NORTH SEA REGION ELECTRIC MOBILITY NETWORK
e-mobility NSR

Main findings WP4: Development of a Transnational e-mobility plan

Position paper based on main findings

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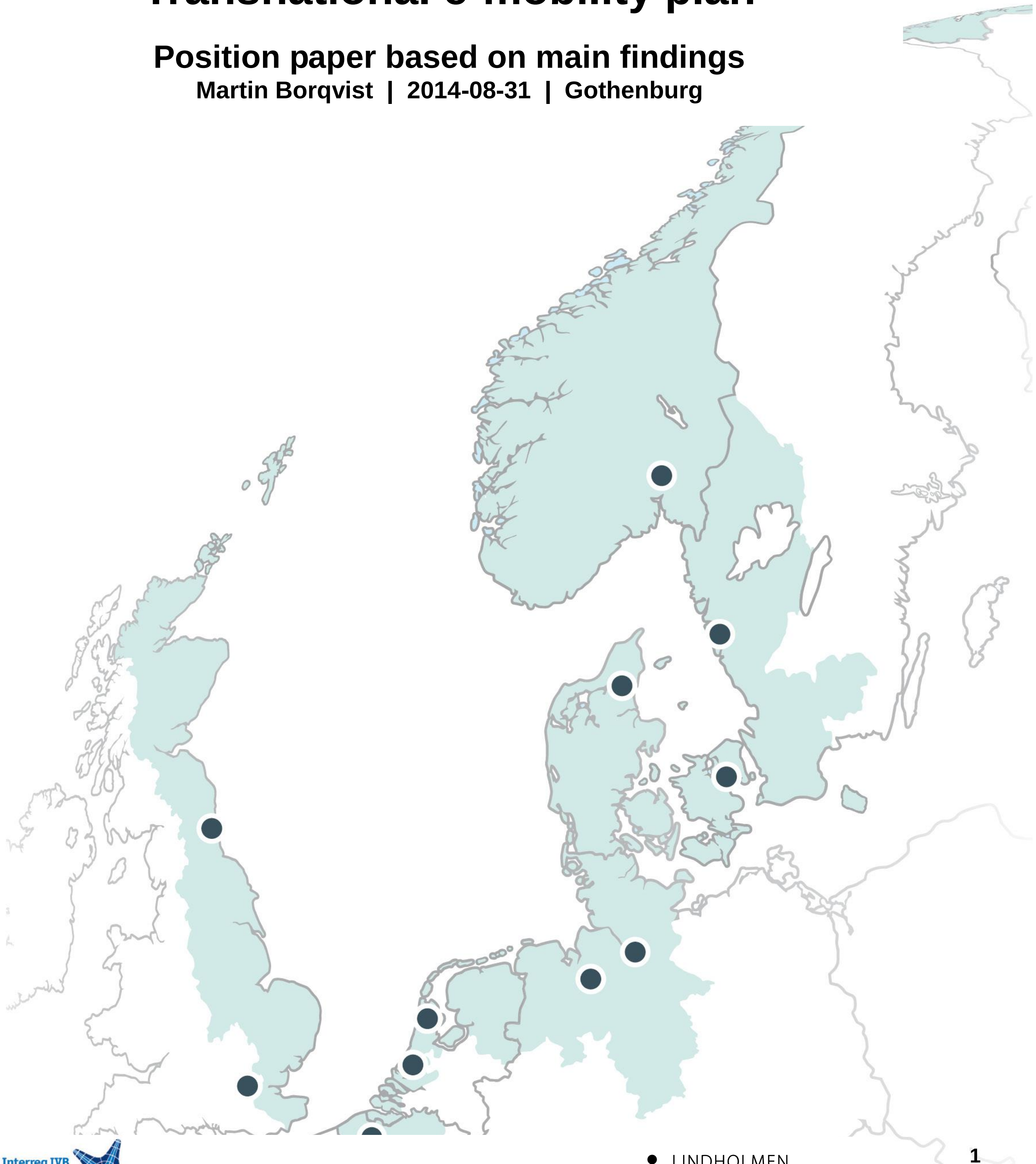

The Interreg IVB North Sea Region Programme
Investing in the future by working together for a sustainable and competitive region

European Union The European Regional Development Fund

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Introduction

The purpose of this document is to outline the main findings from Work package 4 (WP4) in the EU funded project ***North Sea Region Electric Mobility Network (E-mobility NSR).*** The project is being undertaken in the framework of the Interreg IVB North Sea Region Programme (NSR), and has been conducted from October 2011 to September 2014.

