Legislation on Zero-Emission Vehicles: Solution Towards Carbon-Neutrality or a Non-Sustainable Option?

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ABSTRACT

Zero-emission vehicles are increasing in numbers as time goes on. The EU has brought forth an idea to make legislation on the matter and perhaps after 2035 all cars that are produced and sold in the EU will need to be zero-emission vehicles. As the possibility for a legislation that regulates the producing and selling of zero-emission vehicles becomes more relevant, there is a need from other legislations on the subject.

Other parts of the world, including the state of California and Norway have implemented legislations on zero-emission vehicles. There can be much learned from the two entities to see what kind of legislation would fit the system of the EU the best. By comparing the legislations of the two, it is possible to understand, what kind of measures might help to implement only the production of these vehicles.

The importance of the topic speaks for itself, but there is a need to know more about these vehicles. Understanding how they work, what effect they have on the environment and the way they impact the consumers are aspects to consider, when legislation on the subject is being put on the table.

Methodologically, the thesis will make use of different literature and legislations to understand these different aspects of the zero-emission vehicles. The goal of the research is to try and understand what the best possible way is to legislate the production and selling of these vehicles and how to implement this legislation.

The conclusions derived from the thesis are as follows;

Keywords; Zero-Emission Vehicles, EU Environmental Law, Climate-Neutrality

ABBREVIATIONS AND ACRONYMS

ZEV	Zero-Emission Vehicle
EV	Electric Vehicle
EU	European Union
MHDVs	Medium- and Heavy-Duty Vehicles
CARB	The California Air Resources Board
ROG	Reactive Organic Gasses
NOx	Nitrogen Oxides
V2G	Vehicle-to-Grind Technology
CO2	Carbon Dioxide
PV	Photovoltaic Systems
PEV	Plug-in Electric Vehicle
VAT	Value-Added Tax
NDC	Nationally Determined Contribution
JRC	Joint Research Centre
GHG	Greenhouse Gas
DSO	Distribution System Operator
EEC	European Economic Community
THC	Total Hydrocarbon
EPA	Environmental Protection Agency
RED	Renewable Energy Directive

1. INTRODUCTION

Background

Climate-neutrality is one of the key components of the EU's current policy and legislation. Being part of international agreements like the Paris Agreement, in which the parties pledge themselves to hold the global average temperature well below under 2°C or to limit the increase of the global temperature average to 1.5°C above pre-industrial levels[1], the EU needs to decrease the use of greenhouses gasses and especially the use of carbon.

To counter the bad influence that greenhouse gasses to our atmosphere, the EU has produced different legislations and policies. Perhaps the most important of them being the European Green Deal, launched in 2019 that aims for Europe not to have any emissions of greenhouse gases by 2050[2]. This difficult goal can only be achieved with strict changes in the Member States' legislation and policies on the consumption of greenhouse gasses.

The European Green Deal tries to decrease greenhouse gas emissions in different sectors, one of which is transportation. Currently, transport emissions represent around 25% of the EU's total greenhouse gas emissions[3] and there seems to be only increasement in the sector. To reach the targets set by the European Green Deal, there needs to be a big decrease of emissions in the sector.

Partly because of this, the EU has launched a new package named "Fit for 55", which among other things, will regulate average emissions of new cars to come down by 55% starting from the year of 2030 and to come down 100% from 2035 compared to the levels of 2021[4]. If this package is approved, it will lead to a focal point of this thesis; that by 2035 all new cars will need to be zero-emission vehicles.

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[1] Paris Agreement under the United Nations Framework Convention on Climate Change (adopted 22 April 2016, in force 4 November 2016) (2016) 55 ILM 4.
[2] The European Commission, "A European Green Deal: Striving to Be the First Climate-Neutral Continent" <https://ec.europa.eu/info/strategy/priorities-2019-2024/european-green-deal_en> (last accessed 8 October 2021).
[3] The European Commission "Transport and the Green Deal" <https://ec.europa.eu/info/strategy/priorities-2019-2024/european-green-deal/transport-and-green-deal_en> (last accessed 8 November 2021).
[4] European Commission, "European Green Deal: Commission proposes transformation of EU economy and society to meet climate ambitions" <https://ec.europa.eu/commission/presscorner/detail/en/IP_21_3541> (last accessed 8 November 2021).

The Fit for 55-Package has opened up the opportunity for an EU legislation that binds the Member States to only sell cars that are zero-emissions from 2035. Is it possible and achievable? There are a lot of car companies in the EU that might benefit or lose in the transition and there needs to be an assessment if this legislation can be proven to be efficient in the future.

There are already some places that have this similar legislation as the research in this thesis will show. California is one of these places. The American state has implemented an executive order by its Governor, Newsome in 2020 that banned the sale of new diesel and gas vehicles starting from 2035[5]. This is almost the exact same legislation that could come to light in the EU as well with the new Fit for 55-Package.

Another example that is going to be taken into consideration is the policies that are already implemented in Norway. In 2020 alone, 54% of all the new cars that were sold in Norway were electric. The following goals for the state are to have all new cars be zero-emission vehicles by 2025, that all city busses will be zero-emission vehicles by 2025 and that distribution would be emission free in the cities by 2030[6].

The reasoning for having California and Norway as tools of comparison is divided in two; Firstly, the two entities in question are the most advanced in ZEV legislations and policies. There are precedents of what can be regulated, how and what impact these different laws and policies can have to a countries transportation sector and decreasing emission. It is important to note, that the two entities differ quite a lot, since they are divided into a sovereign nation, a state of a federal nation and a supranational organization comprised of many different Member States.

Secondly, Norway and California give the possibility to analyze different instruments that regulate ZEVs. As the following chapters will discuss, Norway and California have regulated ZEVs in a very different manner. This opens the possibility to see which entity is the more

[5] Office of Governor Gavin Newsome, "Governor Newsom Announces California Will Phase Out Gasoline-Powered Cars & Drastically Reduce Demand for Fossil Fuel in California's Fight Against Climate Change" (23 September 2020) <https://www.gov.ca.gov/2020/09/23/governor-newsom-announces-california-will-phase-out-gasoline-powered-cars-drastically-reduce-demand-for-fossil-fuel-in-californias-fight-against-climate-change/> (last accessed 9 November 2021).
[6] Government of Norway, "Norway is Electric" (22 June 2021) <https://www.regjeringen.no/en/topics/transport-and-communications/veg/faktaartikler-vei-og-ts/norway-is-electric/id2677481/> (last accessed 9 October 2021).

efficient in regulating ZEVs and to take examples from both different entities, when applied to the EU.

After having these examples that bring to light the fact that the EU is not the only party to look into zero-emission vehicle legislations, let us clarify some vocabulary. Zero-emission vehicles are vehicles that do not run-on gasoline or diesel, but instead by a battery that is powered either by electric energy or hydrogen energy[7]. As the name suggests, the vehicle does not emit greenhouse gas, while it runs.

As transportation is approximately the 25% of all emission in the EU, a new legislation on zero-emissions vehicles could be a decisive victory in the struggle with climate-neutrality by 2050. Unfortunately, there is not enough data as of yet to back up with certainty that this legislation would solve the problem of emissions that come from the transportation sector in Europe.

It is important to note that zero-emission vehicles need energy to work anyhow, and it is important that the energy used is renewable. Otherwise, we would be running in circles by using fossil fuels to charge zero-emissions vehicles. In 2019, renewable energy represented only 19.7% of all energy consumed in the Member States.[8] This in mind, if all new cars should be zero-emission vehicles by 2035, there is a big need to increase the percentage of renewable energy as an energy source in the EU.

With innovation of the zero-emission vehicles come different sorts of problems. As the thesis will show, there might be some environmental harms linked to zero-emission vehicles as well as social problems. These social problems might revolve around the issues of price, that are higher than conventional vehicles as well as the range that the batteries of the vehicles can transport the driver[9].

In any case, this thesis is made to be used as research on how convenient it is to apply legislation that establishes that all new cars should be zero-emission vehicles. This research

[7] Victoria State Government, "Zero Emissions Vehicles" <https://www.energy.vic.gov.au/renewable-energy/zero-emissions-vehicles> (last accessed 9 November 2021).
[8] Eurostat, "Renewable Energy Statistics" (last edited 9 November 2021) <https://ec.europa.eu/eurostat/statistics-explained/index.php?title=Renewable_energy_statistics> (last accessed 9 October 2021).
[9] Farkas-Csamango, Erika, "The Legal Environment of Electromobility in Hungary" (2020) 15 (28) *Journal of Agricultural and Environmental Law,* 181-190.

will be relevant in the coming years when the EU will decide and perhaps even implement the legislation on the Member States. Should the research prove it right to implement such a legislation, we could be looking at a possible solution to the strive towards climate-neutrality.

Purpose, Research Questions

The purpose of this thesis is to analyze different legislations on zero-emissions vehicles, as well as compare them to the current plan that the EU has on the topic. Because of this, there are two main research question that the research will try to answer;

1. What are zero-emission vehicles?
2. What is the role of zero-emission vehicles in reaching climate-neutrality?
3. What can we learn from the legislation of Norway and California?
4. Is the current EU legislation on passenger vehicles enough to promote decarbonization of the sector efficiently?
5. What could the EU legislation on zero-emission vehicles look like?

To answer these research questions will require a lot of research from different sources to come up with an educated conclusion. Because indeed there is no data collected for long, there is no accurate way to establish the impact that the legislation might have. Some speculate that the plug-in vehicles technology will be dominant only in the 2030's or 2050's[10], so the conclusions might not be perfectly accurate.

Thesis Outline

The thesis will be structured into four different chapter as it follows: Chapter 2 will introduce the technical background on zero-emissions vehicles, rather how they work, technical aspects, environmental risks, and possible harms for the consumer. Chapter 3 will then concentrate on the different legislations and policies that already exist on zero-emissions vehicles by using California and Norway as examples.

Chapter 4 analyzes the some of the current existing legislation that the EU has on vehicle consumption when it comes to emissions from the transportation sector and how it was developed. Then two important policies will be discussed, European Green Deal and the Fit

[10] Sandalow, David (ed), *Plug-in Electric Vehicles: What Role for Washington*. Brookings Institution Press, 2009.

for 55-Package, which includes the possible legislation that would make it possible to only sell ZEVs in the EU starting from 2035.

Chapter 5 will compare the existing legislations and the current plan of the EU to see differences in execution and literature. The chapter will then focus on what is a good legislation on zero-emission vehicles, what is an effective legislation on zero-emission vehicles, what we can learn from California and Norway and how this legislation needs to be implemented to make a change towards climate-neutrality by 2050.

Methodology

The thesis is highly theoretical, and in a case like this the best way to succeed in the research is via literature review. This particular type of literature review is a systematic review, in which is a literature review that focuses on a specified research question, and the goal of which is to try and identify, appraise, select, and synthesize all high-quality research evidence found and making arguments that are relevant to that question posed inside of the literature review[11]. This is the best type of methodology for the topic at hand, because the thesis tries to make clear research questions on ZEV legislations and to answer them with good research to answer the research questions.

The topic is rather vague, since there is a need to analyze technical aspects, environmental aspects as well as humanitarian aspects on the subject. This means that there is a great amount of literature that needs to be read in order to have a clear understanding on the different aspects that come with zero-emission vehicles. Referencing to sources will also play a key part in the thesis.

The methodology uses many different sources, which many of are from either articles, official sources, or internet sources, because the topic is rather new and there is not much literature in the realm of books that can be used to answer the question of ZEV legislation in the EU. However, the thesis will try to use as many academic sources as possible to make the conclusions and the research itself credible and knowledgeable.

[11] Bolderston, Amanda, "Writing an Effective Literature Review" (2008) 39 (2) *Journal of Medical Imaging and Radiation Sciences*, 86–92.

2. TECHNICAL, SOCIAL AND ENVIRONMENTAL BACKGROUND ON ZERO-EMISSION VEHICLES

The first chapter will concentrate on the background of the zero-emission vehicles, it will analyze the technical aspects and assess how the vehicles work and what is needed to make the work. The other parts to discuss are the possible risks on the environment that might be encountered with zero-emission vehicles and what possible risks do the consumers have if zero-emission vehicles should become the new standard in automobiles.

2.1 Technical Aspects

Zero-emission vehicles are battery-based and are charged by an electricity source to get the chemical reaction that a gasoline car would use to move[12]. ZEV's use a lithium-ion battery technology where the electrodes inside the battery submerge in an electrolyte. This provides the Li+ ion transfer between the anode and cathode inside the battery. This makes the car perform the forward motion like it was a gasoline powered car.

The development towards an electric vehicle has been long and hard, as for example it took 60 years for the Chevy Corvette-company to create an electric car that can accelerate to 60 miles per hour within 4 seconds. There are two ways to power a ZEV; either by energy storage systems or by fuel cells. Fuel cells turn chemical energy into fuel, whilst energy storage systems use batteries to store the energy used in motion[13].

Hydrogen can also be used as an energy source instead of charging the battery with electric energy. Hydrogen vehicles take hydrogen and electrochemically convert it to electricity in a fuel cell and this way creates energy without pollution. Hydrogen is not a dense gas, so in sectors of transportation, handling, and storing liquefaction or compression are typically used to achieve the wanted result[14].

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[12] Penn State E-education "10.2. Zero Emission Vehicles" <https://www.e-education.psu.edu/eme807/node/671> (last accessed 9 December 2021).
[13] Wilberforce, Tabbi et al. "Developments of Electric Cars and Fuel Cell Hydrogen Electric Cars" (2017) 42 (1) *International Journal of Hydrogen Energy*, 25696-25734.
[14] Hall, Dale et al. " Beyond road vehicles: Survey of Zero-Emission Technology Options Across the Transport Sector" The International Council on Clean Transportation (November 2018).

Hydrogen could be very useful as a fuel since it is one of the most abundant elements on Earth and is mostly chemically bonded hydrocarbons and water. It can be stored quite easily and by using the electrochemical water splitting process, it can be used easily by taking electric energy from a renewable resource[15]. Hydrogen energy could therefore be even better in quality than lithium-ion batteries.

Hydrogen fuel cells are interesting for the fact that during the chemical reaction, the electrons react with oxygen and the previously produced protons to form water that is then ejected from the vehicle as steam. The technology of fuel cells has five different designs, but all of them conduct electrolytes into the cell. Hydrogen is not the only that can make the fuel cells work, as oxidants with fuel can then be transformed into water, electricity as well as other side products[16].

Hydrogen cars have a range of approximately 350 miles (about 560 kilometers). When the speed of the vehicle is low, the engine is powered by a battery whilst at high speeds the fuel cell use hydrogen to produce the used electricity. Also, when there is more power needed (perhaps in a colder weather) the energy is taken from both the battery and the fuel cell. Lastly, when the driver presses the brake pedal some energy is recovered and used to power the battery[17].

The main division is therefore made between electricity powered vehicles and hydrogen powered vehicles. Perhaps the biggest difference between the two might be that electricity is easily applied to the vehicles, whereas hydrogen needs to be worked in order to achieve the chemical reaction that creates energy. Though hydrogen energy might have other advantages that will come later on in the thesis.

ZEV technology is usually discussed referring to private motoring, but there are other types of vehicles that need to be considered. Medium- and heavy-duty vehicles are a big part of the transportation sector, they cover 23% of all greenhouse gas emissions in the US transport sector, for example. To improve the sector, the US has taken an interest in plug-in battery

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[15] Moseley, Garche and Adelmann (eds), *Electrochemical Energy Storage for Renewable Sources and Grid Balancing*. Elsevier 2015.
[16] Dhameja, Sandeep, *Electric Vehicle Battery Systems*. Newnes 2001.
[17] Hydrogen Hub, "An Introduction to Hydrogen Vehicles" (Published 31 October 2021) <https://www.hydrogenhub.org/2017/10/31/introduction-to-hydrogen-cars/> (last accessed 27 December 2021).

electric vehicles that generally have higher powertrain efficiencies and have no direct tailpipe emissions[18].

As previously stated, ZEVs can be roughly divided into electric and hydrogen vehicles. Both of the two have a need to be recharged, as any car would need after running out of gas. To increase ZEVs in circulation, there is a need for infrastructure change to add charging stations along roads. Down sides to ZEV's could therefore be the high cost of infrastructure, the charging time that electric vehicles take and the limited range that electric cars have (the need to make charging stations quite close to one another)[19].

