IEA-Advanced Motor Fuels
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DENMARK

Technology Collaboration Programme
by iea

Denmark

Drivers and Policies

In December 2019, Denmark approved a new Climate Act included a legally binding target to reduce greenhouse gas (GHG) emissions by 70% by 2030 (relative to 1990 level), to reach net-zero emissions by 2050 at the latest and to set milestone targets based on a 5-year cycle. Denmark's political understanding "A fair direction for Denmark," states that a 70% reduction target by 2030 is a very ambitious goal, and it will be particularly difficult to realize the last part of the goal (i.e., from 65% to 70%). Meeting the target will require currently unknown methods and, therefore, a close collaboration with the Danish Council on Climate Change and other experts. The Climate Act was followed by climate action plans, which will contribute to ensuring that national reduction targets are met. The Climate Action Plan in 2020 will include sector strategies and indicators (at a minimum) for central sectors such as agriculture, transport, energy, construction, and industry. Denmark has already taken the first steps toward establishing a professional and efficient energy sector as the basis for the transition to a sustainable green society. In June 2018, all parties of the Danish Parliament reached a political Energy Agreement to further build Denmark's international positions of strength with a focus on renewable energy, energy efficiency improvements, research and development (R&D), and energy regulation. The measures and policies decided in the agreement are now being implemented.

Advanced Motor Fuels Statistics

General Energy Data

Gross energy consumption has been relatively constant since 1990, with falling consumption of coal and increasing consumption of renewable energy (see Figure 1). Gross energy consumption peaked in 2007 at 873 petajoule (PJ) and has since followed a downward trend. Gross energy consumption is expected to drop annually by 1.2% until 2020, after which it will rise slightly to 778 PJ in 2030, corresponding to consumption in 2017. Coal consumption will fall considerably (by 14% annually) until 2030, due in particular to the expected stop in the use of coal in large-scale combined heat and power (CHP) production. In 2030, only the Fynsværket power station and the cement industry will consume large amounts of coal. However, some plants will retain the option for coal operation, although actual use is assumed to be limited.

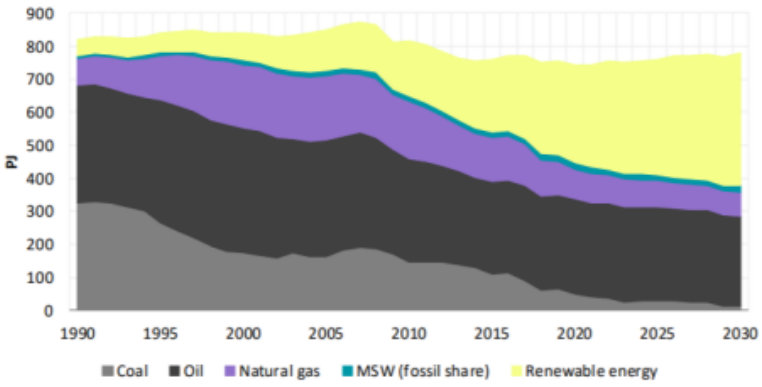

Figure 1. Gross energy consumption by type of energy 1990–2030 (in PJ). The calculation for 1990–2017 has been adjusted for outdoor temperature/degree days relative to normal years (climate-adjusted) and electricity trade with other countries.

Figure 2 shows the total share of renewables (RES) as well as renewables shares for transport (RES-T), electricity consumption (RES-E), heating and cooling (RES-H&C), and district heating (RES-DH), respectively, calculated on the basis of the method described in the EU Renewable Energy (RE) Directive (EU 2009; Eurostat 2018).

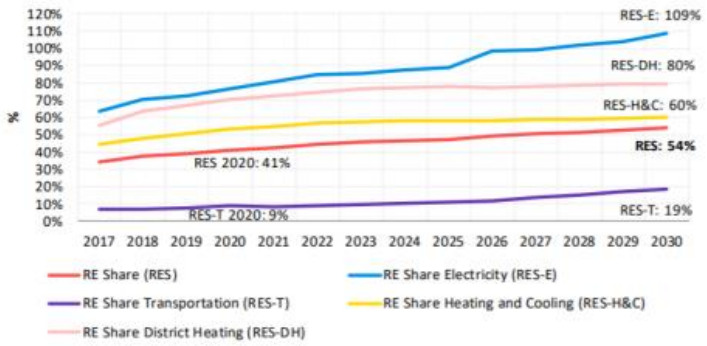

Figure 2. Renewables shares 2017–2030 [%]. The renewables shares are calculated as defined in the RE Directive (Eurostat 2018).

