ANALYZING SCOTLAND'S ENERGY SECTOR

Term paper for ESL200

By

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2022ES11849

Dated: 27th April, 2024

<u>Undertaking by the Student</u>

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Abstract

This report provides a thorough analysis of Scotland's energy sector, presenting its history and evolution, the present status and the plans for future, along with highlighting certain key issues and recommending future strategies. The study highlights Scotland's transition from conventional energy to a country where 100% electricity demand is met from renewable energy, the exponential growth of wind energy in Scotland, the focus on decarbonization and transition to renewables for all forms of energy use and not just electricity. The report presents the future plans of Scotland to transition to a Net Zero country and identifies key areas where certain additional measures may be required to achieve the goals of Net Zero in a more balanced and holistic manner.

Basic Information

Development Indicator	Latest Figure	Year
Population, total [1]	54,36,600	2022
GDP (US$ Billion) [1]	211.7	2022
Poverty headcount ratio at national poverty lines (% of population) [2]	21%	2020-23
Unemployment, total (% of total labour force) (national estimate) [3]	3.4%	2023
Average energy consumption per capita (kWh) [4]	3374	2022
% renewables in total energy consumption [5]	More than 100%	2022
Human development index [1]	0.921	2021

Evolution of Scotland's energy sector – *journey from Coal to Renewables*

Like most Countries, Coal was the main power source behind the industrialization of Scotland through the late 80s and upto the mid-20th century. Coal fuelled a huge iron and steel industry. Coal then took over as the preferred source of power in most industries, especially in the textile sector in Scotland, which spawned some of the biggest companies in the world, such as cotton thread makers Coats & Clark. Coal was also the source of town gas across almost all towns and cities and, by the early 1950s, the mining industry employed over 100,000 people in Scotland alone. Then, with the establishment of the CEGB (Central Electricity Generating Board) in 1958 in the UK and further expansion of the National Grid, electricity generation by coal and its supply became possible through the construction of large coal-fired electricity generating stations across Scotland's coalfields.

Despite the dominance of coal-fired electricity generation, a pioneering renewables sector also blossomed in the 20th century with ambitious hydro-electric schemes in the Highlands and Galloway. Even today the UK's oldest operating hydro-power stations (dating from 1927) can be found on the River Clyde at Bonnington and Stonebyres, close to New Lanark. In the second half of the 20th century, a new branch of electricity generation emerged with the establishment of a pioneering nuclear industry.

The 1970s marked a transformative era for Scotland. The discovery of oil beneath the North Sea waters heralded a new age of prosperity and challenges. Initial exploration revealed vast oil reserves, leading to an influx of investments and rapid infrastructural development. Scotland emerged as a key player in the global energy scene in the Oil sector. The 80s and 90s saw further advancements, with cutting-edge technologies enabling deeper and more efficient drilling, expanding the horizons of this burgeoning sector.

However, the journey wasn't without its challenges. Fluctuating oil prices, political debates over resource ownership, and environmental concerns cast shadows over the industry's growth. Yet, Scotland's oil and gas sector continued to thrive. However, the growing global awareness of climate change and environmental degradation cast the oil and gas industry under intense scrutiny. Scotland, with its reputation for pristine landscapes and commitment to sustainability, has not been an exception.

As the world leaned towards sustainable and renewable energy sources, Scotland's oil and gas industry found itself at a crossroads. The vast knowledge, infrastructure, and technical prowess acquired over decades of hydrocarbon exploration are repurposed to champion the cause of renewable energy. Offshore wind farms, once considered competitors to oil platforms, are now seen as collaborative ventures. The North Sea, known for its oil riches, is also becoming a hub for wind energy. Skilled personnel from the oil and gas sector are transitioning roles, applying their deep-sea expertise to set up and manage wind turbines.

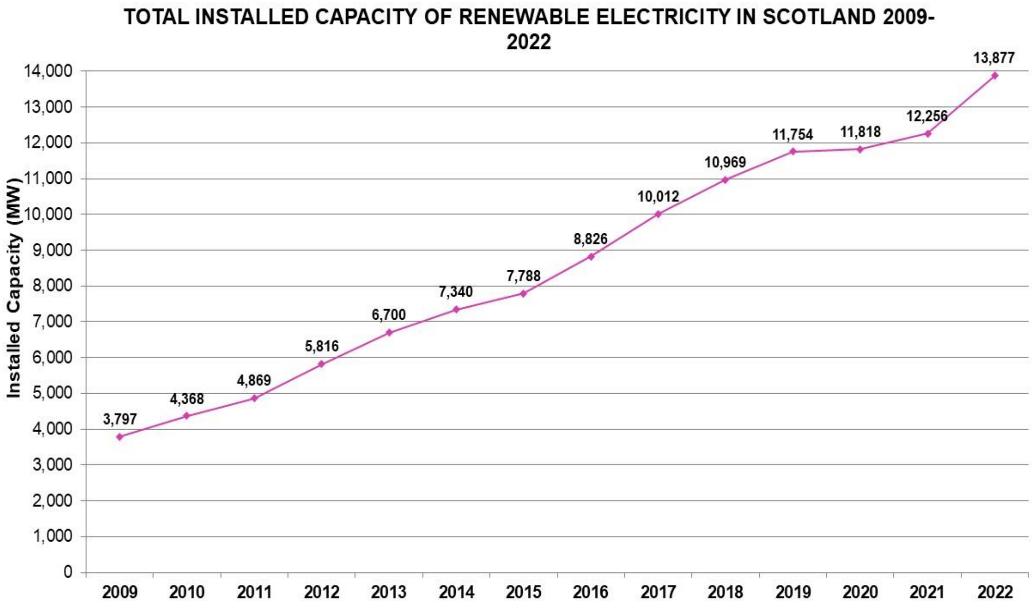
The growth of Renewables in Scotland

In 2002, production of energy from various sources in Scotland stood as - gas (34%), oil (28%), coal (18%) and nuclear (17%), with renewables 3% (principally hydro-electric), prior to the substantial growth in wind power output. In January 2006 the total installed electrical generating capacity from all forms of renewable energy was less than 2 GW, about a fifth of the total electrical production. Despite Scotland having significant quantities of fossil fuel deposits, including substantial proven reserves of oil and gas and 69% of UK coal reserves, the Scottish Government set ambitious targets for renewable energy production.

Scotland's renewable electricity capacity has shown steady growth between 2009 and 2020 with an average annual capacity increase of over 700MW since the end of 2009. In 2022, renewable capacity installed was up 1,621MW up from 2021, the greatest increase in at least 15 years.

