RENEWABLES SCOTLAND 2030

A discussion paper on how to transform Scotland's energy sector by 2030

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COMMON WEAL POLICY

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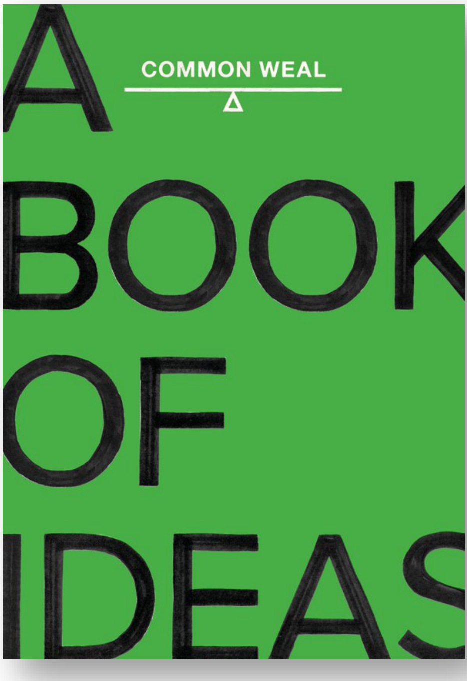

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Executive Summary

This report takes a look at the condition of the Scottish energy industry in comparison to UK and European policies, and looks into options available for Scotland to become an international leader in green technology.

Key Points:-

- UK energy policy since 1980 has failed Scotland. It has led to the six largest energy companies seeing profit margins rise 4.48% since 2016, with 34.9% of households in Scotland currently facing fuel poverty.
- The Scottish Government should invest in energy infrastructure and electric vehicles to meet 75% of overall energy demand by 2030.

Energy Infrastructure

- Scotland has only captured 0.06% of marine energy potential. The Scottish Government should boost R&D in wave and tidal technology, with an aim to capture 25% of marine energy resource by 2030.
- Scotland is on track to meet 100% of electricity demand by 2020. The Scottish Government should look to invest in grid modernisation and energy storage to increase efficiency and decrease costs to consumers.
- The Scottish Government should create a not-for-profit energy company with municipal control, led by a Scottish Energy Agency.
- The Scottish Energy Agency should work with the NorthConnect project to provide Scotland with a route to export its additional renewable resource to mainland Europe.
- Create a National Battery Technology Innovation Centre to drive investment in new innovative battery technology, working with universities.

Electric Vehicles

- Low Emission Zones should create a strategy to slowly increase the level of emissions banned as we move towards a full ban of petrol and diesel vehicles by 2030.
- Create an electric vehicle strategy which increases focus on access to electric vehicles, with an aim to have electric vehicles meet 50% of the car market share.
- Increasing electric vehicle energy use would see an average energy demand increase by 3.82GW.
- Invest £82m in additional funding to build up Scotland's charging infrastructure, with an aim to see five charging stations for every 1,000 electric vehicle drivers.

Autonomous Distribution

- Autonomous vehicles require testing trails in Scotland to have a greater understanding of the market. £19m would be required for testing cars in rural and urban areas, but tests would also be required for shipping and platooning.
- Agricultural technology requires £20m in R&D investment to boost the technology with an aim to implement autonomous testing.
- To meet the legal and ethical guidelines for autonomous vehicles a Connected Autonomous Vehicle Centre is required.

Renewable Shipping

- 15 of the 33 ferries in the Caledonian MacBrayne fleet have an operational profile that makes electric (eight) and hybrid (seven) ferries profitable, with three already run on hybrid technology and two soon to come into service.
- £62m in additional investment is required to meet the green ferry demand by 2030. £121m would be saved in operation costs over a 10 year period, with a return in 5.5 years.
- All ferry services run by Caledonian MacBrayne should be run on electric or hybrid vessels by 2030 with an additional 0.0025GW added to the energy demand.
- Create a Carbon Fund wherein the business sector commits to achieving certain emission reductions through payments to an environmental fund, and these are then fed back to industry actors as investment support for additional costs incurred in enacting measures to reduce emissions.
- Additional strategies in defence, broadband, housing and fishing are required to enhance the efficiency of Scotland's energy policy.

Preface

First Minister Nicola Sturgeon has announced the creation of a Scottish national energy company, with a focus on renewable energy.[1] This signals an increased role for the public-sector in directly meeting Scotland's enormous potential in green energy technology.

This paper will look at options available for Scotland to become an international leader in the fight to tackle climate change and assisting Europe with its energy demand, utilising a public-sector led approach.

The paper sets a 2030 timeline for achieving this transformation, focusing on the changes needed in energy infrastructure, electric vehicles, autonomous distribution and renewable shipping.

Introduction

Scotland has missed the opportunity to develop the North Sea oil industry as efficiently as Norway has, which has seen its oil fund reach over $1 trillion in assets.[2] The UK Government has favoured privatisation in the North Sea allowing the majority of Scottish oil wealth to be captured by private companies, with a number of energy companies being privatised in the 1980-90s under Conservative Government's, including:[3]

- British National Oil Corporation,
- British Gas Corporation,
- British Petroleum,
- Rolls-Royce,
- Central Electricity Generating board (National Grid, National Power & Powergen)

The United Kingdom's energy industry is now dominated by six electricity and gas supply companies. These companies (and their respective nationalities) are:[4]

- Centrica/British Gas (UK)
- Scottish Power (Spanish)
- Scottish & Southern Energy (UK)
- EDF (French)
- E.On (German)
- Npower (German)

Energy prices in the UK are soaring to some of the highest in Europe. The big six energy companies have increased their electricity prices as follows:[5]

- Scottish & Southern Energy raised their prices by 14.9% in June 2017.[6]
- Scottish Power raised their prices by 10.8% in March 2017.
- EDF raised their prices by 8.4% in March 2017.
- E.On raised their prices by 13.8% in April 2017.
- British Gas raised their prices by 12.5% in September 2017.[7]
- Npower raised their prices by 15% in March 2017.

The six largest energy companies may argue that their costs have risen, requiring them to increase prices to keep the companies profitable. The profit margins for these companies have hit the highest level on record, rising 4.48% from 2016.[8] In contrast to these large profits recorded, 34.9% of households in Scotland currently face fuel poverty.[9]

In 2018 the Energy & Climate Intelligence Unit identified network costs as accounting for 27% of the total cost to domestic energy bills.[10] Further, the paper asserts that high network costs are one of the reasons why British industry pays more for electricity than most of its European competitors. An earlier report showed that the six companies operating electricity distribution networks made profits averaging 32% of revenue.[11]

The Energy & Climate Intelligence Unit stated: "These businesses are monopolies operating in a non-competitive environment, and the services they provide are essential - therefore, they are among the lowest-risk investments available. Yet, their profit margins are far higher than in many markets that are genuinely competitive - including energy generation and retailing."

