NORWAY

TRANSPORT

The progressive electrification of land and maritime transport

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NORWAY

The progressive electrification of land and maritime transport

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Accounting for over 29 % of Norway's overall CO_2 emissions, transport-related emissions have fallen sharply since 2012. This trend is mainly due to the fact all stakeholders made significant efforts to progressively electrify both the vehicle fleet and maritime transport. Road freight and domestic air travel are already in line as the next upcoming challenges. Norwegian local governments' efforts in terms of public transit in urban areas have delivered real results but did not lead to a fall in transport demand at the national level. Only train journeys have recently decreased.

Key takeaways

Norway witnessed a decline in its transport CO_2 emissions, decreasing by 11.4% between 2012 and 2018, yet national CO_2 emissions remain relatively stable.

This decrease is mostly due to the decarbonation of the vehicle fleet even with the rise in demand for transport. Norway is now the world's third largest market for electric and hybrid vehicles.

The national incentive policies target demand more than supply to boost sales. Electrifying the vehicle fleet still depends on the production capacity of manufacturers and on the large-scale development of infrastructure for charging stations.

The increasing urbanisation of the Norwegian population, as well as the multi-level consultation tools (Urban Environment Agreements) and the public expenditure orientation of the National Transport Plan (NTP) make cities the driving forces for the development of public and low-impact transport. Oslo, where in 2016 there were more trips by public transit than by car, is a leading figure.

Pressured by local communities, the Norwegian parliament initiated the decarbonation of the fleets circulating in the UNESCO-listed fjords. In line with stricter regulations, the Confederation of Norwegian Enterprises has taken the lead in the electrification of ferries and is extending its efforts against air pollution (NOx) to subsequent GHG emissions.

SUMMARY

1 – Electrification of the vehicle fleet, propelling the reduction of emissions

Since 2012, Norway's overall CO_2 emissions have been on the rise by 1.2% and reaching 45.7 $MtCO_2$ in 2018 (Enerdata, 2019). In contrast to this slight upward trend, **the 29.3% of these transport-related emissions have continuously dropped since 2012 (-11.62%)**, led by a significant fall in those of road transport (-8.48%) since 2015, and, in smaller volumes, by those of shipping (-26.88%) (Table 1). These trends reflect the decrease in fuel consumption since 2012 and diesel since 2015, in parallel with **a dramatic increase in road transport electricity consumption (+2477%) since 2014** (Graph 1), which has now extended to ferry fleet.

TABLE 1

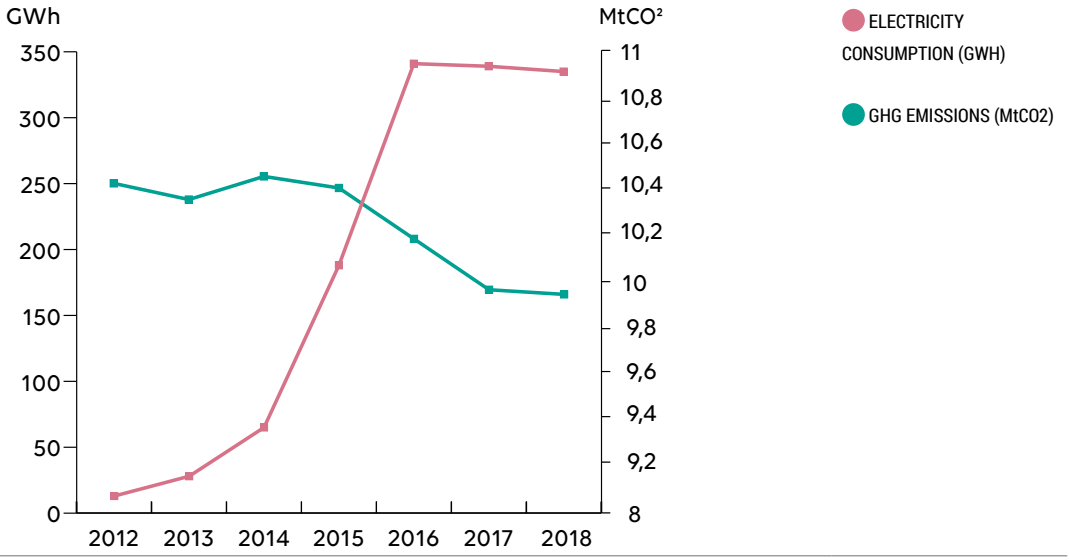
EVOLUTION IN GHG EMISSIONS, FUEL, DIESEL AND ELECTRICITY CONSUMPTION IN THE TRANSPORT SECTOR, ROAD AND NAVIGATION TRANSPORT. – *Source : Enerdata, 2019.*

		2012	2013	2014	2015	2016	2017	2018	Evolution (2012-2017)
GHG Emissions ($MtCO_2$)	All Transport	15,15	14,66	14,50	14,38	13,93	13,42	13,39	-11,6
	Road transport	10,85	10,71	10,91	10,81	10,37	9,93	9,89	-8,8
	Domestic air travel	1,40	1,30	1,36	1,39	1,35	1,40	1,44	2,9
	Navigation	2,79	2,55	2,18	2,14	2,18	2,04	2,03	-27,2
Fuel consumption (Mt)	All Transport	4,77	4,60	4,53	4,49	4,35	4,21	4,20	-11,9
	Road transport	3,18	3,17	3,22	3,23	3,11	2,97	2,96	-6,9
	Navigation	0,83	0,74	0,61	0,60	0,62	0,60	0,60	-27,7
Diesel consumption (Mt)	All Transport	3,26	3,18	3,14	3,17	3,09	2,95	2,96	-9,2
	Road transport	2,16	2,22	2,31	2,37	2,30	2,19	2,20	1,9
	Navigation	0,79	0,69	0,56	0,57	0,59	0,57	0,57	-27,8
Electric consumption (GWh)	All Transport	622	632	654	821	970	965	952	53
	Road transport	13	28	65	188	341	339	335	2477