Context
The purpose of the work within WP4 has been to provide state of the art information as well as insights on gaps and needs regarding e-mobility and charging infrastructure. The reason to do this is to contribute to a long-term basis for e-mobility within the NSR.

Scope
The scope of WP4 consist of creating knowledge through research , demonstration and simulation activities as well as sharing experiences and knowledge with stakeholders through workshops and conferences as a means of co-learning and dissemination

Objectives
- Research, create knowledge and develop tools related to mapping needs and route planning for electric vehicles
- Create knowledge related to charge infrastructure
- Facilitate exchange of competences between stakeholders in the field of e-mobility
- Produce project reports, conference contributions and journal articles and guidelines within the field of e-mobility

Activities and partners

The work package has had two main areas of focus;
1) Charge infrastructure, involving actual tests and evaluation of state of the art (technology and standardisation)
2) Mapping methods, route planning concepts and spatial analysis of e-mobility.

The participating organisations have been; The Cities Institute (CI) and subsequently – following restructuring – the Faculty of Business and Law (FBL) at the London Metropolitan University, Northumbria University (NU), Delft University of Technology (DUT), Hamburg University of Applied Sciences (HAW), The Province of North Holland (PNH), Zero Emission Resource Organisation (ZERO), WFB Wirtschaftsförderung Bremen (WFB) and Lindholmen Science Park (LSP).

Within the two main areas a number of activities have been performed, ranging from research to demonstration and dissemination;
- Research performed at CI / FBL, focusing on map based tools for infrastructure investigations, gap analysis and route planning on macro level as well as on street level.
- Research on spatial analysis of e-mobility and charge infrastructure planning, performed by a researcher at NU with support from colleagues there.

- Research on the standardisation process for charge infrastructure by TUD.
- Subsidisation of fast chargers in North Holland by PNH.
- Demonstration and tests of fast chargers in Gothenburg by LSP.
- Lobbying and monitoring of e-mobility on a national level by ZERO and WFB.
- Monitoring of e-mobility activities, progress and developments within the North Sea Region, as well as joint discussions and synthesis of findings through all partners.

Outcomes and main findings

The electrification of the transport sector is an ongoing process where some variables and contexts change rapidly. This is true for both the development and deployment of electric vehicles (EVs) and charging infrastructure and even for some policy developments. As a consequence, findings can quickly become outdated, and conditions are subject to change. This means it is challenging to make plans and provide specific recommendations on the E-mobility subject.

In this section, the main findings from WP4 are summarized. WP4 has produced a number of deliverables and reports, as well as wider dissemination of this, that describe findings and results from the work performed in more detail. These deliverables are listed in the table below and they are linked to their respective area of focus. In this way, the reader can use this summary report to obtain an overview and the deliverable documents to get more detailed information.

Table 1: Output by WP4

Spatial analysis methods	**Charge infrastructure**
Report: A review of electric vehicle charge point map websites in the NSR **Authors:** Lilley and Richard Kotter (Northumbria University) and Nathaniel Evatt (Cities Institute, London Metropolitan University), 2013	**Report:** Experiences from the Gothenburg fast charging project for electrical vehicles **Authors:** Robert Granström, Helene Gamstedt, Lindholmen Science Park, 2012
Website: The E-mobility Charge Point Platform: http://maps.citiesinstitutesurveys.org/UKEmobility.html **Developed by:** Nathaniel Evatt (Cities Institute), 2013	**Workshop and workshop report:** 1st International Workshop on "Experiences and the future of EV Fast Charging", Workshop report **Author:** Martin Borgqvist, Lindholmen Science Park, 2012

Journal article: Integrating space-syntax and discrete-event simulation for e-mobility analysis *Journal of the American Society of Civil Engineers* 1 (91) 934-945. doi: 10.1061/9780784412909.091-2013 **Authors:** Eiman Y. ElBanhawy, Ruth Dalton (Northumbria University), Khaled Nassar (American University in Cairo), 2013	**Report:** Experiences from the Norwegian – Swedish cooperation on electric vehicle infrastructure **Author:** Martin Borgqvist, Lindholmen Science Park, 2012
Journal article: A Movable Charging Unit for Green Mobility. *ISPRS - International Archives of the Photogrammetry, Remote Sensing and Spatial Information Sciences XL-4/W1* (May 6): 77–82. doi:10.5194/isprsarchives-XL-4-W1-77-2013 **Authors:** ElBanhawy, E. Y (Noprthumbria University) and Nassar, K.	
Conference proceedings: Real-time Electric Mobility Simulation in Metropolitan Areas. A case study: Newcastle-Gateshead *Proceedings of the 30th eCAADe Conference*, eds. Henri; Pavlicek, J.; Hulin, J.; Matejdan; D., 533–546. Technical University in Prague; Faculty of Architecture, Czech Republic, 2012. **Authors:** Eiman Y. ElBanhawy, Ruth Dalton, Emine Mine Thompson, Richard Kotter (Northumbria University), 2012	**Report:** Experience Electrical Vehicle The case of fast charging **Author:** Maria Nilsson, Lindholmen Science Park, 2012

