ETOUR

PART OF MID SWEDEN UNIVERSITY

Sustainable mobility in the periphery: Are electric vehicles the answer?

Review of international literature on electric vehicles and ideas for further research

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ETOUR

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Energimyndigheten

Foreword

This is the second of two reports produced within the project "Charging Infrastructure for Electric Vehicles along the Green Highway", which has been financed during the period 2014-2015 by the Swedish Energy Agency and conducted in collaboration with Jämtkraft Electricity Networks Ltd. and Sundsvall Electric Networks AB. The project aims overall at facilitating the interface between electric vehicles, electric vehicle drivers, and charging infrastructure. Mid-Sweden University is a partner within the project.

Read more about the project here:
http://www.miun.se/forskning/forskningscentra/etour/etour---forskning/projekt/laddinfrastruktur-for-elfordon-langs-green-highway-.

This report serves as a review of the international literature relating to electric vehicles. Among others, it examines the forces leading to the recent rise of the electric vehicle as a possible solution for future mobility needs. It address issues such as the effectiveness of incentives to encourage electric vehicle usage whilst also examining attitudes towards this form of mobility. Further, the report leads to suggestions for future research relating to electric vehicle usage in Sweden's Jämtland and Västernorrland regions.

The report's authors are Professor Dimitri Ioannides and Dr. Sandra Wall-Reinius. However, the report would not have been possible without the input of other collaborators on the project including Kristina Zampoukos (the project P.I.), Fredrik Olausson, Sara Lindahl and Hanna Hirvelä. Especially Kristina read several earlier versions of this report and provided constructive comments, leading to substantial improvements. The research team would also like to thank our partners in the project, Jämtkraft AB Sundsvall Electricity Networks Ltd. for their cooperation. A special thanks goes to project leader Mikael Hagman, who assisted with all sorts of tips and advice, and who made sure that we all at some time had an opportunity to experience driving or, at least, riding in an electric car!

It is important to also mention that we owe a big "thank you" to Kjell Inge Stellander and Asli Tepecik Diş who kindly allowed us to use a map from their report *Green Highway – A 450 km Nordic Cooperative Project*.

Last but certainly not least we wish to thank Anna Backman Åkerblom who provided invaluable help during the final production stages of the report.

The Authors, Östersund, May 2015

Sammanfattning

Den här rapporten sammanställer den senaste internationella samhällsvetenskapliga forskningen om elbilar och vi diskuterar deras möjligheter att bidra till en mer hållbar rörlighet i framtiden. Sammanfattningsvis innehåller rapporten följande avsnitt:

1. En kortfattad överblick över elbilens historiska utveckling och den senaste tidens insatser för att öka elbilarnas popularitet.
2. En sammanfattning av olika politiska åtgärder och incitament för att öka elfordonens popularitet med särskilt fokus på USA och Norge. Vi diskuterar också varför vissa av dessa incitament möjligen inte är hållbara över tid.
3. En översikt över attitydundersökningar som genomförts kring elfordon och andra alternativa bränslen. Flera tidigare studier har diskuterat de faktorer som hindrar konsumenterna från att köpa elbilar, särskilt handlar det om farhågor som rör räckvidd och bristande laddinfrastruktur samt farhågor om att elfordon är alltför dyra och inte motsvarar konsumenternas investering och förväntningar. Brist på tillräcklig kunskap om elbilar och rädsla för att ta steget att använda ny eller oprövad teknik, hindrar också många presumtiva köpare från att köpa dessa bilar.
4. Rapporten ger en översiktlig redogörelse av tidigare studier kring elfordons körsträcka och laddningsmöjligheter. Dessa studier hävdar att några av de mest effektiva laddningsplatserna är vid arbetsplatser och köpcentra.
5. Nästkommande avsnitt skiftar fokus till begreppet bilturism och specifikt den roll som elbilar kan spela i regioner där bilturism är en populär aktivitet. Det främsta exemplet på elbilsturism kommer från Oregon där den har används som ett försök att öka elbilarnas popularitet för såväl bofasta som för turister.
6. I avsnittet diskuterar vi elbilars lämplighet i regioner såsom Jämtland-Västernorrland och identifierar hinder och utmaningar som finns med att introducera elbilar i regioner med låg befolkningstäthet.
7. Ett sätt att analysera de faktorer som antingen uppmuntrar eller hindrar ökad användning av elbilar i Jämtland-Västernorrland, och i andra glesbygdsområden, är att arbeta med en enkel modell som beskriver ”push” och ”pull” faktorer. Modellen baseras på en tidigare modell om elbilsturism av Fjelstul och Fyall (2014).

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Introduction

Rising concerns about global climate change, coupled with worries about humans' over-reliance on fossil fuels for our transportation needs have led to a growing emphasis in many parts of the world on developing vehicles that rely less on gasoline and more on alternative (so-called clean) energy sources. Particular interest has been shown toward developing and promoting electric vehicles, since these are seen as a solution for greening our transportation needs, especially when electricity is generated from renewable (non-fossil fuel sources), such as through wind, hydro, or geothermal power. Such vehicles include the so-called hybrids like the ultra-popular Toyota Prius, which depend on a gasoline-powered generator but increasingly it is the mainstreaming of electric vehicles (EVs), which run entirely on electricity that has grabbed the attention of policymakers.

In a *Dagens Nyheter Op. Ed.* shortly before the September 2014 general election, the Central Party leader and former Minister for Enterprise, Annie Lööf (2014), reported her Party's priorities, revealing Sweden as a country where the need to develop an environment favoring electric cars is taken seriously. Recognizing growing dependence on personal transportation vehicles – a fact that has much to do with increasing decentralization of cities and enhanced urban sprawl (Banister 2008) - and because in large parts of the country (including the very low density rural areas of much of the north) the automobile is the only realistic form of transportation, Lööf proposes that a solution for improving personal mobility in the near future is to take the following steps: provide better incentives for buying environment-friendly cars; build more charging stations throughout the country (including fast charging stations); make it easier to charge whilst at work; and provide incentives to create more environmentally friendly commercial vehicles, including trucks.

Meanwhile, the designation of the E14 highway, which runs between Trondheim in Norway to Sundsvall in Sweden, as a Green (fossil free) Corridor (see Figure 1) is one project aiming to popularize the use of electric vehicles in Nordic countries (www.greenhighway.nu 2015). That project's website states that "the aim is to create a fossil-fuel-free corridor, as well as to demonstrate that investments in green technology boost the economy and contribute to sustainable growth and reduced environmental impact. In extension, this may mean emission free destinations that are attractive to both residents and tourists". According to Tepecik Diş (2012: 7) the "Green Highway is a registered trademark referring to a combination of activities with the same goal – a fossil-free green transportation corridor based on local and renewable energy intended for people who drive eco-friendly vehicles". The designation of this road and, indeed, the entire region, which encompasses this as a test case for electric vehicle usage is not surprising given its low density with small and mid-sized cities situated at considerable distance from each other. The spread-out pattern of development signifies a high dependence on private automobile usage and since this is a region with an abundance of renewable energy it makes sense to harness this towards increasing rates of electric car adoption.

Figure 1: The E-14 Green Highway (Source: Nordregio News Publication, Issue 1, February 2012, reproduced with kind permission of the authors)

Although the Green Highway region sets itself an overtly ambitious (and probably unrealistic) goal of becoming an entirely fossil fuel corridor over the next five years, several achievements have already been met. These include, among others, the positioning of several charging stations along the length of the corridor, including a number of fast charging facilities, the setting up of an electric taxi project in Trondheim and the promotion of electric vehicle usage in the motor fleets of some municipalities. According to various websites[1] there now exist several charging stations between Östersund and Storlien (including a Tesla charging station in Krokom). The Tesla charging station in Krokom is equipped with 8 supercharger stalls that are available at all times (www.teslamotorscom). It is of interest to note that the majority of chargers all the way from Sundsvall to Storlien on the Swedish-Norwegian border are on or within the vicinity of the E-14 while other parts of Jämtland and Västernorrland are severely under-served. Perhaps more significantly, the websites reveal that most chargers on or close to the E-14 are clustered in Norway mostly in or around Trondheim.

That electric vehicles are becoming more popular is unquestionable, especially considering that only a decade ago this type of transportation seemed a distant and perhaps unrealistic

[1] http://www.plugshare.com;

http://www.elbilsverige.se/index.php/ladda;

http://www.ladestasjoner.no/hurtiglading/hurtigladekartet

dream.[2] Sales in countries like Norway offer encouraging signs that people are becoming increasingly used to the notion of driving non gasoline-dependent cars. Nevertheless, to this date the sale of conventional (gasoline powered) vehicles continues to significantly outperform that of electric vehicles and this is a situation that is unlikely to change in the near future, especially given the recent decline in global oil prices.[3] Moreover, the dramatic increase of sales of private cars in countries like China and India due to the rise of the middle class in those high population countries means that even if in some parts of the world electric car usage rates creep up the dominance of the internal combustion engine will remain unassailable for the foreseeable future.

This international literature review covers several issues relating to the development and adoption of the electric car. Following a brief historical background concerning electric vehicles, we explore the role that various financial and other incentives can play in persuading potential buyers to purchase electric vehicles while also examining the possible downside of such measures. Further, we examine the prevailing attitudes towards such modes of transportation and discuss why until recently the majority of consumers continue to resist a shift from conventional gasoline-powered cars to electric vehicles. Our review also briefly examines issues such as driving range, recharging stations, and the ideal locations for placing such facilities.

Following that part, our attention shifts to the concept of drive tourism and, specifically the role that electric vehicles can play in this context. The idea is that using EV drive tourism in a particular destination can act as a demonstration project promoting the adoption of EVs overall among the region's residents. We proceed to explain why it makes sense for electric vehicles to eventually become the transportation mode of choice in low density regions, such as the region that is traversed by the E-14, despite the fact that most authors talk about the adoption of this technology in urban contexts. In fact, as we shall describe some commentators argue that within cities the aim to institute a move from vehicles running on fossil fuels to electric cars falls way short of solving the long-term problem of congestion commonly associated with the rapid growth of personal vehicle usage. Further, the emergence and adoption of electric cars in urban regions perpetuates the dominance of the status quo, geared as it is towards utilizing personal motorized vehicles as opposed to shifting towards other sustainability-oriented solutions (e.g., those emphasizing the necessity of improving accessibility of services to communities through revised land use planning and the shift toward non-car mobility like walking and cycling or collective forms of transportation) (see Banister 2008).

[2] The 2006 American documentary "Who Killed the Electric Car" (Sony Pictures) gave a troubling account of how despite developing and test marketing its first electric car (the EV1) and even though this model was well received by many, GM was a key protagonist in terminating the program demonstrating that the major players in the motor industry were not yet ready to move away from the status quo.

[3] At the time of writing (end of January 2015) the price for a barrel of crude oil was less than $50 compared to approximately $115 per barrel in June 2014 (http://www.vox.com/2014/12/16/7401705/oil-prices-falling)

This factor suggests that when it comes to urban areas perhaps we ought to consider changing our mindset and search for solutions going well beyond the use of motorized personal transportation modes regardless of whether these are electric or not. Further, there is a possibility that the real value of the electric car is to be found through its adoption in low density rural settings, a point that has already been highlighted by others (e.g., Newman et al. 2014).

In the final part of the report we propose a simple framework for comprehending the push and pull factors behind the broader adoption of EV usage in the countryside. The framework draws inspiration from a model of the dynamics of EV tourism as proposed by Fjelstul and Fyall (2014).

Methods and Materials

This report is based on a scan of the international literature, primarily of research articles in scientific journals. Further a handful of reports plus popular media articles as well as various websites were consulted. Almost all the literature examined is no more than a decade old, an unsurprising fact given that the topic of electric cars and their adoption overall is a fairly novel phenomenon. In order to conduct this literature review the search engines Google Scholar and Web of Science were primarily utilized and keywords for our searches included the following: *Electric car adoption; electric cars, mobility and accessibility; obstacles to electric car adoption; attitudes towards electric cars; incentives for adopting electric vehicles; EV recharging infrastructure; consumers of electric cars; electric cars as a solution to transportation problems; electric car adoption in rural regions or the countryside; EVs and tourism*. Because there were numerous articles concentrating on all kinds of alternative fuel vehicles (including hybrids) we made an early decision to narrow the search almost entirely to articles focusing specifically on EVs, meaning cars that depend exclusively on electricity as their source of power. This meant that articles about hybrids and so-called plug-in hybrids, which rely at least partially on gasoline power, were largely ignored though some of these were selected in cases where we felt that the subject area and findings were of relevance to the broader discussion.

Upon choosing a journal article to review in Google Scholar we were often presented with suggestions for similar readings a number of which we examined further. For the purposes of this study we restricted the language of our search to English given that there is a sister report by Zampoukos et al., with a specific Scandinavian focus. We recognize this narrow focus on English language articles as a shortcoming of our search. Regardless, several articles we examined reported on literature undertaken in countries like Denmark, Germany, and the Netherlands though admittedly most studies referred to are US-based. This, in itself, is not surprising considering the big push in recent years to expand the acceptance of alternative fuel vehicles in what arguably is the most auto-dependent country.

The literature review itself is far from exhaustive. We quickly realized that there exist numerous studies of a technical nature (referring specifically to the technology and written with a scientific audience in mind) that were beyond our expertise as social scientists and did not constitute the focus of our study. Further, there are numerous studies relating to people's attitudes towards EVs and the reasons they avoid purchasing these types of cars. We refer to a number of these whilst realizing we have ignored several others, in part because we felt there was much duplication of the subject matter that has already been comprehensively covered elsewhere (see particularly Rezvani et al 2015). Since one of the topics we wished to examine in more detail involves the interrelationship of EVs and tourism we utilized a variety of search engines to look for scientific research on this theme. Unfortunately, we were disappointed to find out that this appears to remain a severely under-researched area.

Historical Background

The history of the electric car is as old as the history of the automobile itself if not older. The very first electric vehicle (EV) to ever be exhibited was a battery-driven tricycle. Battery powered cars were in existence as early as the early 1890s and by 1897 electric taxis had been deployed in London, New York, and Paris (Høyer 2008). According to Duke et al. (2009) by 1898 the very first vehicle to achieve a speed of 100 km/hour was an electric car known as 'La Jamais Contente'. Women were especially keen on electric cars since these lacked the crank necessary for the early gasoline driven vehicles and, generally speaking, public opinion towards these EVs was positive. However, these early horseless carriages were quickly consigned to a footnote of history since the internal combustion engine (ICE) grew in popularity far more rapidly due to the contribution of people like Henry Ford (The Model T Ford in 1909). The main reason behind this was that it was far more convenient and quicker to refuel an ICE vehicle, a situation that has remained unaltered for more than a century.