A big part of the ZEVs are the batteries and the materials that are needed to make the batteries are not as common as one would think. The lithium-ion battery uses materials such as lithium, cobalt and nickel, the latter to keep the battery long-lasting on the outside and inside without damaging the battery itself[20].

Continuing on the topic of electric cars, the electricity created to make these vehicles work comes from common power plants. For example, in the US, from power plants the energy is transported to wherever is needs to be sent via interconnected lines, known as the power grid, run throughout the US Western Interconnection. The power grids usually work independently but they may interact when there is need for example, to provide backup energy for another power grid[21].

Most of the power produced by the plants comes from non-renewable energy, like coal and oil and to power the many charging points that may be needed in our society might mean that there needs to be an increase of power plant energy production. In a situation like that, there is a problem to be solved; If there needs to be more energy produced from renewable energy

[18] Liu, Xinyu et al. "Well-to-Wheels Analysis of Zero-Emission Plug-In Battery Electric Vehicle Technology for Medium- and Heavy-Duty Trucks" (2021) 55 (1) *Environmental Science and Technology*, 538-546.
[19] Moultak, Marissa et al. "Transitioning to Zero-Emission Heavy-Duty Freight Vehicles" The International Council on Clean Transportation (September 2017).
[20] Albertsen, Levke et al. "Circular Business Models for Electric Vehicle Lithium-Ion Batteries: An Analysis of Current Practices of Vehicle Manufacturers and Policies in the EU" (2021) 172 (1) *Resources, Conservation and Recycling*, 1-15.
[21] Duncan, Ashle, "Pulling the Plug on Greenhouse Emissions: The U.S. Power Grid Could Accommodate Plug-in Electric Vehicles" (2008) 3 (1) *Environmental & Energy Law & Policy Journal*, 158-168.

sources to power ZEVs is the benefit from not having emissions in the transportation sector taken away?

2.2 Environmental Impact

To divide this subchapter into two parts, there can be an evaluation on the positive and negative impacts that the ZEV legislation could bring to the EU. This way there can be made an assessment on both sides of the coin. Neutrality is important, for being biased towards either the positives or negatives of the ZEVs would not bring a desired analysis on the impact that the vehicles might have.

2.2.1 Negative Impacts of Zero-Emission Vehicles

There are different risks that might come from ZEVs. The first thing that is discussed in the environmental impact of ZEVs is the batteries that are used in electric vehicles. These lithium-ion batteries have a problem in recycling, for example as in 2018 only three percent of the batteries are recycled. A problem using lithium includes also potential fire hazards and, in the US, also a lack of legislation on the recycling of the lithium-ion batteries[22].

The recycling of the batteries could become a massive problem, as up to four million metric tons of lithium waste from ZEV battery packs could be made from 2015 to 2040. Also, there could be problems with the raw extraction of lithium and nickel as well as having landfills for the batteries[23]. This could be a big problem in the future, even though it might not be a problem right away.

Lithium-ion batteries have other negative environmental impacts, namely form the process that leads to recover lithium and nickel. Extracting lithium uses a huge amount of water, almost 500,000 gallons per metric ton of said lithium. In the extraction the miners pump salty water to the surface, which after months evaporates into the air as mixture of manganese, potassium, borax, and lithium salts that are harmful to the environment[24].

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[22] Neuhaus, Lauren. "The Electrifying Problem of Used Lithium-Ion Batteries: Recommendations for Recycling and Disposal" (2018) 42 (1) *University of California, Davis*, 65-91.
[23] Or, Tyler et al. "Recycling of Mixed Cathode Lithium-Ion Batteries for Electric Vehicles: Current Status and Future Outlook" (2019) 2 (1) *Carbon Energy*, 6-43.
[24] Institute for Energy Research, "The Environmental Impact of Lithium Batteries" (Published 12 November 2020) < https://www.instituteforenergyresearch.org/renewable/the-environmental-impact-of-lithium-batteries/> (last accessed 13 December 2021).

The mining of lithium is troublesome since the mining sites usually take same areas with nature conservation area. This creates degradation in the conservation area ecosystem and for example, forces species to migrate outside of the area[25]. If the mining site is close to a waterfront, there is also a possibility to destroying aquatic ecosystems that are essential in every state of the world.

With dangers such as these, should it be still fine to increase ZEVs that are lithium-ion battery based? The problem with both mining and the disposing of these batteries seems to be a big one in the future. However, technology goes on as time does and perhaps when 2050 comes closer there might be new possibilities available to combat the problems related to the lithium-ion batteries that are present today.

There is another problem that might occur. If the energy for the ZEVs does not come from renewable sources, the CO2 emissions will inevitably increase drastically[26]. This means that the damage made to the planet will continue to be the same it was, even without ZEVs. This goes against the usefulness of ZEVs, since the whole point is to decrease CO2 emissions and not keep them the same.

According to some, the ZEVs would not even bring the results wanted in decrease the emissions of CO2. The California Air Resources Board has discussed the best scenario from ZEVs, which would be that the vehicles will cut emissions of ROG and NOx only by roughly 10% x from cars that have been manufactured after model year 2002[27]. If this would be the case, the decrease would not be significant.

2.2.2 Positive Impacts of Zero-Emission Vehicles

ZEVs can first and foremost bring the CO2 consumption on the transport sector down in a radical fashion if done right. By increasing renewable energy as the main energy source to power up the ZEVs, we have the possibility to not decrease the transportation and to make it

[25] Agusdinata, Datu Buyung et al. "Socio-Environmental Impacts of Lithium Mineral Extraction: Towards a Research Agenda" (2018) 13 (12) *Environmental Research Letter*, 1-14.
[26] You Matter, "Are Electric Cars Really Greener?" (Published 25 September 2018) <https://youmatter.world/en/are-electric-cars-eco-friendly-and-zero-emission-vehicles-26440/> (last accessed 14 December 2021).
[27] Gruenspecht, Howard, "Zero Emission Vehicles: A Dirty Little Secret" (2001) 142 (7) *Resources for the Future*, 7-10.

sustainable for the future. But only with renewable energy can the best be brought out in the ZEVs.

Renewable energy can be a tricky thing, however. For example, wind energy only works as long as there is wind blowing. The energy that is excess can be stored and use on a later occasion, but the electrical grid that is used today has a very limited capacity to store energy and could not meet the amount that is needed in our society to uphold the current use of energy[28].

ZEVs could have a positive impact on this. There is a possibility of vehicle-to-grind technology that could make the ZEVs (in this case electric cars) to store electricity. This technology could be used to power houses and even businesses and when there is a need, it can be transferred back to the national grid. This has been tested in England by a non-profit consultancy, Cenex[29].

V2G technology could open the possibility not to create too much excess energy to be used, as the electricity grid could draw only the amount it needs. The possibility to use ZEVs as energy stores and to give out the energy when needed, could help to stabilize the supply and demand of electricity. It could also provide the ZEV owners with a business opportunity as there could be compensations for the owners to have the power grid use the ZEVs are storages and distributors[30].

If there is possibility to make ZEVs be a useful part of the distribution and circulation of electricity or even other energy in the society, ZEVs could revolutionize the energy sector especially in dealing with renewable energy. By making the ZEVs operate as a storage for excess wind energy, for example could help renewable energy power other sectors than just transportation.

[28] NASA Global Climate Change, "Study: Wind Farms Can Store and Deliver Surplus Energy" (Published 23 March 2014) <https://climate.nasa.gov/news/1055/study-wind-farms-can-store-and-deliver-surplus-energy/> (last accessed 14 December 2021).
[29] Warwick, "Energy Stored in Electric Car Batteries Could Be Used to Power Homes" (Published 10 November 2021) <https://warwick.ac.uk/newsandevents/pressreleases/energy_stored_in> (last accessed 14 December 2021.)
[30] Hutton Matthew & Hutton, Thomas, "Legal and Regulatory Impediments to Vehicle-to-Grid Aggregation" (2012) 36 (2) *William & Mary Environmental Law and Policy Review*, 337-366.

Producing ZEVs can possibly also diminish the emissions deriving from car production. This comes thanks to the reduction of material consumed by the light duty vehicles that are zero-emission. Iron and steel are mostly taken out of the production of vehicles and replaced by HSS[31]. If the materials are also more sustainable it could mean that producing the ZEVs is more convenient than fossil fuel powered vehicles.

Hydrogen vehicles can have a large positive impact on the environment as well, if used correctly. The Finnish company P2X, for example is planning to build the first green hydrogen production plant in Harjavalta, Finland. The plant will be ready for the end of 2021, and the production facility that is planned has a capacity of 20 megawatts and the by-products it generates (oxygen and thermal energy) are also required by different industries[32].

This gives thoughts to prefer hydrogen energy vehicles, as it seems to be better paired with renewable energy at the moment than electric vehicles. The P2X Hydrogen facility works with hydro energy, which can be easily harvested in nations like the aforementioned Finland. This could be harvested to bring around hydrogen energy vehicles in nations like Norway, Sweden and Denmark, where the ecosystems are somewhat similar to Finland.

2.3 Consumer Risk-Analysis

Consumer risks are sometimes based on the demand and supply-curve. The lithium-ion batteries in electric cars are going to be produced as long as there as all the needed components are available. If one of the three main ingredients of the battery (nickel, cobalt, or lithium) was to decrease critically in the world the consumers would not be able to buy these ZEVs.

What comes to nickel, for example China has become very powerful in its market. Lately, for example a Chinese cobalt refiner company invested almost 2.1 billion US dollars for a nickel project in Indonesia[33]. By having companies in a single country be very powerful on the

[31] Palencia, Juan C. González et al. "Energy, Environmental and Economic Impact of Mini-Sized and Zero-Emission Vehicle Diffusion on a Light-Duty Vehicle Fleet" (2016) 181 (1) *Applied Energy Journal*, 96-109.
[32] P2X Solutions, "First green hydrogen production plant in Harjavalta" (Published 10 August 2021) <https://p2x.fi/en/first-green-hydrogen-production-plant-in-harjavalta/> (last accessed 2 January 2022).
[33] CNBC, "China's Huayou Invests in $2.1 Billion Indonesia Nickel Project" (Published 25 May 2021) < https://www.cnbc.com/2021/05/25/chinas-huayou-invests-in-2point1-billion-indonesia-nickel-project.html> (last accessed 13 December).

supply of one of the main ingredients, there is a risk for a global monopoly and therefore a standard setting in prices. This would be unfortunate for the consumers since the prices of ZEVs would stay the same and perhaps out of reach for many consumers.

ZEVs might have an impact on the finances of the average consumer as well. A survey, that took into consideration consumers from Spain, Slovenia and Poland explained that if the prices of ZEVs decrease by 20 percent, they might buy one[34]. This leads to understand, that ZEVs are pretty pricy cars. And because of that not everybody can afford to buy one unless the price is decreased.

The possible negatives of ZEVs could be different in various parts of the world. If the northern part of the EU is taken into consideration, the temperature during winter needs to be assessed. The batteries of the electric vehicles, for example could take a hit during cold months. If the vehicle usually runs 240 kilometers before there is a need to charge, in frosty weathers the vehicle would only run 140 kilometers before needing a charge. studies discovered that in -20°C the average range decreased by 12 percent when the car's cabin heater was not used[35].

The survey also mentions that consumers would be pursued to buy a ZEV, if price of fuels increases by 30 percent. This would make a lot of people invest on a ZEV or even prefer the public transport in their area. The Fit for 55-package would bring the ZEVs to be the only sold version of new cars in 2035 but people could still continue to drive fossil fueled older cars if they desire to.

There could be positive impacts to the consumers as well. If the Clean Energy for All Europeans Act can be brought to fruition, the consumers could more easily produce their own energy[36] and with the introduction of perhaps solar power to ZEVs or just the farming of consumers own energy it could make for a profitable way to use your own transportation, without spending too much money on the energy used to power the ZEVs.

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[34] Knez, Matjaz et al. "Features Influencing Policy Recommendations for the Promotion of Zero-Emission Vehicles in Slovenia, Spain, and Poland" (2021) 23 (1) *Clean Technologies and Environmental Policy*, 749–764.
[35] Green Cars, "How Cold Weather Affects Electric Cars" (Published 11 August 2021) <https://www.greencars.com/post/how-cold-weather-affects-electric-cars> (last accessed 27 December 2021).
[36] European Commission, "Clean energy for all Europeans package completed: good for consumers, good for growth and jobs, and good for the planet" (Published 22 May 2019) <https://ec.europa.eu/info/news/clean-energy-all-europeans-package-completed-good-consumers-good-growth-and-jobs-and-good-planet-2019-may-22_en> (last accessed 14 December 2021).

At the moment, in parts of the EU ZEVs bring important help to consumers when they invest on the new car technology. The Finnish Government's proposal of 14 October 2021 introduced the removal of car taxation on cars that are full electric vehicles. This exception applies to all cars and vans that have a zero emissions rate of CO2 and that are presented to the authorities for car-tax assessment starting from 1 October 2021 or after that[37]. This tax exception is expected to increase ZEVs in Finland.

The infrastructure and costs of the vehicles are not the only thing that keeps consumers from buying ZEVs. There is not much consumer demand and there is little consumer awareness to these vehicles. Also, as in the US has developed, there is not much availability to purchase a ZEV in America outside of California, where the ZEV legislation has been passed[38]. The increase of ZEVs seems to be a way to make people understand the need to decrease the CO2 emissions from the transportation sector.

Summary

The goal of the first chapter was simply to understand the characteristics of the ZEVs and to assess the environmental and consumer impact that they might have if the legislation on the vehicles is implemented in the future. Technical aspects are important to understand how the vehicles can function, without using non-renewable fuel, such as diesel or gasoline. It also elevates the importance of ZEVs as there is a need to decrease emissions from passenger and public vehicles in the EU.

Many important points were elevated in the question of the positives and negatives of ZEVs. The necessity of increasing renewable energy sources to make ZEVs impactful and the question of the vehicle-to-grind technology that might get ZEVs even more integrated into the energy sector of the EU than what was thought before. The possibility for citizens of the EU to produce their own energy with the Clean Energy for All Europeans-package could also bring individual advantages for the future.

[37] Finnish Tax Administration, "Relief of Car Tax on Fully-Electric Vehicles" <https://www.vero.fi/en/individuals/vehicles/car_tax/> (last accessed 14 December 2021).
[38] Arroyo, Vicki et al. "New Strategies for Reducing Transportation Emissions and Preparing for Climate Impacts" (2017) 44 (4) *Fordham Urban Law Journal*, 919-968.

The chapter tried to answer the question what zero-emission vehicles and it are was explained in the beginning of the chapter. ZEVs are either electricity or hydrogen powered vehicles that use lithium-ion batteries or fuel cells to perform the same duty that gasoline performs in fossil fuel vehicles. Hydrogen vehicles take the hydrogen entered into the vehicle and electrochemically transform the gas into electricity that then powers the whole vehicle to work as would a fossil fuel car.

Secondly, the chapter analyzed what is the role of zero-emission vehicles could be in reaching climate-neutrality. As the chapter introduced, the idea revolves around the decreasing of CO2 emissions of the transportation sector. If the energy to power up these vehicles comes from a renewable energy source, ZEVs can have a huge role to reach the climate-neutrality that the EU is trying to reach by 2050.

After assessing the basic information about ZEVs, on how they work and what their impact on the environment and on the consumer might be, the next step is to understand how the circulation, production and selling of these vehicles is being legislated in different parts of the world. The second chapter will be a Segway to just that; to see how we can legislate the production and selling of ZEVs.

3. EVALUATING EXISTING ZERO-EMISSION VEHICLE LEGISLATIONS AND POLICIES

There already exists some legislation on ZEVs. This chapter will evaluate two different legislators' views on how to regulate ZEVs in the society of today. The two examples that this chapter is fixated on are the nation of Norway and the US state of California. The key is to analyze the legislations in a similar fashion to understand what can be drawn in the probable future legislation of the EU on ZEVs. The chapter will also analyze how the legislations and various policies have impacted the two actors since their introduction.

3.1 California

In 2019, out of all the emissions in California the transportation sector occupied 41 percent of the emissions. The statewide emissions dropped below the 2020 GHG limit during 2016 and have stayed there every year after[39]. However, the transportation sector does remain the largest source of GHG emissions in California. With this, from 2016 the number has been decreasing on an effective manner, especially with heavy-duty vehicles.

