
*Department of Media and Social Science*

*Master in Energy, Environment and Society*

**Master Thesis**

# Decarbonising light-weight urban transport: A case study of Stavanger, Norway

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15/06/21

UNIVERSITY OF STAVANGER

**MASTER DEGREE IN**
Energy, Environment and Society

MASTER THESIS

**CANDIDATE NUMBER:** 4818

**SEMESTER:** Spring

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**MASTER THESIS TITLE:** Decarbonising light-weight urban transport: A case study of Stavanger, Norway

**SUBJECT WORDS/KEY WORDS:** Decarbonising, multi-level perspective, energy justice, low-carbon transition

**PAGE NUMBERS:** 79

**STAVANGER**

15/06/2021

**……**
**DATE/YEAR**

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## Abstract

The scope of this study is to analyse and discuss measures from Stavanger´s Climate- and environment plan 2018-2030 to gain insight into how the national urban growth agreement is implemented on a regional level.

Contemporary environmental challenges present formidable societal challenges. The Paris Agreement in 2015 stands as a global response to motivate nations to address the impact of climate change and secure sustainable development for the future. Scholars have drawn comparisons to ´wicked problems´ due to environmental challenges, complexity, interconnected nature and obscurity. A Multi-Level Perspective (MLP) framework will conceptualize the complex process of a socio-technological transition. A decarbonising theoretical framework is discussed to understand the logic of strategies, and a critical energy justice framework is reviewed to identify the possible injustices when decarbonising lightweight transport. A 'window of opportunity' is present due to pressure on existing fossil-fuelled paradigms that could change technical regimes and landscape changes

In this study, a case study approach is used to collect relevant data, and a literature review method is used to analyse the data collected. It has been identified three distinct areas of focus in Stavanger municipality: Improvement and facilitation of public transportation, bicycle and pedestrian infrastructure; Promoting environmental friendly mobility; Utilization and facilitation of innovative technology. Additionally, two distinct barriers are identified: How to decarbonize; How to make the transition equitable. A general conclusion is that there are incentives present. Still, they depended upon several long-term, environmentally-friendly mobility projects, which may not provide sufficient results in short-term perspectives.

## Acknowledgements

This master thesis represents the completion of my master program; Master in Energy, Environment and Society at the University of Stavanger. First of all, I would like to express my sincere gratitude to my supervisor Siddharth Sareen for his immense contribution, motivation and not least patience throughout the semester.
I would also like to thank my family for their continuous support.

Stavanger, June 2020

Tormod Evensen Hansen

# 1. Introduction

Contemporary environmental challenges, such as climate change (Nema, Nema, & Roy, 2012), loss of biodiversity (Skogen, Helland, & Kaltenborn, 2018) and resource depletion (Hussain, Khan, & Zhou, 2020) presents formidable societal challenges. For some, the change in climate may seem invisible and therefore difficult to address, but for other the changes are already noticeable (Rudiak-Gould, 2013). Over the year's humankind has seen an increasingly rapid change within our society. Such as advanced medical and societal science, along with industrial evolution enabling a growth in population which in turn threatens our food and energy security (van Bavel, 2013).

Since the 1950s century, population has grown each year with respectively 30% to 56% with no annual numbers lower than 30%. Now, the population is about to reach 8 billion, and the density (P/Km2) has increased each year from the 1950s (Worldometer, 2020). This measurement indicates that the population is growing, living closer and causing increased energy consumption (Cropper & Griffiths, 1994). Persistence of food- and energy security is not the only problem which result from a growing population, in fact, an accelerating production of energy, food and other vital consumables produce high amounts of greenhouse gases (GHG) (Weber & Sciubba, 2018). Studies show that there is a connection between emission of GHG, economic growth and a rise in temperature (Ritchie & Roser, 2019) (Bekun, Alola, & Sarkodie, 2018). In order to mitigate the potential, but also current change in climate, The United Nations Framework Convention on Climate Change (UNFCCC) introduced the global objective of keeping the global temperature rise below 2 degrees Celsius in the Paris Agreement in 2015. The aim with the agreement was to motivate countries to address the impacts of climate change, and secure a sustainable development for the future (UNFCCC, 2020).

A total of 195 countries have endorsed the Paris Agreement where all have pledged to cut emissions. The agreement represented the first legally binding climate treaty on a global scale. Out of the 195 countries, 175 countries signed the agreement, and 166 of them ratified the agreement. It was determined that the agreement would be implemented when at least 55 countries committed, who together accounted for 55% of the global emissions. This was accomplished in October 2016, and the agreement became active on November 4, 2016 (Jakobsen & Kallbekken, 2020). Additionally, Bodansky (2016) argued that the Paris

Agreement *"(...) justifies cautious optimism about the future of international climate policy"* and *"Success or failure in combatting climate change will depend as much or more on other factors, such as domestic politics and technological change"* (Bodansky, 2016, p. 319).

## 1.1 Context

Bodansky (2016) reasoned that the Paris Agreement provides new hope to the UN climate change regime. But solutions to climate change required domestic politics and technological change (Bodansky, 2016, pp. 318-319). Frank Incropera (Incropera, 2015) explains climate change as a *"uniquely challenging environmental problem"* (Incropera, 2015, p. 21) and compared it to a *´wicked problem´*. Wicked problem was introduced by Rittel and Webber (1973) and defines a social or cultural problem that is incomplete, contradictory and changing in demands, hence difficult to recognise. Often difficult or impossible to solve due to its complexity, interconnected nature and obscurity (Rittel & Webber, 1973, pp. 161-165).

However, as Geels (2011) argues, resolving contemporary environmental challenges can only be realised by deep-structural changes from socio-technical transition because they entail alternations in overall transport and energy systems. Which in turn involves technology, policy, markets, consumer practices, infrastructure, cultural meaning and scientific knowledge. Consequently, constructing long-term, complex transitions that requires a multitude of present actors (Geels, 2011, p. 24).

### 1.1.1 Norway´s climate politics initiative

Norway is one of the 166 countries that has ratified the UNFCCC agreement and through an agreement with the EU, Norway is dedicated to reduce emissions by at least 40% within 2030. The Norwegian government is actively working for reducing GHG emissions, and to guarantee a goal of 40% reduction in emissions, Norway established a Climate Act that would function as a framework for climate policy (Government of Norway, 2020). The Climate Act §1 operates as a tool for promoting a low-carbon transition to a low-emission society in Norway by 2050 (Ministry of Climate and Environment, 2018).

A principle of ´the polluter pays´ is essential in the Norwegian governmental climate policy. More than 80% of emissions in Norway are regulated by either a tax or quota limitation under the EU quota system; EU Emission Trading Centre (EU EST). The quota system is a system

that confine the quantity of emissions a NGO´s or other emitting actors in society can produce (Government of Norway, 2020).

Financial instruments are not the only tools to achieve the set climate goals. Law regulation and support schemes also represent an effective instrument that Norway has applied. In 2017 a new law on public procurement was initiated. The law represented a new regulation that would reduce GHG emissions and encourage climate-friendly solutions throughout the society (Government of Norway, 2020). E.g. use of mineral oil for heating homes in Norway was forbidden from 2020. Additionally, public support schemes have been established to encourage low-emission solutions with the intention of reducing GHG emissions. In order to facilitate for a low-carbon society, development of technology is essential to adjust the society, and therefore is state-sponsored support schemes such as Klimasats funded by the Government to provide support (Government of Norway, 2020).

The Government of Norway has made a substantial commitment to climate and environmentally friendly mobility solutions (Government of Norway, 2020). This is due to the fact that the mobility sector represents one third of all GHG emissions in Norway (Ministry of Transport, 2016, p. 217). In 2018, there was approx. 9 million tonnes GHG emission reported from transport, which the Government aims to halve by 2030 (Ministry of Transport, 2016, p. 15). The Norwegian Public Roads Administration will represent an important tool in the governmental framework to reshape public transport by implementing environmentally friendly transport, operation and maintenance of the road, intensify the development of an electrified transport sector and increase knowledge about vehicles and emissions. E.g. new emission test has been developed in the EU - World Harmonized Light-duty Vehicles Test Procedures (WLTP). This test identifies consumption of fuel and CO2 emissions while including driving patterns and other causal factors to deliver a more precise quantity of emissions (The Norwegian Public Roads Administration, 2020).

Norway is in a unique position globally when it comes to electrification of the transport sector, no countries in the world have more electric cars per capita. By the end of 2019 there was a total of 250.000 registered electrical vehicles, and that accounts for 9% of the whole Norwegian car fleet (Government of Norway, 2020). The reason behind the increasingly amount of electrical cars in Norway is due to the national and local incentives, and a goal of promoting zero-emission vehicles. The incentives include;

- No purchase/import taxes.
- Exception from 25% VAT discount on purchase.
- No annual road tax.
- No charges on toll roads or ferries (maximum 50% of original rate if necessary).
- Free municipal parking (also set to a maximum of 50% of original rate if necessary).
- Access to bus lanes.
- Fiscal compensation for the scrapping of fossil vans when converting to a zero-emission van.

These incentives have been declared to be valid until the end of 2021 by the Government and will be revised and adjusted in accordance with the market development after 2021 (The Norwegian Electric Vehicle Association, 2020).

Additionally, an urban growth agreement in cooperation with major cities in Norway is also initiated by the government. The agreement provides structure in the development and will ensure that the growth of urban areas is required to follow national guidelines for better public transport, cycling and walking path options. The government White Paper Meld.St.33 (2016-2017) presented a National Transport Plan (2018-2029) where 66.4 billion NOK was devoted for urban growth agreements, earmarked for public transport, cyclists and pedestrian options. An urban growth agreement constitutes a mutually binding contract between the state, county councils and municipalities. Moreover, the reason for urban growth agreements is to steer local government towards the goal of growth in personal transport in urban areas should be taken by public transport, bicycle and walking options. The actions and measures must focus on better accessibility, and in particular facilitate attractive options to the use of private vehicles (Ministry of Transport, 2016).

## 1.2 Aim of the Study

The purpose of this study is to analyse and discuss a sub-goal from Stavanger´s Climate- and environment plan 2018-2030 in order to gain insight in how the national urban growth agreement is implemented on a regional level. In the Climate- and environment plan 2018-2030 in Stavanger municipality, the goal within the transport sector is to reduce the direct GHG emissions by 50% in difference with 2015, and by 95-100% in 2040. In order to achieve this, one sub goal is getting 70% of private transport taken by bicycle, walking or public transport by 2030.

The main research question is:

*What is Stavanger municipality in Norway doing to reduce their emissions from its transport sector, and to achieve a target of shifting 70% of the personal transport to public transport, bicycle or walking modes by 2030?*

Research questions that will be discussed are:

- What measures are being implemented in the region of Stavanger in order to promote more environmental friendly transport sources?
- What are the potential barriers that the municipality is facing in implementing these ambitious measures?
- What has so far been the environmental effects from the implemented measures?

# 2. Theory

This chapter presents the theoretical framework for the study. First, the Multi-Level Perspective (MLP) will be discussed on the basis that the scope of this study is a socio-technological transition in Stavanger municipality. The MLP framework conceptualize the complex process which a socio-technological transition is, but also presents the challenges related to an interconnected relationship between different actors in the process. The MLP framework will therefore enhance the understanding of the complexity in socio-technological transitions being discussed in this study.

Additionally, the local decarbonising measures implemented by Stavanger municipality in order to meet the national goals of reducing GHG emissions from the transport sector will be analysed. The theoretical framework this study will draw on is reports from Centres for Environment-friendly Energy Research (FME). FME is a large-scale, funded research centre who carry out long-term research targeted towards renewable energy, energy efficiency and social science aspects of energy research. The research activities are carried out in close collaboration between research groups, trade and industry and the public administration (The Research Council of Norway, 2021). Reports from the research groups, Mobility Zero Emission Energy Systems (MOZEES), and Centre for Sustainable Energy studies (CenSES), compounded in FME MOZEES and FME CenSES (2018) report provide challenges, opportunities and strategies associated with decarbonising the transport sector in Norway. Which in turn will enable this study to identify strategies in relation to decarbonisation of Stavanger´s transport sector.

Lastly, a critical energy justice framework discussed by Sovacool, Martiskainen, Hook and Baker (2019), Jenkins, McCauley, Heffron, Stephan and Rehner (2016), and McCauley, Ramasar, Heffron, Sovacool, Mebratu and Mundaca (2019) will be reviewed in order to identify the possible injustices which could occur in decarbonising transitions. The reason for using these theoretical frameworks is that they provide different, but important arguments into the discussion of the case at hand.

## 2.1 Multi-Level Perspective

The scope of this study is arguably about a transition - a transition from a fossil fuelled depended society to a low-emission society. More specifically for this study, reduce GHG emissions in the transport sector. Geels (2011) argue that the MLP function as a middle-range framework for analysing socio-technological transitions to sustainability. Essentially, the MLP model is a framework for understanding the interactions between actors, developments and innovation in a transition.

The MLP model view transitions as a non-linear process where there are interrelations on three analytical levels; Niches, socio-technical regimes and technical landscapes. Niches represent technological solutions with the opportunity to alter socio-technological regimes. In terms of the scope of this study, an electrification of mobility represents a niche. For a niche to become part of the regime, there must be a change in the landscape that disturbs the pressure of the existing regime (Geels, 2011, pp. 26-27). Examples of such pressing landscape is the Paris agreement between nations and to ensure that the global temperature does not rise with 2 degrees Celsius. When the pressure on the existing socio-technical regime is established, a ´window of opportunity´ emerges, that can lead to changes in the existing socio-technical regime where a new regime affects the landscape (Geels, 2011, p. 28). An important element of the MLP model is that it does not provide a simple cause, but rather an interactive process on different levels that are linked together - A circular causality (Geels, 2011, p. 29).

The model has been applied to variety of studies regarding transitions, and some historic studies. Examples of this are land transport Geels (2005), where the MLP framework was applied in a historical case-study of the transition from horse-drawn carriages to automobiles in the USA (1860-1930). The study from Geels (2005) identified that a technological substitution approach in a transition was too simple because important stepping stones such as electric tram and bicycles were neglected. Illustrating the importance of analytical framework on how transitions from one socio-technical system to another come about (Geels, 2005)

MLP framework has also been used in future and ongoing electricity transitions studies such as Verbong and Geels (2007) multi-level analysis of the Dutch electricity systems (1960-2004). In this study it was concluded that niche-innovations are seeds for system change, but in order to do a balanced assessment, one should not only analyse niche-innovations, but also

regime developments (Verbong & Geels, 2007). Furthermore, another study from Verbong and Geels (2010) explored sustainability transitions in the electricity sector with socio-technical pathways. From this study the MLP theory provided the tools for systematic assessment of possible transition pathways, policy goals and strategies. Even though it could not predict a precise development, it enriched the analytical depth and reflectivity in policy making (Verbong & Geels, 2010).

Additionally, the MLP framework has been applied to mobility and ´green´ cars studies. E.g. Nykvist and Whitmarsh (2008) multi-level analysis of sustainable mobility transitions and niche development in the UK and Sweden (Nykvist & Whitmarsh, 2008). Also Bree, Verbong and Kramer (2010) used the MLP in a study of the introduction of hydrogen and battery-electric vehicles, where the MLP was used to analyse the dynamics in the relationship between car manufactures, costumers and developments that pressured this connection (Bree, Verbong, & Kramer, 2010).