Chart 1: Total Installed Capacity of Renewable Electricity in Scotland 2009-2022

[6]

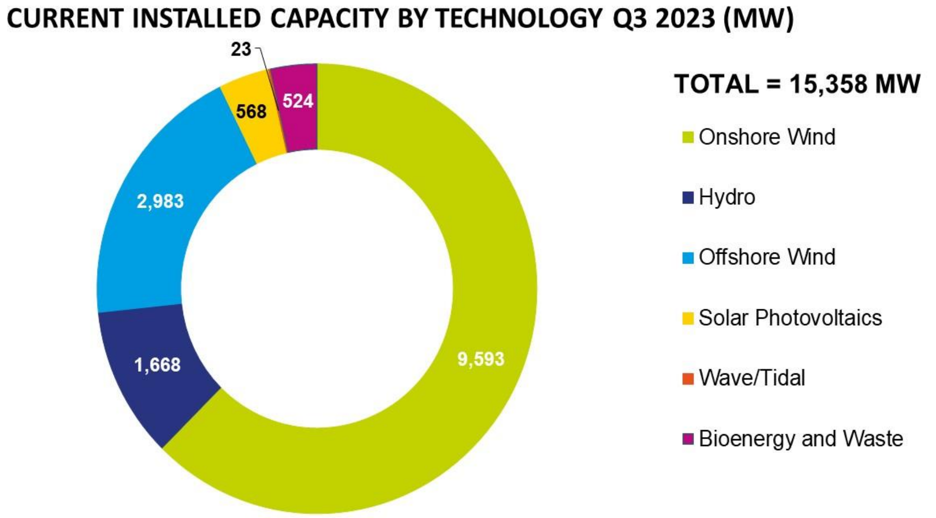


In 2005 the aim was for 18% of Scotland's electricity production to be generated by renewable sources by 2010, rising to 40% by 2020. In 2007 this was increased to 50% of electricity from renewables by 2020, with an interim target of 31% by 2011. The following year new targets to reduce overall greenhouse gas emissions by 80% by 2050 were announced and then confirmed in the 2009 Climate Change Delivery Plan.

The chart below sets out the current mix of renewable electricity generation capacity in Scotland. With the total now over 15GW, the sector is over four times bigger than it was at the end of 2008. Onshore wind is the biggest single technology, accounting for 62% of installed capacity, increasing by 748MW in the last 12 months. Offshore wind, hydro and solar photovoltaics are Scotland’s other major renewable power sources. Installed offshore capacity has increased rapidly over the last few years, with capacity increasing by 897MW in the year.

Chart 2: Current Installed Capacity of Renewable Electricity (Q3 2023)

[6]

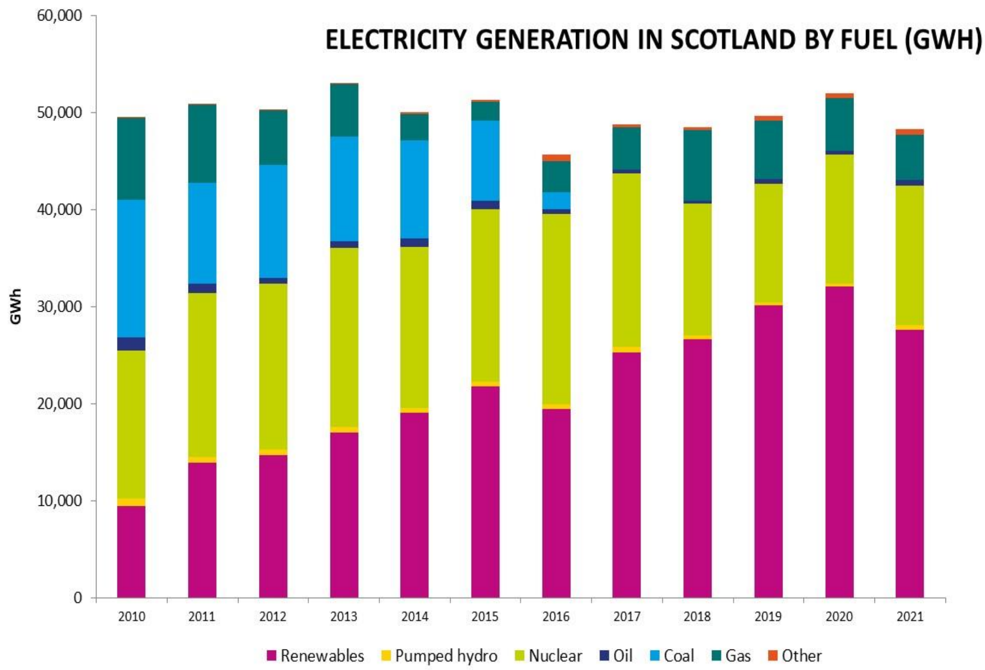


Note: Bioenergy and Waste includes biomass (273 MW), landfill gas (116 MW), energy from waste (68 MW), anaerobic digestion (60 MW) and sewage, sludge digestion (8 MW).

The proportion of the country's power generation from renewables has also grown significantly in recent years. The 2021 figures show that renewables were once again the single largest contributor to electricity generation in Scotland.

Chart 3: Electricity Generation in Scotland by Fuel 2010-2021

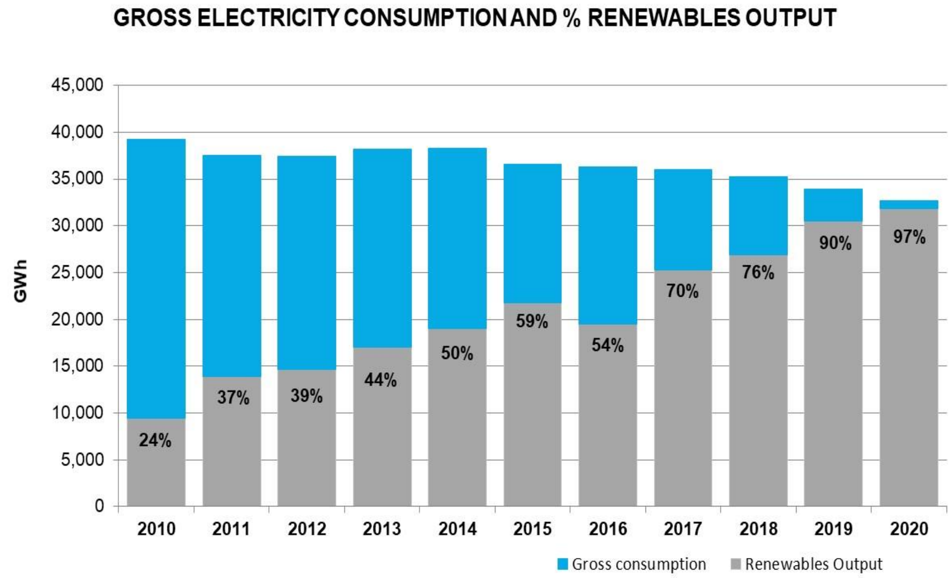
[6]