For over 100 years it has been the gasoline-powered engine that has dominated the road transportation sphere. Høyer (2008) maintains that a major challenge to the widespread adoption of EVs – one that still poses problems today - was from the outset the problem of charging such vehicles in a timely manner (see also Duke et al. 2009). Certainly when it comes to refueling, a conventional ICE vehicle has always been far more convenient and hence more desirable.

It was not until the 1960s, 70s, and 80s that scientists seriously began looking at the possibility of EV development once more (Harding 1999; Dijk et al. 2013). This had much to do with growing concerns at the time about diminishing fossil fuel reserves (e.g., as postulated by the Club of Rome[4]), the growing alarm about enhanced atmospheric pollution and the realization of the role played by the transportation sector in contributing to this problem. In Japan, for example, the Ministry of International Trade and Industry (MITI)

[4] The Club of Rome is a global think tank best known for its path breaking book from the early 1970s *The Limits to Growth*.

"established a basic market expansion plan for BPEVs in 1976" (Åhman 2006). Still, by 1980 only 4000 EVs had been sold worldwide and the outlook at the time did not look favorable in terms of their increasing popularity (Dijk et al. 2013). It was only after the Kyoto Protocol that the explicit link of transportation sector towards fossil fuel led pollution was made (Høyer 2008). Despite these events, however, most automobile manufacturers continued for a number of years to demonstrate widespread reluctance to shift their production towards EVs. This reluctance was well evidenced in the 2006 American documentary "Who killed the Electric Car"[5], which specifically demonstrates the resistance of large automakers such as General Motors towards developing EVs despite the fact that they had developed a prototype battery-powered car. Dijk et al. (2013) point out that in general the US auto industry, most likely in agreement with the powerful oil sector, was very much against clean air restrictions and lobbied successfully to reduce these, thus in effect damaging the chances of making EVs more popular.

The gradual shift towards the search for alternative sources of energy for running cars and other vehicles has undeniably been influenced by the growing alarm relating to climate change caused by increasing carbon dioxide levels in the atmosphere. According to Chapman (2007) transport is responsible for approximately 27% of global CO_2 emissions and "car use, road freight and aviation are the principal contributors to greenhouse emissions from the transport sector" (p. 354). Road transportation itself accounts for 81% of the total energy required by the entire transportation sector and thus, undeniably efforts must be made to reduce the dominance of oil whilst searching for new non-polluting sources of energy. This is especially the case when it comes to the use of personal cars, which are the second largest producer of greenhouse gas emissions following road freight (Chapman 2007: p. 357).

Over the last few years, especially in the aftermath of the Kyoto Treaty, there has been growing rhetoric in developed countries encouraging people to reduce their auto dependence. This is particularly the case for the dozens of trips people tend to take, which are often of a very short distance (such as journeys to school and for shopping) and could easily be replaced by walking or cycling. Additionally, in numerous communities (especially denser urban areas) worldwide, schemes have been implemented to encourage people to reduce or entirely avoid utilizing their personal cars, especially for in-city trips and, instead, use collective means of transportation (car pools, transit, etc.) (Banister 2000; 2008).

The tide begins to shift

In the United States, where the private car dominates more than anywhere else in the world, an increasing number of communities have sought ways to adopt transportation alternatives such as walking, cycling, and transit. The conversion of riparian and railway corridors into hiking and cycling paths has been a well-established practice in many communities for more than a quarter century. The 1991 ISTEA (Intermodal Surface Transportation Act) quite clearly

[5] See footnote 1.

made the connection between land use and transportation, underlining that to enhance the efficiency of public mass transit systems there is a necessity to encourage higher density development and mixed land uses (Newman and Kenworthy 1996). Unfortunately, however, despite a handful of success stories, the overwhelming evidence is that the country still finds itself a long way off from a drastic change in people's mindset to a point where they will reduce their dependence on private automobiles. If the recent downturn in oil prices is anything to go by it is interesting to note that it has led to rising sales of conventional ICE vehicles.

Nevertheless, there has been a gradual, though growing change in thinking in terms of moving towards vehicles, which either reduce or entirely eliminate dependence on gasoline. To a large extent the impetus for this change were the several initiatives mimicking California's zero emission regulations of 1990, which sprouted up at different times in various parts of the US (Høyer 2008; Gordon, Sperling and Livingston 2012; Dijk et al. 2013). Calef and Goble (2007) discuss how the California Air Resources Board (CARB) was set up in September 1990 with the direct aim of cleaning the air in major metropolitan areas such as Los Angeles. The objective was to develop zero emission vehicles, including EVs even though at that time the technology was still very much in its infancy.[6] Calef and Goble term this type of regulation, aimed at creating and providing EVs on a commercial basis within a set timeframe as "*technology forcing*" (p. 2). They argue, however, that in the beginning the automobile lobby, not to mention the oil industry, objected strongly to this regulation and sought to undermine it. In the meantime, in Europe similar moves were initiated by the French government in 1992 to encourage EVs as a means of cleaning the air. In that case, the French government's proposals generated little, if any, debate.

In reality the constraints imposed by the inability to substantially improve the battery life required for EVs meant that the requirements of the CARB were substantially amended by 1996, resulting in a far less ambitious agenda. This led, at least initially, to the acceptance of the so-called hybrids, which made a breakthrough in the late 1990s. It is only more recently that there has been a slow yet rising interest towards electric vehicles and other non-gasoline dependent vehicles. Indeed, according to Dijk et al. (2013) there were certain areas where demonstration experiments of electric cars were initiated (e.g., Rugen Island in Germany) and the public's reaction towards these vehicles was, for the most part, favorable even though that enthusiasm did not initially translate to willingness to actually buy such models.

The growing acceptance of hybrid vehicles such as the Toyota Prius and the Honda Insight since the late 1990s had to do not so much with concerns about consumers' environmental footprint but rather with worries about the rising cost of fuel and the associated need to increase the average mileage per unit of fuel used. Unlike the pure EV, which failed to inspire consumer confidence due to negative perceptions regarding limited range and

[6] The ambitious requirement put forth by the CARB was that 2% of passenger cars and light trucks sold in California by 1998 had to have zero emissions. The idea was that gradually there would be an increase in this percentage, with 5% of cars being zero emission by 2001 and 10% by 2003.

refueling opportunities, not to mention high purchase costs, hybrids emerged as a popular option since the driver of such vehicles is always able to fall back on gasoline power once the car has used up its battery power (Skerlos and Winebrake 2010). However, despite the growing popularity of such vehicles some analysts question how economical/efficient they really are in terms of energy consumption especially compared to other options such as new diesel powered alternatives (Høyer 2008). Moreover, while the popularity of hybrids increased, most automakers refrained from developing such models, choosing instead to make their existing models more efficient (e.g., VW's Bluemotion line) (Dijk et al. 2013).

Arguably, the breakthrough shift in attitude towards EVs occurred roughly around 2005 at a time when climate change worries and not so much clean air issues were beginning to make the news. Such worries led the governments of various countries "to demand the car industry to decrease vehicle CO_2 emissions even further" (Dijk et al. 2013). Various programs were embraced in Europe and in the US to promote EVs and as a result a growing number of automakers began to engage in earnest in the research and development of such vehicles. "The American Recovery and Reinvestment Act (ARRA) of 2009 provides over $2 billion for electric vehicle and battery technologies, geared toward achieving a goal of one million electric vehicles on US roads by 2015" (Egbue and Long 2012: 717; see also Skerlos and Winebrake 2010). Emphasis on improving battery technology has been especially important while as Egbue and Long argue there has also been a concerted effort through the US Department of Energy's vehicle improvement program to make batteries significantly more affordable. According to Fox (2011) vehicles using electric motors as their principal power source (also known as plug-in vehicles) were meant to go into mass production in 2011, simultaneously leading to the need for numerous charging stations.

It was not only in the US that moves towards encouraging the introduction of EVs took place. In 2008, the Irish Ministry of Transport put forth an ambitious agenda that by the year 2020, 230,000 privately owned cars in the country would be EVs; that is 10% of all private cars (Brady and O' Mahony 2011). Similarly, in 2007 the New Zealand Ministry for Economic Development proposed various programs for reducing carbon emissions and in tandem with this "the Energy Efficiency and Conservation Agency (EECA) have also proposed the wide scale deployment of electric vehicles (battery electric vehicles (BEVs)), in part because the lack of an efficient public transportation system in that country for long-distance trips means there is a high dependence on automobile transportation (Duke et al. 2009: 3455).

Table 1: Glossary of terms relating to alternative fuel vehicles

Vehicle Type	Characteristics	e.g., of vehicles	Range
Hybrid Electric Vehicle (HEV)	Normally powered by a regular internal combustion engine but also has a battery charged by breaking and the regular engine (do not have to plug in)	Toyota Prius; Honda Insight	Similar range to regular internal combustion vehicles.
Plug-in Hybrid Electric Vehicle (PHEV)	Gets its power from an internal combustion engine that partially uses energy from a battery. The battery is charged by plugging into an electricity source. These vehicles normally begin their trip using battery power and once that is reduced and eliminated they switch to gasoline power. Their range is similar to a regular car but they only run off battery power for a small portion of the entire trip.	Chevrolet Volt; Toyota Plug-in Hybrid Prius.	Similar range to regular internal combustion vehicles.
Battery Electric Vehicle (BEV)	These vehicles operate entirely on battery power and do not have fuel tanks. The battery is recharged by plugging in.	Nissan Leaf; Tesla Roadster; Tesla Model S	160 KM for the Leaf depending on weather etc; Tesla has a range of about 300 to approximately 450 KM.
Fuel Cell Vehicles (FCV)	These vehicles are ones where hydrogen is converted into electricity from fuel cells.	Toyota Mirai (scheduled to be in production late 2015)	Range 650 KM

Source: Based on: Duke et al (2009); Fox (2011) and; Bronstein and MacArthur (2011)

The introduction of battery powered electric vehicles (EVs) such as the Nissan Leaf and plug-in hybrids, including the Chevy Volt and the Toyota Plug-in Hybrid, have marked the latest in a long line of developments aimed at reducing and finally eliminating oil dependency (see Table 1). Nevertheless, cynics argue that it is simplistic to view EVs as entirely zero emission since the electricity required to power them is not always generated from clean sources. If, for instance, the main source of electricity is either a coal or an oil dependent power station

then the carbon footprint of the vehicles depending on this electricity is much higher than some would like us to believe (Høyer 2008; Hawkins et al 2012; Hickman 2012). This is especially a major concern in countries like China where much of the electricity production derives from fossil fuels (e.g., coal power stations) thus making little environmental sense to switch to EVs. Moreover, as Hawkins et al. conclude "the production phase of EVs proved substantially more intensive" (p. 61) than that of conventional cars, meaning there is a high level of toxicity in manufacturing such vehicles, thus leading to increased global warming potential. Further, Thomas (2012) pessimistically argues that in the US it was a mistake for the Obama administration to opt for EVs and PHEVs as the sole alternatives for encouraging an "alternative vehicle strategy" (p. 60-61) since this would only lead to approximately a 7.5% reduction in greenhouse gas emissions. Instead, Thomas suggests that a better strategy would be to replace all vehicles in the country with fuel cell vehicles.

Others dismiss these arguments. Martin Eberhard and Marc Tarpenning (2007) who represent Tesla Motors, which has rapidly evolved as the world's premium EV, have argued (perhaps not surprisingly) that while such concerns have merit, in reality the electric car "is significantly more efficient and pollutes less than all alternatives" (p. 1). With the increasing generation of "clean" energy from renewable sources (e.g., wind power) worries about the carbon footprint of EVs are of course reduced.

Table 2: List of selected EVs manufactured by mainstream car companies

Car Company	EV Model	Range
BMW	i-3	130-160 km
Citroen C - Zero	C-zero	150 km
Fiat 500e	500e	140 km
Ford Focus Electric	Focus electric	122 km
Honda FIT EV	FIT EV	132 km
Mitsubishi i--MiEV	i-MiEV	170 km
Nissan Leaf	Leaf	200 km
VW	E-Golf	190 km

If it happens, the target of one million plug-in cars circulating on American roads by 2015 (Bronstein and MacArthur 2011; Egbue and Long 2012; Miller 2014) is, of course, but a tiny

proportion of the total fleet of approximately 250 million vehicles on American roads.[7] [8] On the plus side, however, it is evident that for the first time a concerted attempt is being made to begin the process of stepping away from the dependency on the internal combustion engine. Importantly, the efforts to increase the availability of EVs over the next few years whilst strengthening demand for these, mean that various governments, including the US, have instituted a number of incentives targeting both the manufacturers (for research and development) and the general public. As a result, all major auto manufacturers are expected to introduce plug-in models over the coming years (Hidrue et al. 2011) (Table 2).

In the accompanying ETOUR report to this one, Zampoukos et al (2015) review Swedish and Norwegian documents and investigations in order to identify rhetoric, tendencies and arguments in the national electric vehicle agenda, whilst they also discuss differences between those countries regarding strategies, responsibility and implementation. By contrast, our emphasis here is specifically on programs and incentives that have been put forth in various countries such as the US but also Norway in order to encourage EV adoption. The next section examines the effect, which various incentives have had on demand for EVs, while we also address the downside of such enticements.

Incentives: Pros and Cons

The laws and policies set forth in the United States in an attempt to encourage the development and sales of EVs include, among others, large-scale investments in the manufacturing of more efficient and ultimately affordable batteries. After all, for a long time the high cost of the batteries alone has acted as a major deterrent to potential buyers since this contributes to the high cost of EVs compared to conventional cars (Hidrue et al. 2011; Gordon et al. 2012). The existing incentives to encourage the move towards lower and zero carbon emission vehicles in the US target both the supply and the demand side. From the supply perspective there exist federal level incentives given to manufacturers to continue research on and development of EVs. From the demand perspective consumers are awarded federal tax credits ($7500 per vehicle) and loans for buying and owning a plug-in vehicle. Many states provide additional incentives ranging from financial bonuses and tax credits (California gives an additional $3000 in tax credits) to perks such as the ability of EVs to use designated High Occupancy Vehicle (HOV) lanes regardless of number of passengers per car or to park for free (Gordon et al. 2012; Krause et al. 2013). In some Californian municipalities like Hermosa Beach, electric vehicles displaying a zero emission decal are eligible to park without charge in municipal parking sites. In Los Angeles the various utility companies offer reduced rates to persons who charge their EVs during off-peak hours (Information extracted

[7] There were 172,000 EVs in the US at the end of 2013 and by September 2014 this number had risen to about 260,000, which is considerably short of the target for 2015.

