Progress Report
2014

Review
of Pre-Market Phase
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Executive Summary and Recommendations
Electric mobility will be the key to achieving climate-friendlier mobility throughout the world and will also constitute an important contribution to Germany’s energy transition. Electric vehicles emit significantly less CO₂, especially if powered by renewable electricity. In addition, as part of smart grids, the energy storage systems of electric vehicles can help to balance out fluctuations in the supply of wind and solar power, thereby supporting the development and market take-up of these volatile energy sources.

Germany has set itself a number of ambitious policy goals to be attained by 2020:
• To make German industry the leading global supplier.
• To establish Germany as the leading global market.
• To have one million electric vehicles on the road in Germany.

Electric mobility is becoming increasingly important internationally. The market is growing rapidly all over the world, particularly in countries with the preconditions required for its development.

The Fourth Report of the German National Platform for Electric Mobility marks the conclusion of the pre-market phase (2010–2014) and reviews the progress that has been made up to this point. Looking ahead to the commencement of the market ramp-up phase (2015–2017), the NPE also presents a package of measures and a roadmap outlining how Germany can deliver the targets it has set itself by 2020.

The results achieved up to the end of the pre-market phase have been somewhat mixed. German industry is well under way of becoming the leading global supplier. By the end of 2014, German manufacturers already had 17 electric vehicle models on the market and they will continue to expand their product ranges over the next few years. A further twelve new models have been announced for 2015. Germany’s focus on promoting research and development (R&D), regulation and standardisation and education and training has delivered global success. The key industries are now cooperating successfully with researchers throughout the electric mobility value chain.

The next step is to convert German industry’s potential into higher market shares, enabling it to become the world’s leading supplier. Electric vehicles must be able to compete with other power-train technologies, particularly in terms of price and range. This still requires a significant level of pre-competitive research and development. The NPE estimates that a total of 2.2 billion euros of R&D project funding will be required in order to drive forward the innovations necessary until the conclusion of the market ramp-up phase at the end of 2017. Assuming an average funding share of 50 percent, this means that Germany’s federal government will need to spend 360 million euros per annum on R&D.
Public funding of special programmes has numerous research and economic benefits and contributes substantially to sustainable economic growth and employment. Moreover, public funding will also lever investment from the private sector. In addition, it plays a particularly important role in bringing together academic institutions and small and medium-sized enterprises from different industries, both within and outside of the NPE.

In the international ranking of lead markets, Germany occupies an average position. At present, approximately 24,000 electric vehicles are registered in Germany, while there are around 4,800 AC charging points at some 2,400 different locations, as well as about 100 fast charging points. This provides a solid platform for the market ramp-up phase in Germany.

According to present estimates, only additional measures can ensure Germany’s achieving the goal of one million electric vehicles. In contrast to the NPE’s 2012 Progress Report, there now is sufficient experience and data with regard to user behaviour to allow for the creation of a targeted framework for promoting electric mobility in Germany. In order to establish Germany as the leading global market with one million electric vehicles on the road by 2020, the NPE recommends the rapid implementation of the set of measures outlined below as a matter of priority. On governmental side, the NPE considers the introduction of a special depreciation allowance for business users and the co-financing of the public charging infrastructure as the next important steps. It will also be necessary to ensure that the successful cross-sectoral engagement of industry in the field of electric mobility is continued.

| Lead market goal | 1. Introduction of a special depreciation allowance for business users (amounting to an annual loss in tax revenue of around 0.2 billion euros).  
2. Rapid implementation of the set of legislative measures for promoting electric mobility.  
4. Implementation of the EU directive on alternative fuels, including the expansion of the charging infrastructure in accordance with the recommendations of the Standardisation Roadmap Version 3.0.  
5. Roll out of private and public procurement initiatives. |
| Leading supplier goal | 6. Continuing research and development into new topics and securing its funding through Federal Government support (public funding of approx. 360 million euros p.a.).  
7. Joint research into and promotion of the establishment of a cell manufacturing facility in Germany. |
1. Introduction of a special depreciation allowance for business users

We recommend the use of monetary incentives to achieve the goal of one million electric vehicles on the German roads by 2020. The NPE believes that a special depreciation allowance should be prioritised, projections asserting the particular efficiency of this measure. Depending on the exact number of new registrations, it is estimated that a special depreciation allowance would have a full twelve-month impact on the federal budget equivalent to the loss of 0.2 billion euros in tax revenue. However, in the year of the measure's introduction (2015) the loss would not exceed 30 million euros, rising to a maximum of 290 million euros in 2019.

