A street scene in Newcastle, UK, featuring the Monument and a charging station in the foreground. The charging station is a dark brown pillar with a white top and a blue LED light band. It has a green LCD screen and a white panel with text.

# North East Electric Vehicle Roadmap

 urban foresight

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# North East Electric Vehicle Roadmap

This report has been produced by Urban Foresight as part of Task 18 of International Energy Agency's Implementing Agreement on Hybrid and Electric Vehicles

Requests for further information should be directed to:

**Dr David A. Beeton**

Director | Urban Foresight

Operating Agent Task 18: 'EV Ecosystems' | International Energy Agency Hybrid & Electric Vehicle Implementing Agreement

E: [david.beeton@urbanforesight.org](mailto:david.beeton@urbanforesight.org)

W: [www.urbanforesight.org](http://www.urbanforesight.org)

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Urban Foresight Limited

Registered in England and Wales No.7705420

8 The Crescent | Newcastle upon Tyne | NE7 7ST | United Kingdom

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# Executive Summary

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This report presents a future outlook for a major electric vehicle programme in the region of North East England, United Kingdom. A summary of the key developments and achievements of the programme to date is provided as well as the outputs of a strategic roadmapping workshop that brought together key stakeholders from industry, research and the public sector. From this a timeline of priority actions and objectives is defined, quantifying future challenges and opportunities.

The report is part of the global 'EV Ecosystems' project (IA-HEV Task 18) run by Urban Foresight on behalf of the International Energy Agency's Hybrid and Electric Vehicle Implementing Agreement.

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Introduction

# 1 Introduction

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## 1.1 Background

The report summarises the experiences and future plans for a major electric vehicle (EV) programme in the region of North East England, United Kingdom. Much of this is based on a roadmapping workshop that was held as part of the global 'EV Ecosystems' project which is an initiative of the International Energy Agency's Hybrid and Electric Vehicle Implementing Agreement. This project is engaging with pioneering cities and regions around the world to identify insights and best practice in preparing for mass adoption of plug-in EVs. This will create an international roadmap to provide guidance on the policies, technologies and operating models that are being developed to create EV ecosystems.

## 1.2 Structure of the Report

The first chapter summarises the key developments and achievements to date in the North East EV programme. The process adopted in the roadmapping workshop is then described and the outputs of this process are summarised. This includes a ranked list of priorities and a series of outline action plans to respond to selected opportunities and challenges. The report concludes with a summary of next steps. This includes recommendations on how to progress the roadmap and a timeline of actions and milestones for the North East EV programme.



Electric Vehicles in  
North East England

## 2 Electric Vehicles in North East England

---

### 2.1 Overview

North East England has a vision to become a world leader in the development, manufacturing and deployment of EV technologies. The region is at the centre of the EV manufacturing industry in the UK, attracting major investments to produce vehicles, batteries and specialist components. This includes a £423 million investment by Nissan to establish the region as its European headquarters for the manufacture of LEAF and batteries.

To attract these investments, an £80 million programme of major pilots and new innovation assets was initiated in 2008. This has established North East England as a leading intentional knowledge centre and test bed for EV and recharging infrastructure technologies.

### 2.2 Profile of North East England

North East England has a population of 2.6 million people largely concentrated around the main urban centres of Newcastle, Sunderland and Middlesbrough. Its compact nature and the fact that its main urban centres lie within a 45 mile radius make the region ideally suited to the operational range of current EV technology.

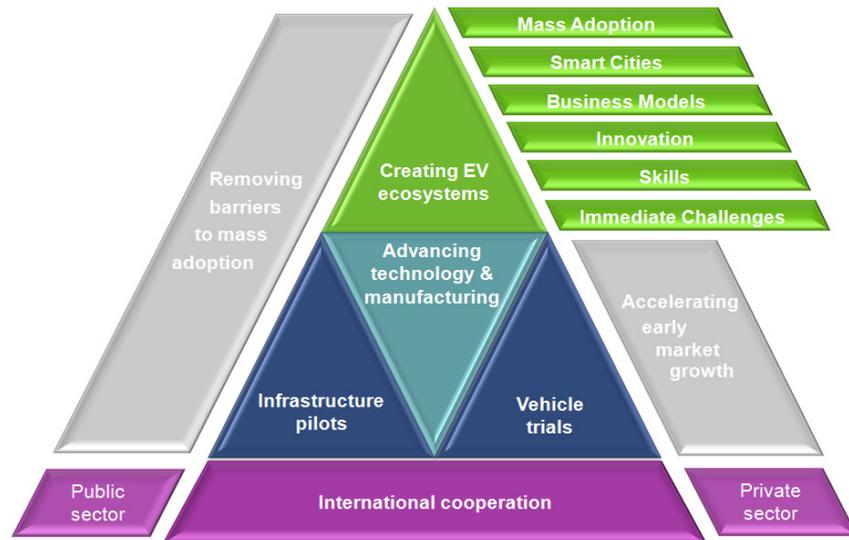
The region has traditionally been an industrial heartland of the United Kingdom, with a strong manufacturing sector. This includes Nissan, which is the UK's largest car manufacturing plant and one of the most productive in Europe. Recent years have seen a decline in manufacturing and an increased focus in high technology sectors including: process industries, life sciences, renewable energy, advanced manufacturing and low carbon vehicles.

### 2.3 Electric Vehicle Programme

The North East EV programme started in late 2008. It was instigated and coordinated by One North East, a government-funded regional economic development agency.

In the broadest sense, investments in the programme were catalysed by three factors: reducing emissions from road transport, decreasing dependence on imported fossil fuels and creating new green industries to stimulate economic growth. However, given the importance of automotive manufacturing to the regional economy, securing future investments in this industry was a key motivator.

A particular objective of the programme was to create one of the first environments to support early mass adoption of EVs. This encompassed a range of projects covering manufacturing, infrastructure, innovation, skills and awareness raising. This is summarised in Figure 1 and described in the following sections.



**Figure 1: Strategic overview of the North East England EV programme**

### 2.3.1 Recharging Infrastructure

North East England began one of Europe’s first modern large-scale recharging infrastructure pilots in early 2009. Initially focused on the city of Newcastle upon Tyne, it set out to inform EV infrastructure policy and system design. The infrastructure trial has since expanded as part of the national ‘Plugged in Places’ project to connect all of the major population centres in North East England and to establish the UK’s first regional recharging network for EVs. 1,300 recharging points are being installed in public locations, workplaces and homes.

An explicit objective of this £7.8 million project has been to incentivise investments in EV technologies. To date, this has resulted in over 40 public and private sector organisations collectively committing in excess of £1 million towards the cost of recharging points on their premises. This has been coordinated through a campaign called ‘Lead the Charge’.

In 2010 the region also launched the UK’s first back office scheme for EV recharging. The customer-facing scheme called ‘Charge Your Car’ provides administrative services such as driver registration, payments and customer support. Information is provided on the location and use of recharging points and the system also captures valuable data on a vehicle’s charging history and basic diagnostic information on recharging performance.

The North East has also been leading on the deployment of 50kW DC rapid chargers. Twelve of these units are being installed in strategic locations across the region.

### **2.3.2 Electric Vehicle Trials and Fleets**

Infrastructure deployment in the North East has created a large-scale test environment to evaluate factors such as vehicle performance, driver behaviours, impacts on energy grids and the design and performance of recharging networks. This is being exploited through integration with structured trials and demonstrations of vehicles from a range of manufacturers, which is providing valuable data for industry and policymakers.

The 2009 SMART Move trial was one of the UK's first EV demonstrations. EVs were integrated into 10 different vehicle fleets and driven by 264 individuals during the trial.

The £10 million 'Switch EV' demonstration programme expanded this further, supporting a number of manufacturers in accelerating the introduction of new EV technologies to the UK market. This project is part of a national programme run by the Technology Strategy Board. It includes vehicles from AVID, Liberty Electric Cars, Mitsubishi, Nissan, Peugeot and Smith Electric Vehicles. These vehicles are being made available organisations and individuals across North East England. This includes a number of key trials, such as piloting the integration of EVs into a car club operation.

The region's EV trials are being supported by Newcastle University which is fitting each vehicle with bespoke data collection units to take information directly from the CAN-bus or GPS system. This is providing data on the effects of road topology and congestion on vehicle range and environmental impacts extrapolated from energy exchange and battery usage.

### **2.3.3 R&D, Manufacturing and Capacity Building**

In 2009 the UK government designated the North East as the UK's Low Carbon Economic Area for Ultra Low Carbon Vehicles. This gave the region a leading role in supporting the transition of the automotive sector to a low carbon future.

As North East England is set to become one of the world's major EV manufacturing regions, investments are being made in national innovation assets to support further technical development and provide the skills required to shape future growth in this new industry. Central to this is a new £8.4 million Skills Academy which will become the UK's national training centre for the ultra low carbon vehicle industry. This will provide skills required for large-scale manufacturing of EVs and advanced batteries as well as specialist EV training to vehicle technicians, dealerships, and first responders.

Investments are also being made in an existing test track facility, which will be upgraded and opened up to provide specialist facilities for development of ultra-low carbon vehicles.

The North East is actively participating in a number of international programmes. At the European level this includes ENEVATE and the E-Mobility Network for the North Sea Region. At the global level, the region is also participating in the EV Ecosystems project (IEA HEV Task 18) and has been designated as the UK's pilot region for the Electric Vehicle Initiative (EVI).

## 2.4 Summary of Key Developments and Achievements to Date

The culmination of the projects, pilots and investments described above have resulted in over £500 million being invested in the North East to advance EV technologies and infrastructure. Figure 2 summarises the key projects and achievements to date.