The short-term profit goals for private companies have prevailed over successive UK Government's since 1979. UK energy policy over the past three decades has been based on the privatisation and marketisation of the energy sector, using private companies to drive down costs through increased competition. However, with absence of capacity constraints, reports have indicated that the effect of privatisation has allowed the energy market to form an oligopoly, affecting the price structures.[12] Companies have been identified as targeting a pricing structure that favoured quantity of use rather than charging an on average-cost price basis. This means that increasingly higher-income groups, including businesses, were charged less. This has singled out lower-income groups with one study finding that customers that use pre-payment meters can pay up to 40% more compared to those using direct debit. Prices for consumers had fallen until 2002. However, France (where the energy sector has remained largely nationalised) had a similar experience during this period, so the problem of high prices cannot be put down to privatisation alone. Since then, prices have risen with knock-on effects on consumers.

The reliance on private firms has led to an extraction of wealth, with private finance prioritised above infrastructure requirements. This has allowed private and public firms from foreign countries to have more control over UK energy interests. UK ownership over its energy distribution network is just 11.5%.[13]

The purpose of this paper is to identify how to further enhance the energy sector in Scotland. Looking at the infrastructure in place now, this paper will discuss how best to develop the energy sector so that it is better suited for renewable technology, electric vehicles (EV), autonomous vehicles, the shipping industry and the adaptability of new energy storage systems.

Electrical Infrastructure

Scottish resource

Network infrastructure plays a crucial role in creating a link between energy generation, supply and consumption. The network facilitates access to the market through shared supply. These assets deliver a wide range of social benefits to the population.

However, lack of regulation of the private, commercial and natural monopolies of the "big six" energy companies means Scotland's network infrastructure is extremely inefficient and requires a large scale transition. An enhanced information technology system is required for a "smart" electricity grid.

It is also important to build renewable infrastructure at all scales, providing clear incentives to decrease the carbon footprint in Scotland and meet 75% of Scotland's energy demand through renewable technologies by 2030.

Scotland is very rich in energy resource, however it has been widely underdeveloped. Scotland is currently producing the following power capacity:[14]

- Onshore wind: 6.767GW produced, 11.5GW potential,
- Offshore wind: 0.187GW produced, 25GW potential,
- Wave/Tidal: 0.013GW produced, 21.5GW potential,
- Sewage sludge digestion: 0.007GW produced, potential is variable,
- Anaerobic digestion: 0.033GW produced, potential is variable,
- Solar Photovoltaics: 0.328GW produced, potential is variable,
- Landfill gas: 0.116GW produced, potential is variable,
- Energy from waste: 0.018GW produced, potential is variable,
- Hydro: 1.632GW produced, 2.7GW potential,
- Animal biomass: 0.013GW produced, potential is variable,
- Plant biomass: 0.0196GW produced, potential is variable,

That creates a total of 9.309GW of power capacity with a potential of over 60GW.[15]

It should be noted that the production of energy is also reliant on the capacity factor of the type of production. For example wind energy has a capacity factor of around 25% in 1993 but has since risen to 37% in 2017.[16]

Assuming a capacity factor of 30%, we would see a total of 2.7927GW (24,464GWh) of power produced.

Wave and tidal power have higher capacity factors as their resource is constant, creating a base load of supply. However, as tidal and wave generation are early in their development, there is great potential to optimise implementation. Scotland has broken world records in tidal generation, with the MeyGen project, run by Atlantis Resources, generating 700MWh of electricity from two turbines in August 2017. That is the equivalent of heating 2,000 homes from two turbines.[17] In 2014 researchers from Edinburgh University estimated that 1.9GW was available in the Pentland Firth, between mainland Scotland and Orkney.[18] Scotland's marine energy sector had invested £217m by 2014, with 62% of the supply chain based in Scotland. This is of great benefit to local economies. It is estimated that Scotland's marine energy sector could be worth £50 billion by 2050. That is dependent on Scotland building up wave and tidal energy, which is currently 0.06% of total potential of 21.5GW, with some estimates expecting marine energy to reach 33GW. Scotland should seek to increase R&D investment in wave & tidal energy, with an aim to see 25% of the resource being captured by 2030, which would provide an additional 5.375GW.

There is significant additional capacity in development across Scotland, with projects under construction at 2GW, projects awaiting construction at 6.4GW and projects in planning at 3.2GW. This means that current and future production should reach 21.1GW. With Scottish total demand at 20.2GW, Scotland should meet 100% of electricity demand by 2020.[19]

With 100% electricity energy being met by 2020, Scotland still needs to additionally build up its renewable heat and transport infrastructure, as the targets for this are a tenth of Scotland's targets for electric energy. The renewable energy targets set by the Scottish Governments is:[20]

- Renewable electricity: 100% by 2020, currently at 54%,
- Renewable heat: 11% by 2020, currently at 5.3%,
- Renewable transport: 10% by 2020, currently at 3.1%
- Energy consumption: -12% by 2020, currently at -15%
- Overall renewable energy: 30% by 2020, currently at 17.8%

For a Scottish Energy Strategy, Scotland should also identify the possible increases to electricity demand through changes in technology. The introduction of EVs to the Scottish vehicle market could increase an average energy demand by further 3.82GW.

With the offshore wind and wave & tidal generation capacity for expansion, Scotland could become a major exporter of renewable energy to mainland Europe. But it requires a revolution of green investment to boost an industry which could supply thousands of jobs and create the infrastructure to become a world leader in renewable technology.[21]

Scotland needs an energy strategy that is capable of building this infrastructure. This paper suggests looking at two models; the Nordic development model and the German municipal model. We will then discuss how this can influence a Scottish model for 2030.

Nordic development model

Collective learning and knowledge formation is a key asset to the Nordic regional energy focus. This collectivist approach has led to the Danish wind energy industry operating without patenting prototypes, with no patents until the mid-1990s. Norway and Denmark have more decentred economic decision-making in the energy industry, with public, private and civic associations being involved in the formulation of policy. All organisations are subject to democratic processes, including election of board members.[22]

There have been five key principles to the Nordic approach:

1. Resources should be commonly owned to benefit the community as a whole rather than vested interests.
2. Resources should be geared to social need rather than private economic returns.
3. Support for principles of collective learning and knowledge formation.
4. Development of decentred institutional structures that spread economic decision making power.
5. A mix of forms of collective and public ownership that allow strategic planning at higher levels to fuse with local democracy and community participation.