2. Rapid implementation of the announced set of legislative measures for promoting electric mobility

The proposed non-monetary measures are key elements for the development of the global lead market and should therefore be in force by the time the market ramp-up phase begins in 2015. As well as directly promoting electric mobility by granting special rights to electric vehicle users, the proposed measures also aim at removing the barriers to electric mobility that exist in everyday life.

3. Strengthening of investment partnerships for building semi-public or public charging infrastructure

The NPE supports the goal of building a nationwide public charging infrastructure. The infrastructure should be expanded gradually, according to the increase in electric vehicle numbers. Based on today's technological standards, an approximate investment of 550 million euros until 2020 is required to achieve the goal of one million electric vehicles by 2020. However, this sum requires revision on an annual basis, as it can be expected to decrease with the increase of the number of charging units produced and the according reduction of manufacturing costs. As yet, charging points and a fast charging network cannot be operated profitably and this is unlikely to change before 2020. The NPE therefore recommends co-financing through a partnership programme between the private sector and government. The NPE believes that the requisite financing can be managed by a smart mix of various different elements. These could include an investment programme, parking space management arrangements, licensing, B2B partnerships or the integration of existing national and European funding programmes. This approach would not only award innovation, but also and above all investment in charging points and their long-term operation. Interoperable payment and access systems will be required in order to enable efficient and customer-friendly use of the public charging infrastructure. As of mid-2015, newly built charging infrastructure will be designated “publicly accessible” by the energy industry, making it available for ad-hoc use by customers.

4. Implementation of the EU directive on alternative fuels, including the expansion of the charging infrastructure in accordance with the recommendations of the Standardisation Roadmap Version 3.0

It is essential that the Combined Charging System (CCS) should be bindingly adopted as the global standard for normal and fast charging. In Europe, the adoption of the CCS was enshrined in an EU Directive in 2014 and it is also set to become established as the standard in the US.
Negotiations are ongoing with China, Japan and other partners regarding their adoption of the CCS. In order to avoid jeopardising the consensus and stable investment environment that have been created, the NPE discourages investment in solutions outside the CCS roadmap. It is imperative to upgrade infrastructure throughout Germany to CCS-compatibility as soon as possible.

5. Roll out of private and public procurement initiatives
As yet, the purchase of electric vehicles only pays off for specific user groups – primarily in commercial fleets. These are also crucial for the penetration of the used car market. Therefore, public as well as private procurement programmes should be initiated and rolled out. The NPE believes that special depreciation regulations would support a faster market ramp-up by providing additional momentum and greater visibility.

6. Continuing research and development into new topics and securing its funding through Federal Government support
Research and development will play a key role in establishing Germany as the world’s leading supplier and building a high-quality, international lead market. The NPE recommends that Germany’s federal government support research and development along the entire value chain with at least 360 million euros p.a. throughout the market ramp-up phase. The funding should be based on the Systemic Approach Roadmap and the technology roadmaps and the main priority areas outlined therein. The bulk of the funding should be shared between the areas of vehicle technology, batteries, ICT and charging infrastructure. Furthermore, the funding should be both secure and stable and should potentially continue beyond the market ramp-up phase.

7. Joint research into and promotion of the establishment of a long-term cell manufacturing facility in Germany
Supply at least partly outstrips demand in the global market for the second generation lithium-ion cells that dominate the market at present. As things currently stand, a significant increase in production of this type of cells in Germany would not be economically viable. However, the rise in the number of electric vehicles that the market ramp-up phase will bring about, will clearly require a substantial increase in the production of both cells and the materials necessary for their production. It will therefore be important for German industry to establish manufacturing of third- and fourth-generation cells in Germany. To achieve this, it will be necessary to enhance research and development work in the fields of materials, battery cells and systems as well as in the optimisation of the relevant manufacturing processes. In order to enable and jointly promote the establishment of a profitable and sustainable mass production capability for cells, know-how in Germany will need to be continuously developed on the basis of existing research production lines.