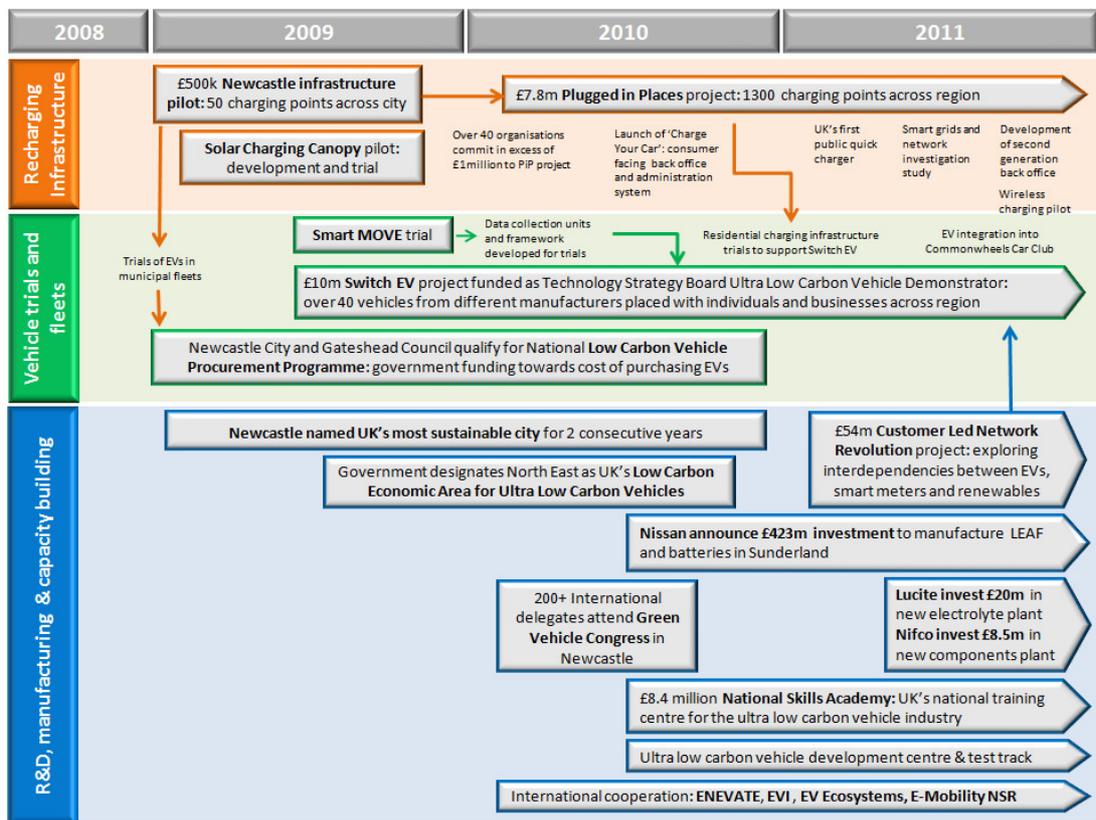


Figure 2: Timeline of key developments and achievements in the North East EV programme



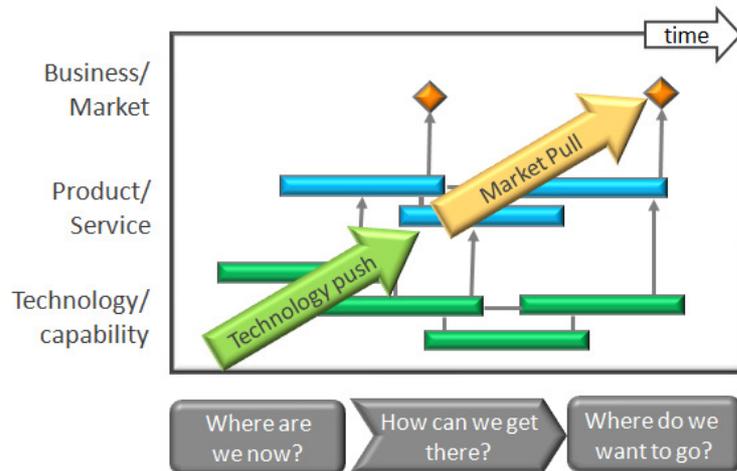
〔 Exploring the Future 〕

# 3 Exploring the Future

## 3.1 Introduction

To explore future challenges and opportunities facing the North East EV programme, a roadmapping workshop was held on 14<sup>th</sup> March 2011 in Newcastle upon Tyne, United Kingdom.

Roadmaps are used to provide a structured future outlook of important trends and drivers. This draws on the expertise of key actors in the field, combining knowledge on emerging priorities and actions. As shown in Figure 3 essential elements of the approach include the quantification of when an issue is likely be important and the interrelated nature of developments in markets, products/services and technologies.



**Figure 3: A generic roadmap structure**

20 experts from 13 organisations attended the workshop as summarised in Figure 4. A full list of participants and the workshop agenda is provided in Appendix I.

The workshop had the following two broad aims:

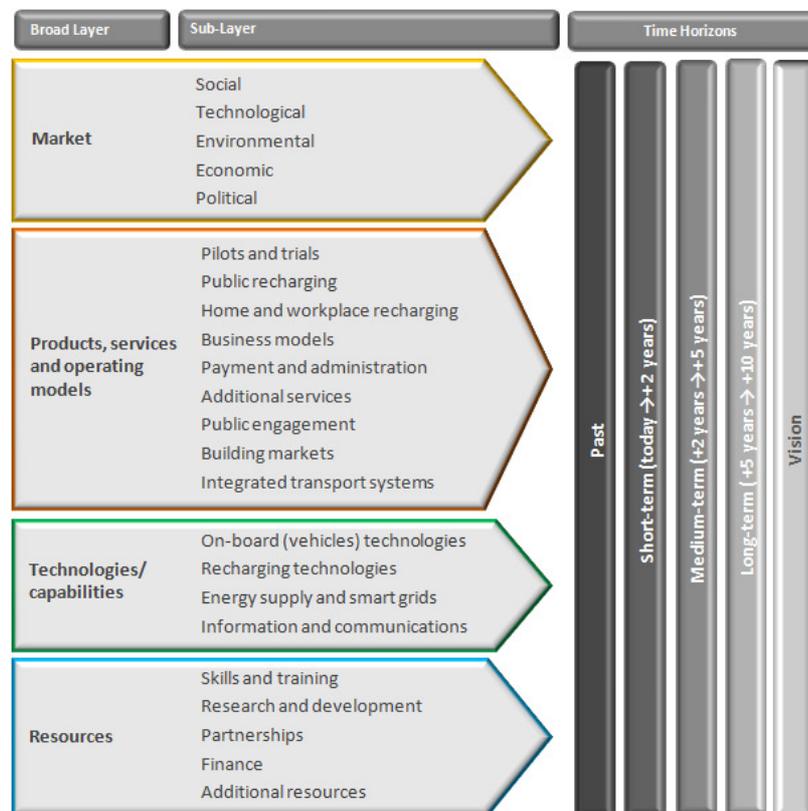
1. To identify and prioritise the main high-level trends and drivers and opportunities related to the aims of the North East EV programme;
2. To formulate outline strategies to address key strategic opportunities and challenges.

Industry:			
			
Local government:			
			
Universities:			

**Figure 4: Organisations represented at the Newcastle roadmapping workshop**

### 3.2 Strategic Landscape

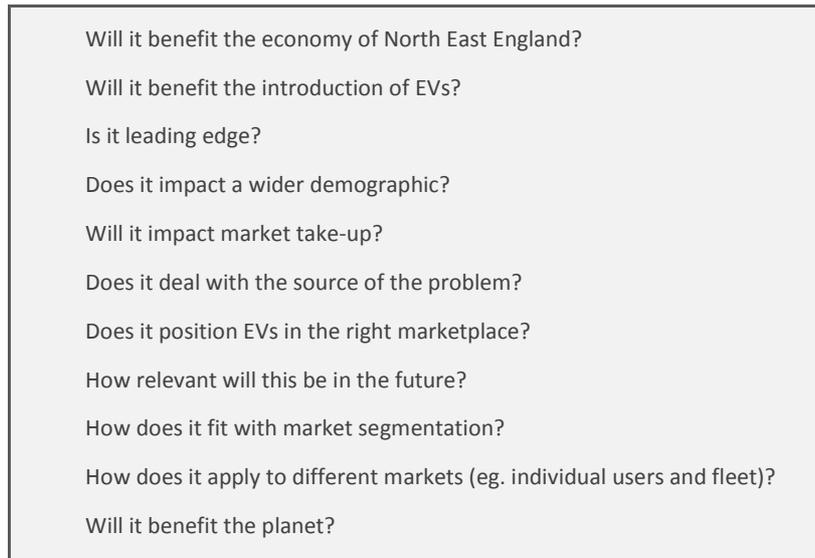
The first session of the workshop explored the ‘strategic landscape’ of trends and drivers facing the EV sector and the region of North East England. This information is ordered by a ‘roadmap architecture’ that was developed before the workshop. As shown in Figure 5 this architecture comprised a series of categories and time horizons that were used to structure the data collection and also to communicate the information captured in the workshop. The definitions of these categories are shown in Appendix II.



**Figure 5: Roadmap architecture**

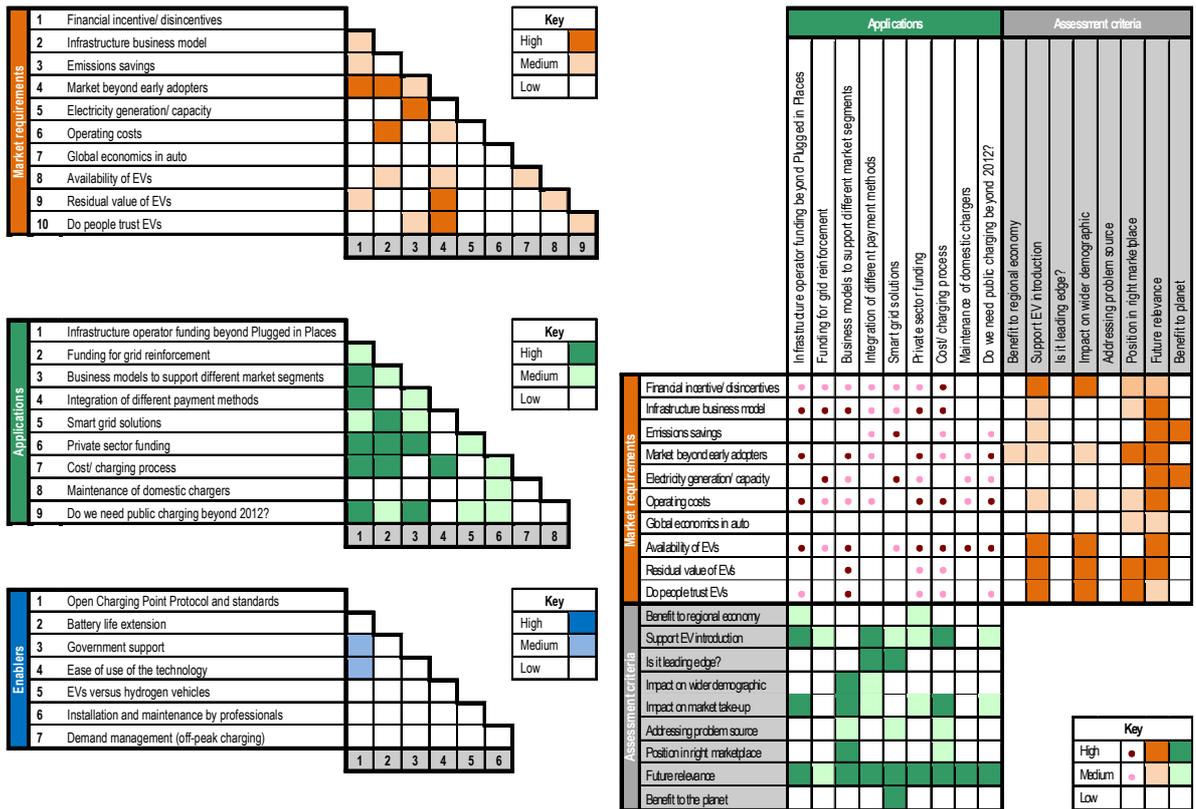
### 3.3 Priority Issues and Actions

The second session of the workshop identified key priorities for the programme using a voting process. Participants filtered issues and actions that they believed to be the most important. Priorities were separately identified and ranked in the three categories of 'markets', 'applications' (i.e. products, services and operating models) and 'enablers' (i.e. technologies, capabilities and resources). This process was informed by a set of assessment criteria developed in the workshop and summarised in Figure 6.