The literature presented emphasise the importance and relevance of an analytical framework in socio-technical transitions in order to understand the dynamics within the transitions. Geels (2005) historical study on the shift from horse-drawn carriages to automobiles in the USA illustrate the importance of a detailed and comprehensive framework in contrast to a technological substitute. Also, Verbong and Geels (2007) and Verbong and Geels (2010) use of MLP framework in relation to electrical transitions, highlights the significance of the analytical framework as a tool to strengthen the understanding and identification of policies and policy makers. In addition, Nykvist and Whitmarsh (2008), and Bree et al., (2010) studies demonstrated that the MLP framework can be applied to mobility transitions, hence a sensible reason for using the MLP framework in this case-study of Stavanger. The MLP model will enable a definition of introductory niches, existing regimes and pressing landscapes within Norwegian climate and environmental transitions. Additionally, this will help to generate specific insight towards the motivation behind the proposed measures by the Government, and conceptualise the mobility transition.

However, in order to understand the motives behind the incentives from Stavanger municipality, a theoretical view on decarbonisation will be discussed in the following section. As presented in the previous section, the MLP framework enables analysis of socio-technical

transition, but the theoretical view on decarbonisation will enable more definite reasons for applied strategies.

## 2.2 Decarbonisation of transport

In the position paper prepared by FME MOZEES and FME CenSES (2018) the need for a decarbonised transport sector is discussed with its opportunities and challenges. The report is based upon the research carried out by MoZEES and CenSES on the role of electrification in the transport sector in Norway. The strength of the collected data lies with the fact that it is based upon insights from several disciplines collected through a multitude of research methods accumulating a greater scope upon the question at hand (Fridstrøm, et al., 2018, p. 6).

As mentioned, the Norwegian government has shown a great deal of policy commitment towards dealing with the current and future change in climate due to GHG emissions. The National Transport plan was introduced in 2018 to work as a national framework and strategy for future development of the Norwegian transport sector in coming years. The discussion of exploring, utilizing and implementing available technology has a big presence in the National Transport plan, proposing new technology utilization is inevitable in order to achieve current climate goals (Ministry of Transport, 2016, p. 105).

The report from FME MOZEES and FME CenSES (2018) reason that if Norway is to meet their obligations, the transport sector will need a transition and argue that the cut in GHG emissions could be done with five general strategies (Fridstrøm, et al., 2018, p. 6):

1. Reduction in economic activity (GDP) and standard of living which will reduce the transport demand.
2. Reduction in the mobility of people and goods at all income levels
3. A shift in travel and freight to less carbon intensive methods
4. Improved energy efficiency of vehicles and other means of mobility
5. Transition to less carbon intensive energy carries

The first strategy would be efficient, but also unfeasible. According to the Fridstrøm, et al., (2018), one percent cut in the Norwegian GHG emission through a proportional cut in GDP, would add to up approximately NOK 62 000 loss in value per ton of CO2 equivalents. It is

highly unlikely that communities with a democratic political system could go in and directly change the very way of life when other strategies could be applied (Fridstrøm, et al., 2018, p. 39).

The second strategy is the opposite of economic growth and conflicting to the fundamental principles of trade, movement and wellbeing that has been developed over centuries. Although, some version of the second strategy, such as urban city planning and regulation may reduce the mobility for private transport. One should instead promote public transport infrastructure and facilitate for more appealing bicycle and predecessor possibilities. However, reshaping urban landscape is time-consuming and would only yield effects in the long term making it less attractive in a shorter term perspective (Fridstrøm, et al., 2018, p. 39).

The third strategy would entail a change from fossil fuelled means of private mobility, to public transportation powered by a sustainable source of energy such as electricity. Meaning that both the user and the producer must adapt. Yet, the potential of reducing GHG emissions are limited due to intermodal competition with barriers of new technology. Making the strategy depended upon very powerful incentives in order to achieve a shift both in the source of transport, but also the source of energy to power the transport (Fridstrøm, et al., 2018, p. 39).

The fourth and fifth strategy then may be the most promising. Both require a technological transition, but also incentives from the policy makers in the sense that they must support the technological innovations (Fridstrøm, et al., 2018, p. 40). In relation to presented policy incentives in the 1.1.1 chapter above, it does appear that Norwegian policy makers commit to technological innovations such improving energy efficiency, and less carbon intensive mobility methods. Likewise, according to Browne, O'Mahony and Caufield (2012), it appears to be an increasingly emphasis on developing innovative technologies and promoting incentives to support alternative renewable mobility options, globally.

Banister (2008) argue that there is four similar ways to engage the GHG emissions in transport. The first (1) is reduced freight and travel demand. The second (2) is a reduction in distance through land-use policy measures. The third (3) is a modal shift, from road and air to sea and rail. And the fourth (4) is increased energy efficiency through technological

innovations. Similar to Banister (2008) and Fridstrøm, et al., (2018) approaches is the typology of an *avoid-shift-improve* triplet. Basically, one can either *avoid* GHG emissions by reducing the total amounts of transport similar to Banister (2008) and Fridstrøm, et al., (2018) first and second approach. *Shift* the dynamic in transport sector where the need for transport are moved from one carbon intensive source to another less-carbon intensive source like Banister (2008) and Fridstrøm, et al., (2018) third way. Or *improve* the excising dynamic by the use of energy technology like Banister (2008) and Fridstrøm, et al., (2018) fourth option (Fridstrøm, et al., 2018, p. 9).

The most realistic approach might be to avoid GHG emissions by facilitating for shorter commutes through enchanted urban planning and densification, making public transport and other means of transport like bicycle and walking an attractive alternative to private cars, reflecting Banister (2008) and Fridstrøm, et al., (2018) first and second option. However, this approach may only yield results in a long-term perspective as it takes time to reshape urban areas and facilitate for alternative transport methods. In a shorter perspective, car sharing arrangements may serve as a source of reduction in transport, but it is unlikely for such schemes to reduce the volume to a significant degree globally (Fridstrøm, et al., 2018, p. 9).

Moreover, a modal shift from road and air to sea and rail as proposed in Banister (2008), and Fridstrøm et al., (2018) third strategy may also seem appealing. A modal shift has been a part of official policy debates for years, both in EU and individual states. However, according to numbers from Eurostat (Fridstrøm, et al., 2018, p. 10) the numbers om freight ton kilometres has hardly seen any change in Europe. Additionally, a comprehensive modelling study for Norway in 2014 (Fridstrøm & Alfsen, 2014) explored a number of radical policy options such as rise in fuel costs and toll rates by 50%. The result from the study showed that even though a number of radical policy's where implemented, the reduction in GHG emissions from long and short distance travel would not affect the emission numbers by more than 16% (Fridstrøm, et al., 2018, p. 10).

When the GHG emissions cannot be avoided, and a shift would be more promising in a long-term perspective, the most promising short-term path may then be Banister (2008) and Fridstrøm et al., (2018) approach number four with a direct improvement, more specifically an improved energy efficiency, of the transport source. However, according to Fridstrøm et al., (2018, p. 10), the extent which existing sources of transport could be modified is

depended upon which kind of source it is. One purposed opportunity is to substitute existing intensive fossil fuel combustion in cargo ships for compressed natural gas (CNG), battery or fuel cell electric motors. Yet, this proves to be a more challenging improvement in the case of vehicles and aircrafts where a transition of energy source would require a replacement of the vehicle and aircraft as a whole (Fridstrøm, et al., 2018, p. 10).

Encouraged by the need for decreasing the environmental footprints from transport, the manufactures are obligated to reduce the GHG emission from passenger cars by the emission targets set by the European Commission for 2021. Measured by the New European Driving Cycle (NEDC), an averaged passenger car brought into the European market cannot exceed 95 gCO2/km in 2021. In Europe, from 2001 to 2016, the gCO2/km rate has decreased from 170 to 118 gCO2/km. This is mainly caused by improved laboratory testing rather than improved on-road fuel mileage (Fridstrøm, et al., 2018, p. 10). Additionally, Tietge et al. (2017) argue that the discrepancy between on-road and approved emission rates has increased from 9% in 2001 to 42% in 2016, making the actual numbers of reduction in GHG emissions rates for new cars less than 9%. Which in turn illustrate the slight effect that regulatory measures bring about, and only emphasise the need for a total socio-technical, low-carbon transition.

However, a low-carbon transition requires interrelations between a various of different involved designing actors, and using actors, where they all play a role (Geels, 2011, p. 24). In a study from Ryghaug and Toftaker (2016) they researched how the user forms of governance and mobility practices in Norway, related to the use of electrical vehicles, have been shaped by the role of which user imaginaries play in the ongoing transition towards an electrified transport sector (Fridstrøm, et al., 2018, p. 22).

According to Ryghaug and Toftaker (2016) early users were looked upon as driven by environmental and economic gains, but also curious for innovative technology. Yet, the future users would not be driven by environmental and innovative perspective, but rather the economic gain and quality of the products. In general, the current and future users of electrified transport would primarily be concerned with the quality of the technology, i.e. mile coverage and ease of use, and economic advantages i.e. taxation, VAT-discount, rather than the excitement and curiosity of new technology.

Thus, making the prospect of an adoption of electrical vehicles from a consumer perspective depended upon three specific factors, economic motivation, technological practicality and context factors. There has also been other studies to identify similar contributing factor such as, Bjerken, Nørbech and Nordtømme (2016), and Sierzchula, Bakker, Matt and van Mee (2014).

According to Sierzchula et al., (2014), the technological practicality contain the aspects of an electric vehicle performance characteristics, such as mile coverage and charging time. Also, an identified factor from the study illustrates the link between increased battery size and cost, and mile coverage. So, increasing the size of batteries battery (which improve the mile coverage) would also raise the total charging time, but also the total fee for the electric vehicle. Consequently, as Sierzchula et al., (2014) emphasise, the purchase fee for electric vehicles constitute one of the more significant barriers. Which only stress the need for economic incentives from policy makers as drivers in order to facilitate for electrical vehicle diffusion.

Bjerken et al., (2016) argue that in order to overcome barriers such as the total purchase fee, policies promoting electric vehicle use must be present. This include incentives related to tax or other economic benefits such as reduced parking, toll, ferries fee, access to bus lanes or car pool lanes. Proposed incentives from Bjerken et al., (2016) can be seen in correspondences with the ones presented earlier in sub-section 1.1.1.

Additionally, a third identified factor that influence the future user of electrical vehicle is context factors. According to Sierzchula et al., (2014), these factors include fuel prices and availability of charging stations. Yet, a countries level of urban density could provide advantages for improved motivation of electric vehicles due to shorter travel distance and improve accessibility to charging stations.

After a review of an analytical framework (MLP) to identify the dynamics in a socio-technical transition, and theoretical strategies to engage decarbonisation of transport, it will be important to understand which effects socio-technical transition may cause. In the next section, a critical energy justice perspective will be discussed in order to reason between the need for decarbonisation and the effects it could create, both in terms of promising solutions and negative outcomes.

## 2.3 A critical energy justice perspective

The concept of a low-carbon transition is usually associated as something positive because it involves distancing oneself from fossil fuel resources and moving the focus over to renewable energy sources. In relation to the climate challenges we face today, a transition is mainly considered as necessary and overall satisfactory for everyone. However, according to the work from Sovacool, et al., (2019), McCauley, et al., (2019) and Jenkins, et al., (2016) there is evidence that a low-carbon transition may actually lead to injustices and vulnerabilities. Sovacool et al. (2019, p. 581) argue that studies on low-carbon transitions tend to explore the overall value from a shift in energy source, but fail to examine how they affect pre-existing socio-economic problems that become more apparent in the transition. McCauley, et al., (2019, p. 917) state that new injustices of the low carbon energy transition are only emerging, and that many are not yet evident to policymakers or researchers.

Sovacool, et al. (2019), McCauley, et al., (2019) and Jenkins, et al., (2016) discuss and provides a critical view on the ongoing low-carbon society transition, with a conceptual framework of energy justice, divided on four distinctive aspects; distributive justice (costs and benefits), procedural justice (due process), cosmopolitan justice (global externalities) and recognition justice (vulnerable groups).

The research done by Alberini et al. (2018), Burke et al. (2018), Noel et al. (2018), Ürge-Vorsatz et al. (2014) have focused on the justice benefits and co-benefits to low-carbon transitions, renewable energy. On the other side, Sovacool et al. (2019) McCauley, et al., (2019) and Jenkins, et al., (2016) approach is more characterized and influenced by the ethical and moral dimension of low-carbon transitions. So essentially, Sovacool et al. (2019, p. 582) ask what types of *injustices* is linked with low-carbon transitions, rather than asking what types of *justices* is related to low-carbon transitions like studies mentioned above. Also, McCauley, et al., (2019, p. 916) argue that a socio-technical transition must take into consideration questions of energy justice to ensure that policies, plans and programmes guarantee fair and equitable access to resources and technologies.

The challenge to reduce GHG emissions and economic activity was early perceived as a technical task that could be modified by science and administrated by policies. However, in recent times, this perception of the challenge has changed significantly with the recognition

that the decarbonisation challenge cannot be solved without the social aspect present because they are entangled together (Smith & Stirling, 2010; Sovacool, 2014; Geels, et al., 2016). Sovacool, et al., (2019, p. 582) suggest that recognition of a social aspect is essential in the process, and argued for different fields of energy analysis such as energy policy, climate policy, environmental science, geography and innovative studies to involve the social dimension. E.g. studies on the political-economic dynamics determining incumbent industry power Geels (2014), the social psychology of public climate change engagement Shove (2010), the differentiated diffusion of low-carbon technology between and across societies Mulvaney (2013, 2014), and the regulatory policies that can stimulate low-carbon housebuilding Horne and Dalton (2014).

An effect from the introduction of a social aspect in the broad energy-analysis dimension is the acknowledgement and emphasize of how important a social aspect is within energy analysis, which is the importance of a present *justice* in low-carbon energy systems and transitions. In a broad-spectrum that means that a transition in energy systems would not just consider the effects of a shift in energy sources and its benefits, but also how it actually would affect the user of it (McCauley, et al., 2019). The origin of the term energy justice is however not a newly formed concept with roots back until at least 1980s (Perez-Guerrero, 1982; Weinberg, 1985), where it in later years have become more applied to the topic of low-carbon transitions. Scholars in this field have argued that even though a low-carbon transition would contribute to normative goods in the sense that it would create a less carbon intensive society, a transition may also bring about new, or worsen pre-existing inequalities in society (Newell & Mulvaney, 2013). Sovacool et al. (2019, p. 582) argue that all major socio-technical transitions must be approached with an open and democratic participation including a widespread number of participants from different sectors in order to identify and minimize unwanted impacts. A failure to organize a widespread democratic participation could not only bring about less responsive and representative policy choices, but also cultivate friction and resentment in societies through exclusion and inequality.

To identify injustices and analyse the case of Stavanger, a holistic framework of energy justice study discussed by Sovacool, et al., (2019), McCauley, et al., (2019) and Jenkins, et al., (2016) is portrayed. This framework consists of four interconnected branches of modern justice theory in order to discover and identify possible injustices. Jenkins, et al., (2016)

reviewed a nuclear example from the UK, and Sovacool, et al., (2019) analysed the data from four low-carbon transitions in Europe with this framework.

### Distributive Justice

The distributive branch of justice is associated with temporal issues of allocating social goods and ills throughout societies. McCauley et al., (2019), Sovacool et al., (2019) and Jenkins, et al., (2016) argue that distributive justice is divvied into three aspects of distribution; the first is to identify the goods and ills that are located in the society (e.g. food, clothing, power, wealth or respect). The second is to identify the entities between who and what they get (e.g. people of importance, stakeholders, generations). And the third which is to identify the most reasonable and fair method of distribution based on entitlement (e.g. status, need, merit, rights). Sovacool, et al., (2019, p. 358) argue that in relation to low-carbon transition, this aspect can help development of energy systems where costs are shared and participants are equally benefitted.

### Procedural Justice

The second branch which McCauley et al., (2019), Sovacool et al., (2019) and Jenkins, et al., (2016) discuss is the procedural justice. This branch deals with the subject of public participation, due process and representative justice. The focus is to identify those with responsibility to plan and alter the process, and whether it is an open democratic decision-making-process with a fair representation influenced by impartially and objectivity. In relation to low-carbon transitions, Sovacool, et al., (2019, p. 589) emphasise a fair procedure can enable systems that are designed to promote outcomes that benefit all, rather then some.