On the 25th of September 2020, the Governor of California Gavin Newsom made an Executive Order that demanded the stoppage of selling new cars that run on fossil fuels by the year of 2035. Zero-emission vehicles and the Executive Order will replace these new cars also asks the state to take "bigger actions to tackle the issue of the dirtiest oil extraction and to support the workers and job retention and creation as we make a just transition away from fossil fuels"[40].

3.1.1 The Executive Order and the Assembly Bill

The Executive Order continues by setting further goals of the State of California that everyone of "medium- and heavy-duty vehicles in the State need to be zero-emission as well by 2045 for all operations where feasible and by 2035 for drayage trucks". The Governor the mentions

[39] California Air Resource Board, "California Greenhouse Gas Emissions for 2000 to 2019" (Published July 28 2021).
[40] Office of Governor Gavin Newsom, "Governor Newsom Announces California Will Phase Out Gasoline-Powered Cars & Drastically Reduce Demand for Fossil Fuel in California's Fight Against Climate Change" (published 23 September 2020) <https://www.gov.ca.gov/2020/09/23/governor-newsom-announces-california-will-phase-out-gasoline-powered-cars-drastically-reduce-demand-for-fossil-fuel-in-californias-fight-against-climate-change/> (last accessed 4 January 2022).

that there need to be strategies made for the State Air Resources Board to cooperate with other US agencies to achieve 100% zero-emission from off-road vehicles and equipment operations in California by 2035[41].

It continues with the Executive Order saying that the State Air Resources Board needs to act consistently with technological aptitude and to take into consideration cost-effectiveness. The different agencies, like the Energy Agency, Transportation Agency and The Labor and Workforce Development Agency need to keep consulting the State Air Resources Board on developments on the matter. The Order then mentions the goal of California to be carbon-neutral by 2045.

The targets that the Executive Order poses are that California provides 100% of in-state sales of new passenger cars and trucks to be zero-emission by 2035. The wording excludes the sales of cars in other states. The Executive Order also emphasizes the cooperation between the State, the sellers of cars with the CARB.

After the Executive Order, the State of California decided to make the Order into a legislation. On 14 February 2021, the Assembly Bill number 1069 was implemented. In the introduction of the bill, the Executive Order of Governor Newsom is mentioned with the goal to sell only ZEVs by the year of 2035. The first new information that the bill introduces is the establishment of a target of California for 60% of the new ZEVs sold in the state for "noncommercial private use" need to be purchased by or on behalf of persons from an underrepresented community[42].

The bill will prohibit the state board of California from pursuing some strategies implementing "any goals for zero-emission passenger vehicle sales established by statutes or executive orders unless those strategies are designed to achieve the goals established by this bill" at the same time. The bill will also require the state board of California "annually to post a zero-emission vehicle equity report on its website telling the state's progress towards the achievement the zero-emission vehicle equity goal that has been set by the State".

[41] Executive Department State of California, Executive Order N-79-20, 23 September 2020.
[42] Assembly Bill of California, no.1069 (published 18 February 2021).

Equity goals are also mentioned in the Assembly Bill. It states that ZEV and equity goals are equally important to achieve. Regulations made to achieve zero-emission vehicle goals need to also ensure that the population of zero-emission vehicle buyers reflects the population of the state of California. Equity in this case, means that the price of the ZEVs needs to be affordable for every social class to be able to buy one. This can also be taken into account by cutting annual fees on the ZEVs.[43]

The Assembly Bill, therefore, introduces the prohibition to sell fossil fuel powered vehicles and to sell only ZEVs starting from 2035. However, one of the questions in chapter 1 speculate on the impact that ZEVs might have on consumers and the Assembly Bill does take in to account the possible buyers of the product with the equity clause. With driving down, the price of the ZEVs, the economical impact of the vehicles could be less drastic.

3.1.2 Equity and the California Air Resource Board

Equity seems to be offered not only to low-income people, but also to those that live in air pollution districts or even disadvantaged communities. For this, the California Air Resource Board has brought forward an income cap and MSRP caps that are aimed at targeting incentives towards the people that were transcribed above. This program, as the programs in such States as Pennsylvania and Oregon are moving towards a good end, but it only takes into account a third of all buyers of ZEVs[44].

On the same plan the CARB also introduced the Clean Cars 4 All program (which was called the California Enhanced Fleet Modernization Program before) that offers lower-income consumers and those living in the pollution districts rebates that are up to $9,500 for the purchase of a new or used plug-in vehicle[45]. This is already of great help to the consumers that will need to buy a ZEV after 2035, but there is more that could be done for the consumers to ease the pain of transition.

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[43] National Center for Sustainable Transportation, "Equity Impacts of Fee Systems to Support Zero Emission Vehicle Sales in California" (published 6 June 2016) <https://ucdavis.app.box.com/v/event-20160606PPT> (last accessed 5 January 2022).
[44] Hardman, Scott et al. "A Perspective on Equity in the Transition to Electric Vehicle" (2021) 2 (1) *MIT Science Policy Review*, 46-54.
[45] California Air Resource Board, "Annual Performance Goals for the Enhanced Fleet Modernization Program and Clean Cars 4 All" < https://ww2.arb.ca.gov/resources/documents/2019-2020-Goals-EFMP-CC4A> (last accessed 6 January 2022).

A problem that might come from this program is that statistically, 40 percent of the of the consumers that are from a low-income household do not purchase cars from dealerships in California[46]. This comes to be a major setback, if indeed there is a need for a dealership to be affiliated to the program for the consumer to get helped in the purchase of a new car, since the consumer might get a better price by internet purchasing, for example.

The CARB program makes light to a very important issue, but equity seems not to be achieved in the current state. The legislation speaks of equity but leaves the interpretation of the concept open on the subject of how to achieve such a thing. Though, the question of equity is very important for the possible future legislation of the EU as well, since there are many people in Europe that come from lower-income households.

Equal possibility is also a way to enforce the new legislation better as well, since if more consumers have the possibility to get help in the purchase of ZEVs, the CO2 pollution from transportation and especially from private driving will decrease, like is the plan and the fight towards carbon-neutrality will be on the good way. It remains to be seen how such an equality could be incorporated into the legislation.

To increase the understanding of the Executive Order made by Governor Newsome, the CARB made an approval for the Advanced Clean Trucks regulation 2020 and it required an increase (measured by percentage) of medium- and heavy-duty ZEVs starting from 2024[47]. This regulation was the first of its kind and can be considered as the beginning of the Executive Order.

The idea behind the ZEV program that California has made with regulations is to issue credits to the manufacturers for selling ZEVs within the state itself. After that to allow these credits to be applied to offset SUV and light-duty truck purchases, since these vehicles are preferred by the consumers. By the year of 2025, the California ZEV program mandates that at least 15%

[46] Pierce, Gregory et al. ”Supporting Lower-Income Households’ Purchase of Clean Vehicles: Implications from California-Wide Survey Results” (2020) UCLA Luskin Center of Innovation.
[47] McCarthy, Caitlin et al. “State Clean Transportation Initiatives” (2021) 51 (3) *Environmental Law Reporter*, 10181-10193.

of vehicle sales need to be ZEVs[48]. This progression in stages ensures that the transition to the selling of ZEVs is without difficulties.

3.1.3 Renewable Energy

The dependence of the increasement of renewable energy in the sector of ZEVs was discussed beforehand. California has made great process in this field as well, as in April of 2021 the State reached a goal of 94.5 percentage of renewable energy[49]. This is a great achievement, since the energy needed to power the ZEVs will come from a clean source of energy, which will not create C02.

The renewable sources used in the State include hydropower and small-scale (little less than 1-megawatt), customer-sited solar photovoltaic systems[50]. The weather is taken into consideration well, since California is a State known for its sunny days that run throughout the year. Harvesting solar power though, is something that cannot be done throughout the whole of Europe.

The renewable energy increase is not specified in the legislation, but since the legislation sets the goal of carbon-neutrality by 2045, it can be understood that the goal is comprised by the increase of renewable energy as an energy source for the ZEVs. The increase of renewable energy is not given to a specific agency, but it seems that the State has found a way to increase the energy source in any case.

A piece of federal legislation that kickstarted the goal towards a sustainable future in California was the implementation of the Clean Air Act. The Act protects public health and public welfare as well as regulates the emissions of hazardous air pollutants[51]. The Act was first introduced in 1970 and amended last in 1990, which has given a direction for California to move towards.

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[48] Norem, Erik III, "An Electric Future for Today: An Analysis of Policy Options for State & Provincial Electric Vehicle Impact Standards to Expand Electric Vehicle Use" (2019) 8 (1) *LSU Journal of Energy Law and Resources*, 127-154.
[49] The Hill, "California Blazes a Trail with 95 Percent Renewable Energy" (Published 6 May 2021) <https://thehill.com/opinion/energy-environment/552218-california-blazes-a-trail-with-95-percent-renewable-energy> (last accessed 7 January 2022).
[50] U.S. EIA, Electricity Data Browser, California net generation for all sectors, Fuel Type (Annual), 2001-19.
[51] 42 U.S.C. §7401 et seq. (1970) United States Code, 2018 Edition, Supplement 1, Title 42 – The Public Health and Welfare.

California has not gone without problems with its emission regulations and most notably the Trump Administration proposed revocation of California's authority to set stricter emission regulations and to require a more and more increasing number of ZEVs in the area of the State[52]. This, however, is changing with the Biden Administration since the President is know for being active in the fight against climate change.

The EU would be in a similar situation, since there are some legislations already on display that regulate air pollution and hazardous air pollutants. This gives the possibility to learn from the legislation that already exists in the EU, to understand how to regulate air pollution. Perhaps this could help in the building of a ZEV legislation as it has help in the case of California.

The legislation on ZEVs in California giver precedents on what things need to be taken into considerations. Mostly meaning the importance of equity, to give equal chance of buying ZEVs, the division of duty between agencies (if applicable outside of California) and the increase in renewable energy to fulfill the emission goals. After analyzing California, it is time to move on the other side of the world to understand how ZEVs are regulated closer to the EU Member States.

3.2 Norway

Norway is another country that is a front-runner in the legislations on ZEVs in the entire world at the moment. One of the biggest policies of the last years was that the Norwegian Government made the national goal that all new cars sold by 2025 should be ZEVs (either electric or hydrogen). In the end of 2020, Norway had more than 330,000 vehicles registered that were electric vehicles. In addition, electric vehicles working with a battery had a 54 % market share in the year of 2020[53].

In 2019, the emissions from the transportation sector in Norway were 28.4 percent of all CO2 emissions[54]. The total number of CO2 emissions in 2019 amounted to 42.2 million tons of

[52] Metz, Matthew & London, Janelle, "State Vehicle Electrification Mandates and Federal Preemption" (2020) 9 (2) *Michigan Journal of Environmental & Administrative Law*, 433-482.
[53] Bli Medlem, "Norwegian EV Policy" <https://elbil.no/english/norwegian-ev-policy/> (last accessed 12 January 2022).
[54] Norwegian Environmental Agency, "Greenhouse Gas Emissions 1990-2019" National Inventory Report, March 2021.

emissions, which is big. However, this is the lowest amount of total CO2 emissions since 1995, this gives understanding that Norway has improved over the year in decreasing CO2 almost on an annual basis. The same goes for the emissions from the transportation sector, in which the 2019 number was 8.5 million tons. This is the lowest number of emissions since 2000, when the emissions were 8.4 million tons.

3.2.1 Infrastructure

Norway made another very important change for ZEVs in 2016, when the E-Number plate was introduced. This plate on an electric vehicle gives the authorities a possibility to choose some local incentives which include thigs such as free parking, using bus lanes based on these plates. A second purpose is to increase the awareness of clean vehicles on the roads of Norway. The ones that have the authority to decide these fees and exemption categories are the municipalities of Norway[55].

The nation went out of its way to make the charging of the electric vehicles easier for the consumers as well. By 2017, the Norwegian Government brought to light a program that would construct every 50 km of Norwegian highway a charging point for the vehicles, targeting rural places without prior charging points in the most[56]. The goal of the policy was to make sure that the drivers of the vehicles would not run out of energy and be left on the side of the road during their trips.

The state has decided to bring change with policies mostly. Changing the infrastructure of the country is indeed important to make sure the citizens can drive up to the north of Norway and find charging points without problems. It is crucial, especially with the cold winters that Norway suffers every year, and the batteries of electric vehicles need more charging depending on the coldness.

Covered things as infrastructure, the easements of ZEV drivers and the quick transition to the selling of only ZEVs by the year of 2025 make Norway a very woken nation on the situation of decreasing emissions of CO2 in the transportation industry. However, there is perhaps an

[55] European Alternative Fuels Observatory, “Norway” (Published in 2019) <https://www.eafo.eu/countries/norway/1747/incentives> (last accessed 12 January 2022).
[56] Schulz, Felix & Rode, Johannes, ”Public Charging Infrastructure and Electric Vehicles in Norway” (2022) 160 (1) *Energy Policy*, 1-12.

even more important part of the Norwegian policies on ZEVs that has not yet been covered. That being taxation.

Electric vehicles enjoy a positive position in the tax system of Norway. The State has implemented an exemption for the purchase tax and the value added tax for the consumers that choose to buy an electric vehicle[57]. These exemptions work as an easement for the possibility to buy and electric vehicle for the consumers of Norway and drop the prices of the electric vehicles.

3.2.2 Polluter Pays-Taxation

Norway has also made an interesting taxation system to decrease the amount of fossil fuel cars in its territory. Petrol and Diesel vehicles will have a "polluter pays" tax system, which means a higher tax for the vehicles that work with petrol and diesel, while the ZEVs enjoy a lower taxation[58]. This is a good way to make fossil fuel cars less appealing for the consumers as well as making the production of fossil fuel cars more convenient for the car producers at the same time.

It is interesting that the wording chosen for this taxation is the "polluter pays" taxation system. The name of the system is in reference to the polluter pays-principle that is well known in international law. The principle is one of the most important ones in environmental law and it constitutes that those who pollute should pay for all the environmental harm that they cause[59]. It basically gives for example energy companies the possibility to pollute, as long as they are ready to pay for it.

Therefore, taxation is a major part of the appeal when it comes to what kind of vehicle the consumers will choose. To an average consumer the costs of annual taxes can take the appeal away from a vehicle that might be lest costly at the time of purchase but more costly in the long run. The question of taxation should therefore be considered in the legislation of the EU for ZEVs.

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[57] Bjerkan, Kristin Ystmark, et al. "Incentives for Promoting Battery Electric Vehicle (BEV) Adoption in Norway" (2016) 43 (1) *Transportation Research*, 169–180.
[58] Autocar Professional, "Norway to Phase Out Petrol, Diesel Cars by 2025 with "Polluter Pays" Tax (Published 27 February 2017) <https://www.autocarpro.in/news-international/norway-phase-petrol-diesel-cars-2025-polluter-pays-tax-23809> (last accessed 13 January 2022).
[59] Scotford, Eloise, Environmental Principles, and the Evolution of Environmental Law. Hart Publishing 2017.

While there is not a direct legislation regarding the prohibition of fossil fuel vehicles after 2025, Norway has a legislation on implementing policies on the subject of climate change. Known as the Climate Change Act of 2017, it establishes the goals that Norway will follow to try and achieve its goal to fulfill the emissions decrease imposed by the Paris Agreement from 2015.

The Climate Act is divided into six sections that establish the purpose of the Act, the climate targets for 2030 and 2050, the reviewing of the climate targets for every five years and the annual reporting to the Storting[60]. The Acts purpose is to "promote the implementation of Norway's climate targets as part of its process of transformation to a low-emission society by 2050".

The second section of the legislation makes reference to the emissions and removals of greenhouse gases by Norway's first nationally determined contribution that was submitted for the Paris Agreement. It is interesting that the sections mentions that the King in Council with regulations, decide that this Act will apply to emissions and the removals of said greenhouse gases other than those to which the first paragraph of the Act mentions.

Next are the climate targets set by Norway. For 2030 is the reduction of at least 50-55 % from the level in the reference year 1990, while for 2050 will try to become a low-emission society. This means the decrease of 90 to 95% in reference to the 1990-levels of emissions. The last two sections are on the five-year reviewing and the annual reporting. The review will be based on the best possible technology available and be quantitative and measurable as much as possible. The annual reporting notices that in budgetary questions the emission goals should be taken into consideration and the expected effect of the proposed budget.

