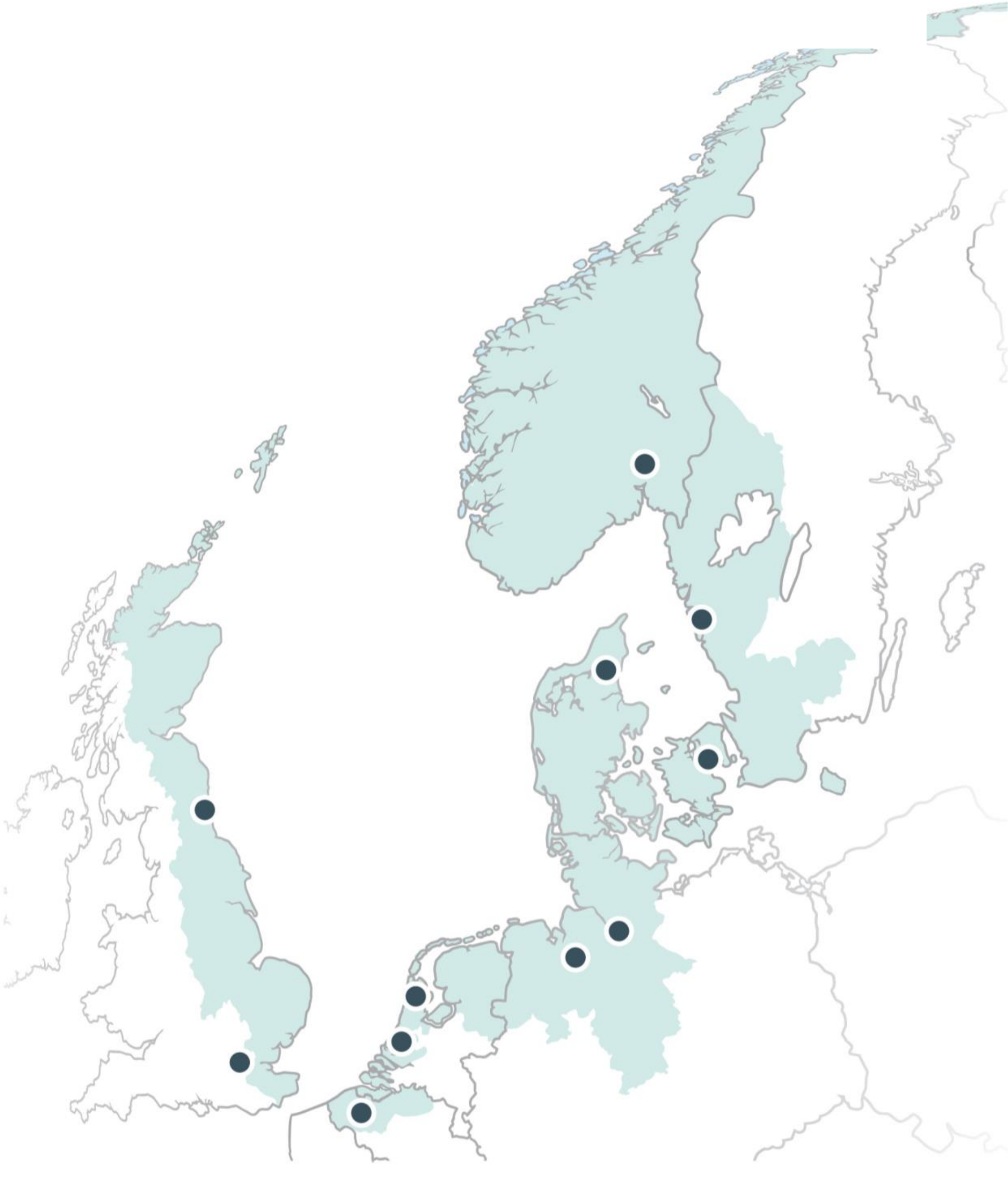
REPORT TO INFORM THE SETTING UP OF REGIONAL E-MOBILITY INFORMATION CENTRES

Work Package 6, Activity 8

Dr Stephen Shaw, Dr Louise Bunce and Dr Rita Kottász
11th April 2014 | London



North Sea Region Programme
Investing in the future by working together for a sustainable and competitive region
European Union
The European Regional Development Fund
London metropolitan university

Table of content

Executive Summary

This paper informs the setting up of regional E-Mobility Information Centres (EMICs), and further develops the findings of the main report for WP 6.6. Drawing on evidence from the UK with transnational comparisons, it highlights two critical awareness gaps that must be overcome if mainstream market drivers are to convert to the new and as yet unfamiliar technology of electric mobility, and thus the information that should be communicated to current and potential users:

1. Adapting to Electric Vehicles (EVs): Overcoming apprehensions of potential users with respect to vehicle performance, range, and recharging procedures;

2. Provision of Public Charging Infrastructure (PCI): Addressing concerns over shortcomings with respect to availability, interoperability, convenience and ease of use.

Empirical evidence from trials in the UK highlights the relative ease with which the early market for EVs has adapted to new routines for journey planning, driving and recharging. Analysis suggests that, for most people, the initial psychological deterrents do not translate into significant real-world barriers. The positive narrative of adjustment, diminishing concerns and increased satisfaction provides a powerful message that can be emphasised in communications strategies to promote the personal and business advantages (as opposed to the wider environmental benefits) of electric driving. Public policy acknowledges, nevertheless, that if 'mass market' users are to be converted to electric driving, an effective PCI must be installed to reduce the understandable concerns of drivers making longer trips beyond the range of their vehicles, and to accommodate residents without off-street parking who are unable to recharge at home.

In accordance with the UK Government's intentions, an initial set of around 3000 points was installed in publicly accessible places by 2012. Match-funding (£30 million 2011-13) supported eight trial areas known as 'Plugged-In Places', and in some areas a relatively dense cluster of points has been installed. However, the House of Commons Transport Committee (2012)[1] concluded that provision across

[1] The House of Commons, Transport Committee (2012) Transport Committee - Fourth Report Plug-in vehicles, plugged in policy? 12th September.

the country as a whole is far from even and fails to match the emerging demand to refuel EVs. A survey (Censuswide and Rexel 2013)[2] revealed that over 40% drivers 'would consider acquiring an EV', but around half were put off because they 'did not know where they could plug-in'. The UK Government (2013 OLEV: 10)[3] acknowledges that, as yet, 'most people have little, if any knowledge' of EVs, and a recent report by the Transport Research Laboratory (TRL 2013: 7)[4] argues strongly that key players should 'develop a united voice to educate and inform the public'.

The pioneering early market seems to have adapted to electric driving with enthusiasm, but significant awareness gaps continue to inhibit acceptance by the more cautious mainstream users. To ensure wider acceptance, a PCI that is fit for purpose will need to be in place. It must offer adequate spatial coverage, interoperability between network providers, and be well sited and designed to accommodate anticipated demand. The authors conclude that there is considerable potential to adapt and develop the Electric Mobility Information Centre (EMIC) model that is currently being piloted in Denmark by E-Mobility NSR Partners HTK as a medium to communicate the benefits of EVs more widely. The emphasis is on the presentation of user information that is comprehensive, clear and credible to private drivers and firms that would benefit most from the switch to EVs. It features locally based campaigns that include hands-on experience, including test-drives.