Conference proceedings: A Heuristic Approach for Investigating the Integration of Electric Mobility Charging Infrastructure in Metropolitan Areas: An Agent-based Modeling Simulation *IEEE*, 74 – 86. doi: 10.1109/EFEA.2012.6294081-2012. **Authors:** Eiman ElBanhawy, Ruth Dalton, Emine Mine Thompson and Richard Kotter, Northumbria University, 2012	**Report:** Standardization of EV Recharging Infrastructures **Author:** Sjoerd Bakker, Delft University of Technology, 2013
Conference proceedings: Syntactic Approach to Electric Mobility in Metropolitan Areas: NE 1 district core, segment map *Space Syntax Symposium, South Korea, 2013* **Authors:** Eiman Y. ElBanhawy and Ruth Dalton, Northumbria University, 2013	**Report:** Procurement of fast chargers **Authors:** Peter Lindgren, Lindholmen Science Park, 2014
Conference proceedings: Model of Transports to simulate EV system *GeoComputation Conference, China, 2013* **Authors:** ElBanhawy, E. Y. and Dalton, R. C. (Northumbria University)	
Conference presentation / paper in proceedings: Agent based modeling of Electric Vehicles *IEEE Transportation Electrification*	

Conference and Expo (ITEC 2014), Michigan **Authors:** ElBanhawy, E. Y.; Dalton, R. (both Northumbria University) and Anumba, C. (Penn Stat Univeristy, USA), 2014	
Conference presentation / paper in proceedings: A Hybrid Simulation User-Equilibrium Basis for Identifying EV Charging Hotspots in Transportation Network. Inner urban Core, State College *IEEE Transportation Electrification Conference and Expo (ITEC 2014),* Michigan **Authors:** Eiman Y ElBanhawy, Northumbria University 2014	
Conference presentation / paper in proceedings: Analysis of Space-Time Behaviour of Electric vehicle commuter, Experience the metropolitan and inter-cities scales *IEEE Transportation Electrification Conference and Expo (ITEC 2014),* Michigan. **Authors:** Eiman El Banhawy (Northumbria University), 2014.	

<u>Conference proceedings:</u> Investigating the evolution of e-mobility in its urban context a longitudinal study in Newcastle area *HEVC 2014* **<u>Authors:</u>** Eiman Y. ElBanhawy, Northumbria University, 2014	

Introduction and uptake of electric vehicles

Within the last five years the introduction of vehicles with electric propulsion has taken up pace. The vehicles taken under consideration in this report are pure electric vehicles (EVs) and plug-in hybrid electric vehicles (PHEVs).

Regarding electric cars, three main paths of development can be identified;

- The evolvement of hybrid electric vehicles (HEVs) in to PHEVs
    - E.g. the Prius PHEV
- The conversion of conventional models into EVs and/or PHEVs
    - E.g. Mitsubishi iMiEV, Ford Focus Electric and Volvo V60 PHEV
- The development of EVs and PHEVs from scratch
    - E.g. Nissan Leaf, Tesla Model S and Chevy Volt/Opel Ampera

In addition to this two other main trends can be identified;

- The development of new types of smaller electric vehicles, ranging from bikes to small four wheelers
    - E.g. E-bikes, Renault Twizy etc.

- The electrification of heavy and commercial vehicles
    - E.g. electric and plug-in hybrid city buses, trolley vehicles etc.