The growing capacity of renewables has translated into a significant increase in renewable electricity output, which more than quadrupled from 8,003GWh in 2007 to 32,063GWh in 2020. Even though, renewable generation contributed little over 50% of total electricity generation in Scotland in 2021, as shown above, the percentage of electricity consumption by renewables was approximately 97% of Scotland’s gross electricity consumption in 2020. In fact, On 26 January 2024, the Scottish Government confirmed that Scotland generated the equivalent of 113% of Scotland's electricity consumption from renewable energy sources, making it the highest percentage figure ever recorded for renewable energy production in Scotland. It was hailed as a significant milestone in Scotland's journey to net zero.

Chart 4: Electricity Consumption and % Renewables Output

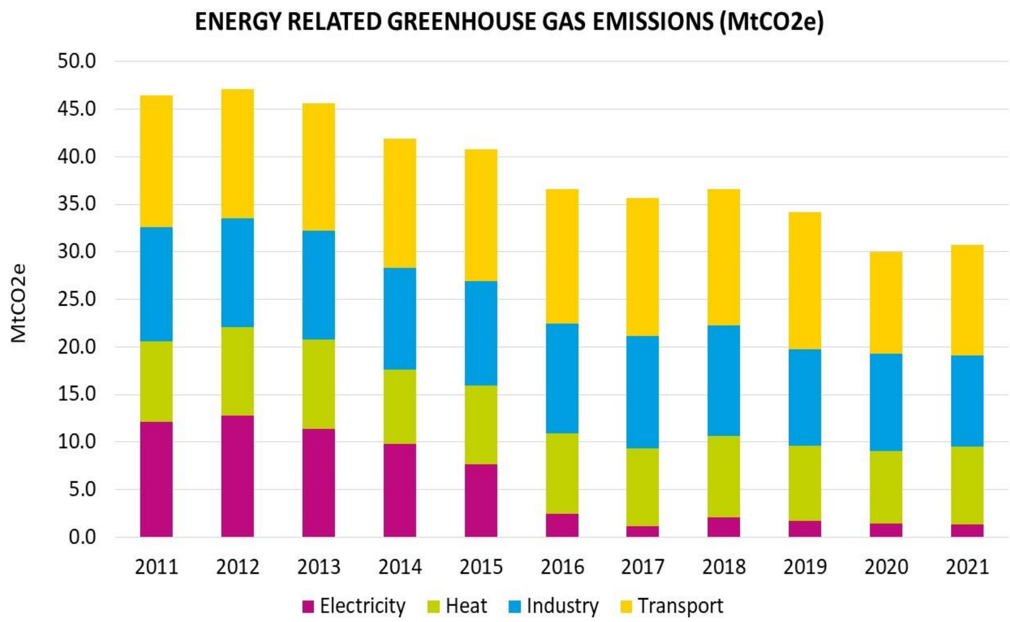
[6]



The massive penetration of renewables in Scottish energy industry has caused a sharp reduction in the emissions related to the electricity sector, showing values of 89% emissions reduction since 2011. By contrast, the heat sector, industry, and transport have shown slight reductions of around 3%, 20% and 16% respectively.

Chart 9: Energy Related Greenhouse Gas Emissions (MtCO2e)

[6]



A brief on key renewable energy technologies in Scotland

Renewable energy is the mainstay of energy consumption in Scotland. It has grown tremendously over the last five decades, supported explicitly by enabling political will and a resilient commitment of the Country towards Climate Change targets. Already about 100% of electricity consumption in Scotland is through renewable energy only. The Govt. plans that by 2030 50% of Scotland's overall energy consumption will be met though generation from renewable sources, and by 2045 the aim is to de-carbonise the energy system completely. The following section discussed the key renewable energy technologies in Scotland, their historical evolution, the basics of operation, the current status of installations and the plans for future:

Wind Energy

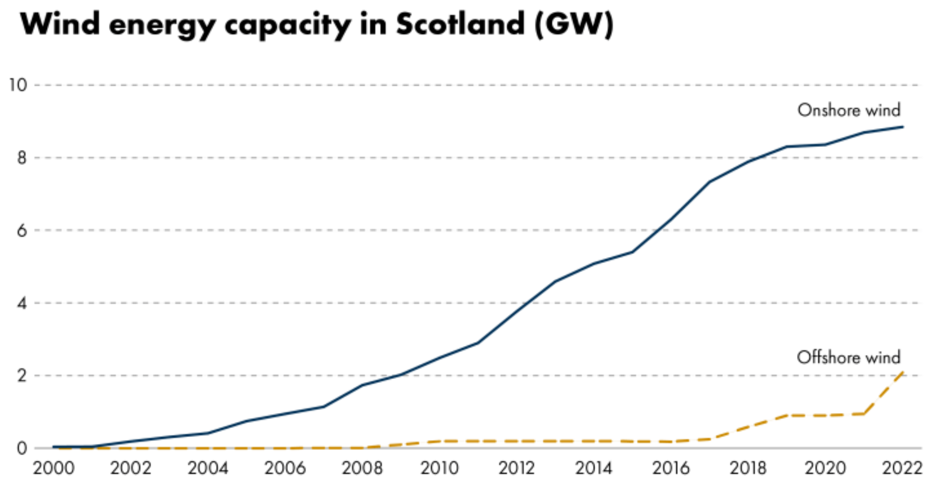
Wind turbines transform a natural asset – the wind – into energy that can be used to power homes and businesses. A Wind Turbine essentially contains a mast and rotor blades. The height of the mast is dependent on the wind speed in the concerned area. The basic idea of the technology is that wind hits the rotor blades and they being to turn. The box behind the blades contains a nacelle and generator. When the blades spin, the generator turns the kinetic energy into electricity. The top of the box has a device called an anemometer which measures wind speed and direction and provides that info back to the nacelle. The electricity produced flows through the turbine tower via cables. The electricity then reaches a transformer at the base of the tower which converts the energy into a higher voltage which can be more effectively transmitted to the Grid.

Renewable wind capacity alone in Scotland is presently over 11GW. This is 39% of the UK capacity, and approximately 5% of European and 1% of world total installed wind capacity. In 2022, almost 28 TWh of zero carbon electricity was generated by renewable wind in Scotland, representing 35% of all wind generation in the UK. This is in contrast to 2008, when only about 3.34 TWh of electricity was generated by wind turbines in Scotland, representing an increase of over 700% in 14 years!