[8] In fact Rezvani et al. (2015) maintain that by 2011 the share of EVs as a proportion of all light duty vehicles sold in the US, EU and main Asian markets was but 0.06% out of 51.1 million.

from Tesla vehicles website). "Encouraged by these actions, along with advances in lithium-ion battery technology and recent success stories for hybrid electric vehicles, automakers have begun a major push to develop plug-in battery vehicles. Indeed, all major automakers have R&D programs for electric vehicles (EVs) and have indicated their intentions to begin mass production within the next few years" (Hidrue et al. 2011: 687).

Norway, "is the leading country in terms of governmental incentives" when it comes to EVs (Haakana et al. 2013: 9). These incentives, which were originally introduced in the late 1990s and early 2000s aim "to bring BEVs up to or beyond par with similar conventional (ICE) vehicles, both from an economical and functional view" (Hannisdahl et al. 2013). These incentives amount both to economic enticements but also other advantages for EV drivers including the right to park for free and the unrestricted use of transit-only lanes (see Table 3). Also, according to Vidal (2014) it is cheaper to insure an EV while the government offers subsidies for home charging points.

Incentives such as these undoubtedly have had a positive impact on increased EV sales in Norway, especially considering this is a country where conventional vehicles are heavily taxed in relation to most other countries. Hannisdahl et al. (2013) have argued that regular cars are taxed according to several factors such as their weight, their emissions, as well as adding 25% VAT. By contrast, an EV is exempt of both VAT and other import duties. As evidenced by a recent study (Figenbaum et al. 2014) a key motive driving the increase in EV sales other than the vehicles' low operating costs was the free use of toll roads.

Table 3: Incentives for EVs in Norway

Free parking at public parking spaces
Free use of toll roads
Access to public transit lanes
An annual road tax fee of 400 NOK as opposed to 2800 NOK for ICE vehicles (2011)
Free charging at public charging stations
Purchase price excludes new vehicle registration tax and VAT
50% discount in company car tax
Free access on road ferries (driver must pay)

Source: Haakana et al. (2013: 21); Hannisdahl et al. (2013).

Sales' figures for the Tesla S attest to the rising popularity of EVs in Norway. Matters are helped because Norway has almost 4000 charging stations around the country following the implementation of a government grant (Hannisdahl et al. 2013). Norway has, in fact, registered the highest volume of sales of the Tesla S of any country in Europe (Jones 2014). In

April 2014, King reported on *Autoblog* (citing a *Wall Street Journal* article) that the American-built Tesla sold during the preceding March almost 1,500 cars throughout Norway beating the second best-selling vehicle (Volkswagen Golf), which only sold 624 units. What is remarkable is that this volume of sales surpassed a 28 year old record for monthly sales set by Ford Sierra in the 1980s (1,454 cars). Even more astounding was that just a month earlier – February 2014 - the Nissan Leaf (also an EV) was the best-selling vehicle in Norway. King maintains that such a volume of sale is particularly impressive considering Norway's modest population size (5.1 million people). If the same per capita basis was assumed for sales of the Tesla S in the US that would translate to 94,000 EVs sold per month, making it the best-selling American car!

There are several reasons behind this impressive sales volume despite the expensive price tag associated with the Tesla S. What has driven the high volume of sales in Norway is undoubtedly the large number of perks associated with buying a Tesla S such as access to free parking, use of bus lanes and exemption from ferry and road tolls (which can be significant). Also, despite the fact that a Tesla S retails for approximately $100,000 (which is hardly cheap) the high cost of gasoline-powered cars in Norway and the fact that an equivalent car such as the BMW 7 Series would cost about $300,000 mean that the Tesla is actually great value for money. Indeed, the price of the car reflects the enormous subsidies one receives, which act to suppress the final price.

Overall, EV sales in Norway have been astounding. By the end of 2012 there were 9,500 EVs, representing an increase of 4,679 from the previous year (Hannisdahl et al. 2013). At the beginning of 2014 there were over 21,000 EVs registered in Norway and sales were averaging 1200 a month (10% of all sales) (Vidal 2014). To put matters into perspective this compared to just about 170,000 EVs registered at the time in the whole of the US a country that has more than 300,000,000 people whereas Norway only has a population of 5 million. In the UK, with a population of 63 million there were barely 5000 EVs at the same time. Surprisingly, in Sweden sales of EVs have been far more modest that in Norway, partly because incentives have never been as strong and the ones that exist do not distinguish between EVs and other so-called clean energy vehicles including hybrids. Moreover, Sweden lags far behind Norway when it comes to recharging infrastructure.

Ironically, the high pace of EV sales in Norway means that the goal of reaching 50,000 EVs in that country by the fall of 2017 (Hannisdahl et al. 2013) may actually be achieved as early as the middle of 2015[9]. If this is indeed the case it means that the current period of generous incentives in Norway may be coming to a premature end since it has always been the aim to reduce or eliminate such benefits once the targeted number of EVs has been reached. The question is what happens afterwards? Will the removal of incentives dramatically lead to a

[9] Although this is not an official source, a Wikipedia page entry for "Plug-in electric vehicles in Norway" reports that by March 2014, 1 in every 100 cars in Norway was electric. By December 2014 there were more than 40,000 plug-in EVs in the country, 95% of which were all-electric (see: http://en.wikipedia.org/wiki/Plug-in_electric_vehicles_in_Norway).

reduction in EV sales or is the hope that by then the EV's popularity will have increased to an extent whereby consumers will no longer need these benefits to help them make up their mind as to whether or not to purchase an EV?

When it comes to EVs, the issue of incentives has generated debate as to whether these, in the long run, can lead to more costs than benefits. To be sure, incentives are important given the hefty price tag associated with such cars and they act as a carrot to entice more consumers to adopt what arguably are cleaner transportation modes. However, several questions arise: First, some observers express concerns that at least some of the incentives like driving on high occupancy lanes and using bus corridors defeat the purpose that these initiatives were made for in the first place (i.e., to relieve congestion and to encourage mass transit or car sharing as well as other non-motorized forms of mobility like cycling and walking) (Deshayes 2014). Second, there is the issue that such incentives, like tax elimination or cuts, can prove burdensome to society in the long run when it comes to identifying sources of funding for various infrastructural and/or social programs.

An early Swedish study by Carlsson and Johansson-Stenmann (2003) suggests it is a poor idea for governments to promote the introduction and adoption of personal use EVs by subsidizing them through incentives packages since this will inevitably lead to a substantial decline in tax revenue and, presumably, a reduction in funds for various public sector projects. Their finding was that compared to conventional petrol cars, battery driven electric cars "do not seem to be socially profitable" (p. 25). Essentially, the authors argue that by providing incentives for purchasing EVs their drivers are subsidized quite heavily especially since, among others, they also avoid paying the high fuel taxes, which are commonplace in most European countries.

In the context of EV adoption in the United States, Gordon et al. (2012) have also expressed concern that "the transition to PEVs further cuts into fuel revenue streams. Today, motorists face an average gas tax of 49 cents per gallon of gasoline (18 cents in federal taxes) and 54 cents per gallon of diesel (24 cents in federal taxes). Electric vehicle drivers, however, are spared these fees" (16). The authors proceed to argue that there is a danger that the tax revenue stream in some American states will begin to diminish thus making it harder to find funds for building and maintaining roads, bridges, tunnels, and so on.[10] This has led to calls, at least in some jurisdictions, to find alternative ways to collect taxes from EV users. Washington is the first state to charge a flat $100 annual fee to EV drivers as a user charge while Oregon considered legislation to make EV drivers pay 1.43 cents per mile driven "compared to an average of 2 cents per mile in gas taxes currently paid by American drivers" (17).

There is also the question as to whether such incentives positively influence demand for EVs (Gallagher and Muehlegger 2011). While undoubtedly the generous incentives and other

[10] In the US money accumulated through transport related taxes can only be placed into transport related projects and, unlike Europe, cannot be used for social projects

programs in Norway appear to strengthen demand others have expressed a degree of skepticism as to whether it is ultimately these measures that are the most significant motivating factors when deciding whether or not to purchase an EV. For instance, Gordon et al. (2012) contend that the tax credits given to EV users in the US vary according to a household's taxation liability. In other words, a middle class household can only receive the full $7,500 federal tax credit for an EV if it had no other tax credits such as those for dependents and mortgage interest payments. In effect, it is only those in the higher income groups that benefit fully from these tax credits while the middle classes end up losing out.

Meanwhile, Skerlos and Winebrake (2010) suggest that incentives such as tax credits should actually vary both by consumer income and also by the region where the sale of the EV takes place because, they argue, that the social benefits deriving from such programs are not equitable. One of their arguments is that "it is interesting to consider an alternative to a uniform tax credit where significantly larger credits are offered in regions featuring high net benefits of PHEV use . . . and reduced credits are offered in regions featuring low net benefits (p. 706).

On the matter of the effectiveness of federal and state government incentives for alternative fuel vehicles, Diamond's (2009) research on hybrid electric vehicles in the US finds that it is not so much the incentives that inspire the sales as much as the price of gasoline. He argues that "gasoline prices serve as the most visible signal for consumers to think about fuel savings and fuel economy, so it is reasonable that relatively minor variations in gasoline prices could lead to significant changes in adoption patterns, particularly for people in the market for a new car as gas prices rise or fall" (p. 982). He also reinforces the idea that Americans are not keen on tax credits since these only kick in after the purchase of the car and not during the time of sale. In his opinion, only incentives leading to reduced costs for the consumer upfront would be desirable. This may explain why the Norwegian incentives are more appealing than those in the US. In Norway, the monetary incentives come at the point of purchase, meaning the buyer receives a substantial savings from the outset. In the US one has to file a tax return stipulating the full amount that has been spent on an EV and then one hopes to receive a refund, which according to the Internal Revenue Service may end up being less than the maximum allowed.

This notion is reinforced in the study by Gallagher and Muehlegger (2011) who examined the difference between state sales tax waivers and state income tax credits in enticing consumers to buy EVs. Of interest is their comment that "even though state sales tax waivers tend to be less generous than state income tax credits, we find that the mean sales tax waiver (value $1077) is associated with three times the increase in sales of the mean income tax credit (value $2011). This is not entirely surprising since a sales tax credit would mean that the consumer pays less or no sales tax *upfront* and thus the overall cost of the vehicle is immediately reduced. By contrast, to receive a tax credit one has to pay the full cost of the vehicle, including tax, upfront and then proceed to apply for a tax refund. Despite the average refund being higher than the sales tax waiver it is obvious that most people prefer to have less to pay from the outset and not worry as to when they will receive their refund. This

leads Gallagher and Muehlegger (2011) to conclude that policymakers should seriously consider the types of incentives they give out.

While an incentives' package that is attractively developed and presented to consumers such as the one that has existed in Norway for some years can likely increase the sales' volume it is important to also examine overall attitudes towards EVs given that in many markets people remain largely skeptical about this new technology. This is hardly surprising given that EVs are still very new and the technology is undergoing adjustments (for example in terms of increasing driving range). On the whole, in most markets consumers remain largely unfamiliar about EVs since very few of them are actually in circulation. Additionally, common fears include anxiety about these vehicles' perceived range restrictions and the possibility that there will not be a charging station to be found in an emergency. Other concerns include the worry that the upfront costs for such vehicles are far too high compared to those of many conventional vehicles while there is evidence to suggest that consumers do not really understand the savings they could derive from operating such vehicles given the lower operational costs they incur (Graham Rowe et al. 2012; Rezvani et al. 2015).

In their comprehensive overview of the drivers for and barriers against consumer adoption of EVs, Rezvani et al (2015) conclude that in spite of increasing environmental awareness, the use of EVs is still insignificant and one of the major challenges is to understand consumer behavior towards EVs. We need to know more about what factors influence consumer intentions to purchase EVs and what reasons stop them from doing so. The next section pays close attention to studies, which concern consumers' attitudes towards EVs.

Attitudes towards electric cars

> *Motivating consumers to shift to PEVs is complicated because some of the benefits resulting from the switch are societal in nature, rather than individual and hedonic. . . And even the individual benefits that occur are not fully recognized until many years after the vehicle is purchased. Persuading consumers to pay immediate costs in exchange for long-term benefit is not an easy marketing task (Krause et al. 2013: 433).*

The preceding quote indicates that despite many people professing their strong advocacy of the environment and the consumption of green products, all too often these considerations are of lesser importance than their economic priorities. In other words, although they are likely to agree with the statement that the world should be greener in the future they are extremely hesitant about paying an upfront premium for this distant goal.

Most consumers remain suspicious about adopting new technologies that have not been proven in the mass market (Egbue and Long 2012). This is unsurprising considering the majority of consumers, especially those who are not technologically savvy, adopt a wait-and-see attitude when a brand new product hits the market. They know from past experience

that this new product may suffer from "teething problems" and prefer to wait until it has been around for a while and its early adopters give it a positive review. In fact, they are likely to wait for a new model that presumably has ironed out any problems the original one may have presented. Also, they may expect that once a product becomes established its price may actually fall. That has certainly been the case with computer technology over the last three decades while it took several years for customers to embrace plasma and LCD television sets as these became progressively cheaper. Such barriers indicate according to Egbue and Long that both manufacturers and policymakers must be aware of consumer concerns and be able to address these if they want acceptance levels for their products to rise.

Despite the impressive sales of EVs in Norway, not to mention the numerous consumer incentives in that country and many others, including China, to nudge them towards buying alternative fuel vehicles, the electric car has a long way to go before it becomes the vehicle of choice for the majority. Rezvani et al. (2015) note the disappointing sales' figures for EVs by indicating that in 2011 they accounted for 0.06% of all light duty vehicles collectively sold in the US, the EU, and main Asian markets. According to Howard (2013), by the first half of 2013 EV sales in the US had drastically improved compared to the same period a year earlier, although considering a total of eight million cars were sold and only 25,000 of these were EVs that figure sounds far from promising. Of these 25,000 EVs only the Nissan Leaf and the Tesla had what would be considered reasonable sales figures. There were several reasons for the modest improvement in sales such as reduced sales prices, which were prompted by factors like cheaper batteries. Also, Howard points out that some people were convinced that despite range anxiety their everyday driving needs of around 20-40 miles fell well within the safety range of not having to worry about recharging during the day. However, the majority of people who expressed such an opinion were those in the 2 or more car households where one of the cars was not an EV (something to fall back on if the EV is not charged).