**Figure 6: Assessment criteria developed to filter priority issues and actions**

Following the workshop the data generated was analysed to quantify the links between priorities. A cross impact analysis was used to structure this process, with the strength of the relationship quantified. Examples of this are shown in Figure 7.



**Figure 7: Examples of cross-impact analysis to establish links between priority issues and actions**

### 3.4 Topic Roadmaps

In the final session of the workshop, the participants split into four groups to develop 'topic' roadmaps as outline strategies on how to respond to some of the opportunities and challenges identified. This used the roadmap architecture to define a timeline of key milestones and actions related to market needs, suitable product/service applications, and enabling technologies and capabilities.



North East EV  
Programme Roadmap



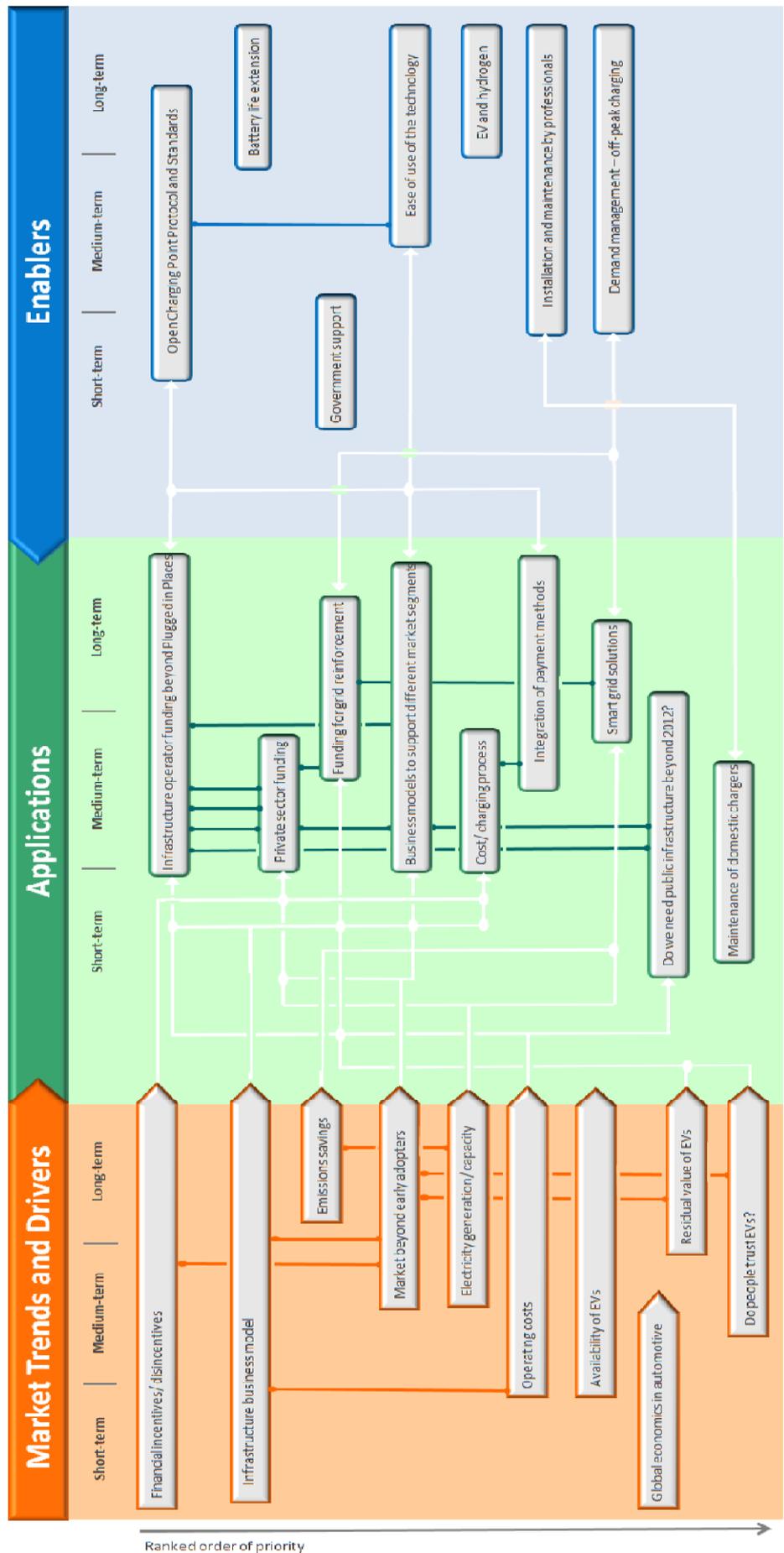
Rank	Markets	Applications	Enablers
1.	Financial incentives/ disincentives	How will North East infrastructure operator be funded beyond PiP?	Open Charging Point Protocol and communications standards
2.	Business model to support charging infrastructure	Who pays the cost of reinforcing the grid?	Battery life
3.	Emissions savings	Business models to support different market segments	Government support
4.	Is there a market beyond early adopters/ niche?	Integration of payment methods (EV, transport, general commercial)	Ease of use of the technology
5.	Ability to provide enough electricity generation and capacity	Smart grid solutions	EVs versus hydrogen vehicles
6.	Operating costs	Private sector funding	Installation and maintenance by professionals
7.	Global economics in automotive	Cost/ charging process	Demand management (off- peak charging)
8.	Availability of EVs	Maintenance of domestic chargers	
9.	Residual value of EVs	Do we need public charging beyond 2012?	
10.	Do people trust EVs		

**Figure 9: Ranked priority issues and actions**

#### 4.4 Linkages and Forward Plan

As explained in Section 8, roadmaps enable integration of market, product/service and technology plans. This requires quantification of links between the priorities to establish the related benefits and impacts.

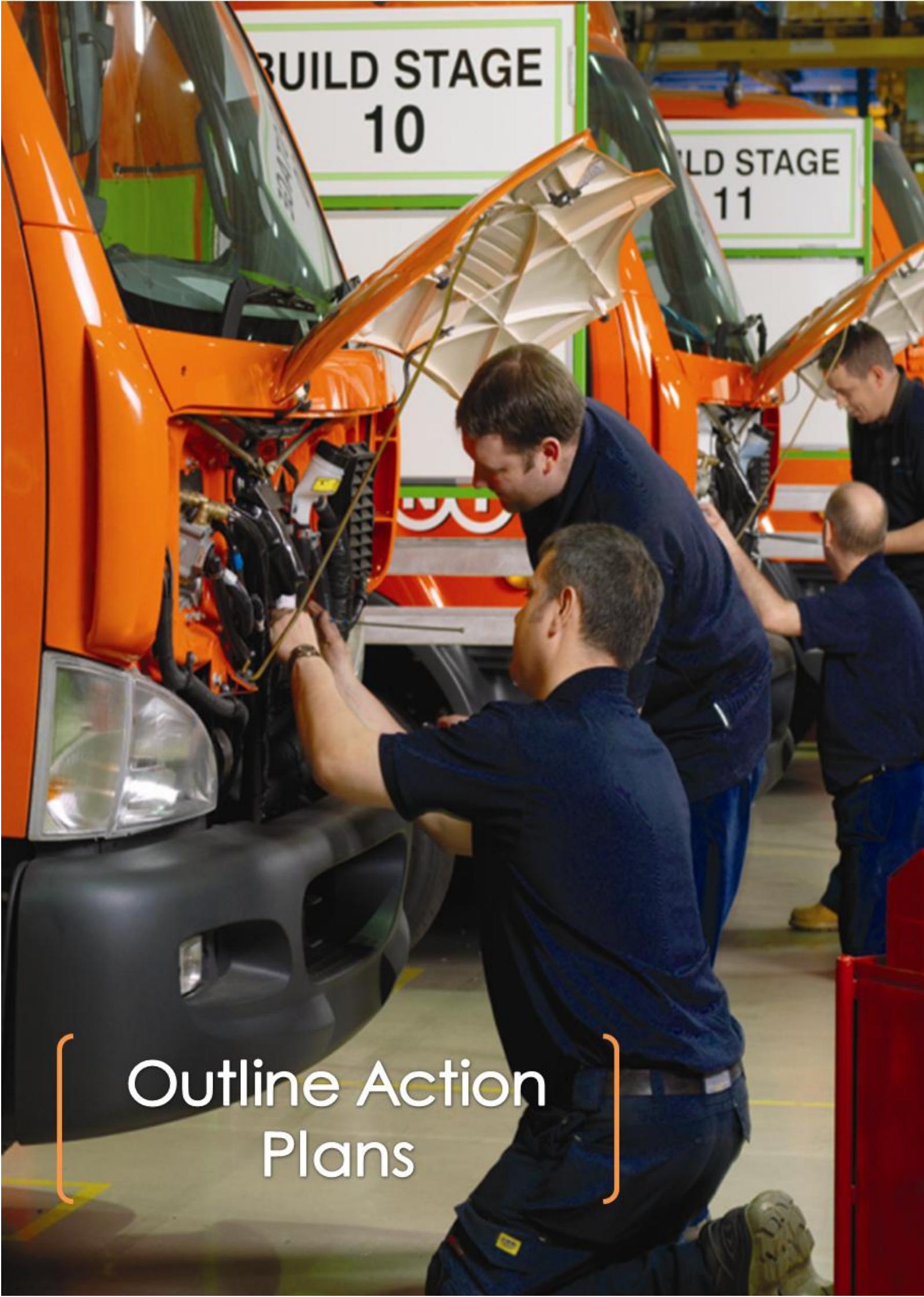
This reveals the interactions and relationships, which are illustrated in Figure 10. It also supports the development of a high-level description of the timeline of key issues and actions facing the programme as a basis of a forward plan (summarised in Figure 11).