### Cosmopolitan justice

The cosmopolitan justice is according to McCauley et al., (2019), Sovacool et al., (2019) and Jenkins, et al., (2016) based upon the notion that all human beings are bound and protected by moral principles with equal worth regardless of ethnicity, gender or social status. But also according to Sovacool, et al., (2019, p. 589) obliged to a collective responsibility for each other's wellbeing. In relation to a low-carbon transition, this branch within the framework focus on that everyone is being treated as equal, and no members of society gets disregarded based on beliefs, status etc.

### Recognition justice

The last branch within the framework discussed by McCauley et al., (2019), Sovacool et al., (2019) and Jenkins, et al., (2016) is the aspect of identification. More precisely, the identification of vulnerable members who may be affected to a greater extent than others by a low-carbon transition (e.g. chronically ill, poor or unemployed). With emphasize from Sovacool, et al., (2019, p. 589) placed on understanding differences alongside protecting equal rights.

These four branches within the energy justice framework discussed by McCauley et al., (2019), Sovacool et al., (2019) and Jenkins, et al., (2016) all complement each other with important pieces of the puzzle to construct a reasonable framework to unveil injustices. The distributive and procedural justice creates a basis for mapping the distribution of social goods through a fair (or unfair) decision-making process. Sovacool, et al., (2019, p. 589) consider that the cosmopolitan justice brings the moral responsibility for each other into the equation, with the recognition justice adding the final layer of an identification of possible vulnerabilities.

After the assessment of a critical energy system, it has become even more evident that the aspect of justice is significant in socio-technical transition. This is because it provides a societal analytical dimension to the complexity of a transition. Throughout this theoretical review, two other substantial theoretical frameworks have been discussed. In relation to each other, they all contribute with different, but equally important, insights to a socio-technical transition. Hence, the choice of these distinct theoretical frameworks will enhance the studies overall analysis in the case of Stavanger.

# 3. Research Methodology

After the establishment of globally, nationally and locally motivations for low-carbon transitions in chapter one. Accompanied by theoretical views on socio-technical transitions in order to design a foundation for further discussion in chapter two, it is imperative to explain the research methodology which this study apply in order to analyse the socio-technical transition in Stavanger.

In this chapter, the description of applied research techniques to analyse the socio-technical transition in Stavanger is presented and discussed, which includes how the data is collected, processed and analysed. Lawrence W. Neuman (2011) describe the term methodology as an understanding of the entire research process. Where the entire research process in a whole define its social-organizational context, philosophical assumptions, ethical principles, and political impacts of new understanding. Neuman (2011) explains the term methods as a collection of specific techniques that we apply to study social phenomena and various cases, with an assortment of measures and techniques, to gather and polish collected data and information (Neuman, 2011, p. 2). Norman Blaikie (2019) also refers to the term methods as "techniques of data collection and analysis" (Blaikie & Priest, 2019, p. 200). Essentially, research methods construct the opportunity to produce particular forms of data, which in turn can be analysed and used for research, but also provides the opportunity for systematic control during studies or projects.

The intention of this chapter is to explain the methodological process of this project, including the methods which has been used to collect relevant information to answer the research questions, but also the research strategy.

## 3.1 Research strategy

A research strategy is to devise opportunities and strategies to answer the research questions, hence the strategy chosen depends upon how the questions are formulated, and what they seek to answers. Research question investigating *what* are often easier to answer than *why* and *how*, but there will always be underlying factors that complicates the process. Therefore, a researcher cannot evade the selection of concepts, categories and logic ways to meet the questions (Blaikie & Priest, 2019, p. 90).

In this study an abductive strategy is chosen to answer the research question. An abductive approach can answer both *what* and *why* questions. Contrary, a deductive approach is used test a theory, thus answering *why* questions. In this study elucidating reasons can provide understanding rather than explanations. This kind of logical approach is about establishing theories from social activities (Blaikie & Priest, 2019, p. 99). As in the case of this thesis, relates to the human emissions of GHG and their habits to use private cars rather than a public transport offer.

The reason for an abductive approach is takes human factors into account such as; interpretations, motives and intentions that people feel in everyday life and influence their behaviour (Blaikie & Priest, 2019, p. 99). Therefore, the goal is to find out why people chose their private car rather than a public transport. Something that will be studied through how Stavanger municipality organizes an attractive offer within public transport, cycling and pedestrian's options. The process forms a picture of the current amount of emissions in Norway, and further conceptualize the transition initiated by the Government through a framework. This strategy allows events to be seen in a wider context. One weakness is that the research strategy does not have a set of criteria that allow an assessment of the validity of the abductive conclusion (Blaikie & Priest, 2019, pp. 100-101).

## 3.2 Qualitative research

There is a large body of literature on research methods, and one significant distinction is the difference between qualitative and quantitative methods (Blaikie & Priest, 2019, p. 200). Qualitative methods are often used to collect data in the form of text as opposed to quantitative data which often is expressed in the form of numbers or other units of measurement. In this study a qualitative approach is chosen to gain in-depth knowledge and create a comprehensive understanding of specific contexts which in this case is the decarbonisation of transport in Stavanger municipality (Blaikie & Priest, 2019, pp. 200-201). There are several methods for collecting and analysing data within a qualitative methodological framework. In this study a case study approach is used to collect relevant data, and a literature review method is used to analyse the data collected (Blaikie & Priest, 2019, p. 203).

## 3.3 Case-studies

Case-studies have a long history and has through-out the years been applied to social anthropology, political studies, sociology, management and planning studies (e.g. research on cities) (Blaikie & Priest, 2019, p. 181). Norman Blaikie and Jan Priest (2019) argues that many scholars suggest that case-studies offers a great possibility for low-budget, single person study. Also, a case-study allow the researchers to study one aspect of a problem within a limited time-scale (Blaikie & Priest, 2019, p. 182). However, they also emphasize that case-studies have been regarded in different ways throughout the history, from being a type of research design integrated alongside experiments, survey and field research, and involving the use of particular research methods, qualitative, but also as being a method for selecting the source of data. Stake (2005, p. 443) argued that *"Case study is not a methodological choice but a choice of what is to be studied"* (Blaikie & Priest, 2019, p. 181).

A clear definition of case studies varies in different literature, but a common understanding is that a case-study is used as *"umbrella term for a family of research methods having in common the decision to focus on inquiry around an instance"* (Adelman, Jenkins, & Kemmis, 1977). With some methods more frequent than others, but all still considered legitimate, what is then so distinct with a case-study? Goode & Hatt (1952) expressed their distinction of a case-study on the basis of a social unit and the manner in which it is studied, meaning that a case-study tries *"to keep together, as a unit, those characteristics which are relevant to the scientific problem being investigated"* (Goode & Hatt, 1952, p. 333). Rather than identifying case-studies with a specific way of collecting data, a case-study was regarded as *"a mode of organizing data in terms of some chosen unit"* (Goode & Hatt, 1952, p. 339) (Blaikie & Priest, 2019, p. 183).

Like Goode & Hatt (1952) Mitchell (1983) recognized case-studies being characterized as an inquiry of a unit rather than a scope on individuals. However, Mitchell (1952) criticised Goode & Hatt (1952) understanding of firstly lacking room for other activities than statistical analysis, and secondly the disregard of the context which the case is located in (Blaikie & Priest, 2019, p. 183).
Yin (2003) have also addressed the questions of what constitutes a case-study in detail, and he suggested that the key to defining are with the way research questions are formulated and how the research question is weighted. Yin (2003) defines a case study as an empirical inquiry that

investigates a contemporary phenomenon within its real life context, especially when boundaries between phenomena and context are not clearly evident (Blaikie & Priest, 2019, pp. 183-184). In relation to a decarbonisation of the transport sector in Stavanger, this clearly relates to the dilemma between decreasing GHG emissions from transport and making it acceptable, but also achievable with the local populations already established patterns of motion in society.

However, even though case studies offer a great opportunity for single-handed, low budget on studies within a timeframe (Blaikie & Priest, 2019, p. 182), there is some critics that are important to address. Blaikie and Priest (2019) underlines some distinct criticism that questions whether it is possible to generalize or theorize from case studies (Blaikie & Priest, 2019, p. 186). For generalization, the critics narrative primarily reason about the lack of sufficient amounts details, but also the element of relatability. Blaikie and Priest (2019) argue that *"if the researcher provide sufficiently detailed descriptions of their cases, it is possible for others to make judgements about whether the findings can re relate. The burden of proof is on the user rather than the originator of the research"* (Blaikie & Priest, 2019, p. 187). For the latter, Blaikie and Priest (2019) reason that theorizing from single case studies will not be sufficient, but can be satisfactorily from a collection of case studies *"if researchers work cumulatively by building on each other's work"* (Blaikie & Priest, 2019, p. 189).

## 3.5 Case selection and approach

This thesis examines how the municipality of Stavanger are working towards national guidelines of reducing their emissions from the transport sector, and achieving a sub-goal of getting 70% of the person/passenger transport to rather choose public transport, bicycle or walking by 2030. As discussed earlier in this thesis, the need for a societal transition onto a more sustainable foundation is evident, but also extremely complex. In this thesis the focus will be on one crucial area with a lot of prospects for improvement, the transport sector. More precisely, the decarbonisation of the transport sector in Stavanger and what actions the municipality are implementing in order to reach both national, but also local set goals. Therefore, a larger set of relevant governmental documents, independent reports and literature will be reviewed in order to create a foundation for discussing what the municipality of Stavanger are implementing in order to reduce their emission, and achieving a target of 70% selecting public transport rather than own personal vehicles by 2030.

Well formulated questions are essential to *"define the nature and the scope of research"* (Blaikie & Priest, 2019, p. 68) but also to establish boundaries surrounding the phenomena in question, and essentially how it will be studied (Blaikie & Priest, 2019). As discussed earlier in this chapter, the research strategy chosen will depend upon the research questions. As presented, this thesis encompasses an abductive approach where the questions are formulated using the interrogative word *what.* This kind of logical approach is about establishing theories from social activities (Blaikie & Priest, 2019, p. 99), by implementing a bottom up approach which provides descriptions and understanding that reflect the social actors point of view rather than the researchers (Blaikie & Priest, 2019, pp. 99-100). The intention behind this is due to the fact that the actions implemented in Stavanger will affect the everyday life of local population in different ways making it a matter of the people.

## 3.6 Primary, secondary and tertiary data

Data in social research can originate from 3 main types of collections: *primary, secondary and tertiary.* Primary data refers to data generated from a researchers own study, and is characterised as 'new data'. *Secondary* data are considered as 'raw data' collected from, or in other studies conducted by someone else, and the purpose can diverge from the original study in contrast to a new study. *Tertiary* data is similar to secondary data, but deviates by being analysed by either the original collector, or the secondary handler of the data (Blaikie & Priest, 2019, p. 156).

In this thesis no primary data has been collected on the basis of two factors: the first is due to the pandemics limitation to meaningful fieldwork. E.g. qualitative interviews with relevant actors, such as NGO´s, representatives from Stavanger municipality, Kolumbus or The Norwegian Public Roads Administration. Secondly, considerable amounts of relevant data are accessible from different sources, such as governmental reports, newspapers and other researcher's studies. On the other hand, secondary data constitutes most of the data collected in this study which is described in the literature review and, findings and analysis chapter. Moreover, a lesser amount of tertiary data is collected from Karolina Barbara Shahid´s master thesis on the implementation of toll rings in the Stavanger region (Shahid, 2019).

## 3.7 Limitations and data reduction

One important, but often forgotten element in a social research process is to understand and evaluate what the strength and weakness the study may encompass, but also what kind of limitations that are present. Blaikie and Priest (2019) emphasize that some researchers may hesitate to uncover weakness in their studies due to fear of being judged as insufficient. However, what they argue is that a reluctant to expose a study's weakness can be interpreted as shallow understanding of research (Blaikie & Priest, 2019, p. 29).

This study contains both strength and weaknesses. First off, one weakness with this research would probably be the narrow scope of inquiry. The transition and decarbonising of a transport sector is barley analysed enough with only a societal aspect present. A transition, regardless of sector, is a highly complex process involving a multitude of actors that contributes with a huge amount of different experiences. Therefore, in order to illustrate the full picture and gain understanding of the decarbonisation as a whole one would need to involve the economic (e.g. Funding), technological (e.g. Grid-systems) and political aspect in a bigger manner, especially when discussing a construction of new infrastructure and promotion of new technology (E.g. hydrogen and other renewable fuel sources). However, there is limitation to cover all the necessary aspects of a transition in the transport sector (E.g. covers more than just light-weight transport vehicles). On the other hand, the scope of this thesis touches the surface of the change in society, and maybe findings and discussions from this case-study can enrich other studies in various ways.

## 3.8 Ethical consideration

The empirical and theoretical literature which has been utilised in this study is collected from already existing research, hence it will appear well grounded with regards to anonymity and notification obligation. The study does contain an analysis of interviews from a representative in FNB political party. However, this qualitative study is conducted in a Master thesis by Karolina Shahid (Shahid, 2019). The demands regarding confidentiality are therefore already satisfactory due to it being analysed tertiary data. This study will therefore be characterized by presentations of others findings and reproductions from other studies. Consequently, there has been paid attention to references in the text, accommodated with a complete reference list in the end of the document.

# 4. Literature review

## 4.1 National transport plan 2018-2029

From the government White Paper Meld. St 33, a National Transport plan was presented and constitute a future-oriented plan over 12 years. The fundamental purpose of the plan was to function as a framework for the future development of transport. This entail that future development of infrastructure must recognise the importance of climate-neutral transport solutions. Also, opportunities offered from innovative technology must be considered and utilized. The transport of the future should be fast, efficient and emission-free. Additionally, soft road users must be emphasised. To promote climate-neutral mobility nationwide in urban areas, urban environment and urban growth agreements with municipalities will ensure both partly funding and a common framework. These agreements will enable municipalities to develop mobility infrastructure which both promotes the goal of climate-neutral mobility, but also promotes safe transportation and facilitates value creation (Ministry of Transport, 2016, pp. 9-10).

A well-functioning and sustainable transport system are of great value to users and enable ease of mobility in society. E.g. a well-functioning transport system will promote easier access to services, opportunities for education, work and participation in leisure activities which in turn enhance the overall wellbeing in society. Through the Urban Growth Agreements, Urban Environment Agreements and Reward schemes, the Government will contribute with 66,4 billion NOK during the National Transport plan 12-year plan. These funds are mainly earmarked for the operation of local public transport, and infrastructural development with emphasis on soft-road users (Ministry of Transport, 2016, pp. 11-13)

## 4.2 Regional urban growth agreement 2019-2029

An urban growth agreement is a coordination between an Urban Environment Agreement, and a Urban Development Agreement decided in Government by the Ministry of Local Government and Modernization, and the Ministry of Transport and Communications (Regjeringen, 2018).

The grounds of the urban growth agreement between North Jæren, Rogaland county municipality and the Ministry of Transport and Communication is that it will function as a

tool to develop a mobility system that promotes growth in alternative, environmentally friendly transport methods, rather than a growth in the use of private vehicles. The measures must ensure accessibility and promote reasonably alternatives to private cars. This is due to the set goal in the National Transport Plan, of placing an increasing growth of needed mobility onto public transport or other environmental friendly mobility sources (Rogaland County Council, 2019, p. 1).