The NPE recommends co-funding the ongoing development of this manufacturing capability through a partnership programme between the private sector and the government. Furthermore, Germany should continue to develop and promote its know-how across the entire value chain, from materials to battery system and cell manufacturing. In 2015, the NPE intends to draw up a roadmap on integrated cell and battery production in Germany. Once it has been verified and the technological details have been settled, the value creation and employment model should be jointly implemented.
It is therefore clear that Germany remains on the right track. All actors concerned have committed to helping Germany become the world’s leading supplier and lead market, and it is now up to them to implement the necessary actions.

The industry is working hard to improve the performance of electric vehicles in order to develop their potential, especially in metropolitan regions and their outskirts; meanwhile, the ramp-up of the electric mobility market will continue to receive support from the Germany Federal Government. The NPE will pursue its monitoring work throughout the market ramp-up phase ending in 2017.
2 International Benchmarking

*Data of EV and charging points in Germany dates from July 2014. Number of EV in other countries dates from June 2014. Number of charging points in other countries dates from December 2013.
Electric mobility is becoming increasingly important internationally. The market is growing rapidly all over the world, particularly in countries that have created the underlying conditions needed to support its development. German industry is on course to become the leading global supplier. As far as its goal of becoming the lead market is concerned, Germany still occupies only an average position in the international ranking.

Electric mobility is an imperative for the economy, the environment and society as a whole. As a result, government, industry, researchers and civil society in countries all over the world are setting themselves ambitious goals and are competing to provide users with the best solutions. At the conclusion of the pre-market phase, Germany can be said to be starting from a good position compared to other countries with strong automotive industries such as the US, China, Japan and France (see Figure 1).

In terms of its aspirations of becoming the leading supplier – i.e. achieving global technology leadership in products, services and solutions – Germany is within touching distance of the US. This strong position can be attributed to the systematic research and development efforts undertaken during the pre-market phase (see Chapter 3). Federal government initiatives such as the four showcase regions electric mobility, the model regions, the leading-edge clusters MAI Carbon and Elektromobilität Süd-West (Electric Mobility South-West) and the research campuses ARENA 2036, EUREF and OHLF

Germany has acquired a good starting position in the global market

Figure 1: Benchmarking the world’s leading automotive nations with regard to electric mobility, 2014

Tight international competition for leadership in technology

Source: authors’ own illustration
are all flagship projects with international impact. Over the past four years, Germany’s federal government has spent a total of around 1.5 billion euros on the development of electric mobility, whilst a further 17 billion euros have been invested by the industry. The results speak for themselves – thanks to this investment, German automotive manufacturers will have launched 17 production models by the end of 2014, with a further twelve models announced for 2015. No other nation can boast such an extensive product portfolio. The continuing expansion of its range of models over the next few years will provide Germany with added momentum in its pursuit of global supply leadership and this should also translate into rising sales figures.

The success achieved to date is built on an approach that encompasses the entire value chain, from materials and components through electric vehicles and charging infrastructure right up to services and complete solutions. Nevertheless, the US still holds a small lead over Germany in the race for global supply leadership. One reason for this slight advantage is the combination of a fast-track market rollout of domestic models and high levels of public funds for research and investment in the US.

In China, the rise in electric vehicle numbers, accompanied by increased local component manufacture and some technology development activity, points to a clear trend towards both the development of China as lead market and its emergence as a leading supplier. Even today, China has a highly dynamic and rapidly growing market with a wide range of different models. There is evidence of high levels of public funding and investment particularly in electrical component technology, batteries and infrastructure, together with the establishment of the relevant industrial facilities. There are signs that China is likely to become the highest-volume electric mobility market and could thus potentially draw level with the US market.

The regulatory framework for business constitutes a key driver of foreign investment in electric mobility technology. For instance, all the countries referred to above have regulations designed to curb CO₂ emissions. Mobility is facing new challenges as a result of climate change, dwindling crude oil reserves and urbanisation resulting from the continuous growth of the global population. Accordingly, the development of alternative power-train technologies is becoming a growing imperative and the pressure to come up with innovative solutions is rising as efforts continue to cut the transport sector’s CO₂ emissions.

