ both an electric motor powered by a battery and ICE where the latter charges the battery and therefore does not require access to an external charge point; and
- **Extended-Range EVs (EREVs)** comprise the same components as PHEVs but the wheels are always driven by an electric motor with the ICE acting as a generator to recharge the battery when it is depleted.

Fuel cell electric vehicle

Other low carbon vehicles include: **fuel cell electric vehicles (FCEVs)[3]** which comprise an electric engine that utilises a mixture of compressed hydrogen and oxygen obtained from the air with water representing the only waste product from this process.

Increased EV sales will inevitably lead to a significant increase in electricity demand especially during the evening peak when the majority of EV owners are assumed will be charging their vehicles once they reach home from work. This will demand increased network grid reinforcement both at the local distribution network and at national level. To partially mitigate this potentially onerous cost impact on developing enhanced grid networks in the near future, intelligent digital technologies will be increasingly incorporated within EVs in the medium to long term. In the short term, high premium EVs such as the Volvo EX90[4] – due to be released in 2023 and will have two electric motors controlling both the front and rear axles to provide four-wheel drive – with a battery capacity of 111kWh. This will be Volvo's first electric model to have bi-directional charging capability allowing it to charge another EV with a low battery charge. This capability is being explored further to determine whether load management services could be provided directly to the Grid i.e. Vehicle-to-Grid (V2G) technology.

The International Energy Agency (IEA)[5] has stated that after a decade of growth, the number of electric cars worldwide will reach the 10m mark representing 1 per cent of the total vehicle count. BEVs accounted for two-thirds of new electric vehicle (EV) registrations and comprised 66 per cent of the total stock in 2020. China has the largest EV fleet comprising 4.5m EVs while Europe has a total of 3.2m EVs which includes BEVs, PHEVs and light commercial vehicles.

Phasing out the ICE

During CoP26 in 2021, the then UK Prime Minister, Boris Johnson, re-emphasised the country's commitment to 'phase out ICE vehicles by 2035' and end their sales by 2030. As of March 2022, there are more than 840,000 plug-in vehicles registered in the UK comprising a combination of

460,000 BEVs and 380,000 PHEVs.

Initially, the government concentrated on providing plug-in grants for the purchase of EVs but the focus has turned increasingly towards investment countrywide on charge point (CP) infrastructure. Total funding committed to vehicle grants and infrastructure is now anticipated to amount to £2.5bn with £1.6bn dedicated to EV charging infrastructure to meet government's plans to achieve 300,000 public EV CPs by 2030. This will result in CPs outnumbering existing conventional fuel pumps by a factor of 5.

£950m will be assigned to a rapid charging fund (RCF) which is envisaged to fund 6,000 high powered charge stations across England's motorways and major A-roads by 2035. This is expected to future-proof electrical capacity on strategic roadways in preparation of increased EV uptake. The private sector will be encouraged to likewise deliver CPs where this is commercially viable.

A further £500m will be offered to local authorities (LAs) to enable them to extensively develop 'high quality' EV charge point coverage. This complements the financial support given to 140 LAs since 2017 in respect of an On-Street Residential Charge-point Scheme (ORCS) designed to install 4,000 CPs.

Workplace charging scheme

A Workplace Charging Scheme (WCS) – which will be extended to Small and Medium size Enterprises (SMEs) - is also offering up to £350 discount off the cost and installation of an EVCP for a total of 40 sockets.

However, from 1 April 2022, the UK government has withdrawn the Electric Vehicle Home-Charge Scheme (EVHS) and replaced it with the EV CP grant. The latter provides funding of 75 per cent of the costs of purchasing and installing EV CPs in a domestic property - to a maximum of £350 (including VAT).

Other financial incentives for would be EV purchasers have included exemption from Vehicle Excise Duty (VED) for BEVs due to their zero CO2 tailpipe emissions. In contrast, PHEVs are subject to a VED levy varying from £10-140 depending on their specific vehicle's CO_2 emissions in the first year of ownership but then PHEV owners face an on-going annual charge of £140 in subsequent years. However, in the 17 November 2022 budget, the UK chancellor, Jeremy Hunt, outlined in his Autumn Statement that from 2025, EVs will be subject to road tax which could become a financial barrier in the medium term to the purchase of future EVs which is also currently already amplified by the cost-of-living crisis.

Although there will be a slight increase in their future running costs, the added attraction of EVs has been supplemented by new BEVs incorporating larger battery capacities which will provide increased driving ranges comparable to that of conventional fossil fuelled vehicles with up to 200-300 miles of driving range from a fully charged battery.