In 2014 the UK Government launched a national campaign 'Go Ultra Low' [www.goultralow.com]. This includes a national 'one stop' portal for existing and potential users of EVs and other Ultra Low Emission Vehicles (ULEVs). The Go Ultra Low website fits well with the recommended form and content for EMICs highlighted in the Report for WP 6.6. The analysis in this paper suggests that transnational and national portals should be complemented by 'going local': information on the benefits and practical issues for people and firms adapting to electric driving in the context of the area concerned. The Appendix to this paper assesses the content of other national, and (sub-) regional EMIC websites in Greater London, Eastern Counties Noth East of England.

[2] Censuswide and Rexel cited in Next Greencar (06.09 2013). Retrieved from www.nextgreencar.com/news/6335/40-UK-drivers-would-consider-buying-EV

[3] Office for Low Emission Vehicles (2013). *Driving the Future Today: A Strategy for Ultra Low Emission Vehicles in the UK.*

[4] Hutchins et al (2013) PPR668: *Assessing the role of the Plugged-in Car Grant and Plugged-in Places Scheme in electric vehicle take-up,* London: DfT Transport Research Laboratory.

Introduction

The environmental and economic objectives for electrifying road transport justify public subsidies and other interventions to support the early market for electric vehicles (EVs). In the UK as in other NSR countries, the technology is now tried and tested. And vehicle manufacturers seem willing and able to take on the challenge of New Product Development to prepare the way for mass marketization.

Nevertheless, despite the availability of reliable and road ready EVs, and a range of financial incentives to support market growth, critics comment that the uptake by mainstream drivers and fleet managers has been relatively slow to materialise, and those who support electrification of road transport express frustration at the pace of change (Kay et al: 2013).

This report highlights some significant gaps in public and private awareness that seem to be holding back the rate of growth in demand for EVs: barriers that must be overcome if mass market users are to convert from traditional ICE vehicles. Until this critical tipping point is reached, the anticipated environmental, economic and other benefits cannot be achieved. Drawing on evidence from recent research in the UK with transnational comparisons, the report will consider E-mobility awareness needs with respect to:

1. Adapting to Electric Vehicles (EVs): Overcoming apprehensions of potential users with respect to vehicle performance, range, and recharging procedures;

2. Provision of Public Charging Infrastructure (PCI): Addressing concerns over shortcomings with respect to availability, interoperability, convenience and ease of use.

Adapting to Electric Vehicles (EVs): Overcoming user apprehensions

The extent to which EVs will be assessed as a viable form of personal transport depends largely on whether would-be consumers will perceive them as an attractive proposition (Schuitema, Anable, Skippon & Kinnear, 2013; Lane, 2011). Global market leaders have capitalized on rapid advances in EV technology to produce high performance, well branded EVs. Nevertheless, it seems that a sizable portion of the UK public hold stereotypes of EVs that are based on outdated associations with golf buggies and milk floats. As yet, they are widely perceived as low performance vehicles with slow speeds and short ranges (Burgess, King, Harris & Lewis, 2013; Graham-Rowe, Gardner, Abraham, Skippon, Dittmar, Hutchins & Stannard, 2012).

Analysis of experimental evidence provides deeper insights into attitudes and expectations of people who have driven an EV (Carroll, Walsh, Burgess, Harris, Mansbridge, King & Bunce, 2013; Franke & Krems, 2013; Switch EV, 2013; Graham-Rowe et al., 2012; Vilimek, Keinath & Schwalm, 2012; Everett, Burgess, Harris, Mansbridge, Lewis, Walsh, Carroll, 2011; Franke, Neumann, Bühler, Cocron & Krems, 2011; Nilsson, 2011; Turrentine, Garas, Lentz & Woodjack, 2011; Carroll, 2010). Studies have highlighted three important deterrents for nearly all new electric drivers: concerns over performance, limited range, and the inconvenience of recharging. To what extent are these prejudices altered by real-world practical driving experience?

Performance

Technological advances have led to the production of high performance EVs by established and reputable car manufacturers including BMW, Mercedes, Nissan, and Ford. Nevertheless, EVs have been negatively stereotyped. How do drivers *experience* the performance of EVs? In experimental trials of EV use, the results tend not to support the traditional view of EVs as slow or 'milk-float' type vehicles.

In the UK's Ultra Low Carbon Vehicle Demonstrator Program (ULCVDP, Carroll et al., 2013; Everett et al., 2011) 349 drivers drove an EV for at least 3 months, and they were interviewed about their pre-EV use expectations and post-driving experiences. The results revealed that nearly all drivers *expected* the EV to under-perform in comparison to their ICE vehicle. However, a significant number (40%) of drivers rated their EV as performing *better than* their normal car after 3 months experience, despite having high expectations (Everett et al., 2011: 15). Likewise, in the Switch EV trial of 44 EVs in the North East of England (Switch EV, 2013) drivers preconceived EVs as low performance vehicles: *"They're almost like dinky toys"* (ibid: 5). However, after the one-year trial, 77% of drivers thought the acceleration of the EV was as good or faster than that of an ICE, with one driver saying: *"I found it was better than any car I've ever driven before"* and another explaining: *"It can out-perform any other car that I've driven"* (ibid: 6).

EVs were also described as having good acceleration in Neilsson (2011) and were therefore rated as 'fun' and 'exciting' to drive. Similarly, drivers of the MINI E taking part in a study by in Vilimek et al., (2012) described driving with a single accelerator pedal as being *"fascinating, almost game-like: it enables sporty driving"* (Vilimek et al., 2012). Finally, in a 6-month UK trial of fleet drivers (Carroll, 2010) drivers reported that EVs exceeded expectations on all performance criteria, with 72% of 190 respondents agreeing that they would use an EV as their regular car.
One exception to this research that should be mentioned is a UK trial of 40 EV drivers conducted by Graham Rowe et al., (2012). In that trial, many drivers felt that the power and performance of their EVs were substandard, meaning that they lacked confidence in some driving situations and found driving less pleasurable than ICE models. However, the finding from this study does not follow the general trend and it could possibly be the result of a lower performance EV model that was being trialled.

Range

Another significant barrier is limited range which leads to 'range anxiety': a psychological phenomenon whereby drivers are afraid of running out of charge before reaching their destination (Franke et al., 2011). In the ULCVDP 349 EVs were tested for a minimum of 3 months on everyday journeys by 'real-life' users. Pre-trial, all private drivers indicated that they would be concerned about reaching their destination in their EV compared to their 'normal' ICE car, but 'after 3 months, this dropped significantly, by 35%. The drop in range anxiety is in part due to the increased understanding of vehicle capabilities, driving techniques and journey planning. Charging data also shows users gained more confidence in their journey distance.' (Everett et al., 2011: 3).

Similarly, in the Switch EV project (Switch EV, 2013) over 90% of 192 EV drivers were initially concerned about the limited driving range of their EV before they used it, but after the trial 80% of drivers thought that the overall experience of driving an EV was either as good or better than that of driving an ICE car.

