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Rolling the snowball: Norway's efforts to electrify transportation

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Norway's policies to encourage electric vehicle (EV) adoption have been highly successful. In 2017, 39 per cent of all new car sales in Norway were all-electric or hybrid, making it the world's most advanced market for electric vehicles (IEA 2018). This high rate of EV ownership is the result of 30 years of EV policies, Norway's particular political economy, and significant improvements in EV and battery technology. This paper argues that Norway's sustained EV policy interventions are not only starting to decarbonize personal transportation but also spurring innovative electrification efforts in other sectors such as maritime transport and short-haul aviation. To explain this pattern of scaling, the paper employs Bernstein and Hoffmann's (2018) framework on policy pathways towards decarbonization. It finds political causal mechanisms of capacity building and normalization helped create a welcoming domestic environment to realize early uptake and scaling of electric vehicles, and subsequently fostered secondary scaling in other modes of transportation. The initial scaling was facilitated by Norway's unique political economy. Ironically, Norway's climate leadership is, in part, because of its desire to sustain oil and gas development. This desire steered the emission mitigation focus towards sectors of the economy that are less contentious and lack opposing incumbents. Indirectly, the wealth from hydrocarbon extraction bankrolls these pricey policies and the growing number of beneficiaries ensure these policies remain in place, creating positive feedbacks. Despite these domestic political economic concerns, the demonstration effects from Norway's electrification are spurring other countries, companies and cities to pursue action. Evidence for these causal mechanisms and effects is drawn from interviews with key policy and industry participants and observers of Norway's electrification efforts along with a range of secondary sources.

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Abbreviations

BEV	Battery electric vehicle
CEM	Clean Energy Ministerial
EV	Electric vehicle
EVI	Electric Vehicles Initiative
ICEV	Internal combustion engine vehicle
NRDC	Natural Resources Defense Council
UNEP	United Nations Environment Programme

Executive Summary

Nearly a quarter of all energy-related greenhouse gas emissions in the world in 2016 were from transportation (IEA 2019). Electrification is a crucial way to decarbonize this rapidly growing sector. As the world's most advanced market for electric vehicles, Norway is on the global forefront of electrifying passenger vehicles. In 2017, 39 per cent of all new car sales in the Nordic nation were battery electric or hybrid electric (IEA 2018). This high market penetration of EVs is the result of many factors: 30 years of policies encouraging EV adoption and use, Norway's particular political economy, especially the presence of major oil and gas industry and a lack of domestic auto manufacturing, and considerable improvements in EV and battery technology.

Theoretical Framework

Understanding the politics behind Norway's largely successful EV policies and the broader politics of decarbonization requires considering the fractal nature of carbon lock-in, where multiple mechanisms interplay with mutually reinforcing subsystems (Bernstein and Hoffmann 2018). This working paper employs Bernstein and Hoffmann's framework which examines how discrete interventions may propagate wider system effects via three transformative political mechanisms: normalization, where an intervention actively reframes policy discourse; capacity building, which promotes material, institutional, and cognitive change; and coalition building, which creates new winners and neutralizes losers. These mechanisms can support an intervention to scale up and entrench; in other words, these three factors can, over time, help these initiatives to grow, catalyze other initiatives and become more durable or costly to eliminate. The degree of scaling or entrenchment can place the intervention on three potential trajectories within the particular subsystem the intervention seeks to influence: reinforcing carbon lock-in, system improvement via efficiency gains, or decarbonization.

In this discussion paper, Norway's EV policy regime is the intervention under examination and the subsystem it seeks to influence is the personal transportation sector of Norway. However, the success of Norway's EV policies have catalyzed action in other countries and has inspired electrification efforts in Norway's maritime transport and domestic aviation, which will be discussed in the context of scaling.

Transformative Political Mechanisms

The EV policies of Norway have sought to **build capacity** through early direct financial support for businesses interested in manufacturing, significant and sustained financial incentives for EV purchase, and a growing suite of incentives to make EV use easier. The national EV user group, *Norsk elbilforening*, also built societal capacity, particularly of its membership.

Longstanding environmental **norms** in Norwegian society conditioned the possibility for EV policies, which in turn helped to normalize EV adoption. Powerful demonstration effects of EVs on the streets of Norway and peer-to-peer influence has helped to make EV ownership commonplace.

Lack of Opposition

Unlike the EV policies in many other jurisdictions, Norway's EV policies were achieved with minimal contestation or opposition. Early policies did not impose costs on fossil-fuel powered vehicles or come with great expense to the state treasury as there were very few EVs on

the road at the time. Instead, these policies removed costs for EV owners. Further, a lack of domestic auto manufacturing sector that was tooled to produce competing internal combustion engine vehicles, a powerful fossil fuel industry that did not want to be the target of additional climate policies, and a formal consensus by major political parties on EV policies are all important factors that straightened the path to Norway's success with electrifying personal transportation. In this environment, building a powerful coalition to challenge incumbent actors was unnecessary.

Scaling

The absence of opposition combined with the causal mechanisms of capacity building and normalization catalyzed early simple and modular scaling of EV policies, EV adoption and related infrastructure, where policies expanded domestically and then were consciously mimicked in other jurisdictions. Once the success of EV policies became entrenched in Norway, it spurred secondary, self-organized scaling as domestic actors sought to electrify other modes of transportation, notably maritime transport and aviation. The powerful demonstration effects of EVs has inspired Norwegians to take action in other parts of the economy.