Wind turbines can be located on land – Offshore or in shallow bodies of water, usually in the ocean – Onshore. Scotland has both Onshore and Offshore wind energy capacity. For onshore wind, there is about 8.78 GW of installed capacity as on date, which is planned to increase to over 20 GW by 2030. For offshore wind, there is currently about 2.1 GW installed capacity as of June 2022, which is planned to be increased to 8 to 11 GW by 2030.

Chart 4: Growth of wind energy capacity in Scotland

[10]



Hydro power

Scotland has the UK's highest mountains and largest inland lochs (lakes). Combined with a high rainfall this makes production of hydroelectricity viable in the region. Hydroelectric generation in Scotland started early in the 20th century – kickstarted by the need for power to drive aluminium smelting plants in the Scottish Highlands. This led to the construction of the Laggan dam and hydroelectric system in 1934.

Scotland now has 85% of the UK's hydroelectric energy resource, much of it developed in the 1950s by the North of Scotland Hydro-Electric Board. The board played a large part in bringing 'power from the glens' into Scottish homes. By 1965, 54 main power stations and 78 dams had been built, providing a total generating capacity of over 1,000MW. Scotland now provides 85% of Great Britain's hydro-electric resource, with a total generation capacity of 1,500 MW. However, hydro power now lags behind other forms of renewables as all the focus in the last decade or two has been on the exploration and development of wind and other forms of renewable energy. Hydro electric energy, which was about 1442 MW in 2008 has only grown to about 1662 MW in 2022, which is also largely due to the limited remaining potential for hydro power development in Scotland. A recent study assessed only about 400 to 500 MW remaining commercially viable potential for hydro power in Scotland.

Wave and Tidal Energy

Scotland is a world leader in the development and deployment of wave and tidal energy technologies. It plays host to the world's leading wave and tidal energy test centre, the European Marine Energy Centre (EMEC) in Orkney, the world's largest tidal stream array and the world's most powerful tidal stream turbine [11].

Water in the oceans is constantly in motion due to waves and tides, and energy can be harvested from these kinds of motions. Waves, driven by the winds, make the water oscillate in roughly circular orbits extending to a depth of one half of the wavelength of the wave (distance between peaks). Tides, related to the gravitational pull of the Moon and Sun on the oceans, are like very long-wavelength waves that can produce very strong currents in some coastal areas due to the geometry of the shoreline. In terms of power generation technologies, both refer to the extraction of kinetic energy from the ocean to generate electricity (again, by spinning a turbine just as hydroelectric dams or wind farms do), but the locations of each and the mechanisms that they use for generating power are slightly different.

Wave energy projects extract energy from waves on the surface of the water, or from wave motion a bit deeper (a few 10s of meters) in the ocean. Surface wave energy technologies capture the kinetic energy in breaking waves – these provide periodic impulses that spin a turbine.

Tidal energy is a form of power produced by the natural rise and fall of tides caused by the gravitational interaction between Earth, the sun, and the moon. Tidal currents with sufficient energy for harvesting occur when water passes through a constriction, causing the water to move faster. Using specially engineered generators in suitable locations, tidal energy can be converted into useful forms of power, including electricity. Suitable locations for capturing tidal energy include those with large differences in tidal range, which is the difference between high tide and low tides, and where tidal channels and waterways become smaller and tidal currents become stronger.

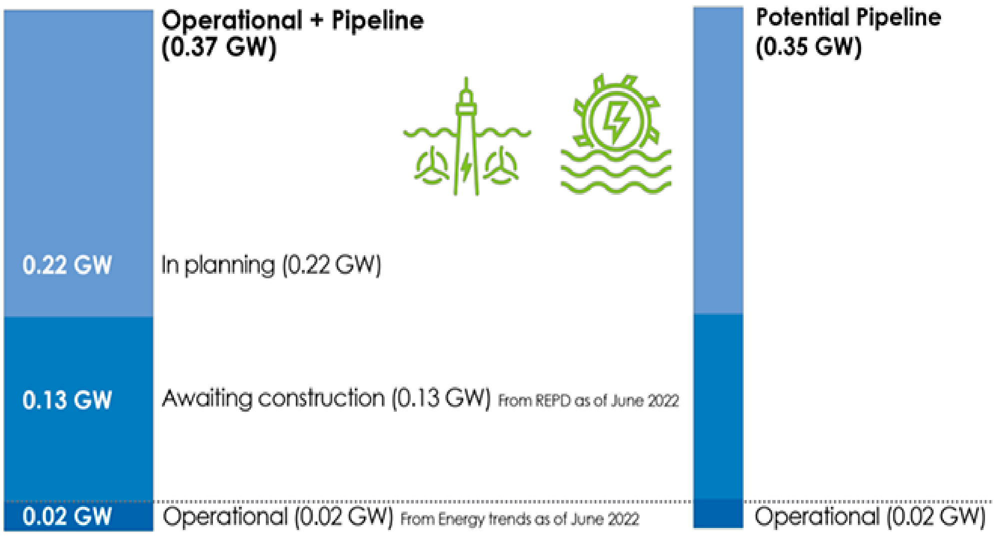
There are several ways to harness tidal energy. Tidal turbines can be installed in places with strong tidal activity, either floating or on the sea floor, individually or in arrays. They look and operate much like wind turbines, using blades to turn a rotor that powers a generator, but must be significantly more robust given their operating environment and, as tidal turbines are much smaller than large wind turbines, more turbines are required to produce the same amount of energy. Multiple tidal demonstration projects are under way in the United States.

Turbines placed in tidal streams capture energy from the current, and underwater cables transmit it to the grid. Tidal stream systems can capture energy at sites with high tidal velocities created by land constrictions, such as in straits or inlets.