The RES and RES-T are subject to binding national European Union (EU) targets established in 2020. The EU RE Directive also sets out a 2030 target for 27% renewables for EU countries together, but this target has not been implemented as national obligations. Instead, EU Member States are obligated to account for their contributions to reaching the common EU target in their National Energy and Climate Plans.

The projections (from Danish Energy Agency 2019, 2023 and Energistyrelsen) show that the RES is expected to be 41% in 2020, in which case Denmark will have met, and exceeded, its EU obligation for a 30% renewables share by 2020. The RES-T will reach 9% in 2020, revealing a shortfall of 1 percentage point compared with the RE Directive obligation of 10% in 2020. The overall RES will increase to 54% in 2030. The projection depends on the deployment of offshore wind, onshore wind, and solar photovoltaic (PV) and on the conversion of CHP plants to biomass; energy-efficiency improvements in transport, industry, services, and households will contribute to a lesser extent.

The rate of renewables deployment in electricity supply is expected to exceed the rate of increase in electricity consumption, and Denmark's production of electricity from renewables is expected to exceed its electricity consumption from 2028. The country's RES-E is expected to increase to 109% in 2030, but the increase is particularly contingent on the offshore wind farms included in the 2018 Energy Agreement being commissioned by 2030.

There are also updated expectations regarding deployment of commercial solar PV (ground-mounted solar farms) and replacement of older onshore wind turbines with fewer, more efficient turbines. The projection of onshore wind and solar PV deployment depends on developments in electricity prices: maintenance of the level for tender prices achieved in the 2018 technology-neutral tendering round, voluntary renewable energy targets from large consumers, and the market for power purchase agreements (PPAs)/guarantees of origin. A high percentage of RES-E affects calculation of the RES-T because the RE Directive uses a multiplication factor of four for the renewables share of electric road transport and a multiplication factor of 1.5 for the renewables share of electric rail transport. Considering this background, RES-T increases to 19% in 2030, contingent on the number of electrified passenger cars and vans increasing to around 9% of the total number in 2030, and an increased use of electricity in rail transport.

Greater use of bio-natural gas in transport will contribute only to a very limited extent. The blending ratio of biofuels in petrol and diesel is expected to be maintained at the current level in the absence of new measures. Fuel consumption for domestic air traffic is included in the calculation of the renewables share. The aviation sector has announced ambitious plans for biofuel blending, but as these announcements are neither binding nor reflect a profitable development pathway for companies in the absence of new measures, the plans have not been included in a renewables contribution from this sector. Measured in relation to final energy consumption, the share of fossil fuels in the transport sector will fall from 95% in 2017 to 92% in 2030. This decrease is due to a combination of electrification of the rail and road transport sectors, as well as improved energy efficiency for conventional vehicles. Fossil fuel consumption in road transport is expected to amount to 73% of total fossil fuel consumption by the transport sector in the absence of any new measures.

Details on Advanced Motor Fuels

Renewables share increasingly consists of electricity produced from renewable energy sources (see Figure 3). In 2030, the RES-E by the transport sector will correspond to the consumption of first-generation biofuels; consumption of second-generation biofuels will constitute a smaller share.

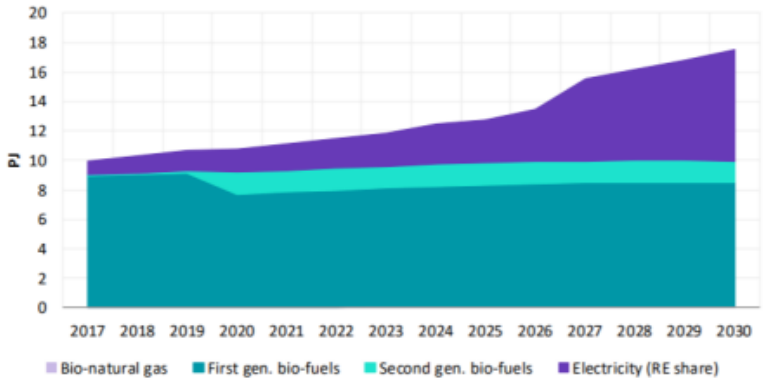

Figure 3. Renewable energy consumption by the transport sector 2017–2030 (in PJ).