Other zero emission technologies in transport have included FCEVs such as the Toyota Mirai which is reliant on hydrogen as a fuel and whose waste stream is predominantly water vapour. This latter genre has required substantial financial support from the UK Government and has led to the construction of a number of hydrogen fuelling stations.[6]. Although they represent a relatively small number, FCEVs allow rapid charging and offer a driving range equivalent to modern medium sized conventional vehicles of around 300 miles.

Common EV anxieties

There are still 'key anxieties' exhibited by prospective EV purchasers with the more frequent ones characterised as follows:

The average price of the majority of mid range EVs fall in the range of £25,000 - £30,000 and therefore, in some instances, the overall cost of an EV can represent almost double that of a conventional family saloon. However, manufacturers plan to accelerate their transition to the production of BEVs which should inevitably lead to increased economies of scale and therefore a gradual fall in the price of the latter.

Although the upfront capital costs of EVs are still currently more expensive to buy outright than traditional ICE cars, prospective EV owners should base their purchase decision on the total cost of ownership over four years according to the latest government findings. The latter addresses common misconceptions regarding the premium cost of ownership of EVs relative to conventional vehicles. It emphasises that an EV owner could save c. £170 per 1,000 miles in running costs which would completely offset the EV price premium at the end of four years of ownership. This is predominantly due to the running costs for EVs equating to c. 2 pence/mile when charging the vehicle using off-peak electricity compared to the c. 20p/mile for petrol (and even higher for diesel) fuel costs for ICE cars. In addition, the fewer moving parts in an EV translate to less maintenance costs. Further financial incentives are also available for EVs including (until 2024) zero road tax and favourable company car tax rates – which are expected to save some EV drivers over £2,000/year.

Apart from reduced maintenance costs other non-financial benefits of EVs include:

- **positive impact on air quality leading to improved health benefits;**
- **increased safety precautions in the event of an accident;**
- **reduced effect on climate change (despite the need to recycle the batteries); and**
- **a major contribution to tackling noise pollution.**

Additional monetary benefits are anticipated with business EV owners through the implementation of V2G technology which will encourage the development of demand response service offerings (Flexibility) from local DNOs[8]. This could take the form of discharging batteries during a DNO's peak demand periods and therefore offsetting or delaying the capital costs necessary for localised grid reinforcement. EV owners could also benefit from reduced electricity costs when recharging during off-peak hours when there is a surplus of generation capacity. Nissan offer V2G compatible EVs in the UK with both their Nissan Leaf BEVs and the enV200 van models[9].

Numerous financial payment methods have been formulated to accelerate the transition to EV ownership without having to incur the full upfront capital cost of an EV. In particular by leasing over a 2/3/4 year periods with fixed monthly fees inflation-proofing your vehicle costs for the duration of the lease.

A lack of conveniently accessible EV charge points close to home and their driving range limitations – commonly referred to as range anxiety – have often been blamed as reasons for delaying their EV purchase. Especially for those without access to off-street parking at home, increased reliance will be placed on workplace charging or 'community hubs' located within retail, hospitality, leisure centre car parks, etc. UK Government funding has been increased to encourage both the number of charge points strategically available around the UK and the range of fast charging capabilities.

Initially, the low carbon transportation sector was dominated on the supply side by the large global auto manufacturers developing niche markets in EVs. However, a robust and widespread EV charging infrastructure capability was becoming a necessity and had to be more price competitive. This encouraged the entry of new CP service providers such as BP's Chargemaster, Shell's Ubitricity and PodPoint.

Home charging is slow

EV charging has taken various forms. Home charging is generally provided at 3.7kW or 7kW as most domestic properties have single phase power facilitating a driving range of c15-30 miles. For those households benefitting from a three-phase supply and most commercial properties, faster charge points of 22kW are now fairly common. Nevertheless home charging is still regarded as slow charging and best used for overnight charging as a BEV would take between 6-12 hours to fully charge while a PHEV might take 2 -4 hours. Whereas fast charging can take 3-4 hours to fully charge a BEV using an output of 7kW at single phase or 22kW at three phases.

One of UK's leading providers of domestic smart EV charging points is PodPoint[10] and one of their standard wall boxes is pictured. Installation of a PodPoint application will also allow access to their extensive network of other public charge points across the UK.

Some energy suppliers offer special 'electric vehicle' tariff structures which encourage EV drivers to charge overnight by offering a discounted unit rate for electricity that equates to c2p/mile. Island utility companies such as Manx Utilities[11] offer a specialised EV tariff which provides a discounted rate of 12p/kWh (2022) pricing off-peak



Home charging is generally provided at 3.7 or 7kW



The availability of EV charging from lamp posts is increasing steadily

relative to their standard rate of 22p/kWh.