Interestingly, in an interview based study of EV drivers in Sweden (Nilsson, 2011), drivers did not blame the EV when they occasionally experienced range limitations, but rather, acknowledged that it was their own inexperience in managing range that caused range anxiety. Thus successful reduction of range anxiety is due to several driver factors including a better understanding of the EV's performance capacities, adapting driving style, and journey planning (Turrentine et al., 2011). Nevertheless, after 3 months drivers in the ULCVDP stated that the adequate daily range of an EV is between 92-120 miles, thus, despite confidence in the vehicle's ability, an increased range is still desired. This reinforces the need to be able to recharge EVs away from home, and hence for an effective public charge point network, which was not available in 2009/10 during the trial.

Recharging

Connected to the phenomenon of range anxiety is the issue of recharging. This is because of concerns over the length of time it takes to recharge and location of charging points. Charging is often perceived as a 'inconvenient' because potential drivers foresee spending hours waiting for the vehicle to recharge as opposed to refuelling at a petrol station in under 10 minutes (Bunce et al., submitted). In addition, drivers want the reassurance of a public charging infrastructure to enable them to recharge their EV on longer journeys. In practice, however, recharging the EV is usually done at home over night, similarly to a mobile phone, while the driver does not need to use it (Nilsson, 2011; Turrentine et al., 2011).

Over half the drivers in the ULCVDP initially thought that the speed of charge would not suit their requirements, however this decreased to just a quarter of drivers after 3 months (Carroll et al., 2013). Drivers found the process easy and convenient: *"I found charging very easy: plug it into the mains… that's it… wake up in the morning and it's all done… and away I go. Takes me 30 seconds…"* (Everett, 2011: 9). Similarly in Nilsson (2011) and Graham-Rowe et al., (2012)[5] drivers actually thought that recharging, as opposed to refuelling, was convenient and *timesaving* because it meant that you never needed to stop on route to refuel. One driver explained: *"It was a delight during the week not having to go to a petrol station"* (Graham-Rowe et al., 2012: 146), however, several other drivers in that trial bemoaned the lack of public charging infrastructure which meant that they sometimes had to use an ICE car to make a journey. Despite this, over time, drivers generally become more relaxed about recharging and find that they do not need to recharge every day, sometimes only

[5] This was a UK trial in which 40 drivers (20 female) drove either a BEV or HBEV for one week.

charging every few days (Bunce et al., submitted; Switch EV, 2013; Turrentine et al., 2011).

Participants in the EV trials discussed above represent the 'pioneer' and 'innovator' market: the early adopters. As new EV drivers, their experiences highlight the comparative ease of adaptation to new routines for journey planning and recharging over the first few weeks of electric driving, as well as a preference for plugging in their vehicles at home. In the UK as in other countries, the Government (OLEV 2011: 7-8) anticipates that private drivers will normally charge their EVs at home overnight or at work where they are able to do so. Further, it accepts that that the range capabilities of EVs seem adequate for the majority of people's everyday journeys (Pearre et al., 2011). Nevertheless, public policy also accepts that a basic infrastructure for recharging EVs in public places may be needed to stimulate 'mainstream' market growth in demand for EVs.

Pure battery (as opposed to hybrid) electric vehicles (BEVs) have a 'usable' range of about 70 miles, as confirmed by participants in the ULCVDP (Everett *et al* 2011). For everyday use, this *should* be acceptable. In the international MINI E trials, it was estimated that 90% of all the journeys could in fact be achieved with the performance range of EVs (Vilimek et al., 2013). Thus, there is strong empirical evidence that the current range of BEVs matches the usage patterns of most drivers. However, it does not necessarily match their e*xpressed* demand. Some 95% trips in Great Britain are less than 25 miles (RAE 2010: 26), but drivers need to be confident that they *could* make a spontaneous or emergency trip, and once a week or more, most people want to make a longer trip. Further, in densely developed urban areas, many residents, including two-thirds of Londoners, lack off-street parking and are unable to recharge their EV from home (GLA 2009: 6). Thus, the facility to recharge EVs in public or semi-public parking areas is necessary to reassure drivers that they will not be stranded with a flat battery: the almost universal concern emphasised in the discussion of 'range anxiety' above.

The desirability of interventions to address these understandable concerns was emphasised by the Royal Academy of Engineering (2010: 7): 'creating a pervasive network of public charging points [will be] a *major but necessary investment if EVs are to achieve acceptability in mainstream market segments'.* The availability of public charging infrastructure (PCI) is a critical 'prerequisite to truly mass market penetration' (ibid: 26). In the pioneering phase of market growth, as in other countries, such infrastructure has been absent or, at best, extremely patchy. The growth of electric driving - especially in metropolitan areas where drivers are unable to charge vehicles at home/work - requires a comprehensive PCI that is fit for purpose and which enables drivers to roam beyond the usable range of their EV and outside the domain of their local provider. Typically, national, regional and local governments set targets for the number of charge points to be installed within geographical areas and encouraged providers to locate them in public places to maximise visual impact. But how are well-intentioned policies scaled down and implemented at the 'micro-level' of neighbourhoods, streets and car parks?

Public Charging Infrastructure (PCI): Addressing concerns over shortcomings in provision

This section foregrounds the significance of public charging infrastructure (PCI), and the implications for communications to would-be EV users. In the UK, the Government's broad intentions to set up a national PCI were set out in *Making the Connection: The Plug-In Vehicle Infrastructure Strategy* (OLEV 2011). This strategy statement has guided subsequent action by Local Authorities and other stakeholders. During this period 2011-13, the emphasis was explicitly on learning from diverse approaches, with an emphasis on innovation and experimentation, especially under the 'Plugged-in Place' (P-IP) programme through which the Government offered up to 50% match funding to area-based consortia business and public sector partners across the UK, with a budget allocation of £30 million (2011-13).

A further policy statement was published in 2013 in *Driving the Future Today: A Strategy for Ultra Low Emission Vehicles in the UK* (OLEV 2013). This reconfirms (ibid: 6-7) 'the inevitable transition' to Ultra Low Emission Vehicles (ULEVs), and that the Government is 'committed to supporting the development of a flourishing market for ULEVs in the UK... The emergence of ULEVs as a real option for consumers and businesses... has begun'. In this context, the Government reviewed progress in facilitating the provision of a national PCI. It concluded (ibid: 8) that the P-IP programme had 'provided important lessons to inform future roll-out', and announced a further workstream for shaping the required infrastructure (ibid: 13):

'We will continue to provide a national package of up to £37 million through to May 2015 to support the installation of chargepoints in homes, residential streets, railway station and public sector car parks and rapid chargepoints to facilitate longer journeys, inviting a second round of bids from train operators, local authorities and the wider public sector by 2013'.

The authors of this paper consider the challenge of creating a more comprehensive national and potentially a *transnational* PCI that will satisfy the requirements of mainstream market EV users in the years ahead. The section below focuses on with interrelated issues that must be addressed in the near future:

i. Availability;
ii. Interoperability between networks;
iii. Convenience and ease of use.

Reference is made to a critical report by the House of Commons, Transport Committee (HoC 2012) *Plug-in vehicles, plugged in policy*? And in particular its review of evidence on progress towards a national PCI. Reference is also made to findings from the E-mobility NSR Project WP 3.6 (Kotter and Shaw 2013), and other critical reports. Although the evidence is somewhat patchy, it suggests that gaps remain between the macro-level aspirations to create a nation-wide PCI and implementation of objectives at 'street level'. The authors discuss a number of good practice initiatives to overcome these shortcomings from the user's perspective.