Conclusion

While there is little dispute of the instrumental role of Norway's EV policies in spurring high EV adoption rates, there is still doubt if these policies will result in the broader decarbonization of the transportation sector. Between 1990 and 2017, greenhouse gas emissions from road traffic rose 22 per cent (SSB 2018). Oil-powered prosperity in Norway significantly increased household consumption, increasing overall car ownership and the volume of material goods transported on Norwegian roads. However, recent evidence suggests road transportation emissions may have peaked. Between 2016 and 2017, this source of pollution dropped 9.5 per cent, the largest ever drop in transportation-related emissions (SSB 2018). A 2025 national ban on internal combustion engine vehicle sales will serve to further accelerate this trend. When these recent developments are considered, the personal transportation subsystem is likely on a decarbonization trajectory.

It is difficult to disentangle the success of Norway's EV policies with the success of its fossil fuel industry. A powerful incumbent oil and gas industry has continued to increase pollution as it pushes opportunities for emission reductions to other corners of the economy. While the normalization and capacity building in EV policy has catalyzed scaling domestically and internationally, whether these political dynamics support or deflect from economy-wide decarbonization, which also puts pressure on the oil and gas industry remains uncertain.

Introduction

The electrification of transport, in particular vehicles, is widely seen as a key avenue to reduce carbon pollution. Transportation accounted for 24 per cent of global greenhouse gas emissions from fuel combustion in 2016 (IEA 2019). For such a large challenge, one small country stands above all others in the success of its electric vehicle policies. In 2017, 39 per cent of all car sales in Norway were all-electric or hybrid, making the country the world's most advanced market of electric vehicles (IEA 2018). Norway is in a league of its own, well ahead of the second and third place—occupied by its Nordic brethren of Iceland and Sweden, with 11.7 per cent and 6.3 per cent, respectively (IEA 2018). Of the 2.5 million cars in Norway in 2017, 210,000 or 8.4 per cent were plug-in hybrid or battery electric: the greatest number of electric vehicles (EV) per person in the world (European Alternative Fuels Observatory 2018).[1] In comparison, most industrialized countries have EV ownership rates of under one per cent.

What are the political dynamics that led to the success of Norway's electric vehicle policy? And can this policy hasten the decarbonization of Norway's broader economy? This working paper applies Bernstein and Hoffmann's (2018) framework to examine the politics behind Norway's electric vehicle governance experiment and how this success is inspiring Norwegians to electrify other modes of transport. I will show that the transformative political mechanisms of capacity change and normalization, especially, helped scale up electrification efforts.

Ironically, Norway's electric vehicle leadership has been, in part, because of its desire to sustain oil and gas development. The state and Norwegians quickly became dependent on the oil and gas industry to fund generous welfare policies, create employment and generate export earnings. The carbon lock-in caused by oil and gas extraction steered the emission mitigation focus towards less contentious sectors of the economy that lack opposing incumbents. As the state continued to expand oil and gas production, national emissions continued to increase, despite world-leading electric vehicle policies. Between 1990 and 2016, Norway's overall greenhouse gas emissions have increased three per cent (United Nations 2019). Ultimately, the degree to which Norway's EV policy can be transformative is dependent, in part, on whether this policy can disrupt the carbon content of Norway's broader economy.

The economic windfall from hydrocarbon extraction indirectly funded these expensive EV policies and the increasing numbers of beneficiaries ensure they remain durable. Despite these domestic political economic dynamics, the demonstration effects from Norway are spurring other countries, companies and cities to electrify transportation.

For the purposes of this paper, the boundaries of this intervention are Norway's EV policy regime. However, the knock-on effects of Norway's EV policies on other countries will also be discussed along with how EV leadership has spurred low-carbon innovation within Norway for maritime transport and aviation.

I begin the discussion with a brief history of Norway's EV policies before detailing the causal role of capacity building and normalization. Next, I discuss the scaling of these policies, including the impact on decarbonization efforts in maritime transportation and short-haul aviation, as well as the international influence of Norway's EV policies. Evidence for these causal mechanisms and effects is drawn from eight interviews with key policy and industry participants and observers of Norway's electrification efforts along with a range of primary and secondary sources.

1 Moreover, Norway's electricity grid is one of the cleanest in the world, with 96 per cent of the power coming from emission-free hydroelectricity (Energy Facts Norway 2018).