Referring to the US, a recent *Wall Street Journal* (*WSJ*) article suggested that, overall, EVs have not been selling as well as some had predicted for various reasons including limited consumer knowledge, the notion that EVs cost too much, and the fact that existing incentives to promote their sales are actually largely ineffective (Chernova 2014 – see the previous section). This WSJ article drew from an academic study by Krause et al. (2013) supported by the University of Kansas and Indiana University, which revealed that "recent marketing surveys and opinion polls suggest that significant portions of the population, between 46 and 57%, are unwilling to even consider purchasing a PEV . . . A 2011 survey conducted by the Minetta Transportation Institute found that, when compared to other types of alternative-fueled vehicles, including hybrid, compressed natural gas, and fuel cell, the plurality (40%) of respondents ranked electric vehicles last" (p. 434).

According to Krause et al., it is all very well for the early adopters to buy an EV but for mass commercialization to occur it is the mainstream car customer who must be enticed. Unlike the early adopter who likely fits the profile of a person up to date with technology or wants to promote public good the mainstream driver demands a tangible private value return for spending so much on a new car. One question the authors ask is whether such mainstream

consumers are indeed uninformed about EVs? Do they misunderstand the technology? Do they know the kind of incentives that currently exist, and what these are meant to achieve?

Krause et al. reported that most respondents were unable to answer several questions regarding EVs. They thought, for instance, that such cars require just as much maintenance as ICEs, despite having a smaller number of breakable parts and not requiring routine maintenance like oil changes. Respondents also believed that by using EVs the fuel savings would be far smaller than they actually are. Worryingly, the respondents of this study came from urban regions, "the geographic regions where daily travel patterns are expected to be more conducive to PEV use and adoption" (p. 439). Krause et al conclude that adoption rates of EVs are as low as they are because the negative feelings of the mainstream consumers lead them to assume that these cars will cost far more than in reality. Nevertheless, these authors also believe that even if these consumers had perceptions that were correct they still would be highly unlikely to purchase an EV maybe because they would continue to assume the cost of the vehicle to be too high and the range too low (compared to conventional vehicles). One additional finding was that both financial incentives and other state-provided benefits like driving on HOVs had little noticeable effect on increasing demand for EVs. In part this was because respondents lacked a good grasp of the various incentives on offer (for instance, state as well as federal) (see previous section).

Hidrue et al. (2011) sought to identify whether there was a certain price consumers wish to pay for an EV if it offers certain desired features provided in conventional cars. They utilized a national web-based survey in which 3029 respondents were asked to choose between their preferred gasoline-powered vehicle and two hypothetical electric versions of that identical vehicle. This study was in response to previous research suggesting customers show reluctance to buy electric vehicles because of high costs (including battery costs), range anxiety, unsatisfactory charging times, and the absence of adequate charging infrastructure (especially fast chargers). The sample included representatives of US residents over 17 years of age. Some of the findings were as follows: Among the variables likely to influence a person's willingness to pursue an EV are age (being younger or at most of middle age), being university educated, the expectation of high gas prices in the future, having somewhere to install an EV charger at their home, the likelihood of buying a small car on their next purchase, and the tendency to buy new items as they enter the market. Another variable leading to higher willingness to buy an EV is the expectation of going on a trip of more than 160 km at least once per month. This is surprising given that limited range is often perceived as a hurdle to owning an EV. Even though it could be expected that multicar households are likelier to wish to own an EV (given they would then have options depending on range driven) this particular study did not support this assumption. The regional analysis of the entire US revealed, as expected, that the most EV-oriented regions are California, Florida, and the NE United States. The paper also reports on the premium respondents would pay or the compensation a respondent would ask for to switch from a gas powered vehicle to an EV. The EV-oriented respondents were willing to pay a premium of over $2000 whereas those who were deemed to be gas vehicle oriented revealed they would have to be compensated over $20,000 before switching to an EV.

In conclusion, Hidrue et al. (2011) confirm findings of several studies. For instance, the propensity to buy an EV increases according to youth, green life style, the belief that gas prices will rise significantly in the coming years, and living where there is a place to plug in. It also increases when people are willing to forego a large powerful vehicle or a sports car and opt for a smaller car. Meanwhile, the income of a person or the ownership of multiple cars does not seem to affect willingness to buy an EV. Rather, most persons desire an EV only if they perceive it will realistically lead to savings (especially from fuel spending) not because they see this as a step towards saving the environment.

Beyond the issue of costs additional hurdles standing in the way or mainstream consumers are both technological (as, for example, the aforementioned worries about range and recharging) but also involve social and political considerations (Christensen et al. 2012; Steinhilber et al. 2013). Graham-Rowe et al. (2012) argue that many consumers prioritize their mobility needs over their environmental beliefs while a fear prevails that since this technology is fairly new it may soon be rendered obsolete. Presumably, then, there is a concern that if one buys an early model EV and the technology rapidly evolves it will hard to sell that car in the future.

Graham-Rowe et al. contend that a study of people with no EV experience likely leads to many misconceptions whereas "sampling the views of drivers who have direct experience with EVs may better represent the responses of future consumers, by reducing psychological distance and rendering EV construal concrete" (p. 141). However, they also argue that such studies of EV users have been those of so-called early adopters, leading to biases in the results, because invariably these people are the ones likelier to demonstrate a strong commitment to the environment whereas the vast majority of drivers (regardless of their environmental priorities) think of things other than the environment in their daily mobility choices.

Through a qualitative study conducted in the UK, Graham-Rowe et al. (2012) focused on 40 ICE drivers recruited from the Transport Research Laboratory database to test use either an EV or a plug-in hybrid. The test duration for each participant was for one week. The aim of the researchers was to construct grounded theory and generate hypotheses. It was not an exercise in testing their preconceived ideas. Among the findings from this research was that all drivers, regardless of personal wealth, seek cost minimization and, in cases where gasoline prices are high, then they justify the spending of more money for an EV compared to an ICE. However, if the fuel charges are low then that incentive to buy an EV is reduced. Other findings included perceptions that the alternative energy vehicles were not aesthetically pleasing while many respondents believed these cars were not as environmentally friendly as one might think. Overall, although the study revealed that the so-called mainstream drivers' attitudes towards alternative energy vehicles improved following a test period, concurrently they perceived several obstacles. This led Graham-Rowe et al. to conclude that there is still some way to go before mainstream drivers (even those who have test driven an EV or other alternative fuel car) can be more open to making the switch away from ICEs.

Since people describing themselves as "green" may be a target group for sellers of EVs and other alternative fuel vehicles, unsurprisingly there have been studies investigating this specific market niche's attitudes about this form of mobility. In Sacramento, California researchers held focus group sessions with supporters of pro-environment initiatives aiming to identify why so many pro-environment persons remain unwilling to match this support when it comes to their transportation preferences. In other words, despite being "environmentally friendly" these individuals continue to drive vehicles that are anything but good for the environment (Flamm and Agrawal 2012). Among the issues discussed in the focus group meetings were the attributes people seek when choosing a vehicle. Many spoke about fuel consumption (given rising prices of fuel in the region). It is important to point out that most participants view driving as an inevitability given the distances they must cover in any given day. Thus, they equate having a car with a small engine and lower fuel consumption as an adequate pro-environment step. This statement led to more probing by the facilitator, which, in turn, led many of the participants to admit that it is not the environment per se that determines their choice as to what kind of vehicle to drive but rather the impact this may have on their wallet. So, once more, even for this group of people, cost concerns override other considerations.

An important finding in the Sacramento study is that people commonly display what is known as "cognitive dissonance" meaning they are well aware that despite their professed pro-environment attitudes their choice of vehicle fails to mirror these thoughts. They rationalize this contradiction by identifying several obstacles to buying hybrids or EVs. By far, the dominant answer given for not pursuing the purchase of a hybrid (which at the time of the study they believed to be the only viable environmentally friendly car) was the expense or rather the extra expense associated with these vehicles compared to ICEs. The underlying excuse is that based on their income/resources available it made no sense to buy a hybrid.

Others argued that hybrids are generally too small (compared to the average US vehicle) and failed to meet their various requirements (like towing a boat). Yet others were worried (a common concern, especially among American motorists) that these cars are not as safe as conventional vehicles while there was also a belief that the technology has not yet been proven *vis à vis* gasoline-run vehicles. It seemed to be a common conception that they would only consider buying a hybrid vehicle once this type of vehicle has become a regular phenomenon on the roads. Presumably, the same could be said about EVs. Until these cars become a common sight on roads throughout the world (the status quo) relatively few people are likely to take the plunge and invest in them.

An interesting finding in the Flamm and Agrawal (2012) study is that certain participants in the focus groups were averse to driving unless absolutely necessary. To them it makes little sense to buy an expensive hybrid or electric vehicle since they believe their environmental footprint from driving is already low. If one drives less than once a week, perhaps to go to the supermarket and ends up covering fewer than 50 km per week the justification of buying a very expensive electric car (such as a Tesla) perhaps seems counterintuitive. Newman et al.

(2014) underline this point when it comes to urban areas, maintaining that in high density cities, which offer ample opportunities for public transportation, walking, and cycling it makes little sense to own an expensive electric car that mostly sits in the driveway. One has to assume that if the EV is too expensive and it is rarely driven consumers would feel they are not obtaining a reasonable return on their investment.

Some additional issues emerge from the Sacramento study: First, there are those who enjoy having a high-powered car (maybe a sports car), believing that as long as they are green in everything else they do in their lives they are entitled to a little bit of fun regardless of whether this is deemed environmentally harmful. So, if they recycle, use solar panels on the house, and ride their bicycle to work every day they feel justified to go for a spin in their high-powered Ford Mustang at the weekend. Second, the focus group participants said they would consider buying greener vehicles the next time they were looking for a new car but only if they had the following characteristics among others: cheaper than they are currently; offer a good range of features; and the technology is reliable.

Kahn (2007) offers a more promising perspective regarding the attitudes of pro-environment consumers towards transportation choices. He argues that California environmentalists (defined as those who vote "green") make greener transportation choices than those of their average consumer counterparts. For instance, they are likelier to cycle or use public transportation systems, buy less gasoline, and also have a propensity toward buying greener vehicles. His suggestion is that there is status attached with choosing, for example to purchase a hybrid vehicle. For instance, if one's aim is to live a green lifestyle then that person will reflect this through actions like recycling, advocating cycling and walking, and being a minimalist consumer. A person like this would derive more status by driving a hybrid as opposed to opting to own a gas guzzler like a Hummer. Also, by choosing such a vehicle then the green person seeks to evade charges of being a hypocrite; thus, a so-called green person who drives an EV or a hybrid would feel that he or she are more acceptable in the eyes of others as opposed to a self-professed green who drives a Corvette. Especially in cases where someone lives in a geographical area with other like-minded individuals (other greens) it would not be regarded as politically correct to drive a fuel inefficient car; a green vehicle, by contrast, would reflect conformance to social peer pressure.

While the aforementioned studies mostly examine mainstream consumers, some researchers have focused on the motivations of early adopters, namely the people who decide to purchase alternative fuel vehicles. Ozaki and Sevastynova (2011), for example, investigated what drives consumers to pursue sustainable energy innovations by examining the reasons leading consumers to buy a hybrid. Their point of departure was:

> *We need to understand what makes consumers consider buying a hybrid vehicle and how policy can encourage them. The relationship between possibilities produced by technological innovations and actual sustainable outcomes is heavily mediated by consumers' attitudes towards those innovations . . . consumers' perceptions of the real advantages of these innovations in transport technologies are critical. Consumer acceptance, including*

> *subsequent use and rebound effects, is an important condition for a technological shift and the long-term success of a new sustainable transport system (p. 2217).*

In 2009 the authors contacted 4000 British Toyota Prius owners who had bought their vehicle in the preceding two years. They also interviewed sellers in dealerships to construct the identity of the typical hybrid car buyer. It was revealed that buyers of such vehicles are well informed, having completed much research before shopping for a car. It was shown that if buyers are from a major city (London) they are unlikely to have a second vehicle, something which is not the case for persons from the countryside. The study revealed that the survey respondents were heavily influenced by financial motives in deciding to buy a hybrid, including the notion that they would be exempt from paying congestion fees if they lived within a certain distance from London (within the M25 perimeter). Other factors influencing these buyers included the perception that these would lead to environmental benefits while social norms also seemed important (like being respectful of others and socially responsible). The so-called expression of self, whereby a person asserts her compliance with social norms and reflects a personal identity (being fashionable, green, trendy, etc.) was also considered an important motivating factor. In sum the study by Ozaki and Sevastyanova reflects that the adoption of hybrids by consumers is motivated by a complex set of factors and cannot be easily attributed to one issue (such as costs) as some researchers have concluded.

Drawing from their extensive literature review, Rezvani et al (2015) also underline the significant role of symbolic meanings, expression of self-identity and lifestyles, social norms, as well as emotions in consumer adoption behavior. For example, those who believe a pro-environmental self-identity fits with their self-image are likelier to demonstrate positive perceptions towards EVs (Schuitema et al 2013). Schuitema and others also suggest that consumer emotions and feelings, which include pleasure, joy, excitement, pride, but also embarrassment can in various ways affect attitudes and intentions to adopt EVs. Rezvani et al. (2015) maintain that they see a lot of potential in expanding the research agenda relating to consumer emotions in EV adoption studies since this could lead to "theoretical frameworks of emotions in psychology . . ., ethics and consumer behavior areas. . . Understanding the cognitive and emotional responses can help marketing specialists and policy makers in designing their communication, education and policies to possibly overcome some barriers to adoption of EVs" (p. 134)

Driving range, recharging stations, and their location

Attitude studies such as the ones discussed in the previous section reveal that consumers who are thinking of purchasing an EV worry excessively as to whether the available recharging infrastructure within the spheres of their everyday lives will suffice to serve their needs. Since there is always the real fear of inadequate range (stemming from the fact that most existing EVs have a range of 150 km or less) this leads to worries that one will be unable to complete a journey without recharging at least once. Add to this, the problem that

it usually takes too long to recharge an EV compared to a conventional car and we can understand why such vehicles have, until recently, suffered from limited popularity.