So, the legislation does not impose certain regulations to achieve the goals set by Norway to complete the NDC, but it tells the amounts of decrease that needs to be achieved by a certain time. This can happen exactly with the different policies that the country has installed to its citizens with legislation such as not having purchase taxation and VAT on ZEVs and by

[60] Norwegian Climate Change Act (Lov om Klimamål) NO. 2173 (in force 1 January 2018, Amended 25 June 2021).

installing the aforementioned charging stations at every 50 kilometers in the main road of their territory.

There has been a change in legislation as well to increase the number of ZEVs even in less populated areas of the country. The Professional Transport Act (Yrkestransportlova) was changed on the 24th of March 2017. This change made so that the Regional Governments can set local environmental standards for vehicles that are used for taxi transport[61]. In practice, this means that some municipalities in Norway can choose to make taxis in their region to be a ZEV, which is a huge change for the positive.

To have such a long way thought plan, like moving from private driving to taxis is a great way to tackle all the areas of transportation. Especially in this day and age, where car companies such as Uber and Yango have taken over the transportation sector. If these companies can be compared to taxi companies, we can take another sector that is decreased from the emissions of CO2.

According to an article by Sebastiaan Deuten and other research from the Joint Research Centre of the European Commission, it was found that the Norwegian EV policy has been able to reduce the overall GHG emissions. However, it was argued that this is not easily transferrable to other countries because the electricity in Norway originates largely from renewable energy in the form of hydropower[62].

This ties up to the presumption that renewable energy is needed for the decarbonization of the transportation sector. Still, it can be a possible since nations like Finland have started to invest in renewable energy, but for many other MS there is a big need to invest in infrastructure and many of the states may not have the financial capital to invest in renewable energy, which means that there might be a need for some help from the EU.

The article mentions the curious consequences that came to the country after the tolls were exempted and with the access to public busses. It found that it led to reductions in toll revenues and increased travel times for public transport users, which can be considered a

[61] Aarhaug, Jorge et al. ”Mapping the Possibilities for Emission Regulation for Taxis in the Buskerud, Telemark and Vestfold Regions” (2018) TØI Report 1652/2018 (Norwegian Center for Transportation Research).
[62] Deuten, Sebastiaan et al. ”Analysis and Testing of Electric Car Incentive Scenarios in the Netherlands and Norway” (2020) 151 (1) *Technological Forecasting & Social Change*, 119846- 119847.

negative consequence of the Norwegian model for policy on the vehicles that are not fossil powered.

3.2.3 ZEV Database

Norway was not only a frontrunner on the infrastructure of electric vehicles, but also in the creation of a central database collecting information on the vehicles to maximizing their use in the nation. This was born from a cooperation between the governmental entity Enova and the Norwegian Electric Vehicle Association, and it is called NOBIL. The information used by the database comes from EV consumers, charging stations owners, operators, and other contributors[63].

According to the database, the energy used in the charging stations is all emissions free and by having the charging stations close to one another it can help to increase the number of ZEVs in Norway. The number of different infrastructure changes that the ZEVs have made in Norway are incredible and the results are showing, especially with the fact that the energy is coming from renewable sources.

Electric vehicles are the most sold in Norway, but hydrogen energy is also very used to power cars, busses, delivery vans and trucks. NEL Hydrogen is a company that makes Hydrogen Fueling Station in Norway, and they offer a full tank for a fueling of 3 to 5 minutes[64]. Depending on the possible problems that might face the battery powered electric vehicles, hydrogen cars and charging stations might become the future of the industry on the side of ZEVs.

Hydrogen has not been used as much in Norway, since that will require the same amount of work that the electrical charging stations took. However, in 2010 a study showed the plans that Norway had in store to increase the amount of hydrogen used for vehicles. The production share was estimated to be 62% by 2050, the delivery share 58% and the total of hydrogen use should increase from 117 t/a to 189,241 t/a[65].

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[63] Nobil, ”Welcome to the Charging Station Database NOBIL” (Published 10 July 2012) <https://info.nobil.no/eng> (last accessed 17 January 2022).
[64] NEL Hydrogen, “Hydrogen Fueling” <https://nelhydrogen.com/market/hydrogen-fueling/> (last accessed 17 January 2022).
[65] Stiller, Christoph et al. ”Pathways to a Hydrogen Fuel Infrastructure in Norway” (2010) 35 (1) *International Journal of Hydrogen Energy*, 2597–2601.

What can be certain is that Norway is the most innovative country in the world when it comes to ZEVs. The taxation, easement of costs and infrastructure work done by the government is to be complimented and other nations could learn a lot from Norway. There are many interesting aspects that the EU should consider for the possible legislation they might implement on the ZEVs.

3.3 Impact of the Legislations

Before the chapter is rounded out in a summary, there is a need to take a look at how much and in which way the legislations and policies on ZEV's have impacted Norway and California so far. An important part of this analysis is to understand how efficient the legislation and policies on ZEV's have been and if the two players are closer to climate-neutrality at the moment.

3.3.1 Impact in California

In July of 2021, an article of the Insider claimed that 1 out of 5 owners of electric vehicles in California changed back to gas powered cars. The reasoning behind this change seemed to be that charging battery powered cars is "a hassle"[66]. The article mentions ford cars especially, where an owner explained his battery dropped to 23%, when he was searching for a place where to charge his car. The article says that while there are "level 1" charging stations (home level) but not level 2 that can be found in charging stations in California.

This can be understood in a way that, whilst Norway has majorly invested in charging stations built in as close to each other as convenient, California still has a lot of planning to do with charging stations. Especially for the fact that distances are quite long from Northern California to Los Angeles, for example. This change might not last for long, however since the price of gas is increasing steadily.

California has made intentions to better their involvement with ZEV's and especially with hydrogen vehicles, that have not been in the center of attention in the State. California is behind on hydrogen compared to Battery EV's, but it leads in the infrastructure that is needed

[66] Business Insider, "1 in 5 Electric Vehicle Owners in California Switched Back to Gas Because Charging Their Cars is a Hassle, Research Shows" (Published 28 July 2021) <https://www.businessinsider.com/electric-car-owners-switching-gas-charging-a-hassle-study-2021-4?r=US&IR=T> (last accessed 28 February 2022).

for hydrogen vehicles. There are plans to make hydrogen projects in ports and investments on hydrogen are increasing. The Los Angeles Department of Water & Power is already trying to convert gas using power plants work on with hydrogen[67].

The same source reports that in 2021 California made increases in ZEV selling, and 11.5 percent of new vehicle sales were ZEVs last year. The state makes approximately half of the total ZEV sales in the USA with nearly one million ZEVs sold to date. It also makes it the sixth biggest market in the world for ZEV selling. California is also trying to home to 34 ZEV manufacturers into the state to have a bigger supply of ZEVs for the consumers and make the transition easier.

This means that while there have been some problems with battery EV's and their charging stations, the state has continued to better both electric vehicles and started to invest in hydrogen solutions along the way. 2035 as a deadline, there needs to be bettering in the transportation sector and whilst there have been problems and the consumers have been unhappy in some ways, there is a commitment in the state to increase ZEVs and there is enough renewable energy to power the vehicles sustainably.

3.3.2 Impact in Norway

In Norway the impact of the policies has been much different, although the timeframe has been longer than in California. The price of carbon has gone out of the convenience for the transportation sector (the price exceeds €1370 per ton of CO2 for car owners)[68]. This has certainly decreased the use of carbon and therefore lowered the emissions of CO2 in Norway. The taxation made by the Government on CO2 emitting raw material is also used to increase the use of zero-emission solutions, like the aforementioned investment in charging stations.

The same article that mentions the price per ton of CO2 emissions per car owner in Norway also mentions that the taxation system that the country uses can be replicated in almost any other nation, even without national public finance constraints that some countries may have.

[67] New Zealand Foreign Affairs and Trade, "California's Zero Emission Vehicle Market 4 November 2021" (Published 4 November 2021) < https://www.mfat.govt.nz/en/trade/mfat-market-reports/market-reports-americas/report-on-californias-zero-emission-vehicle-market-4-november-2021/> (last accessed 28 February 2022).
[68] Fridstrøm, Lasse, "The Norwegian Vehicle Electrification Policy and Its Implicit Price of Carbon" (2021) 1346 (13) *Sustainability*, 1-14.

However, the author mentions that this is possible only in principle, not in practice. It obviously depends on the financial situations and the individual income level in a nation, but the taxation seems to have worked in Norway, and therefore could be one of the solutions to increase ZEVs in a drastic manner to reach climate neutrality.

What comes to hydrogen vehicles in Norway, there has been some impact in the policies implemented in the country. Because EVs have gone so far in the nation, there is a movement towards hydrogen solutions. Just at the start of February 2020, the Norwegian wholesaler company, Asko started to transporting goods with hydrogen powered trucks[69]. This news is very forward moving and if it turns out to become the standard for company trucks, there is an imminent need to make more charging stations as well.

Before this, however a sad event decreased the investing in hydrogen technology not just in Norway but also in other countries. In June of 2019, the Nel hydrogen filling station exploded, and it made the company close other 10 stations[70]. As the previous paragraph shows, there has been a slowing down but not a stop in hydrogen solutions. Norway will make filling stations more secure but surely will continue to let companies move forth, like Asko did with its hydrogen fueled trucks.

An article by Paal Brevik Wangsnessa and Askill Harkjerr Halsea[71] investigated the effect that the increasing EV numbers have on Distribution System Operators' costs from 2008 to 2017. The paper came to the conclusion that CO2 emissions have decreased by the increase of EV's, but the DSOs of the nation have increased their workload a lot. This means that possibly there could be a need to revolutionize the energy sector to be able to answer the demand of energy created by the increasing number of ZEVs.

As the chapter has shown, the problem with Norway is not on renewable energy availability, but it seems that there could be a problem with the distribution of energy, if ZEVs become

[69] Green Car Congress, "In Norway, Asko Begins Piloting Use of Hydrogen Fuel-Cell Trucks" (Published 2 February 2020) <https://www.greencarcongress.com/2020/02/20200202-asko.html> (last accessed 28 February 2022).
[70] Electrive.com, "Norway: Explosion at Hydrogen Filling Station" (Published 11 June 2019) <https://www.electrive.com/2019/06/11/norway-explosion-at-fuel-cell-filling-station/> (last accessed 28 February 2022).
[71] Wangsnessa, Paal Brevik & Halse, Askill Harkjerr, "The Impact of Electric Vehicle Density on Local Grid Costs: Empirical Evidence from Norway" (2021) 42 (5) *Energy Journal*, 149-167.

more popular in Norway and even in the EU, if the legislation is made on ZEVs in the near future. It is important not to overload the distribution systems and not to solve one problem, while creating another.

To summarize the impact that the legislations and policies have had on both of the entities, it seems to have more positive impacts in Norway. EVs seem to work wonderfully, since the taxation makes it appealing to own an EV and the country owns the most EVs per habitant. Also, the nation is getting more into hydrogen vehicles. California has been struggling, with the consumers still choosing to go back to gas cars. However, as the subchapter realizes, the change seems to move into a future with ZEVs in California as well.

Summary

The second chapter exemplified how two different entities have been able to legislate on the topic of ZEVs. California and Norway have different things that they concentrate on when trying to answer the question "how should ZEVs be legislated". Now it is time to sum up what has been analyzed during the chapter and to see how the chapter can answer the research questions of the thesis.

Both of the entities have been able to decrease their emissions of C02 in their respective transportation sectors. As the chapter discovered, the emissions of both have reached the lowest numbers in a long time and this gives confidence in the effectiveness of the ways that the two regulate their emissions. The facts speak on behalf of how the EU can learn something from the two.

California got its legislation on ZEVs on the move in 2010, when the Governor Newsome gave an Executive Order to sell only ZEVs in California starting from 2035 onwards. The Executive Order involved medium- and heavy-duty vehicles and drayage trucks as well along with light-duty vehicles that are used by private citizens in their everyday life. California had policies made by the CARB as well to increase the impact of the legislation in a shorter time in the transportation sector.

The legislation of California introduced the important concept, which is equity that is implied to make sure lower-income citizens can be able to afford ZEVs, once they are the only vehicles that can be purchased. Renewable energy is an important part of the ZEV policy in

California, and it has increased over the years. There is also the Clean Air Act, that is implemented at the Federal level in the US, and it was the pioneer for legislations such as the Assembly Bill of California for the ZEVs.

The other entity that was analyzed in the chapter was Norway, that has been active in air pollution for decades. While Norway does not have a legislation that ban the selling or production of fossil fuel powered vehicles, it has a Climate Act that is holds in it the NDC of Norway to complete their part of the Paris Agreement. The Act establishes the goals to decrease the emissions in Norway, without specifying how to complete the decrease. To achieve the goals, the Government has made many different policies on ZEVs, for example.

The policies that Norway has implemented to decrease the CO2 emission on the transportation sector are made to ease the life of the consumers. Taxation on purchase and VAT on ZEVs have been taken out and toll payments have also been removed from consumers that have chosen the vehicles. Another part of the Norwegian policies has been the change in infrastructure to increase the numbers of charging station of electric vehicles to make sure no cars are out of fuel wherever you go. The energy comes out of hydro energy mostly, so the amount of renewable energy is also high to power the ZEVs.

The impact on the two entities has been different from one another. Norway has become one of the best countries for ZEVs with great infrastructure, taxations and other policies that make them worth using. In California the impact has been mixed, since some consumers have changed their preference back to gas vehicles, but with the change in gas prices, the supply of ZEVs and 2035 that is always closer, the state makes steady advancement towards their goal to sell only ZEVs by that date.

This chapter can answer to of the research question. The first one being what is the role of zero-emission vehicles in reaching climate-neutrality. Especially, when considering the impact in Norway ZEVs can bring a great positive impact in reaching climate-neutrality by helping consumers buy ZEVs and to charge the vehicles with renewable energy. California has shown that by having different agencies helping out with the problem, it is more efficient, and the decrease of fossil fuel vehicles can bring climate-neutrality closer.

The second research question that can be answered is what we can learn from California and Norway. We can learn that taxation and equality are important concepts to implement into a legislation on ZEVs. To make it easier for consumers to buy ZEVs and to better the infrastructure to advance the circulation of ZEVs can bring results. Lastly, the dependence on the increase of renewable energy to achieve ZEV goals has proven to be vital to make the transition from fossil fuels to climate-neutrality.

From the two entities that are used as example in this thesis, it is time to look inward and to understand how the legislature of EU can be changed for the better and if there should be a ZEV legislation for the MS. But before that conversation can take place, there should be a thorough analysis on what the legislation on vehicles is nowadays in the EU. And that is what will be discussed next.

4 CURRENT EU LEGISLATION ON VEHICLE CONSUMPTION IN TRANSPORTATION

The third chapter will cover the different legislations that the EU already has on vehicle consumption in the transportation sector. The chapter will be split into four different subchapters that will involve development. Regulations, Directives and other key factors that create the rules that bind vehicle consumption in the EU, such as the Dieselgate, the European Green Deal and the most important for ZEVs Fit for 55-package.

The goal of the chapter is to see what regulations there are on vehicle consumption, how much they might change with regulations on ZEVs in the future and if the existing legislation is enough to promote decarbonization of the transportation sector in an efficient manner.

4.1 Development of Legislation and Current Regulations and Directives

The EU has had legislations on the impact of gasses used in motor vehicles since the 1970's, when Directive 70/220/EC was established. This includes light-duty vehicles (passenger cars), while there is a same Directive for heavy-duty vehicles (trucks and such), Directive 88/77/EC. Both of these two Directives have been amended to suit better the needs of today versus the needs of the 1970's.

However, according to the European Environmental Agency, since the year 2000, the average CO2 emissions from new passenger vehicles has been decreasing until 2016, after which there has been a slight increase until 2019[72]. The data suggests that there has only been monitoring on the topic since 2000, which means that the development of legislation has not effectively began before this year. However, once the data has been archived the decrease of CO2 emissions from new passenger cars was notable.

The development of the legislations that will be analyzed in the next section of the chapter are based on the problems found in the framework of the Kyoto Protocol, from 1998[73]. This explains, why the new passenger vehicle emissions decreased after the year of 2000. The

[72] European Environmental Agency, "Average CO2 Emissions from Newly Registered Motor Vehicles in Europe" (Published 13 August 2020) < https://www.eea.europa.eu/data-and-maps/indicators/average-co2-emissions-from-motor-vehicles/assessment-2> (last accessed 17 April 2022).
[73] Hooftman, Nils, et al. "A Review of the European Passenger Car Regulations – Real Driving Emissions vs Local Air Quality" (2018) 86 (1) Renewable and Sustainable Energy Law, 1-21.

decrease also came from a voluntary agreement between the Association of European Automobile Manufacturers and the European Commission to decrease the average CO2 emissions from new passenger vehicles to 140 g/km by the year of 2008. These facts lead to the Regulations and Directives that will be discussed next.