Like Germany, the US has recognised the economic importance of electric mobility to future industrial value creation. In order to leverage electric mobility’s potential for the domestic labour market and economic growth, the government has invested around 21 billion euros in research and development since 2007. A variety of different programmes to promote independence from oil have also been carried out e.g. by the US Department of Energy (DoE) as part of the Clean Energy Grand Challenges. Research priorities include energy storage, the development of new components e.g. for power electronics and electric motors, and vehicle simulation and testing technologies. The fact that the government was quick to provide support from an early stage also accounts for the speedy market entry of US manufactured vehicle models.
In terms of developing into a lead market – i.e. of becoming an internationally acclaimed high-quality showcase for electric mobility – Germany currently performs on average. While 24,000 electric vehicles and around 4,800 public charging points are certainly a promising start, they are not enough to single Germany out as a global leader.

<table>
<thead>
<tr>
<th>Country</th>
<th>1st six months 2013</th>
<th>Change</th>
<th>1st six months 2014</th>
</tr>
</thead>
<tbody>
<tr>
<td>US</td>
<td>40,300</td>
<td>+ 34%</td>
<td>53,800</td>
</tr>
<tr>
<td>Japan</td>
<td>14,400</td>
<td>+ 8%</td>
<td>15,600</td>
</tr>
<tr>
<td>Norway</td>
<td>2,500</td>
<td>+ 310%</td>
<td>10,400</td>
</tr>
<tr>
<td>Netherlands</td>
<td>2,600</td>
<td>+ 240%</td>
<td>8,800</td>
</tr>
<tr>
<td>China</td>
<td>3,500</td>
<td>+ 113%</td>
<td>7,400</td>
</tr>
<tr>
<td>France</td>
<td>7,700</td>
<td>− 8%</td>
<td>7,000</td>
</tr>
<tr>
<td>Germany</td>
<td>3,400</td>
<td>+ 78%</td>
<td>6,100</td>
</tr>
<tr>
<td>Denmark</td>
<td>260</td>
<td>+ 145%</td>
<td>600</td>
</tr>
</tbody>
</table>

Source: KBA, Polk

Notwithstanding a high average growth rate of 46 percent, the electric mobility markets in the countries shown in Figure 2 remain poorly developed. It is noticeable that the highest growth rates are in countries such as Norway, Denmark and the Netherlands which have no classic domestic vehicle manufacturers of their own, meaning that they have been able to prioritise market growth right from the outset. Monetary incentives have proved to be a particularly effective means of promoting market growth.

The Netherlands pursue the ambitious target of one million electric vehicles by 2025. In order to achieve this goal, the Dutch government has passed legislation exempting purchasers of electric vehicles from both road tax and the 42.5 percent Private Vehicle and Motorcycle Tax that applies to vehicles bought in or imported into the Netherlands (Belasting Personenauto’s en Motorrijwielen). The exemption constitutes a substantial tax saving compared to conventional vehicles, amounting to between five and eight thousand euros for mid-size cars. Additional tax breaks have been introduced for the private use of official and company cars. Electric vehicles benefit from a significant reduction in the tax rate of between 14 and 25 percent of the vehicle’s list price that is applicable to conventional company cars. This amounts to a tax saving of around 2,000 euros a year compared to conventional company cars.

In addition to these central government measures, some of the Netherlands’ largest local authorities have rolled out their own electric mobility programmes. Amsterdam has been particularly active in promoting the introduction of electric cars and aims at almost 100 percent electric vehicles on its roads by 2040. Parking has been made easier for electric vehicle owners by fast-tracking their applications for residents’ parking permits.
Now that the market ramp-up phase is about to begin (see Chapter 4), the German National Platform for Electric Mobility is increasingly turning its attention to its ambition to become the world’s lead market. Vehicle users are one of the factors that will drive the development of a successful market. Whether or not a consumer will buy an electric vehicle will be influenced by three key factors:

- the cost of electric vehicles (based on the Total Cost of Ownership (TCO)),
- the distance coverage of electric vehicles, and the related issue of
- the availability of a public charging infrastructure.