German municipal model

Germany's energy sector has been going through a municipalisation period, with 72 new municipal power utilities being established. Having also gone through a period of privatisation in the 1990s, the electrical power supply of municipalities in Germany has seen an increase in public ownership. The local authority has identified that municipalisation offers the opportunity to implement an independent energy policy at local level. This is critical in creating a transformation to a sustainable energy system based on energy efficiency and renewable energies. Creating a municipal energy company allows strong governance in the local energy market. The return for each municipality running its own local utility is significant when the focus is on affordable energy as opposed to increasing returns.[23]

Assessing the performance based on ten targets related to the energy transition, climate protection, and the local economic impact, German studies have shown that the trend towards the municipal ownership of local utilities produces the following "high to very high" criteria:

- Achieving environmental objectives and organization of the local "Energiewende".
- Higher local added value.
- Harnessing tax regulations for improving municipal services.
- Improving the income situation of the city.
- Democratization of supply and stronger orientation towards the common good (public value).
- Creating and protecting good jobs.
- Acting in social responsibility in energy supply.
- Expansion of eco-efficient energy services.
- Harnessing customer relations and public image.
- Materialising synergies with other sectors.

Scotland 2030 model

To lead the Scottish 2030 model for energy infrastructure, the creation of a Scottish Energy Agency (SEA) will be required to oversee the sector and set key targets and objectives, similar to those described by the German and Nordic models. The SEA will be required to prioritise renewable energy on cost analysis, detailing how best to identify which technologies have the most cost/power efficiencies, so to keep costs to the consumers as low as possible. The SEA and its subsidiaries should be run as a not-for-profit national energy company, with local authorities in control of supply, and generation controlled nationally.

A Scottish Electricity Generation Corporation (SEGN) will be responsible for generation, grid-network and distribution of electricity produced in Scotland. This will be the main body to re-build the national gird, under the direction of the SEA. The SEGN would also coordinate the pricing arrangements and delivery of the service across the system. The SEGN would be responsible for meeting the sector targets for carbon emission reduction.

For increased community involvement, the Scottish local authorities will run Local Energy Companies (LEC) in similar fashion to the German municipal method, increasing democracy of supply and decreasing energy costs. However, in some areas local authorities could look to combine electricity generation and supply companies to provide better service to its constituents. For rural areas, more community-based schemes might be developed that would be in the position to generate surplus electricity to the national grid.

A Scottish Renewable Energy Network (SREN) should be created to promote more localised forms of public ownership. SREN would be responsible for providing direction towards renewable energy, and would be made up of all the established LECs in Scotland.

The SEGC would become the owners and operators of local distribution networks – currently controlled by the Distribution Network Operators (DNOs). From here LECs would then be responsible for the domestic supply.

For the Scottish model to be successful, a list of objectives to complete by 2030 should be identified[i] to ensure the energy company is running for the benefit of Scotland:

1. Reducing fuel poverty levels and price discrimination between consumers so that access to green energy can benefit everyone in society, with an aim of eradicating fuel poverty in Scotland.
2. Achieving environmental objectives with a 75% target for generating Scotland's energy demand through

[i] Strategies identified in the Energy Infrastructure section of this paper have previously been identified by Common Weal. For further detail please read Repossessing the Future: A Common Weal Strategy for Community and Democratic Ownership of Scotland's Energy Resources, authored by Andrew Cumbers, Mike Danson, Geoff Whittam, Gordon Morgan and George Callaghan, September 2013.

renewable technologies by 2030.

3. Increasing the participation within local authorities by decentralising the utility supply and creating a model of collective and public ownership.
4. Investing in green and smart technology to create further efficiencies within the infrastructure without disrupting the cost to consumers.
5. Ensuring social value is optimised through creating not-for-profit structures to meet consumer demand.

The UK currently regulates the energy policy, thus to nationalise the industry fully in the model discussed, Scotland would either require independence or devolution of the energy policy with the SEGN utilising the infrastructure of SSE and Scottish Power to manage the network.

North Sea oil

Although the SEA will be targeting renewable technologies to meet its energy demand, it would also take responsibility over North Sea oil & gas.[24] Nationalisation of the sector has passed its stage of desirability as the assets have reached a point of decline, as well as the large decommissioning costs that would be required for the North Sea.

A strategy that obtains 51% of all new oil & gas fields would develop greater public control. The rate of production will need to be managed at a reduced pace. This will be necessary so that any price fluctuations can be mitigated against. Further, as a non-renewable resource, oil & gas will play a decreasingly important part in the national energy strategy as renewable technology becomes more efficient and cheaper.[25]

Oil & gas is significant to Aberdeenshire and the surrounding areas. So as not to dramatically affect the local economy, a plan of diversification and weaning off the reliance on oil & gas is necessary to encourage job security. A decommissioning strategy is also needed to control the reduction of oil production in the area.

Each local authority will need to work with the SEA so that they can strategise how to change the industry without having adverse effects on the local economy.

Energy Infrastructure

Scotland has the potential to become interconnected into the European energy market with the aim of sharing renewable resources, such as Italian solar PVs supplying Scotland with energy, or Scotland exporting its massive wind and marine potential to Latvia or Croatia. This creates a pan-European, carbon-free, durable and sustainable energy supply, through a European “super-grid”.

NorthConnect is a group that have proposed an important scheme currently going through the processes of approval.[26] It is proposed that a 400 mile HVDC interconnector will be laid across the floor of the North Sea, connecting Scotland (Peterhead) to Norway (Samnanger). With construction expected to start in 2020, the NorthConnect route will be the first to connect Scotland to mainland Europe. Norway has already got an interconnector route to Denmark and the Netherlands, with two more additional routes planned to Germany.

NorthConnect is a Norwegian company set up by four electricity companies: Agder Energei, E-CO, Lyse and Vattenfall.[27] The make-up of these companies are as follows:

- Agder Energei: A private Norwegian company with 45.5% state ownership.
- E-CO: A public Norwegian company that are municipally owned.
- Lyse: A public Norwegian company that are municipally owned.
- Vattenfall: A public Swedish company that are wholly owned by the Swedish Government.

SSE were at one point involved in NorthConnect but in 2013, they backed out.[28] A Lords Committee made it clear that the Norwegian Government was unwilling to contemplate a Norway to Scotland interconnector project if it would be privately owned at the UK side, such was the importance for the Norwegians of the grid being state-owned. SSE are a private company headquartered in Perth, and were fined in 2013 for a record £10.5 million by regulator Ofgem for miss-selling gas and electricity to the public.[29]

With Scotland’s massive renewable energy potential, there is further potential to export additional power that is generated to mainland Europe. Scotland should be looking at similar countries nearby, and see the examples that they are setting.