Scotland's wave and tidal capacity is still in its infancy, with only about 0.02 GW installed operational capacity. However, with about 17,000 km of shoreline, there's a strong policy focus on augmenting the wave and tidal operational capacity to about 0.37 MW by 2027:

Chart 5: Scotland's shoreline wave /tidal capacity (operational and pipeline)

[12]



Bio-energy

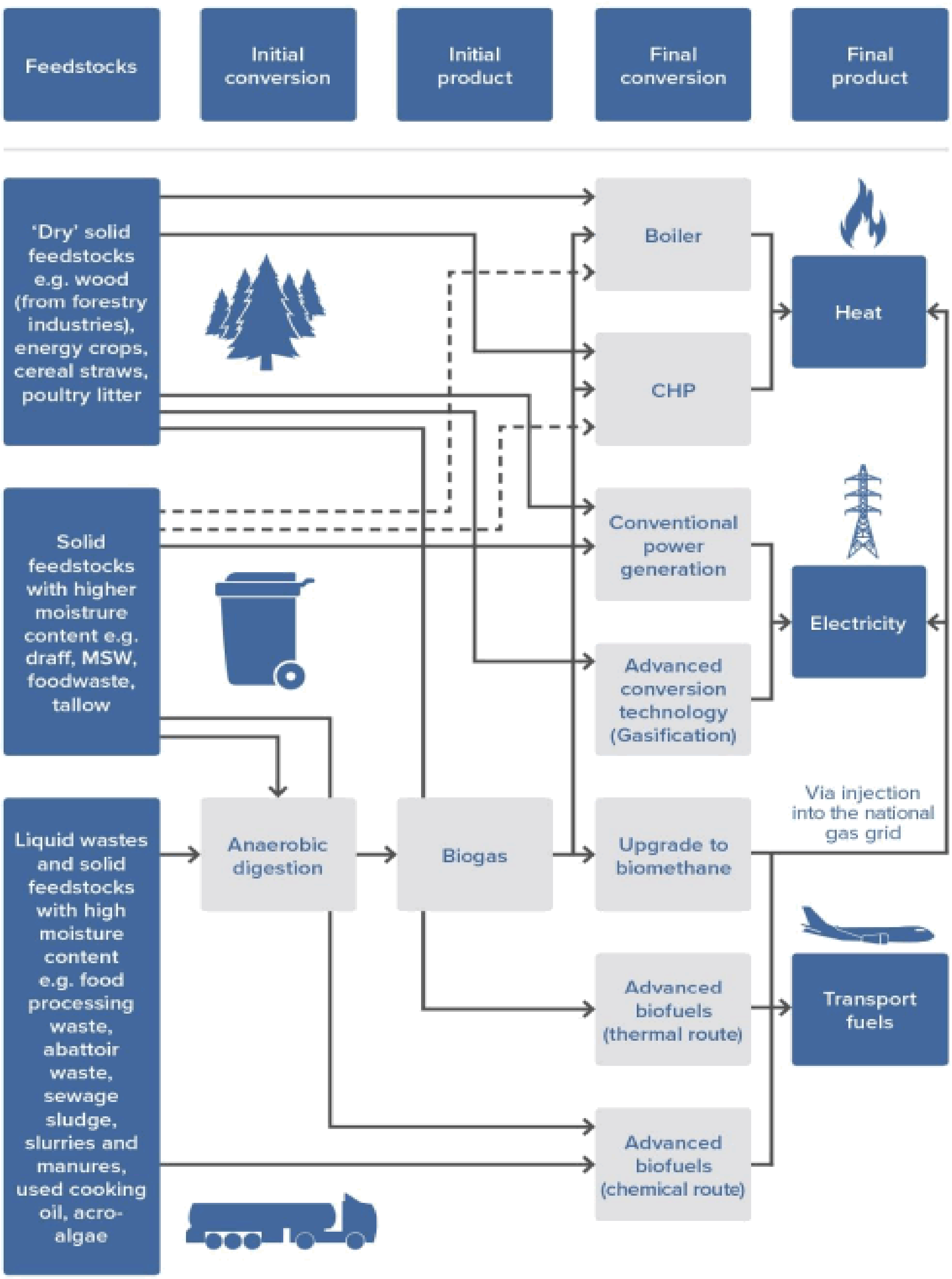
Bioenergy is one of many diverse resources available to help meet demand for energy. It is a form of renewable energy that is derived from recently living organic materials known as biomass, which can be used to produce transportation fuels, heat, electricity, and products.

Biomass is a renewable energy resource derived from plant- and algae-based materials that include Crop wastes, Forest residues, Purpose-grown grasses, Woody energy crops, Microalgae, Urban wood waste, etc. Biomass is a versatile renewable energy source. It can be converted into liquid transportation fuels that are equivalent to fossil-based fuels, such as gasoline, jet, and diesel fuel (bio-fuel). Bioenergy technologies enable the reuse of carbon from biomass and waste streams into reduced-emissions fuels for cars, trucks, jets and ships; bioproducts; and renewable power.

Biofuels include cellulosic ethanol, biodiesel, and renewable hydrocarbon "drop-in" fuels. The two most common types of biofuels in use today are ethanol and biodiesel. Biofuels can be used in airplanes and most vehicles that are on the road. Renewable transportation fuels that are functionally equivalent to petroleum fuels lower the carbon intensity of vehicles and airplanes.

Biopower technologies convert renewable biomass fuels into heat and electricity using processes like those used with fossil fuels. There are three ways to harvest the energy stored in biomass to produce biopower: burning, bacterial decay, and conversion to a gas or liquid fuel. Biopower can offset the need for carbon fuels burned in power plants, thus lowering the carbon intensity of electricity generation.

Chart 6: Process for conversion of bioresources to bioenergy



[13]

Bio energy has contributed to both renewable heat output as well as renewable electricity generation in Scotland. The majority of both capacity and output of Scotland's renewable heat in 2019 came from biomass primary combustion and biomass combined heat and power

(CHP). Together, these technologies account for 1.65 GW of capacity and 3,678 GWh of output. Biomethane makes up 14% of output, followed by heat pumps (8%) and energy from waste (7%).

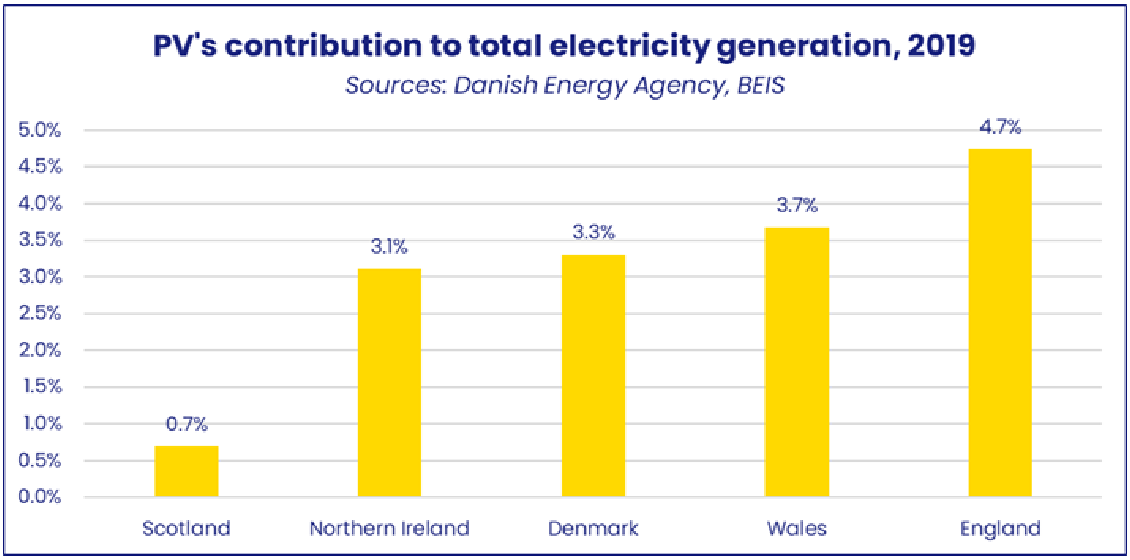
Bioenergy and energy from waste accounted for 8.1% of all renewable electricity generated in Scotland in 2019 (2,472 GWh). There are 183 MW of bioenergy projects in the pipeline, the vast majority of which are energy from waste projects.