GRAPH 1

EVOLUTION IN GHG EMISSIONS ($MTCO_2$) AND NORWEGIAN TRANSPORT SECTOR'S ELECTRICITY CONSUMPTION 2012-2018

- Source : Enerdata – 2019



As a result of these substantial drops, Norway has fulfilled its 2020 vehicle emission reduction objectives since 2017 (Climate Action, 2018). In 2012, the country adopted the goal of 85 grams of CO_2 per kilometer by 2020, corresponding to the average emissions per passenger-kilometer from new vehicles, a more ambitious target than the European Union (95g/km by 2020). In December of the same year, this rate reached 74 g/km since Tesla sales sharply rose, leaving last in the national sales ranking diesel-powered cars (Climate Action 2018). The Norwegian Parliament hopes to achieve its goal of selling only "zero emissions cars" (ZEC) by 2025.

However, the electrification of the Norwegian vehicle fleet failed to spark a delay in emissions on domestic or imported electricity generation. Firstly because 96% of domestic electricity generation in Norway comes from a low-GHG emitter, hydropower. Secondly, Norway did not use external production to meet the increase in demand. As a net annual exporter of electricity through interconnection networks with neighbouring countries (Energy Facts Norway, 2019), only seasonal variations in it reservoirs can lead to some one-off import peaks. Finally, between 2010 and 2017, Norwegian electricity generation climbed by around 16 000 Gwh whereas at the same time, the electricity demand of the transport sector increased by only 400 Gwh (Enerdata, 2019). Without making emissions from electricity generation any higher, the new installed electricity generation capacity and/or the increase in the use rate of existing capacity, based on a low-emissions source, have been more than adequate to cover the electrification of vehicle fleet.

Finally, the evolution in transport volumes in 2017 compared to 2016 (Farstad, 2017) highlights that the emissions did not plummet because of a decline in demand :

- Domestic travel increased 1.7% and freight tonne-kilometers transport by 2.6%.
- The volume of private road traffic rose 1.1%, public transit by 7% for bus journeys (+29 million) and 5% for metro travel (+10 million).
- There was also a leap in domestic air travel, rising 1.9% (+240,000)
- Solely train travel witnessed a slight dip of 1.4% (1 million).

FOR A BETTER UNDERSTANDING

TRANSPORT IN NORWAY AND SUSTAINABLE DEVELOPMENT GOALS (SDGS)

Norway released its first ever assessment report on the implementation of the SDGs in 2016 (Gouvernement of Norway, 2016). With a renewable energy rate at 69 % (including transport), and two thirds of urban population less than 500 meters away from public transit (Urban Transport, 2018), transport-related dimensions of SDG 7 (sustainable energy) and 11 (sustainable cities) appear to be correctly taken into account. However, the country is still making efforts to fulfil the aim of creating inclusive cities.

BOX 1

2. A generous and stable incentive policy at all levels of governance

Implemented incentives at both national and local levels reflect consistency within all actions initiated by stakeholders from transport and related sectors (Table 2). In addition to tax incentives, direct subsidies were established and decided by local authorities and private transport or parking operators (free or discounted tolls), to which are added several user privileges (at local level) by local authorities such as free parking and access to bus lanes. Other aspects enhance the use of electric and hybrid vehicles (E&H V) for instance, adequate speed limits : 80 km/h for main roads and 100 ~ 110 km/h for motorways in a country that extends over 2000 km. 83 % of the time, the average distance traveled is less than 80 km, and the average citizen travels about once a month an average distance of 213 km (TOI, 2018) : average journeys in Norway are thus within reach of autonomy and being powered by modern electric and hybrid vehicle batteries. Finally, the electrification of the car fleet is being facilitated by the price gap between electricity, among the cheapest in Europe, and fossil fuels, among the most expensive. In total, overall energy savings achieved by using a E&H V are the largest in Europe and about twice as much as in Germany (TOI, 2015).