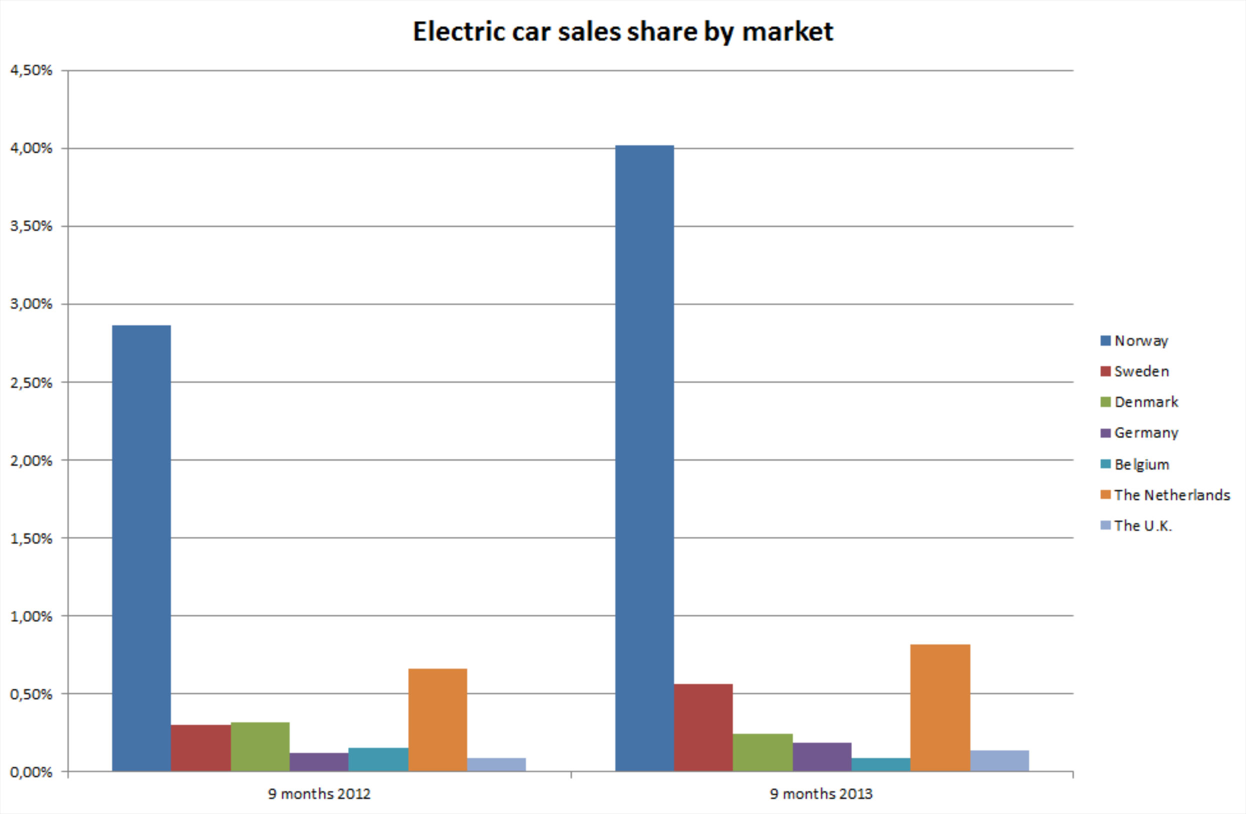
When it comes to the introduction of electric vehicles, regional conditions and differences foster certain kinds of vehicles. In Norway e.g., national incentives have accelerated the introduction of EVs, but not PHEVs. In the Netherlands, implemented policies have resulted in a large number of PHEVs, but not as many pure EVs.

At the moment, there is no single open source of aggregated information on new sales of electric vehicles within the NSR, or even the EU as a whole. There are data services that are offered for paying users, e.g. the Automotive Industry Data (AID) Newsletter (http://www.eagleaid.com/). Open data on sales are available for some countries on national websites (e.g. agencies that list figures on new registrations of vehicles), but not necessarily on a common format between countries. Some national sources list EVs and PHEVs separately, but some aggregate EV, PHEV and hybrid electric vehicles (HEV) sales into one single category. In other countries, national data is available for purchase.

Table 2. National websites that list electric vehicle market statistics

Country	**National electric vehicle market statistics**
Norway	www.gronnbil.no
Sweden	www.bilsweden.se www.trafa.se
Germany	http://www.kba.de/
The Netherlands	http://www.raivereniging.nl/ http://www.rvo.nl/
The UK	http://www.smmt.co.uk/

Table 3: New electric car sales by market



Source: AID accessed through www.elbil.no

The Charge infrastructure

Since about 2008, the main developments within the charge infrastructure area have been the standardisation of normal charging and the introduction of fast charging.