Availability

In most countries there has been something of 'chicken-and-egg' debate on how to nurture the early market for EVs. Should a basic network of charge points be provided at the outset to reassure drivers and thus stimulate demand, with public subsidy if necessary? Or should this be left to market forces with commercial charge point providers responding to the demand pattern of EV drivers, as and when it develops? Acknowledging that uncertainty over early market demand for PCI would deter commercial network providers, the UK government's *Plugged-in Places* initiative 2011-13 pump-primed the initial PCI network within the areas that qualified for match funding in Central Scotland, East of England, Greater Manchester, London, the Midlands, Milton Keynes, the North East of England and Northern Ireland (see Figure 1).

Figure 1: Plugged-in Places in UK (Source: OLEV 2011)

The Government (OLEV 2011: 8) envisaged that this initial public subsidy would establish a network of points in publically accessible places that would soon become commercially viable and thus attractive to investors. An important aspect of the remit of P-IPs would be to 'to install chargepoints in public places where they are most needed' (ibid: 9). A notable example is Greater London, where Mayor Boris Johnson has provided a strong personal commitment to the project. As set out in *London's Electric Vehicle Strategy: Turning London Electric* (Mayor of London 2009: 22), priority has been given to installing a dense network of charge points:

'As a minimum, the pan-London EV network will aim to ensure that no Londoner is more than one mile from a public charging point by 2015. With 2,500 public charging points delivered by 2015, a focus on early adopter areas, especially in the early years, is important. After 2015, mass market uptake of EVs will drive demand for additional infrastructure in London'**.**

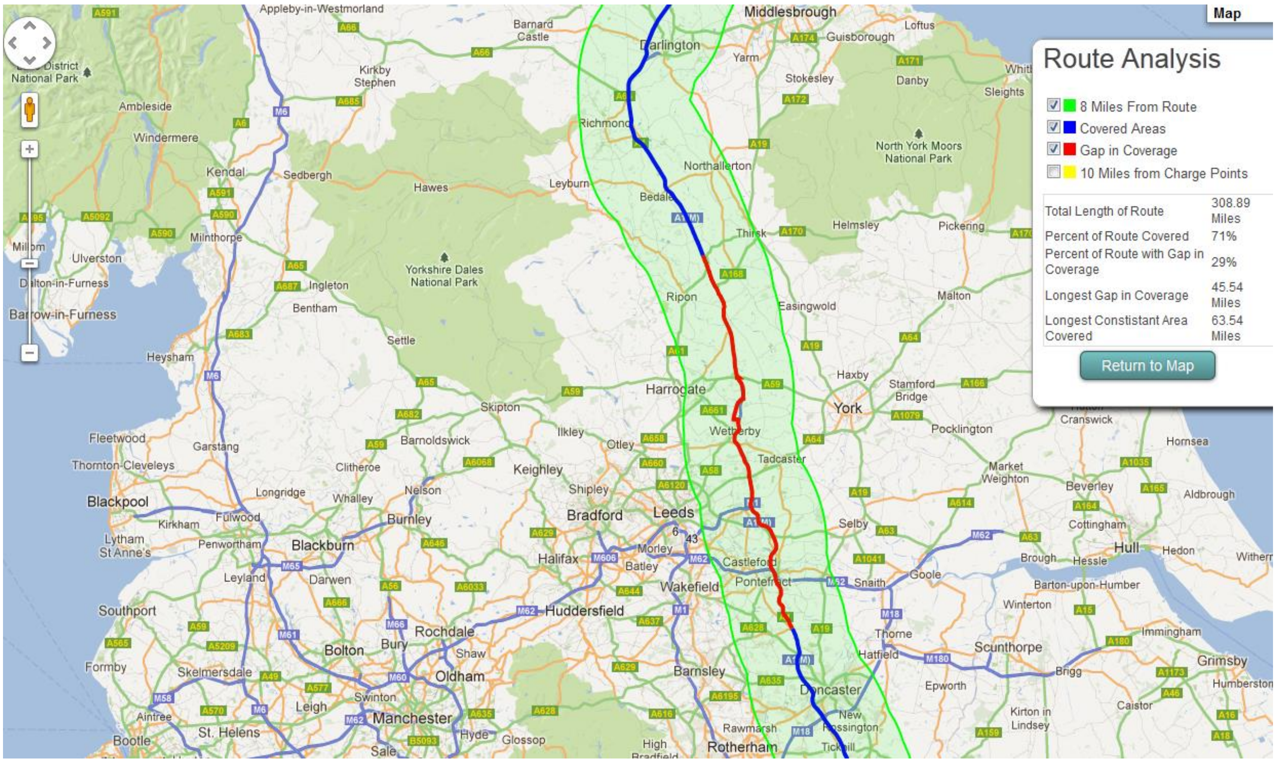
The Strategy (ibid: 24) sought to balance equitable coverage with concentrations across town centres and other transport nodes with targeting of EV hotspots in residential areas where utilisation was likely to be highest. By May 2013 Source London, the capital's chargepoint network and membership scheme (https://www.sourcelondon.net/ accessed 14.10.13), had 'met the Mayor of London's commitment to provide 1,300 publicly accessible charging points'. In accordance with the Mayor's vision, this paved the way for private investment to expand the PCI and eliminate the need for public subsidy.

The House of Commons Transport Committee (HoC 2012, para. 20) heard evidence that reinforced the argument for pump priming the creation of a comprehensive national recharging network: 'Drivers very much welcomed the public charging infrastructure … people are worried, if they travelled somewhere that is 45 miles, whether they have enough energy to get home'. The Department for Transport (DfT) confirmed that, in the period up to March 2012, the P-IPs had installed nearly 1700 charge points. However, the break down for each area showed considerable variation, with relatively high concentrations in Greater London (640) and North East England (399) as shown in Figure 2, and gaps between points on longer distance routes such as the A1 corridor from London north to Newcastle, shown in Figures 3 and 4. Cross border routes across the North Sea Region present an even greater cahllenge andwould require considerable planning, as illustrated in Figure 5.