TABLE 2

RELATIVE ADVANTAGES OF DIFFERENT BEV INCENTIVES IN NORWAY IN 2017 AND FUTURE PLANS – *Source : TOI, 2018.*

INCENTIVES	INTRODUCTION YEAR	BATTERY ELECTRIC VEHICLE (BEV) BUYERS – RELATIVE ADVANTAGE	FUTURE PLANS
FISCAL INCENTIVES : REDUCTION OF PURCHASE PRICE/YEARLY COST GIVES COMPETITIVE PRICES			
EXEMPTION FROM REGISTRATION FEES	1990/1996	TAX BASED ON THE VEHICLE'S EMISSIONS AND WEIGHT.	UNTIL 2020
VAT EXEMPTION	2001	VEHICLES COMPETING AGAINST BEVQ ARE SUBJECT TO 25 % VA ON THE RETAIL PRICE, MINUS REGISTRATION TAX.	UNTIL 2020
REDUCED ANNUAL VEHICLE LICENCE FEE	1996/2004	52 € FOR HYDROGREN AND BEVS; 360-420 € FOR DIESEL VEHICLES	TO BE CONTINUED INDEFINITELY
REDUCED COMPANY CAR TAX	2000	THE TAX ON COMPANY CARS IS LOWER BUT BEVS ARE RARELY USED AS COMPANY CARS.	THIS INCENTIVE MAY BE REVISED IN 2018
EXEMPTION FROM RE-REGISTRATION FEES	2018	TAX IS LEVIED ON THE CHANGE OF OWNERSHIP OF ICEVS AND PHEVS : THE MORE RECENT THE VEHICLE, THE HIGHER THE TAX.	INTRODUCED IN 2018
DIRECT SUBSIDIES TO USERS : REDUCTION OF VARIABLE COSTS AND HELP SOLVING RANGE CHALLEGNES			
FREE TOLL ROADS	1997	IN OSLO-AREA, MOTORISTS CAN SAVE 600-1000€ ; IN SOME PLACES UP TO 2,500€	LAW REVISED SO THAT RATES FOR BATTERY ELECTRIC VEHICLES IN TOLL ROADS AND FERRIES WILL BE DECIDED BY LOCAL GOVERNMENTS, UP TO A MAXIMUM RATE OF 50 % OF THE ICEV RATE.
REDUCED FARES ON FERRIES	2009	BENEFICIAL TO FERRY USERS	
FINANCIAL SUPPORT (NORMAL CHARGING STATIONS)	2009	REDUCES INVESTORS' RISK, REDUCES USERS' RANGE ANXIETY, EXPAND USAGE.	NATIONAL PLAN FOR CHARGING INFRASTRUCTURE SHALL BE DEVELOPED.
FINANCIAL SUPPORT (FAST CHARGING STATIONS)	2011	MORE FAST-CHARGING STATIONS BOOST BEV KM DRIVEN & MARKET SHARES	ENOVA[1] SUPPORT PROGRAMME TO ESTABLISH FAST-CHARGING ALONG MAJOR TRANSPORT CORRIDORS. CITY FAST-CHARGING IS LEFT TO COMMERCIAL ACTORS
USER PRIVILEGES : REDUCTION OF TIMES COSTS AND PROVIDING USERS WITH RELATIVE ADVANTAGES			
ACCESS TO BUS LANES	2003/2005	BEV USERS SAVE TIME DRIVING TO WORK IN THE BUS LANE DURING RUSH HOURS.	LOCAL AUTHORITIES HAVE GIVEN THE AUTHORITY TO INTRODUCE RESTRICTIONS IF BEVS DELAY BUSES.
FREE PARKING	1999	USERS GET A PARKING SPACE IN SCARCE OR EXPENSIVE AREAS AND SAVE TIME LOOKING FOR A SPACE.	LOCAL AUTHORITIES WILL BE GIVEN THE AUTHORITY TO INTRODUCE RATES UP TO 50 % OF THE ICEV RATE.
FREE CHARGING (SOME PLACES)		NOT REGULATED BY NATIONAL LAW, BUT OFTEN BUNDLED WITH FREE MUNICIPAL PARKING.	LOCAL AUTHORITIES AND PARKING OPERATORS DECIDE WHETHER THIS INCENTIVE WILL CONTINUE.

In a 2016 survey, electric and hybrid vehicle users estimated that local incentives represent an average value of 1,500 euros/year/vehicle (TOI 2018). Reductions in tolls accounted for 50 %, time savings with access to bus lanes 30 %, free parking 16 % and ferry prices 4 %. The incentives vary a lot among individual users : about 10 % of users do not receive any of these benefits while 10 % withdraw more than 4,000 euros/year. The geographical variation of local incentives must also be

1 – Norwegian public company charged with the promotion of environmentally-sound energy production and consumption

highlighted as the highest values are found in the countries near large cities that are suitable for the deployment of electric and hybrid vehicles (the counties of Oslo, Akershus, Sør-Trøndelag and Hordaland). The owners of Buskerud County, although having a below-average share of electric vehicles, record a strong incentive thanks to the time saved in bus lanes.

FOR A BETTER UNDERSTANDING

THE NORWEGIAN NATIONAL TRANSPORT PLAN

The Norwegian National Transport Plan (NTP) is a strategic document defining the main directions in transport and mobility. Renewed every four years, the document is a result of the participation of the administrative bodies of different modes of transport, counties (fylke), and cities (Page 10), and is then voted by the National Parliament. The 4th plan (2014-2023) stating "The growth in passenger transport in the main urban areas must be absorbed by public transport, cycling and walking", achieved by combining modal shift incentives and enhanced intercity mobility. To this end, it planned on increasing yearly rail investments by 50 % as well as a large rail reform ending early 2017 and replacing the National Rail Administration by the Norwegian Railway Directorate for managing the network on behalf of the state and public company Bane Nor SF for the construction and maintenance of railways. There were three calls for tender in 2018 to assign the operation of the lines to private operators. The latest national travel survey from 2014, states that travel was 64 % by car, 21 % by foot, 9 % by public transport and 4 % by bicycle (Urban Transport Group, 2018). In 2016, the same institute calculated that public spending on public transit increased by 73 % since 2005, and that same year, the use of public transit reached a new peak with 665 million passengers (TOI, 2017).

Paradoxically, the electrification of the car fleet is never mentioned in this plan. The 5th plan (2018-2029) aims to develop a "safe transport system that produces more value and contributes to a low-carbon society." Though the plan focuses more on digitalisation and electrification, the former Minister of Transport and Communications, Ketil Solvik-Olsen, promised all the same in the foreword that Norway will witness "The most hectic and ambitious construction period" for railways since the 1960s, in order to "provide more attractive and competitive railway services for both freight and passenger transport." Also, 24 billion NOK (2.5 billion euros) are allocated to support public transit, cycling and pedestrians, sending a strong signal on what direction Norway will take in the near future..

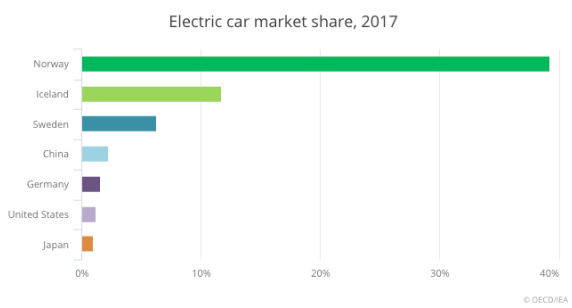
BOX 2

• EMISSION DECLINE BOOSTED BY PLUG-IN HYBRID ELECTRIC VEHICLE (PHEV) SALES • Norway has hoisted itself up to 3rd place in the global electric car market, just behind the two giants : China and the USA. In 2017, Norwegian PHEV sales reached 20 % market share each (Graph 2). In the same year, electric and hybrid vehicles accounted for 7.6 % of the country's total passenger car fleet, up from 97,532 electric cars at the end of 2016 to 139,474 at the end of 2017, plus 67,577 hybrid cars and around 1,500 4-wheel electric motorcycles (Graph 3). If the trend continues, electric and hybrid vehicles' share could reach 10 % of total fleet in 2019 (TOI, 2018).