Fast charging test and demonstration

Experiences from the demonstration activities in Gothenburg include:

- The first Gothenburg fast charging project indicates that available chargers were immature in terms of maintainability, info about certification, winter performances and adaption to national safety praxis. The recommendation is to run more test projects with fast chargers to learn about next charger-generation and avoid loss of credibility.

- The high cost associated with the establishment of a charging site ruins most of the business cases. Without public grants, the only profitable case is a delivery company with fast charging to get more mileages/day with sufficient power on site and indoor charging to keep the cost down for the charging site (= not public).

- The user study highlighted the location of chargers as determination of behavioural pattern. General public location may have a limited effect on individual EV users.

However, from a company perspective, fast charger may be useful as it directly influence the efficacy of the usage of EVs. The participants that did not experience an added value of having access to a fast charger at the test site were those that (1) not represent the correct user group (2) have had access to the EV for a long time and they already match their daily routine according to the range of the EV, (3) do not have a need to drive long distances, (4) do not have a natural placement of the fast charger for it to play a significant role in their driving; (5) the amount of extra energy the fast charger provides does not play a significant role in their daily driving. However, some interesting (significant) changes in attitudes and behaviour were identified in the survey that needs further investigations (participant alternated from completely agree to completely disagree). The following aspects were identified as influencing the use of the fast charger: Location, amount of charge, cost of charging, time, current battery level, driving distance, safety of the place, and timing.

- No actual proof was found indicating that fast charging is essential for the introduction of EVs. And the "Denmark syndrome", compared with the "Norwegian success", indicates that there are other forces that are more important. However, in our studies an added value for car-sharing was pointed out as a driving force to develop a fast charging infrastructure parallel to a shift from owning to renting the vehicle.

Standardisation

Key developments and challenges within the standardisation work include:

- An EU standard has been defined (although formally only proposed) that specifies the use of Type2 plugs on the wall side and Type2 or Combo2 on the vehicle side.

- In practice, many other standards are still in use in the NSR and this will continue to be the situation for the coming years. This ‘early lock-in’ is the result of early infrastructure deployment in these countries and charging stations are often equipped with the local standard domestic or industrial sockets or, less so, with a variety of dedicated EV plugs like the Type 1, 2, or 3 sockets. Not all countries subscribe to the new standard (yet) and will continue to install other sockets than the soon-to-be standard Type2. Cross-border travel with EVs will therefore continue to require carrying multiple cables with different plugs. For current early adopters of EVs this is most likely not a problem, given their enthusiasm and personal motivation, but the next generation of EV drivers will expect to be able to charge everywhere with a single cable. In the current transition phase, it is advisable to install charging stations which offer both the Type2 socket as well as the local de-facto ‘standard’ socket.

- The real challenge for the future lies in the standardization of the identification and payment systems which is needed to allow EV drivers to roam between different national and international networks; network interoperability.

- Interoperability (or roaming) between various recharging networks has not been realized within most NSR countries. Sometimes these networks are regional and EV drivers can only use chargers within their own region (e.g. U.K. plugged-in-places networks, though there are now some inter-operability solutions between some neigbouring plugged-in-places networks, and some pay-As-You Go access solutions through some providers nationally. In other countries (e.g. Germany) charging station networks belong to specific electric utilities or service providers and EV drivers are then limited to their provider's network. It seems that the desire to realize national recharging networks (national roaming solutions) is prioritized over international interoperability. This implies that the individual countries may get locked-in into their own systems and standards and that international roaming will be even more difficult to achieve. There are several initiatives to realize solutions cross-border roaming (e.g. Ladenetz/Treaty of Vaals and Hubject). These may lead to a true European standard for identification and payment systems (and billing among providers) or to an additional service layer which is able to connect various standards.

- Currently, trip planning is (still) necessary for EV drivers when they make cross-border trips, and additional re-charging cables may be needed and so are ad-hoc agreements with recharging network operators to make use of their chargers.

Route planning and gap-analysis

The key to developing a comprehensive and inter-operable charging network is knowing where the infrastructure gaps in the region are and where user needs are not catered for. The key challenges and developments in this area of transport- and infrastructure planning are as follows:

- *Scaling up to the 'bigger picture'*: how to raise the confidence of EV users who wish to make longer journeys, including transnational journeys through international transport hubs to/from other NSR countries and elsewhere in Europe via ferry ports, airports and the Channel Tunnel?