4.1.1 Regulations and Directives

Directive 70/220 regulated that no Member State shall refuse grating the EEC type approval or either, national type approval of any vehicle on grounds relating to air pollution from gases coming out of engines of motor vehicles . This means that if the Community at the time had a grant submitted by a Member State, the Community could deny the approval on the ground that the vehicle makes too much harm in terms of air pollution.

Other two important legislations that are tied to vehicle consumption are Regulation 433/2009 and Regulation 333/2019 that amends the first one. The first Regulation is important for the fact that it set emissions standards for the performance of new vehicles. This included specific emissions for "alternative-fuel vehicles" which has a reduction of 5 percent in European technical standards[74]. These alternative fuel-vehicles mostly include vehicles powered by biofuels and other such vehicles.

The newer Regulation sets the targets for emission reductions by 2020 and even beyond that. Reductions of CO2 emissions from cars are mandatory and set a goal of 120g CO2/km and 95g CO2/km in 2020. The means that are used to reach the target are; reducing to 130g CO2/km by means of improving the technology of motors and by an extra 10g CO2/km reduction with more effective car features[75]. These features are such as tyre pressures and improving air conditioning in cars.

Difficulty can be found in the fact that these targets do not apply to all new cars, but to the average squadron of new vehicles made by a particular car manufacturer. There is also a softening of the requirements on the industry gradually using varying the average from 65% in 2012 to 100% from 2020 forward. To make a differentiation, the possible legislation on

[74] Regulation (EC) No 443/2009 of the European Parliament and of the Council of 23 April 2009 Setting Emission Performance Standards for New Passenger Cars as Part of the Community's Integrated Approach to Reduce CO2 Emissions from Light-Duty Vehicles [2009] OJ L140/1.
[75] Calster, Geert van & Reins, Leonie, EU Environmental Law. Edward Elgar Publishing 2017.

mandatory ZEVs would probably include all new cars, not to be only required on some particular car manufacturers.

Interestingly, Regulation 333/2014 includes the introduction of "super credits" for the target set on 95g CO2/km. This takes into consideration all new passenger cars and by calculating average specific emissions of CO2, each new car with less than 50g CO2/km will be counted as 2 passenger cars in 2020, 1.67 passenger cars in 2021, 1.33 passenger cars in 2022 and 1 passenger car in 2023[76].

In practice, this means that the manufacturers of cars can count ZEVs and low-emission vehicles more than once, when they calculate their average fleet emissions. By this, ZEVs count for two passenger cars in 2020. The counter goes down in a linear manner in time because ZEVs and low-emission vehicles should become the normal by 2023 in these standards.

While this helps with the emissions of cars produced in the area of the EU, it does not involve cars that are brought to the EU manufactured elsewhere. California has made a legislation on the selling of ZEVs and while this is an innovative legislation in the EU, it does not involve every Member State and it does not require the cars manufactured in the EU to be ZEVs. Many cars manufacture in the EU might not even care about the Regulation if the producing of ZEVs is less profitable than to deal with the penalization of the Regulation.

Speaking of penalties there have been some set-in case if the car manufacturers do not meet the objectives set. The penalties range from 5 Euros for the 1st gram over the limit, to 95 Euro for every gram above 3 grams of the limit from 2012 to 2018. From 2019 onwards the penalty goes up to 95 Euro for every gram over the limit[77]. The penalties are a great idea to make limitations for manufacturers emissions on average, but this could also lead European companies to transfer their manufacturing process elsewhere to avoid the penalties and the consequences for emissions.

[76] Regulation (EU) No 333/2014 of the European Parliament and of the Council of 11 March 2014 Amending Regulation (EC) No 443/2009 to Define the Modalities for Reaching the 2020 Target to Reduce CO2 Emissions from New Passenger Cars [2014] OJ L103/15.
[77] Regulation (EU) 2019/631 of the European Parliament and of the Council of 17 April of 2019 Setting CO2 Emission Performance Standards for New Passenger Cars and for New Light Commercial Vehicles and Repealing Regulations (EC) No 443/2009 and (EU) No 510/2011 [2019] OJ L111/13.

4.1.2 Euro 6 and Super-Credits

Next is Regulation 715/2007, which entails the type of approval of motor vehicles with respect to emissions from light passenger and commercial vehicles and on the access to vehicle repair and maintenance information. This particular Regulation introduces a common technical requirement and for approved vehicles and their replacement parts. An example of this would be the replacement of pollution control devices (article 11)[78]. The Regulation makes the manufacturers have their cars registered with EU approval.

The Regulation involves the "Euro 6" norm as well, that tightens the emission values of the passenger cars even more than it already did. Staring from 2014, all new cars needed to be equipped with engines that were certified with Euro 6 certifications. These engines are supposedly to reduce NOx emissions in diesel powered cars from 180mg/km to a much smaller amount of 80mg/km. These certifications are important to limit how much engines make emissions in cars.

This Regulation was made to limit and control the emissions that come from the tailpipe of cars. By limiting the emissions that the tailpipes of cars emit, you can limit gas powered cars and at the same time push the manufacturers to go into a less polluting direction with ZEVs and low-emission solutions. Combined with the certifications that are needed in new car engines, the pair makes strict but fair regulations to lower the emissions that come from passenger cars in the EU.

All of the aforementioned Regulations are important to make a difference in the emissions of the transportation sector, but it has many limitations as notes in the previous paragraphs. The fact is that while the Regulations push for less polluting options, there is no mandatory switch to ZEVs. There can be a discussion on the pros and cons of these Regulations, but this proves that even if the EU does not yet have a legislation on mandatory selling of ZEVs, there is much legislation on the emissions of passenger cars.

Lastly, a Regulation that should be looked at is Regulation 595/2009 that establishes limits to the emissions from heavy-duty vehicles. This Regulation makes limits on emission values on

[78] Regulation (EC) No 715/2007 of the European Parliament and of the Council of 20 June 2007 on Type Approval of Motor Vehicles with Respect to Emissions from Light Passenger and Commercial Vehicles (Euro 5 and Euro 6) and on Access to Vehicle Repair and Maintenance Information [2007] OJ L171/1.

heavy-duty vehicles, like the previous Regulation does for the emission values of passenger vehicles. The Regulation establishes the "Euro IV" emission limits, which entails CO emissions, THC emissions and NOx emissions among others, which makes it a legislation that covers many different emissions that are harmful for the air quality[79].

Therefore, the EU has different legislations of the on the consumption that comes from passenger and heavy-duty vehicles. It also proves that the EU is trying different things to reduce the emissions from the private transportation sector with legal and financial limitations. But what happens when there are manufacturing companies, that do not comply with there legislations? There is one notable case that shows how this situation can become reality, where manufacturers did not meet emission legislations.

4.2 Dieselgate

The transition towards a climate-neutral EU has not come without some bumps in the road in the last decade. The last subchapter showed that car manufacturers have had many limitations to make their cars creating larger quantities of emissions. However, some of the companies have had trouble adjusting or simply did not want to pay the luxuries that came from going against the Regulations. An extreme example of this came from the year of 2008 to 2015 with the Dieselgate-scandal.

The scandal included different Volkswagen cars and one model of Audi that under normal conditions while in operation, did not comply with the NOx emission standards that were set by the EU. This included more than millions of cars worldwide. The diesel-powered cars lowered the air quality with their emission, which was not only against EU regulations but also against the Clean Air Act in the USA[80].

In fact, the ones that found out about the scandal first were not the authorities in Europe, but rather the Environmental Protection Agency of the USA in September of 2015. Volkswagen installed devices into their cars engines to reduce emissions during vehicle testing. These devices were software's that enabled the cars to pass emission tests under laboratory

[79] Regulation (EC) No 595/2009 of the European Parliament and of the Council of 18 June 2009 on Type-Approval of Motor Vehicles and Engines with Respect to Emissions from Heavy Duty Vehicles (Euro VI) and on Access to Vehicle Repair and Maintenance Information [2009] OJ L188/1.
[80] Bothe, Michael, "Dieselgate as an Issue of Urban Planning – German Approaches" (2020) 4 (1) *Journal of Comparative Urban Law and Policy*, 285-295.

conditions and to emit 40 times the amount of pollution that was allowed in the US during a normal use[81].

To put it into poor words, the cars software's were modified to understand when the car is under testing and would perform differently than it would usually do on the road. The software was obviously installed in the cars in a fraudulent way and the at least the top head of the company seemed to be aware of it. The goal was naturally to keep producing diesel cars with taking no regard for the emission limits that were established by the EU and the US. Financial gain was the end goal of the company with the move, and it would have continued if the fraud was not uncovered in 2015.

The scandal begs the question, if the legislation implemented by the EU on car manufacturers are being followed by all, or if there are still some companies that are trying to find way to circle them. Although, the uncovering of the scandal has brought the inspection of the cars to be even more strict than before and the EU will not take chances with companies pulling off something similar.

These kinds of scandals may be defeated with legislation similar to the one in California that establishes a date, after which only ZEVs can be sold. The engines do not have much room to be played with in terms of the emissions from the engines and tailpipes of cars and the chance of having more scandals like these decreases drastically. Though the manufacturers will always try to find ways to spend less and gain more profits from the sale of these products of theirs.

Different consequences came from the different entities involved with the case. In April of 2019, the European Commission officially accused the company for "illegal collusion to avoid competition on emissions reduction technology"[82]. The biggest take on the EU's side on the case was that the company went totally against the EU's competition rules and environmental regulations.

[81] Jung, Jae C. & Sharon, Elizabeth, "The Volkswagen Emissions Scandal and its Aftermath" (2019) 38 (4) *Global Business and Organizational Excellence*, 6-15.
[82] Clean Energy Wire, "Dieselgate - A Timeline of the Car Emissions Fraud Scandal in Germany" (Published 25 May 2020) <https://www.cleanenergywire.org/factsheets/dieselgate-timeline-car-emissions-fraud-scandal-germany> (last accessed 4 March 2022).

The case reached 2020, when in May the German Federal Court of Justice (Bundesgerichtshof), ruled against Volkswagen by claiming that the car owners were entitled to damages from the emission scandal. The owners should be able to return the cars and receive the price they paid for them minus a share for using the car[83]. This is a great case law for possible new ones in the future.

The Dieselgate-scandal gives the public a great view on the fact that car manufacturers might pull a fast one on emissions from their cars. It also reassures us, that since it has been discovered, there is less possibility that it will be done again by the different car manufactures in Europe. To be able to reach climate-neutrality by 2050, there is possible need to move forward from gas powered vehicles.

4.3 European Green Deal and Fit for 55

There are two other important policies that the EU has implemented in recent years, that will influence the possible legislation on ZEV in the Union. The European Green Deal sets the targets that include the EU to go climate-neutral by 2050 and the Fit for 55-package includes the possibility of selling only ZEVs as new cars starting from the year of 2035 being implemented to all of the Member States.

4.3.1 European Green Deal

As mentioned in the introduction of the thesis, the goal of the policy along with climate-neutrality by 2050 is to achieve a 55 percent decrease of greenhouse gas emissions compared with 1990 in 2030. The European Green Deal has brought up much needed conversation on the amount of emission that the EU makes every year and how to reduce them, while at the same time increasing sustainable alternatives.

The sustainable alternatives in question are things like; bettering energy efficiency in buildings, to increase the amount of public transport, to have cleaner energy and better technology innovations and making products that last longer and that can be recycled and re-

[83] DW, "Germany's Top Court Backs VW Customers Over Dieselgate" (Published 22 February 2019) <https://www.dw.com/en/germanys-top-court-backs-vw-customers-over-dieselgate/a-47631589> (last accessed 4 March 2022).

used[2]. In the context of ZEVs, cleaner energy is needed to be then used as the energy for powering the vehicles.

Energy is important in the European Green Deal and that is why the EU has made a strategy called the "Clean Energy Transition". The policy has three key principles to accomplish; to ensure clean and affordable energy supplied in the EU, to develop fully integrated, interconnected, and digitalized EU energy market and to prioritize energy efficiency, to improve the aforementioned energy efficiency in buildings and make the power sector largely be run by renewable energy[84].

An important part in the topic of ZEVs is hydrogen, as the thesis has showed multiple times. As part of the Green Deal, the EU has also made a hydrogen strategy to increase the use of renewable hydrogen in the EU. The strategy suggests the use of hydrogen as feedstock, fuel and as an energy carrier or storage. The strategy mentions that from now to 2024 the EU will install 6GW of renewable hydrogen electrolysers in the EU, from 2025 to 2030 hydrogen will become an intrinsic part of the EU's integrated energy system and from 2030 onwards renewable hydrogen will be deployed at a large scale in the EU[85].

By producing and distributing more renewable hydrogen all over the EU, the possibility for the increase of both producing and selling of hydrogen powered cars rises. The strategy also concentrates on making the use of hydrogen more secure for its use, which would draw even more companies to invest in hydrogen powered cars. The strategy is not mandatory on Member States, however which means that the States themselves will most likely invest a very drastically different amount into hydrogen technology.

The European Green Deal is therefore a measure to ensure the EU's commitment on decreasing the number of emissions, that the Union has comply with according to the Paris Agreement. The decrease is done in many different sectors, as the subchapter has showed with energy efficiency and renewable energy being on the frontlines of change. With the European ZEVs can have purer energy to run their motors with.

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[84] European Commission, "Energy and the Green Deal: A Clean Energy Transition" <https://ec.europa.eu/info/strategy/priorities-2019-2024/european-green-deal/energy-and-green-deal_en> (last accessed 4 March 2022).
[85] European Commission, "A Hydrogen Strategy for a Climate Neutral Europe" (published 8 July 2020) <https://ec.europa.eu/commission/presscorner/detail/en/fs_20_1296> (last accessed 4 March 2022).

4.3.2 Fit for 55

With the European Green Deal, the Fit for 55-package was introduced to the citizens in the year 2021. The main idea of the package is to make sure that the EU has climate, energy, land use, transport and taxation policies that are fit to reducing greenhouse gas emissions by 55% by 2030 compared to the levels of 1990[86]. Part of the package is to require the average emissions of all new cars to come down from 55% in 2030 to 100% in 2035 and require that all new cars registered from 2035 will be ZEVs.

However, the package has a small problem with the wording, as all registered new cars means that cars sold as new outside of the EU do not need to be ZEVs. Though the wording seems to be understood as all registered new cars in the EU could be cars that are manufactured elsewhere but are registered in the EU as new cars also need to be ZEVs. So, from the words of the European Commission, it is not clear what constitutes a new car in the sense of which vehicles need to be ZEVs by 2035.

If the package would only consist in cars manufactured in the EU, it would possibly mean that most of the cars bought in the EU would be from outside the Union. This obviously depends on the fact if the price of ZEVs comes down a bit from what they cost nowadays. The package would be much more efficient, if it consisted of all the new cars that are sold in the EU, not depending on where they were manufactured. This way, there is less possibility for the consumers to still choose gas cars as an option.

According to the Council of the European Union, the main issue has been with the transition to ZEVs with how slowly it is moving. The Council makes a remark on the issue in its Presidency progress report and wondered if the transition could be done faster and even if the transition is premature for the framework that has been thought[87]. The Council makes a fair point, since unlike California and Norway, the EU has grown very slowly in the development of ZEVs.

[86] European Commission, "European Green Deal: Commission Proposes Transformation of EU Economy and Society to Meet Climate Ambitions" (Published 14 July 2021) <https://ec.europa.eu/commission/presscorner/detail/en/IP_21_3541> (last accessed 5 March 2022).
[87] Council of the European Union Presidency Progress Report on the Fit for 55 Package on 22 November 2021, 13977/21.

The Council then mentions that the differences between the Member States have not been taken into consideration enough. It explains that there is much difference in affordability and in slow infrastructure and that is why the timeframe might not work on the package. Other than the differentiation, the Council finds that second-hand car markets, the volume of derogations on zero- and low emission vehicles and the differentiation between cars and vans might have an impact on the question.

What comes to renewable energy, the package does try to push to a revision of the Renewable Energy Directive to deliver on the target of reaching a decrease of green house gas emissions by 55% to the levels of 1990. The Directive that is in force at the moment, targets at least a 32% reduction, which does not reach the wanted target[88]. ZEVs go hand-in-hand with renewable energy, since the energy that will be used to power the vehicles needs to be renewable.