GRAPH 2

ELECTRIC MARKET SHARE IN 2017, BY COUNTRY.

Source : IEA Global Electric Vehicle Outlook, 2018.

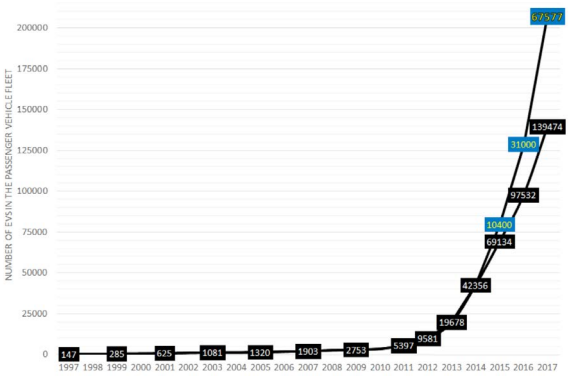


These sales took the electric and hybrid car production market by surprise. In a country with a population totalling to 5 million inhabitants, the large-scale deployment of electric and hybrid vehicles still depends on the capacity of manufacturers, to ensure the industrial-scale production, subject itself to the world market. Over 4,000 Norwegians are on the waiting list for the Opel "Ampera-e", delivery time ranging from 12 to 18 months. Without specifying the number of Norwegians involved, Tesla has a large order ready for its "Model 3" and is showing delays in deliveries. Supply shortages also concern other models (Hyundai "Ioniq", Volkwagen "E-Golf"), ranging from a few months to over a year (TOI, 2018).

GRAPH 3

ELECTRIC PASSENGER CAR (BLACK) AND PHEV FLEET (BLUE) FROM 1997-2017.

Source : OFVAS, 2017 retrieved from TOI, 2018.



EXPERIENCE FEEDBACK

THE INFLUENCE OF THE NORWEGIAN ELECTRIC CAR ASSOCIATION

The Norwegian Electric Car Association (Norsk elbilforening), with 70,000 members, has played an influential role in legitimising electric vehicles. As a member of the European Association for Electromobility (AVERE) and World Electric Vehicle Association (WEVA), the Norsk elbilforening represents electric vehicle owners in Norway and promotes vehicles that function only or partially with renewable energy. As they defend the idea that these vehicles are the best transport alternative in terms of local environment, climate, energy efficiency and economy, the association cooperates with the Norwegian government, the electric vehicle industry and endorses Norway as the best policy example in terms of electric vehicles in Europe and worldwide.

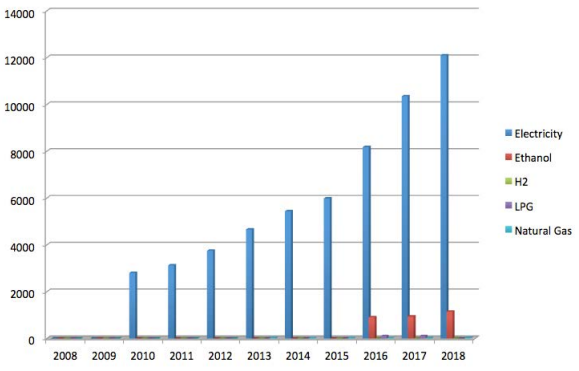
BOX 3

Besides having to depend on the availability of electric and hybrid vehicles, the electrification of the Norwegian vehicle fleet also depends on its ability to develop the appropriate infrastructure, notably charging points (Graph 4) an effort being made by a growing number of companies. Although the implementation of infrastructure is slower than the growth of electric and hybrid vehicles on the market, 3,000 public charging points, more than 42,000 charging points in homes and over 1,00 fast-charging stations have been installed. They are placed every 50 km on main roads in 2017 and are mainly funded by ENOVA SF, an agency of the Norwegian Ministry of Petroleum and Energy which has a 200-million-euro budget. In addition to this, charging infrastructure is growingly used to attract customers to major shopping centres. For example, all IKEA stores are now equipped with fast-charging stations, as are multiple fast-food restaurants. So far, total investment in electric charging infrastructure has exceeded 100 million euros and has led to a 7% drop in the total number of service stations in Norway between "2012 and 2016 (TOI, 2018).

GRAPH 4

EVOLUTION IN QUANTITY OF ALTERNATIVE FUEL INFRASTRUCTURE IN NORWAY.

Source : European Alternative Fuels Observatory



In order to support this long-term development of charging infrastructure, the 2018-2029 National Transport Plan provides for a new fund of 105 million euros (Ministry of Transport, 2017). However, the choice to invest in electrification deprives the government of financial gains because of the exemptions and tax reductions granted on the purchase of electric vehicles (VAT, annual license fees, registrations fees) (TOI, 2018).

FOR A BETTER UNDERSTANDING

DYNAMIC RESEARCH AND DEVELOPMENT ON HYDROGEN

Nordic countries are state of the art concerning the deployment of hydrogen vehicles (HV), that is notably due to its transnational cooperation via the Scandinavian Hydrogen Highway Partnership, even with an almost-inexistent local market. In Norway the national strategy for hydrogen was introduced in 2016 with the aim to propel research on hydrogen and financially incite the development of appropriate infrastructure. Most research and development activities on hydrogen take place at the Norwegian University of Science and Technology (NTNU), at the Scientific and industrial research foundation (SINTEF), the Institute for Energy Technology (IFE), as well as within the "Mozees" (Mobility Zero Emission Energy System) project that works on battery value chains, systems and applications. ENOVA SF financially supports the enhancement of hydrogen supply stations and the updating of hydrogen vehicles. Similar to electric and hybrid vehicles, many financial incentives have been set up for HV : exemption of registration fees, VAT, taxes for car companies, free tolls or even reduced ferry transport fees, parking fees and access to bus lanes. In 2018, Norway had around 100 HV on record, most of them located in Oslo because of access to hydrogen supply stations. (Langeland, O et al., 2018).