Pearre et al. (2011) examined whether people's range anxiety when it comes to the use of EVs is exaggerated. They argued that even though people generally worry about limited range, most individuals rarely drive far (certainly not far enough to have to recharge during the day). Indeed, there is little published research on the actual range needs most drivers have on a daily basis leading the authors to state that, rather than reflecting existing driving patterns, concerns about limited range are mostly directed by misperceptions. To address this issue of range and get a better idea of how to improve the design of EVs, Pearre et al. sought to find out how Americans actually utilize their conventional gasoline powered cars.

Their Atlanta-based research identifies that 9% of vehicles in their sample of 484 drivers of regular gasoline vehicles never exceeded 100 miles (160 km) of driving in a day and 21% never exceeded 150 miles (240 km) in a day. This implies that most of these drivers could substitute their regular cars with EVs without significantly having to adapt their driving habits since the actual range driven is within the limit of several EVs (see Table 2). For longer trips, (and given that the average US family owns 1.9 vehicles) the authors argue that adaptation could take place by simply using another longer-range vehicle (most likely a gasoline powered car or a hybrid).

Certainly, with the rise in use of EVs eventually there will be a need to provide far more recharging facilities than currently exist. Among the locations where such facilities can be available will be industrial and commercial places (Fox 2011). For instance, a company (such as a retail establishment) that provides recharging ability in its parking area can entice customers to visit. Employees who drive EVs can also benefit by recharging whilst at work. It is worth mentioning that in the US when a business provides a minimum of 3% of its parking area for recharging EVs then it can obtain LEED credits[11] (a US based green building certification program: see United States Building Council website).

Recharging a vehicle can be achieved at different rates. By using AC current (Level 1) users can recharge their vehicles through a simple household plug (120 or 240 V receptacle)[12]. Unfortunately, this is extremely time consuming (12-18 hours) depending on the battery's energy capacity and its discharge level. AC current (Level 2) is a special charger that has to be hard-wired into the premises' wiring system. It is faster than Level 1 (4-8 hours).

[11] LEED (Leaders in Environmental and Energy Design) is a certification scheme that relates to energy and resource efficient buildings. See:

http://leed.usgbc.org/leed.html?gclid=Cj0KEQiAgMKmBRDMjo_F9OfUubABEiQAp8Ky1ySaDorOY-WQewC5KpxScPcCOFOXkUzdzHBlrAH-Pn0aAinc8P8HAQ

[12] Charging through a regular plug in the US will take longer than in the UK. Note that if one is to be dependent on household charging then one needs off-street parking facilities, something not everyone has, especially in urban areas.

Meanwhile, DC charging (Level 3) is meant to recharge a battery in as little as ten to fifteen minutes.

Level 1 is evidently not optimal while a Level 3 unit costs as much as ten to twenty times more than a Level 2. DC level 3 recharging is really reserved for suppliers who can actually make a profit from selling the electricity. This makes Level 2 (at the time of writing of Fox's article in 2011) the most realistic type of recharging stations.

Schroeder and Traber (2012) questioned whether investing in very expensive fast charging stations makes sense given low EV adoption rates. They argued that either a considerable larger number of EVs would have to enter the market or that the cost of the charging stations would have to be reduced significantly. Their point was that in Germany at the time of writing it made no sense to invest in public access fast chargers (especially as incentives were found to be too low). However, they maintained (like Fox 2011) that in commercial spaces such as those provided by supermarkets and other large retailers or shopping centers the provision of recharging facilities can act as a perk for customers. While the main revenue of these businesses is derived from sales of their products they can be sure to entice EV users if the latter can be assured they can recharge their cars while shopping.

One of the most important questions when it comes to alternative fuel vehicles and especially EVs is where to locate the recharging infrastructure. Presumably, the location of recharging stations could be such so as not only to cater to the drivers themselves but also benefit nearby communities. Wang (2011) has developed a flow-recharging location model for siting recharging stations at tourist destinations to serve recreational visitors. His inspiration for the study is that EVs and other alternative fuel vehicles (not hybrids) have a limited driving range and there are not many refueling options in convenient places. In a previous study his suggestion for refueling electric scooters was that recharging stations "were economically located at tourist attractions, meaning that while the charging took place the traveler could visit the attraction as part of their ongoing journey" (pp. 155-156). One reason the location of the recharging station should be at the actual destination area is that tourists can use the time it takes to recharge to shop and visit the attractions of their choice. Indeed, it may actually be an advantage to have a slower recharging station at the destination as this means more time for conducting a visit. By contrast, fast recharging stations can be located on the highway like gas stations. According to Wang the faster the rate of recharging the fewer recharging stations are required.

Chen, Kockelman, and Khan (2013) support the idea that in final analysis it is the access of EV charging stations (or lack thereof) that influences EV adoption rates. They contend that without refueling infrastructure the EV remains the vehicle of the future. Moreover, they argue that if more public charging stations are available the owners' anxiety will be reduced. Through a case study of Seattle, they investigated when and where vehicles are likely to be parked and for how long in order to identify the best sites for locating public charging stations. Not surprisingly the longest parking periods are at workplaces and schools, while regular errands (like shopping) demanded much less parking time. Identifying parking

behavior can, according to the authors, be useful for helping identify the location of potential recharging stations.

The issue of where to locate recharging facilities is especially important in the context of developing EV drive tourism. That is, if a region wishes to establish itself as a popular destination for users of electric vehicles then a strategy must be devised as to where and when the drivers of EVs can most efficiently recharge their cars. This issue is further explored in the next section, which examines the concept of electric vehicle tourism as a subset of so-called drive tourism (Prideaux and Carson 2003; Zillinger 2007; Prideaux and Carson 2010; Wang 2011).

EVs and Drive Tourism

An OECD (2012) report maintained that tourism, as a key economic sector of the modern era, functions as key push factor behind the transition toward a green economy. "Due to tourism's cross-cutting nature and close connections to numerous sectors at destination and international levels, even small improvements toward greater sustainability will have important impacts in the shift toward more sustainable, cleaner and low-carbon economic growth" (p. 7). One example offered in the OECD report of pioneers in green innovation in the tourism industry is the Boutique Hotel Stadthalle in Austria, which is listed as a zero energy building since it consumes no more energy than it generates from solar cells and heat pumps[13]. This hotel charges guests' EVs for free and gives discounts to those who travel in an eco-friendly way (including acting "eco-friendly while at the stay" – like renting electric scooters and using locally produced foods).

The concept of green tourism goes one step further by encouraging, among others, the use of non-fossil-fuel dependent transportation systems to and from destinations, as well as within destinations. Høyer (2010) points out the obvious link of tourism and travel arguing that without travel we cannot have tourism (see also Lumston and Page 2004; Duval 2007). As Prideaux and Carson (2003) argue, specifically in the context of the private automobile, "the tourism industry has benefitted enormously from the car's ability to provide almost unrestricted land travel and in developed nations a significant proportion of domestic travellers utilise cars as their main form of holiday transport" (307-308).

Thus, when thinking about sustainable tourism and sustainable destinations we have to factor in the mobility not only to and from the destination but also within the destination itself. This is because between 40-60% of environmental effects related to tourism are caused by transport (Gössling et al. 2010; see also Ceron and Dubois 2007; Yang 2010). According to

[13] http://www.hotelstadthalle.at/en . The hotel's website boasts that this is the world's first to have a zero energy balance.

Høyer (2010) these effects do not only take into account energy consumption but also noise and other types of pollution as well as encroachment on the landscape and waste.

A handful of destinations worldwide have long been "car-free" (e.g., the Greek island of Hydra and the GAST towns in Switzerland) but these are, of course, transportation dependent for their links with their markets. Høyer contends that if destinations are to be truly sustainable one of the most vital steps is to reduce individuals' mobility by searching for non-motorized transportation forms or encouraging collective transportation. He did not mention alternative fuel personal vehicles such as EVs at the time of writing. In Röros, Norway (a town of 4500 people that receives 800,000 visitors per year) there have been efforts to reduce volume of transport to and from the city, including attempts to lower the volume of tourism industry related goods coming from other regions[14]. This means that the industry has to depend increasingly on locally produced food and other goods. In the meantime, within the destination itself, bicycle transport is encouraged during summer time and sled chairs during the winter (Høyer 2010)).

Høyer recommends that in order to encourage alternative transportation within destinations there is a need to institute a "carrots and sticks" system. The sticks would be disincentives to driving, including the introduction of high parking fees, toll charges, fewer parking spots, or just making driving harder in the destination. Hotels could provide information on their websites warning prospective clients of limited parking opportunities and suggesting that they should consider not arriving by private vehicle. Carrots would be incentives to encourage the use of alternative forms of transport as happened in Davos, Switzerland. These include the introduction and availability of more efficient public transportation, while also making it easier for locals and visitors to use bicycles or horses to get around (Høyer 2010).

Tourism Routes as part of the Attraction

While it is important to think of ways of dissuading visitors within specific destinations from using their cars whilst encouraging them to either use non-motorized modes or collective forms of transportation it is also imperative to come up with approaches to making the transportation to and from the destinations more environmentally friendly. Certainly, if destinations are linked to their major markets via electrified railway then it goes without saying that encouraging people to travel by train is preferable than using any other mode.

The historic connection of railway transportation to tourism development in peripheral areas is, of course, well documented in the case of the evolution of national parks in countries like the US (Runte 1974, 1987, 1990; Ioannides and Timothy 2010) as well as Australia (Hall 1992). It has also been noted in comparative studies of national parks of Australia, Canada, New Zealand, the USA, and Sweden (Hall and Shultis 1991; Wall-Reinius 2009). It is of interest to

[14] http://en.roros.no/sustainable-tourism/

note that tourist access to the northern Swedish mountains, where some of the country's national parks have long been established was, at the beginning of the twentieth century, highly restricted given the absence of good transport links. This changed after the railway began to play an essential role for the tourist organisation STF, and became an important force behind tourism development in the mountains (Wall-Reinius 2009).

Studies show that the railway remains the dominant means of transport for visitors to the very northernmost part of the mountainous Sweden accounting for 65% of summer visitors (mainly back-country hikers) though this represents a decline from 75% in the 1980s (Wall-Reinius and Ioannides 2013). During that time the use of personal cars has increased while airplane arrivals have increased substantially.

Despite the continued dominance of the railway as the means of tourist transportation to and from the northern Swedish mountains, when it comes to visits to the mountain range as a whole (especially destinations further south), the train is by no means the most common means of transportation. Rather, it has been the growing popularity of the automobile that has made national parks and other tourist attractions in these more southerly parts of peripheral Sweden broadly accessible. Today, in the western part of Härjedalen, 90% of the tourists travel by car, whereas 52% of the tourists travel by car to Åre (Länstransportplan 2014-2025 för Jämtlandslän; Bodén 2010).

A recent study among summer visitors (mainly back-country hikers) to the Jämtland Mountains shows that two thirds of the Swedish visitors and about one third of the international visitors travel by car to and from the area. Meanwhile, 38% of the Swedish visitors and 57% of the international visitors travel by train (Wall-Reinius & Olausson 2015). This trend is unlikely to change with projections indicating that by the year 2025 the use of cars by visitors to the Jämtland-Härjedalen will increase (Länstransportplan 2014-2025 för Jämtlandslän; Bodén 2010). The obvious problem associated with this trend is that some destinations like Vemdalen and Åre have already been suffering from overcrowding, traffic congestion, as well as air and noise pollution during peak seasons.

Because it is impossible to link all destinations by new railway connections or indeed other forms of collective transportation due to the low development density in much of the region, in order to realistically meet sustainability objectives and protect resources whilst enhancing the quality of visitor experience a major push should perhaps be made towards adopting alternative personal transportation systems to and from the destinations but also within these places (Manning et al 2014; see also Timothy 2010). Importantly, the issue is how to reduce the motorists' carbon footprint. This can be done by encouraging the use of alternative fuel vehicles and most importantly EVs. Before proceeding to discuss the concept of drive tourism and specifically EV drive tourism we briefly explore the issue of tourism routes as attractions.

Tourism routes can function as attractions in their own right (e.g., if they offer stunning scenic views or they traverse historically important landscapes) but also as links between several clusters of tourist attractions (Briedenhann and Wickens 2004). In Europe the concept

of cultural routes has been around since the 1960s and today many countries worldwide have tourism routes like wine tourism routes in California and in Australia.

Referring specifically to Norway, Denstadli and Jacobsen (2010) have discussed the importance of "drive tourism". Their argument is that travelers are not only interested in traveling to specific destinations but count the whole trip – including the drive/transit between different destinations – as a vital component of the total experience they seek. The authors contend that even though drive-tourism is a vital type of tourism in many regions, most studies concerning tourism planning tend to focus on the destinations (both primary and secondary) while little has been done about road users' experiences and assessment of routes, facilities and other related factors (but see Timothy 2010). These authors maintain that the road trip itself takes care of the wanderlust requirement of at least some travelers, especially those wanting to drive more slowly and enjoy the scenery whilst also having the flexibility to be masters of their own itinerary (people traveling by recreational vehicle (RV) fit this profile).

The Norwegian "Public Roads Administration suggests that unique landscapes combined with well organised routes, including rest areas and possibilities for pull over at lookouts will encourage longer stays and more returning visitors" (p. 781). There is also a need to provide quality eateries and lodgings along these routes. Denstadli and Jacobsen identified that: "motor tourists' motivations and satisfaction with facilities along the route are significant determinants for their overall satisfaction with driving the route, which in turn, increases their intentions to recommend the route to friends and family" (p. 787).