The urban growth agreement on North Jæren is to apply between a period of 10 years, from 2019 to 2029. The agreement is geographically bound to Stavanger, Sandnes, Sola and Randaberg which constitutes North-Jæren. From the agreement, measures regarding transport, financing and land use are covered and are in accordance with the framework, goals and priorities presented in the National Transport Plan. Through Bymiljøpakken North Jæren (The Urban Growth Agreement North Jæren), the agreement will be managed and coordinated (Rogaland County Council, 2019, pp. 1-2).

### 4.3 Climate and environmental plan, Stavanger municipality, 2018-2030

In 2018, Stavanger City Council adopted a Climate and Environment plan for 2018-2030. The plan is a comprehensive climate strategy involving projects, challenges, goals and solutions targeting climate change over a 12 years' period. The basis of the plan covers the society as a whole, where different sections of the society are evaluated and divided into different chapters. Since the scope of this study focuses on transport, the focus will not be placed on the rest of the Climate and Environmental plan, but rather the transport chapter. This will be done through a sub-document of the plan - Action plan 2018-2022 (Stavanger Municipality, 2018).

### 4.4 Action plan, Stavanger municipality, 2018-2022

Stavanger is a municipality in Rogaland county, located along the coast in western Norway. It is Norway's fourth most populated municipality with approx. 144 000 citizens and a density of 559 inhabitants per km². The municipality share close boarder with other municipalities such as Sandnes, Randaberg and Sola, which in turn is constitute North Jæren. North Jæren is the third largest settlement with approx. 230 000 inhabitants (Thorsnæs, 2021). Due to the fact that Stavanger is one of the largest cities, located in one of the biggest settlements in Norway, it composes a highly interesting place of inquiry.


*Figure 1, map of Stavanger. Source: Google Maps*

The action plan is a detailed strategy plan of specific action points that will help achieve the goals of the Climate and Environmental Plan in the period 2018-2022. However, the municipality cannot achieve the goals on their own and therefore other actors will be involved, but through a facilitation and coordination by the municipality of Stavanger (Stavanger City Council, 2018, p. 4).

The plan contains two focus areas within the transport sector with three sub-goals each. It is then further narrowed down to specific goals onto the specific focus areas, and then further explained with both the direct measures and the participating actors which is present in order to achieve the sub-goals. Some of the sub-goals are not being reviewed here and that is because they are not in relevance to the raised questions in this thesis.

### 4.4.1 Reduction of transport volume and change in travel habits

The first focus area (1) is a reduction of transport volume and travel habits where the sub-goal (1.1) aim to get 70% of the personal transport shifted over to alternative sources like bicycle, walking and public transport in 2030. Firstly, to achieve the sub-goal (1.1), the municipality must ensure good accessibility for the public transport in the urban areas. Secondly, the share

of bicycles must be increased by 1% each year, and make up 25% in 2030. Thirdly, the municipality have to make it more attractive to walk. Fourthly, more urban areas in the city centrum must be car-free and reserved for soft road-users. And lastly, there must be a reduction in average travel length (Stavanger City Council, 2018, p. 5).

In table one to five, the most prominent actions, collected from the Action Plan (2018), in relation to this study is presented. The reason for outlining them in tables is to make clear which actions are connected to assigned focus-area, but also to highlight responsibility from the municipality, and in some focus-areas, the participating external actors.

With regards to the case-study of Stavanger, it is central to establish understanding of what kind of actions that are present in these plans. But it is also important to highlight which contributing departments and external participants that are present in the development.

| **Actions** | **Responsibility Stavanger municipality** |
|---|---|
| Facilitate good densification along the bus route and the main public transport network. | Urban and community planning |
| Help facilitate self-driving buses. | Urban and community planning<br>Urban environment and development (BMU) |
| Establish places for common transport solutions in the districts (mobility points). | Urban and community planning<br>BMU |

*Table 1, measures for increased use of public transport.* Source: (Stavanger City Council, 2018, p. 5).

Table 1 presents the actions directed towards sub-goal 1.1 to increase use for public transportation. There are no external actors present in these chosen actions, and makes the Urban and community planning, and Urban environment and development (BMU) department in Stavanger municipality responsible for carrying out these actions. The common

denominator is that they are all long-term prospects which require infrastructural change and innovative technology.

| **Actions** | **Responsibility Stavanger municipality** | **External actors** |
|---|---|---|
| Continue to focus on upgrading the main network for bicycles and have a high standard of operation and maintenance. | Urban and community planning<br>BMU | The Norwegian Public Roads Administration cooperation with North-Jæren |
| Continue to focus on establishing, operating and maintaining safe and good bicycle parking throughout the city, especially for electric bicycles. | BMU | |
| Strengthen the city bike scheme by increasing the number of parking spaces and the number of city bikes, and ensure that the average walking distance to the parking spaces is reduced annually. | BMU | City-bicycle Kolumbus cooperation at North-Jæren |
| Continue to focus on information and campaigns to get more people to cycle and promote safe cycling culture. | BMU<br>Urban and community planning | Cooperation on North Jæren |

*Table 2, measures for increased use of bicycling.* Source: *(Stavanger City Council, 2018, p. 5).*

Table 2 display actions regarding the goal of increasing the share of bicycles 1% each year, and make up 25% in 2030 in the area of Stavanger. In order to achieve this, the municipality focus on facilitating for cycling through infrastructural change and cycle schemes. The Urban and community planning and BMU departments are the responsible internal actors which is to coordinate these actions, with the help from external contributors such as Kolumbus, and the cooperation at North Jæren.

| Actions | Responsibility Stavanger municipality | External actors |
|---|---|---|
| Implement the shortcut project in all districts to map, equip and establish new shortcuts to important. destinations in everyday life, e.g. kindergarten, school, bus stops and other important places in the local community. | Urban and community planning<br>BMU | Cooperation on North Jæren |
| Ensure good maintenance of the identified shortcuts. | BMU | |
| Initiate and support walking campaigns such as Beintøft (Go to school competition). | BMU | Environmental agents |

*Table 3, measures for increased walking.* Source: *(Stavanger City Council, 2018, p. 7).*

In table 3, actions for increased walking is presented. The municipality have to make it more attractive to walk in order to achieve sub-goal 1.1 that aim to get 70% of the personal transport shifted over to alternative sources like walking. These actions are also highly deepened upon development in infrastructure and schemes like the measures for cycling. Additionally, the Urban and community planning, and BMU are the responsible for coordination of the measures in partnership with a cooperation at North Jæren and the Environmental Agents (Miljøagentene, 2021).

| Actions | Responsibility Stavanger municipality | External actors |
|---|---|---|
| Regulate and establish car-free zones. | Urban and community planning<br>BMU | |

| | | |
|---|---|---|
| Facilitate car sharing schemes such as Nabobil, Bilkollektivet, electric car sharing schemes, etc., e.g. through priority parking. | Urban and community planning | HjemJobbHjem<br>Nabobil<br>Bildelingordning |
| Stavanger municipality will support, and be a HjemJobbHjem company. | Support and development | HjemJobbHjem |
| Implement attitude-creating measures and provide information on environmentally friendly transport to citizens through regular campaigns such as Environmental Sunday and European Mobility Week | BMU | Cooperation on North Jæren |
| Contribute to the development of open car sharing schemes for electric and rechargeable hybrid cars by participating as a costumer or contributor in other ways. | BMU (Mobility project) | HjemJobbHjem |
| Establish Mobility Point at Stavanger station and Fiskepirterminal. | Urban and community planning | |

*Table 4, , measures for car-free areas, carpooling/car sharing, mobility impact.* Source: *(Stavanger City Council, 2018, pp. 7-8).*

Table 4 present actions towards the establishment of car-free zones, incentives such as car-share schemes, but also mobility impact awareness schemes. These actions accommodate the first focus area to reduce transport volume and the sub-goal (1.1) to facilitate for soft road-users and car-free zones. These actions not as dependent on infrastructural change compared with the previous tables. However, these are more depended upon environmental friendly promoting schemes. The coordinative responsibility from the municipality are as previous tables, the Urban and community planning, and BMU department, but also to support the HjemJobbHjem scheme. Present external actors are independent car sharing schemes such as Nabobil and Bildelingordningen.

| Actions | Responsibility Stavanger municipality |
|---|---|
| Facilitate for 80-90% of new homes are built on either existing developed areas or in areas that are being transformed from other purposes to residential purposes. | Urban and community planning |
| Prioritize children in their own area when allocating kindergarten places, through the use of kindergarten districts similar to school districts. As far as possible, it must be ensured that the kindergarten is not located on the other side of a toll ring in relation to the home | Childhood department |
| Co-locate chores in everyday life. | Urban and community planning |

*Table 5, measures to get a shorter travel distance to chores in everyday life (work, kindergartens, school, leisure activities.* Source: *(Stavanger City Council, 2018, pp. 8-9).*

In the last proposed actions towards the first focus, presented in table 5, measures aimed at everyday life dynamics are established. In order to make the personal vehicle non-essential, everyday chores must be in reach without the use of a personal vehicle. The Urban and community planning department, together with the childhood department in Stavanger are assigned to facilitate and organize for improvements on this area. Arrangements of locating children in the most sensible kindergarten or school provide a relatively short-term action. But the other two, and especially the first one, constitute long-term measures depended upon infrastructural change.

### 4.4.2 Promoting renewable fuels and technology in the transport sector

The second focus area targeted in the Action plan is to promote renewable fuels and technology in the transport sector (2), where the sub-goal (2.1) is to reduce GHG emissions from light-weight vehicles by 80% within 2030 and by 100% within 2040. In order to achieve the sub-goal (2.1) the municipality will firstly ensure that all new personal cars in Stavanger will be zero-emission vehicles in 2025 in line with the National framework. Secondly, Stavanger municipality´s own carpark must consist of zero-emission vehicles within 2025. Thirdly, there must be facilitated for good accessibility on fossil-free fuel before the demand

occurs. And lastly, it must be considered to introduce environmental zones/emission-free zones (Stavanger City Council, 2018, p. 10).

The measures regarding the second focus area is bundled into table 6. These are actions that targets the facilitation of alternative use of renewable energy as a substitute for fossil-fuelled energy. These actions are characterised by establishment of charging opportunities, both in the urban area, but also in housing estates. Additionally, economic incentives for electric vehicles are present. The Urban and community planning department, together with BMU, Stavanger parking and Bymiljøpakken is responsible for the coordination for these measures. External actors are developers, Lyse, Grønn kontakt, Stavanger Forum, partners in Bymiljøpakken, Rogaland county and the State. As for the potential of these measures, establishment of charging points is somewhat a short-term project, but will require funds. Also, maintaining reasonable toll fees for renewable energy sourced vehicles is also short-term prospects and only require policy makers to engage.

| **Actions** | **Responsibility Stavanger municipality** | **External actors** |
|---|---|---|
| Arrange for sufficient power supply for the establishment of a charging point in addition to the municipal plan´s requirements for new buildings. | Urban and community planning | Developers/builders |
| Facilitate a sufficient number of parking places with charging capacity to be able to cover the need. | Urban and community planning<br>BMU<br>Stavanger parking | |
| Ensure adequate charging options for residents in areas with residential zone parking. | Urban and community planning<br>BMU | |

| | | |
|---|---|---|
| | Stavanger parking | |
| Establish several charging points in parking houses that can be used in the evening/night by residents in the residential zone. | BMU<br>Stavanger parking | |
| Prioritize emission-free cars in the parking policy. The fee shall not exceed 50% of the ordinary rate. | Urban and community planning<br>Stavanger parking | |
| Contribute to the establishment of fillings stations for emission-free vehicles in appropriate locations. | Urban and community planning<br>BMU | Lyse<br>Grønn Kontakt<br>Stavanger Forum |
| Work to establish a support scheme for the establishment of charging infrastructure for housing associations and co-owners. | BMU | |
| Maintain environmental differentiation of toll ring, benefit for emission-free vehicles (maximum half rate). | Urban and community planning<br>Bymiljøpakken | Partners in Bymiljøpakken,<br>The State |
| Maintain environmental differentiation for emission-free vehicles on ferries (maximum half rate). | | Rogaland county<br>The State |
| Consider introducing zero or low emission zones for all transport in central areas. | Urban and community planning | |
| Increase the proportion of reserved spaces for zero-emission cars, and by 2022 have a proportion of reserved spaces that at least corresponds to the proportion of zero-emission cars in Stavanger. | Urban and community planning<br>BMU | |

| | | |
|---|---|---|
| To the greatest extent possible, request/set requirements that all the municipality´s associated companies (KF, IKS, AS) must choose zero-emission cars when procuring company cars. | BMU Purchasing | |

*Table 6, , measures to facilitate for zero-emission light-weight vehicles.* Source: *(Stavanger City Council, 2018, pp. 10-12).*

The actions presented above is the direct measures which the municipality of Stavanger applied in November 2018, and developments in the climate and environmental area will be described in an annual status report, which provides an overall overview based on established indicators for each field (Stavanger City Council, 2018, p. 1).

### 4.4.3 Annual report 2020

According to the annual report, extensive work was carried out in 2020, both internally and externally, with follow-up of the action plan and dissemination of the municipality´s high ambitions in the climate and environmental area (Stavanger Municipality , 2020, p. 168).

According to goals and strategies in the Climate and Environmental plan 2018-2030, one of the main measures for a decreased volume in private transport is to facilitate for shorter-commutes and travel distance. In the annual rapport (2020) it is stated that this matter is highly present in ongoing and future area zoning plans and detailed zoning plan because it would contribute to shorter distances between daily chores. However, the measures will vary upon whether it is an urban or rural area (Stavanger Municipality , 2020, p. 16).

A well-designed public transportation infrastructure is an important contributor to the reduction of private transport and promotion of shorter travel distance. According to a national travel habit survey, there was a growth in the public transport travellers until Mars 2020, until national guidelines restricted people from using public transportation due to risk of infection from Covid-19. However, in September 2020 a cycle path on the stretch from Asser Jåttens road, along E39, to the boarder on Sandnes municipality opened, which is a part of the bicycle road discussed in more detail in the section 5.3.2. Additionally, the work on the bus road from Gausel station to Boganesveien started (Stavanger Municipality , 2020, p. 16),

which is a part of the bus road project in Bymiljøpakken and is further reviewed in section 5.3.1 on this study.

In the report it emerges that there have been measures implemented in relevance to the focus area of changing travel habits and reducing the volume of traffic. For example, in 2020, the first mobility point was established in Hillevåg, which corresponds to actions in table 1, *Measures for increased use of public transport* (Stavanger City Council, 2018, p. 5). The purpose of a mobility point is to gather several mobility functions (city-bikes, electric scooters, bicycle parking, bus stop) in one place. According to the report, the main argument behind a mobility point is to make it easier to choose an alternative to the private car when you have several options gathered in one place (Stavanger Municipality , 2020, p. 168).

Campaigns such as Mobility week was arranged in 2020 between 16 and 22 September whit a variety of activities, including a bicycle workshop, bicycle course, informative course on electrical bicycles and EV panels, an organized hike and more (Stavanger Municipality , 2020, p. 168). This can clearly be seen as a response to actions in table 2, *Measures for increased bicycling* (Stavanger City Council, 2018, p. 5).

Other schemes were also further developed in the municipality, such as HjemJobbHjem, Beintøft and Oslo car-collective dep. Stavanger. HjemJobbHjem is a company agreement where employees get access to buy bus and train ticket, free city bikes and a lot of other motivating offers to choose alternatives to the private car (HjemJobbHjem, 2020). The scheme introduced an electrical-bicycle leasing offer in 2019 and 2020. 900 employees in the municipality's departments took advantage of this offer, which makes up 9% of the employees. Beintøft is another campaign in 2020 designed to promote bicycling towards the youth. In total 3823 pupils divided by 16 schools in Stavanger municipality participated in the competition where the class with the most km travelled on bicycle were awarded (Stavanger Municipality , 2020, p. 169). The Beintøft scheme is a youth targeted walk, cycle or travel by public transport campaign (Miljøagentene, 2021). Oslo car-collective dep. Stavanger is another scheme which has seen growth in the region from 2019 to 2020 with respectively 221 users in 2019 and 398 users in the end of 2020 making an increase by 78% (Stavanger Municipality , 2020, p. 169). The Car-collective is a car-sharing service making it possible for people replace their need for a car with the possibility to share through a range of different

services. The goal is essentially to contribute to a greener city with a better environment through less cars and unnecessary driving (Car collective, 2021).