BOX 4

3. The all-electric strategy sought by stakeholders from maritime, air and land transport sectors

• SLOW PROGRESS FOR BUSES AND LORRIES • In 2018, 78.2% of Norwegian road traffic (in km) was made up of passenger cars whereas vans/trucks represented 16.3%, lorries just 4.4% and buses 1.3% (Statistics Norway, 2019). The electrification of these vehicles remains modest : in 2018, the country accounted for 3,800 vans, 3 lorries and 26 buses (including 5 hydrogen buses) that were all electric. Like all over the world, except from China were 98.3% of worldwide electric buses are located, Norway is facing a restricted offer in terms of electric vehicles. Many pilot bus projects were launched in Norwegian towns such as Stavanger, Trondheim, Lillehammer, Kristiansand and Oslo. The Norwegian food transport company Asko tested out an 18-gross-tonne-electric lorry in Oslo, capable of carrying a load up to 5 tonnes and a range of up to 200 km, these features make it a serious rival to its combustion engine counterparts. Asko even ordered 10 Tesla electric trailers expected to be received by 2020, like other Norwegian companies : Travel Retail Norway ordered two of these trailers and Bring, ordered one (Guri et al., 2018). Added on to the lack of supply, financial incentives are not as developed as those for passenger cars, but the 2018-2029 National Transport Plan provides for new legislation to facilitate modular combinations of lorry-trailers on certain roads that can reduce transport costs and increase the efficiency of freight transport by up to 50% compared to conventional modular combinations (Ministry of Transport, 2017).

• CIVIL SOCIETY'S ROLE IN THE DECARBONATION OF MARITIME TRANSPORT • Within the 2018-2029 National Transport Plan, the increasing use of maritime transport for freight is as much a major focus as pursuing the electrification of the maritime transport sector. Norwegian GHG emissions from its internal shipping sector reached 2.17 $MtCO_2$ in 2017 (Enerdata, 2019). Extending the length

of the Northern sea, Norway owns the ninth biggest merchant fleet in the world and is the second largest exporter of seafood products. The country has 32 maritime ports connected to the national transport network, 700 fishing ports as well as multiple international fjords used by excursion boats. The decarbonation of the maritime sector for Norway is therefore a very strategic decision.

Norwegian civil society plays a decisive role for transport electrification momentum. The decisions to decarbonate fjords are a result of complaints from multiple local citizen collectives concerning touristic excursion boats. The Norwegian Maritime Authority (NMA) is a key component for regulating pollutant emissions from vessels in fjords (Box 3). The NMA enforces these regulations through regular inspections. Based on these successes, it is now planning to extend these bans nationwide (Safety4Sea, 2019).

FOR A BETTER UNDERSTANDING

THE DECARBONATION OF FJORDS LED BY NATURAL HERITAGE REPRESENTATIVES

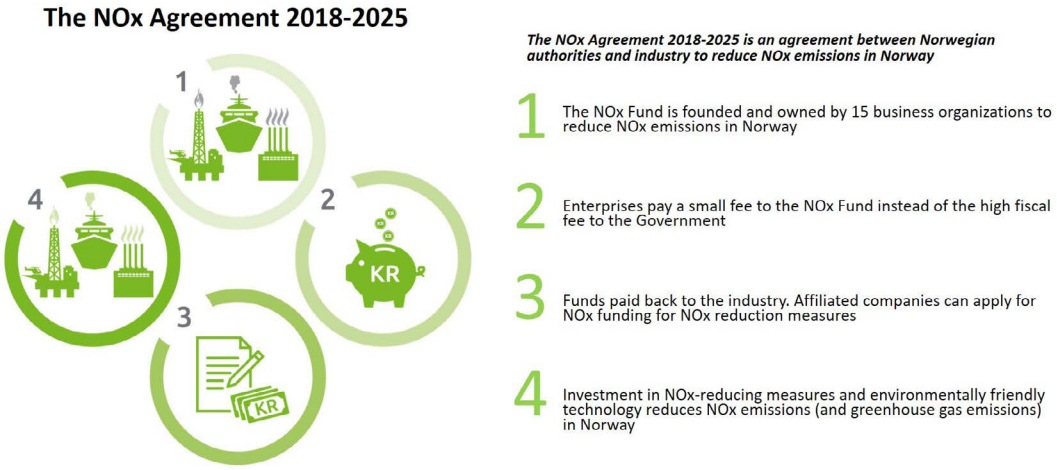
In 2015, around 180 excursion boats and 130 ships cruised the Norwegian fjords, meaning over 300,000 passengers passed through the fjords resulting in significant air pollution with impacts on the health of local communities and ecosystems. To deal with this situation, the Norwegian Parliament adopted a resolution to ban all GHG emissions from cruise ships and ferries traveling in the fjords (Nærøyfjord, Aurlandsfjord, Geirangerfjord, Sunnylvsfjord and Tafjord) by 2026. These fjords are in West Norway and registered on UNESCO's World Heritage List since 2005. With three main axes (climate, public health, environmental protection), this resolution will make these fjords an international leading maritime zone. This is in response to the 2015 decision to force all new vessels to adopt low and zero emission technology (UNESCO, 2018). To accomplish these objectives, the regulations are becoming stricter. On March 1st, 2019, the new and enhanced requirements relate to the level of nitrogen oxide emissions, the ban on incineration of waste and the use of scrubbers to remove sulphur oxides (SOx) and nitrogen oxides (NOx). For example, every ship that does not use electrical or hydrogen systems should be equipped with catalytic converters, low sulphur fuel or other alternatives (FathomWorld, 2019).