Because of the high significance of drive tourism for many destinations, both in terms of traveling from the origins but also for getting around within the specific destination, the adoption of zero emission vehicles emerges as a potential goal of vital importance. The question is whether or not there have been serious efforts to encourage this form of tourist mobility and, if so, what has their outcome been? Moreover, if EV related tourism could be encouraged on a grand scale in a specific tourist region, could this have a demonstration effect over time whereby local inhabitants and other visitors who do not use EVs would become increasingly welcoming toward zero emission cars? In relation to this, it would be useful to draw from earlier knowledge regarding the role of social norms, or the neighbor effect, on consumer intentions to adopt EVs (Kahn 2007; Ozaki and Svastyanova 2011; Rezvani et al 2015). A point of departure is that a "green" neighborhood influences not only isolated individuals but eventually leads the whole neighborhood to adopt environmentally-friendly behavior. In the same manner, if we think of a destination that involves among others the adoption of sustainable accommodations and carbon-free transportation systems we may assume that social norms could lead both inhabitants and visitors to eventually adapt their lifestyle in order to portray a green lifestyle. In turn, developing a superior understanding of how social norms may influence consumers to begin using EVs has policy implications for many localities wishing to green their identity (Rezvani et al 2015).

Because our review of the literature revealed very little relating to drive tourism and electric vehicles, the inspiration of how a region can proceed to adopt EV tourism is drawn mostly

from professional reports. Specifically, we turn to the case of Oregon where there has been a targeted effort by the Oregon Transportation Research and Education Consortium (ORTEC) to directly tie the tourism industry with EV mobility (Bronstein and MacArthur 2011). Bronstein and MacArthur argue that to persuade people to adopt an EV as opposed to a conventional ICE vehicle there is a need for improved marketing and demonstration efforts. The authors' belief is that the tourism sector is particularly well poised to lead people to EV adoption as it can build (or expand on) a brand for eco-conscious travelers. Referring specifically to Oregon they write that "the tourism and hospitality industry have been given the unenviable and yet critical task of evolving to support a largely unknown, undeveloped market: the electric vehicle traveler" (p. 1). In examining Oregon as a test bed for EV adoption they discuss how this state has been investing heavily in charging infrastructure and since this is one of the key destination states in the US the tourism sector is well poised to capture and promote the EV traveler market. Their argument is that by building the EV into the state's brand it can attract more EV drivers, while also educating tourists and residents about electric transportation.

What exists by way of EV infrastructure in Oregon?

"Federal American Recovery and Reinvestment Act grants have funded the installation of up to eight quick charge stations along I–5 between Eugene and Ashland to complete an important leg of the nation's first 'West Coast Green Highway'[15] which runs from Vancouver to San Diego" (p. 3). An additional 22 quick charge stations have been planned for the two prime visitor destinations within the state that is the Oregon coast and the Columbia River Gorge. Further, there exists a public-private partnership including the Department of Energy, State of Oregon, ECOtality and Nissan that is in the process of installing 800 public charging stations and 22 DC quick chargers around the main cities in the period 2012-2015.

Because of being one of the states with so much charging infrastructure it is not surprising that automakers have been targeting the region for release of EVs on a grand scale. Indeed, Oregon was one of the first states in the US to see the release of the Nissan Leaf and was also chosen for the introduction of the plug-in hybrid Prius. To increase the popularity of such vehicles, certain individuals were given the opportunity to conduct test drives while a car-sharing community in Portland added two of these EVs to its fleet.

How does tourism relate to these initiatives? Oregon is a leading tourist destination and the majority of visitors in the state access attractions by private car. Many travelers are from Oregon itself and nearby states (like Washington) and use their own vehicles when they

[15] The "West Coast Electric Highway" is an extensive network of electric vehicle (EV) DC fast charging stations located every 25 to 50 miles along Interstate 5 and other major roadways in the Pacific Northwest. The Washington State Department of Transportation leads the charge on the **Washington** segment and the Oregon Department of Transportation heads up the **Oregon** segment. The west coast has a robust EV charging network with thousands of Level 2 charging pedestals and dozens of DC fast chargers.

travel while others who come from further afield are likely to rent cars (e.g., after they arrive by air). Many of the travelers to the state are well educated and the majority of them are retirees, which are characteristics of EV adopters. Additionally, many of these travelers indicate they are pro-environment.

Hotels, events and scenic areas are in a key position to create a niche for EV users (Bronstein and MacArthur 2011). Even if the travelers to Oregon cannot afford an EV of their own they could gain familiarity of the new technology and put any fears they might have at ease. For instance, they could be exposed to EVs through renting such cars or participating in car-share schemes. "Rental and car-share fleets have a mass buying power that individuals do not, and can invest in a few electric vehicles without the same level of risk as a single household. In addition, bulk purchases of EVs by fleet operators may help in the short run to reduce the price of batteries by spurring production levels (p. 6).

Bronstein and MacArthur emphasize that to enhance the popularity of EV tourism several actors can play a key role in supporting this mode of transportation. Hotels could play charging points on their premises so that customers can charge their vehicles while they are resting. Car rental companies could provide more EVs in their fleets while the taxi services in many localities could also switch make the switch to EVs. Then, of course, various destinations throughout the state including cities as well as popular attractions could provide strategically placed charge stations to be used by the drivers of EVs while they are visiting. For instance, charge points could be placed in parking lots at popular trailheads; the idea is that the vehicle can be charged while its owner is hiking.

Perhaps, ORTEC's notion that the popularity of the EV should increase by encouraging electric car tourism development in the state could be of relevance to the situation in the region traversed by the E-14 Green Highway in Sweden and Norway. Specifically, it would be interesting to explore whether or not drive tourism whereby a considerable number of arrivals utilize EVs would entice locals in the region to acquire such vehicles.

EVs in the Countryside: Do they Make Sense?

When discussing EVs most people think of these as vehicles for urban regions. In part this is because, at least the early EV models were tiny vehicles (usually two-seater cars with very limited storage capacity) and they were not known for having powerful engines. This meant they were perfect for low-speed short trips within built-up areas. Additionally the fears of the owners of such vehicles about limited range were allayed since within a city the opportunities for recharging are likely to be plenty compared to what is available in rural regions.

There is also the issue that when a new product comes into the market it usually makes its appearance at the high end of the urban hierarchy before trickling down to increasingly less densely populated regions (Haugen 2012). Thus, one would expect that EVs are likelier to catch on in popularity first within major metropolitan regions. Subsequently, persons in

lower-ranked cities may be enticed to buy such cars and eventually the technology will likely trickle down to rural areas as long as residents there feel that the product's advantages exceed the disadvantages.

The EV's urban bias is also witnessed by the fact that the majority of studies undertaken on this subject such as research on people's attitudes, their fear about range, and the effects of EVs have most frequently been carried out within metropolitan areas. A recent study, for example, that was conducted to assess the feelings of EV users in Norway concentrated exclusively on the Oslo-Kongsberg region; this was not surprising as this is the region with 40% of the country's EVs (Figenbaum et al. 2014).

At this point we pose the following two questions: (a) Do EVs make sense as the vehicle of choice in high density metropolitan regions; and (b) is the best place for encouraging the growth of alternative fuel vehicles (including EVs) the countryside?

To answer the first question we briefly explore whether or not EVs can actually become a long term solution for urban mobility. To be sure, from a sustainability standpoint an EV will always be preferred over an ICE vehicle as long as the electricity is derived from renewable resources. Moreover, if we adopt the pessimistic stance that automobile usage is on the rise in all major cities worldwide, including ones traditionally associated with non-motorized forms of transportation such as Amsterdam (Rienstra and Nijkamp 1998), then advocating for the use of EVs to eventually replace conventional cars makes sense. However, the question is does the gradual replacement of ICEs with hybrids and EVs solve a whole number of other problems – beyond environmental concerns - associated with city-based transportation? How, for instance, will the adoption of EVs alleviate the excessive problems of congestion, which are getting progressively worse in all cities throughout the world (see Zampoukos et al. 2015)? Moreover, if one way to encourage higher EV adoption rates is to offer incentives such as the ability to avoid congestion and parking charges or to use limited access lanes (e.g., those reserved for busses and high occupancy vehicles) how will cities be relieved of the excessive pressures associated with personal motorized transportation modes?

Some observers argue that it makes more sense for urban regions to concentrate on enhancing accessibility through planning procedures that encourage high density mixed land use and limit sprawl as a way of relieving dependence on high rates of personal mobility (Banister 2008). Seeking to make cities more amenable to non-motorized forms of personal mobility (e.g., cycling and walking) and by encouraging, where necessary, collective forms of transportation seems a far more realistic long-term solution for enhancing their sustainability as opposed to perpetuating the use of personal cars (even if these are clean energy vehicles).

Newman et al. (2014) reinforce the idea that "the urban niche is not necessarily the most appropriate for such [EV] vehicles" (p. 308). They reflect that especially within European cities, where densities are high compared to most urban areas in North America, there are numerous alternatives (subways, busses, bike-paths) allowing citizens to move around

without using a car. In fact, numerous cities, at least within their cores, are walkable (or bikeable) and many people in these do not need a car on a daily basis. Newman et al. emphasize that given the range of existing alternatives for making transportation within cities increasingly carbon free "it appears perverse that such a concerted effort is being made to promote electric vehicles as a sustainable urban mobility mode" (p. 310).

In spite of this situation, the obvious answer as to why EVs are promoted in urban areas is because cities are markets for (expensive) consumer goods and already dominated by conventional automobiles while trends indicate that the presence of this mode of mobility is constantly increasing. Rienstra and Nijkamp (1998) argue that despite Amsterdam's reputation as a city offering numerous alternative transportation choices to the automobile, car usage in the 1990s was expanding very quickly. Given this situation, it makes sense to pursue policies that gradually replace cars utilizing fossil fuels with ones that have zero emissions as opposed to proceeding with more drastic measures seeking to entirely change urban land use patterns as well as people's lifestyles (Newman et al. 2014).

Newman et al. also argue that the prevailing notion that EVs are more appropriate for cities stem from the following: (a) their limited range and speed dissuades rural residents from investing in these; (b) the density of cities makes it more efficient – because of economies of scale - to invest in charging infrastructure. Nevertheless, they also see that:

> *with low car ownership levels, established public transport infrastructures, growing use of walking and cycling (including e-bikes), and short distances travelled it could indeed be argued that both the potential of densely populated areas and the degree to which electric vehicle use improve the situation are limited . . . These problems are exacerbated by the lack of (domestic) space within which to park and recharge electric vehicles for many potential owners. Moreover, because the trips tend to be of short length in which vehicles are often stationary in traffic the vehicles are being used well below their theoretical capacity (p. 313).*

The problem then for EVs within urban areas is that because they are likely to be underutilized, consumers may wish to avoid investing in what is perceived to be an expensive product (compared to a conventional automobile) if they are not going to get the most use out of it. By contrast if someone lives on the rural-urban fringe and beyond city limits it would make more financial sense to invest in an EV since larger driving distances mean one can justify spending the extra premium on such a vehicle from the outset. Other advantages of owning an EV in a suburban or rural locale are factors like having adequate land and garage space to provide charging opportunities, something many urban dwellers may not have if their only parking space in on the street outside their home.

Plötz et al. (2014) reinforce this argument by arguing that, somewhat surprisingly, the most likely group of early adopters of EVs in Germany is that of professional middle-aged men with a technical background who live on the rural-urban fringe or further out in the countryside and not, as may be expected, the younger inhabitants of urban areas. They explain that one reason behind this is that "EVs need to travel many vehicle kilometers in

order to have lower total CO_2 emissions than conventional vehicles" (p. 99) but also in order to recoup the high cost of purchasing an EV in the first place. Additionally, in Germany the residents of cities are less likely to own cars in the first place given that they have many other alternatives for getting around. As a result, they suggest that policymakers should place emphasis on attracting the inhabitants of suburban and rural areas to buy EVs as early adopters.

Overall, Newman et al. (2014) suggest that despite theories of innovation diffusion, which perceive the process of new products trickling down the urban hierarchy, it makes sense for early adopters of EVs to be those depending heavily on their cars on a daily basis. This applies to people living in low-density areas where accessibility to various services is low and the availability of alternative forms of transportation (e.g., railway and bus-lines) is limited or non-existent. In these environments, personal EVs are likelier to be used on a regular basis so that consumers who purchase them feel they are getting their worth in terms of their investment.

Whether or not the EV catches on any time soon in the Jämtland-Västernorrland region and especially within the very low density rural parts of this geographic area is a subject for debate.[16] Writing about alternative energy vehicles in low density regions of Sweden Haugen (2012) argues that despite the heavy dependence on private cars the embrace of electric vehicles, hybrids and other low or no emission vehicles remains weak. She acknowledges that the inadequate provision of charging facilities must be considered as one factor behind the low acceptance of such vehicles but warns that this is not the sole obstacle that needs to be overcome. Rather, she maintains that diffusion of innovation dictates that various groups will adopt the new technology at different times with those in high ranking urban areas being likelier to embrace the new technology as opposed to those in a remote rural region.

In addition to the probable lack of adequate knowledge about this type of vehicles one also expects that people in a high latitude rural region may be skeptical about adopting EVs given fears that the weather is too cold, especially in winter, to properly charge these (Haakana et al. 2013). There are also concerns that existing EV models may be unable to handle the especially adverse weather conditions prevailing in these regions on a par with 4-wheel drive ICE vehicles. Finally, there is also the question as to whether only those rural residents who already own a conventional vehicle might consider purchasing an EV as a second car to be used only when the weather conditions are appropriate.