The Scottish Government should look to involve the SEA into this project so that Scotland’s major energy export route can be state-owned by Scotland as well as Norway and Sweden. Projects of this importance should remain in public hands. After the failure to capture the benefits of North Sea oil as well as Norway, if Scotland were not to be represented in the NorthConnect project it would be a very significant missed opportunity, and could be a sign that renewable energy is “business as usual”; a continuum with the failed North Sea oil legacy.

Grid Modernisation

Smart grids are having an increasingly important role to play in energy infrastructure, as they have the potential to create a completely decarbonised electricity system. A strategy to implement a smart grid and grid storage within communities would better capture the capacity factor of renewable technologies.[30]

Orkney has been home to the UK’s first ‘smart grid’ since 2009. This network has allowed the same amount of renewable energy to be connected to Orkney’s distribution network as would have been possible by conventional network reinforcement, at a fraction of the cost.[31]

Active Network Management (ANM) allows power flows at several points on the network to be monitored, and controls the flows from renewable generators. The technology allows central control from 'pinch-points' across the network to meet a more efficient supply.

Scotland currently runs the UK's first large-scale battery on Orkney. The battery is a 2MW lithium-ion device connected to the distribution network through the islands ANM system.[32]

On the Isle of Eigg, residents benefit from batteries connected to hydro schemes, wind turbines and solar PV panels. The ability to store energy from these schemes has resulted in 98% of power on the island coming from a renewable source. Grid-scale batteries can reach a power capacity of around 100MW currently, with an efficiency of up to 90%.[33]

Energy storage

With a 'smart grid' in place, and 50-years of electricity storage in Scotland (with the Cruachan Power Station opening in Argyll in 1965), there is a requirement to build up Scotland's energy storage to better meet the needs of renewable energy and provide security of supply to Scottish consumers. This paper proposes focusing on a grid-scale battery storage system to best meet the needs of the public and ensure adaptability of new and fast-coming technologies.[ii]

A battery storage system is an electrochemical device that stores electrical energy in the form of chemical energy, with the ability to later re-convert the energy back into electricity. A range of these systems exist such as lead-acid, lithium-ion, metal-air and flow batteries. It should be noted that lithium-ion is the current battery of choice for EVs, which has seen an increase in efficiencies.[34] The battery storage system can operate in a range of scales.

This system can be utilised to balance demand and supply and alter the frequency of the electricity of the grid. Grid-scale battery storage has great capability with renewable energy generation. In the short term, large-scale batteries can be used for other services such as regulating the frequency of electricity from renewables generation.[35]

This has an advantage over pumped hydro storage as this is not reliant on the geography and can provide ancillary services to the electricity grid. This system also allows a variety of batteries, meaning that a best-fit approach can be taken which sees newer and more improved batteries with better efficiency being implemented without affecting the infrastructure of the grid.[36]

With the increase in domestic generation in Scotland (principally through rooftop solar PV) there is a growing market for domestic energy battery storage to allow consumers to better manage their energy usage. For off-grid communities in Scotland, or those in areas with insufficient grid access, these home-based storage solutions can allow for a secure and stable energy supply.[37]

With the rise in potential of supercapacitors, new technologies will play an increased role in meeting Scotland's energy demands.[38] To keep up to date with this progress, a National Battery Technology Innovation Centre (NBTIC) is required to drive the investment in battery technology so that Scotland can develop both grid-scale and domestic scale batteries to boost the efficiencies in Scotland's renewable energy market to bring down costs and increase over-supply for exportation.

Creating access to this Center in each university across Scotland can be an important step to ensuring innovation and building a network of experience that can drive these technologies to the forefront.

Renewable District Heating Network

The Scottish Government needs to identify opportunities for district heating to encourage more investment in renewable heat. With Scotland currently meeting 5% of renewable heat, with a government aim to meet 11% by 2020, more should be done to bring this closer to 100% by 2030.

Local authorities should be required to maintain a heat map of the constituent area, allowing each area to identify failures in their heating network. These maps should identify the heat loads distribution and supply, which can better source renewable energy to meet these heat loads.

Two previously proposed policies should be reconsidered which allow Local Authorities to overcome financial barriers to district heating schemes. The Planning Policy Statement on Planning and Climate Change would allow Local Authorities the power to force new developments to connect to existing district infrastructure. The Community Infrastructure Levy recovers the up-front costs of district heating schemes from new developments.

To compliment this, existing developments should also be allowed to pursue similar policies, which can allow replacing or substantially upgrading heat generating facilities with a target of increasing green facilities. Further, a 'smart grid' of the heating network should also be adopted to ensure similar efficiencies as seen in the electricity network.

All new builds of 50 houses should be linked to some form of district heating, allowing for the generation to be easily upgraded with sources, electricity, geo-thermal, hydrogen from local electrolysis etc. There needs to be major changes to building regulations to improve this.

Housing strategy

To better meet heat demands, the Scottish Government should develop a strategy to decrease the demand for heating. This can be accomplished through a housing strategy. A National Housing Company can be created to build intrinsically warm social housing to meeting housing

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[ii] Liquid air energy storage has been discussed previously by Brian Richardson with the release of The Future of the Energy Storage industry in Scotland in January 2014 by the Jimmy Reid Foundation, and should be read to learn more on additional energy storage proposals.

demands. Further, this company should be created to build and install district heating systems (where one boiler serves an entire block of houses or flats via insulated piping, greatly improving efficiency).[iii]

Affordability

Scotland has a massive resource of renewable energy, and with the policies detailed above, could become a mass exporter of energy to regions of the UK and mainland Europe once its own energy demands have been met.

Common Weal has previously called for the creation of a Scottish National Investment Bank (SNIB) which utilises a Scottish Government injection of £225 million of 'paid-in' capital with that accumulated figure over six years being 'subscribed', giving a total subscribed capital of £1.35 billion from year one. The SNIB should be allowed a leverage ratio of 2.5 times the amount of subscribed capital, meaning it could raise £3.37 billion that would be available finance for SNIB loans from year one.[iv] With this investment system setup, Scotland could find the capital to invest in its energy infrastructure detailed in this paper.