BOX 5

Another important key actor in the Norwegian decarbonation movement is the Confederation of Norwegian Enterprise (NHO). This organisation hopes to forge ahead with national industrial decarbonation, particularly the maritime sector. To do so, the NHO is considering expanding the "NOx Fund" base to GHG emissions. The NOx Fund was launched in 2008 with the aim of replacing the tax on nitrogen oxide (NOx) emissions from offshore platforms and the maritime industry (Graph 5). The Fund currently allows participating companies to pool their private investment costs to meet government targets for reducing pollutant emissions, while retaining control over contributions and subsidies. By including GHGs, the NHO would take the lead on global maritime regulations on GHG emissions under development by the International Maritime Organisation (IMO), developing its own constraints and GHG emissions management tools (NOx-fondet, 2019).

GRAPH 5

THE NORWEGIAN NOX FUND. *Source : NOx-fondet, 2019.*



Private ferry operators are also attempting to rapidly conduct the conversion of their fleet. Initiated in 2010 by the Norwegian battery system developer ZEM, the ZEMAPHOR project aspires to adapt lithium-ion batteries (Li-Ion) to applications other than the automotive sector. This initiative jointly led by DNV GL, the largest accredited international registration and classification company in Norway wishes to electrify 25% of Norwegian ships (shipping, offshore and transport) by 2020. Of the 180 ferries operating in Norwegian waters, their overall GHG emissions were estimated at 400,000 tonnes of CO_2 per year (PPMC, 2019). According to the environmental group Bellona and Siemens, 127 of these 180 ships could be electrified, which would reduce emissions by 75%. This appraisal is based on the results of the first all-electric Norwegian ferry "Ampère" put into service in 2015. Resulting from a partnership between Norled AS, a shipping company and shipyards Fjellstrand Shipyard, Siemens AS and the Canadian company Corvus Energy, "Ampère" reduced emissions by 95% and costs by 80% compared to gas tanks in addition to reducing noise pollution in the water (Electrek, 2018). These results, more optimistic than expected in 2018, enabled the shipyard Havyard to receive many production orders for new electric ferries for the Norwegian transport conglomerate Fjord1. In May 2018, five new ferries commenced operations and in 2019, another five will sail. These trends stimulate the global demand for electrical conversion of marine engines and enable Norway to pursue its ambition of having GHG emissions-free maritime waters.

The electrification of ferries is joined by a desire to postpone part of the passenger transport on sea routes since the 8 largest Norwegian cities are located on the coast. A group of 6 private operators, 'NCE Maritime CleanTech", are developing a project called Urban Water Shettler that aims by 2022 to provide metro-like services via electric maritime shuttles, easing the pressure on public land transport.

• AIRLINES POSITION THEMSELVES AS LEADERS IN ELECTRIC AVIATION • With 10% of overall GHG emissions originating from the transport sector, domestic air travel is also considered within Norway's Strategy for the electrification of transport. Indeed, Avinor, the state-owned company that operates most of the country's civilian airports, has presented to major global aircraft and engine manufacturers its intention to make Norway a world leader in electric aviation. The company's ambition is to make all domestic short-distance flights electric (1 hour and a half fights) by 2040 (Avinor, 2018). The short routes between the 44 airports that the company operates already, enhance the testing of the first domestic electric flights.

To make this project a reality, the Norwegian government with the aim of continuing to deliver

predictable regulatory frameworks and long-term support, has mandated the public company to evaluate the incentives necessary to ensure the electrification of the sector. The regional airline companies Widerøe and SAS, partners of the project, will purchase the upcoming electric aircraft available on the market and Avinor will take care of the required infrastructure. The Norwegian Association for air sports and Zero Emission Resource Organisation (a Norwegian environmental organisation founded in 2002 with the aim to reduce national GHGs) also supports this ambition (Avinor, 2018).

4. Norwegian cities implementing decarbonation and changes in use

• MUTLI-SCALE COOPERATION TO ENHANCE PUBLIC TRANSIT COMPETITIVENESS • With built areas representing just 2% of overall Norwegian land, Norway has the lowest population density in Europe, just behind Iceland (NTP 2018-2029). 80% of the population lives in the city, meaning municipalities have a key role to play in the coordination with other levels of governance : the state and counties. They are responsible for funding local and regional public transit, their connection to road infrastructure, and regional transportation planning.

In 2014, the fourth NTP designed the Urban Environment Agreements, a tool to help organise collaboration between the State, counties (fylke) and communes (kommune) for the implementation of the national objectives at all scales, and this within the 9 largest urban areas of the country. In each area, each level of governance set objectives for the use of public and low-impact transport. The fourth NTP provides a fund of 16.9 billion NOK (€2.1 billion) to finance these agreements, joined by a bonus scheme with 9.2 billion NOK (€1.16 billion) to reward urban areas committing measurable efforts to strengthen the competitiveness of public transport, and a congestion charge for cars. The 5th NTP increases this envelope to 12.2 billion NOK (€2.15 billion). Trondheim was the first city to benefit from this programme. After an agreement was reached in 2016 between the national government, the County of Sør–Trøndelag and the municipality of Trondheim. Funding for the necessary investments come from 3 different sources : tolls (€650 million), bonus system (€150 million and the special fund (€250 million) (Gouvernement de Norvège, 2016).

In a comparative study on Scandinavian countries, the Urban Transport Group analysed in 2017 that the rapid urbanisation of the Norwegian population, in addition to the place climate was given within national policies, have fostered the emergence of strong consensus between Norwegian cities on the need to support public and low-impact transport, as well as the reduction of the number of personal cars in urban areas. In that respect, while the supply of public buses (in kilometres per person) has been dropping since 2005 in most cities, since 2010 it is once again on the rise. In 2016, two-thirds of urban area inhabitants lived within 500 meters of public transport (Norwegian Government, 2016). Finally, many efforts have been made to simplify users' understanding of the network : reduction of tariff zones, easier payment methods, etc.