Solar Photovoltaic

As of the end of 2020, Scotland had only around 3% of the UK's total deployed solar generation capacity – far below the per-capita deployment for the rest of the UK. Despite the clear potential for solar power in Scotland, its share of power is far lower than that of England and Wales, as well as Northern Ireland and Denmark which are on an equivalent latitude.

Chart 7: Solar contribution to 2019 electricity generation, selected countries

[14]



Solar technologies currently account for 410MW of electricity generation capacity in Scotland, enough to power around 90,000 homes. There is potential in Scotland for 11GW of roof-mounted solar PV to be installed across the country which would provide nearly a third of Scotland's current electricity needs. The recent years have seen a sustained increase in demand for installation of solar panels on rooftops in Sottish homes. However, there is no policy backing from the Scottish Govt. yet, nor are there any defined targets or timebound plan for Solar PV installations by capacity or energy, due to which the demand is not as much supported by supply as it should be.

Scotland's energy future

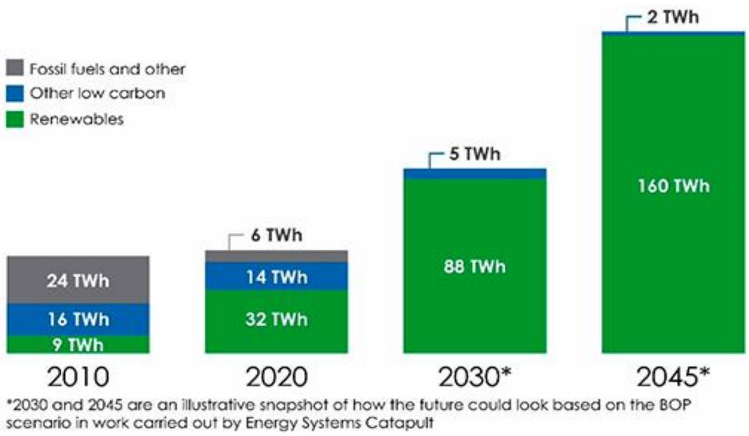
Scotland aims to produce 50% of all energy (not just electricity) from renewable sources by 2030. An ambitious target has been set with a 7 year plan to build an extra 8GW of offshore wind power by 2030. It remains a policy of the Scottish Government to reduce emissions to net zero by 2045.

Scotland is at the forefront of the clean energy transition. Some of the key ambitions in Scotland's energy future are:

1. More than 20 GW of additional renewable electricity on- and offshore by 2030
2. An ambition for hydrogen to provide 5 GW or the equivalent of 15% of Scotland's current energy needs by 2030 and 25 GW of hydrogen production capacity by 2045.
3. Increased contributions from solar, hydro and marine energy to our energy mix.
4. Accelerated decarbonisation of domestic industry, transport and heat
5. Establishment of a national public energy agency – Heat and Energy Efficiency Scotland
6. By 2030, the need for new petrol and diesel cars and vans phased out and car kilometres reduced by 20%.
7. Generation of surplus electricity, enabling export of electricity and renewable hydrogen to support decarbonisation across Europe.
8. Energy security through development of own resources and additional energy storage.
9. A just transition by maintaining or increasing employment in Scotland's energy production sector against a decline in North Sea production.

Chart 8: Electricity generation – past, present and future [12]

The volume of available renewable energy in Scotland continues to grow. Since 2000, Scotland has increased its renewable electricity capacity almost 10 times and the current pipeline could more than double the same. Looking ahead to 2045, this could increase further.



There is significant additional renewable energy capacity in development across Scotland, with projects either in planning or already consented totalling almost 23GW. Capacity increases in the short term will come from onshore wind, with 5.7GW of capacity already consented and a further 7GW in planning. Offshore wind has 4.2GW already consented with an additional 4.1GW in planning. There is also 1.1GW of solar projects at various stages of development and 316MW of wave and tidal projects either in planning or already consented.

Chart 8: Pre-operational Capacity of Renewables Projects Q2 2023

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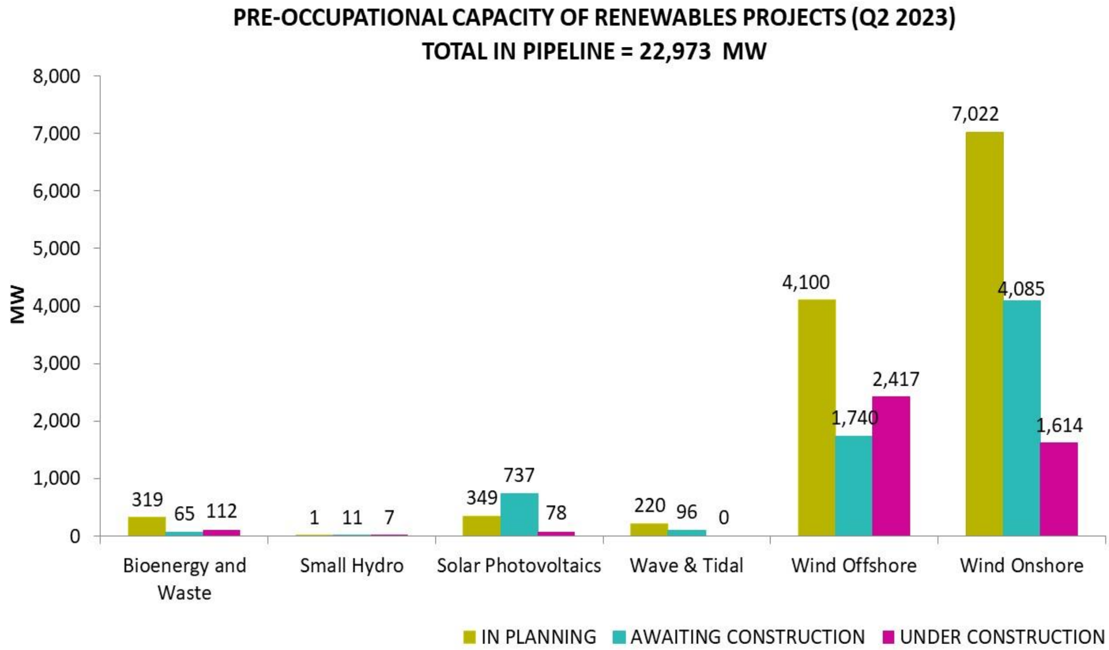