Public charging stations for EVs are becoming more commonplace. As of October 2022, there were 59,059 charging points (CPs) at 21,378 locations around the country according to EV charging app specialists Zapmap.

An increasing number of large organisations operating significantly sized vehicle fleets are gradually transitioning to low-carbon technologies as the speed and capacity of commercial EV charge points have improved. Public charging points (CPs) are being established in various forms ranging from dedicated charging hubs where more than 40 cars can be charged simultaneously to chargers incorporated in lamp-posts and on bollards in residential streets to facilitate overnight charging for EV owners whose properties do not have a driveway. This is the case with Shell's Ubitricity which operates the UK's largest public charging network for electric vehicles through on-street lamp post and bollard chargers.

Fast charging up to 100kW

The advent of Rapid Charging comprising either 43kW AC chargers or 50kW DC chargers with even larger EV capacity up to 100kW is now become more readily available. The larger EV stations are capable of charging the majority of EVs to 70-80 per cent of total capacity within 30 minutes to 1 hour depending on the size of the battery. However, the rising cost of electricity during 2022 has been accompanied by a significant rise in the average cost of public charging. Research instigated by the RAC has revealed that the average cost of a Rapid Charge (up to 100kW) increased by 72 per cent in the last 12 months to September 2022 while an Ultra-Rapid charge has increased by 87 per cent.

Some vehicle manufacturers such as BMW, Porsche and Ford are supporting the need to reinforce the grid infrastructure to develop an ultra-rapid (350kW) EV charging network in Europe which will recharge EVs in less than 20 minutes.

Large EV Charge Point Operators (CPOs) have also established collaborative alliances with utility service companies and National Grid to provide fast and ultra-fast EV charging capability ranging from 50kW to 150kW and as large as 350kW. This has encouraged organisations operating large commercial fleets such as delivery vans to switch to all–electric alternatives – zero emission vehicles (ZEVs) as is the case with British Gas / Centrica [12] and which utilise a 'virtual fuel card' for EV charging.

The majority of EVs have a relatively short driving range of c150 miles compared to conventional ICE based vehicles. However, the next generation of EVs such as the popular Nissan Leaf has a driving range of c180 miles while the latest Tesla Model S has a range of over 310 miles.

Increased lithium ion battery capacity and advances in battery storage technologies is already leading to major improvements in the total driving range of modern EVs. Given that the average vehicle journey is c9 miles/day than the range of an EV should not be a major concern. Access to home charging and the development by the public and private sector of a wide range of fast and ultra-fast EV charging stations will also contribute to building confidence and allaying prospective EV purchasers' anxiety regarding the perceived short driving range of the average EV model.

EVs are regarded as very energy efficient with 60 per cent of the electrical energy from the national grid is converted to power at the wheels in contrast to the 20 per cent of the energy stored in conventional fuels for ICE vehicles. Other environmental benefits consist of zero emission of CO2 and other tailpipe discharges.

Advancements in EV technologies and additional incentives are expected to lower the cost of EV batteries reducing the Life Cycle cost of EVs compared to conventional ICE cars. EDF - a major energy supplier in the UK - has suggested that across the lifecycle of an EV the latter is around 14 times more carbon efficient than a typical ICE vehicle.

Petrol mixed with ethanol

Advances in bio-fuel production have resulted in low carbon emission solutions by powering ICE vehicles with petrol mixed with ethanol with petrol and diesel with methyl fatty acid. Percentage mixes of up to 10 per cent - known as E10 petrol – has been at fuel courts across the UK. This is expected to cut transport related CO2 emissions by 750,000 tonnes a year. Motorists will be expected to take advantage of a new E10 compatibility checker to determine whether their vehicles can effectively use this higher percentage of ethanol in petrol. Ethanol will comprise low-grade grains, sugars and waste wood and will greatly support the UK Government's ambitions to achieve net zero by 2050[13].

Growth in e-mobility is expected to continue at a high pace but major changes will be required in the interaction between the EV customer and the local electricity supplier as the latter anticipate increasing challenges on the resilience of their networks particularly at peak charging times.

For 2030 zero emission targets to be met rapid transformations are expected in the transport and e-mobility landscape from the universal and ubiquitous adoption of ultra-fast wireless charging of EVs to the design and development of high energy battery systems. Current designs of EV batteries are comparatively heavy in order to deliver the required driving range capability. This translates into more energy being consumed in a single journey. Developments in the 'highly energy dense solid state cells' sector will lead to batteries with better energy storage, a more compact design and the capability of being fast charged. Alternative forms of low and zero emission transportation schemes have been trialled including compressed natural gas, liquid natural gas and liquid petroleum gas.