The packages renewable energy goal is not the only change that could be brought onto the energy sector. The EU has even proposed to revise the energy taxation of the Union[89]. This could make the cost of electricity decrease for the consumers of the Union, which then could boost the selling of ZEVs in the EU. By decreasing taxation of energy products and production, you also make it more appealing for consumers to harvest their own energy, like solar energy.

The Fit for 55-Package is the closest that the EU has ever come to make legislation that makes it possible to only manufacture and sell ZEVs in the area of the Union. Though as seen from this subchapter, the package is not perfect and has some flaws that might be big hurdles to implementing the desires of it. It is a step forward, however that the package is even considered to be adapted and if it is adapted by the Member States, the EU might be on a good pace to reach their climate targets.

[88] European Parliament, "Revision of the Renewable Energy Directive: Fit for 55 Package" (Published 12 November 2021) <https://www.europarl.europa.eu/thinktank/en/document/EPRS_BRI(2021)698781> (last accessed 5 March 2022).
[89] COM(2021) 563 final. Proposal for Council Directive restructuring the Union Framework for the Taxation of Energy Products and Electricity (Recast).

Summary

The third chapter of the thesis explored the different legislations and policies that the EU has on the consumption of vehicles. The chapter found that there are many Regulations that establish the pollution limits for car manufacturers, the Dieselgate-scandal and how it might affect the car companies in the EU and lastly, the European Green Deal and the Fit for 55-Package how they have mentioned things like ZEV regulations and renewable energy legislation revisions.

The first subchapter on the different Regulations and Directives that exist in EU legislation found many different laws that regulate the transportation sector emissions. Two of these were Regulation 433/2009 and Regulation 333/2019 followed by Regulation 715/2007 and Regulation 2019/631. These Regulations all set limits on different matter that have to do with passenger vehicles in the EU.

The Regulations gave major information on such issues with cars as the limit of emissions permitted on average, penalties and the technology needed to decrease the emissions coming from passenger cars. Interestingly the penalties are given in with different amount of euros with going over certain limits of emissions per kilometer. Also, the importance of gadgets such as the pollution control devices made the assumption that the EU has been looking into improving gas powered cars lower emissions, while not having a concrete legislation on ZEVs as of yet.

The second subchapter tackled the Dieselgate-scandal and how it affected the industry after it. The scandal was surrounded with cars that emitted much more pollution, while they were not being tested. The scandal was dealt with by different states involved and the Volkswagen still is not over the case. The case can impact the industry in a positive manner, since test will be more thorough, but there is no guarantee that car companies will not try to do things like this again in the future.

The third and final subchapter concentrated on the European Green Deal and the Fit for 55-Package. It discovered the importance of the two policies to decrease the emissions of the EU in time by the EU's timeline and how the package can impact the ZEV industry in Europe by making ZEVs the only new vehicles to be sold in the EU by 2035. While the package has not

been confirmed yet to be implemented, the European Green Deal will surely improve important concepts such as renewable energy and energy efficiency.

Chapter 4 has concentrated on answering the research question on whether the current EU legislation on passenger vehicles enough to promote decarbonization of the transportation sector efficiently. While in theory, there is much legislation that regulates passenger car emissions and there are plans on the decarbonization of the sector, there is much in the EU that does not work efficiently.

This has mainly been shown by the Dieselgate-scandal explored in the chapter, which is the living proof of the failure of EU legislation effectiveness on passenger car emissions. While part of the problem might be the low surveillance by agencies, which seems to make us understand that the agencies in the EU are not as efficient as in the USA, for example the legislation in itself does not help the decarbonization of the sector in an efficient manner, not even closely when compared to California and Norway.

The EU has developed its legislation on transportation emissions in time, but the effectiveness is a problem. The EU has no agency like the CARB in the state of California that has an important position in the emissions made by, for example in the transportation sector. The EU might have come to this problem for the reason that it has too many nations to surveille, and the legislations made are not efficient in themselves. Perhaps there is a need to make sure that the Member States are more bound to respect the emission restrictions.

While there is no ZEV legislation, as mentioned multiple times the EU has made great progress to make sure that the transportation sector is trying to decrease the emissions from vehicles as much as possible. However, if the Fit for 55-Package is passed, it might make the transportation sector even better from what it could be with the legislations at the moment. It remains to be seen what kind of legislation on ZEVs the EU will decide to make and there is much to be learned from the two entities already introduced in this thesis.

5 COMPARING LEGISLATIONS AND ANALYZING AN IDEAL LEGISLATION ON ZERO-EMISSION VEHICLES

Now that the legislations and policies of all of the three parties on the topic have been analyzed, the thesis will aim to compare the two existing legislations and policies and see what can be learned by the EU in the field of regulations on ZEVs. This fourth and final chapter will concentrate on comparing the legislations and policies of Norway and California with the EU. Then the chapter will analyze what the EU can learn from the two other parties and finally how could this possible legislation be implemented.

5.1 Lessons Learned from California and Norway

As chapter 3 has shown, there are living examples how ZEVs can be regulated with laws and policies. When it comes to ZEV legislation in the EU, California and Norway can be used to draw the most efficient ways to legislate the topic out. This subchapter will do just that, to see what the EU can learn from the already existing ways to regulate the manufacturing or selling of ZEVs.

At this point, it is important to note that all of the three entities are quite different from one another. Norway being a sovereign state, with little ties to the EU, California being a single state in a Federal nation and the EU being a supranational organization that comprises of different legal cultures, history and other things that make it more complicated to implement ZEV legislation directly into the legal system of all its Member States.

California and Norway have very different approaches to increase the number of ZEVs in their respective areas. California has had an Executive Order and an Assembly Bill that imply there will be only ZEVs sold after 2035. On top of that California tries to achieve a goal on equity, meaning that every citizen needs to have the equal opportunity to afford buying a ZEV, when they become mandatory in the State. Equity is an important concept that the EU should definitely take into consideration if it makes a ZEV legislation.

If ZEVs become the only sold vehicles in the EU, there needs to be a drop in the price of the vehicles, so that every citizen can buy one. However, the EU might be in a difficult situation, since many Member States are in a very different financial situation. This could mean that the producing of ZEVs inside the EU needs to be increased and at the same time there would need

to be decrease in the cost of transporting ZEVs to the Member States and the taxation on different vehicle costs.

California has made an interesting point on the Assembly Bill in what the state board of California can legislate in the topic of ZEVs. The State Air Resources board cannot make any kind of laws that are in conflict with the goals that need to be achieved in the Assembly Bill. This makes sure that there is no hindrance with achieving the goal that is to sell only ZEVs starting from the year of 2035. The EU could implement this by making sure that Member States do not make their own legislations that would not have the same direction that the EU intends to have.

The Executive Order that was issued provided that the State Air Resources Board should act consistently with technological aptitude and to take into consideration cost-effectiveness. This is another important trait that the EU should look into. Perhaps by having a singular agency that would supervise the topic or perhaps grow another agency to take care of the supervision of technology and cost-effectiveness in the EU. This could include cooperation with European manufacturers, for example.

The California Air Resource Board also brought forth the Clean Cars 4 All-program, which tries to achieve equity in the state. The rebates that are up to $9,500 for lower-income households could give an idea for the EU to help the Member States that may have problems with transition. This could include an EU sponsored help to Member States to increase their production, investing and purchase of ZEVs in Europe. This could lessen the gap between ZEV producing MS and those who are struggling with the transition to ZEVs.

Norway, on the other hand could show the EU how the increase of ZEVs could be done with many different policies. Starting from perhaps the most effective, taxation. The taxation on gasoline powered vehicles and the freedoms made to those who own a ZEV are effective ways to increase ZEVs, while at the same time decreasing fossil fuel powered vehicles. Making it more convenient to own a ZEV leads them to become more popular and the transition to selling only them easier.

From the Assembly Bill and the Climate Change Act, we can also compare the different agencies that are in play with the enforcement of the laws. California has the CARB

overseeing some of the different aspects such as the controlling of air quality and the Clean Cars 4 All-program. Norway has the Government surveilling the annual reporting and reviewing of the climate targets that were set on the Act as well as the NOBIL that maintains the national ZEV database to better some of the aspect of ZEV policies in the nation.

This can be seen as an aspect to explore in the EU, as having some agencies made to follow the ZEV development and supervision in the area could be vitally important for the progress of ZEVs. This comes especially after the Dieselgate-scandal, mentioned in chapter 4. To make sure the manufacturers do not misuse a legislation on carbon emissions, there should be an agency that is more efficient than before.

Comparing instruments used between California and Norway, it can be found that Norway has made policies to improve on the "skeleton" of ZEVs, which could be considered infrastructure, the ZEV database and the taxations. California has focused on banning the selling of combustion engine vehicles with the Assembly Bill working on a wide range and using agencies, such as the CARB to then maintain the legislation and surveille a smooth transition to when the law comes into force.

Taxation is perhaps the most efficient way to make a change in vehicle powering options, as can be seen what has happened with diesel vehicles. Finland also be taken as an example with diesel car taxation, as there is a tax on driving power for different passenger cars that are normally set at 5.5 cents per day (diesel vehicles are the example here) for each partial or complete 100 kilograms of the total vehicle mass[90]. This tax has heavily been the reason why Finland sells way less diesel cars than before.

Taxation is important, for it puts a price on emissions, like the polluter pays-principle in international law. People are willing to change their consumption habits if other options are made unappealing and much more costly than other options.

The Professional Transport Act of Norway also gives an interesting option for the EU to legislate professional cars, as well as passenger cars. This could be even extended to public transportation, taking even impact on the emissions from the transportation sector in Europe.

[90] Traficom, "Structure and Quantity of Vehicle Tax" (Published 30 November 2020) <https://www.traficom.fi/en/transport/road/structure-and-quantity-vehicle-tax> (last accessed 28 March 2022).

As mentioned in chapter 3, this kind of policy could be immensely helpful in the biggest cities in Europe, that heavily rely not only in private transportation, but also in public transport and taxi services.

Another important concept that Norway has brought up is the importance of the infrastructure in ZEV increase. Charging stations need to make close enough to each other, that there is a much less possibility for drivers to be left on the road with no possibility to charge their vehicle in sight. Norway has made sure that for EVs, there are charging stations every 50 kilometers in their highways. This is an important thing to keep in mind and there will be a need to invest a lot of money to make this possible in the area of the EU.

Norway has made a significant effort in creating a database for ZEVs and this could be included for the EU as well. This is a very efficient way also to include the voices of EV consumers, charging stations owners, operators, and other contributors on things such as the aforementioned infrastructure. The database makes it easier to overlook possible problem with the charging stations and ZEVs, to contain possible manufacturing or other constant problems that might happen.

Lastly, Norway has made good efforts to try and increase hydrogen vehicles in its transportation sector, with especially heavy-duty vehicles used for deliveries, for example. This is one of the businesses that increases emissions and if there could be a united alignment in the EU that all Member States agree on, the Union could move onto a transportation of goods, for example that functions only with hydrogen vehicles. Granted, there needs to be a safety increase in the charging stations of hydrogen and other investment in the area of technology.

5.2 Comparing the Existing Legislation and the EU

From the lessons we can learn from California and Norway, we move onto the comparison of these two entities to each other and the legislations that have already been done in the EU and the Fit for 55-package. To complete a good comparative analysis, it is important to compare some things from both entities that are similar and to take into consideration the differences in the two. The same will be done with the EU to make sure the comparisons are done between all of the parties involved.

To produce a good comparative analysis, this subchapter will pay careful attention to the problem of equivalency[91]. This will be done by probing how similar and how different the aspects of each legal system under this study are, the difference being in a singular country, a state in a federal system country and a supranational organization, which being the European Union.

Firstly, there can be a comparison done with the California Assembly Bill and the Fit for 55-Package that the EU has proposed, which includes the selling of only ZEVs in the EU starting from 2035, like the Assembly Bill does. Norway on the other hand is a bit more efficient in its goals for ZEVs, as the goal for the country is to sell only ZEVs by the years of 2025, which is way sooner than the other two entities.

However, the Assembly Bill includes that 60% of the new ZEVs sold in the state for "noncommercial private use" need to be purchased by or on behalf of persons from an underrepresented community. This is something that is not included in the Fit for 55-Package. Norway has also included things such as hydrogen vehicles to be used in different delivery systems as soon as possible. Non-commercial private use vehicles are important, but the commercial vehicles should not be forgotten as well.

The Fit for 55-Package legislates passenger cars and light commercial vehicles, which are vans. This is where a slight difference can be found, as the Assembly Bill considers only non-commercial private use vehicles. The package also includes a target before hitting 100% of ZEVs in 2030, as by then 60% of the new cars sold need to be ZEVs, which is not legislated in the Assembly Bill of California.

Some of the policies of California and Norway can be compared as well. As the State of California has equity introduced in the Assembly Bill and executed via the Clean Cars for All-Program, it can be slightly compared with the "polluter pays-tax". Both of the policies try to advance the increasing of ZEVs, while at the same time take people's attention out of gasoline powered vehicles. However, one of the policies gives money to low-income households, while the other puts taxes on all gasoline vehicles, no matter what income.

[91] Reitz, John C., "How to Do Comparative Law" (1998) 46 (1) *The American Journal of Comparative Law*, 617-636.

There are also the targets that can be compared between the Assembly Bill of California and the Climate Change Act in Norway. The Assembly Bill confirms the selling of only ZEVs inside the state by 2035 and also sets a 60% target on non-commercial private use vehicles in the same span of years. Norway has climate targets to 2030 and 2050 with a 5-year review of the climate targets and an annual reporting on how well the state is doing towards the climate targets set.

The reduction in Norway for 2030 is to reduce 50 to 55 percent of all emissions compared to the 1990-level of GHG emissions. The idea is similar with the Fit for 55-Package brought forth in the EU. The second target in 2050 is 90 to 95 percent decrease compared to the 1990-levels. Overall, the targets in Norway are broader, with more room to create different policies that aim only for the decrease of GHG emissions in total. California's law takes only into consideration the reduction of combustion engine vehicles to decrease CO2 emissions, with no secure targets set.

The Clean Cars for All-Program might help a bit with the purchase of a ZEV, but there is still the cost of maintaining cars that might take the lower-class out of the ZEV market. As possible the middle-class citizens as well since they are not classified to be a part of the program. Norway on the other hand seems to be more of an order to get rid of gasoline vehicles by bringing up a taxation on combustion engine vehicles. Norway is more efficient, but California's way is better for the lower-income families.

Both entities are also efficient with renewable energy and have similar goals when it comes to achieve carbon-neutrality. California has put the goal to 2045, while Norway will try to arrive by 2050 to become a low-emission society. Norway has the same goal that the EU has on becoming a climate-neutral continent in 2050, which are important to fulfill some of the goals of the Paris Agreement.

While there is not much of legislation on the matter, both California and Norway have made great progress on renewable energy, as chapter 3 of the thesis shows. Both of the entities have been also good in including renewable energy in their ZEV programs, as most of the electricity used to power EVs has come from different renewable energy sources, such as wind and hydro energy.

The EU has made efforts in the European Green Deal to increase the use of cleaner energy and to revise the legislations on renewable energy, but there is still too much energy used in the EU that comes from sources such as coal. In comparison to California and Norway, the EU is very much behind in the race of securing the energy for ZEVs to be from different renewable energy sources.

What comes to EU and Norway, there can be a comparison made with the penalties the two entities inflict on combustion engine vehicles. Regulation 433/2009 and Regulation 333/2019 set penalties for the said vehicles. These Penalties are 95€ for every gram that goes beyond the emission limit. Norway's "polluter-pays" taxation has a similar effect on combustion engine vehicles and the amount is to be considered in the same range as the NOx taxation, which in 2013 was 17,01 NOK (around 2€) for every kg of emitted[92].

However, with Norway proposing to increase the taxation on carbon dioxide to 2000 NOK per ton by the year of 2030 from the 590 NOK per ton[93] that it was before, the polluter pays-taxation might also be increased soon. This will probably also increase the numbers of ZEVs sold in Norway, since the taxation on combustion engine vehicles becomes more and more unsustainable for average citizens.

The EU has not promoted ZEVs as efficiently as Norway and California have been over the years. This possibly comes from the Union being concentrated in different aspects of decreasing emissions. For example, the EU has done well with the European Green Deal and the revision on different legislations on renewable energy. However, the decarbonization of the transportation has not been a priority, even more confirmed with how long the ZEV legislation has taken to be even proposed.