The majority of Scotland's greenhouse gas emissions come from energy systems (79%) but since 1990 total emissions have reduced by half, with energy supply making the largest reduction in emissions. With increasing levels of renewable electricity and the closure of coal fired power stations in Scotland, the CO_2 intensity of the electricity system has reduced by 90%. By 2030, Scotland must reduce its overall emissions by 75%, as compared to 2019 levels, and 90% reduction by 2040.

Chart 9: Energy related greenhouse gas emissions $MtCO_2e$ (1990 -2045)

[12]

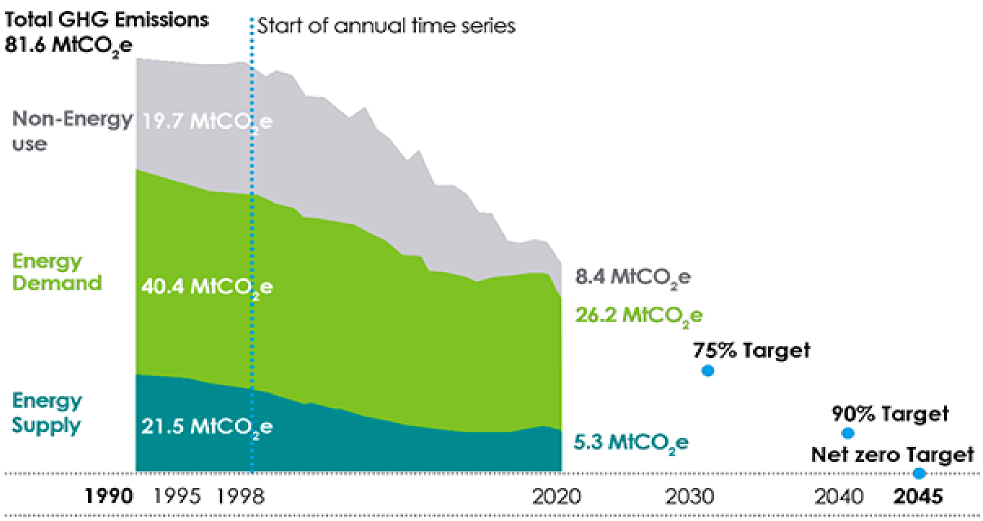
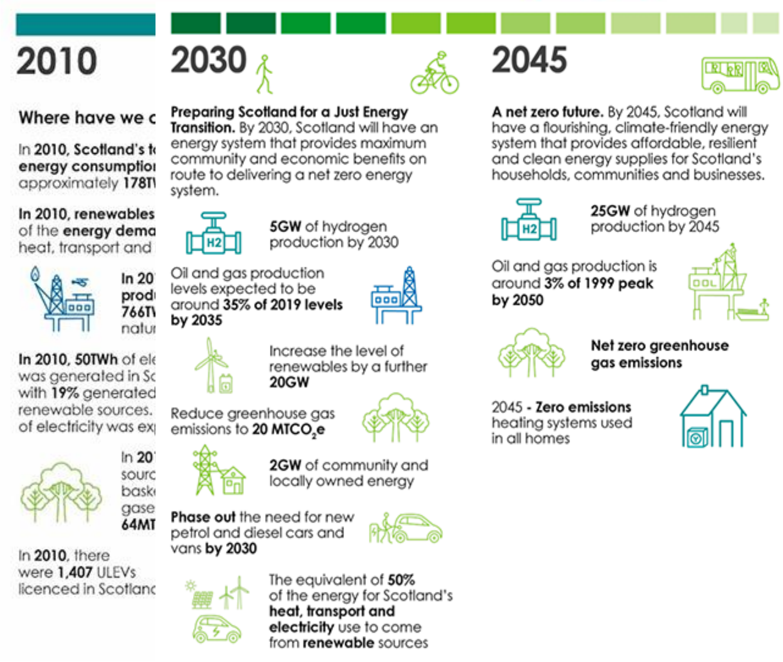


Chart 10: Scotland's Transition to Net Zero – As-is and To-be……… [12]



As seen from the above schematic, Scotland's transition to Net Zero by 2045 involves maximizing home grown clear energy production, which by 2030, is expected to grow substantially, significantly reducing GHG emissions and maximizing energy export opportunities and opportunities for production of Hydrogen for use in Scotland and for export. Oil and gas in the North Sea is becoming less plentiful and harder to extract. There is expected to be no nuclear power, coal extraction or use of unconventional oil and gas or exploration of onshore conventional oil and gas.

It is expected that Carbon Capture Utilisation and Storage will be on its way to being an established technology in Scotland by 2030. By 2032, industrial emissions are expected to decrease by 43% from 2018 levels.

Conclusions, Issues and Recommendations

Scotland, like any Country, started with usage of conventional forms of energy – coal and gas for heating and electricity generation, followed by large scale development of hydro power, through the establishment of North of Scotland Hydro Electric Board. In between, there has been establishment of Nuclear Power plants as well. However, by the start of 21st Century, Scotland had consciously started transitioning from conventional forms of energy to renewables. There has been consistent policy backing for the same from the Govt. of Scotland, with defined trajectories for achieving renewable energy capacity installation targets and moving away from conventional energy with no further investments in coal or gas or nuclear power generation at all.

Scotland's transition to renewables has been so rapid and determined that, today, almost 100% of its electricity consumption is being met through renewable energy generation and, in fact, the energy generation from Wind alone is higher than the domestic demand, resulting in net export of energy to neighboring countries. More than 50% of all energy usage in Scotland, today, is through renewable energy.