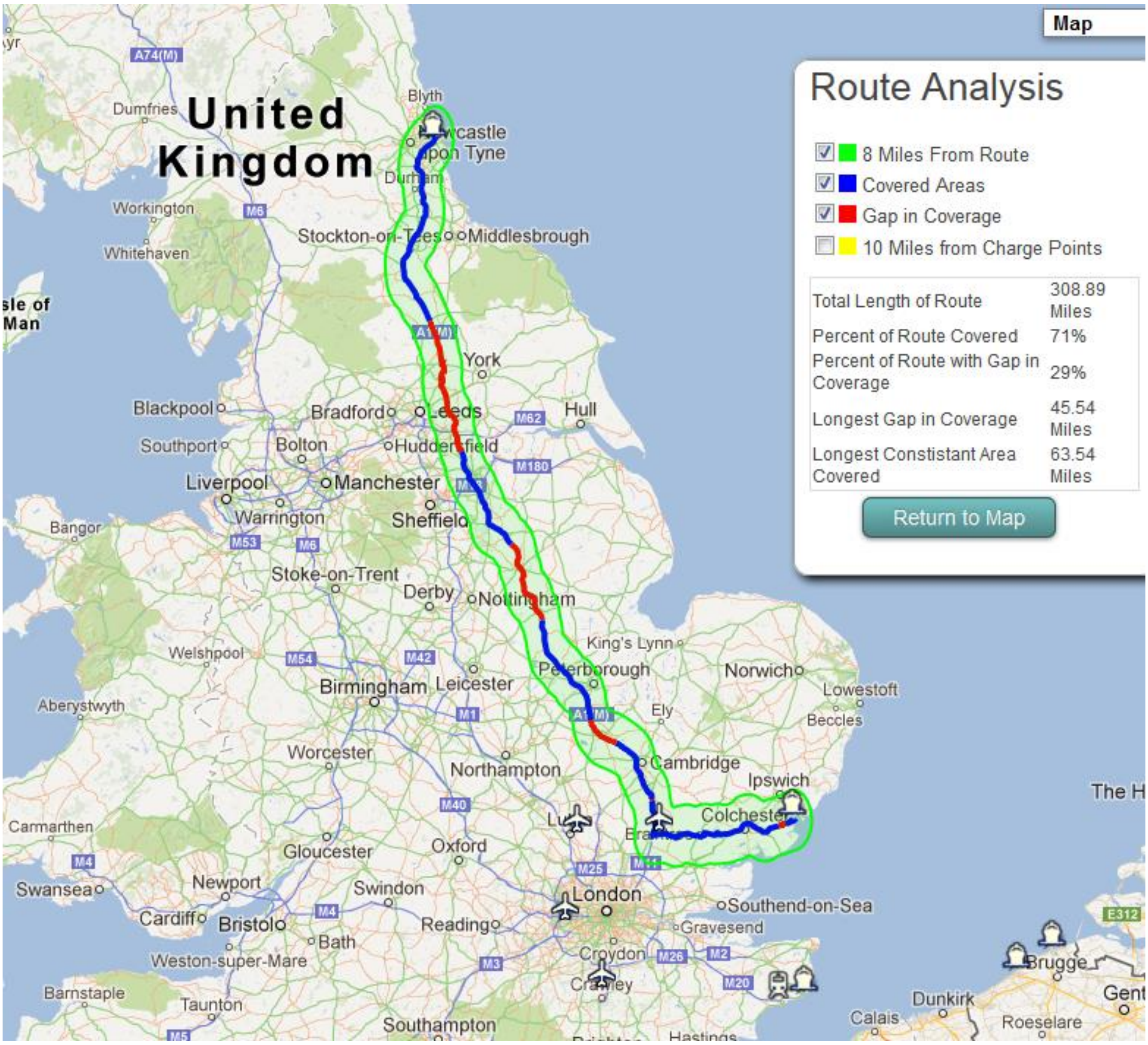
Figure 2: The number of charge points installed in each P-IP to 31.03.12
Source: House of Commons Transport Committee (September 2012)

Plugged-In Place	Chargepoints installed
East of England	135
London	640
Manchester	0
Midlands	100
Milton Keynes	115
North East	399
Northern Ireland	85
Scotland	199
Total	1673

Figures 3: Digital maps showing gaps between chargepoints along A1 route, England
(Source E Mobility NSR WP 4) ©2013 Google Maps

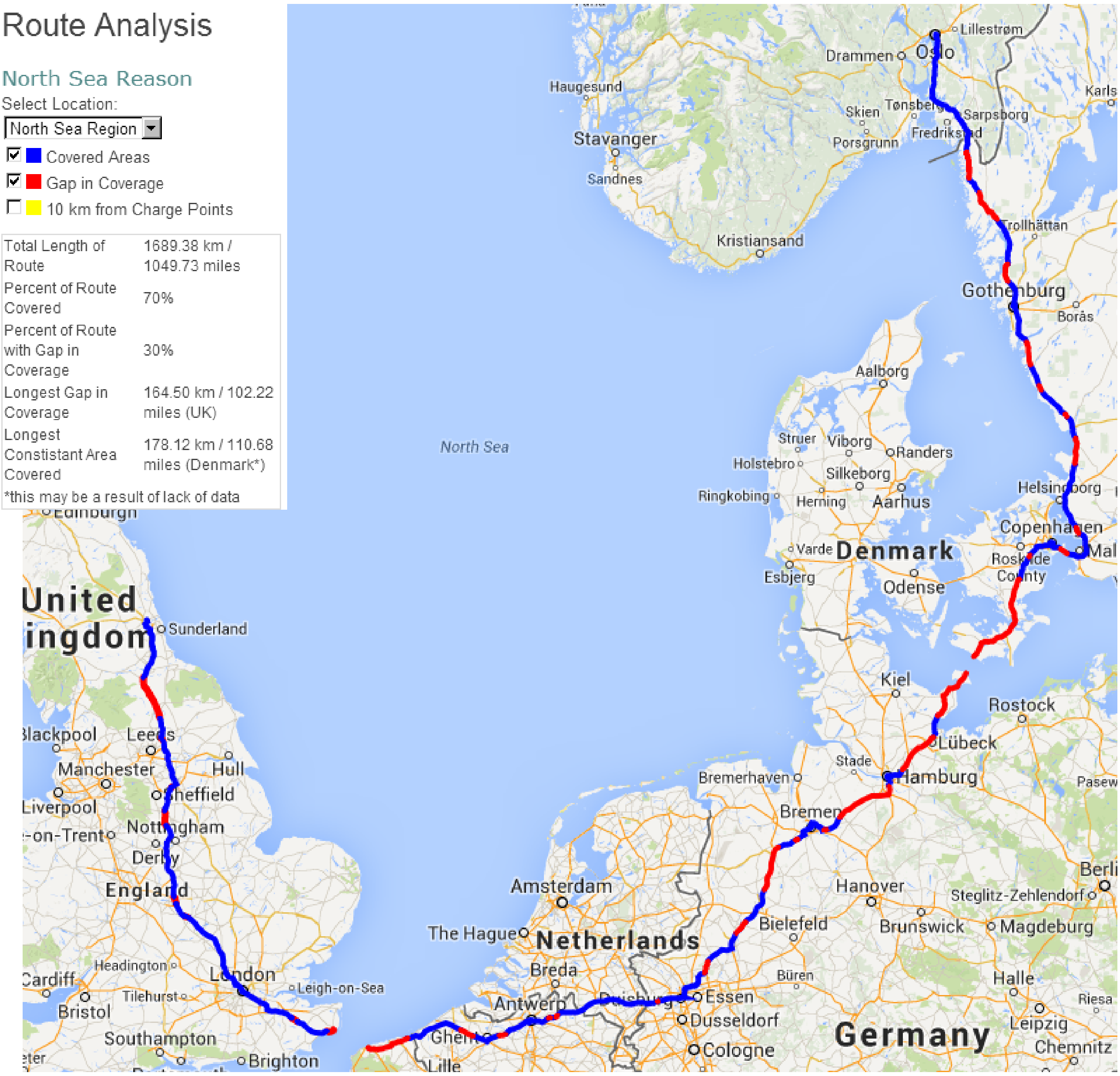


Figures 4: Digital maps showing gaps between chargepoints along A1 route, England
(Source E Mobility NSR WP 4) ©2013 Google Maps



Interactive map interface avaiable on: http://maps.citiesinstitutesurveys.org/UKEmobility.html (February 2014)

Figure 5: Example of transnational route across the North Sea Region (Source E-Mobility NSR WP 4) ©2013 Google Maps



Interactive map interface avaiable on: http://maps.citiesinstitutesurveys.org/UKEmobility.html (February 2014)

Interoperability

From the outset, the UK Government had stated its intention to encourage a degree of standardization and harmonization in the emerging PCI (OLEV 2011: 9). In practice, however, each P-IP set up a subscription-based scheme that gave its members an attractive offer: unlimited recharging from points within its network using a membership card for a nominal annual subscription (e.g. £10/Euros 12 per annum in Greater London). However, the membership smartcard did not give access to other networks, as their respective back-office systems communicated only with their own members at the interface of their chargepoints. Further, alongside such area-based subscription schemes, independent operators established up pay-as-you-go networks with open access.