**Figure 10: Relationship between priority trends, applications and enablers**

	Short-term	Medium-term	Long-term
Markets	<p>Financial incentives and disincentives for accelerating uptake and removing barriers to adoption of EVs are a core focus. Purchase subsidies are outside the remit of the programme, but local incentives such as free parking and electricity will play an important role.</p> <p>Financial incentives, should be balanced against the need to develop sustainable business models for recharging infrastructure operation and vehicle operation.</p>	<p>Affordability and availability of vehicles will limit market growth. This raises a need to understand the likely profile of the market beyond early adopters and to raise general awareness and confidence in EVs.</p> <p>Creating a sustainable business model for recharging infrastructure will require operating costs to be minimised wherever possible.</p>	<p>Achieving meaningful emissions savings from EVs will be central to mass market adoption. This is closely tied to the electricity generation mix.</p> <p>Mass market adoption of EVs raises concerns about grid capacity.</p>
Applications	<p>The expectation that most people will charge EVs at home raises questions about the type and amount of public recharging infrastructure required.</p> <p>Home recharging will be a key opportunity area. This will require skills and service models for the installation and maintenance of domestic charging points.</p>	<p>Government funds for recharging infrastructure operation will end in 2013. This requires identification of new private sector-led vehicles to sustain and develop the network installed in the North East.</p> <p>It is unlikely that there will be a universal business model. It is important to understand the needs of different market segments.</p>	<p>Greater functionality and potential revenue streams will come from integrated payment methods (including alternative forms of transport and other commercial goods) and EV becoming an integral part of a smart grid solution.</p>
Enablers	<p>A key initial priority is UK-wide interoperability for recharging infrastructure. An open charge point protocol would enable users to recharge anytime and anywhere. It is also likely to reduce operating costs.</p> <p>Government support will be required to support the growth of the early market. However, it is important not to create a market based on subsidies. Public support, therefore will be phased out in the medium-term in favour of private sector-led solutions.</p>	<p>The ease of use of EVs and recharging infrastructure will be a key factor in market uptake. This will be supported by common standards and further developments in technology.</p> <p>It is vital to ensure that there are sufficient skilled professionals to install and maintain recharging infrastructure and to service EVs. This is essentially a safety issue.</p> <p>Commercial models and technologies for demand management will address concerns about grid capacity and enable EVs to function as an integral part of smart grid solution.</p>	<p>Extension of the operating life of batteries will be an important development area. This relates to both extending the duration of operation in vehicles but also developing second-use applications.</p> <p>It is necessary to understand the likely developments in hydrogen-fuelled vehicles and how this will impact the evolution of EV technologies. This raises a question whether EVs be considered as a stepping stone to fuel cell vehicles or are the development paths for these technologies largely independent?</p>

**Figure 11: Timeline of priority issues and actions**



BUILD STAGE  
10

BUILD STAGE  
11

Outline Action  
Plans

# 5 Outline Action Plans

## 5.1 Overview

In the final session of the workshop, the participants split into four groups to develop ‘topic’ roadmaps as outline strategies on how to respond to the opportunities and challenges represented by the priority issues of:

- Communication standards, interoperability, payment and back office
- Consumer interface and nurturing the market
- Hydrogen and/or electric vehicles
- Future business models for recharging infrastructure

These roadmaps are shown in the following sections and accompanied by a summary explanation of the key points raised by the roadmaps.

## 5.2 Communication Standards, Interoperability, Payment and Back Office

<b>Vision Statement</b> UK/EU interoperable system for EV transport and payment (2020 to 2025)
<b>Where are we today? (necessary conditions)</b> <ul style="list-style-type: none"><li>• One North East ‘Charge Your Car’ card in place</li><li>• Exploration of charge point supplier interoperability</li><li>• Second generation back office procurement imminent</li><li>• No agreed access media (Near Field Communications)</li><li>• Chargepoint manufacturers are not talking re. comms</li><li>• No agreed interoperability for back office</li></ul>
<b>What are the next steps? (growth)</b> <ul style="list-style-type: none"><li>• Government to choose access media (MIFARE/ DESfire) (→ UK interoperability)</li><li>• Encourage chargepoint manufacturers to work together on back office</li><li>• Procure second generation back office</li><li>• UK to decide on global back office (or not...)</li></ul>
<b>Future opportunities and capabilities required (mass market)</b> <ul style="list-style-type: none"><li>• Help!</li><li>• OLEV needs to lead decision-making process</li><li>• Understand requirements and business case for second generation back office</li></ul>

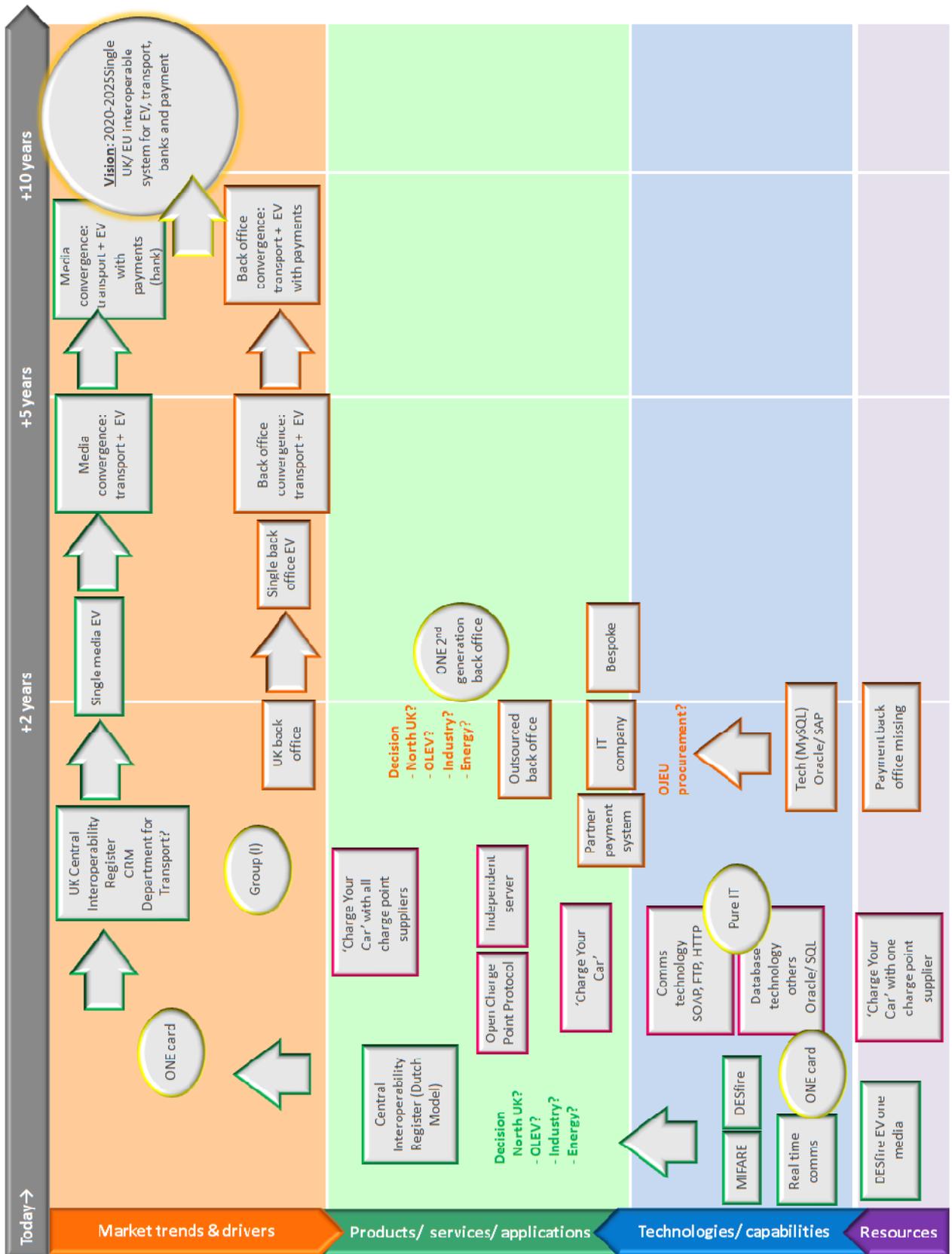
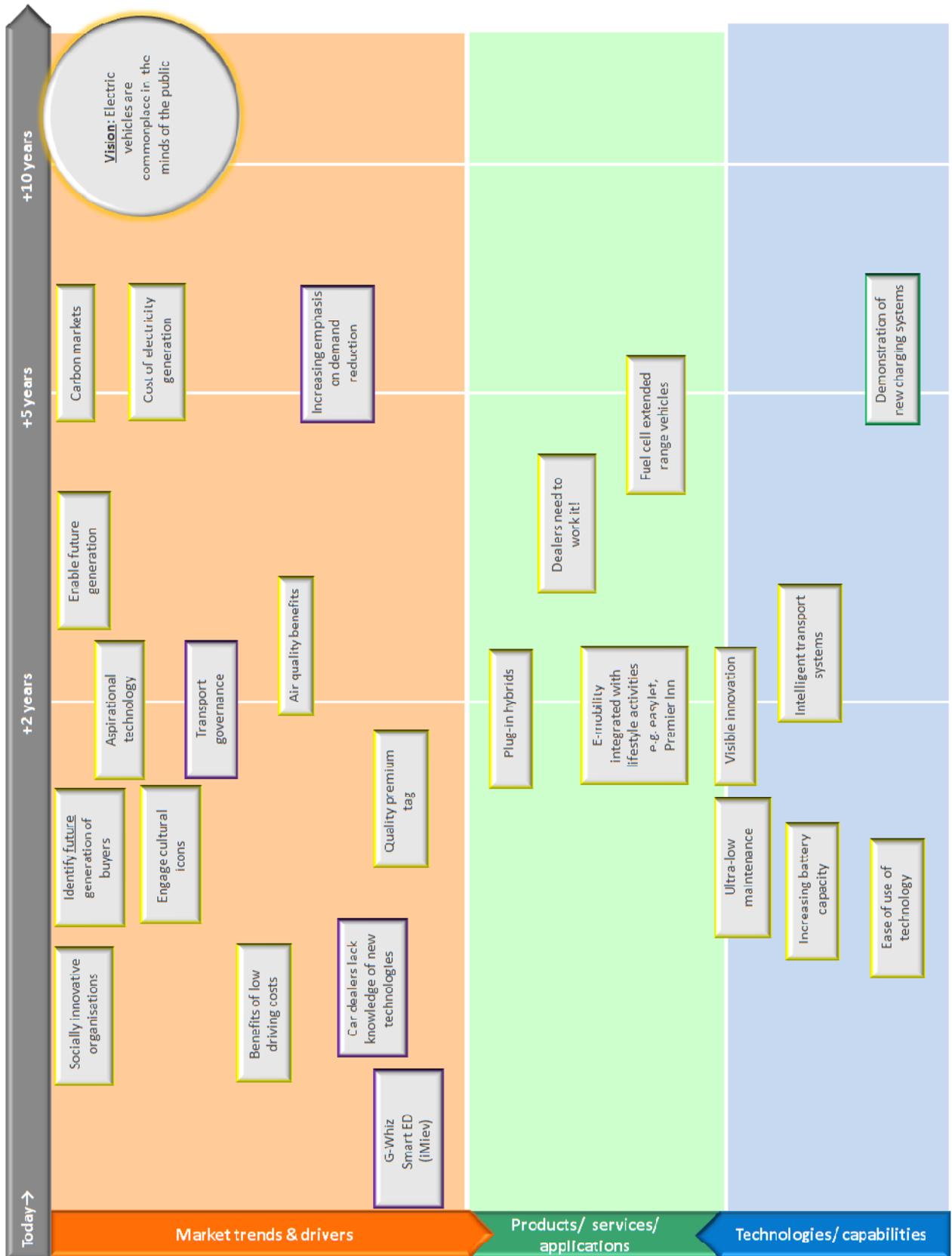