The potential and growing popularity of car sharing schemes have been widely discussed by scholars in recent years. E.g. Liao, Timmermans and van Wee (2020) inquiry of the potential car sharing mobility of reducing private car ownership and role of system attributes. Their empirical inquiry provided results that displayed 40% of car drives would be willing to replace some of their car trips with car sharing schemes, and further that 20% may forgo a planned purchase or dismiss current car if car sharing became available nearby (Liao, et al., 2020, p. 935). Also, deploying electric vehicles in car sharing schemes is preferred to fossil-fuelled vehicles by some users, but it was not shown any negative impact for other users. However, their study highlighted that a higher intention of trip replacement did not necessarily correspond to a higher intention of reducing car ownership. Furthermore, Liao, et al., (2020, p. 935) argued that change in the system attributes of the vehicle did not have a substantial impact on user intention, which imply that decision to use car sharing options mainly are depended upon other factors.

Moreover, a case study from Miglioe, D´Orso and Caminiti (2020) on the environmental benefits of car sharing in Palermo, Italy emphasise the potential of car sharing schemes to enhance a low-carbon transition of mobility options. With an application of COPERT (user-friendly software tool which can be used for the estimation of road-transport related pollutant emission) in the inquiry on Palermo, results indicated that car sharing could provide benefits in term of a decrease in emission up to 38% CO2 (2020, p. 2128). However, they underline that these numbers are limited compared to the emission from the entire fleet moving in Palermo. Still, Miglioe, et al., (2020, p. 2137) argue that car sharing options plays an important role because it is an alternative option of mobility against private vehicle use, and would stand as complementary to public transport systems. Moreover, they emphasise that policy makers can reinforce this complementary with necessary coordination of car sharing in neighbourhoods and public transportation hubs. Concluding with that car sharing is one of the more important services related to sustainable mobility, and could represent a contributor to engaging problems such as air pollution in modern cities (Miglioe, et al., 2020, p. 2138).

There have also been improvements in the other focus area regarding promoting renewable fuels and technology in the transport sector. The municipality are continuously working to

improve the charging opportunities in the region and in 2020 over 100 communities have gained charging stations which add up to 3800 charging points (Stavanger Municipality , 2020, p. 169).

| | **Share of new electric car sales** | | **Number of electric cars** | |
|---|---|---|---|---|
| **Year** | **2019** | **2020** | **2019** | **2020** |
| **Stavanger** | 55,6% | 60,7% | 9448 | 11 629 |
| **Annual increase** | 5,1% | | 2,9% | |

*Table 7, annual growth from 2019-2020 in electric car sales/share of electric cars in Stavanger.* Source: ***(Stavanger Municipality , 2020, p. 169).***

Table 7 above illustrate a growth in sales of electric cars with the share of electric cars in new car sales has increased from 55,6% in 2019 to 60,7% in 2020. Consequently, increasing the numbers of electrical cars. In 2019 the amount of electrical cars was 9448 and in the end of 2020 the amount was 11 629 of all the registered cars in Stavanger (Stavanger Municipality , 2020, p. 169).

This is also the case for the cars which employees in the municipality and associated companies, where 265 out 552 registered cars are now electric. Making it an increase from 34,8% in 2019 to 48% in 2020 (Stavanger Municipality , 2020, p. 169).

# 5. Findings and analysis

As a direct result of the Paris-Agreement in 2015, Norway promoted the goal of a transition into a low-emission society by 2050. In order to reach the goal, the objective is to reduce GHG by 40% within 2030, and further 80-95% by 2050 (Government of Norway, 2020). That entails reducing the annual emission per capita from the current 10 tons per capita, to 1-2 tons per capita. By implementing the Climate Act in 2017 (Government of Norway, 2020), Norway would ensure a national framework for future environmental policy promoting the transition into a low-emission society (Government of Norway, 2020).

The transport sector in Norway, alone stands for one third of the national emissions where traffic on the road, that consist of private vehicles, public transport and commercial transport of gods, make up 56% of the total GHG emission from the transport sector. In comparison to the total amounts of emission on a national level, the road traffic represent 17% of all emission on a national level, making it the biggest single contributor to GHG after oil- and gas production (Statistics Norway, 2019). From these statistics there is no doubt that the transport sector makes up a vast amount of the total emissions, and therefore making it a clear and obvious target when reaching for the low-emission society goal.

Nevertheless, the transport sector and more specifically the private, public and commercial vehicles, has seen an increasingly technological advancement over the last years. e.g. the development of more precise emission testing programs such as World Harmonized Light-duty Vehicles Test Procedures (WLTP), that measures fuel consumption and CO2 emissions, as well as including driving patterns and other essential factors to provide a more realistic figure on emitted GHG (The Norwegian Public Roads Administration, 2020). However, energy efficiency of fossil-fuelled vehicles, regardless of the amount of emission, will not alone provide the ideal solution to a decarbonised transport sector. This is where an electrification, a zero-growth in personal traffic and an attractive public transport system can provide the opportunity to reduce the direct emission from the transport sector.

In the case of Stavanger Municipality, the need for a decarbonised transport sector is essential in order to meet the national goals of low-emission society by 2050. According to numbers gathered from the Climate and Environmental plan for Stavanger municipality (2018), road traffic alone generated 52% of the GHG emissions in Stavanger in 2016 making the transport

sector a huge priority in future development plans (Stavanger Municipality, 2018, p. 11). The Climate and environment plan 2018-2030 (2018) is a direct response to the National Transport Plan 2018-2029 (2016) which is structured around the objective to construct reasonable infrastructure for public transport, but also take advantage of opportunities offered by available technology, in order to reduce the carbon footprint from the transport sector and promote the goal of zero-growth in personal transport (Stavanger Municipality, 2018, p. 11).

To be able to meet these objectives and reduce road traffic in urban areas, there are several measures being implemented in Stavanger to develop more attractive offers than a fossil-fuel vehicle. The main targets were to initiate a development of the public transport infrastructure, a facilitation of numerous bicycle and walking paths, and promoting electrical cars and other means of electrified transport, e.g. bicycle, scooter (Stavanger City Council, 2018, p. 13).

In order to reach the targets in the Climate and Environmental plan 2018-2030 (2018), a new urban growth agreement was signed to replace the old city agreement plan (2017) between the State , Rogaland County Municipality, Stavanger, Sandnes, Sola and Randaberg in 2018 to secure further partial funding for development of public transport network, bicycle- and walking paths that were labelled Bymiljøpakken (Rogaland County Council, 2019).

## 5.1 Bymiljøpakken (Urban Growth Agreement)

Bymiljøpakken represents a 30 billion NOK bundle of projects which is intended to address the environmental issues related to traffic towards 2033 (Rogaland County Council, 2020). Bymiljøpakken is led by a steering group that has the main responsibility for managing and coordinating Bymiljøpakken. Their work will provide a basis for agreed case submission to decision-making organs, county councils and city, and municipal councils, regarding prioritizing the funds in the Bymiljøpakken. The steering group is led by the Norwegian Public Roads Administration, with the Norwegian Railway Directorate and the State Administrator in Rogaland represented, together with Rogaland County Municipality, Stavanger, Sandnes, Sola and Randaberg municipalities (Bymiljøpakken, 2021).

Bymiljøpakken is essentially a collection of projects which is to be set in place to reduce the current emission from transport through facilitation and development of the travel network in the region. This includes the improvement of bus- and bicycle roads and pedestrian paths in

order to strengthen the public transport network. This includes specifically two big projects, a 50 km long stretch of bus lanes with a price tag of 10,2 billion NOK, and a 13 km long cycle path from Sandnes to Stavanger with an estimated price tag of 1,4 billion NOK. Funded mainly from toll fees, and partly with 11 billion NOK from the State through the National Transport Plan, and remaining 1.5 Billion NOK from VAT refunds from the region (Bymiljøpakken, 2021).

The toll fees are collected from toll rings where you have to pay whenever you drive into a different part of the region. They are strategical placed in the area of highest traffic congestion, but also placed in around centrum areas where people often travel in order to motivate people to choose alternative transport instead of personal vehicles. Figure 2 illustrates where the toll rings are located and which area they cover (Bymiljøpakken, 2021).

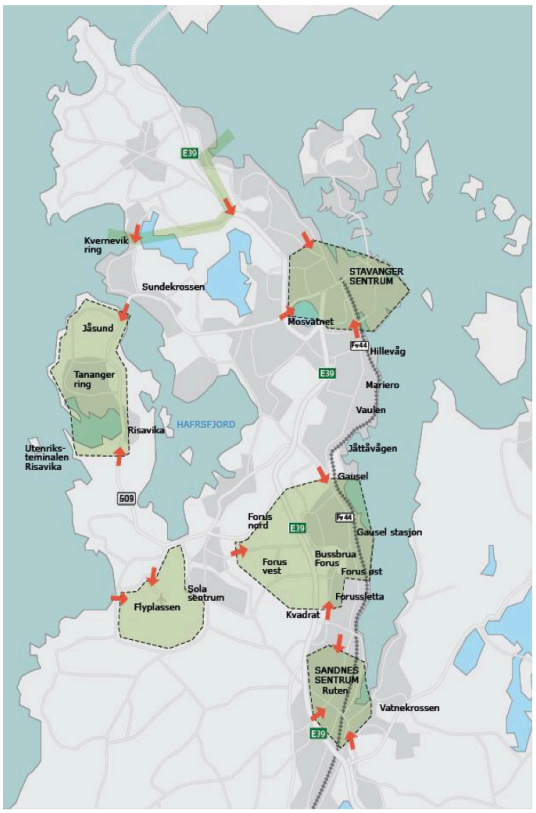


*Figure 2, toll rings at North Jæren.* Source: *(Bymiljøpakken, 2020)*.

As figure 2 illustrates, the tolls rings are located around the centrum of Stavanger making everyone that seeks to get within the area of Stavanger centrum compelled to pay a certain amount of toll fee. However, that only applies to certain means of transport with electrical cars, cyclists, moped and motorcycles are relieved from the fees. The group and fee were originally divided into four sections as table 8 illustrates.

| | Light cars | Heavy cars |
|---|---|---|
| Normal hours | 22 kr | 55 kr |
| Rush hours (7-9 am and 3-5 pm) | 44 kr | 110 kr |
| Normal hours with electronic tag | 17,60 kr | No discount |
| Rush hours with electronic tag | 35,20 kr | No discount |

*Table 8, original toll fees from 2018.* Source: *(Bymiljøpakken, 2020)*

### 5.2.1 The opposition against toll rings

The implementation of toll rate fees 1 October 2018 created a massive uproar from the public on the basis of that it was considered an unfair system. As a result of this, a political independent, collective initiated group were created on social media platforms that went under the slogan of ´Nok er Nok´ (enough is enough) (Vissgren, 2019). As a result of the collective initiate ´Nok er Nok´, and a feeling that their voice was not heard, a political party was formed as a response to the implementation of governmental policies that included more toll stations and higher toll rates in order to fund the reconstruction of the infrastructure in the region (Kalstad, 2018).

The storyline of ´Nok er Nok´ and FNB, and the social impacts from the implementation of Bymiljøpakken, and more precisely the funding of Bymiljøpakken through toll fees has been studied in a Master thesis by Karolina Barbara Shahid (Shahid, 2019). The study is based on qualitative interviews with the key actors, which is the stakeholder within Bymiljøpakken (Rogaland County, Stavanger municipality, Sandnes municipality, Sola municipality, Randaberg municipality, Railroad directive, State Highways Authority and Kolumbus) and Nok er Nok campaign (later FNB political party) (Shahid, 2019, pp. 16-20).

Findings from interviews with the leader of FNB reveal what they oppose and what the they agree with. First off, they agree with most of the projects in Bymiljøpakken, but they don't agree with the bus lane projects, and more specifically, how they are designed. The leader said that *"bus roads is a good idea, but they did not have to make it as big and costly as they have done"* (Shahid, 2019, p. 37). FNB agree with the principal of an attractive and satisfactory public transport system, but what they disagree on is the fact that it is the car users that are supposed to pay the toll fees. The leader argues that *"since a functional public transport system, cycle paths and pedestrians is in everybody's interest, then why should only*

*those who drive a car pay for it"* (Shahid, 2019, p. 37). Additionally, the FNB party acknowledge the need for e decarbonised transport sector, the leader points to bad city planning as a reason for high density of cars and an obstacle for people wanting to use public transport systems. The leader of FNB adds that *"in the region of Stavanger, most of the businesses and offices are located at Forus, but hardly anyone lives there, and all new housing projects are put everywhere else except of where people actually work, and since we have a poor public transport system, everyone chose to use their car"* (Shahid, 2019, p. 38).

The statement of a poor public transport system originates form a national survey conducted by Aftenposten (2015) that explored how the people in five major Norwegian cities, including Stavanger, consider their public transportation offer. In the survey Stavanger was the city who came out with the least satisfied users (Yousefi, 2015).

However, an unfair funding system and an insufficient public transport offer is not the only critics FNB made towards the Bymiljøpakken. They also argued that it was socially unfair and would potentially affect the local population and businesses in a negative way by putting up barriers (in this case toll rings) in places that would suit some, but entangle other. FNB argued that e.g. some parents located in another toll ring would not have the economic resources to travel in and out of the rings in order to complete daily chores and other leisure activities. Also the local businesses would potentially be affected by a decrease in costumers due to location of toll rings (Shahid, 2019, p. 19). The barriers which FNB refers to is demonstrated through an article in Stavanger Aftenblad (Lønning, 2019) where a respondent stated that toll rings reduced life quality, argued by the fact that people have to rethink their if they can travel across the rings due to the high toll fees, hence a decrease in quality of life.

Moreover, one would think that a survey was conducted by the government in order to indicate the publics opinion and concerns regarding Bymiljøpakken. According to a representative from the Norwegian Public Roads Administration in Karolina Shahid´s study (2019), conducting such a survey on a large scale would be difficult because *"it is complicated work to ask people in advance what they want their city to look like in 15-30 years"* and *"I don't know any surveys that was carried out in advance"* (Shahid, 2019, p. 49). Additionally, when questioned about the effect high toll rates could influence for people's economy the representative responded that *"It is difficult for us to have an opinion about this. But of course, we can see that it is demanding for some people paying large amounts of*

*money and many do not have an alternative. The system is not fair; it is not based on how much income you have for example. But this is the way which the government can collect money through toll stations."* (Shahid, 2019, p. 55). The lack of consequence assessments also appears in an article from Stavanger Aftenblad (2018) where the head of secretariat confirmed that there was no consequence assessment either on the effects Bymiljøpakken would have on local business, nor private household finances (Søndeland, 2018).

Consequently, the leader of FNB argue that the implementation of toll rings has contributed positively to the zero-growth target of personal vehicles, but with negative consequences (Shahid, 2019, p. 57). FNB considers the narrative of Bymiljøpakken as socially unfair and a contributor to higher societal differences because of the high toll fees. So, those with a robust economy would not notice it, but the people with less economic opportunities however, are the ones who would have to switch to public transport offers which means less cars on the road, but to an unfair price.