At the time of writing, progress towards integration of the national PCI remains somewhat limited with respect to access, payment and information on the location of available points: a situation which restricts the freedom of drivers to roam beyond their 'home' area and the usable range of their vehicle: a shortcoming undermines its main purpose, i.e. reassurance that longer journeys can be successfully completed. The situation contrasts with alternative models such as the former 'E-Laad' network in the Netherlands, which enabled integration between PCI networks through an Open Charge Point Protocol (OCPP view: http://www.ocpp.nl/.)

The challenge of interoperability was addressed by the East of England P-IP ('EValu8'), which pursued its remit to learn from innovative practice by focussing on integration within and beyond its geographical boundaries. At first, subscribers to EValu8's 'Source East' network could not roam beyond the East of England, unless they joined additional schemes. This was a significant constraint, especially for commuters driving between the region and the capital where Source London is the major PCI provider. Evalu8 also anticipated a demand to travel to the Midlands and the North, especially along the A1/M1 trunk road corridor. And that in the longer term, there was potential to develop transnational traffic from passenger and freight movement between the East of England through the airports at Luton and Stansted, as well as through the sea ports of Felixstowe and Harwich. In response, EValu8 negotiated a Memorandum of Understanding with 'Source London' and other neighbouring P-IPs to harmonise technology and communications standards. Since autumn 2012, these agreements have enabled 'mutual roaming' e.g. for longer distance commuting and other journeys into Greater London.

The House of Commons Transport Committee (2012, para. 23) had also highlighted the urgent need to standardize and simplify the emerging PCI:

'If the Government wishes to encourage sales of plug-in vehicles, then consumers may need confidence that they will be able to charge their cars in public spaces, if required. Although the Plugged-in Places pilot trials have made progress towards providing infrastructure, there is further work to be done in standardising access to infrastructure, both in terms of widening access to membership schemes and ensuring interoperability of cars and infrastructure in different locations'.

The Committee commented on the variety of membership or registration schemes in operation, noting the evidence they heard from General Motors (ibid, para. 24), who told them that:
'Different charging schemes from across the UK should be harmonized...to use electric points in different parts of the country... you would have to be a member of multiple schemes... this off-putting and complicated for customers and only serves to reinforce concerns over range anxiety'.

It concluded with a recommendation that '[m]aking sure that vehicle owners can access chargepoints across the UK should be a priority for the Department for Transport's (DfT's) plug-in vehicle strategy. The DfT should set out how it will remove barriers to chargepoint access across the country'. Further, harmonisation and interoperability between countries must be secured between Member States (ibid para. 25):'The DfT should set out how it intends to reach agreement in the EU on the types of infrastructure to be used as standard for plug-in vehicles'.

As Bakker (2013: 16) observes, the Netherlands provides a useful model whereby drivers can access around 2500 points nationwide with a pay-as-you-go RDIF card (ibid: 17). However, this is exceptional as most EU countries have at least two providers with separate schemes. Although the European Commission has encouraged standradization of the Type 2 plug (Mennekes), the 'real problem [both within and between countries] is much more in the different identification systems that are used to grant access to chargers and to arrange payment.' (ibid: 16). Bakker (ibid: 22) concludes that given the unlikeliness of a 'single Eurioepan system for raoming between the networks, it would be best if charging station operators would be able to include ad hoc and payment systems in their chargers (using SMS or credit card payments for instance).'

Convenience and Ease of Use

The discussion above foregrounds the aspirations of public policy to provide EV users with a PCI that offers comprehensive spatial coverage and interoperability. In some areas of the UK relatively high densities of 'refuelling' places have already been achieved.

In this section it is argued that careful attention must also be given to the quality of decision making at the micro-level of neighbourhoods, streets and car parks where the detailed siting and design of EV recharging places can have significant implications for their utility, i.e. their convenience and ease of use from the driver's point of view.

Guidelines for installation tend to emphasise the promotional benefits of siting charge points to maximize their visibility, not only to EV users but also to the general public. Deventer et al. (2011: 32-3) highlight the symbolic value of conspicuously locating chargepoints at prescribed distances along linear corridor routes in the Unites States and Japan, as well as 'circle corridoring' in the Netherlands. Ideally, the siting and design of PCI should accommodate the schedule of activities and travel patterns of the intended users. These may include work and study, shopping, escorting children and dependents, leisure and so on. For example, Figure 6 illustrates an on-street EV parking bay in the vicinity of University College London in the London Borough of Camden and adjacent to a large bookstore that has proved popular among university staff, students and visitors for top-up charging, and is highly visible to the many passers-by.

Figure 6: Well-sited, well-used points can attract favourable attention from passers-by (photo: S. Shaw)

If, however, such parking spaces are conspicuously underused , the effect may be the opposite to that which was intended, as illustrated in Figure 7.

Figure 7: Conversely, points that are conspicuously under-used do little to promote electric mobility (photo: S. Shaw)

Commuter park-and-ride locations, where EVs are regularly parked up for eight hours or more may also be appropriate, as shown in Figure 8 in the London Borough of Greenwich. Further examples include public car parks that are within a short walk of town centre shopping, civic and entertainment facilities. Cultural and other leisure attractions where visitors typically stay for 2-5 hours may also be highly suitable if appropriate publicity is given to their availability and location.

Figure 8: Commuter car parks in railway stations Insert photo of EV bay at North Greenwich commuter car park, LB Greenwich (photo A. Witting)

As the primary agencies for transport and land use planning in their areas, UK Local Authorities tend to play the lead role in the detailed siting and detailed design of publicly accessible charge points. The outcome in any particular case is affected by negotiations with key stakeholders that typically include:

1. PCI networks initiated by Plugged-in Places and independent providers;
2. Distribution Network Operators (DNOs) from whom permission must be obtained to secure connection with the grid for installation of charge points;
3. Landlords, especially owners of publicly accessible car parks, e.g. Train Operating Companies at commuter railway stations, supermarkets and other retailers.

A further site constraint is the distance between the chargepoint and the grid, which increases the overall cost, especially where excavation of hard surfaces and longer underground cabling is required.

The supplementary paper to WP 3.6 *Methodologies for Mutual Learning* (Shaw and Evatt 2013) outlines a simple approach to facilitate consultation and to record such negotiations and their outcomes. A pilot study of this technique highlighted a number of factors that can compromise the utility of charge points in the local context. In some cases, personal security concerns may deter some users, especially after dark, as illustrated in Figure 9.