Figure 12: Communication standards, interoperability, payment and back office

### 5.3 Consumer Interface and Nurturing the Market

<p><b>Vision Statement</b></p> <p>EVs are commonplace in the mind of the public and a critical mass across market segments</p>	<p><b>2016-2021</b></p>
<p><b>Where are we today? (necessary conditions)</b></p> <ul style="list-style-type: none"> <li>• Lack of awareness of EVS</li> <li>• Technology (charging, costs, operation)</li> <li>• Availability</li> <li>• At start large organisations driving EV adoption</li> <li>• European/ US role models/ experience available</li> <li>• Starting EV trials</li> </ul>	<p><b>2011</b></p>
<p><b>What are the next steps? (growth)</b></p> <ul style="list-style-type: none"> <li>• What can be achieved through local and national legislation (e.g. planning, park and ride)</li> <li>• Need demonstrations/ visualisations/ create narratives across market segments (fleet/ early adopters/ commercial vehicles)</li> <li>• Identify cultural/ political icons and engage in narratives</li> <li>• Broaden early take-up users/ organisations</li> <li>• Investigate how to expand grid capability and vehicle to grid comms and electricity generation “locally”</li> <li>• Include in integrated transport plans</li> <li>• Make it part of individuals “routines”</li> <li>• Marketing and PR</li> </ul>	<p><b>2011-2016</b></p>
<p><b>Future opportunities and capabilities required (mass market)</b></p> <ul style="list-style-type: none"> <li>• Interoperability - + 1 year</li> <li>• Scarce resources/ environmental impacts = opportunity! = growing</li> <li>• Affordable cars - +5 years</li> <li>• Vehicle manufacturers involvement/ drive in engaging others (business case/ opportunities/ benefits/ “sharing”) = now and ongoing!</li> </ul>	



**Figure 13: Consumer interface and nurturing the market**

## 5.4 Hydrogen and/or Electric Vehicles

<p><b>Vision Statement</b></p> <p>Thriving manufacturing base in North East England</p>	<p><b>2016-2021</b></p>
<p><b>Where are we today? (necessary conditions)</b></p> <ul style="list-style-type: none"> <li>• Lots of resources for both H2 and battery EV</li> <li>• Car makers with intent</li> <li>• Small cluster of high-tech companies</li> <li>• Battery EVs being manufactured in low volumes</li> <li>• Low Carbon vehicle test track facility in North East England</li> <li>• Healthy R&amp;D in regional universities</li> </ul>	<p><b>2011</b></p>
<p><b>What are the next steps? (growth)</b></p> <ul style="list-style-type: none"> <li>• Industrialise/realise emerging opportunities <ul style="list-style-type: none"> <li>→ H2 injection</li> <li>→ H2 generation</li> <li>→ CO2 scrubbing</li> <li>→ Range extension</li> </ul> </li> <li>• Make use of opportunities in non-automotive applications</li> </ul>	<p><b>2011-2016</b></p>
<p><b>Future opportunities and capabilities required (mass market)</b></p> <ul style="list-style-type: none"> <li>• Sub-system manufacture in volume <ul style="list-style-type: none"> <li>→ Membranes</li> <li>→ Fuel cells</li> <li>→ Batteries</li> <li>→ Chemicals</li> </ul> </li> <li>• Battery reuse and recycling</li> <li>• Technicians and engineers</li> <li>• Development of mini/off grid</li> </ul>	<p><b>2016-2021</b></p>

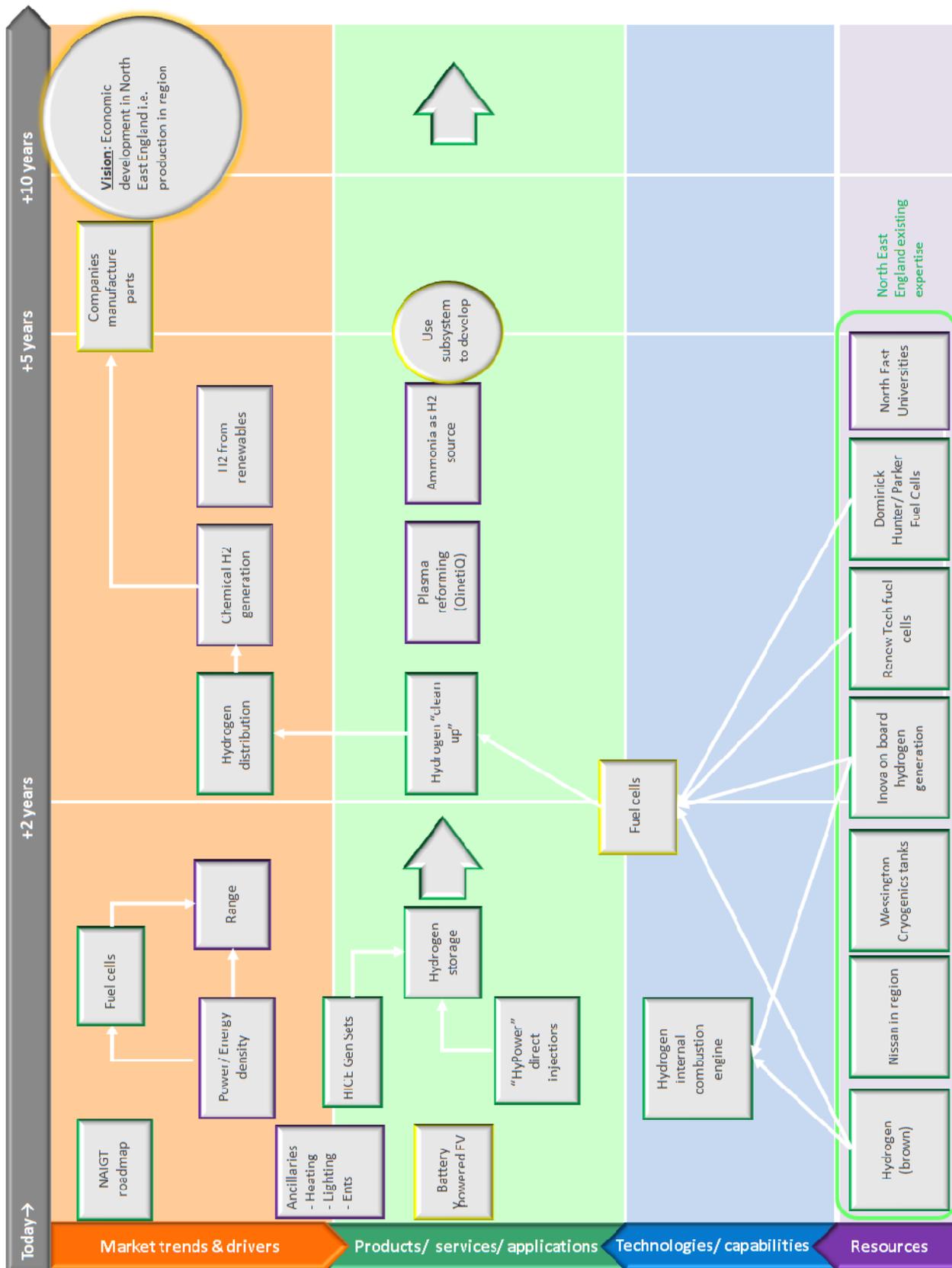


Figure 14: Hydrogen and/or Electric Vehicles

## 5.5 Future Business Model for EV Recharging Infrastructure

Note: no presentation summary was provided by the group.

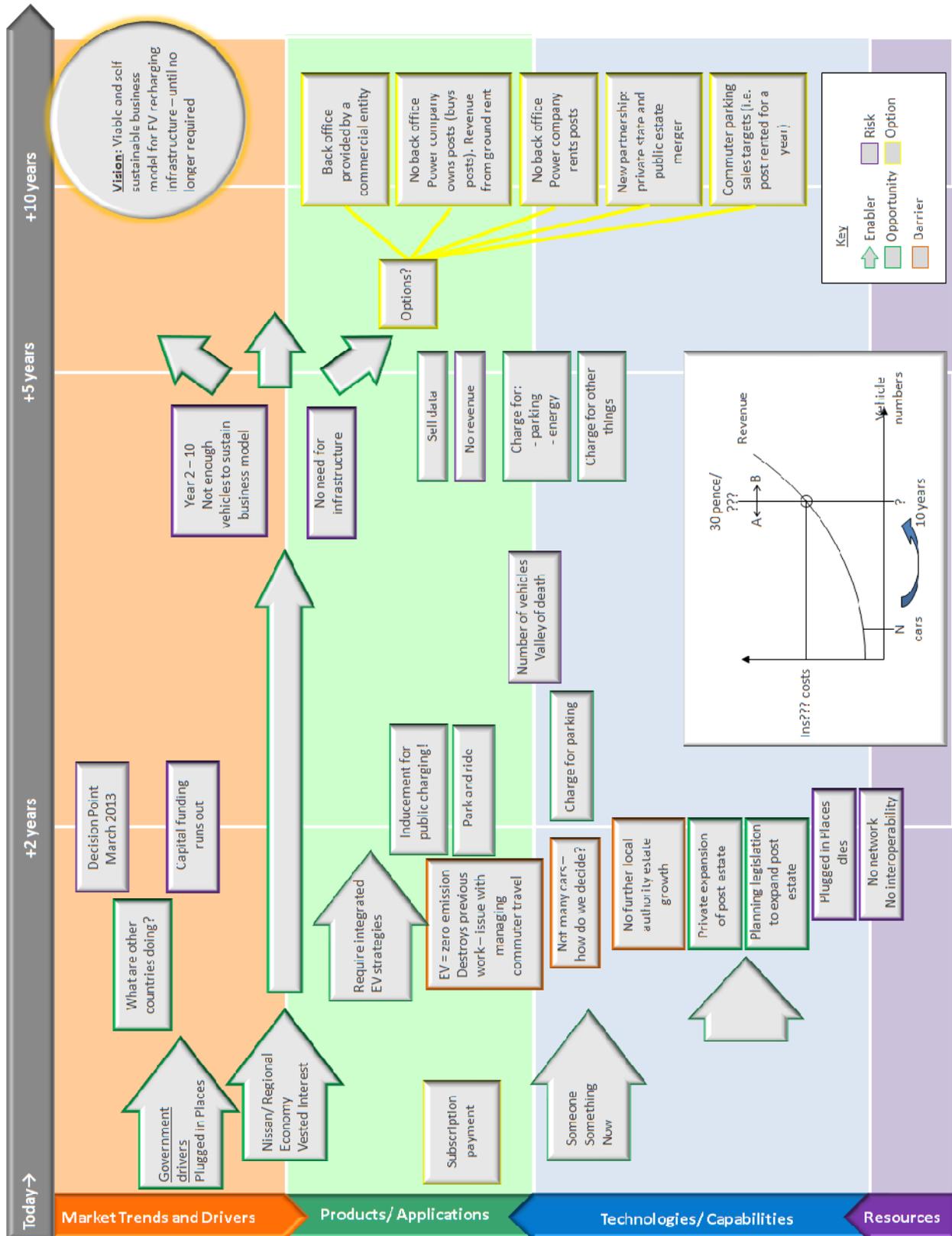


Figure 15: Future business model for EV recharging infrastructure

# [ Moving Forward ]



## 6 Moving Forward

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### 6.1 Overview

The closing discussion of the workshop focused on how the outputs from the roadmapping exercises could be taken forward and what the potential benefits might be. The key points raised in this discussion are summarised in the following sections.