Even if the legislation mentioned in the Fit for 55-Package is put into effect soon, there are many Member States that are not ready for the transition yet. On top of this, EU legislation is quite difficult to make, since the process of making new laws is long and there are many steps

[92] Norway Ministry of the Environment, "Norway: The NOx Tax Scheme" (Published 1 May 2013) <https://unece.org/DAM/env/documents/2013/air/wgsr_51/6_NOx-tax-Norway-geneva-april2013.pdf> (last accessed 31 March 2022).
[93] Reuters, "Norway's Plans to Raise Carbon Tax Draw Oil Industry Ire" (Published 8 January 2021) <https://www.reuters.com/article/us-climate-change-norway-idUSKBN29D1BD> (last accessed 31 March 2022).

in which the provisions could be totally abandoned, or some important parts of the legislation could be changed or taken off the final version of the law.

California has implemented the Executive Order since 2020 and brought an Assembly Bill that fortifies the Executive Order. Norway has been working on increasing the ZEV industry and amount for an even longer time leaving them to be one of the leaders of the industry in the world. The EU can be compared to the other two entities on paper, but the truth is that the Union is behind on ZEVs and when it comes to the decarbonization of the transportation sector, the EU is late on it as well.

5.3 How Could the Legislation be Implemented and What Would it Look Like?

California and Norway made excellent examples on diverse ways the EU could regulate ZEVs in the future. If the EU were to pass a legislation that enables only ZEVs to be sold starting from 2035 or even before that, what would the legislation look like, what type of effect could it have on the Member States and should the legislation only ban other vehicles from being sold or should there be a penalty on every combustion engine car that is in circulation after the legislation comes into effect?

Firsly, Regulation 433/2009 and 333/2019 have established fines for grams that go over the emission cap, which could work like the taxation on combustion engine vehicles has worked for Norway. The belief is that this should be included in the legislation on ZEVs. But what kind of legislation should be selected, taking into consideration that the Member States' legal systems vary from each other, and they are in a different situation, when it comes to financial and technological aspects.

Making the legislation a Regulation or Decision would be the most efficient way to regulate ZEVs, as the two Regulations above have shown. This comes from the fact, that Regulations have general application. They are binding in their entirety, like Decisions and they are directly applicable in all Member States[94]. This would make sure, that all of the Member States are bound to respect the increase of ZEVs in their country and to increase renewable energy and other layers that come with the legislation on ZEVs.

[94] Reinisch, August, *Essentials of EU Law*. 2nd Edition. Cambridge University Press 2012.

The other side of the coin would be that the legislation is made into a Directive, which is less binding to the Member States. Directives are binding, for the result to be achieved, to each Member State to which they are addressed, but they leave the national authorities the choice of form and methods to achieve these goals[95]. This helps, when there is difference between the legal systems of Member States and when there is time needed for some Member States to implement a legislation.

In the conversation between Regulations and Directives comes the question, if the legislation was a Regulation would some of the Member States be ready to directly implement the new legislation on ZEVs to their national systems. There are big questions especially with renewable energy and financial situations between nations. Countries such as Poland and the Czech Republic that are efficiently producing energy with coal might be ones to struggle with the transaction towards renewable energy.

Therefore, the suggested legislation should be a Directive with the goal being perhaps the decrease of CO2 emissions in the transportation sector by a certain percentage with a not too long deadline to fulfill the objective. This way different Member States could concentrate either on increasing their amount of renewable energy in their energy sector, or perhaps invest in ZEVs made in other Member States, which would increase the capital and that way reward the technological advancements in certain Member States.

A Regulation would be too strict and as mentioned above, it is too hard to make different legal systems to just accept a legislation like the ZEV legislation into their systems, without having a say on how to fulfill the objectives of the legislation. A Decision would have a similar disadvantage, which is why it would be unwise to implement the legislation as a Decision as well.

There is also a possibility to chop up different parts of the ZEV legislation into a clear Regulation and having other policies to help implement different parts in a better way with different legal systems, like Norway has done. This would include a Regulation that establishes ZEVs as the only new cars to be sold from 2035. After this, there could be a

[95] Craig, Paul & De Búrca, Grainne, *EU Law: Texts, Cases and Materials*. 7th Edition. Oxford University Press 2020.

Directive that with time would secure that the Member States can increase their renewable energy to power the ZEVs.

Then the EU could make some policies that involve the infrastructure around ZEVs. This could include money from the EU given to the Member States to construct charging stations around their territories, to secure the amount of charging stations in every Member State, like Norway has done. This could also be made in the biggest connecting freeways between Member States to make sure travelling from one country to another in Europe is easy with many charging stations.

Taking a page out of California's book, some policies around the ZEV legislations should concentrate on equity. Making sure that low-income citizens in the EU can afford a ZEV becomes important if these legislations and policies are passed and afterwards implemented in the EU. Perhaps not by giving money to these low-income households, but perhaps as Norway has done, to make a taxation on combustion engine vehicles for as long as the ZEV legislation is not in force.

As Norway has shown, a database for the ZEVs could be important as well to let the citizens of the EU be involved with the process. It also makes it easier to monitor charging stations, their owners and possible problems that might occur with certain types of car brands etc. It is not only important to increase ZEVs, but to have great ZEVs with no problems and especially not to repeat what happened with the Dieselgate-scandal. This requires stricter testing of the vehicles and more surveillance.

These legislations and policies might be effective, but there is also a possibility that some of the policies do not make it into force. With the EU's decision-making being quite complex, it can be safely assumed that the process to all of the actions above will take quite some time to put into fruition. However, to make ZEVs successful at the level of California and Norway, there is a reason to believe that all of the above are essential to successfully implement the selling of only ZEVs by the year of 2035.

Summary

Chapter 5 has made some comparative analysis on the two existing policies and legislations on ZEVs, with the legislations that the EU has made on combustion engine vehicles, including their consumption and the possible future legislation that involves the selling of only ZEVs in the EU, starting from 2035, as introduced by the Fit for 55-Package. The chapter also included the lessons that the EU can learn from California and Norway, finishing with how the legislation could be implemented and what it would regulate specifically.

From California the biggest take aways were on the subject of equity, which would be of vital importance to the EU ZEV legislation as well. Another important thing is that the State Air Resources Board cannot make any legislations and policies that would hinder the achievement of the Assembly Bill, that implements the selling of only ZEVs starting from the year of 2035 onwards.

Specifically, from Norway, the EU can take much more tips on how to legislate ZEVs. Starting with the polluter pays-taxation to infrastructure, Norway has showed that there is a thorough need for innovation and investment in the ZEV sector. As California also showed renewable energy needs to be on a high level in order to power the ZEVs with no involvement with carbon or other fossil fuels.

The comparative analysis found similarities in the goals of the entities, when it comes to the year that is trying to be reached. Other than that, there is much difference between Norway, California, and the EU. California has equity, Norway has taxation and infrastructure, and the EU has penalties for excess emissions but objectively, Norway's system is the one that covers the most solutions for different problems with ZEVs.

The chapter's goal was to answer the research question of what the EU legislation on zero-emission vehicles could look like. Two different ways can be taken; Directives that are implemented in the way that every Member State sees as fit, with a united goal for the start of selling ZEVs or with a general Regulation on the selling of only ZEVs, with then different policies and soft law, to try and cover as many problems as possible, like Norway has done on the topic.

With the lessons learned from the other two entities and with the two suggested ways to go with the legislation on ZEVs, the EU could improve the whole industry and popular opinion on the importance of ZEVs in the road to becoming climate neutral. Decarbonization can be achieved with the help of decreasing the CO2 emissions from the wide transportation sector that the EU has. This can bring a cleaner environment to all EU citizens and even create a better future on this planet for many more generations that do not need to think about decarbonization any longer.

CONCLUSION

After going through the various stages of the analysis on the topic of ZEV legislations, concentrating on different aspects, like the existing policies and legislations that can be found in California and Norway, the EU's current laws, the technical analysis on the vehicles themselves and what the new legislation on ZEVs in the EU could look like in the near future, it is time to draw concluding remarks.

The ongoing fight against climate change and towards the possibility of a climate-neutral European continent needs to go through the bettering of emissions from the transportation sectors both in the public and private stages. This thesis has shown the importance of regulating ZEVs in the EU and confirmed that the legislation could work, as it has done in California and Norway.

Chapter 2 answered the research question what ZEVs are by understanding the technical aspects of the vehicles. This included the choice, which can be made between electricity powered vehicles and hydrogen powered vehicles that countries can use to step away from fossil fuel powered vehicles. As science is not there yet, the chapter also made assumptions on what kind of impacts the increase of ZEVs could have in both a positive and negative way, with different outcomes.

Another important aspect that the chapter considered was the impact on the consumers that the increase of ZEVs could have, with price of the vehicles to the risks that come with battery powered EVs. The term of ZEVs was also tackled during the chapter with words such as renewable energy sources being in the spotlight. This confirmed the need there is to decrease the amount of fossil fuels used and to replace them with more sustainable options to better the quality of air that we breath.

Following the discussion on the technical aspects of the ZEVs, chapter 3 introduced the two entities that can show the EU, how to legislate ZEVs in an efficient way. These entities being California and Norway. The chapter explored different way to regulate ZEVs, like with Executive Orders and Assembly Bills and with many different policies, such as taxations on combustion engine vehicles and the introduction of new infrastructure on the roads that increases the usability of ZEVs.

The chapter also tried to unveil the impacts that the legislations and policies have had in California and Norway to understand the possible advantages of these kinds of regulations and perhaps even the risks that come with them. While from Norway's side most of the impacts have been positive (without mentioning problems with hydrogen powered vehicles), California has had some blow back from consumers. However, this negative feedback has not had an enormous impact on the continuation to regulate ZEVs, but on the contrary ZEVs keep increasing in California.

Chapter 4 introduced the legislations that the EU has already made on combustion engine vehicles and their emission levels. The research found that there are important regulations that are applied to these vehicles and that there are quite severe financial consequences if these legislations are not followed by manufacturers and such. The conclusion being that the EU has made a good job to promote the decreasing usage of combustion engine vehicles with consequences like fines used to make them less appealing in theory.

The chapter also explored some of the reasons for the EU not having effectiveness in regulating the emission limits in the transportation sector. This is even more met with the fact that EU legislation is hard to make, since the process is long and there is the need to have a lot of people on the same level, when it comes to the topic and how the topic will be regulated when a proposal becomes law.

The chapter aimed to answer the research question of the existing legislation being enough to efficiently promoting the decarbonization of the transportation sector. To this extent, the EU has not made a fine job, which can be seen in the Dieselgate-scandal, that was a backlash on diesel powered vehicle emissions. However, the EU has also created the European Green Deal and the Fit for-55 packages, that try to achieve the environmental goals set by the EU for 2050. The Fit for 55-package also includes the possible future legislation on ZEVs, if it is passed in the future.

At last, chapter 5 then covered the important stage of comparative analysis between the three entities involved in this thesis. Taking into consideration the diversity of the three entities, the goal was to compare the similarities and differences between the three. The financial side can be found in all three, though in different ways. The EU has made fines on combustion engine vehicles, Norway has made taxations to decrease them, and California has made a financial

help for lower-income households to afford ZEVs by the time the legislation on them comes into force.

The chapter also tried to achieve, which part of the legislations and policies made by California and Norway should be used in the possible future legislations made by the EU as well. California's view on equity is and important piece to achieve the affordability and availability of ZEVs for all citizens and Member States of the EU. Norway's policies have shown the importance of a taxation and of infrastructure, that can be implemented outside of the legislations.

Finally, the chapter begged the question on what the legislation then should look like. Whether it would be better to have directly implemented Regulations or to have Directives that can be implemented differently in different Member States.

So, the main question being should the EU make a legislation that effectively bans other vehicles except ZEVs, what is the answer? Yes, the EU should make a legislation on ZEVs, but it should be done in a sustainable manner. This requires an improvement in renewable energy, investing in largely on infrastructure that supports the ZEVs in the whole are of the EU and to cover all of the topics that were presented in this thesis that both Norway and California have already covered.

With the EU's emissions from the transportation sector being as big as they are, something should be done to decrease these emissions as much as possible. ZEVs are the future of the sector, and the EU should get on the same level as California and Norway to try achieving climate-neutrality by 2050. Granted there is much to be made for the EU to arise to this level, but on the fight to purify our atmosphere there are some sacrifices that must be made to achieve the goals that have been set by the Union.

BIBLIOGRAPHY

Books, articles and other literary sources

1. Farkas-Csamango, Erika, “The Legal Environment of Electromobility in Hungary” (2020) 15 (28) *Journal of Agricultural and Environmental Law,* 181-190.
2. Sandalow, David (ed), Plug-in Electric Vehicles: What Role for Washington. Brookings Institution Press, 2009.
3. Bolderston, Amanda, “Writing an Effective Literature Review" (2008) 39 (2) *Journal of Medical Imaging and Radiation Sciences*, 86–92.
4. Wilberforce, Tabbi et al. ”Developments of Electric Cars and Fuel Cell Hydrogen Electric Cars” (2017) 42 (1) *International Journal of Hydrogen Energy*, 25696-25734.
5. Hall, Dale et al. ” Beyond road vehicles: Survey of Zero-Emission Technology Options Across the Transport Sector” The International Council on Clean Transportation (November 2018).
6. Moseley, Garche and Adelmann (eds), *Electrochemical Energy Storage for Renewable Sources and Grid Balancing*. Elsevier 2015.
7. Dhameja, Sandeep, *Electric Vehicle Battery Systems*. Newnes 2001.
8. Liu, Xinyu et al. ”Well-to-Wheels Analysis of Zero-Emission Plug-In Battery Electric Vehicle Technology for Medium- and Heavy-Duty Trucks” (2021) 55 (1) *Environmental Science and Technology*, 538-546.
9. Moultak, Marissa et al. ”Transitioning to Zero-Emission Heavy-Duty Freight Vehicles” The International Council on Clean Transportation (September 2017).
10. Albertsen, Levke et al. “Circular Business Models for Electric Vehicle Lithium-Ion Batteries: An Analysis of Current Practices of Vehicle Manufacturers and Policies in the EU” (2021) 172 (1) *Resources, Conservation and Recycling*, 1-15.
11. Duncan, Ashle, ”Pulling the Plug on Greenhouse Emissions: The U.S. Power Grid Could Accommodate Plug-in Electric Vehicles” (2008) 3 (1) *Environmental & Energy Law & Policy Journal*, 158-168.
12. Neuhaus, Lauren. ”The Electrifying Problem of Used Lithium-Ion Batteries: Recommendations for Recycling and Disposal” (2018) 42 (1) *University of California, Davis*, 65-91.
13. Or, Tyler et al. “Recycling of Mixed Cathode Lithium-Ion Batteries for Electric Vehicles: Current Status and Future Outlook” (2019) 2 (1) *Carbon Energy*, 6-43.
14. Agusdinata, Datu Buyung et al. “Socio-Environmental Impacts of Lithium Mineral Extraction: Towards a Research Agenda” (2018) 13 (12) *Environmental Research Letter*, 1-14.