A Brief History of Norway's EV Policies

Norway has a long history of involvement in electric vehicles. In the 1910s and 1920s, industrialist Arthur Bjerke manufactured electric vehicles in Norway. He wrote the government in 1915 asking, unsuccessfully, for reduced fees for EVs because they are less polluting than fossil fuel-powered cars (Mom 2004). Like elsewhere in the world, internal combustion engine vehicles (ICEVs) quickly decimated their electric rival. It was not until the 1970s, as a result of a global oil supply crisis, that electric vehicles began to be considered once again. Figenbaum and Kolbenstvedt (2013) describe five phases to the development of the Norway's modern EV market. First, during the concept development phase (1970 to 1989) the Norwegian government provided research funding for domestic private companies from the 1970s to 1990s to produce EV prototypes. Norwegian industrialist Lars Ringdal made several EV prototypes (Kristensen, Thomassen et al 2017). In 1987, Frederic Hauge helped propel EVs to national attention through publicity-minded civil disobedience. Hauge, the founder of the Norwegian environmental group Bellona, refused to pay import fees on a Fiat Panda that had been retrofitted as an electric vehicle (Kristensen, Thomassen et al 2017, Charles 2018). A year later, vehicle registration and import taxes on electric vehicle imports were waived. Norway's vehicle taxes are among the highest in the world. Altogether, VAT and a registration tax can amount to 40 to 50 per cent of the vehicle's total price (DICE 2014).[2] Eliminating the registration tax for electric vehicles served to dramatically lower the overall consumer cost of these vehicles. Norway also boasts one of the highest fuel tax in the world (Figenbaum et al 2015). Since battery electric vehicles do not consume fossil fuels, operational costs are further reduced.

Second, the initial test phase (1990 to 1999) saw commercialization as the goal for government incentives. This period maintained the important exemption from vehicle-related taxes and a suite of new policies meant to encourage EV use. In 1995, Bellona's Hauge and Morten Harket, the front man for the 1980s Norwegian boy band A-Ha, drove through Oslo's toll roads in the same Fiat Panda without paying the tolls, chaining themselves to Hauge's mini-car upon threat of arrest (Digges 2018). Later that year after more media coverage and advocacy by Bellona and EV manufacturers, Oslo exempted toll fees for electric vehicles. A year later it lowered an annual road tax followed by toll waivers on all national roads and free ferry transportation. Some municipalities also offered free parking for EVs. In these early years, electric vehicles were still very much a novelty owned by a handful of sustainability and technology enthusiasts. At the end of this phase, two producers to the Norwegian EV market, Norway's Think Motors and Denmark's Kewet went bankrupt. Considerable government policy intervention was not sufficient to create a profitable domestic EV manufacturing industry.

Third, sporadic EV supply marked the early market phase (2000 to 2009). Ford bought the bankrupt Think which was soon sold and went bankrupt again. New French EVs replaced domestically produced cars and the government introduced several additional incentives, including free use of EVs in bus lanes and car tax reductions for companies purchasing EVs.

Fourth, during the so-called market introduction phase (2009 to 2013) domestic production of Think and Pure (formerly Kewet), along with EVs from Mitsubishi, Nissan, and Peugeot, encouraged price competition making EVs much more affordable. This increased competition let to the re-bankruptcy of Think and Pure. Meanwhile, technological advances in

2 These high vehicle taxes are meant to enable the state to raise the funds from vehicle users necessary to maintain public roads.

batteries and drivetrains made EVs much more energy efficient.[3] During this time, the government began building a public charging station network across Norway.

The fifth, and current, phase of the development of the EV market in Norway (2013 to present) is characterized by rapid expansion. More recent state investments have focused on charging infrastructure and on waiving the 25 per cent value-added tax on leasing EVs. In 2017, the government set a non-binding goal of zero fossil-fuel powered vehicle sales in Norway by 2025.

Cities like Oslo and Bergen have layered on additional incentives beyond the national policies, such as free parking and charging, free ferries, no tolls for tunnels, and free access to municipal HOV lanes. In addition to no VAT and vehicle purchasing tax, in 2017 Oslo added a congestion charge for all internal combustion engine vehicles using toll roads and started banning diesel cars on the most polluting days. By 2019, it will ban cars from the city centre. In 2023, the city plans to have a zero-emission taxi fleet. Paal Mork, a city official at Oslo's Agency for Urban Environment, noted how Oslo's EV efforts helped it to be named the European Green Capital for 2019. The city is using this year to promote Oslo as the EV capital of the world.

As EV adoption increased exponentially during this fifth phase, several earlier policies which promoted EV use needed to be changed. For instance, Oslo is phasing in toll fees for electric vehicles, albeit still at a reduced rate compared to ICEVs. The city is also beginning to charge for charging at public stations, to generate revenue to expand charging infrastructure (Portvik 2019).

Norway's EV policy regime had different policy instruments and settings over the past three decades, what Hall (1993) calls "first order" and "second order" change. However, the overall objective remained the same: increasing adoption and use of electric vehicles. This "thermostatic" policy dynamic is similar to what Cashore and Howlett (2007) found when examining forestry policy development in the United States. Despite the evolution of different policy instruments and settings over time, the overall objective to increase EV adoption and use has endured.

To summarize, besides the intermittent and ultimately unsuccessful subsidies given to domestic manufacturing, the overall durability and complementarity of Norway's EV policies is remarkable. Few, if any, countries can boast of a similarly broad suite of policy tools to promote EV purchase and use. Even as the costs of these policies increase for the Norwegian Treasury and as governments shift from Stoltenberg's red-green government to Solberg's blue-dark blue government, these policies have proven stable and offered certainty for Norway's EV market. Meanwhile, opposition to these generous EV policies has been minimal, reducing the likelihood of retrenchment. The next section will examine how capacity building and normalization has helped to secure Norway's EV policy success.