### 6.2 Roadmap

The outputs of the roadmapping workshop provide a starting point to support the development of a robust forward plan for the EV programme in North East England. This will be essential as key projects transition to new organisations with the closure of One North East.

A key achievement in the roadmapping workshop was to assemble a range of stakeholders from industry and the public sector. It is proposed that these individuals and organisations continue to support the forward plan for the North East EV programme.

It is also desirable to engage stakeholders that were not represented in the workshop, but have an interest or relevant expertise. The roadmap provides a basis for dialogue with all relevant stakeholders in the programme.

The roadmap will enable the region to share and signpost its experiences and progress to a global audience. This will support the ambition to sustain and capitalise on its position as a leading knowledge centre for the development and deployment of EV technologies.

A key output of the roadmapping process is the articulation of a set of priority issues and actions. While this should not be seen as prescriptive, it does enable focus and resources to be targeted at important areas.

As the EV sector is moving at a rapid pace, it is recognised that priorities and necessary actions are likely to change over time. To ensure that the roadmap is kept up to date, a 'refresh' workshop should be scheduled within twelve months to revisit and iterate necessary elements.

### 6.3 Objectives and Actions

From the priorities identified in the roadmapping workshop, a series of key objectives, tasks and actions have been summarised in Figure 16. For each of these, a task owner or champion should be assigned responsibility for ensuring that appropriate actions are taken. Progress in each of these areas will provide coordinated support to the long-term objectives and vision of the North East EV programme.

	Short-term	Medium-term	Long-term
Markets	<ul style="list-style-type: none"> <li>Support measures to accelerate uptake and remove barriers to adoption of EVs.</li> </ul>	<ul style="list-style-type: none"> <li>Understand the likely profile of the market beyond early adopters</li> <li>Raise public awareness and confidence in EVs.</li> </ul>	<ul style="list-style-type: none"> <li>Support measures to achieve emissions reduction via clean energy</li> <li>Understand long-term grid capacity issues.</li> </ul>
Applications	<ul style="list-style-type: none"> <li>Support creation of sustainable business models for recharging infrastructure and vehicle operation.</li> <li>Work to minimise operating costs of recharging infrastructure wherever possible.</li> </ul>	<ul style="list-style-type: none"> <li>Establish home recharging as a key area of focus covering skills, service models and maintenance.</li> <li>Pilot commercial models and technologies for demand management</li> </ul>	<ul style="list-style-type: none"> <li>Investigate and track developments related to integrated payment methods and smart grids.</li> </ul>
Enablers	<ul style="list-style-type: none"> <li>Work to achieve UK-wide interoperability for recharging infrastructure.</li> <li>Identify new private sector-led vehicles to sustain and develop the North East recharging infrastructure network beyond end of current funding period in 2013.</li> </ul>	<ul style="list-style-type: none"> <li>Ensure that there are sufficient skilled professionals to install and maintain recharging infrastructure and to service EVs.</li> </ul>	<ul style="list-style-type: none"> <li>R&amp;D programmes and industry support to extend the operating life of batteries.</li> <li>Understand likely developments in hydrogen-fuelled vehicles and how this will impact the evolution of EV technologies.</li> </ul>

**Figure 16: Timeline of priority objectives, tasks and actions**

# Appendix



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Environment  
Agency

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# I. Roadmapping Workshop Details

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Date: Monday 14<sup>th</sup> March 2011  
Venue: One North East, Stella House, Goldcrest Way, Newburn Riverside,  
Newcastle upon Tyne NE15 8NY, United Kingdom

## Agenda

10:55	Welcome and introductions	David Beeton, One North East
11:00	Workshop aims and objectives	David Beeton, One North East
11:15	North East EV Programme: Key Facts	Josey Wardle, One North East
11:25	Strategic landscape brainstorming: Emerging market trends and drivers	All
11:55	Operating models, services and products	
12:45	Lunch	All
13:15	Strategic landscape brainstorming contd: Emerging technologies and capabilities Resource requirements	All
14:00	Future priority opportunities and challenges	All
14:30	Topic roadmaps	All (breakout groups)
15:30	Presentation of topic roadmaps and next steps	All
16:30	Close	

## Participants

David Baglee	Project Manager	University of Sunderland
Paul Lewins	Group Engineer Network Development	Sunderland City Council
Bob Donaldson	Transport Strategy Manager	Sunderland City Council
Andrew Hunter	Operations Director	Vinci Energy
Matthew Lumsden	Managing Director	Future Transport Systems
Edward Bentley	Researcher	Northumbria University
Phil Evans	Head of E-Mobility	RWE npower
Jon Bird	Head of Sustainability	CE Electric
Richard Kotter	Senior Lecturer	Northumbria University
Alexandra Prescott	Special Advisor	One North East
Steve McDonald	Senior Specialist	NaREC
John Lowes	Senior Specialist	Nissan
Anya Bramich	Marketing Manager	One North East
Mark Wilson	Transport Advisor	Newcastle City Council
Neil Ellison	Sustainability Manager	Stockton Borough Council
Colin Herron	Activity Manager	One North East
John McGargill	Strategic Traffic Studies Manager	Durham County Council
Andrew Robinson	Researcher	Newcastle University
Adrian Morris	Operations Manager	Sunderland University

## II. Roadmap Architecture

Broad Layer	Sub-Layer	Definition
Market	Social	The social systems in which we live, including demographics, lifestyle choices, aspirations, working patterns and desires.
	Technological	The influence of technology on society and markets
	Environmental	The physical environment in which we live and the associated impacts of energy production, waste, emissions and pollution
	Economic	The influence of the financial systems that affect our lives, encompassing global, national, corporate and personal economic considerations
	Political	Changes and influences in the systems that govern us, including policy, regulation, legislation, and other political processes
Products, services and operating models	Pilots & trials	Examples, experience, key findings and best practice from infrastructure pilots and EV trials
	Public recharging	Developments in the provision of publicly accessible recharging points, including installation, maintenance and operation.
	Home & workplace recharging	Private recharging points that are installed in domestic or commercial premises, including installation, maintenance and operation.
	Business models	Organisational structures, operating processes and commercial offerings to create, capture and deliver value in operation of EVs and infrastructure
	Payment & administration	Technologies and service models to operate EV infrastructure and manage customer accounts
	Additional services (beyond recharging batteries)	Additional products, services and revenue generating opportunities associated with the operation of EVs in cities
	Public engagement	Public engagement, marketing and education to raise awareness and create the social change required for mass adoption of EVs
	Building markets	Measures to remove barriers to ownership and encourage adoption of EVs, covering incentives, retail channels, leasing and fleet uptake
	Integrated transport systems	Integrating EVs into wider transport systems
Technologies/capabilities	Design, analysis & modelling	Key considerations, processes and analysis for the design of EV ecosystems
	On-board (vehicles) technologies	The impact of emerging technologies, systems and standards for application in vehicles
	Recharging technologies	Technologies, systems and standards for application in recharging infrastructure
	Energy supply & smart grids	Generation and distribution of energy including smart grid concepts and renewable energy
	Information & communications technology	Technologies and systems for communication between customers, vehicles, recharging infrastructure and back office
Resources	Skills & training	Interventions to provide necessary commercial and technical skills
	Research & development	Priority areas of research and development
	Partnerships	Collaborations, international partnerships and commercial agreements
	Finance	Sources of funding to support investments
	Additional resources	Additional resources that underpin developments in the sector