Electrical Vehicles

Electric Vehicle Policy Comparison

The UK has failed to implement effective policy to introduce more EVs to the vehicle market. Below is a comparison of UK to Norway, the Netherlands and Germany;

The United Kingdom:[39]

- Free EV charging
- The Plug-in Car Grant—covers 35% of the cost of a car (up to a maximum of £4,500) and 20% of the cost of a van (up to a maximum of £8,000)
- Exemption from cannula circulation tax
- Private use of company cars, reducing the taxable income benefit based on the CO2

These policies have seen proven to be ineffective in Scotland with more than 99% of road vehicles run on petrol (53%) or Diesel (46%). Electric and hybrid cars make up less than 1% of vehicle share, with 4,500 new electric and hybrid registrations in 2015, a 25% increase from 2014.[40] The UK has an average number of charging stations of 0.31 for every 1,000 registered vehicles.[41]

Norway:[42]

- No purchase/import taxes (1990)
- Exemption from 25% value added tax (VAT) on purchase (2001)
- Low annual road tax (1996)
- 50% reduced company car tax (2000)
- Exemption from 25% VAT on leasing (2015)
- No charges on toll roads or ferries (1997 and 2009)
- Free municipal parking (1999)
- Access to bus lanes (2005)

96% of EV owners in Norway have access to a charging station in their own homes. For those without access to a charging system at home or travelling extended distances, Norway also has a well-established charging system. Norway is also home to the world's largest EV fast-charging station, opened in Nebbenes (60km north of Oslo).[43] Norway has an average number of charging stations of 2.4 for every 1,000 registered vehicles.

Netherlands:

- New car registration tax - based on CO2 emissions per vehicle, and is zero for zero emission vehicles, which can save thousands of dollars compared to high CO2 emitting vehicles. Plug-in Hybrids (PHEVs) get a graduated reduction.
- Ownership tax - a tax based on vehicle weight and type of powertrain. ZEVs are exempt from this tax while PHEVs get a weight reduction credit.
- Tax exemption on private use of company cars - private use of a company car for more than 500 km adds a taxable benefit to an employee's income. Again ZEVs are exempt from this and PHEVs receive a graduated reduction. This is significant because around 90% of PEVs are registered to companies.

Over 50% of the EVs in the Netherlands are SUVs. This is because taxes are based on the size and weight of the vehicle, with most significant benefits being earned on the largest EVs. The government then reduced the amount of exemptions for heavy EVs in 2016.

This tax was significant because it could save a top-percent tax earner from 6,000 to 7,000 euros ($6,600 to $7,700) per year. The benefit was reduced because many plug-in hybrid owners were running their vehicles on gas or diesel instead of electricity. The government hoped that this move would encourage more EVs, but instead the Netherlands experienced a 73% drop in sales in the first six months of 2016. The market recovered somewhat by year-end, but overall EV sales declined.

Charging infrastructure in the Netherlands has been achieved with public-private partnerships. This partnership is a consortium of regional and state-owned electricity grid operators. Netherlands has an average number of charging stations of 1.1 for every 1,000 registered vehicles.

Germany:

- Ownership tax - Ten-year exemption for BEVs registered before 2016 and a five-year one for BEVs registered between 2016 and 2020. PHEVs pay the

[iii] This has been discussed in more detail by Malcolm Fraser in his Housekeeping Scotland discussion paper outlining a new agenda for housing, October 2016.

[iv] This has been discussed in more detail in Blueprint for a Scottish National Investment Bank, jointly by Common Weal and the New Economics Foundation. Written by Laurie Macfarlane in October 2016.

tax, which is lowered in proportion to their lower CO2.
- Grants - 4,000 euros ($4,950 US) for pure electric cars and 3,000 euros ($3,713 US) for hybrids. The grant applies only to cars up to a maximum list price of 60,000 euros ($74,250 US).
- Private use of company cars - the tax on the taxable benefit to employee income is reduced by a formula involving the capacity of electric energy storage in the vehicle.
- Minor incentives:
  - BEVs exempt from emissions inspection
  - Low interest loans for companies to purchase PEVs
- Preferential or free parking, access to HOV lanes, and restricted traffic zones for low emission vehicles (electric range of 40 km or more).

The funding for EV charging infrastructure primarily comes from private-public partnerships. Germany has an average number of charging stations of 0.19 for every 1,000 registered vehicles.

Electric Vehicle Policy Results

Norway has seen the greatest success with the highest share of EVs in its vehicle market than any other nation at 13.7%. Oslo has the highest share with EVs making up 20%. EV drivers identified the tax exemptions for EVs as the number one incentive. Norway also operates with a high tax for high emission Internal Combustion Engine (ICE) vehicles, which means that the price for EVs are very close.

With the high tax on ICE vehicles, the cost of the exemption on EVs can be generally covered, together with falling prices for EVs.[44]

Bloomberg New Energy Finance (BNEF) analysts predict that the falling cost of batteries, with higher demand, is leading to a tipping point in which an EV car will become cheaper than conventional cars by 2022, even if conventional cars improve their fuel efficiency by 3.5%. Senior analyst for the BNEF, Salim Morsy, said: “In the next few years, the cost-of-ownership advantage will continue to lie with conventional cars, and therefore don’t expect EVs to exceed 5% of sales in most markets – except where subsidies make up the difference. However, that cost comparison is set to change radically in the 2020s.” The report also predicts that 35% of new car sales will be EVs by 2040, cutting oil consumption by 14% and using 8% of all electricity.[45]

With falling costs of batteries and the exemptions remaining the same in Norway, EVs sales are increasing. The drop in EV sales from the reduction of tax exemptions in the Netherlands provides further proof that the tax exemptions model is working.[46]

Out of all the countries, Norway also has the highest ICE fuel prices and the lowest electricity prices. The Netherlands have similar electricity rates, however they only have slightly higher rates on ICE fuels than the UK, with Germany being similar to the UK. However all four countries are in the top third in Europe for high ICE fuel prices. So there may be room for increased energy price fixing, which can be another benefit to incentivise EV drivers.

Norway and the Netherlands have the largest number of charging stations, with significant numbers above Scotland. ChargePlace Scotland, the national network of electric vehicle charge points across Scotland, has estimated that over 700 charging points exist.[47] By comparison Norway, a country with a population similar to Scotland, currently has a network of over 7,600 charging points. Norway has also opened the world’s fastest charging station, which can charge 28 vehicles in half an hour.[48] The Netherlands can charge their cars in 15 to 30 minutes, every 50 miles along the country’s major motorways.[49]

Pollution

A report from the Royal College of Physicians and the Royal College of Paediatrics and Child Health has revealed that an average of 40,000 deaths each year can be attributed to outdoor air pollution in the UK.[50] Based on the research, Friends of the Earth Scotland have estimated that this equates to around 2,500 – 3,500 deaths each year in Scotland.[51]

Scotland will be introducing its first Low Emission Zone (LEZ) in Glasgow, aiming to reduce the illegal levels of air pollution identified in the city. LEZ’s, to be implemented by 2020, have also been announced for Aberdeen, Dundee and Edinburgh.[52]

A strategy should be created to slowly increase the level of these LEZs in the process of moving towards a full ban on petrol and diesel vehicles by 2030. A full ban on petrol and diesel vehicles should be implemented by the local authorities in LEZs once the area EV market share has reached a certain percentage of the vehicle market share, prior to 2030.