Furthermore, the statement from FNB about the implementation of toll rings has decreased the amount of private vehicles was confirmed by a survey conducted by Stavanger Aftenblad in 2018 (2018). The survey was conducted with 2629 informants over the age of 18 in a period from May to June 2018. Results from the survey showed that 56% continued to use their personal car to work regardless of toll stations fees, while 22% cycled or walked. 12% stated they got to work by bus or train, and 6% drove electric cars and 4% mopeds. This constituted a decrease of 10% in personal vehicles on the road in the time period (Bayer, Leknes, & Muller-Eie, 2018).

As a result of the resistance Bymiljøpakken received, especially with the method of funding through toll fees, the urban growth agreement was renegotiated with an additional governmental grants of 1,7 billion NOK to fund the projects in Bymiljøpakken in late November 2019. Additionally, a proportion of the additional grants was earmarked for cut in toll fees and the construction of a public transport offer (Fosse, 2019). On January the 9th 2020, Stavanger Aftenblad (2020) confirmed, with clarification from the regional toll company Ferde, that the first day without rush hour fee would be 10 February 2020 (Fosse, 2020). Underneath the updated prices in comparison with the original fees is shown in table 9.

| **Type vehicle** | **Light cars** | | **Heavy cars** | | **Electric cars** | |
|---|---|---|---|---|---|---|
| **Year** | *2018* | *2020* | *2018* | *2020* | *2018* | *2020* |
| Normal hours | 22 kr | 23 kr | 55 kr | 58 kr | NA | 11,50 kr |
| Rush hours | 44 kr | NA | 110 kr | NA | NA | NA |
| Normal hours with tag | 17,60 kr | 18,40 kr | No discount | NA | NA | 9,20 kr |
| Rush hour with tag | 35,20 kr | NA | No discount | NA | NA | NA |

*Table 9, comparison between 2018 and 2020 toll fees.* Source: *(Fosse, 2020).*

## 5.3 The progress of big projects

Every year, Bymiljøpakken publishes a status report in which the progress of the projects is presented. However, a report for 2021 has not yet been published, so the 2020 report is used to present the ongoing development of the two biggest projects (bus road and cycle path) which aims to develop an alternative transport network in order to reduce the amount of personal vehicles and facilitate for a zero-growth target in the region of Stavanger municipality.

### 5.3.1 The bus road

The bus lanes are a coherent high-quality bus system that is being constructed on North Jæren (which includes Stavanger municipality). The project consists of a total of 22 sections and is divided into four corridors (Bymiljøpakken, 2020, p. 5). See figure 3 below for e detailed graphic of the project.

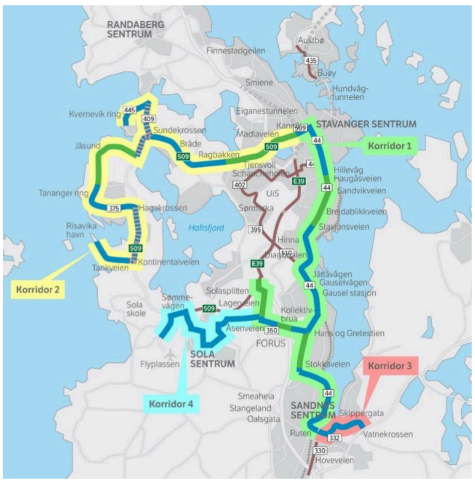


*Figure 3, map of the bus road project in Bymiljøpakken.* Source: *(Bymiljøpakken, 2020, p. 5)*

The project is presented as a high-quality public transport network with a coherent public transport road that ensures punctuality, high capacity and facilitates the desired urban development. The bus lanes are mainly planned with two-sided solutions for pedestrians and cyclists. In sum, this provides a predictable public transport, walking and cycling offer for road users on North Jæren (Bymiljøpakken, 2020, p. 5).

The status of the projects in 2020 is that the bus route in corridor 1 (see figure 3) is scheduled to be completed in 2023. Corridor 1 is prioritized as the most important part of the project because it ensures a high-quality public transport service between Stavanger, Forus and Sandnes. This corridor is prioritised due to the fact that 60% of the public transport systems users lives and works along this stretch which accommodates the first action outlined in the Action Plan (2018) under; *Measures to get a shorter travel distance to chores in everyday life (work, kindergartens, school, leisure activities* (Stavanger City Council, 2018, pp. 8-9). Additionally, the establishment of this corridor will ensure a connection to the hospital at Ullandhaug. The development of corridor 2-4 continuous and is being built continuously (Bymiljøpakken, 2021, p. 5).

However, the specific project of bus roads, like Bymiljøpakken, received quite a bit media coverage. In Dagbladet (2019), the leader of FNB defined the project as scandal. He argues that the bus roads only will cause more traffic jam and longer travels times. In addition, he argues that it is actually putting pedestrians at risk because they have to cross the roads in order to arrive at the bus stops, which are located in between the two car lanes on each side, and the bus road lanes in the middle (Gilbrant & Bones, 2019). The traffic related discussion is not the only thematic which has been given attention in media, e.g. in Stavanger Aftenblad (2020), they reported that approx. 120 properties would be affected by the development of a bus road, and that the 67 million NOK was paid in land compensation from the state to affected residents (Frøyland, 2020).

### 5.3.2 The bicycle road

The bicycle road is a planned coherent high-standard cycle path along the road E39 from Stavanger to Sandnes, via Forus/Lura. The cycle path is reserved for cyclists and will provide

a safe, secure and fast transport with as short and direct routes as possible (Bymiljøpakken, 2020, p. 3). Figure 4 underneath illustrates how this is planned.

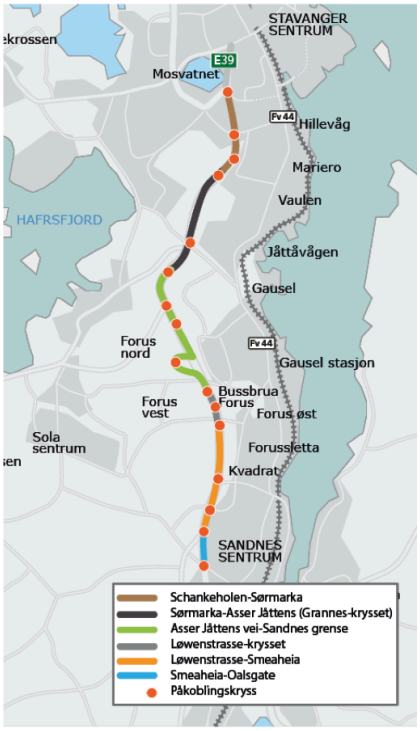


*Figure 4, map of the planned bike path.* Source: *(Bymiljøpakken, 2020, p. 2).*

The main purpose of the cycle path is to facilitate the transfer of work trips on North Jæren from passenger cars to bicycles, especially to the workplaces in Forus/Lura area. It will also function as an efficient cycle path from the districts to the city centrum of Stavanger and Sandnes (Bymiljøpakken, 2020, p. 2).

As discussed in 5.3.1, the bus roads received a lot of media coverage. Likewise, the bicycle road also did. 27 August, 2020, journalists from NRK (2020) reported that the bicycle road with the cost 100 000 NOK per meter would open. When the project leader in The National Public Road was asked if the project is worth it, the response was that the it was a prioritized and decided, but others would have to answer whether it was worth it. NRK then interviewed some passing roads users at Forus. The response they received was characterised by mixed feelings, with some questioned the price tag and whether it was justified by an increase of users. However, one person argued that it was a waste of money and that the bicycle users already have established bicycle paths. Moreover, one informant argued that the road was fantastic and that it would increase the share of biking in Stavanger. This statement was also

supported by Ray Pritchard, a scientist from Norce (Norwegian Research Centre). He also argued that the implementation of the bicycle road would cause more cyclists and more cycling (Ellingsen, Akhtar, & Stokka, 2020)

## 5.4 Smaller projects in Stavanger municipality

Also, in addition to the bigger projects in Bymiljøpakken, there is also a numerous smaller projects to enhance the public transport, pedestrian and cycle offer in the area of Stavanger municipality. E.g. Ryfylkegata in eastern Stavanger centrum are being rebuild for the development of a road without cars, but with a bike path on the side and bus road in the middle. The project was intended to be finalized in mid-May 2021, but was delayed caused by unpredictable layers of rock that had to be removed (Stavanger Municipality, 2021).

Another project in Stavanger municipality, but outside the centrum area is the construction of a bicycle lanes in Hjalmar Johansens street. The purpose is to facilitate for soft road users, both pedestrians and biking. By reducing the width of the car lanes there will be space to add new broader sidewalk and a bike lane. The work is indented to start in the spring 2021 (Stavanger Municipality, 2021). There is also projected a reopening of a 60 m long pedestrian passage between Muségata and Vålandsbakken in March 2021 that would enable a significant shortcut for walking activities in the centrum of Stavanger (Stavanger Kommune, 2021).

## 5.5 Rv. 13 Ryfast – tunnel road connection

Ryfast is a 14,4 km long underground and underwater tunnels connection consisting of Ryfylketunnel, Eiganestunnel and Hundvågstunnel. The project is independent from Bymiljøpakken, but was a project approved by the Government 12 June, 2012 and started in November 2013. Although some aspects of urban transport are steered by the municipality, the Norwegian Public Roads Administration at national level also has high influence on the actual development of traffic in Stavanger by building expensive projects that increase road capacity and incentivise car use. E.g. for instance in the case of this tunnel-project, users could use it toll free until 1. February 2021.

The first part of the project was finalised December 30, 2020 when Ryfylketunnel was opened, with Hundvågtunnel and Eiganestunnel being finalised and opened in mid-April 2021. The reason for bringing this project forward in this study is due to the fact that it would

contribute to a relief of traffic in centrum areas of Stavanger. Forecasts presented in Stavanger Aftenbladet (2020) indicated that the traffic picture in Stavanger would change forever with urban area roads being cleared for much of the cars travelling through Stavanger centrum (Jøssang, 2020). Figure 5 underneath illustrates how traffic are guided underground in tunnels instead of going through the centrum of Stavanger.

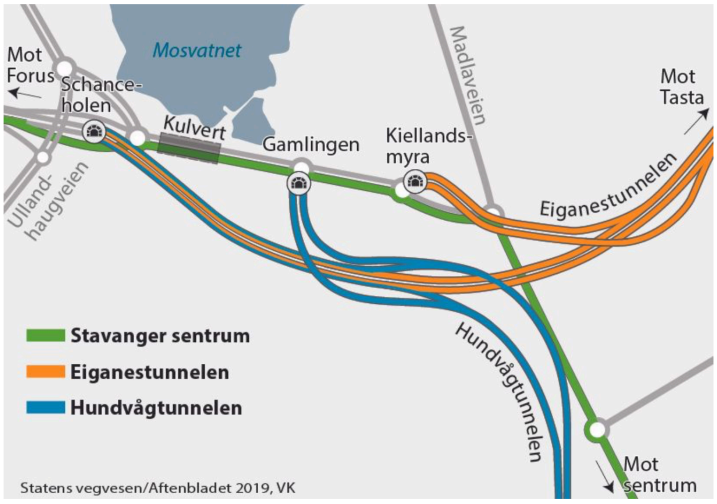


*Figure 5, map of the location of Eiganestunnel and Hundvågstunnel. Source: (Jøssang, 2020).*

## 5.6 Key number and statistics

As presented in previous parts of this study, Stavanger has implemented and initiated a number of measures to reduce GHG emissions from the transport sector in accordance with national climate goals and the zero-growth goal in the region. In this section, some key numbers will be presented on how the development has affected the targeted focus areas. This includes the use of public transportation network, bicycling, rates on registered new cars, change in travel habits and the overall numbers of the GHG emission from the transport sector before and after the implementation. Additionally, some years will vary based on available data.

### 5.6.1 Public transport

According to numbers from Statistics Norway (SSB), there was registered more than 718 million travels with public transport in Norway in 2019, which is an increase by 5,3% from 2018. The city with the highest growth in percentage was Stavanger with 18,5% increase (Statistics Norway, 2020). However, in 2020 the number of travels with public transportation, nationwide, was down to 450 million, which is a decrease by 37% from 2019. The decline is

mainly due to the various national and local measures that have been introduced to deal with the Covid-19 pandemic situation since mid-March 2020 (Statistics Norway, 2021).

| | 2017 | 2018 | 2019 | 2020 |
|---|---|---|---|---|
| Travels per citizen (boarding) | 72 | 74 | 87 | 61 |
| Passenger km per citizen (km) | 436 | 448 | 482 | 352 |
| Travel length (km) | 6 | 6 | 6 | 6 |

*Table 10, public transport taken by bus in Stavanger from 2017-2020. Source: (Statistics Norway, 2021).*

Table 10 presents numbers collected from SSB (2021) and illustrate how there was a slight improvement from 2017-2019 on both travels per citizen and the passenger km travelled. However, 2020 is highly affected by the national restrictions due to Covid-19.

### 5.6.2 Bicycle use

In Stavanger municipality there is 9 bicycle counting points spread around the city in order to monitor the bike traffic. In the most recent report from Bymiljøpakken (2019) there has been presented numbers from 2018 on the amounts of daily passages. In the report an increase of 56% in bicycle passes from 2017 to 2018 is presented in table 11 (Bymiljøpakken, 2019).

| Location | 2017 | 2018 | Change |
|---|---|---|---|
| Brevig | 12 | 16 | 27% |
| Forus West | 301 | 661 | 120% |
| Hillevåg | 282 | 486 | 72% |
| Mosvannet | 33 | 104 | 215% |
| Møllebukta | 497 | 789 | 59% |
| Sandal | 146 | 220 | 50% |
| Stokkavannet | 77 | 107 | 39% |
| Sørmarka | 513 | 856 | 67% |
| Tjensvollkrysset | 571 | 870 | 27% |
| **Total** | 2433 | 4108 | 56% |

*Table 11, number of total passages per day at different passing points, Stavanger. Source: (Bymiljøpakken, 2019).*

The significant growth in bike use may explained by at least one factor, electrical bicycles. In 2015 a city bike scheme was introduced in Stavanger when a total of 167 electrical city bikes were placed around in the municipality. The electrical bike was equipped with a speed limit of 20 km/h to the price of 30 NOK per hour (Håland, 2015).

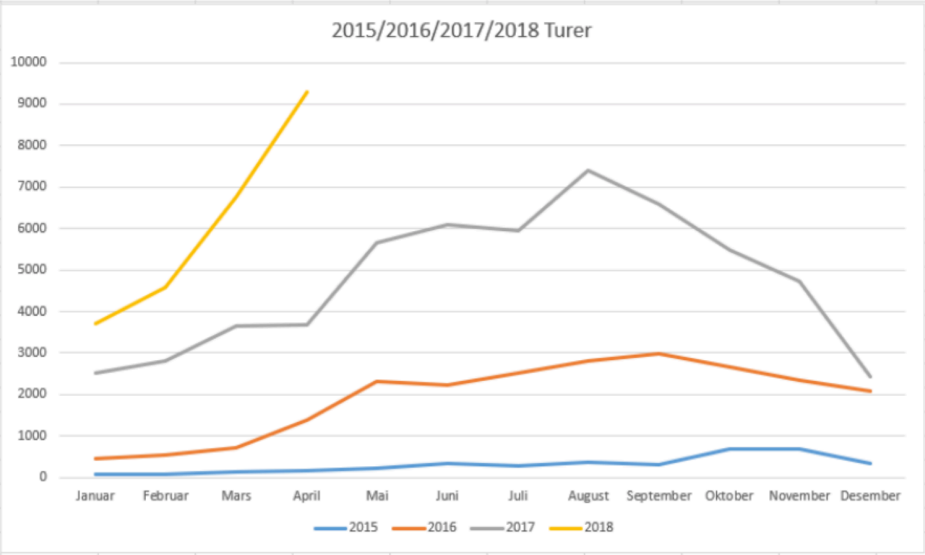


*Figure 6, growth in trips taken by city bikes from 2015-2018. Source: (Iversen, 2018).*

Figure 6 above illustrates the major growth of city bikes trips with a major leap in May 2018. In 2019 additional 500 new bikes were scheduled to be placed out in the region and also 100 new charging stations (Iversen, 2018). In 2020 Stavanger Aftenblad recounted that there in total is 750 city bikes in the region and that there in total have been made close to 100.000 trips with a collected km of 420.000 km travelled with the electrical city bikes at North-Jæren (Bjørheim, 2020) Moreover, in 2018 sales figures for bicycle shops in the region reported a noteworthy growth in sales of private electrical bikes from the sales in 2017 (Fintland, 2018).