# III. Strategic Landscape Transcription

	Past	Today	+ 2 years	+ 5 years	+ 10 years	Vision	
<b>Social</b>	<p>2011 ⇒ Buying an EV – what's in it for me?</p> <p>2011 ⇒ EVs in a rural areas</p> <p>People seem increasingly technology-hungry</p> <p>Today: Need to commute</p> <p>Today ⇒ Vandilism</p> <p>Social conscience</p> <p>Now/ ongoing ⇒ Most consumers buy used cars: need viable stock (warranties etc)</p>	<p>2011-15 ⇒ To encourage use of EVs, how about a "charging subsidy" where user is paid to charge EV (like feed-in tariff)</p> <p>Improving public perception of EVs: Performance &amp; Range</p> <p>EVs appear gimmicky. Peoples car purchasing habits are much more focused around status (e.g. 4x4)</p> <p>Lack of understanding of running costs = tax/ electricity/ servicing/ maintenance</p> <p><b>Affordability</b></p>	<p>2011 ⇒ Effect of "power rationings". Scapes on attitudes!</p> <p>EVs is seen as a less robust and more frivolous transport mode. Currently lacking consumer credibility.</p> <p>Families likely to have 2 cars – petrol/ diesel and EV.</p> <p>100 signatories gains a charging station</p> <p>Lack of understanding of running costs = tax/ electricity/ servicing/ maintenance</p> <p><b>Affordability</b></p> <p>Price of vehicles below conventional</p>	<p>Vehicle recycling and 2<sup>nd</sup> hand market – no EVs – levels of income related to demographics</p> <p>Future vehicles develop around journey requirements</p> <p>2012 ⇒ Fleet use stimulates domestic adoption.</p> <p>2012 ⇒ Where do I buy an additional battery?</p> <p>Range extension</p> <p>Who can afford an EV?</p>	<p>2011 ⇒ What will happen when early adopters have their cars? Will the market stand up?</p> <p>(Potential) shift in balance from private transport to public transport. Less demand for private cars.</p> <p>EVs become a component in a travel process – swift changeovers.</p>	<p>⇒ 2020: Move towards work from home, videoconferences etc.</p> <p>2015 ⇒ car sharing</p> <p>Risks that safety concerns/ media headlines undermines development of EV market</p>	
<b>Technological</b>	<p>2011: Not addressing use of photovoltaic charging to any significant level at present</p> <p>Now ⇒ iPhone generation</p> <p>2011 ⇒ How do I charge on the motorway?</p> <p>2011 ⇒ How do I guarantee a recharge?</p> <p><b>Availability of vehicles</b></p>	<p>Need to understand new/ changed safety risks from EVs – use to reassure consumers and/ or improve safety.</p> <p>Now ⇒ Technology/ability not in place to pay for electricity &amp; parking – implication when technology comes about</p> <p>2013 ⇒ Easy to use! Automatic, foolproof</p>	<p>Charge point booking</p> <p>Conflict of bluetooth with EV infrastructure</p> <p>ITS applications: will they be in the vehicle or by the roadside (Who leads?)</p> <p>Improved battery technology addresses range anxiety</p> <p>300km range target</p>	<p>2010 ⇒ +5years. Acceptance of the technology in terms of reliability, &amp; costs to buy, run, maintain, dispose of.</p> <p><b>Do people trust EVs? Reliability/ support/ cost/ longevity?</b></p>	<p>2015 + ⇒ What will impact of fuel cell vehicles on market/customer perception?</p> <p>Pure EV ⇒ Hydrogen fuel cell</p> <p>Fuel alternatives to electricity</p>	<p>EVs outperform internal combustion engine vehicles in all ways</p> <p>New and future technology is the only way we will be able to support future population growth and stable societies</p>	
<b>Environmental</b>	<p>Declining air quality</p> <p>CO2 and other emissions to air</p> <p>EV purchasing in fleets based on low carbon vehicle procurement programme – what incentives/grant funding is going to be available for fleets?</p> <p>Increasing oil prices</p>	<p>UK is leading the way on electrification</p> <p>Impact of natural disasters, middle east oil, Japanese earthquake and tsunami</p> <p>Renewable energy sources</p>	<p>Carbon credits for production of EV batteries and vehicles?</p> <p>EVs can play a major part in noise reduction in cities</p> <p>Private sector engagement: users paying for infrastructure</p> <p>Business models for infrastructure capitalise on high charge point utilisation or focus on low use (e.g. insurance)</p>	<p>Green power through charging posts</p> <p>Energy production, will it meet demand?</p>	<p>What are the CO<sub>2</sub> savings? Tailpipe vs electricity gen.</p> <p>Not just CO<sub>2</sub>: what about PM<sub>10</sub>, NO<sub>x</sub>, ammonia etc.? Air quality targets</p>	<p>⇒ 2030: will energy supply be sufficiently decarbonised to maximise emissions reduction?</p>	<p>Depletion of natural resources</p>
<b>Economic</b>	<p>EV purchasing in fleets based on low carbon vehicle procurement programme – what incentives/grant funding is going to be available for fleets?</p> <p>Increasing oil prices</p>	<p>2011 ⇒ Is carbon expenditure higher with EVs? If so, why should I buy?</p> <p>EV seen to promote car use and doesn't address congestion or active travel issues</p> <p>Today ⇒ long-term. Response to economic drivers changing purchasing behaviours (£10 per year congestion charges)</p> <p>Personal spending limited by economic climate. Limited uptake</p> <p>Difficult to move from 'early adopter' to mass market motivation</p> <p>Sustainable business models</p>	<p>Fleet penetration- financial models</p> <p>EVs powered by locally sourced energy can help insulate from fossil fuel price/ supply issues</p> <p>Impact on take up on fuel tax income</p> <p>Cost of public charging</p>	<p>⇒ 2015: Integration and replacement of local authority fleet vehicles</p> <p>Rent-out your EV network launched in UK</p> <p>Cost of electricity for charging (tariff structure)</p> <p><b>Global economics: in automotive</b></p>	<p>Ability to provide enough electric generation capacity</p>	<p>Residual value of vehicles</p> <p>⇒ 2030: Will trend towards demand reduction on roads limit growth?</p>	

Market Trends & Drivers



	Past	Today	+ 2 years	+ 5 years	+ 10 years	Vision	
Payment and back office	<p>Will people pay for public charging?</p> <p>Charge post-manufacturers – do the rates what they need to offer? i.e. will it be them that operate a back office?</p> <p>Now =&gt; Smartcards, intelligent back office payment facilities</p> <p>Include paying for charging at the same time as paying for parking (through a meter)</p>	<p>Integration of payment methods with transport/ EVs and general commercial purchasing interoperability: UK level and commercial issues</p> <p>Who will take this on and create a charging model?</p> <p>Who manages the recharges cost in back office? Utilities/ OEMs/ Local Authorities/ Government?</p> <p>Use of data back-channel for usage/congestion/ vehicle maintenance</p> <p>Barriers to mass adoption – affordability etc – makes messaging more difficult</p> <p>Availability – people need to see cars on road/ in neighbourhoods</p> <p>Hotels, ??? companies etc – leasing of EV batteries/ cars</p> <p>Charge users for infrastructure use?</p> <p>Range issues will tend to favour plug-in hybrids</p> <p>No clear plan for an integrated transport system without EV.</p> <p>Multi-modal transport solutions</p>	<p>2012 =&gt; Urban mass transit schemes deliver opportunity for EV payment</p> <p>Include paying for charging at the same time as paying for parking (through a meter)</p> <p>How to make public charging points pay</p> <p>Progresses with other payment options (parking etc.)</p> <p>What is the value of the data that we are collecting?</p> <p>Visualisation of usability and sort and hard infrastructure</p> <p>Public electric mobility information</p> <p>Integrated 'customer journey' to be offered mainly by major utilities</p> <p>2012 =&gt; market expectations cannot be met</p> <p>Single back office to handle EV scheme, cycle scheme, transport scheme or multiple?</p> <p>National smartcard offers opportunity for integration</p>	<p>Hard to yet see a model for recharging/ billing unless premium rates are applied e.g. payment by credit card at a commercial rate</p> <p>Join up the UK National EV call centre</p> <p>Tie in EV recharging to parking meter systems in city centres</p> <p>Managing &amp; charging EV scheme needs to be linked to parking management</p> <p>Who do I call for help?</p> <p>National EV charging call centre</p> <p>EVs will be very attractive to the high-end aspirational vehicles are improved</p> <p>2013 =&gt; Single view of personal transport needs. Integrating personal &amp; public EV car clubs</p>	<p>National smartcard influences EV payment techniques. ITSO Pricing, time of day, supplier, clear costs identified to end user</p> <p>Paying for EV charging becomes inconsequential, it just happens</p> <p>Internal structure for 'wider' transport systems. Cost? Recycling &amp; reuse</p> <p>Predicting demand for recharging points using real-time data</p> <p>Private sector funding 'Big Business' develops EV offerings i.e. Tesco Mobile =&gt; Tesco EV utilisation</p> <p>Large scale fleet adoption New vehicle ownership models emerge to incentivise utilisation</p> <p>London cycle scheme. 2015 =&gt; Car becomes a travel assistant rather than just a means of transport</p>	<p>2015 =&gt; Systems to ensure that my recharge bill is a 'one stop shop'.</p> <p>2015 =&gt; Predict the recharge point and how much it will cost</p> <p>Who manages the recharge cost in back office? PowerTS/ EVs OEMs/ Local Authorities/ Plugged In Places?</p> <p>Introduce carbon costs into the travel cost equation</p> <p>EVs and low carbon technologies become status symbols</p> <p>Infrastructure (ITS installations) helps me source a charging point</p>	<p>EVs become low cost high volume preferred option</p>
Additional services	<p>No one really knows? Media information not helping</p> <p>Congestion charge</p> <p>Free parking</p> <p>Milk floats and quadricycles</p> <p>Call back of Prius</p>	<p>Is public engagement and awareness raising the manufacturers responsibility? Who are the public? Potential customers or more general?</p> <p>Rebate on EV price</p> <p>Range issues will tend to favour plug-in hybrids</p> <p>No clear plan for an integrated transport system without EV.</p> <p>Multi-modal transport solutions</p>	<p>What is the value of the data that we are collecting?</p> <p>Visualisation of usability and sort and hard infrastructure</p> <p>Public electric mobility information</p> <p>Integrated 'customer journey' to be offered mainly by major utilities</p> <p>2012 =&gt; market expectations cannot be met</p> <p>Single back office to handle EV scheme, cycle scheme, transport scheme or multiple?</p> <p>National smartcard offers opportunity for integration</p>	<p>Managing &amp; charging EV scheme needs to be linked to parking management</p> <p>Who do I call for help?</p> <p>National EV charging call centre</p> <p>EVs will be very attractive to the high-end aspirational vehicles are improved</p> <p>2013 =&gt; Single view of personal transport needs. Integrating personal &amp; public EV car clubs</p>	<p>Internal structure for 'wider' transport systems. Cost? Recycling &amp; reuse</p> <p>Predicting demand for recharging points using real-time data</p> <p>Private sector funding 'Big Business' develops EV offerings i.e. Tesco Mobile =&gt; Tesco EV utilisation</p> <p>Large scale fleet adoption New vehicle ownership models emerge to incentivise utilisation</p> <p>London cycle scheme. 2015 =&gt; Car becomes a travel assistant rather than just a means of transport</p>	<p>2015 =&gt; Systems to ensure that my recharge bill is a 'one stop shop'.</p> <p>2015 =&gt; Predict the recharge point and how much it will cost</p> <p>Who manages the recharge cost in back office? PowerTS/ EVs OEMs/ Local Authorities/ Plugged In Places?</p> <p>Introduce carbon costs into the travel cost equation</p> <p>EVs and low carbon technologies become status symbols</p> <p>Infrastructure (ITS installations) helps me source a charging point</p>	<p>EVs become low cost high volume preferred option</p>
Public engagement	<p>Is public engagement and awareness raising the manufacturers responsibility? Who are the public? Potential customers or more general?</p> <p>Rebate on EV price</p> <p>Range issues will tend to favour plug-in hybrids</p> <p>No clear plan for an integrated transport system without EV.</p> <p>Multi-modal transport solutions</p>	<p>What is the value of the data that we are collecting?</p> <p>Visualisation of usability and sort and hard infrastructure</p> <p>Public electric mobility information</p> <p>Integrated 'customer journey' to be offered mainly by major utilities</p> <p>2012 =&gt; market expectations cannot be met</p> <p>Single back office to handle EV scheme, cycle scheme, transport scheme or multiple?</p> <p>National smartcard offers opportunity for integration</p>	<p>Managing &amp; charging EV scheme needs to be linked to parking management</p> <p>Who do I call for help?</p> <p>National EV charging call centre</p> <p>EVs will be very attractive to the high-end aspirational vehicles are improved</p> <p>2013 =&gt; Single view of personal transport needs. Integrating personal &amp; public EV car clubs</p>	<p>Managing &amp; charging EV scheme needs to be linked to parking management</p> <p>Who do I call for help?</p> <p>National EV charging call centre</p> <p>EVs will be very attractive to the high-end aspirational vehicles are improved</p> <p>2013 =&gt; Single view of personal transport needs. Integrating personal &amp; public EV car clubs</p>	<p>Internal structure for 'wider' transport systems. Cost? Recycling &amp; reuse</p> <p>Predicting demand for recharging points using real-time data</p> <p>Private sector funding 'Big Business' develops EV offerings i.e. Tesco Mobile =&gt; Tesco EV utilisation</p> <p>Large scale fleet adoption New vehicle ownership models emerge to incentivise utilisation</p> <p>London cycle scheme. 2015 =&gt; Car becomes a travel assistant rather than just a means of transport</p>	<p>2015 =&gt; Systems to ensure that my recharge bill is a 'one stop shop'.</p> <p>2015 =&gt; Predict the recharge point and how much it will cost</p> <p>Who manages the recharge cost in back office? PowerTS/ EVs OEMs/ Local Authorities/ Plugged In Places?</p> <p>Introduce carbon costs into the travel cost equation</p> <p>EVs and low carbon technologies become status symbols</p> <p>Infrastructure (ITS installations) helps me source a charging point</p>	<p>EVs become low cost high volume preferred option</p>
Creating markets	<p>Is public engagement and awareness raising the manufacturers responsibility? Who are the public? Potential customers or more general?</p> <p>Rebate on EV price</p> <p>Range issues will tend to favour plug-in hybrids</p> <p>No clear plan for an integrated transport system without EV.</p> <p>Multi-modal transport solutions</p>	<p>What is the value of the data that we are collecting?</p> <p>Visualisation of usability and sort and hard infrastructure</p> <p>Public electric mobility information</p> <p>Integrated 'customer journey' to be offered mainly by major utilities</p> <p>2012 =&gt; market expectations cannot be met</p> <p>Single back office to handle EV scheme, cycle scheme, transport scheme or multiple?</p> <p>National smartcard offers opportunity for integration</p>	<p>Managing &amp; charging EV scheme needs to be linked to parking management</p> <p>Who do I call for help?</p> <p>National EV charging call centre</p> <p>EVs will be very attractive to the high-end aspirational vehicles are improved</p> <p>2013 =&gt; Single view of personal transport needs. Integrating personal &amp; public EV car clubs</p>	<p>Managing &amp; charging EV scheme needs to be linked to parking management</p> <p>Who do I call for help?</p> <p>National EV charging call centre</p> <p>EVs will be very attractive to the high-end aspirational vehicles are improved</p> <p>2013 =&gt; Single view of personal transport needs. Integrating personal &amp; public EV car clubs</p>	<p>Internal structure for 'wider' transport systems. Cost? Recycling &amp; reuse</p> <p>Predicting demand for recharging points using real-time data</p> <p>Private sector funding 'Big Business' develops EV offerings i.e. Tesco Mobile =&gt; Tesco EV utilisation</p> <p>Large scale fleet adoption New vehicle ownership models emerge to incentivise utilisation</p> <p>London cycle scheme. 2015 =&gt; Car becomes a travel assistant rather than just a means of transport</p>	<p>2015 =&gt; Systems to ensure that my recharge bill is a 'one stop shop'.</p> <p>2015 =&gt; Predict the recharge point and how much it will cost</p> <p>Who manages the recharge cost in back office? PowerTS/ EVs OEMs/ Local Authorities/ Plugged In Places?</p> <p>Introduce carbon costs into the travel cost equation</p> <p>EVs and low carbon technologies become status symbols</p> <p>Infrastructure (ITS installations) helps me source a charging point</p>	<p>EVs become low cost high volume preferred option</p>
Integrated transport	<p>Is public engagement and awareness raising the manufacturers responsibility? Who are the public? Potential customers or more general?</p> <p>Rebate on EV price</p> <p>Range issues will tend to favour plug-in hybrids</p> <p>No clear plan for an integrated transport system without EV.</p> <p>Multi-modal transport solutions</p>	<p>What is the value of the data that we are collecting?</p> <p>Visualisation of usability and sort and hard infrastructure</p> <p>Public electric mobility information</p> <p>Integrated 'customer journey' to be offered mainly by major utilities</p> <p>2012 =&gt; market expectations cannot be met</p> <p>Single back office to handle EV scheme, cycle scheme, transport scheme or multiple?</p> <p>National smartcard offers opportunity for integration</p>	<p>Managing &amp; charging EV scheme needs to be linked to parking management</p> <p>Who do I call for help?</p> <p>National EV charging call centre</p> <p>EVs will be very attractive to the high-end aspirational vehicles are improved</p> <p>2013 =&gt; Single view of personal transport needs. Integrating personal &amp; public EV car clubs</p>	<p>Managing &amp; charging EV scheme needs to be linked to parking management</p> <p>Who do I call for help?</p> <p>National EV charging call centre</p> <p>EVs will be very attractive to the high-end aspirational vehicles are improved</p> <p>2013 =&gt; Single view of personal transport needs. Integrating personal &amp; public EV car clubs</p>	<p>Internal structure for 'wider' transport systems. Cost? Recycling &amp; reuse</p> <p>Predicting demand for recharging points using real-time data</p> <p>Private sector funding 'Big Business' develops EV offerings i.e. Tesco Mobile =&gt; Tesco EV utilisation</p> <p>Large scale fleet adoption New vehicle ownership models emerge to incentivise utilisation</p> <p>London cycle scheme. 2015 =&gt; Car becomes a travel assistant rather than just a means of transport</p>	<p>2015 =&gt; Systems to ensure that my recharge bill is a 'one stop shop'.</p> <p>2015 =&gt; Predict the recharge point and how much it will cost</p> <p>Who manages the recharge cost in back office? PowerTS/ EVs OEMs/ Local Authorities/ Plugged In Places?</p> <p>Introduce carbon costs into the travel cost equation</p> <p>EVs and low carbon technologies become status symbols</p> <p>Infrastructure (ITS installations) helps me source a charging point</p>	<p>EVs become low cost high volume preferred option</p>