Sales of electric cars in particular are therefore likely to increase considerably, and by 2030, electric and plug-in hybrid cars are expected to amount to about 48% of all new car registrations. This trend is expected to increase the percentage of zero- and lower-emission cars on the road to about 22% in 2030, corresponding to around 730,000 electric and plug-in hybrid cars, of which purely electric vehicles will amount to about 75%, as shown in Figure 4. A beginning transition is also expected for vans, so that the number of electric cars and vans in 2030 will total around 800,000.

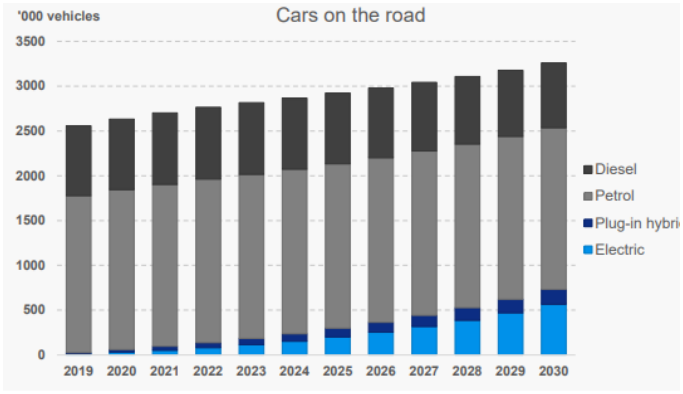

Figure 4. Number of cars by technology, 2019–2030

Emissions from road transport

Although sales of electric and plug-in hybrid cars are expected to increase, petrol and diesel cars are still expected to amount to around 78% of cars on the road in 2030, due to inertia in the transition because of the relatively long lifetime of vehicles.

Road transport is responsible for, by far, the majority of emissions from the transport sector. In 2019, road transport emitted 12.4 million tonnes CO_2e, corresponding to 92% of total emissions by the transport sector. Emissions fell during the Covid-19 pandemic to 11.4 million tonnes CO_2e in 2020 and 11.6 million tonnes CO_2e in 2021. The projection show an increase in emissions in the wake of the pandemic, but after this, emissions are projected to decrease significantly in spite of continuous growth in demand for road transport. By 2025, emissions will have fallen to 11.2 million tonnes CO_2e, and by 2030 and 2035, they will have fallen to 9.6 million tonnes CO_2e and 7.3 million tonnes CO_2e, respectively.

Cars account for the largest share of emissions from road transport, at 57% in 2021, followed by vans and lorries. Figure 5 shows GHG emissions from road transport, broken down by type of vehicle and cross-border trade. Cars are also the category for which the projected decrease in emissions is greatest in absolute figures. Despite a continued increase in traffic, the projection shows a reduction in emissions of GHGs from all vehicle types. This decrease is attributable to vehicle electrification, higher blending ratios for renewable fuels, and continued energy-efficiency improvements in conventional vehicles.

Emissions from rail transport

In 2019, rail transport emitted 0.2 million tonnes of CO_2e, corresponding to around 2% of emissions by the transport sector. Despite an expected expansion in train operations, a considerable reduction in emissions is projected after 2025, corresponding to the electrification of inter-city and regional trains, which are responsible for most emissions. In 2030, emissions from rail transport are projected to be 0.02 million tonnes CO_2e — a mere tenth of today's emissions — and in 2035, there will be no emissions at all. The last diesel trains are expected to be phased out just after 2030.

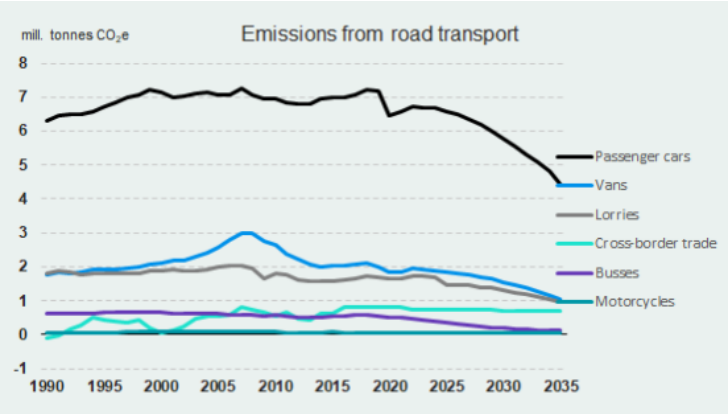

Figure 5. Emissions from road transport by vehicle

Emissions from domestic aviation

Emissions from domestic aviation were 0.15 million tonnes CO_2e in 2019, corresponding to around 1% of total transport sector emissions. As a result of the Covid-19 pandemic, emissions from domestic aviation were 0.08 million tonnes CO_2e in 2020 and 0.09 million tonnes CO_2e in 2021. The projection that activity in the sector will increase gradually as a result of increased demand for domestic flights includes a caveat that it may not return to the pre-pandemic level until 2025.