Since the 1990s, car share cooperatives emerged in Oslo, Bergen and Trondheim. In Oslo for example, Bilkollektivet, the best car-sharing service provider, is both a cooperative owned by its members and a not-for-profit organisation (Institute for Transport Economics, 2018). Bergen the second biggest Norwegian city, is also relying on the expansion of intermodal platforms on the outskirts of the city to make alternatives more credible to private car owners. In May 2018, the city inaugurated its first platform : a car-share station directly connected to all public transport services, cycle lanes, bicycle stations and live transport information (Share North, 2018).

Finally, Norwegian cities are highly involved within networks such as the « Smart City Network Norway » that brings together 14 cities from 5 regions including Oslo and Bergen. Norway's biggest cities are signatories of the European Covenant of Mayors representing 26% of Norwegians, each of them having tabled an action plan.

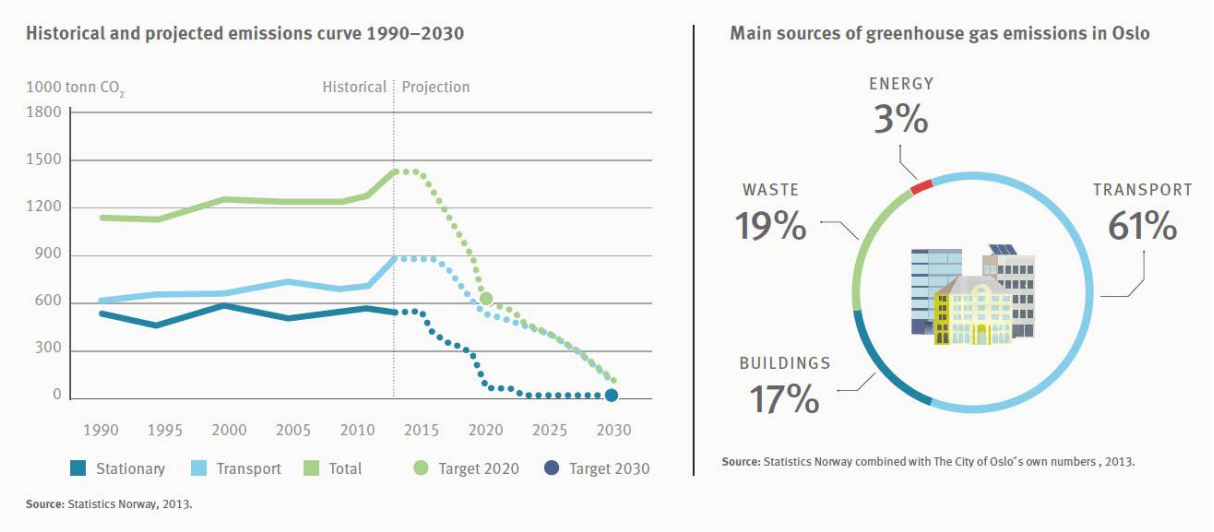
• OSLO, GLOBAL ELECTRIC TRANSPORT CAPITAL • Symbol of Norwegian dynamism, Oslo developed ambitious targets and plans to reduce transport sector emissions. The Norwegian capital had a population of 673,469 inhabitants in 2018 and a metropolitan area of about 1.7 million inhabitants (World Population Review, 2019). 28% of the national population lives in the capital which is also considered a fylkeskommune (County of Norway), and extends over 480 km². The town has meadows and spacious parks covered with cross-country ski trails, while being an important node for rail and port communication, served by a network of roads and numerous suburban trains..

On January 1st; 2019, Oslo became the European Green Capital and hopes to become a carbon-neutral city in 2030. To this end, the municipality is aiming to reduce its GHG emissions by 36% by 2020 compared to 1990, and by 95% prior to 2030, though city emissions in 2015 were still relatively close to those of 1990 (Graph 6). The new Mayor Raymond Johansen, elected in 2015, has committed to reducing the city's emissions by 10% each year of his mandate, a target he is already achieving. In 2013, Oslo GHG emissions amounted to 1.4 $MtCO_2eq$ of which 61% came from the transport sector, half of which related to passenger transport and the other half to freight transport and construction activities (Graph 7). As a result, transportation is at the heart of the municipal GHG emission reduction policy (City of Oslo, 2016).

GRAPH 6

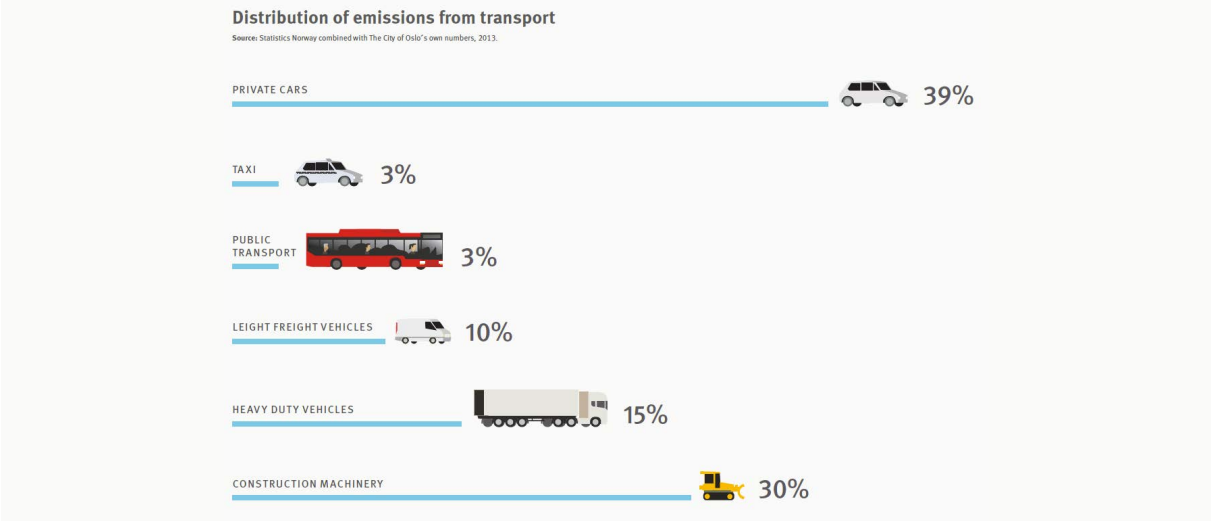
HISTORICAL EVOLUTION AND PROJECTED GHG EMISSIONS FROM OSLO BETWEEN 1990 AND 2030 AND THEIR SHARES BY SECTOR.