Scottish Electric Vehicle Infrastructure

With the success of tax exemptions in Norway and the Netherlands leading to increased numbers of EV drivers, Scotland should look to emulate this. Initially starting with a halt of import taxation to EVs. On top of this, VAT should be capped at 50% for purchasing or leasing EVs. This should see greater access to EVs by making them more competitive to the Scottish market.

One of the other issues is the access to EV charging stations. With Scotland’s poor record on charging stations discussed above, the Scottish Government should further incentivise building charging stations. The distance travelled on a single charge and the availability or convenience of charging points were cited as key deterrents by people who did not wish to buy an EV.

Scotland needs to develop a strategy to increase the number of EVs running on the roads. There are currently around 2.86 million cars registered in Scotland with 44% of greenhouse gas emissions coming from cars and an increase of emissions between 2013-14 by 0.7%, the car market in Scotland is in poor condition in terms of renewables.[53] Scotland should aim to target EVs at 50% of vehicle market share by 2030.

With the increase in automation in vehicles, car ownership may actually decrease over time, with fewer cars on the roads but will be more intensely used. It is a better assumption to assume that the increase in cars will slowly shrink by 2030, and this is exacerbated as the further autonomous cars begin to break the market. The number of cars in Scotland increased around 1.5% from 2014-2015. For purposes of generating a maximum power required, it is assumed that this trend continues, we can expect to have 3.57 million cars registered in Scotland by 2030.[54]

There are increased energy demands from having 1.785 million EVs running on Scottish roads. The average distance of 15,000km per year, with the average consumption of EVs at 10kWh/100km, would amount to 1500kWh (0.0015GWh) for each car per year. With 1.785 million vehicles producing 0.0015GWh, the total amount of power required would be 2677.5GWh, dividing this by 8760 hours (the number of hours in a year) an additional 0.31GW of power would be required to meet 50% market demand at a minimum. Assuming all cars charging at once the maximum demand would reach 7.33GW. Calculating the average, we would see around 3.82GW of demand, with peak times reaching between this and 7.88GW.

To meet this demand Scotland should increase infrastructure funding for charging stations with an aim to see five charging stations for every 1,000 EV drivers by 2030. This would require over 8900 charging stations to be built in Scotland. Assuming a cost of £10,000 per charging station, this could cost an additional £82m to build this infrastructure. As demand for EVs grows, so would the demand for EV infrastructure, so investment may increase gradually, with further costs in rural areas.

Public concern over the ability of EVs has gradually been allayed with improvements in battery technology. With an average cost of petrol per litre at €1.5 and an average price of electricity for EVs at €0.25Kw per hour, consumption is averaged at 5L/100km and 10kWh/100km. This equates to an annual total of €1,125 for petrol and €375 for electricity.[55] Scotland does not require free charging as the low price is incentive enough. Greater access to EVs should be targeted. Scotland could also seek to allow successful policies for EV drivers' outwith financial incentives, with access to bus lanes and free parking within LEZs.

France and the United Kingdom plan to ban petrol and diesel cars by 2040,[56] in contrast the SNP aim to achieve this by 2032.[57] The ban is a symbol of significant progress, however without a detailed plan of how to decrease the use of petrol and diesel cars and increase the market share of EVs, the practicality of the ban is weakened. A ten year national strategy is required to increase the EV market to 50% by 2030, with a ban commencing once the target has been reached. If the Scottish Government were to announce a ban prior to meeting the target, lower-income groups could become increasingly singled out.

Hydrogen can be an acceptable alternative where the technology is not yet ready to allow for full electrification. This can include goods vehicles, shipping and aircraft and it should be considered where electric engines are unfeasible.

Autonomous Distribution

Autonomous Framework

Industry and society are becoming more and more digitised as autonomous machines continue to grow in all aspects of life. AVs are fast becoming the technology of the future, but we must implement policy now so as not to stunt the growth of this important technology.

The legal framework for AV implementation will need to be prepared prior to mass use. A national programme that will test the use of AVs within certain council districts, both rural and urban, will be required to better understand the structure of AVs in Scotland. This will better shape the legal framework of the efficiencies of AVs.

There have been five identified levels of AVs:[58]

- L0: Driver only; Driver continuously in control of speed and direction
- L1: Assisted; Driver continuously performs the longitudinal or lateral dynamic driving task
- L2: Partial automation; Driver must monitor the dynamic driving task and the driving environment at all times
- L3: Conditional automation; Driver does not need to monitor the dynamic driving task nor the driving environment at all times but must always be in a position to resume control
- L4: High automation; Driver is not required as system preforms dynamic driving in all situations during defined use case, such as urban automated driving, but automation hasn't been fully adapted to all roads including rural areas.
- L5: Full automation; System performs the lateral and longitudinal dynamic driving task in all situations encountered during the entire journey. No driver required.

L0 – L3 are considered connected vehicles, with L4 and L5 considered AVs.

L5 vehicles are still some way ahead in the future. However industry experts expect these vehicles to become operational by 2030. This paper looks to build the case for building the network required so that these vehicles can have near-seamless implementation in urban areas. Another strategy is required to meet rural needs.

In the UK, Bristol, Coventry, Greenwich and Milton Keynes have had L5 vehicle pilots in 2015 with around £19m provided to fund this.[59] The Scottish Government needs to begin its own trials with local authorities tendering bids with a fund which can pilot these vehicles in both rural and urban areas.

The AV market requires the infrastructure for new roads and communication, however AV technology has not yet reached the point where the development is capable of enabling the changes discussed below. Consideration should be given to these technologies now. This is required to avoid the short to medium term changes to infrastructure that would be required in 2030 to retrofit to make AVs implementable. Any transport infrastructure being built now and leading up to 2030 should be designed to have future compatibility, with functionality built-in.

Ofcom stated that in 2016, 6% of all UK A and B roads did not have mobile voice coverage, and 20% of A and B roads did not have any 4G mobile data coverage. However this has improved from 10% and 47% respectively in 2015. Mobile coverage needs to be improved on Scottish roads, particularly in rural areas, to take full advantage across Scotland of the possibilities of connected vehicles. Without these improvements, communities without access to fast mobile and broadband coverage could become more isolated with the implementation of AVs.[60] A strategy on building up Scotland's broadband will be required to create the bedrock of success for AVs.

Market impact

There are many sectors which will face benefits from the introduction of AV technology:[61]

- Telecommunications: The data that connected vehicles and AVs require will increase. With communication over mobile networks, this can generate growth in the data transmissions sector. PwC have estimated a growth of 12% annually until 2030 due to this.
- Insurance: With the increase in data and road safety, premiums will begin to fall significantly. Liability will then also shift from the drivers of the vehicles to the manufacturers, as the data can identify where any faults have occurred more easily.
- Public: With the fall in premiums, the public will see an increase in their capital. Further, connectivity will encourage a fall in congestion, increasing time saved and decreasing travel related stress.
- Integrated transport: More efficient arrangements can be made for public and company travel, improving road capacity and reducing the cost of transportation overall.
- Planning: Automated vehicles will be able to park themselves out of city centres allowing better use of urban space. Further, industry distribution systems can then work at low traffic level times, which further reduces congestion at busier times. The connectivity between vehicles and emergency vehicles can further increase emergency service response times.