3 The development of lithium-ion batteries by traditional vehicle manufacturers, which reduced the cost of EVs, was a necessary but not sufficient factor in explaining the increase of EVs in Norway. Other countries where lithium-ion battery EVs are sold but without such substantive economic incentives, did not see a similar increase in EV adoption (Figenbaum 2016).

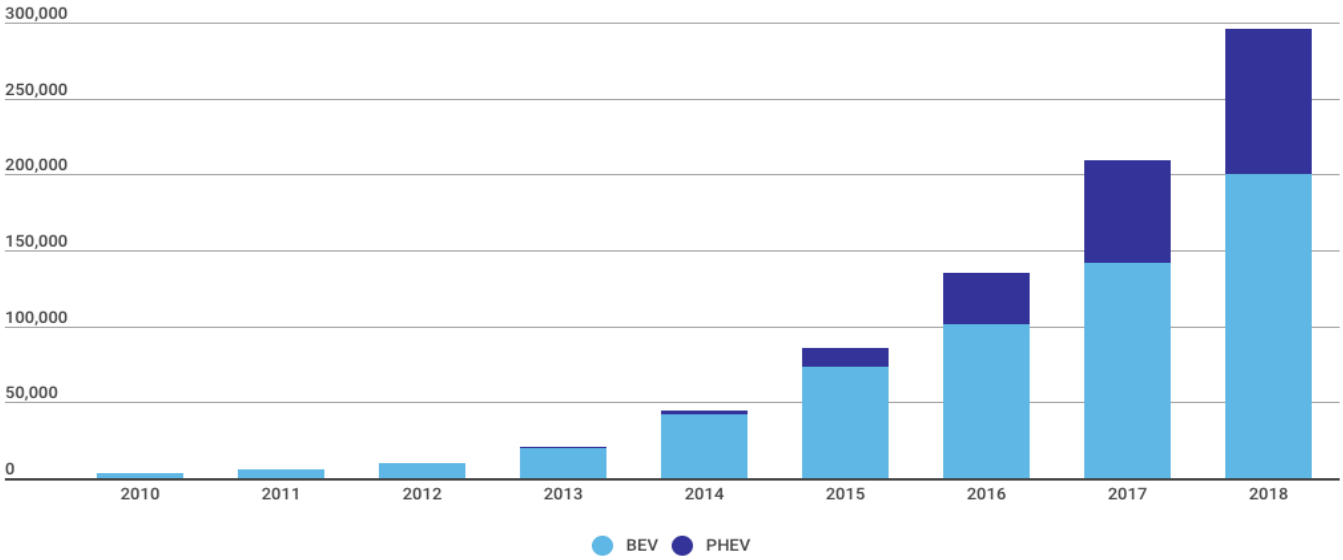

Figure 1: Electric vehicle fleet in Norway, battery electric (BEV) and plug-in hybrid electric vehicles, 2010-2018. Source: The Norwegian Public Roads Administration

Transformative Political Mechanisms

Capacity Changes

The transformative mechanism of capacity building works through changing the material, institutional and cognitive capacities of actors (Selin and Vandeveer 2005, Bernstein and Cashore 2012, Weible and Sabatier 2014). In the case of Norwegian EV policy, capacity building focuses on the ability for initiatives to teach how to act on climate change and sometimes on providing the direct financial or political resources to the governance initiative and groups that support it to pursue or implement the initiative. In the early EV policy in Norway (1970s and 1980s), the main focus was to provide direct financial support for businesses interested in manufacturing. In the 1990s that shifted to providing financial incentives to purchase EVs through reduced taxes. During the 2000s, as large international vehicle manufacturers began to dominate the nascent Norwegian EV market and domestic EV manufacturing collapsed, government policy focused on making EV use easier. Free charging, parking, toll roads and ferries all reduced the operating cost and increased driving convenience for EV users.

The EV user group, *Norsk elbilforening*, founded in 1995, beyond building coalitions with environmental groups and municipalities also built societal capacity, especially of its membership, through public education on the benefits of EVs. It offers insurance, legal advice, educational resources specifically targeted to electric vehicle users, and maintains an open access database of EV charging stations. It produces an annual survey of its membership and a Nordic EV Barometer which examines attitudes towards EVs among the broader public in Norway, Sweden, Finland and Denmark.

The upfront EV incentives are the main driver of EV adoption. Once in place, a suite of EV policies effectively made the price of electric vehicles the same as conventional vehicles (Aasness and Odeck 2015), making it much easier for Norwegians to choose green. A May 2018 survey conducted by *Norsk elbilforening* of 9520 of its members with BEVs found that 63 per cent of respondents would not have purchased a BEV if there were no exemptions for the VAT

and purchase tax (Norsk elbilforening 2018).[4] These policies designed to reduce the up-front cost of a BEV were a much greater determinant of EV adoption than the many policies designed to make EV use more convenient. Paal Mork, an official at the city of Oslo, noted: "I would love to say it's because of environmental concern, but I believe it's not. For some people it is, but the majority have different reasons. It very much boils down to the pricing" (NEV05). This also suggests that capacity building is a more powerful determinant than normalization on EV adoption rates in Norway. In other words, a logic of consequences has primacy over a logic of appropriateness.