The answer as to what impedes people from wanting to embrace an EV and what factors it would take to convince them to change their mind, especially in high-latitude and low-

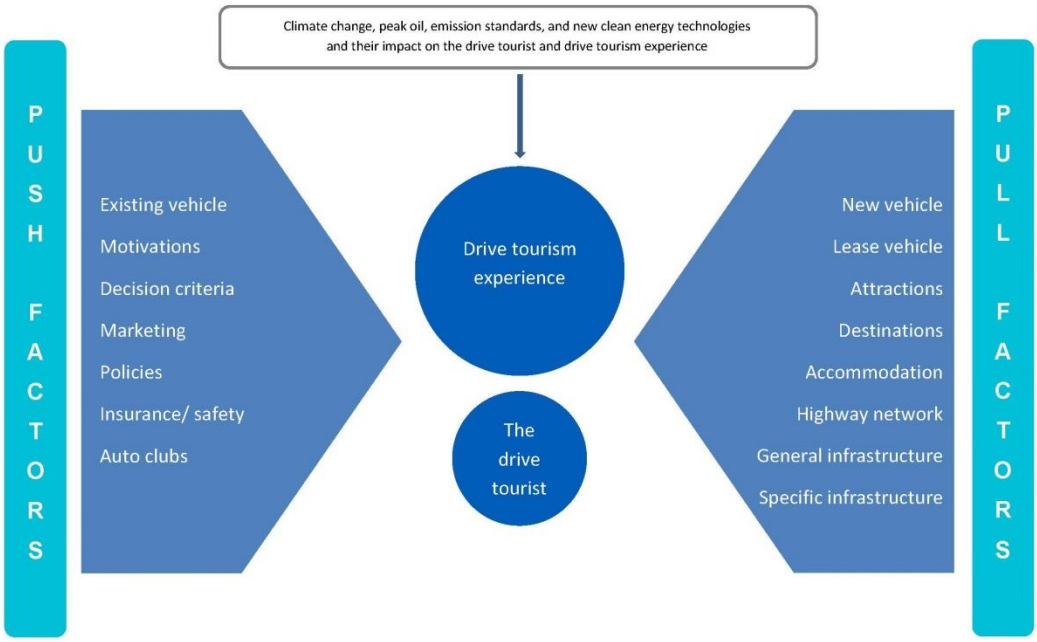
[16] A historical study examining the adoption of conventional automobiles in Sweden during the period 1960-1975 (Lindgren et al. 2010) explores how despite the enormous investment in road infrastructure as a means to promote greater levels of regional equality it was mostly income levels that explained levels of car ownership. Not surprisingly, in the 1950s per capita car ownership was highest in metropolitan regions though by the 1970s the adoption rates of private automobiles increased dramatically in sparsely populated country as the car became a necessity in these regions.

density areas, we propose an analysis of people's attitudes towards such vehicles in Jämtland-Västernorrland. Such an analysis can benefit from a simple model of EV adoption as it relates to low density areas. The development of such a model appears in the next section and it is one that borrows heavily from the framework presented by Fjelstul and Fyall (2014) for electric vehicle tourism in the US.

Toward model of EV Adoption in the Countryside

Our proposed framework for understanding the push and pull factors behind the adoption of EVs in the countryside is loosely based on the "drive-tourism" framework put forth by Fjelstul and Fyall (2014). Referring specifically to the US they examine the pressures leading to the need to reduce dependence on ICEs. Their point of departure is that EVs have not been selling well despite efforts to make such vehicles more popular. Their paper's main focus is to offer a push-pull model for drive tourism (see Figure 2).

Figure 2: Drive-Tourism Model (summarized from Fjelstul and Fyall 2014)



The point of Fjelstul and Fyall (2014) is that:

> *So many dimensions have the potential to be impacted by the emergence of new clean energy technologies that the entire model of drive tourism as currently exists is open to change. Arguably, the development and/or critique of future theory and conceptualizing in the field will be driven by these new technologies, whereas theories of the diffusion of innovation, branding and brand loyalty, and experiential marketing and consumption, to name but a few, will play integral roles in establishing whether the green agenda really will fundamentally*

> *shift the demand and supply and push and pull factors that shape the drive tourist and ultimately the drive tourism experience (n.p.).*

Their model presents the main push/pull factors that they perceive as influencing EV drive tourism in the United States:

Push Factors

The first push factor according to Fjelstul and Fyall involves the vehicle type itself. Their argument is that sooner or later EVs will become "mainstream" and, therefore, driving a conventional ICE vehicle will become increasingly frowned upon since it will no longer be the socially acceptable norm. Secondly, they argue that motivations to adopt a greener lifestyle are already making many people (especially younger people in urban areas) question the necessity of owning a car. If these individuals are going to drive, for example while on vacation, they are less likely to be resistant to renting/using an EV. As a third factor, which influences EV drive tourism, come various decision criteria such as those deriving from income and employment status, household composition, vacation time, and the effects of seasonality. To varying degrees all of these will influence whether or not EVs are used while on holiday while the issue of appearing "cool" while driving such vehicles also becomes a consideration.

Marketing also shapes change in demand. With no or limited presence of the product (in this case the EV) in the market it is hard for consumers to form an opinion about it. Then there are the policies, especially those leading to incentives aimed at encouraging the purchase of EVs. As we have already highlighted, such policies are largely ineffective if consumers fail to be convinced as to their value. Also, as Fjelstul and Fyall indicate it is sometimes hard to achieve anything positive with pro-EV policies, when simultaneously there are mixed signals sent out by the government such as continuing to find ways to suppress oil prices. The final two push factors that may influence EV demand are insurance premiums and auto associations. If insurance rates were lower for the drivers of EVs compared to those choosing ICEs this may encourage people to seek clean energy vehicles. Meanwhile, auto associations can be key actors in terms of contributing toward enhanced EV popularity by endorsing this technology.

Pull Factors

In the case of drive tourism there are also several pull factors, which influence whether or not consumers will choose EVs and, if so, which model to purchase. The first such factor is the actual availability of new cars. There are many different types of cars available on the market not just conventional ICEs but also hybrids, electrics, and ones that use other forms of alternative energy. These vehicles come at different prices and vary in size, performance, and so on. Also, even if the vehicles are powered by gasoline engines, manufacturers regularly seek to discover ways to decrease consumption and improve their efficiency, thus ensuring

that ICEs remain a popular option for most consumers. Today, many people shy away from buying an EV because they think it lacks the coolness of a conventional car. This situation, however, is likely to change as the EV technology is refined and automobile designers become more aware of what consumers actually require.

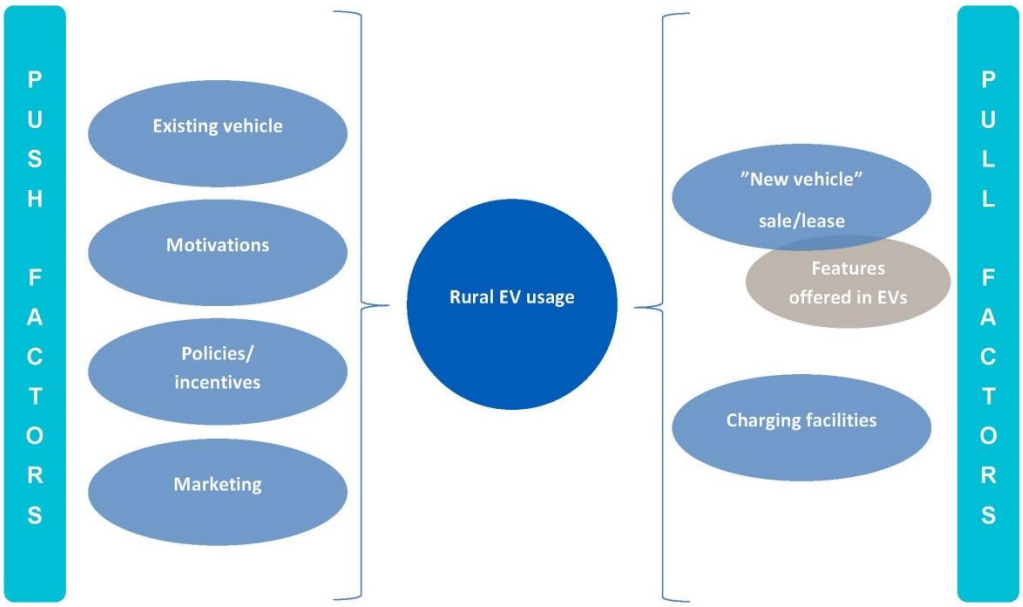
One way, of course, to encourage enhanced interest in EVs is by increasing the opportunities for leasing or renting such cars. If visitors arriving at a destination (e.g., at the airport or railway station) are able to rent an EV for an affordable price (one that is competitive with that of a conventional car) they would be in a position to test drive this car for a few days, thus forming a better opinion as to what it has to offer. Meanwhile, the ability to lease an EV on a three year basis as opposed to buying one outright could also be an attractive option for some consumers since in some instances this enables them to pay a monthly fee without having to put down a substantial deposit. The relatively short term of the lease means that if at the end of the contract these consumers dislike what the EV has to offer they can switch to another model including a conventional car.

Yet another way to encourage EV adoption among drive tourists is by ensuring that attractions and destinations are set up with the infrastructure to cater to the users of such vehicles. This means having charging facilities either at single attractions or scattered throughout popular destinations. Similarly, hotels and other visitor accommodations could ensure they offer charging facilities for their guests especially since the latter could charge their vehicles while they rest. These types of infrastructure as well as general charging opportunities offered on highways are imperative as pull factors for persuading skeptical consumers to make the shift towards EVs.

Amended framework for EV usage in sparsely populated areas

Based on the model of EV tourism presented in the preceding section we propose here a simple push-pull factor framework relating to the possible enhancement of EV usage in the countryside. The framework incorporates factors that may push consumers towards considering the adoption of EVs while pull factors that might act as enticements are also taken into account. The model as it appears here is simple and can be expanded to consider many more factors on either side of the consumers' final choice (see Figure 3).

Figure 3: Model for EV Usage in the Countryside



As push factors we consider the following: (a) Does the rural consumer already own a vehicle and, if so, what type of vehicle? Does this consumer see the need for a second vehicle (e.g., multi-person household); (c) what kind of incentives/policies would be considered positive from the consumers' point of view in terms of convincing them to acquire an EV; (d) are there existing marketing efforts to encourage consumers in sparsely populated areas to acquire an EV and, if not, what kind or promotional efforts could be adopted to enhance these vehicles visibility in the market?

There are also pull-factors that may draw consumers to the EV: (a) the first has to do with the question as to whether or not the rural dweller is in a situation where she is considering buying or leasing a new vehicle; if so, what exists on the market will act as a draw and if the new vehicle is going to be a second car in the household may influence the decision to go green. The ability to lease may be a more attractive option to buying since the rural consumer would not have to put down a significant deposit. Further, the options offered by the EV they are considering such as extended range, the ability to drive in adverse (icy) conditions, or to tow a trailer will also play a role in enticing potential customers; (b) the second factor has to do with what exists by way of charging facilities in the community

where the consumers live as well as where they work, shop, play, and so on. The presence or absence of such charging infrastructure will be a catalyst as to whether or not they choose to acquire an EV.

Concluding Remarks

This report has presented an overview of the international literature regarding electric vehicles and, specifically, has discussed issues such as whether or not the policy environment in various countries that leads to incentives for adopting such technologies has worked successfully. Arguments as to why certain incentives may actually not be beneficial in the long run have been presented. Moreover, we have examined several attitude studies concerning clean energy vehicles, including EVs, noting that despite the gradual increase in these cars' popularity over recent years there are still many consumers who are exceedingly hesitant about taking the plunge to "go electric". Various hurdles need to overcome if these vehicles are going to become the mainstream vehicle of choice in the near future. These include concerns relating to limited range and the perception that such vehicles are not powerful enough, especially for the open road. Then there are consumers who do not think that EVs offer a "cool" enough style because of size, looks, comfort, and so on. What is interesting from some of the attitude studies is that there are situations where those who would be labeled "green consumers" still do not think it is wise to invest in an EV due to the high cost associated with these. These consumers feel that they make green choices in the way they live, including the fact that they do not drive very much and, therefore, they do not see the point of investing in an expensive EV when this is going to spend most of the time not being used.

Beyond the discussion concerning consumers' attitudes and, especially the obstacles toward adopting EVs, we briefly examine the issue of driving range with regards to where to locate charging facilities for EV users. We then shift direction and discuss the use of EVs in a tourism context given that developing a program for promoting and utilizing such vehicles in popular tourist destinations might act as a step towards making regions more EV-friendly for everyone, including residents. The example of what has been happening in Oregon to promote EV tourism with the eventual goal of making the state one of the leaders in EV usage throughout the US has been discussed. Based on that study we propose that a step forward in this research is to survey Norwegian drivers of EVs who reside in the region of Trøndelag to explore among others their driving behavior whilst on holiday in Sweden as well as gathering information as to their attitudes concerning advantages and obstacles, which exist in relationship to their trips.

In the final part of the review we have focused on the issue as to whether or not the use of EVs makes sense in rural/low density regions given that it is precisely in such areas that owning a private car becomes a necessity. In contrast to urban areas where there exist a whole range of alternative solutions to enhance their sustainability (including the promotion of non-motorized transportation options) people in rural areas depend heavily on cars,

especially since other forms of transportation (e.g., rail or bus) cannot always be provided on a competitive basis. Based on this argument, we propose a study on the factors promoting or inhibiting EV usage, especially in the countryside (in this case, what constitutes a very low density area in a remote part of Sweden) through the use of a simple "EV in the countryside" framework.

References

Banister, D. (2008). "The sustainable mobility paradigm." *Transport Policy* 15(2): 73-80.

Banister, D. (2000). "Sustainable urban development and transport – a Eurovision for 2020." *Transport Reviews*, 20(1): 113-130.

Bodén, B. 2010. *Resande och fjällturism. En utredning om tillgänglighet och expansion i sex turistorter i Dalarna och Jämtland*. ETOUR 2010:25, Östersund.

Brady, J. and O' Mahony, M. (2011). "Travel to work in Dublin. The potential impacts of electric vehicles on climate change and urban air quality." *Transportation Research Part D*, 16: 188-193.

Briedenhann, J. and Wickens, E. (2004). "Tourism routes as a tool for the economic development of rural areas – vibrant hope or impossible dream?" *Tourism Management*, 25: 71-79.

Bronstein, S. and MacArthur, J. (2011). "Electric vehicles and the Oregon tourism industry: A White Paper." Portland, Oregon: Oregon Transportation Research and Education Consortium.

Calef, D. and Goble, R. (2007). "The allure of technology: How France and California promoted electric and hybrid vehicles to reduce urban air pollution." *Policy Sci*, 40: 1-34.

Carlsson, F. and Johansson-Stenman, O. (2003). "Costs and benefits for electric vehicles: A 2010 perspective." *Journal of Transport Economics and Policy*, 37(1): 1-28.

Ceron, J.P. and Dubois, G. (2007). "Limits to tourism? A backcasting scenario for sustainable tourism mobility in 2050." *Tourism and Hospitality Planning and Development*, 4(3): 191-209.

Chapman, L. (2007). "Transport and climate change: a review." *Journal of Transport Geography*, 15: 354-367.

Chen, T.D., Kockelman, K.M., and Khan, M. (2013). 'The electric vehicle charging station location problem: A parking-based assignment method for Seattle.' Published in the *Proceedings of the 92nd Annual Meeting of the Transportation Research Board in Washington DC*, (January 2013).

Chernova, Y. (2014). "What's holding back electric-car sales?" *The Wall Street Journal*, http://http://www.wsj.com/articles/what-s-holding-back-electric-car-sales-1411937798 (Date accessed, January 20, 2015).