Impact on electricity demand

With rapid EV growth forecast for the coming decade, the National Grid Electricity System Operator's (NG ESO's) Future Energy Scenarios Report[14], 'Community Renewables', considers the impact of this growth on electricity demand. The report projects that unconstrained EV charging demand at peak times could rise to approximately 24GW by 2050 However, NG ESO also highlights that this demand could be significantly mitigated by implementing smart charging techniques and further reduced by exploiting V2G techniques for load control and the provision of flexibility services to the local DNOs.

To avoid system peaks a number of alternative and innovative load control measures have been explored including the integration of EV charge point infrastructure with renewable energy sources. This has been explored by the Shetland Islands where tidal power is the fuel supply for the Island's EVs[15] .

REFERENCES

1 https://nextgreencar.com/electric-cars/statistics/
2 https://www.zap-map.com/statistics/
3 https://www.mdpi.com/2624-6511/4/1/22
4 Autocar Magazine - January 2023 pp8-11
5 https://www.iea.org/reports/global-ev-outlook-2021/trends-and-developments-in-electric-vehicle-markets
6 https://www.driving.co.uk/news/the-future-of-hydrogen-filing-stations-in-britain/
7 https://www.biffa.co.uk/media-centre/news/uks-largest-fleet-of-electric-waste-vehicles-launches-in-manchester
8 https://theenergyst.com/uk-power-networks-awards-123mw-of-flex-contracts-evs-included/
9 https://www.nissan.co.uk/range/electric-cars/v2g.html
10 https://pod-point.com/about
11 https://www.manxutilities.im/your-home/electricity/electric-vehicles/
12 https://www.centrica.com/media-centre/news/2021/centrica-introduces-virtual-fuel-card-for-electric-fleet-charging/
13 https://www.gov.uk/government/news/fuelling-a-greener-future-e10-petrol-set-for-september-2021-launch
14 https://www.nationalgrid.com/uk/stories/journey-to-net-zero-stories/eso-future-energy-scenarios-next-30-years
15 https://www.novainnovation.com/news/news_/i per cent20tidal-powered-cars-driving-scotland-to-net-zero/

ENTRY FORM

Please mark your answers below by placing a cross in the box. Don't forget that some questions might have more than one correct answer. You may find it helpful to mark the answers in pencil first before filling in the final answers in ink. Once you have completed the answer sheet, return it to the address below. Photocopies are acceptable.

Questions

1) What's the difference between a Battery Electric Vehicle (BEV) and Plug-in Hybrid EV(PHEV)?
- ☐ No battery
- ☐ No electric motor
- ☐ Includes an internal combustion engine (ICE)
- ☐ No difference

2) What are the benefits of V2G technology?
- ☐ Does not require a battery
- ☐ Can re-charge another EV
- ☐ Can provide demand support to local DNO
- ☐ No benefit

3) The UK Government's Road to Zero policy anticipates that PHEVs will be phased out by:
- ☐ 2025
- ☐ 2030
- ☐ 2035
- ☐ 2040

4) What's the current value of the UK's Plug-in grant to encourage purchase of EVs?
- ☐ £2,500
- ☐ £3,000
- ☐ £0
- ☐ £3,500

5) Which model of car is not a pure battery driven EV (BEV)?
- ☐ Nissan Leaf
- ☐ Tesla X
- ☐ Mitsubishi Outlander
- ☐ Renault Zoe

6) What is the quoted driving range of a Fuel Cell Electric Vehicle (FCEV) such as the Toyota Mirai?
- ☐ 100 miles
- ☐ 300 miles
- ☐ 500 miles
- ☐ 50 miles

7) What is the highest EV charge capability currently available for commercial use?
- ☐ 100
- ☐ 350kW
- ☐ 150kW
- ☐ 50kW

8) What is the ethanol content of the bio-fuel known as E10 in petrol?
- ☐ 10gms
- ☐ 10cc
- ☐ 10 per cent
- ☐ 100 per cent

9) What is a gigafactory?
- ☐ Electronic chip manufacturer
- ☐ High-volume battery manufacturer
- ☐ Solar panel manufacturer
- ☐ Wind turbine manufacturer?

10) What is the source of renewable energy used to charge EVs in the Shetland Island?
- ☐ Hydro
- ☐ Wind
- ☐ Solar
- ☐ Tidal

Please complete your details below in block capitals.

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