Normalization

That said, norms remain a crucial catalyst in the success of Norway's EV policies. Some norms have been long-standing in Norway and others have resulted from the EV policy itself. Norwegian society has long had strong environmental norms. These pre-existing norms, which conditioned the possibility for EV policy, were strengthened from the 1970s through the 1990s. The 1973 oil crisis spurred a new interest or normative shift among highly industrialized countries in energy conservation that lasted until the 1980s. This energy efficiency norm helped catalyze some of the research and development efforts in EVs in Norway during this period. The rising concern of global warming in the late 1980s and early 1990s was, in no small part, aided by Norway's Prime Minister Gro Harlem Brundtland. It was Brundtland who chaired the World Commission on Environment and Development, which published its final report, *Our Common Future*, in 1987. This and her subsequent environmental leadership helped her earn the nickname as the "world's environment minister" (Ryggvik 2015) and the "Mother of Sustainable Development" (Norwegian Ministry of Foreign Affairs 2017). The clear example set by Brundtland on the international stage further normalized domestic environmental action.

Beyond these norms conditioning the possibility for EV policies, the EV policies themselves helped to normalize EV adoption. In the 1990s and 2000s Kewet's Buddy or the Think City EVs helped imprint upon Norwegians that the country is a leader in EV manufacturing and usage; although spotting one of the EVs was a rarity in those early years. This changed in the 2010s and in recent years the top selling models in Norway have been battery or hybrid electric. For instance in 2017, all of the top 15 selling passenger vehicles in Norway were hybrid or battery electric except for the 14th place Volvo V90 diesel (Opplysningsrådet for Veitrafikken AS 2018). It is now normal for Norwegians to purchase an electric vehicle.

Seeing other Norwegians use EVs also provides powerful demonstration effects, where 'keeping up with the Johansens' materially translates into purchasing a zero-emission vehicle. A 2016 survey of 8000 vehicle users in Norway found peer-to-peer influence particularly important for battery EV adoption compared to ICEVs; family and friends were far more influential than information from dealers or advertising (Figenbaum 2016). These findings were replicated in a 2017 survey of EV users. For those surveyed, 72 per cent inspired at least another friend, family member or acquaintance to purchase an EV (Norsk elbilforening 2018). When future EV owners sought out information on EVs, they looked to media coverage and other EV owners, over dealers and advertising.[5] These evident demonstration effects help to further normalize the adoption and use of electric vehicles in Norway.

4 Norsk elbilforening survey data is used by environmental groups and city officials to inform EV policy reform (NEV05).

5 There are signs that the decision to use an EV is durable. For those surveyed, 90 per cent would replace their EV with another EV rather than revert back to a ICEV (Norsk elbilforening 2018). For the majority of households that

Contestation and Opposition

Norway's EV policies are significant in that they have been achieved with minimal contestation or opposition. Early policy proposals did not increase costs for fossil-fuel powered vehicles or the state treasury; rather, they removed costs for electric car owners. In the 1990s, the cost was so minimal because there were nearly no electric vehicles in Norway and a noteworthy absence of vested interests opposing these measures.

Unlike countries with incumbent vehicle manufacturers, such as neighbouring Sweden's Volvo, incentives to encourage electric vehicle adoption did not pose a threat for Norway because it did not have a vehicle manufacturing industry. Policymakers did not have to worry about driving up costs for local manufacturers and suppliers of ICEVs and eroding their competitiveness. Nor did they have to worry about increasing the cost to drive your existing car with an internal combustion engine at first.[6] Thus for a consensus-minded society, it was easy not to say no to electric vehicle policies.

No political parties that have been part of a ruling coalition have successfully opposed EV policies. Unlike in Canada, the United States, or Australia, where electric vehicles policies were used as a political wedge and were highly unstable, in Norway a formal consensus exists on climate policy across political parties since 2008, and this agreement has been renewed several times since (Labor Party et al 2008). Unlike more contentious climate policies facing fossil fuel production and use, electric vehicles were a technological solution that all parties could support. That is not to say the government has not attempted to scale back EV purchase incentives. As electric vehicles became more numerous and the cost to the Treasury increased, Erna Solberg's ruling Conservative Party attempted in 2017 to roll-back a generous tax benefit for electric vehicles. However, this attempt at retrenchment was met by public and political resistance from the Norwegian Electric Vehicle Association and the Liberal Party, a key coalition member of Solberg's then minority government (Agence-France Presse 2017). In the end, the plan to remove the so-called 'Tesla tax' was scrapped.

While some equity concerns have also been raised regarding the regressive, non-income dependent nature of some of the EV subsidies and electric car traffic jams in bus lanes that slow public transit, these concerns have not rallied sufficient opposition to lead to a phase out of these EV policies.

In short, Norway's unique political economy has created an environment where ambitious electric vehicle policies faced almost no opposition. The lack of additional costs for ICEV users, an absence of incumbent automakers, and a consensus-based political system where all parties could agree on the value of increasing EV adoption's success, helps to explain EV adoption in Norway.

Scaling

The causal mechanisms of capacity building and normalization combined with the lack of domestic contestation enabled early simple and modular scaling of EV policies, EV adoption and related infrastructure. Once the success with EVs became entrenched, it fostered secondary, self-organized scaling in other modes of transportation, particularly maritime transport and aviation.

own both a BEV and an ICEV, the BEV has become the daily commuting car, decreasing the ICEV usage by 90 per cent.