Cybersecurity

There are important concerns over hacking susceptible AVs for malicious purposes. In September 2016, a team of hackers were able to take the control of a Tesla Model S from 12 miles away which involved interfering with brakes, door locks and other electronically controlled features.[62] Due to this, there is an increase in the need for data protection and cybersecurity, with the Scottish Government required to take a leading role to secure funding for this. Cybersecurity should fall under the remit of the Ministry of Defence, which would require a Scottish defence strategy.[63]

Autonomous agricultural development

With the introduction of AVs, farming in Scotland can change significantly, with crop production systems becoming more efficient. AVs also have the ability to increase the number of small farms. Agricultural AVs are likely to decrease in size in comparison to current farming machinery.[64]

An industrial strategy is required to boost the agri-tech industry. Previous R&D funding has reached £160m for the UK, however this has begun to decrease in recent years. Scotland should commit to investing £20m in the agri-tech industry and look at how this technology can boost the crofting communities, as well as larger farms. Bringing high technology to rural communities can provide the jobs required to assist in stopping rural populations from dwindling.[65]

Ethical concerns

In the context of AVs, there are ethical concerns over how to react to accidents involving passengers and external parties (pedestrians, wildlife, equestrian etc.), with question marks over who AVs should be designed to primarily protect. A report by Professor Newman found that "even though participants approve of autonomous vehicles that might sacrifice passengers to save others, respondents would prefer not to ride in such vehicles".[66]

The manufacturing of these systems shouldn't prioritise casualties; they should be designed so that such prioritisation should never have to be made. The AV can be prevented from driving at certain speeds in specific areas, so that they are still capable of avoiding obstacles that present itself on the road. This is referred to as "defensive driving".

It is a clear failure in design where engineers are asked to develop and cross ethical boundaries in robotics. R&D should be tied into a culture of ethical concern. Standards and guidelines should be developed prior to the implementation of AVs by a Connected & Autonomous Vehicle Centre (CAVC).

Freight transport

The European Commission-funded Safe Road Trains for the Environment project seeks to implement lorry platooning in the EU.[67] Lorry platooning is the deployment of a lead lorry that makes decisions on the road and communicates wirelessly with Lorries behind to form a road-train. This has seen trails begun across northern Europe, showing the system to be more fuel-efficient.

This can be an early example of AV on Scottish roads, and the Scottish Government should seek to run its own trials. Early education on the application and logistics are essential prior to its full implementation.

Autonomous Shipping

Autonomous ships are being developed in several scales, from small remotely operated subsea gliders to unmanned cargo ships. The applications form AV can be applied across industries such as oil & gas, offshore renewables and marine science. Autonomous shipping is growing under market conditions, and Scotland must capture this growth with a Scottish Autonomous Shipping Forum (SASF).

The purpose of SASF is to help the public and industry actors in maritime cluster together to realise innovative autonomous ship projects through sharing and cooperating. The EU has been working on growing this industry with Finland as a speciality country.[68] Scotland should be present in this growth, listening to concerns and areas for growth, and drive the industry.

Discussing the development of the autonomous shipping industry, Norway Minister of Transport and Communications Ketil Solvik-Olsen has said: “What we thought would happen in 10-15 years, that's already happening now".[69]

Scotland should seek to open an official testing area, identified by Marine Scotland (MS) (which should play a central role). Scotland has nothing in the current regulatory framework that stimulates the development of new technology in the shipping sector. However, the technology and development should not go in front of security. Security plays a crucial role in developing this technology and keeping it safe from attack.

Regulation is one of the biggest challenges for autonomous ships, as regulations are agreed through the International Maritime Organisation (IMO). MS should be tasked with agreeing autonomous marine regulations, working with both industry actors and government agencies.

Job Losses to Automation

Many jobs in the energy industry are at threat of decreasing due to the increasing role automation has in performing tasks that we currently need to perform ourselves. Each industry and each job sees different rates at which automation is replacing work.

As well as a new government strategy in dealing with the effects of automation, government institutions also require redesigning to handle these effects. It is a matter of timing before job losses begin to take effect in Scottish industry, so a social security system designed to better assist people that fall victim to the rise in automation is a requirement to civilise industry in the near future.

A Universal Basic Income, Job Guarantee Scheme and Negative Income Tax are some of the ideas proposed by Dr Craig Dalzell in his Common Weal paper on Social security.[70]

Renewable Shipping

Scottish seas

The vision for Scotland in 2050 is to establish a world leading environmentally friendly and efficient shipping industry, with battery, hydrogen or other environmentally friendly fuels powering this industry. By 2030 Scotland should seek to have gas emissions drop by 40% from domestic shipping.

By 2030 Scotland should have a fleet of highly-productive and energy efficient ships running at zero or low emissions. To meet this requirement, the infrastructure for environmentally friendly fuels should be installed at competitive rates. Efficient ports and coastal services should be designed to better coordinate transport chains along the coast.

The Scottish Government needs to gather the expertise together in the shipping industry by providing more power to MS. The aims of MS would be to focus on co-operation between industry actors and the value chain. Industry actors all have a responsibility to implement the changes required to decrease gas emissions, but the steps that are needed should reflect the commercial and sustainable opportunities to protect the jobs within the industry. The Scottish Government should also seek to establish an open innovation platform which can also look into cross-industry examples, as well as looking at multi-national examples of how to gain further efficiencies in the industry.

MS will conduct annual studies to identify key segments in which obstacles are hindering growth in green technology. This means that all contract forms across the industry must be reviewed so that a drive towards green alternatives are better rewarded, with testing and implementing new green technology also being considered.

Ferries & passenger ships

Concrete and effective steps are needed to boost the market for green solutions in shipping. Scotland has a large ferry service sector which is currently running old and pollutant vessels, with the oldest ferry still in operation, MV Eigg, launched in 1974. 19 of the existing fleet of 33 vessels operated under state-owned Caledonian

MacBrayne (CalMac) were built prior to 2000.[71] The Scottish Government should be aiming to encourage the replacement of its oldest and most polluting elements of the ferry fleet.