Figure 9: In some cases personal security may be an issue, especially after dark (photo: S. Shaw)

In some cases, the way marking and signage could be improved. For example, Figure 10 shows an on-street charge point that has been installed without a sign to indicate to drivers that the parking space is reserved for EVs; thus it is unknowingly occupied by other users and seldom available to park and charge EVs. Other chargepoints may be underused because their location is absent from any web map that EV drivers can access.

Figure 10: Lack of signage to reserve spaces for EVs may undermine their utility (photo: S. Shaw)

The situation may be exacerbated where adjacent premises and land-uses are not compatible, e.g. a chargepoint outside a fast food outlet raised objections from the proprietor that the recharging of EVs (for 2 hours +) deterred short term parking by their customers, with consequent loss of trade. Figure 11 suggests the possibility of similar conflicts outside a video hire shop.

Figure 11: This may be exacerbated where on-street spaces are in high demand for short-term use (photo: S. Shaw)

Conclusion

The empirical studies discussed above highlight the relative ease with which early converts to electric driving have adapted to new routines for journey planning, driving and recharging their vehicles. After a few weeks experience, pioneers and early adopters appear to have overcome the common apprehensions and anxieties concerning EVs. Analysis suggests that, for most people, the initial psychological deterrents do not translate into significant real-world barriers. The positive narrative of adjustment, diminishing concerns and increased satisfaction provides a powerful message that can be emphasised in EMIC communications strategies to promote the personal (as opposed to the wider public and environmental) benefits of electric driving to mainstream users. Further, despite initial reservations over *in*convenience and time consuming process of charging their EV from home, many of the early market users discovered that recharging from home was more convenient and *timesaving* compared with refuelling a conventional ICE vehicle at a filling station.

Public policy acknowledges, nevertheless, that a comprehensive infrastructure for recharging EVs in public places is a necessary precondition for mainstream market acceptance. A public charging infrastructure (PCI) is essential to reassure drivers that they can complete longer trips beyond the usable range of their vehicles, and to accommodate residents without off-street parking to recharge at home. The UK Government and their counterparts in other NSR countries accept that initial subsidy and other intervention - especially standardization - is needed to establish the emerging PCI until investment becomes attractive to commercial providers (a transition that is now nearing completion in the capital with the commercialization of Source London). Over the period 2011-13, the public and private sectors installed a basic PCI with around 3000 charge points nationwide. Nevertheless, some critical challenges must be addressed as the charging points are made visibile in neighbourhoods, streets and car parks, and their presence communicated to would-be users.

At the time of writing, the UK is entering a new phase in the development of the national PCI: a further £11m/ Euro 13m for English Local Authorities (2013-15) with 75% contribution for targeted sites, e.g. railway station car parks. A key challenge is to consolidate, harmonize and integrate the PCI, not only for *cross-country* but also for *cross-border* electric driving. The discussion above has highlighted three critical aspects of user expectations that have implications for communications. To summarise:

1. Availability: A network of public charging places must be available with comprehensive coverage, distributed to match expected use patterns. The UK Government has pump-primed the installation of EV charge points initiated through eight pilot 'Plugged-In Places' (P-IPs). These have been managed by public-private consortia to encourage innovation and stimulate the early market for EVs. There has been some thoughtful planning to target areas where greatest demand is anticipated. By 2012 an initial PCI of around 3000 points had been created. However, the House of Commons Transport Committee concluded (2012) that, as yet, network coverage was still far from comprehensive across the country. Further, there was 'no clear relationship between the demand for plug-in cars and the supply of chargepoints. The Committee concluded that this 'may raise questions about the assumption that providing infrastructure will stimulate the demand for plug-in cars' (ibid 30).

2. Interoperability: From the user's perspective, the PCI should be standardized and sufficiently joined-up to enable roaming between the networks of different providers. In general, each P-IP set up a subscription-based scheme that gave its members unlimited access to points within their 'home' network. These area-based networks were established alongside independent pay-as-you-go schemes. As yet the goal of integration has been achieved on a limited scale, compared, for example, with the level of integration in the Netherlands (originally initiated by the E-Laad scheme). Exceptions include the North East of England P-IP (CyC) which has expended (e.g. into Scotland) with pay-as-you-go options, and the East of England P-PIP (EValu8) which negotiated agreements with the London PI-P and other neighbours to facilitate inter-communication between their respective back-office systems, and 'mutual roaming.' Progress is now being made, but the freedom to roam with ease between regions in the UK, and across the North Sea Region, remains an aspiration at the time of writing.

3. Convenience and ease of use: In principle, the PCI should be located to fit around the user's travel patterns: work, study, escorting children, shopping, leisure, and so on. Further, careful thought must be given to siting and design in the local context of neighbourhoods, streets and parking places, and points should be highly visible to attract attention from actual and potential EV users. In practice, installation of the PCI depends on negotiations between local stakeholders, especially: Local Authorities; and chargepoint providers; Distribution Network Operators (DNOs); and 'host' landlords. The cost of installation is a critical constraint, especially distance from the grid. The supplementary paper (Shaw and Evatt 2012)WP 3.6 *Methodologies for Mutual Learning* outlines a simple approach to facilitate consultation and to record such negotiations and their outcomes. Initial piloting of this technique highlighted a range of siting and design issues that can reduce the utility of chargepoints including: personal security issues; inadequate waymarking and signage; and incompatibility of adjacent land-uses.

Despite these initial shortcomings in the PCI, the early adopters appear to have overcome the psychological barriers, and 'converted' with some enthusiasm to electric driving. Nevertheless, as Deventer et al (2011: 37) observe, the 'crux lies with the more cautious cohorts that follow the leaders'. Barriers of (low) product awareness and reluctance to adopt the New Product will deter the 'early majority'. A recent survey (Censuswide and Rexel 2013) of 'mainstream' drivers in the UK (n = 1188) revealed some encouraging news: 41% of respondents would consider purchasing an EV. However, 50% were put off because they did not know where they could plug-in. Over 60% perceived EVs to be impractical because of the insufficient number of charging points, and over 70% had never seen a charge point.

A well-targeted and joined-up approach will be critical to effective promotion of user benefits. The authors believe that there is considerable potential to adapt and develop the Electric Mobility Information Centre (EMIC) model that is currently being piloted in Denmark by E-Mobility NSR Partners HTK (with its website that is currently being translated into English) as a medium to communicate the benefits of EVs more widely. The emphasis is on the presentation of user information that is comprehensive, clear and credible to private drivers and firms that would benefit most from the switch to EVs. It features locally based campaigns that include hands-on experience, including test-drives.

In 2014 the UK Government launched a national campaign 'Go Ultra Low' [www.goultralow.com]. This includes a national 'one stop' portal for existing and potential users of EVs and other Ultra Low Emission Vehicles (ULEVs). The Go Ultra Low website fits well with the recommended form and content for EMICs highlighted in the Report for WP 6.6. The analysis in this paper suggests that transnational and national portals should be complemented by 'going local': information on the benefits and practical issues for people and firms adapting to electric driving in the context of the area concerned. The Appendix to this paper assesses the content of other national, and (sub-) regional EMIC websites in Greater London, Eastern Counties Noth East of England.