### 5.6.3 Car use

As mentioned previous, the Covid-19 pandemic has overall changed the need for mobility and this has also influenced the most recent data on daily car use. According to the annual report from Kolumbus (2021), presented in table 12, data collected from 3 measuring points by central roads in Stavanger, indicate there has overall been a decrease from 2018 to 2020, but with the 2020 numbers being affected by the Covid-19 pandemic.

| Measuring point | 2018 | 2019 | 2020 | %19-20 |
|---|---|---|---|---|
| E39 Auglend | 61 681 | 60 147 | 58 015 | -3,5% |
| Fv427 Storhaugstunnel | 11 987 | 11 547 | 10 860 | -5,9% |
| Fv44 Hillevågstunnel | 13 856 | 13 2020 | 12 185 | -7,7% |

*Table 12, numbers of daily passing cars, Stavanger. Source: (Kolumbus, 2021, p. 11).*

Moreover, with the goal of reaching a zero-growth in personal transport the data on new registered cars indicates whether it is progressing towards a reduction or increase. From SSB (2021) numbers on annual registered cars by fuel indicates a decrease in cars with gasoline and diesel, but an increase in electrical cars. From 2018 to 2020 the total decrease in gasoline and diesel fuelled cars was 5660 and the total amount of electrical cars increased with 4218 in the same period making it a decrease of 1442 cars in total in this time period as table 13 illustrate (Statistics Norway, 2021).

| Fuel type | 2018 | 2019 | 2020 |
|---|---|---|---|
| Gasoline | 26 805 | 25 373 | 23 205 |
| Diesel | 24 985 | 23 768 | 22 925 |
| Electric | 6 343 | 8 636 | 10 561 |

*Table 13, total amount of new registered cars in Stavanger from 2018-2020. Source: (Statistics Norway, 2021).*

Additionally, car sharing schemes provides another way to reduce numbers of cars without ending car dependence in full. Numbers from 2019 (Nenseth & Julsrud, 2019) showed that approx. 5% of those with license in Norway have registered onto car schemes sites. In the capital of Norway, Oslo Bilkollektivet (car-collective) increased by 45% from 2020-2021 with over 12 000 members. In Bergen, Bildeleringen has experienced a growth of 10-15% over the last couple of years (Dyregrov, 2021). In Stavanger car-sharing schemes such as Bilkollektivet (Car collective, 2021) experienced a significant growth in 2020 with an increase of 78% in memberships (Stavanger Municipality , 2020, p. 169).

### 5.6.4 Emission from transport

In 2016 road traffic in Stavanger accounted for 53% of the total GHG emissions in the region (Stavanger Municipality, 2018, p. 11). According to numbers from Miljødirektoratet (Norwegian Environment Agency, 2021) presented in table 14 underneath the total amounts

of emission from road traffic has decreased in the time period from 2016-2019. This is approximately a 16,1% cut in the total emissions from road traffic from 2016 to 2019. Noticeable, it is personal vehicles who have seen the biggest reduction in total emissions with a cut of 20 865,3 CO2 equivalents, but this is probably partly due to the increase of electrical cars in the region.

| **Emission source** | **2016** | **2017** | **2018** | **2019** |
|---|---|---|---|---|
| Bus | 11 754,5 | 10 814,4 | 10 606,7 | 9 529,7 |
| Personal vehicle | 115 688 | 107 881,8 | 105 641,7 | 94 822,7 |
| Heavy vehicle | 23 348,9 | 21 323 | 22 849,7 | 21 917,3 |
| Van | 20 912,5 | 18 490,3 | 18 900,5 | 17 792 |
| Total | 171 703,9 | 158 509,5 | 157 998,6 | 144 061,7 |

*Table 14, the emissions have unit CO2 equivalents, which means that the emissions for each gas are weighted according to the gas´s global warming potential (GWP). Source: (Norwegian Environment Agency, 2021).*

# 6. Discussion

Throughout this study governmental literature has been reviewed with actions and measures implemented by the municipality of Stavanger in order to reduce their emissions from the transport sector, and more specifically to achieve a target of getting 70% of private transport taken by environmental friendly sources of transport by 2030. Furthermore, relevant theoretical frameworks such as the Multi-Level perspective (MLP) (Geels, 2011), the decarbonisation of transport (Fridstrøm, et al., 2018; Banister, 2008) and a critical energy justice perspective (Sovacool, et al., 2019; McCauley, et al., 2019; Jenkins, et al., 2016) has been presented in order to discuss findings, dilemmas and reasons for the selected case in this study.

The initiative to target the mobility aspect in the Norwegian society is due to the fact that the transport sector in Norway constitute one third of all GHG emissions (Ministry of Transport, 2016). Additionally, in Stavanger, road traffic accounted for 52% of the total GHG emission in 2016 (Stavanger Municipality, 2018, p. 11) making it a clear and obvious target for a socio-technological transition. According to Geels (2011), socio-technological transitions are complex and involve long-term process compromising multiple actors. Hence a Multi-Level Perspective enables identification of key elements such as; Niches, that represents technological solutions with opportunity to become a part of the next key element, which is socio-technological regimes. In this case, socio-technological regimes represent the established fossil fuelled depended paradigm and the niche is represented as electrification and decarbonisation of the transport sector. However, for the niches to become a part of the excising socio-technological regime, there has to be a pressure on the technical landscape. In this case, the pressure is represented by the Paris Agreement and Norway´s initiative to reduce GHG emissions. When a pressure on the technical landscape appears, a ´window of opportunity´ will emerge and a niche can manifest and lead to changes in the existing socio-technical regime where it affects the technical landscape (Geels, 2011, pp. 26-28).

In relation to this study, one could conclude that there is a ‘window of opportunity’ present at the moment. With all the attention and focus climate change and GHG emissions are receiving, which pressures the existing fossil fuelled paradigm, it could result in alteration to the technical landscape. There is a lot of incentives from national level down to local level that have been presented in this study, and there has been identified three distinct areas of

focus: Improvement and facilitation of public transportation, bicycle and pedestrian infrastructure; promoting environmental friendly mobility; utilization and facilitation of innovative technology. Conversely, this study has also identified two distinct barriers which must be addressed: How to decarbonise; How to make the transition equitable. Throughout this discussion, the identified focus areas will be addressed at first, then the identified barriers will be discussed afterwards.

## 6.1 Improvement and facilitation of public transportation, bicycle and pedestrian infrastructure

The very roots of the effort to enhance the public transportation, bicycle and pedestrian infrastructure stems from the national objective stated in the National transport plan 2018-2029, government White Paper Meld.St.33 (2016). The basis of the plan is that mobility infrastructure should be built, maintained and organized better, with a commitment to facilitate for soft road users, but also to benefit the climate footprint in a positive way. With this objective, it is imperative that the infrastructure in urban areas stands in accordance with the development in order to Norway as a whole to work towards a facilitation for the use of public transportation (Ministry of Transport, 2016, pp. 11-13). In order to organizes for this objective, an urban growth agreement was put in place between North Jæren, Rogaland county municipality and the Ministry of Transport and Communications. The purpose of the urban growth agreement was to operate as a tool to help achieve the goal of making the growth of needed mobility to be taken by public transportation, bicycle, walking or other environmental friendly mobility sources (Rogaland County Council, 2019, pp. 1-2). The agreement was to be managed through Bymiljøpakken (2020) which was based on the framework presented in the National Transport plan (2016) and would provide partial funding from the state. In addition, a comprehensive Environmental and Climate plan (2018) was adopted by Stavanger City Council that outlines projects and goals. The Environmental and Climate plan (2018) was accompanied by an Action plan (2018) with a period span from 2018-2022, and this is where the direct actions and measures for Stavanger was presented.

Throughout this study, there has been presented numerous actions and measures targeting the mobility infrastructure in Stavanger, both from the Action Plan (2018), and projects initiated from Bymiljøpakken (2020). These actions and measures includes bigger projects such as the 50 km long stretch of bus roads and 13 km long bicycle road Sandnes to Stavanger, both with

the intended function to promote and facilitate the use of alternative mobility sources. Also, the bus roads are structured with two-sided solutions for pedestrians and cyclist making it beneficial for soft road users as well. Additionally, the now finished project of 14,4 km long underground- and water tunnel systems, Ryfast (2020), which was independent from either Bymiljøpakken and the local government, would also benefit and relief centrum of Stavanger for thru traffic in the coming years according to forecasts (Jøssang, 2020). Furthermore, some smaller projects which intends to promote public transportation and environmental friendly mobility users have also been presented such as Ryfylkegata (2021), Hjalmar Johansens street (2021) and Muségata-Vålandsbakken (2021). This is projects corresponds with actions under *measures for car-free areas, carpooling/car sharing, mobility impact* (Stavanger City Council, 2018, pp. 7-8) and *measures for increased walking* (Stavanger City Council, 2018, p. 7) introduced in the Action Plan (2018).

Numbers collected from SSB (2020), presented in table 10, indicates an annual increase from 2017-2019 of travels and passengers using public transportation (bus), but a decrease from 2019-2020. As mentioned in this study, this is due to the national and local infection control measures during the Covid-19 pandemic. With regard to bike use in the region, Bymiljøpakken (2019) newest available numbers presented in table 11 indicated a significant increase of passages from 2017-2018 at the counting points. Additionally, numbers presented in figure 6, show that city-bikes has travelled 420.000 km on North-Jæren from it first was implemented in 2015, and to 2018.

It might not be a directly connection between the increase in environmental friendly mobility methods, and numbers from three counting points in Stavanger, presented by Kolumbus (2021) in table 12, that indicate an annual decrease in car passages from 2018-2020. However, despite the annual numbers which have been presented does show positive results, there might be other contributing factors that could change this narrative.

## 6.2 Promoting environmental friendly mobility through schemes

For all the measures and actions to yield any results, they have to be promoted and elucidated to the public. This is why another identified area of focus within Stavanger´s transition is to promote environmental friendly mobility.

In the literature review of the annual report (2020) from Stavanger municipality, it was discovered that a multitude of environmental friendly mobility solution schemes has been implemented in the region. E.g. in 2020 the first mobility point was established at Hillevåg which would according to the report make it easier to choose alternative mobility methods if they were centralised at one place (Stavanger Municipality , 2020, p. 168). Additionally, in September 2020, a Mobility week was arranged that included a variety of activities such as bicycle workshops, bicycle courses and more (Stavanger Municipality , 2020, p. 168). Also, car-sharing schemes such as Bilkollektivet (Car collective, 2021) experienced a significant growth in Stavanger with an increase of 78% in memberships (Stavanger Municipality , 2020, p. 169). Which is also the case in Oslo and Bergen where car sharing schemes has experienced a growth in memberships (Dyregrov, 2021). All of which matches the measures and actions presented in the Action Plan (2018) under *measures for car-free areas, carpooling/car sharing, mobility impact* (Stavanger City Council, 2018, pp. 7-8) and *measures for increased use of public transport* (Stavanger City Council, 2018, p. 5).

As proposed by Miglioe, et al., (2020), car sharing schemes can represent one of the most important services related to sustainable mobility, and could be a contributor to engaging problems such as air pollution in modern cities. Yet, the increase of car sharing schemes is highly depended upon facilitation and policy incentives. Additionally, empirical inquiry from Liao, et al., (2020) present that there in fact is a growing willingness towards car sharing schemes, and also a slight will to replace private vehicles if such schemes are established nearby. Which relates to actions presented in *table 4, measures for car-free areas, carpooling/car sharing, mobility impact* (Stavanger City Council, 2018, pp. 7-8).

Furthermore, walking and biking schemes such as HjemJobbHjem (HjemJobbHjem, 2020) and Beintøft (Miljøagentene, 2021) also made a presence for alternative methods of environmental friendly mobility, which relates to actions under *measures for increased walking* (Stavanger City Council, 2018, p. 7) and *measures for increased bicycling* (Stavanger City Council, 2018, p. 6) in the Action Plan (2018).

## 6.3 Utilization and facilitation of innovative technology

The National transport plan 2018-2029 which represents the national framework for the future development of the transport sector states that one must ´take advantage of the opportunities

offered by new technology´ (Ministry of Transport, 2016, p. 9). This is reflected in both Norway's general incentives to electrical vehicles presented in the introduction, and the Action Plan (2018) under the *measures to facilitate for zero-emission light-weight vehicles* (Stavanger City Council, 2018, pp. 10-12).

As discussed earlier in this chapter, the electrification of mobility sources represents a niche in the MLP model (2011), and it is clearly evident that the niche has challenged the existing fossil fuel paradigm in order to reshape the technical landscape. The facilitation, use and sales of electrical cars and bicycles have, as presented in the ´findings and analysis´ and ´litterateur review ´chapter, increased by significant numbers over the last years. Moreover, in the annual report (2020) from Stavanger municipality, an growth in new-car sales of electrical cars were presented with an increase from 55,6% in 2019 to 60,7% in 2020. Creating a growth in the total amount of electrical cars to increase from 9448 in 2019 to 11,629 in 2020, which in percentage of total cars in the region adds up to 14,1% in 2019 against 17% in 2020 (Stavanger Municipality , 2020, p. 169). Statistics gathered from SSB (2021), presented in the ´findings and analysis´ chapter also indicates a decrease in total amounts of new-registered fossil fuelled vehicles (gasoline, diesel) and an increase in electrical vehicles (Statistics Norway, 2021).

However, in order to sustain the growth there is some distinct factors which consumers are influenced by. Studies from Fridstrøm, et al., (2018), Bjerken et al., (2016) and Sierzchula et al., (2014) has recognise that economic incentives, technological practicality and external factors are crucial in the decision-making process to whether a consumer would acquire an electrical vehicle. Though, Stavanger municipality is not in the position to improve some technological attributes (e.g. battery size and mile coverage), incentives and actions, in accordance with national guidelines, can facilitate for some technological features (e.g. purchase fee). Likewise, Norwegian policy regarding economic incentives for electrical vehicles is also highly present, which this study has presented from both national and local frameworks.

Also, one action under *measures to facilitate for zero-emission light-weight vehicles* (Stavanger City Council, 2018, pp. 10-12) in the Action plan (2018) states that; *´To the greatest extent possible, request/set requirements that all the municipality´s associated companies (KF, IKS, AS) must choose zero-emission cars when procuring company cars´.* In

relation to this action, the annual report (2020) reported a growth in share of electrical vehicles in their own car fleet, with an increase from 34,8% in 2019 to 48% in 2020 (Stavanger Municipality , 2020, p. 169).

Moreover, as a result of several actions under *Measures to facilitate for zero-emission light-weight vehicles* (Stavanger City Council, 2018, pp. 10-12) in the Action Plan (2018), which targets the improvement off charging opportunities in the region, numbers from the Annual report (Stavanger Municipality , 2020, p. 169) showed that in 2020 over 100 local communities and housing estates had charging points established. Which adds up to approximately 3800 charging stations. Studies by Ryghaug and Toftaker (2016), Bjerken, Nørbech and Nordtømme (2016) and Sierzchula et al., (2014) argued that external factors such as the availability of charging stations would be crucial in influencing future users of electrical vehicles.