Source : City of Oslo, 2016.



GRAPH 7

DISTRIBUTION OF OSLO'S GHG EMISSIONS DEPENDING ON THE MODE OF TRANSPORT. *Source : City of Oslo, 2016.*



Oslo's Climate-Energy Strategy (2016) was developed in multidisciplinary and cross-sectoral consultation between more than 40 stakeholders from Norway, from the business community to transport, energy and building, all sector managers came together. The local scientific community also contributed to the process through technical advice and development modelling (City of Oslo, 2016). Since 2017, climate budgets with sectoral emission limits have been voted by the city council as part of the usual annual budget process. Then subject to the same requirements of transparency as any other municipal policy, the success of climate policies can be evaluated and measured by the means allocated and the objectives set. It is the city's finance department that is responsible for drafting climate budgets rather than the environmental team, so that advanced emissions targets are achievable and consistent with municipal finance. (C40, 2018).

EXPERIENCE FEEDBACK

OSLO'S PORT IS FOLLOWING SUIT

To achieve the goal of cutting GHG emissions from port activities in two by 2030, the city of Oslo has allowed local ferries and large vessels to use electricity from the port system, even once docked. The Norwegian capital also wants to transfer the biggest quantity possible of goods (originally planned for the road network) to rail and sea. This operation is facilitated by the implementation of regulatory and support tools to promote the development of modular infrastructure and electricity distribution, actions taken in close collaboration with the government, the commercial sector and public agencies.

BOX 6

The 2018 allocated budget to Oslo's GHG reduction actions includes ambitious measures in the transport sector :

- Introduction of new traffic taxes on toll roads at peak times, with exemptions for low-carbon vehicles;
- 5% increase in public transit capacity while maintaining competitive low fares;
- Implantation of public zero-emission transit fleet by 2020;
- Strenghtening of urban planning department's resources in order to guarantee urban planning in harmony with the climate, and action with strong consequences for local mobility (City of Oslo, 2016).

This policy has already proved to be a success : in 2016, and for the first time in Oslo, there were more trips by public transport than by car (C40, 2018). One of the reasons behind this lies in the desire to establish an urban planning that focuses and aims on excluding cars. In fact, Oslo's new urban development goals focus on densifying both habitats and public transit networks. By introducing actions to reduce parking spaces, increasing their rates as well as pedestrian zones, **the new urban policy does not hide its objective to exclude as much as possible the use and presence of cars in the city centre.** The city even set targets for 20 % reduction in private vehicle transport by 2020 and 33% in 2030 compared to 2015 levels.

The arguments for moving towards this low-impact and sustainable mobility also revolve around a concern to improve air quality, increase green spaces and reinvigorate pedestrian public spaces. Oslo is developing their network of cycle paths by aiming to see daily trips by bicycle increase by 25% by 2025 and expanding the range of public transit via new lines of trams and electric buses. **The public transit operator Ruter ordered 70 electric buses, which will be taken over in 2019 by 3 different operators on 13 bus routes in the Oslo area following the successful pilot phase of 6 electric buses.** Building on the good image of electric mobility among passengers, one-third of the order are high-capacity buses making Oslo the Nordic capital for the largest number of these vehicles. The city plans on giving trainings to over 600 bus drivers on how to drive these vehicles and on the various factors influencing vehicle autonomy (topography, weather, driving style). Several large-scale tests will also be conducted to refine interactions between vehicles and charging infrastructure, including stress tests to better manage rest times (Clean Technica, 2019).

For the remaining private cars, the city hopes to keep on promoting the development of electric and hybrid vehicles through reserved lanes, as well as several other advantages. In 2018, the electric and hybrid vehicle in Oslo accounted for 59% of overall new car sales, increasing demand for electric charging points, especially near homes. **Aware that the number of these charging points must increase to support the continuation of this growth, the Oslo Climate Agency has set up since 2017 a subsidy programme to help install battery charging infrastructure in housing cooperatives.** In 2018 alone, 200,000 new private charging points were created despite the decision-making deadlines for condominiums due to the negotiations required between owners. The subsidy programme motivated one of the biggest projects : the Nordseterskogen Housing co-operative in the Ekeberg district introduced 108 new parking spaces, allowing a reduction in the overall installation costs as well as an increase in the added value of housing when sold. As a result of this local success, the Norwegian government is considering extending this subsidy across the entire country (Klima Oslo, 2019).

CONCLUSION :

Targeting demand enabled the Norwegian government to set up incentive policies, boosting sales to the point where the country became the world's third largest market for electric and hybrid vehicles. Decarbonating the vehicle fleet led to the reduction of CO_2 emissions of the transport sector by 11.4% between 2012 and 2018, despite a general increase of transport demand. In addition to these incentives, Norwegian municipalities actively supported the implementation of low-impact public transportation systems, technically and financially enabled by national plans. A challenge remains : the fleet's electrification heavily relies on the production capacities of manufacturers and on their ability to deploy large-scale infrastructure for charging stations. As regards maritime transport, decarbonating ships and ferries is contingent on the protection of natural touristic heritage, on claims by citizen groups, and on private operators' innovations.

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