The projection includes an expectation that the incrementally increasing CO_2 tax on fuels for domestic aviation under the 2022 Green Tax Reform for Industry Etc. agreement, which will take effect in 2025, will put a damper on developments in aviation activity. The projection also assumes general energy efficiency improvements.

Emissions from domestic aviation are expected to increase to 0.13 million tonnes CO_2e in 2025 and 0.14 million tonnes CO_2e in 2030, after which emissions will remain unchanged. Renewable fuels blending is not assessed to be financially feasible without further regulation of the sector, and use of renewable fuels in domestic aviation has therefore not been included in the projection.

Emissions from domestic shipping

Emissions from domestic shipping accounted for 3.9% of total emissions by the transport sector in 2019. The projection shows that emissions will remain more or less constant at around 0.5 million tonnes CO_2e in the period up to 2035. However, the projection predicts a slight reduction in emissions as a result of electrification of a number of short ferry services, partly resulting from deployment of the pool to promote green transition of domestic ferries in 2021 (11 ferries received commitment of funding) and in 2022 (three ferries received commitment of funding); the program replaced 15 existing ferries with 14 green electric-powered ferries, either through refurbishment or new purchase.

Further, the introduction of a CO_2 tax as part of the 2022 Green Tax Reform for Industry Etc. agreement is assessed to increase the incentive to opt for electric ferries when buying new ferries. The projection does not include use of renewable fuels, such as ammonia or methanol in domestic shipping, because such fuels are not financially feasible without further regulation of the sector. Even with the introduction of the agreed CO_2 tax, renewable fuels are associated with a considerable additional cost, including the cost of having to invest in infrastructure, etc.

Outlook

In Denmark, the transportation sector is still almost entirely dependent on oil. By 2050, the government aims to meet all Danish energy demand with renewable energy, including that required by the transportation sector. In 2012, a broad majority in Parliament reached an energy agreement defining initiatives covering crucial energy policy areas for the period 2012–2020, and agreed to discuss additional initiatives for the period after 2020. The analysis from 2012 indicates that by 2020 and beyond, electricity, biogas, and natural gas could become especially attractive as alternatives to petrol and diesel in the transportation sector. Electricity is the most energy-efficient alternative because of high efficiency in the engine and an increase in the share of wind-generated electricity supply.

Energy islands

The world's first energy islands will be constructed in Denmark, exploiting our immense wind resources in the North and Baltic seas. The energy islands will serve as hubs that can create better connections between energy generated from offshore wind and the energy systems in the region around the two seas.

In the North Sea, an artificial island will be constructed, which will be a hub for 3-GW offshore wind farms, with the possibility of 10 GW in the long term — enough to power 10 million households. The wind turbines that will supply power to the island are expected to be larger than they are today, and they will extend further out to sea than before. The technical equipment for energy distribution will be located on the island; it will not be possible to see the turbines from land. The energy islands are part of the development of the energy systems of the future. Political agreements state that electricity from the energy islands should be converted into new forms of energy (e.g., Power-to-X), creating green power that will contribute to the phasing out of fossil fuels in both Denmark and Europe.

In the Baltic Sea, the technical equipment for energy distribution will be located on Bornholm, where electricity from offshore wind farms will be transported to the electricity grid on Zealand and neighboring countries. The offshore wind farms will stand approximately 20 km south-southwest of the coast and will be visible but not dominant on the horizon.

The parks at Bornholm must have a capacity of 2 GW, corresponding to the electricity consumption of two million households. Like the island in the North Sea, the ambition is for electricity from the offshore wind farms to be converted into other forms of energy (Power-to-X).

Additional Information Sources

- Danish Energy Agency, 2019, *Danish Energy and Climate Outlook 2019*, https://ens.dk/sites/ens.dk/files/Analyser/deco19.pdf.
- Energistyrelsen, www.ens.dk.
- Danish Energy Agency, 2023, Denmark's Climate Status and Outlook 2023. https://ens.dk/sites/ens.dk/files/Basisfremskrivning/kf23_hovedrapport_v3_eng.pdf.