Moving forward, the Govt. of Scotland has published a Draft Energy and Just Transition Plan on 10th Jan 2023, which lays out the future path of energy transition in Scotland and the roadmap to achieving Net Zero by 2045. The document has defined route maps for achieving various milestones such as emissions reductions, setting up of wind and other renewable capacity, decarbonizing heat consumption in households, 100% electrification of transport, etc. along with the legislative and Policy support required for achieving the milestones, in terms of enactment of Govt. legislations and Vision documents, setting up of regulatory institutions, lobbying with the UK electricity and gas market regulator and setting up favorable investment climate for green energy capacity building.

However, as is the case with every ambitious plan, challenges remain, which require a concerted effort not just from policy makers, but also from the general population of Scotland in terms of changing their habits and lifestyles to ensure decarbonization. Some of the key vectors in achieving Scotland's energy future plans and recommendations for the same are highlighted below:

Key vector / thrust area	**Issues and Recommendations**
Power Sector decarbonization – setting up more wind energy capacity	Although Scotland has set ambitious targets for installation of more on-shore and off-shore wind capacity, a key challenge with Wind energy is "predictability", due to which situations are likely where huge penetration of wind energy could actually lead to higher energy costs in the system, due to surplus energy being available, which is usually saleable at less than the cost of production. In order to mitigate this risk, hybrid solar and wind power plants shall be required, instead of pure wind, so that Solar generation can complement Wind by being available during day time when wind speeds are low and being not available at night times when wind generation is higher. Hybrid wind+solar energy systems have proven to be far more cost effective as well, because of much higher CUF (Capacity Utilisation Factor)
Power sector decarbonization – Solar capacity building	Scotland requires a robust plan of action for deployment of solar energy technologies. From research, it appears that Solar has suffered an unconscious bias because it is considered that Scotland's weather better suits other renewable energy technologies that harness power from wind and water.

	Unlike other technologies, which require a grid-scale establishment, Solar capacity can be developed at individual and community scale also, if residential rooftops or common society rooftops are extensively utilized for solar PV installations. Another advantage of Solar is that it can not only generate electricity, it can also be used as a source of heat, thereby supporting decarbonization in other areas of energy usage as well. A conscious effort for higher solar development and penetration is required in Scotland, with Policy support. As a matter of Policy, the Govt of Scotland should specify minimum capacity targets for solar installations (Grid scale and rooftop) by a certain year. In addition, the tariff framework should enable adoption of solar PV at household level, by providing tariff discounts / incentives, capital subsidy and making the local electricity suppliers as development and installation partners.
Integrating Hydrogen in electricity systems	Hydrogen has the advantage of being produced from renewable technologies, thereby being purely green. Hydrogen, combined with fuel cell, produces electricity, which can be used to support peak demand in the grid, instead of investing in other form of power plants for the same. Hydrogen can be generated from renewables, so the wind capacity planned in future could be utilized to produce Green Hydrogen on a greater scale, which, in turn, could be re-converted to electricity to meet peak demand, on an as-required basis.
Infrastructure required to support electrification of transport	Scotland has set targets for 100% electrification of transport to achieve Net Zero by 2045. However, this is required to be facilitated through significant investment in grid infrastructure, because electrification would necessitate current carrying capacity in the electricity grid. A very high investment in grid infrastructure increases fixed cost of electricity on end consumers and therefore consumers may need to be shielded from tariff shock through regulatory interventions.
Energy Efficiency	Reducing electricity demand itself is a necessary requirement for decarbonization. This will need both technical and behavioral interventions – technical interventions could include "Demand Response" equipment to regulate energy usage and targeted adoption of energy-efficient appliances by the general public. Behavioral interventions will require measures to induce consumer behavior changes in energy consumption.

Penetration of Bio-energy	A higher penetration of bio-energy is required in Scotland, in addition to the continued focus on increasing wind energy capacity. This will require larger swathes of land being dedicated to energy crops so that domestic Biomass production can be increased. Adoption of Biomass Boilers should be increased to decarbonize domestic heat usage.
Realising untapped potential of Hydro power	Scotland is understood to have about 400 to 500 MW further potential for Hydro power. However, there appears to be no focus on exploring the same or developing further hydro power stations. Hydro is a peaking energy source, which can be ramped up and down to meet peak demand, as opposed to wind, which is uncontrollable. It is important, therefore, that entire Hydro potential of Scotland is utilized.
Battery Storage	On its way to 2045, Scotland could consider adoption of Battery storage on a larger scale in order to more effectively integrate its wind energy with the grid. It is expected that with newer forms of battery technology, the cost will continue to decline. For a sector so heavily reliant on wind power, Battery Storage must be a key focus area for future
Encourage adoption of Electric Vehicles	There needs to be a concerted effort to encourage people to buy EVs by alleviating fears about battery life and range, providing evidence about lifetime of second-hand EVs and ensuring that necessary infrastructure exists and is easy to find.
Community engagement for lifestyle changes	Lifestyle changes in the general population will be required in order to ensure Net Zero goal. People will need to change the way they travel (e.g. cycling instead of motorized vehicle), their diets, their energy use habits, etc. This cannot be legislated as that would amount to intruding in personal freedom. Hence, Govt. will need to create higher community engagement and buy-in through clear articulation of energy objectives, motivation and incentivization to encourage and persuade people to change lifestyle.

Citations

1: Wikipedia

2: Scottish Government website: https://data.gov.scot/poverty

3: Office for National Statistics, UK:
htttps://www.ons.gov.uk/visualisations/labourmarketlocal/S12000026/

4: Website of Statista: https://www.statista.com/statistics/517845/average-electricity-consumption-uk/

5: Website of Scottish Renewables: https://www.scottishrenewables.com/news/1495-more-than-100-of-scotlands-electricity-demand-produced-by-renewables-for-the-first-time

6: Scottish Energy Statistics Hub: https://www.scottishrenewables.com/our-industry/statistics

7: Forum for Renewable Energy Development in Scotland (June 2005). Future Generation Group Report – Scotland's Renewable Energy Potential: Realising the 2020 Target. Edinburgh: The Scottish Executive.

8: "Renewable energy potential" (Press release). Scottish Government. 27 November 2007.

9: REN21 (2011). "Renewables 2011: Global Status Report"

10: https://spice-spotlight.scot/2023/04/26/wind-energy-in-scotland-current-position-and-future-plans/

11: Scottish Government website: https://www.gov.scot/policies/renewable-and-low-carbon-energy/marineenergy/#:~:text=Scotland%20is%20a%20world%20leader,most%20powerful%20tidal%20stream%20turbine

12: Scottish Government - Draft Energy Strategy and Just Transition Plan

13: Scottish Government Bio Energy Update March 2021

14: Solar Energy UK publication - Scotland's Fair Share: Solar's role in achieving net-zero in Scotland