Green shipping technology is relatively new, however it has seen rapid growth in places such as Norway and Denmark. Hybrid electric vessels that are powered to a significant extent by onshore power will often be a good and reasonable alternative for cases in which the operating situation makes it difficult to be exclusively battery-driven. The fleet of passenger and car ferries that operate in Scotland by CalMac shall continue to look towards hybrid or fully-electric vessels. CalMac already has three hybrid ships recently put into operation.[72] Two additional routes are to be replaced by hybrid vessels, with MV Glen Sannox on the Ardrossan-Brodick route[73] and MV Claymore on the Uig Triangle.[74]

Corvus batteries are used in two hybrid ferries for CalMac. These vessels are small in size but are big in technological innovation. They operate with two 375kW electric Voith Schneider propeller units. A 700kW battery pack is recharged overnight and is used to supplement the diesel power. This can allow battery power operation at slack times.[75]

Of the 33 ferries in Scotland, eight have crossing times less than 35 minutes and an operational profile that makes battery-powered solutions profitable, as per the technology seen in Norwegian and Danish ferry service sectors. Seven of the ferries have operating profiles that make hybrid solutions profitable, using a combination of battery power and gas driven propulsion systems.[76]

Assuming an efficiency of 70%,[77] the peak demand for all ferry services to be run by electric power would see a maximum rise of 0.042GW in energy demand, based on the technical specifications within Caledonian Maritime Asset Ltd. records. As discussed in the Energy Infrastructure section, this is easily achievable within Scotland's resource. However, not all ferries are capable of achieving full battery-powered propulsion until the technology continues to advance and drop in price.

Audit Scotland has recently published a report in which it suggests that Transport Scotland doesn't know what future spending requirements are likely to be, with Transport Scotland spending £209 million on ferry service and assets in 2016/17, a rise of 115% on nine years earlier.[78]

With three existing hybrid vessels, and two more vessels soon to come into operation, Scotland could easily see a minimum of 20 vessel in the fleet of 33 operating with electric or hybrid power. Targeting this for 2030, the Scottish Government could expect to invest an additional £62 million to meet this demand, as per costings in Norway and Denmark.[79]

The operational costs with this additional investment would begin to drop, which could see a return in additional investment within 5.5 years, with £121m saved in operational costs by 2030.

Scotland could also see a decrease in noise emitted and in its carbon footprint, with gas emissions dropping by:

- > 48000 tonnes of CO2,
- > 15000 tonnes of diesel,
- > 820 tonnes of NOx.

To reinforce the use of green technology in Scotland, all ferry services should be run on electric or hybrid power by 2030, with a ban on diesel powered engines operating ferry services. This would require CalMac to replace the diesel power in hybrid ferries with LNG, which has been shown to have greater environmental impact.

Scotland needs to help create an effective tender market which allows infrastructure limitations or tender requirements not to hinder the introduction of new, innovative and environmentally friendly vessels.

Continuing the public monopoly on the ferry services so that Scotland can avoid privatisation, Transport Scotland should create a green technology standard in its tendering processes, which would allow public companies such as CalMac to gain a competitive advantage over private companies. This can also be complimented by prioritising zero and low emission contracts for the services.

Fishing & Offshore Vessels

The Scottish Government requires a strategy to encourage local ship-owners to drive towards green technologies without affecting the local economy. Ship-owners should have enhanced financial capacity with a plan to push access to capital. Many ship-owners would struggle to invest in expensive and green fleet renewal without access to state-assistance.

With a new drive towards green technologies, the full effectiveness of this new green revolution will not capture its entire efficiency without the infrastructure needed to drive this industry.

It takes a long time for the new green fleet to be fully implemented, but the transition will require to be transformed quickly. Industry actors will usually work on the cost-benefit of the existing infrastructure, so it must be the responsibility of the state to redesign the infrastructure.

Electricity is going to be the resource of choice for most industry, however this will require the power increase to the grid to be considered, so that increase in power can be met by renewable fuels. Although electricity will be one of the major, and ever increasing fuels that will be used towards the goals for 2030 and beyond, additional fuels will be used to provide the industry with a variety of supply, however that supply will all still be geared towards low or zero emissions.

The pricing and tariffs for onshore charging for ships shall require adaptations so that the supply of power can remain competitive. With competitive pricing, this will encourage further market access to green technologies, which will save ship-owners operational costs.

To increase green technology in the offshore industry, the Scottish Government should allocate permit licenses for exploration and extraction vessels to demand that maritime activity is conducted with limited emissions. Ownership of North Sea assets by the SEA should allow for green transportation in the procurement process, with both new and existing fields.

The Scottish Government also requires a greater strategy on building the fishing industry to better capture the renewable supply of fishing stocks, which has seen great success in Iceland and Norway.[80] The allocation of fishing quotas can be used to encourage fishing vessels to operate using green technologies to drive down emissions.

C02 Fund

The Norwegian oil fund has allowed Norway to collect US$1 trillion in assets.[81] As the North Sea oil industry begins to slow down, Scotland is becoming increasingly aware of its wealth of resource in renewable energy, and its current reliance on carbon emitting infrastructure.

Scotland could establish a C02 fund for the transport sector, wherein the business sector commits to achieving certain given emission reductions through payments to an environmental fund, and these are then fed back to industry actors as investment support for additional costs incurred in enacting measures to reduce emissions.

A C02 fund would provide industry actors with an ambitious direction to develop new green technologies, which allows the business sector greater responsibility to drive towards environmentally friendly technologies in ways that government infrastructure and research & Development (R&D) can't. This would provide the shipping industry with a clear national goal of reducing emissions.

Conclusion

Scotland's capability to implement energy policy is currently hindered and as such is unable to realise its potential as a powerhouse of renewable energy without a radical shift in the UK Government's approach to energy.

The existing energy policy implemented by the UK Government has proven not to be fit for purpose. It has provided a market led, privatised monopoly which has left a significant number of citizens in fuel poverty.

The Scottish Government, over the past number of years has been more proactive, in spite of the limitations of its control. This has encouraged the safeguarding of important landscapes, and directed investment towards green technology. However, limited access to power means successes have also been limited.

By adopting a more collectivist attitude toward energy where necessary and breaking away from the policy regime of the UK Government, Scotland can then invest in the strategic planning and public ownership which has seen success in neighbouring countries.

The structures of the new national energy company may be able to reduce costs for consumers once it is created. However, this energy company will currently have to work within the confines of the UK national energy strategy.

The Scottish Government would have the ability to enact many of the policies put forward throughout this paper under devolution, but a key constraint on a truly transformative policy is the limited fiscal powers devolved to Holyrood (especially borrowing powers), which requires further devolution which encroaches beyond energy policy. The limitations of a UK privately-run energy grid would also act as a limiting factor on the proposals proposed above.

The more powers that the Scottish Parliament can gain – up to and including independence - the better equipped Scotland will be to develop a fully-fledged bespoke energy strategy.

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