6 Over time, the vehicle registration fee has increased for cars that pollute more greenhouse gases. Also, the carbon tax does cover transportation fuels and has increased over time.

Simple scaling occurs when an individual initiative grows or increases its activities. In the case of Norway's EV policies, there clearly has been simple scaling within Norway as the number of EV policies, EV charging stations, companies with EV-related business lines, and EV market share increase.

Outside of Norway, there has been some evidence of modular scaling. Modular scaling is seen when governance interventions are consciously copied elsewhere. Of course, tracing the degree of consciousness of policymakers in one jurisdiction copying the policies of another jurisdiction is difficult to prove. Norway certainly would like others to imitate them. In 2017, Ketil Solvik-Olsen, then Norway's Minister of Transportation, noted that when it comes to electric vehicles "his dream is that other countries would copy Norway."[7]. Some of those dreams have already come to pass. In 1997, Denmark copied Norway's elimination of an extremely high vehicle registration tax for electric vehicles (Danish Ecological Council 2017). In 2012, Iceland removed its VAT for electric vehicles (Wappelhorst and Tietge 2018). However, Norway, Denmark, and Iceland are unique in the magnitude of their vehicle taxes, making mimicry of these tax exemptions difficult elsewhere.[8] Instead, the mimicry is more likely to be seen in the EV use incentives, such as free charging and discounted road tolls, ferry usage and parking.

The power of example is evident in the international interest in Norway's approach to electric vehicles and in Norway's promotion of its EV market. Norway's involvement in the Nordic EV Summits and in international initiatives like EVI and EV 30@30 help to increase the likelihood that other countries would replicate Norwegian EV policies. In 2010, the Electric Vehicles Initiative (EVI) was launched under the Clean Energy Ministerial, 20 years after some of Norway's first policies promoting EV use. It is funded by 16 countries including Norway with a secretariat housed in the International Energy Agency. The main purpose of the EVI is to accelerate the adoption of EVs worldwide. It seeks to build capacity and coalitions and normalize EV use. Although Norway cannot take sole credit for conceiving of the initiative, Norway's success has been a focus of the EVI's work as evidenced by the Nordic EV Outlook 2018, the only region in the world to have to have its own report (IEA 2018).

The Clean Energy Ministerial also launched a campaign in 2017 called EV 30@30. The name connotes the target of at least 30 percent of new vehicle sales by 2030 will be EVs. Norway along with 9 other countries have endorsed the campaign which also has the support of organizations such as C40, Natural Resources Defense Council (NRDC), the Climate Group and the United Nations Environment Programme (UNEP). The goals of EV 30@30 include the following (CEM 2017): a) support the deployment of chargers and tracking its progress to galvanize public and private sector commitments for electric vehicle (EV) uptake in company and supplier fleets; b) scale up policy research and information exchanges; c) support governments in need of policy and technical assistance through training and d) capacity building; and e) establish the Global EV Pilot City Programme, aiming to achieve 100 EV-Friendly Cities over five years. These two programs have reinforced the leadership role of Norway in promoting EV use and have served to increase the likelihood that Norway will stay the course on electric vehicles.

These demonstration effects have helped Oslo to become the 2019 European Green Capital. European cities, research institutes and technology developers that are hoping to scale up EV usage regularly engage city officials in Oslo. Paal Mork with the City of Oslo remarks: "according to the interest we get from all over the world, I believe our model is known. I don't

7 Speech delivered at the 2017 Nordic EV Summit in Drammen, Norway, 6 February 2017.
8 That said, mimicry of tax exemptions is not impossible. In 2017, Ukraine exempted EVs from a VAT. After this reform, EV sales tripled in under two years (Commerce 2019).

think people come here from Germany, from the United States, from Spain, and from all the other countries if they didn't think maybe they could learn something from Norway" (NEV05). The President of the Norwegian EV Association regularly is invited to give presentations outside of Norway. Car manufacturer representatives from Germany and China regularly visit Norway to learn about the country's EV market. Torfinn Belbo, a Transport Advisor with ZERO, notes: "our main vision is Norway as a tool for global change […] we want to create a market for zero emission technologies in Norway and use that market to help drive down costs for zero emission solutions" (NEV02). These domestic and international actors see Norway as a laboratory to test EV technologies, similar to Norway's recognized international leadership as an innovator in the offshore oil and gas service industry.

Within Norway, electric vehicle leadership has catalyzed decarbonization efforts in other sectors: an example of self-organized scaling. Self-organized scaling takes place when an initiative spawns further initiatives as other groups begin to occupy the niches created by the original initiative. Several environmental groups have been key actors promoting the creation of new decarbonization niches: notably Zero and Bellona. For instance, Bellona—which was instrumental in advocating for the first EV purchase incentives—had an explicit strategy to move on to push for decarbonization in other sectors once progress was made on EVs. Bellona analyst Mark Preston Aragones explains:

> As soon as we [Bellona] noticed that the campaign for electric vehicles took its own form, and took off on its own, we were very happy to step back and move on to other issues. At the moment, for example, we're working on other forms of electrification such as the previously mentioned zero-emission construction sites, shipping, slowly looking into how to electrify short-haul aviation. I mean, we've really moved on to other issues (NEV01).