15. Gruenspecht, Howard, “Zero Emission Vehicles: A Dirty Little Secret” (2001) 142 (7) *Resources for the Future*, 7-10.
16. Hutton Matthew & Hutton, Thomas, “Legal and Regulatory Impediments to Vehicle-to-Grid Aggregation” (2012) 36 (2) *William & Mary Environmental Law and Policy Review*, 337-366.
17. Palencia, Juan C. González et al. “Energy, Environmental and Economic Impact of Mini-Sized and Zero-Emission Vehicle Diffusion on a Light-Duty Vehicle Fleet” (2016) 181 (1) Applied Energy Journal, 96-109.
18. Knez, Matjaz et al. “Features Influencing Policy Recommendations for the Promotion of Zero-Emission Vehicles in Slovenia, Spain, and Poland” (2021) 23 (1) *Clean Technologies and Environmental Policy*, 749–764.
19. Arroyo, Vicki et al. “New Strategies for Reducing Transportation Emissions and Preparing for Climate Impacts” (2017) 44 (4) *Fordham Urban Law Journal*, 919-968.
20. Hardman, Scott et al. “A Perspective on Equity in the Transition to Electric Vehicle” (2021) 2 (1) *MIT Science Policy Review*, 46-54.
21. Pierce, Gregory et al. ”Supporting Lower-Income Households’ Purchase of Clean Vehicles: Implications from California-Wide Survey Results” (2020) UCLA Luskin Center of Innovation.
22. McCarthy, Caitlin et al. “State Clean Transportation Initiatives” (2021) 51 (3) *Environmental Law Reporter*, 10181-10193.
23. Norem, Erik III, “An Electric Future for Today: An Analysis of Policy Options for State & Provincial Electric Vehicle Impact Standards to Expand Electric Vehicle Use” (2019) 8 (1) LSU *Journal of Energy Law and Resources*, 127-154.
24. Metz, Matthew & London, Janelle, “State Vehicle Electrification Mandates and Federal Preemption” (2020) 9 (2) *Michigan Journal of Environmental & Administrative Law*, 433-482.
25. Schulz, Felix & Rode, Johannes, ”Public Charging Infrastructure and Electric Vehicles in Norway” (2022) 160 (1) *Energy Policy*, 1-12.
26. Bjerkan, Kristin Ystmark, et al. ”Incentives for Promoting Battery Electric Vehicle (BEV) Adoption in Norway” (2016) 43 (1) *Transportation Research*, 169–180.
27. Scotford, Eloise, Environmental Principles, and the Evolution of Environmental Law. Hart Publishing 2017.
28. Aarhaug, Jorge et al. ”Mapping the Possibilities for Emission Regulation for Taxis in the Buskerud, Telemark and Vestfold Regions” (2018) TØI Report 1652/2018 (Norwegian Center for Transportation Research).

29. Deuten, Sebastiaan et al. ”Analysis and Testing of Electric Car Incentive Scenarios in the Netherlands and Norway” (2020) 151 (1) *Technological Forecasting & Social Change*, 119846- 119847.
30. Stiller, Christoph et al. ”Pathways to a Hydrogen Fuel Infrastructure in Norway” (2010) 35 (1) *International Journal of Hydrogen Energy*, 2597–2601.
31. Fridstrøm, Lasse, “The Norwegian Vehicle Electrification Policy and Its Implicit Price of Carbon” (2021) 1346 (13) *Sustainability*, 1-14.
32. Wangsnessa, Paal Brevik & Halse, Askill Harkjerr, “The Impact of Electric Vehicle Density on Local Grid Costs: Empirical Evidence from Norway” (2021) 42 (5) *Energy Journal*, 149-167.
33. Hooftman, Nils, et al. “A Review of the European Passenger Car Regulations – Real Driving Emissions vs Local Air Quality” (2018) 86 (1) *Renewable and Sustainable Energy Law*, 1-21.
34. Calster, Geert van & Reins, Leonie, EU Environmental Law. Edward Elgar Publishing 2017.
35. Bothe, Michael, “Dieselgate as an Issue of Urban Planning – German Approaches” (2020) 4 (1) *Journal of Comparative Urban Law and Policy*, 285-295.
36. Jung, Jae C. & Sharon, Elizabeth, “The Volkswagen Emissions Scandal and its Aftermath” (2019) 38 (4) *Global Business and Organizational Excellence*, 6-15.
37. Reitz, John C., ”How to Do Comparative Law” (1998) 46 (1) *The American Journal of Comparative Law*, 617-636.
38. Reinisch, August, *Essentials of EU Law*. 2nd Edition. Cambridge University Press 2012.
39. Craig, Paul & De Búrca, Grainne, *EU Law: Texts, Cases and Materials*. 7th Edition. Oxford University Press 2020.

Official sources

1. The European Commission, “A European Green Deal: Striving to Be the First Climate-Neutral Continent” <https://ec.europa.eu/info/strategy/priorities-2019-2024/european-green-deal_en> (last accessed 8 October 2021).
2. The European Commission “Transport and the Green Deal” <https://ec.europa.eu/info/strategy/priorities-2019-2024/european-green-deal/transport-and-green-deal_en> (last accessed 8 November 2021).
3. European Commission, “European Green Deal: Commission proposes transformation of EU economy and society to meet climate ambitions” <https://ec.europa.eu/commission/presscorner/detail/en/IP_21_3541> (last accessed 8 November 2021).

4. California Air Resource Board, “California Greenhouse Gas Emissions for 2000 to 2019” (Published July 28 2021).
5. Office of Governor Gavin Newsome, “Governor Newsom Announces California Will Phase Out Gasoline-Powered Cars & Drastically Reduce Demand for Fossil Fuel in California’s Fight Against Climate Change” (23 September 2020) <https://www.gov.ca.gov/2020/09/23/governor-newsom-announces-california-will-phase-out-gasoline-powered-cars-drastically-reduce-demand-for-fossil-fuel-in-californias-fight-against-climate-change/> (last accessed 9 November 2021).
6. Government of Norway, ”Norway is Electric” (22 June 2021) <https://www.regjeringen.no/en/topics/transport-and-communications/veg/faktaartikler-vei-og-ts/norway-is-electric/id2677481/> (last accessed 9 October 2021).
7. European Commission, “Clean energy for all Europeans package completed: good for consumers, good for growth and jobs, and good for the planet” (Published 22 May 2019) <https://ec.europa.eu/info/news/clean-energy-all-europeans-package-completed-good-consumers-good-growth-and-jobs-and-good-planet-2019-may-22_en> (last accessed 14 December 2021).
8. Finnish Tax Administration, “Relief of Car Tax on Fully-Electric Vehicles” <https://www.vero.fi/en/individuals/vehicles/car_tax/> (last accessed 14 December 2021).
9. Executive Department State of California, Executive Order N-79-20, 23 September 2020.
10. National Center for Sustainable Transportation, “Equity Impacts of Fee Systems to Support Zero Emission Vehicle Sales in California” (published 6 June 2016) <https://ucdavis.app.box.com/v/event-20160606PPT> (last accessed 5 January 2022).
11. California Air Resource Board, “Annual Performance Goals for the Enhanced Fleet Modernization Program and Clean Cars 4 All” < https://ww2.arb.ca.gov/resources/documents/2019-2020-Goals-EFMP-CC4A> (last accessed 6 January 2022).
12. U.S. EIA, Electricity Data Browser, California net generation for all sectors, Fuel Type (Annual), 2001-19.
13. European Alternative Fuels Observatory, “Norway” (Published in 2019) <https://www.eafo.eu/countries/norway/1747/incentives> (last accessed 12 January 2022).
14. New Zealand Foreign Affairs and Trade, “California’s Zero Emission Vehicle Market 4 November 2021” (Published 4 November 2021) < https://www.mfat.govt.nz/en/trade/mfat-market-reports/market-reports-americas/report-on-californias-zero-emission-vehicle-market-4-november-2021/> (last accessed 28 February 2022).

15. European Environmental Agency, “Average CO2 Emissions from Newly Registered Motor Vehicles in Europe” (Published 13 August 2020) < https://www.eea.europa.eu/data-and-maps/indicators/average-co2-emissions-from-motor-vehicles/assessment-2> (last accessed 17 April 2022).
16. European Commission, “Energy and the Green Deal: A Clean Energy Transition” <https://ec.europa.eu/info/strategy/priorities-2019-2024/european-green-deal/energy-and-green-deal_en> (last accessed 4 European Commission, ”A Hydrogen Strategy for a Climate Neutral Europe” (published 8 July 2020) <https://ec.europa.eu/commission/presscorner/detail/en/fs_20_1296> (last accessed 4 March 2022).
17. European Commission, “European Green Deal: Commission Proposes Transformation of EU Economy and Society to Meet Climate Ambitions” (Published 14 July 2021) <https://ec.europa.eu/commission/presscorner/detail/en/IP_21_3541> (last accessed 5 March 2022). March 2022).
18. Council of the European Union Presidency Progress Report on the Fit for 55 Package on 22 November 2021, 13977/21.
19. European Parliament, “Revision of the Renewable Energy Directive: Fit for 55 Package” (Published 12 November 2021) <https://www.europarl.europa.eu/thinktank/en/document/EPRS_BRI(2021)698781> (last accessed 5 March 2022).
20. COM(2021) 563 final. Proposal for Council Directive restructuring the Union Framework for the Taxation of Energy Products and Electricity (Recast).
21. Traficom, “Structure and Quantity of Vehicle Tax” (Published 30 November 2020) <https://www.traficom.fi/en/transport/road/structure-and-quantity-vehicle-tax> (last accessed 28 March 2022).
22. Norway Ministry of the Environment, “Norway: The NOx Tax Scheme” (Published 1 May 2013) <https://unece.org/DAM/env/documents/2013/air/wgsr_51/6_NOx-tax-Norway-geneva-april2013.pdf> (last accessed 31 March 2022).

Legislation

1. Paris Agreement under the United Nations Framework Convention on Climate Change (adopted 22 April 2016, in force 4 November 2016) (2016) 55 ILM 4.
2. Assembly Bill of California, no.1069 (published 18 February 2021).

3. 42 U.S.C. §7401 et seq. (1970) United States Code, 2018 Edition, Supplement 1, Title 42 – The Public Health and Welfare.
4. Norwegian Climate Change Act (Lov om Klimamål) NO. 2173 (in force 1 January 2018, Amended 25 June 2021).
5. Council Directive 70/220/EEC of 20 March 1970 on the Approximation of the Laws of the Member States Relating to Measures to be Taken Against Air Pollution by Gases from Positive-Ignition Engines of Motor Vehicles [1970] OJ L076.
6. Regulation (EC) No 443/2009 of the European Parliament and of the Council of 23 April 2009 Setting Emission Performance Standards for New Passenger Cars as Part of the Community's Integrated Approach to Reduce CO2 Emissions from Light-Duty Vehicles [2009] OJ L140/1.
7. Regulation (EU) No 333/2014 of the European Parliament and of the Council of 11 March 2014 Amending Regulation (EC) No 443/2009 to Define the Modalities for Reaching the 2020 Target to Reduce CO2 Emissions from New Passenger Cars [2014] OJ L103/15.
8. Regulation (EU) 2019/631 of the European Parliament and of the Council of 17 April of 2019 Setting CO2 Emission Performance Standards for New Passenger Cars and for New Light Commercial Vehicles and Repealing Regulations (EC) No 443/2009 and (EU) No 510/2011 [2019] OJ L111/13.
9. Regulation (EC) No 715/2007 of the European Parliament and of the Council of 20 June 2007 on Type Approval of Motor Vehicles with Respect to Emissions from Light Passenger and Commercial Vehicles (Euro 5 and Euro 6) and on Access to Vehicle Repair and Maintenance Information [2007] OJ L171/1.
10. Regulation (EC) No 595/2009 of the European Parliament and of the Council of 18 June 2009 on Type-Approval of Motor Vehicles and Engines with Respect to Emissions from Heavy Duty Vehicles (Euro VI) and on Access to Vehicle Repair and Maintenance Information [2009] OJ L188/1.

Internet sources

1. Victoria State Government <https://www.energy.vic.gov.au/renewable-energy/zero-emissions-vehicles> (last accessed 9 November 2021).
2. Eurostat, “Renewable Energy Statistics” (last edited 9 November 2021) <https://ec.europa.eu/eurostat/statistics-explained/index.php?title=Renewable_energy_statistics> (last accessed 9 October 2021).
3. Penn State E-education ”10.2. Zero Emission Vehicles” <https://www.e-education.psu.edu/eme807/node/671> (last accessed 9 December 2021).

4. Hydrogen Hub, “An Introduction to Hydrogen Vehicles” (Published 31 October 2021) <https://www.hydrogenhub.org/2017/10/31/introduction-to-hydrogen-cars/> (last accessed 27 December 2021).
5. Institute for Energy Research, “The Environmental Impact of Lithium Batteries” (Published 12 November 2020) < https://www.instituteforenergyresearch.org/renewable/the-environmental-impact-of-lithium-batteries/> (last accessed 13 December 2021).
6. You Matter, “Are Electric Cars Really Greener?” (Published 25 September 2018) <https://youmatter.world/en/are-electric-cars-eco-friendly-and-zero-emission-vehicles-26440/> (last accessed 14 December 2021).
7. NASA Global Climate Change, “Study: Wind Farms Can Store and Deliver Surplus Energy” (Published 23 March 2014) <https://climate.nasa.gov/news/1055/study-wind-farms-can-store-and-deliver-surplus-energy/> (last accessed 14 December 2021).
8. Warwick, “Energy Stored in Electric Car Batteries Could Be Used to Power Homes” (Published 10 November 2021) <https://warwick.ac.uk/newsandevents/pressreleases/energy_stored_in> (last accessed 14 December 2021.)
9. P2X Solutions, “First green hydrogen production plant in Harjavalta” (Published 10 August 2021) <https://p2x.fi/en/first-green-hydrogen-production-plant-in-harjavalta/> (last accessed 2 January 2022).
10. CNBC, ”China’s Huayou Invests in $2.1 Billion Indonesia Nickel Project” (Published 25 May 2021) < https://www.cnbc.com/2021/05/25/chinas-huayou-invests-in-2point1-billion-indonesia-nickel-project.html> (last accessed 13 December).
11. Green Cars, “How Cold Weather Affects Electric Cars” (Published 11 August 2021) <https://www.greencars.com/post/how-cold-weather-affects-electric-cars> (last accessed 27 December 2021).
12. Office of Governor Gavin Newsom, “Governor Newsom Announces California Will Phase Out Gasoline-Powered Cars & Drastically Reduce Demand for Fossil Fuel in California’s Fight Against Climate Change” (published 23 September 2020) <https://www.gov.ca.gov/2020/09/23/governor-newsom-announces-california-will-phase-out-gasoline-powered-cars-drastically-reduce-demand-for-fossil-fuel-in-californias-fight-against-climate-change/> (last accessed 4 January 2022).
13. The Hill, ”California Blazes a Trail with 95 Percent Renewable Energy” (Published 6 May 2021) <https://thehill.com/opinion/energy-environment/552218-california-blazes-a-trail-with-95-percent-renewable-energy> (last accessed 7 January 2022).

14. Bli Medlem, ”Norwegian EV Policy” <https://elbil.no/english/norwegian-ev-policy/> (last accessed 12 January 2022).
15. Norwegian Environmental Agency, “Greenhouse Gas Emissions 1990-2019” National Inventory Report, March 2021.
16. Autocar Professional, ”Norway to Phase Out Petrol, Diesel Cars by 2025 with “Polluter Pays” Tax (Published 27 February 2017) <https://www.autocarpro.in/news-international/norway-phase-petrol-diesel-cars-2025-polluter-pays-tax-23809> (last accessed 13 January 2022).
17. Nobil, ”Welcome to the Charging Station Database NOBIL” (Published 10 July 2012) <https://info.nobil.no/eng> (last accessed 17 January 2022).
18. NEL Hydrogen, “Hydrogen Fueling” <https://nelhydrogen.com/market/hydrogen-fueling/> (last accessed 17 January 2022).
19. Business Insider, ”1 in 5 Electric Vehicle Owners in California Switched Back to Gas Because Charging Their Cars is a Hassle, Research Shows” (Published 28 July 2021) <https://www.businessinsider.com/electric-car-owners-switching-gas-charging-a-hassle-study-2021-4?r=US&IR=T> (last accessed 28 February 2022).
20. Green Car Congress, “In Norway, Asko Begins Piloting Use of Hydrogen Fuel-Cell Trucks” (Published 2 February 2020) <https://www.greencarcongress.com/2020/02/20200202-asko.html> (last accessed 28 February 2022).
21. Electrive.com, “Norway: Explosion at Hydrogen Filling Station” (Published 11 June 2019) <https://www.electrive.com/2019/06/11/norway-explosion-at-fuel-cell-filling-station/> (last accessed 28 February 2022).
22. Clean Energy Wire, “Dieselgate - A Timeline of the Car Emissions Fraud Scandal in Germany” (Published 25 May 2020) <https://www.cleanenergywire.org/factsheets/dieselgate-timeline-car-emissions-fraud-scandal-germany> (last accessed 4 March 2022).
23. DW, “Germany's Top Court Backs VW Customers Over Dieselgate” (Published 22 February 2019) <https://www.dw.com/en/germanys-top-court-backs-vw-customers-over-dieselgate/a-47631589> (last accessed 4 March 2022).
24. Reuters, “Norway's Plans to Raise Carbon Tax Draw Oil Industry Ire” (Published 8 January 2021) <https://www.reuters.com/article/us-climate-change-norway-idUSKBN29D1BD> (last accessed 31 March 2022).