References

AMA Research (2013) *Electric Vehicle Charging Infrastructure Market Report – UK 2013-2025 analysis.* AMA Research. Retrieved from: *http://www.amaresearch.co.uk/electric_vehicle_charging_13s.html*

Bakker, S. (2013) Standardization of EV Recharging Infrastructures. Retrieved from: *E-Mobility NSR, Work Package 4.4*, Retrieved from: http://e-mobility-nsr.eu/fileadmin/user_upload/downloads/info-pool/3.2_E-MobilityNSR_International_stakeholder_analysis.pdf

Bunce, L., Harris, M. & Burgess, M. (submitted). Charge up then charge out? Drivers' perceptions and experiences of electric vehicle in the UK. *Transportation Research Part A.*

Burgess, M., King, N., Harris, M. & Lewis, E. (2013). Electric vehicle drivers' reported interactions with the public: Driving stereotype change? *Transportation Research Part F, 17,* 33-44.

Carroll, S. (2010). The Smart move trial: description and initial results. London: Cenex. Retrieved from: www.cenex.co.uk/LinkClick.aspx?fileticket=yUKAcRDJtWg%3D&tabid=60

Carroll, S., Walsh, C., Burgess, M., Harris, M., Mansbridge, S., King, N. & Bunce, L. (2013). Assessing the viability of EVs in daily life. Doc TSB ULCVD-12-036 v1.0.
Retrieved from www.innovateuk.org/ulcv-demonstrator-report

Censuswide and Rexel cited in Next Greencar (06.09 2013). Retrieved from www.nextgreencar.com/news/6335/40-UK-drivers-would-consider-buying-EV

Deventer, P. A. et al. (2011) 'Governing the Transition to E-Mobility: small steps towards a giant leap'. The Hague: Netherlands School of Public Administration. Online access: http://www.nsob.nl/EN/wp-content/uploads/2010/06/e-mobility-webversie.pdf

Everett, A., Burgess, M., Harris, M., Mansbridge, S., Lewis, E., King, N., Walsh, C., Carroll, S. (2011). *Initial findings from the ultra low carbon vehicle demonstrator program. How quickly did users adapt?* Retrieved from: http://www.innovateuk.org/_assets/pdf/press-releases/ulcv_reportaug11.pdf

Franke, T. & Krems, J. F. (2013). Interacting with limited mobility resources: Psychological range levels in electric vehicle use. *Transportation Research Part A, 48,* 109-122.

Franke, T., Neumann, I., Bühler, F., Cocron, P. & Krems, J. F. (2011). Experiencing Range in an Electric Vehicle: Understanding Psychological Barriers. *Applied Psychology: An International Review.* Advance online publication, DOI: 10.1111/j.1464-0597.2011.00474.x

Graham-Rowe, E., Gardner, B., Abraham, C., Skippon, S., Dittmar, H., Hutchins, R. & 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.

Greater London Authority (2009). *London's Electric Vehicle Infrastructure Strategy,* London: Mayor of London/GLA.

IET Standards Ltd (2012). *Successfully Implementing a Plug-in Electric Vehicle Infrastructure, A Technical Roadmap for Local Authorities and their Strategic Partners*, IET Standards Transport Report.

Kay, D., Hill, N. and Newman, D., Ricardo-AEA (2013). *Powering Ahead: the future of low-carbon cars and fuels,* Viewpoint and Executive Summary, April 2013, RAC Foundation: London.

Kotter, R. and Shaw, S. (2013). E-mobility NSR, *Work Package 3, Activity 6: Micro to Macro Investigation*. Retrieved from: http://e-mobility-nsr.eu/archive/new-report-published-mainstream-market-acceptance-of-electric-vehicles-evs-a-micro-to-macro-p/

Lane, B. (January 2011). *Market delivery of ultra-low carbon vehicles in the UK: An evidence review for the RAC Foundation.* Ecolane Transport Consultancy. Retrieved from: http://design.open.ac.uk/documents/Market_delivery_of_ULCVs_in_the_UK-Ecolane.pdf

Nilsson, M (2011). Electric Vehicles: an interview study investigating the phenomenon of range anxiety. Retrieved from: www.elvire.eu/IMG/pdf/An_interview_studyinvestigating_the_phenomenon_of_range_anxiety_ELVIRE-2.pdf).

Royal Academy of Engineering (2010). *Electric Vehicles charged with potential,* London: RAE.

Office for Low Emission Vehicles (2011). *Making the Connection: The Plug-In Vehicle Infrastructure Strategy*. Retrieved from: http://assets.dft.gov.uk/publications/making-the-connection-the-plug-in-vehicle-infrastructure-strategy/plug-in-vehicle-infrastructure-strategy.pdf

Office for Low Emission Vehicles (2013). *Driving the Future Today: A Strategy for Ultra Low Emission Vehicles in the UK.* Retrieved from: https://www.gov.uk/government/publications/driving-the-future-today-a-strategy-for-ultra-low-emission-vehicles-in-the-uk

Pearre, N., Kempton, W., Guensler, R. L. & Elango, V. V. (2011). Electric vehicles: how much range is required for a day's driving? *Transportation Research Part C, 19,* 1171-84.

Philip, A. & Wiederer, R (2010) *Policy opinions for electric vehicle charging infrastructure in cities.* Technical report, Harvard Kennedy School. Retrieved from: www.innovations.harvard.edu/cache/documents/11089/1108934.pdf.

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

Shaw, S. and Evatt, N. (2013) *Methodologies for Mutual Learning.* Supplement to WP 3.6. Retrieved from http://e-mobility-nsr.eu/fileadmin/user_upload/downloads/info-pool/E-mobility_3.6._Supplementary_Paper_to_Main_Report_April_2013.pdf

The House of Commons, Transport Committee (2012) *Transport Committee - Fourth Report Plug-in vehicles, plugged in policy*? 12th September. Retrieved from: http://www.publications.parliament.uk/pa/cm201213/cmselect/cmtran/239/23902.htm

Turrentine, T., Garas, D., Lentz, A. & Woodjack, J. (May 2011). *The UC Davis MINI E consumer study.* Institute of Transportation Studies, University of California, Davis, Research Report UCD-ITS-RR-11-05. Retrieved from http://pubs.its.ucdavis.edu/publication_detail.php?id=1470.

Switch EV (2013). *Switch EV Final Report*. Newcastle University. Retrieved from: http://vehicletrial.switchev.co.uk/the-project.aspx

Vilimek, R., Keinath, A. & Schwalm, M. (2012). The MINI E field study - Similarities and differences in international everyday EV driving. In Stanton, N.A. (Ed.), *Advances in human aspects of road and rail transport* (pp. 363-372). Boca Raton, FL: CRC Press.

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

Contact for this report:

London Metropolitan University
Faculty of Business and Law
84 Moorgate
London EC2M 6SQ

Dr Stephen Shaw (Lead Researcher)
Faculty of Business and Law
Phone: +44 (0)20 7133 3362
Email: s.shaw@londonemt.ac.uk

Dr Louise Bunce
Phone: +44 (0) 207 133 2570
Email: l.bunce@londonemt.ac.uk

Dr Rita Kottász
Faculty of Business and Law
Phone: +44 (0)20 7133 4102
Email: r.kottasz@londonmet.ac.uk

Contact Lead Partner:

Hamburg University of Applied Sciences
Research and Transfer Centre “Applications of Life Sciences”
Prof. Walter Leal
LohbrueggerKirchstrasse 65
21033 Hamburg
Germany
Phone: +49-40-42875-6313
Email: e-mobility@ls.haw-hamburg.de

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
LONDON metropolitan university