## 6.4 Decarbonisation of transport

One of the barriers which this study has identified in the case of Stavanger is how to decarbonise transport. In order to be able to understand the logic behind the measures and the objectives that have been presented in both the literature review and the findings, a theoretical framework for decarbonisation of transport has been presented in the thesis.

Several measures that the municipality of Stavanger has implemented have been presented and discussed. The theoretical justification behind it, however, has not been discussed. According to Fridstrøm et al., (2018) and Banister (2008) there is five general ways to cut the GHG emissions in the transport sector. Although some of them more radical than the others. E.g. the first one that implies a reduction in economic actives (GDP) and standard of living will reduce the transport demand, and the second being a reduction in the mobility and goods at all income levels (Fridstrøm, et al., 2018, p. 6). Even though these two strategies might be the most effective in a short-term perspective, it essentially goes against political, societal and economical values our society is built upon. Evidently making them a ´last resort´ type of strategy. However, the next three strategies presented offers a more realistic type of strategies to decarbonise and cut GHG emission, which also corresponds with a similar theoretical view presented by Banister (2008) which, as presented in the theory chapter, share similarities with the typology of a *avoid-shift-improve* triplet (Fridstrøm, et al., 2018, p. 9).

In relation to the case of Stavanger, this study has recognised some clear patterns that resembles the proposed strategies and the *avoid-shift-improve* triplet. However, a multitude of the actions and measures are either long-term with potential high reduction, or short-term with relatively low effect on GHG emission. The most eminent actions and measures in Stavanger is the development of environmental friendly infrastructure such as the high-quality bus- and bike lanes (Bymiljøpakken, 2020, p. 5) which relates to the *avoid* strategy. Fridstrøm et al., (2018, p. 9) argue that by facilitating for shorter commutes with private cars through improved urban planning and densification, one could make other means of mobility sources more attractive and therefore reduce the amounts of private mobility by car, thus reducing the GHG emissions. However, as Fridstrøm et al., (2018) highlight, this approach may only yield results in the long-term due to the fact that reshaping urban areas demand a great deal of time. An argument that proves valid as the development of the bus road in Bymiljøpakken have a time perspective that extends from 2018-2033, and only 1 of 4 planned corridors being partly done (Bymiljøpakken, 2021, p. 5). Furthermore, Fridstrøm et al., (2018) argue that car-sharing schemes, such as Bilkollektivet (Car collective, 2021), may be short-term option to avoidance of GHG emissions, but providing insufficient amounts of reduction. The prospect of car-sharing schemes is also analysed and presented as an possible compulsory feature by Miglioe, et al., (2020) and Liao, et al., (2020).

Due to avoidance being either radical, long-term or insufficient, and a *shift* in travel and freight from high intensive fossil fuelled transport to less-carbon intensive methods relating to heavy-weight, long distance commercial transport, which this study does not explore, an *improvement* of energy efficiency relates in a stronger degree to this study. However, according to Fridstrøm et al., (2018, p. 10) the concept of improved energy efficiency in existing vehicles proves to be challenging due to difficulties to change combustion engines to electrical motors.

However, the fifth proposed strategy by Fridstrøm et al., (2018, p. 6), which is a transition to less carbon intensive energy carries could provide a shorter-term perspective then reshaping urban areas and developing supportive infrastructure, and by shorter-term perspective referring to the change from fossil fuelled vehicles to electrical vehicles. According to Fridstrøm et al., (2018, p. 39), this strategy requires both a technological transition, but also incentives from policy makers as drivers in the sense that they must support the technological

innovations and niches. This study has shown that there is at least not a lack of support and incentives for technological innovations in Norway. With the national transport framework putting them in a unique position when it comes to promoting and supporting electrified mobility sources (Government of Norway, 2020).

In addition, Ryghaug and Toftaker (2016) study on user form of governance and mobility practices in Norway, in relation to the use of electrical vehicles, they recognized another important element in a technical transition to electrified means of mobility. What they discovered was that early users of electrical cars were looked upon as motivated by both the environmental and economic aspect of it, but also driven by the curiosity of new technology. Yet, what the study noticed was that future users would not necessary be motivated by the environmental and innovative aspect of it, but rather driven by economical gain (tax-reduction etc.), and also the practicality of products, such as mile coverage and ease of use. In relation to the case of Stavanger, this would probably explain why both electrical vehicles have experienced an increase of numbers due to at least economical motivations. Also, actions, measures and incentives presented in the Action Plan (2018) under *measures to facilitate for zero-emission light-weight vehicles* (Stavanger City Council, 2018, pp. 10-12) and in the chapter of Norway´s initiative proves that presence of financial gain is evident.

## 6.5 How to make the transition equitable

The narrative of the ongoing climate debate and how to address the environmental challenges does have a tendency to neglect other societal challenges which could arise from low-carbon transitions. Sovacool et al., (2019, p. 581) argue that the concept of low-carbon transition usually is associated with something positive because it entails a move away from fossil fuelled resources, and applies renewable energy sources that promotes generational responsibility for our planet. However, according to Sovacool et al., (2019), McCauley, et al., (2019) and Jenkins, et al., (2016) low-carbon transitions may lead to injustices and vulnerabilities, or even worsen pre-existing inequalities, as Newell and Mulvaney (2013) argue. Therefore, with a critical energy justice perspective, this study has identified some significant injustice related to low-carbon transitions, which Stavanger had to address in order to continue with the ongoing mobility decarbonisation.

In order to reach the targets in the Climate and Environmental plan 2018-2030 (2018), a urban growth agreement between the State , Rogaland County Municipality, Stavanger, Sandnes, Sola and Randaberg (North-Jæren) was introduced in 2018. The agreement was to secure further partial state funding for development of public transport network, bicycle- and walking paths projects that were labelled Bymiljøpakken (Rogaland County Council, 2019). The price tag of the projects was estimated to 30 billion NOK with 11 billion coming from State funds and the remaining through toll fees.

The toll fees would be collected through toll stations placed around the urban areas on North-Jæren, including Stavanger (see figure 3). Which in turn would make citizens obligated to pay a fee when crossing into new areas. When the toll stations originally were implemented, the toll fees came with an extra ´rush hour´ fee (see table 8). In relation to the presented energy justice perspective, one could argue that the toll rings constitute a distributive injustice, and Sovacool et al. (2019, p. 582) reasoned that situations like this could cultivate friction and resentment in societies through exclusion and inequality. According to McCauley et al., (2019), Sovacool et al., (2019) and Jenkins, et al., (2016) distributive justice is temporal issues with allocating social goods and ills throughout society. Through this branch of justice (distributive), one must first identify the goods and ills, in this case, the ills are represented by toll rings. Secondly, one must identify the entities between who and what they get, which in this case is identified, Bymiljøpakken and the public as entities, where Bymiljøpakken gets funded, and the public road users must pay for it. Thirdly, one must identify the fairest and reasonable method of distribution. A statement from a representative of the FNB party, collected from Shahid´s study (presented in section 5.2.1) made a reasonable point regarding the method of distributing the ills. The representative argued that *"since a functional public transport system, cycle paths and pedestrians is in everybody's interest, then why should only those who drive a car pay for it"* (Shahid, 2019, p. 37). In contrast, McCauley et al., (2019) and Sovacool, et al., (2019, p. 358) reasoned that in relation to low-carbon transition, costs should be shared and participants are equally benefitted.  Which in turn illustrate the distributive injustice from the toll fees.

The second branch within energy justice perspective which McCauley et al., (2019), Sovacool et al., (2019) and Jenkins, et al., (2016) discuss is procedural justice. They argue that this branch represents the subject of due process and representative selection in decision-making processes. In section 5.1 of this study, the participating actors in Bymiljøpakken project is

presented, and they all have one similarity, they are all public organs. McCauley et al., (2019), Sovacool et al., (2019) and Jenkins, et al., (2016) highlight that an open democratic decision-making-process, with a fair representation influenced by impartially and objectivity, is necessary in order to organise a fair procedure that promote outcomes that benefit all, rather then some. Even though the national and local administration is representatives elected through a democratic political system, a participating or independent, non-state connected survey could have provided important contributions.

Regarding the third branch of energy justice, Cosmopolitan justice, which McCauley et al., (2019), Sovacool et al., (2019) and Jenkins, et al., (2016) explains as the collective responsibility for each humans wellbeing. In relation to the case of Stavanger, none injustices within this branch has been identified. However, one could draw parallels to what McCauley et al., (2019), Sovacool et al., (2019) and Jenkins, et al., (2016) mean by ensuring everyone wellbeing. As presented throughout this study, the socio-technical mobility transition demands investments, both in infrastructural change (see 5.3.1 the bus road, 5.3.2 the bicycle road), which in turn is funded through the toll rings. In Shahid´s study (2019, p. 19), the representative from FNB argued that the toll rings would potentially affect the local population in a negative way by restriction some due to financial reasons. E.g. some parents located in one toll ring would not have the economic resources to travel in and out of rings in order to complete daily chores and leisure activities. Which in turn would impact the general wellbeing of affected families. E.g. in the news article in Stavanger Aftenblad (Lønning, 2019) where a respondent argued that the roll rings would reduce their quality of life due to it restricting them, by financial reasons, to travel around in the region by car. This distinct challenge will be elaborated more in the next paragraph.

Within the framework of energy justice, McCauley et al., (2019), Sovacool et al., (2019) and Jenkins, et al., (2016) presented the aspect of identification as the last branch. Recognition justice centres around the recognition of potentially vulnerable groups who might be affected more than others in a socio-technical transition. In Sovacool et al., (2019, p. 584) study, their method of inquiry to reveal injustices was a mixed methods of qualitative research that included interviews amongst others. In relation to this study of Stavanger, the effects from implementation of toll rings and fee did, as proven, impact some. However, the head of secretary in Bymiljøpakken confirmed that no consequence assessment either on the effects Bymiljøpakken would have on local business, nor private household finances (Søndeland,

2018). Additionally, as shown in the study from Shahid (2019, p. 49), the interviewed representative from the Norwegian Public Road Administration stated that no surveys were carried out of his knowledge. When then asked about whether the toll fees potentially might affect people financial status the respondent replied that "*we can see that it is demanding for some people paying large amounts of money and many do not have an alternative. The system is not fair; it is not based on how much income you have for example. But this is the way which the government can collect money through toll stations."* (Shahid, 2019, p. 55). With regards to the statements from the two respondents within the steering group, and the opposition toll rings met, one can reason that a comprehensive assessment of vulnerable groups could in fact made the transition more suitable for the users.

However, after the presented resistance Bymiljøpakken received, especially the method of funding through toll rings and rush hour fees, the government granted additionally funds to the project with a proportion earmarked for cut in toll fees (Fosse, 2019). Which in turn resulted in an abonnement of rush hour fees the 10. February 2020. As presented in table 9, the new rates of toll fees both affected the light-weight car by 1 NOK, and the electrical vehicle which had to pay half rate. According to actions presented in the Action Plan (2018, p. 10), and table 6 in this study, this was the maximum of rate the municipality could put on electrical vehicles.

The presented material on socio-technical, low-carbon transition illustrates the complexity of decarbonising light-weight urban transport. On one side, the national and local measures are present to ensure a sustainable future while facilitating more accessible daily leisure activity. However, on the other side, the actions have and will create obstacles that the policymakers must recognise for future development. Yet, the desire for change must have some value, even though it might prove to be too ambitious when 2030 arrives.

# 7. Conclusion

The purpose of this study was to *investigate what the municipality of Stavanger is doing to reduce their emission from its transport sector, and to achieve a target of shifting 70% of the personal transport to public transport, bicycle and walking modes by 2030*. In order to answer the main research question, three research question were asked; what measures that have been implemented, what constraints the municipality had to overcome, and what are the environmental effects.

- *What measures are being implemented in the region of Stavanger in order to promote more environmental friendly transport sources?*

Findings from this study has identified a Climate and environmental plan 2018-2030 (2018), supplemented by an Action Plan 2018-2022 (2018), motivated by the National Transport plan presented in the government White Paper Meld.St.33 (2016-2017). Resulting in Stavanger municipality creating a foundation and framework towards acting on climate related challenges, such as the emission from the transport sector in this case. Throughout the literature review of this documents in section 4.0 and, findings and analysis in section 5.0 of this study, a number measures are identified. E.g. infrastructural change in regards to public transport, bicycles and pedestrians (Ryfast, bus road, bicycle road and other smaller projects), facilitation of easier access through mobility points (Hillevåg mobility point). Focus on the promotion of environmental friendly transport schemes, such as car sharing, bicycle and walking (Bilkollektivet, HjemJobbHjem, Beintøft, Mobility week). But also the promotion of electrical cars through facilitation of both practical and economical dimensions (tax and fees, charging network).

- *What are the potential barriers that the municipality is facing in implementing these ambitious measures?*

In this study, two distinct barriers have been identified. The first is the strategy behind a decarbonisation of transport. On the background of scholarship from Fridstrøm, et al., (2018) and Banister (2008), this study was supported to conceptualise the decarbonisation of light-weight transport in Stavanger. With this support, this study reason that the measures implemented are either with high-potential and long-term perspective, or relatively low-potential in a short-term perspective.

The second barrier which the municipality had to overcome was how to make it equitable. With support from scholarship from Sovacool, et al., (2019), McCauley, et al., (2019) and Jenkins, et al., (2016) this study identified some injustices which appeared due to the socio-technical transition. E.g. unfair funding system, no impact assessment inquiries and the absence of public participation.

- *What has so far been the environmental effects from the implemented measures?*

In section, 5.6 Number and statistics, key numbers collected from different sources such as SSB (2020), (2021), Bymiljøpakken (2019), Kolumbus (2021) are analysed in order to create a representation of the effects from the measures implemented. In summary numbers from table 10, the overall use of public transport did experience a growth from 2017-2019, but the numbers from 2020 is highly influenced by the national and local restrictions due to the Covid-19 pandemic (Statistics Norway, 2021). Key numbers from Bymiljøpakken (2019) presented in table 11, on the use of bicycle as an alternative mobility option display a growth from 2017-2018. However, no numbers from 2019-2021 was available, hence it was difficult to draw a conclusion on present use of bicycles. Yet, as figure 6 display, there has been a significant growth in the use of city bikes. Also, numbers from Kolumbus (2021) show a decrease in car use, based on three measuring points presented in table 12. Additionally, table 13 present key numbers on new registered cars in Stavanger, and the fossil-fuelled cars have experienced a decrease, and the electric cars have in difference experienced a growth.

With presented literature and findings, a general conclusion is that there is not a lack of ambition, but depends upon a number of long-term, environmental friendly mobility projects which may not provide sufficient results in short-term. However, some statistics insinuate a positive progress towards 2030, but as mentioned, the Covid-19 pandemic might have caused some stagnation. Moreover, economic incentives towards electrical usage yields results and may provide short-term solution towards growth in private vehicles. Additionally, car sharing schemes have shown continuously growth, and proven through empirical studies to have significant effect (Miglioe, et al,. (2020). Consequently, the likelihood to succeed with goals efforts might depend upon short-term solution (e.g. car sharing schemes), rather than the long-term measures (e.g. infrastructural change) due to the extent and aspiration of ambitiously global, national and local goals, and where cities are supposed to play a leading role. Yet, this case-study on Stavanger has only touched the surface and a lot of contributing factors such as alternative renewable fuel sources (e.g. hydrogen), interesting future developments (e.g. self-

driving bus), heavy-weight freight (commercial transport of goods), economic and technological limitations contributions is highly recommended to examine in order to create a more accurate image of the ongoing mobility transition in Stavanger. Additionally, it would be highly recommended to examine what kind of negative, or possible positive, consequences the Covid-19 pandemic has caused the transition. Nonetheless, what this case-study can conclude with, is that incentives are present and Stavanger is working towards a less GHG emission intensive, personal transport sector through infrastructural change and promotion of innovative technology.

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