Of these new niches, this analysis will focus on efforts to electrify maritime shipping and aviation. Early efforts in the late 2000s by environmental groups focused on using renewable fuels. However, as battery technologies improved and the controversy over first generation biofuels increased in the 2010s, the attention of green groups shifted to electrification. In 2010, Zero released its first report on battery electric ferries and successfully pressed politicians to fund a prototype ferry (Opdal 2010). The 2011 budget allocated funding for a development contract tender for a low-emission ferry (NEV04). By 2015, the fully-electric MF Ampere was operational and would save its owners, Norled, one million litres of diesel fuel per year. Seeing that electrification of ferries was possible provided a strong demonstration effect to parliamentarians that this intervention could be scaled and that these new vessels could be built in Norwegian shipyards (Sjøtun 2018). In 2015 the Norwegian Parliament passed legislation requiring all tenders for new passenger ferries to be low or zero-emission technology. According to the Norwegian Centre of Expertise for Maritime CleanTech, this decision led to an "electric revolution in the Norwegian fjords" (Launes 2018).

Within a few months of the Ampere being launched, Siemens published a report on the cost savings of electrifying Denmark's ferry fleet (Siemens 2015). Also in 2015, Bellona and Siemens co-published analysis that found seven out of ten ferry routes in Norway could operate with battery or hybrid power systems (Bellona and Siemens 2015). Beyond tendering policies, the government sought to further incentivize electric maritime transport; it lowered harbour taxes,

increased taxes on fossil fuels, required all ports to have shore-to-ship power infrastructure, and provided direct financial support for innovative projects.[9]

These incentives and new technology appear to be working. The battery electric technology which debuted in Ampere will be in 72 ferries in Norway by 2022. Norled is scheduled to pilot a hydrogen-electric ferry in 2022 in Rogaland, Norway, which will be more effective for longer distances than the current battery technologies allow.

This electrification ambition extended beyond ferries and now also includes much larger and more polluting cruise ships. In 2018 the Norwegian Parliament adopted a resolution, the first of its kind in the world, to prohibit greenhouse gas emissions from cruise ships and ferries entering Norwegian fjords and harbours by no later than 2026 (Launes 2018).[10] The 2018 decision and other electric maritime transport policies are spurring investment decisions from local boat operators and shipyards as well as large international companies like Siemens that opened a highly automated and digitized manufacturing facility in Norway in 2018 to build batteries for marine and offshore oil applications (Moore 2018).[11] Hurtigruten, one of Norway's largest cruise lines, is retrofitting nine cruise ships to be powered by a combination of battery power, liquified natural gas, and liquified biogas from fish processing plants along the coast (Moore 2018). A company press release noted it "has been in close cooperation with Bellona to make sure the new and chosen solution is the "state of the art" within technology and sustainable solutions" (Hurtigruten 2018). It also is launching the world's first purpose-built hybrid cruise ship in the spring of 2019.

When asked how the 2015 decision for passenger ferries related to the 2018 parliamentary decision on cruise ships, Marius Gjerset, a technical and policy analyst at Zero, responded:

> […] due to the success of the Norwegian electrical vehicle policy, many politicians saw that electrification in the transport sector is happening, the batteries and electric solutions are working and this is coming fast. Even though it's not the same policy instruments, the success for EV policy in Norway was an important part of the background for why we succeeded with this parliamentary decision [on electric ferries]. Important politicians in parliament, which have been important for EV policy development and important EV political supporters, they were the important politicians behind this decision (NEV04).

Paal Mork, an official at the city of Oslo, shared the importance of EV policy success in catalyzing electric ferry use in Norway:

> it would have been a hard job starting with the [electric] ferries if we didn't have the whole technology and also the understanding and acceptance based throughout the electrical vehicle policy […] So the whole transport sector is being electrified, and that's very positive. For this part I think, we couldn't have done it if we didn't look back on the

9 One of the largest projects funded by the state-funded low carbon innovation agency Enova is the Yara Birkelund, which when built will be the world's first fully electric and autonomous container ship (ASA 2017).
10 This decision to have zero-emissions cruise ships is not without contention. Unlike with EVs, there is domestic opposition. Existing cruise lines and local communities which have benefitted from maritime tourism based upon large, polluting cruise ships fear a loss of tourism income. However, these two groups were unsuccessful at blocking the 2018 policy.
11 In 2018, this facility used the same technology it used to power the MF Ampere and other electric marine vessels to install the world's first lithium-ion battery for an offshore oil rig on the Norwegian Continental Shelf (Siemens 2018).

success we had with electric vehicles (NEV05).

The success of EV policies has emboldened the Norwegian government to set the goal of having two-thirds of all passenger and vehicle ferries to be electric by 2030 (Holter and Hodges 2018). This has proven a lifeline for Norwegian shipbuilding companies experiencing declining contracts related to offshore oil and gas supply boats in recent years. In 2017, Ketil Solvik-Olsen, Norway's then Minister of Transport from the far-right wing Progress Party, noted his strong support for electrifying maritime transport and linked this back to Norway's strong tradition of shipbuilding and leadership in maritime shipping.[12]

Like with EV policy, Norwegian politicians shared its early success in electric ferries with international audiences. In January 2019, Norwegian Prime Minister Erna Solberg invited Norled to a trade mission to India to showcase the "innovative and green" Norwegian ferry industry, which can serve as a model for international efforts to make maritime transport more sustainable. Early evidence suggests that Norway is inspiring action to electrify ferries in other countries, such as Washington state in the United States (Vartan 2018).