    - The partnership performed a review of electric vehicle charge point map websites in the North Sea Region, with the aim of identifying if there are any patterns, or any noticeable gaps on the information presented by the interactive EV charge point tools. For each example of a charge point (station) map website, a review has been undertaken by visiting the charge point (station) map website and recording if the site contains the information, which is of key importance from an EV user perspective, such as for example an interactive map, any information on the charger power of the charge points (stations); the type of connection of the charge points (stations); the addresses of the charge points (stations) and further helpful details. It is clear the quality of the information offered is far from comprehensive or consistent between these electric vehicle charge point map websites, so an improvement is clearly needed on the front.

  - The review of existing knowledge bases established the lack of a transnational route planning and gap analysis tool. The E-Mobility NSR partnership highlighted OpenChargeMap as the most accessible and comprehensive spatial dataset that is currently available to facilitate the analysis of routes of transnational importance, such as the 2000-km long corridor between Newcastle (UK) and Oslo (Norway).

  - The partnership provided a mock-example of how a gap-analysis of this particular route based on OpenChargeMap could look like, which could inform the development of a route planning tool. The code and supplementary documentation for this prototype are available for download (free of charge) online (Evatt 2013). It constitutes the foundation for further development, in any of the four functions that the prototype currently entails.

  - A visual analysis of the findings suggests that the analysis might not reliably reflect the situation on the ground. First, the analysis depends on what charge point data is made available to OpenChargeMap. Second, OpenChargeMap does not currently show whether the charge point is available at a given time or “in use.” To verify this, the E-Mobility NSR partnership organised a live survey of this particular corridor for April 2014. Survey results will be made available to the public, and more importantly OpenChargeMap.

- *Scaling down to ‘street level’:* how to ensure that EV users, especially those who are less familiar with the locality, have the confidence to find publicly-accessible points, plug-in, and leave their vehicles charging?

  - In addition to above outlined challenges, the OpenChargeMap does not provide detailed micro-level information about individual charge points (on-side surveys, user feedback), such as accessibility, convenience of their design and location. The partnership provided a mock-example of how such information could be displayed. The code and supplementary documentation for this prototype are available for download (free of charge) online (Evatt 2013).

Research on infrastructure build out

Northumbria University has performed an intensive research project that targets the properties of design for an integrated infrastructure to support EV use. The uncertainty of having a reliable and integrated charging infrastructure presents hurdles to e-mobility uptake, and slows down the growing trend of smart ecosystems and sustainable urban communities as whole. This research project has performed a spatial and temporal analysis of charging patterns based on real information about EV users in one metropolitan area in depth (the urban core of Newcastle upon Tyne). The study outcomes provide recommendations on implementation of EV infrastructure, as well as a methodological approach useful for planning authorities and policy makers in evaluating and measuring the degree of usability of public electric mobility systems they are or will be (re-)designing. The findings have been widely presented and published in the NSR region, Europe more widely, the United States and also Egypt.

Conclusions and recommendations

The EV market is emerging with a large increase of annual sale, but from very low levels. Markets like Norway and the Netherlands are ahead of the rest. This is due to the combination of attractive EV models to purchase, fiscal and other incentives for EVs, as well as efforts to build out charge infrastructure. New models continue to reach the market, but a transition to E-mobility will most likely take time.

Today it is possible to travel longer distances with an EV between NSR - countries, but it is an effort that requires a lot of planning. The main reasons for this is lack of physical infrastructure, lack of comprehensive information on charge locations and lack of interoperability between charger-networks. The latter is due to that charger-network operators have different models for accessing the charge locations, e.g. through subscriptions, which impose barriers to users that are not customers.

Efforts that would increase the possibilities for transnational EV-travel include;

- Stimulating infrastructure to be build out in strategic locations;
  - For the route between Newcastle and Oslo, locations with gaps in fast charge infrastructure includes North-western Germany and Western Sweden.
- Support the development/implementation of solutions that allow drivers simple and convenient access to different charger-networks (roaming).
- Support facilitation of comprehensive and up-to-date information on charger locations.

Regarding the physical charge infrastructure there are still interoperability issues related to the fact that different plugs and sockets exist throughout the region. The proposed EU-standard on charge infrastructure address this and will probably reduce this barrier in the years to come.

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NORTH SEA REGION ELECTRIC MOBILITY NETWORK
e-mobility NSR

About E-Mobility NSR

The Interreg North Sea Region project North Sea Electric Mobility Network (E-Mobility NSR) will help to create favorable conditions to promote the common development of e-mobility in the North Sea Region. Transnational support structures in the shape of a network and virtual routes are envisaged as part of the project, striving towards improving accessibility and the wider use of e-mobility in the North Sea Region countries.

www.e-mobility-nsr.eu

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