Christensen, T.B., Wells, P. and Cipcigan, L. (2012). "Can innovative business models overcome resistance to electric vehicles? Better place and battery electric cars in Denmark." *Energy Policy*, 48: 498-505.

Coad, A, de Haan, P. and Woesdorfer, J.S. (2009). "Consumer support for environmental policies: An application to purchases of green cars." *Ecological Economics*, 68: 2078-2086.

De Haan, P., Mueller, M.G., and Scholz, R.W. (2009). "How much do incentives affect car purchase? Agent-based microsimulation of consumer choice of new cars – Part II: Forecasting effects of feebates based on energy efficiency." *Energy Policy*, 37: 1083-1094.

Denstadli, R.M. and Jacobsen, J.K.S. (2011). "The long and winding roads: Perceived quality of scenic tourism routes." *Tourism Management*, 32: 780-789.

Deshayes, P.H. (2014). "Booming electric car sales under fire in Norway." *Business Insider*, http://www.businessinsider.com/afp-booming-electric-car-sales-under-fire-in-norway-2014-8?IR=T (date accessed, 2 February, 2015).

Diamond, D. (2009). "The impact of government incentives for hybrid-electric vehicles: Evidence from US states." *Energy Policy*, 37: 972-983.

Dijk, M., Orsato, R.J., and Kemp, R. (2013). "The emergence of an electric mobility trajectory." *Energy Policy*, 52: 135-145.

Duke, M., Andrews D., and Anderson, T. (2009). "The feasibility of long range battery electric cars in New Zealand." *Energy Policy*, 37: 3455-3462

Duval, D.T. (2007). *Transport and Tourism: Modes, Network, Flows.* Clevedon: Channel View Publications.

Eberhard, M. and Tarpenning, M. (2007). "The 21st Century electric car." Tesla Motors Inc.

Egbue, O. and Long, S. (2012). "Barriers to widespread adoption of electric cars: an analysis of consumer attitudes and perceptions." *Energy Policy*, 48: 717-729.

Elkind, E.N. and Ku, A. (2013). "Electric vehicle paradise: How Hawaii can lead the world in deployment." Maui Electric Vehicle Alliance.

Figenbaum, E., Kolbenstvedt, M., and Elvebakk, B. (2014). *Electric vehicles – environmental, economic and practical aspects*. Oslo: Institute of Transport Economics.

Flamm, B.J. and Agrawal, A.W. (2012). "Constraints to green vehicle ownership: A focus group study." *Transport Research Part D*, 17: 108-115.

Fjelstul, J. and Fyall, A. (2014). "Sustainable drive tourism: A catalyst for change." *International Journal of Tourism Research*, online DOI: 10.1002/jtr.2013: n.p.

Fox, G. (2011). "Getting ready for electric vehicle charging station." *Industry Applications Society Annual Meeting (IAS), 9-3 October 2011, IEEE, Orlando Florida: 1-7.*

Gallagher, K.S. and Muehlegger, E. (2011). "Giving green to get green? Incentives and consumer adoption of hybrid vehicle technology." *Journal of Environmental Economics and Management*, 61: 1-15.

Gordon, D., Sperling, D. and Livingston, D. (2012). "Policy priorities for advancing the US electric vehicle market." *The Carnegie Papers*. Washington, DC: Carnegie Endowment for International Peace.

Graham-Rowe, E., Gardner, B, Abraham, C., Skippon, S., Dittmar, H., Hutchins, R., and Stannard, J. (2012). "Mainstream consumers driving plug-in battery-electric and plug-in hybrid electric cars: A qualitative analysis of responses and evaluations." *Transportation Research Part A*, 46: 140-153.

Gössling, S., Hall, C.M., Peeters, P. and Scott, D. (2010). "The future of tourism: can tourism growth and climate policy be reconciled? A mitigation perspective." *Tourism Recreation Research*, 35(2): 119-130.

Haakana, A., Laurikko, J., Granström R., and Hagman, R. (2013). Assessing range and performance of electric vehicles in Nordic driving conditions – End of Project Report. Nordisk Energiforskning.

Hall, C.M. (1992). *Wasteland to World Heritage: Preserving Australia's Wilderness*. Carlton: Melbourne University Press.

Hall, C.M. and Shultis, J. (1991). "Railways, tourism and worthless lands: The establishment of national parks in Australia, Canada, New Zealand and the United States." *Australian-Canadian Studies: A Journal for Humanities and Social Science,* 8(2): 57-74.

Hannisdahl, O.H., Malvik, H.V., and Wensaas, G.B. (2013). "The future is electric! The EV revolution in Norway – explanations and lessons learned." Paper presented at the EVS27 (the 27th International Electric Vehicle Symposium), Barcelona, Spain (November 17-20).

Harding, G.G. (1999). "Electric vehicles in the next millennium." *Journal of Power Sources*, 78: 193-198.

Haugen, K. (2012). *Miljöbilens förutsättningar i glesa bygder: Tillgänglighet samt sociala och ekonomiska aspekter för individer och hushåll*. Umeå University, Umeå: TRUM – Rapport 2012:01.

Hawkins, T.R., Singh B., Majeau-Bettez G., and Stromman, A.H. (2012). "Comparative environmental life cycle assessment of conventional and electric vehicles." *Journal of Industrial Ecology*, 17(1): 53-64.

Hickman, L. (2012). "Are electric vehicles bad for the environment?" The Guardian. http://www.theguardian.com/environment/blog/2012/oct/05/electric-cars-emissions-bad-environment (date accessed: January 14, 2015).

Hidrue, M.K., Parsons, G.R., Kempton, W., and Gardner, M.P. (2011). "Willingness to pay for electric vehicles and their attributes." *Resource and Energy Economics*, 33: 686-705.

Howard, B. (2013). "EVs are better cheaper, so why aren't they selling." Extreme Tech, http://www.extremetech.com/extreme/165094-evs-are-better-and-cheaper-so-why-arent-they-selling-actually-they-are (date accessed: January 10, 2015).

Høyer, K.G. (2010). "Sustainable tourism or sustainable mobility? The Norwegian case." *Journal of Sustainable Tourism*, 8(2): 147-160.

Høyer, K.G. (2008). "The history of alternative fuels in transportation: the case of electric and hybrid cars." *Utilities Policy*, 16: 63-71.

Ioannides, D. and Timothy, D. (2010). *Tourism in the USA: A Spatial and Social Synthesis.* London: Routledge.

Jones, C. (2014). "Analysis of Tesla sales by geography." Article retrieved from http://www.forbes.com/sites/chuckjones/2014/07/31/analysis-of-tesla-sales-by-geography/ (date accessed: January 14, 2015)

Kahn, M.E. (2007). "Do greens drive hummers or hybrids? Environmental ideology as a determinant of consumer choice." *Journal of Environmental Economics and Management*, 54: 129-145.

King, D. (2014). "Tesla breaks 28 year-old monthly sales record in Norway." Article retrieved from http://www.autoblog.com/2014/04/07/tesla-breaks-28-year-old-monthly-sales-record-in-norway/ (Date accessed: January 14, 2015).

Kjartansdottir, T. (2012). "Electric vehicles in Iceland: Private consumer market 2013-2017." MS Thesis in International Business, Bifröst University.

Krause, R.M., Carley, S.R., Lane, B.W., and Graham, J.D. (2013). "Perception and reality: Public knowledge of plug-in electric vehicles in 21 US cities." *Energy Policy*, 63: 433-440.

Lieven, T., Muhlmeier, S., Henkel, S. and Waller, J.F. (2011). "Who will buy electric cars? An empirical study in Germany." *Transportation Research Part D*, 16: 236-243.

Lindgren, E., Lindgren, U. and Pettersson, T. (2010). "Driving from the centre to the periphery? The diffusion of private cars in Sweden, 1060-1975." *The Journal of Transport History*, 31(2): 164-181.

Lumston, L. and Page, S. (2004). *Tourism and Transport: Issues and Agenda for the New Millenium*. Elsevier Ltd.

Länstransportplan 2014-2025 för Jämtlandslän. Fastställd av Regionstyrelsen 2014-06-15. DnrRS/2013-19.

Lööf, A. (2014). "Så vill vi göra för att snabba på utvecklingen mot elbilar." *Dagens Nyheter* (onsdag 6 augusti).

Manning, R., Lawson, S., Newman, P., Hallo, J., and Monz, C. (2014). "Emerging principles of sustainable transportation in the national parks." In Manning, R., Lawson, S., Newman, P., Hallo, J. and Monz, C. (eds.) *Sustainable Transportation in the National Parks: From Acadia to Zion*. Hanover, NH: University Press of New England, pp. 273-289.

Melaina, M. and Bremson, J. (2008). "Refueling availability for alternative fuel vehicle markets: Sufficient urban station coverage." *Energy Policy*, 36: 3233-3241.

Miller, J. (2014). "Electric vehicle tourism." Unpublished paper, Arizona State University.

Newman, D., Wells, P., Donovan, C., Nieuwenhuis, P., and Davies, H. (2014). "Urban, sub-urban or rural: where is the best place for electric vehicles?" *International Journal Automotive Technology and Management*, 14(3-4): 306-323.

Newman, P.W.G. and Kenworthy, J.R. (1996). "The land use-transport connection: an overview." *Land Use Policy*, 13(1): 1-22.

Organization for Economic Cooperation and Development (OECD) (2013). "Green innovation in tourism services." *OECD Tourism Papers* 2013(01).

Ozaki, R. and Sevastyanova, K. (2011). "Going hybrid: an analysis of consumer purchase motivations." *Energy Policy*, 39: 2217-2227.

Pearre, N.S., Kempton, W., Guensler, R.L., and Elango. V.V. (2011). "Electric vehicles: How much range is required for a day's driving?" *Transportation Research Part C*, 19: 1171-1184.

Plötz, P., Schneider U, Globisch J., and Dutschke E. (2014). "Who will buy electric vehicles? Identifying early adopters in Germany." *Transportation Research Part A*, 67: 96-109.

Prideaux, B. and Carson, D. (eds.) (2010). *Drive Tourism: Trends and Emerging Markets*. Abington, Oxon: Routledge.

Prideaux, B. and Carson, D. (2003). "A framework for increasing understanding of self-drive tourism markets." *Journal of Vacation Marketing*, 9: 307-313.

Rezvani, Z., Jansson, J and Bodin, J. (2015) "Advances in consumer electric vehicle adoption research: A review and research agenda." *Transportation Research Part D: Transport and Environment*, 34: 122-136

Rienstra, S.A. and Nijkamp, P. (1998). "The role of electric cars in Amsterdam's transport system in the year 2015; a scenario approach." *Transportation Research: D*, 3(1): 29-40.

Runte, A. (1990) *Yosemite: The Embattled Wilderness*. Lincoln: University of Nebraska Press

Runte, A. (1987) *National Parks: The American Experience*. Lincoln: University of Nebraska Press.

Runte, A. (1974) 'Pragmatic alliance: Western railroads and the national parks', *National Parks & Conservation Magazine: The Environmental Journal*, April: 12-21.

Schroeder, A. and Traber, T. (2012). "The economics of fast charging infrastructure for electric vehicles." *Energy Policy*, 43: 136-144.

Schuitema, S., Anable, J., Skippon, S. and Kinnear, N. (2013). "The role of instrumental, hedonic and symbolic attributes in the intention to adapt to electric vehicles." *Transportation Research Part A*, 48: 39-49.

Skerlos, S.J. and Winebrake, J.J. (2010). "Targeting plug-in hybrid electric vehicle policies to increase social benefits." *Energy Policy*, 38: 705-708.

Steinhilber, S., Wells P., and Thankappan, S. (2013). "Socio-technical inertia: understanding the barriers to electric vehicles." *Energy Policy*, 60: 531-539.

Tepecik Diş, A. (2012). "Green Highway – a 450 km Nordic co-operative project." *Nordregio News Publication (Green Economy in Policy and Practice)*, 1: 7-12.

Thomas, S. (2012). "How green are electric vehicles." *International Journal of Hydrogen Energy*, 37: 6053-6062.

Timothy, D. (2010). "Highways and byways: Car-based tourism in the US." In Prideaux, B. and Carson, D. (eds.) *Drive Tourism: Trends and Emerging Markets*. Abington, Oxon: Routledge. pp. 172-193.

Vidal, J. (2014). "Norway has fallen in love with electric cars – but the affair is coming to an end." *The Guardian*. http://www.theguardian.com/environment/2014/jan/29/norway-electric-cars-sale. (Date accessed January 14th, 2015).

Wall-Reinius, S. (2009). "A Ticket to National Parks? Tourism, Railways and the Establishment of National Parks in Sweden." In Frost, W. and Hall, C.M. (eds.), *Tourism and National Parks. International perspectives on development, histories and change*. Routledge, London, pp. 184-196.

Wall-Reinius, S. and Ioannides, D. 2013. 'Past, present and future transportation to peripheral recreational and protected areas in Sweden.' Presentation at AAG 2013 Conference, Los Angeles, CA. Unpublished material.

Wall-Reinius, S. and Olausson, F. (2015), in press. *Undersökning bland besökare i södra Jämtlandsfjällen sommaren 2013*. Östersund: ETOUR Report 2015.

Wang, Y.W. (2011). "Locating flow recharging stations at tourist destinations to serve recreational travelers." *International Journal of Sustainable Transportation*, 5: 153-171.

Weiller, C. and Neely, A. (n.d.) "Electric vehicle rental services: Project in Okinawa, Japan." Cambridge Service Alliance: University of Cambridge.

Yang, W. (2010). "The development of tourism in the low carbon economy." *International Business Research*, 3(4): 212-215.

Zampoukos, K., Olausson, F., Lindahl, S., and Hirvelä, H. (2015). *Elbilar, Hållbarhet och Planering – En Genomlysning av Norska och Svenska Rapporter och Examensarbeten*. Östersund: ETOUR Report 2015:2.

Zillinger, M. (2007). *Guided Tourism: The Role of Guidebooks in German Tourist Behaviour in Sweden*. Östersund: ETOURs Vetenskaplika bokserie V 2007: 18.

Åhman, M. (2006). "Government policy and the development of electric vehicles in Japan." Energy Policy, 34: 433-443.

Åkerman, J. and Höjer, M. (2006). "How much transport can the climate stand? Sweden on a sustainable path in 2050." *Energy policy*, 34: 1944-1957.

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