Norway's electric vehicle policies are also beginning to spur self-organized scaling within the country's aviation sector. In 2018, Avinor, the state-owned company, which operates all of Norway's 44 public airports has adopted similar electric ambitions, pledging that all short-haul flights will be 100 per cent electric by 2040 (Avinor 2018). The former Minister of Transportation Ketil Solvik-Olsen was a very strong proponent of Norway pioneering use of electric aircraft (Avinor 2018):

> In Norway we have succeeded in using batteries on boats and cars. Not necessarily making them ourselves but because we create systems that make it attractive to use them. I also think we can be a pioneer of using batteries aboard our planes […] Getting the big airlines to look to Norway with the experience we have with the electrification of our car fleet and shipping I think will be a success!

To announce the new policy and demonstrate the potential, Avinor purchased a small electric two-seater aircraft, the Pipistrel, and had its CEO and the Minister of Transportation fly in the plane for the media. Kåre Gunnar Fløystad, Chief Advisor to the environmental group Zero, called the Pipistrel plane, "the Buddy of the air" (NEV07). This was in reference to Buddy, the very small Norwegian-made electric car from the early 2000s, but also to the instrumental role that Norway has had in testing and developing an electric vehicle market.

Avinor is set to build the infrastructure necessary to support electric planes, in a similar way that the Norwegian government and municipalities have provided charging infrastructure for vehicles. For example, electric plane users are exempt from pre-existing landing fees and are given free electricity and free use of charging facilities (NEV06).

It is far too early to call Norway's efforts to electrify domestic aviation a success, beyond the international news coverage it has generated. However, the leadership adopted in this sector is a clear instance of the broader normalization of electrification within Norwegian society and an outcome of the demonstration effects of electric passenger vehicles for the wider transportation sector.

12 Speech delivered at the 2017 Nordic EV Summit in Drammen, Norway, 6 February 2017.

Conclusion

> "So it's this small snowball starting to roll and it has gotten bigger. I think that small snowball somehow started with the EVs" -Torfinn Belbo, Zero (NEV02).

Norway's electric vehicle policies have by many metrics been successful. Electric car ownership is rapidly increasing across the country. EVs dominate new car sales. A wide range of policies created incentives for both urban and rural Norwegians, removed many of the traditional barriers for EV ownership such as price and charging infrastructure and made driving EVs more convenient than fossil-powered cars. These capacity building activities combined with strong demonstration effects as owning EVs became normalized. The result is growing momentum that shows little sign of stopping. Despite the high cost to the government, EV policies have largely resisted retrenchment. Furthermore, EV policies have scaled. This is evident not only in the straight-forward expansion of existing policies but also by emboldened environmental groups, politicians and private sector actors who now seek to electrify maritime and air transport.

It remains to be seen if Norway's EV policies will lead to broader decarbonization of the transportation sector. Between 1990 and 2017, emissions from road traffic rose 22 per cent to 8.8 Mt CO2eq, the third biggest source of emissions in the country (SSB 2018). As wealth has increased in Norway, so has household consumption of goods, and its corresponding carbon footprint. A study of the total carbon footprint of Norwegian household consumption from 1999 to 2012 found a 26 per cent increase in annual emissions, a portion of that increase being linked to transportation-related pollution (Steen-Olsen et al 2016).

However, recent evidence suggest e-mobility policies are beginning to reverse the trend of growing pollution. Between 2016 and 2017, Norway experienced its largest ever drop in road transportation-related emissions, 9.5 per cent (SSB 2018). As the vehicle fleet turns over in Norway, emissions will likely continue this downward trend. Norway's average emissions for new passenger cars, measured in grams CO2 per km, have decreased nearly 40 per cent between 2010 and 2016 (Johnsen 2017). If Norway can maintain the EV incentives until declining technology costs put EVs on par with fossil cars and if the country's efforts to electrify light and heavy-duty vehicles come to fruition, then decarbonization of the road transportation sector may be within reach. Ambitious policies like a country-wide ban on internal combustion vehicle sales by 2025 will make the goal even more possible. Increasing success in decarbonizing maritime transport and a new focus on electrifying short-haul aviation may also help to reduce greenhouse gas emissions from Norway's broader transportation sector. In the meantime, the demonstration effects made in the small Norwegian market are proving to other countries that decarbonizing transportation is possible.

Of course, the success of Norway's EV policies cannot be extricated from the success of the country's fossil fuel industry. Ironically, Norway's leadership in EV policies is also because reducing emissions associated with fossil fuel extraction is politically far more difficult. Powerful incumbents and the many beneficiaries of this oil and gas industry ensure it remains central to Norway's economy. In this context, decarbonizing transportation is politically far less difficult and lacking any organized domestic opposition. While the resulting normalization and capacity building in transport electrification has led to scaling domestically and internationally, whether it supports or deflects from broader decarbonization that also puts pressure on the oil and gas sector is uncertain.

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