Products, Services and Operating Models (continued)

	Past	Today	+ 2 years	+ 5 years	+ 10 years	Vision
Design and modelling	Keep it simple	Analysis of EV performance in terms of energy use and emissions	What is the magic number for public charging point provision? Ratio per head of population	Model systems to develop green energy – storage - charging		
On-board vehicle	All automotive manufacturers currently developing electric drive trains. What will win – the energy source race – battery? Ultra efficient diesel? Hydrogen fuel cell?	Think about target market – public and private fleets 2011 ⇒ Embedding mobile technology in vehicle EVs drive smart grid development	How will EV communicate with grid? When to charge/ how long? auto start and stop etc. EVs drive smart grid development	How will battery developments affect EC cost/ life/ performance/ recharging?	Vehicle range extended and made a bespoke functionality to the customer	
Recharging	How will batteries cope now? Life/ cost/ number of recharges/ swap out solutions	Domestic charging linked to smart metering Uncertainty over the extent and capacity of public recharging infrastructure – may become practically redundant. If/when battery range extends	Charging point diagnostics: maintenance, fault reporting, consumer feedback 7+ Kw charging is essential Induction charging – reduce battery size and extend range	EV charging infrastructure influences on microgenerators & energy storage ITS in matching vehicles to zero carbon recharging points	2013 ⇒ induction charging Adapt parking meters to allow for paying for recharging	2015 ⇒ off-grid charging of EVs
Energy supply and smart grids	Need leadership to bring the renewable energy agenda together Smart grids don't exist yet! Current roll out of smart meters not sufficient for EVs ('dumb smart meters')	How do we persuade EV users to use off-peak electricity? Can the national grid handle the extra demand? Interaction of EVs and other new technologies (such as heat pumps) with the development of the 'smart grid'	Vehicle to grid options – compatibility Charge profiles to optimise network/load impact Take-up of green energy – EV is meaningless otherwise 2012 ⇒ Role of the power generators in influencing recharging allocation	Who pays for local reinforcement of electricity network? Pay EV owners for grid connection to increased use of renewables Encourage night charging – up to 100kg CO <sub>2</sub> saving compared to peak	How will the grid cope at street level if EV's are well adopted? Will there be enough generating capacity? Encourage night charging – up to 100kg CO <sub>2</sub> saving compared to peak	Recharging at right times – marginal CO <sub>2</sub> impact of grid Will the energy network handle the charge Data on EV distribution, status & expected charge time informing power generation
ICT	Charging point suppliers do not need to supply back office systems Open Charge Point Protocol to facilitate better back office systems	Cooperative systems – vehicle-to-vehicle, infrastructure-to-vehicle systems Interoperability: coordination of UK and Europe	Real-time communication with charging point is not easy MIFARE vs DESFire 2012 ⇒ How will phones benefit EV/ITS interoperability	Single Near Field Communications Protocol for North East, UK, Europe? 2013 ⇒ Smart range calculation linked to GP's and topography	Lack of coordination between systems and between system providers and infrastructure operators	Telecoms connections to the standard communication networks as installed currently, for example NRTS network - possibly

Technologies/ Capabilities continued

	Past	Today	+ 2 years	+ 5 years	+ 10 years	Vision
<b>Skills and training</b>	No recognition from government on skills and training need Vehicle recovery and emergency organisations require training	Need for vehicle dealerships to have strong support mechanisms for vehicle owners in early years Where will I get my EV fixed?	Service departments not ready for cars on road Emergency services	Integration skills shortages – technology/ transport/ vehicle/ infrastructure	Will government fund new skills and training programmes?	Lack of guidance from OLEV
<b>R&amp;D</b>		Battery technology to improve range Next step – range extenders	Limited financial resource in academia Advances in photovoltaic charging	Communications standards	How will parages learn new skills for EVs? Government funded research into cheaper (aluminium based?) EV batteries	
<b>Partnerships</b>	Dutch E-Laad open charge point protocol	Distribution network operators/ energy companies/ local authority collaboration on EV charging	Safety – install and maintain by competent people			
<b>Finance</b>	Comprehensive spending review and abolition of Regional Development Agencies	To support development of viable business models	Battery cost Battery life	What will happen when government incentives end? Who will buy EVs?	Visibility of ROI	Commercial tipping point of infrastructure
<b>Additional resources</b>	Sell the positives – charge at home or work, no searching for petrol stations	Convergence of PIP in UK				
<b>Resources</b>						

**E:** [info@urbanforesight.org](mailto:info@urbanforesight.org)  
**W:** [www.urbanforesight.org](http://www.urbanforesight.org)

**Urban Foresight Limited**

Registered in England and Wales No.7705420

8 The Crescent | Newcastle upon Tyne | NE7 7ST | United Kingdom

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strategy and  
solutions for  
smart cities