The countries being used as a benchmark in this report have addressed these points through a variety of strategies and measures based on different local, economic and environmental parameters, regulations and goals. The specific mobility requirements of people in different countries also play a central role. None of the countries in question is rushing to build a charging infrastructure in anticipation of future electric vehicle numbers – instead, charging infrastructure is being expanded in line with demand and is currently benefiting from the support of national funding programmes.

However, a comparison with other countries around the world does demonstrate that a wide range of potential instruments may be used to promote electric mobility. In addition to monetary incentives such as cashback schemes and tax breaks, there are also a number of non-monetary measures such as special rights for EV users. The table on page X provides an overview of the instruments employed by the countries with the largest automotive industries and the countries that currently have the highest demand for electric vehicles. White circles, black circles and semi-circles are used to indicate the extent to which the different types of measure are currently deployed.

### Table 2: Comparison of instruments to promote electric mobility around the world

<table>
<thead>
<tr>
<th>Promotion of leading market</th>
<th>Promotion of supply leadership</th>
</tr>
</thead>
<tbody>
<tr>
<td>monetary incentives</td>
<td>measures counteracting</td>
</tr>
<tr>
<td>tax breaks*</td>
<td>charging infrastructure</td>
</tr>
<tr>
<td>cashback</td>
<td>construction and upgrading</td>
</tr>
<tr>
<td>cheaper electricity for EVs</td>
<td>government research funding</td>
</tr>
<tr>
<td>special user rights and</td>
<td>education and training</td>
</tr>
<tr>
<td>privileges</td>
<td>promoting investment</td>
</tr>
</tbody>
</table>

#### Five main automotive nations

- US
- France
- Germany
- China
- Japan

#### Three countries that currently have high demand but lack a sizeable domestic automotive industry

- Norway
- Netherlands
- Denmark

[Image of table]

* tax exemption (e.g., road tax, V.A.T., luxury tax, vehicle registration tax) and lower tax rates

Source: expert assessment
It is evident from this comparison of different countries that there is a close link between supply leadership and market leadership – in order for a country to become a leading supplier it requires a lead market. Innovative products, services and solutions support the development of a lead market serving as a global showcase for electric mobility. This, in turn, can help to promote exports, paving the way towards global supply leadership. In this context, it is clear that Germany has chosen the right approach, beginning with research and development before moving on to production and marketing.

In future, although the individual priorities will shift during the forthcoming market ramp-up phase (see Chapter 4), the NPE will continue to devote its full attention to the double objective of becoming the leading supplier and the lead market.

NPE stands by its objective that Germany become a leading global supplier and lead market.
3
Review of progress to date

- 380 Euros/kWh
  Costs of batteries

- 1.5 Billion Euros
  Public funds

- 4,800
  Public charging points

- 17 Billion Euros
  Investment by industries

- 17
  Production models

- 160 Wh/l
  Energy density of batteries

- Road Tax Exemption

- 82
  R & D flagship projects

- 4
  Showcase regions electric mobility

- 24,000
  Electric vehicles

- CSS
  European standard for normal and fast charging

- 100
  Public fast charging points
The systemic approach constitutes one of the key components of the NPE’s three-phase plan. Electric mobility involves much more than the creation of electric power trains – it is a system that encompasses vehicles, energy supply and transport infrastructure, centered around the user. In order to compete with other power-train technologies, users must recognise the electric mobility system as both substantive and conclusive. We must continue to press ahead with the systematic implementation of the Systemic Roadmap to enable Germany to achieve supply leadership and to continue its aspirations towards the establishment of an international lead market.

The three-phase plan drawn up by the NPE in 2010 and its focus during the first phase on supply leadership themes such as research and development, regulation and standardisation and education and training have delivered international success. Thus, the foundations for the market ramp-up phase and the development of an international lead market have been established. Although the total of 24,000 electric vehicles on the road by the end of 2014 falls well short of the original target of 100,000, the leading supplier and lead market goals are still perfectly achievable. However, this will require a huge effort on behalf of all the stakeholders, together with an extensive package of measures (see Chapters 4 and 5) that will need to be implemented rapidly and as a matter of priority. The key landmark will be to have one million electric vehicles on the road by the end of 2020.
3.1 Systemic approach

Decisive for its strong technological position is Germany’s systemic approach that includes all relevant industries. Rather than being limited to electric vehicles, electric mobility encompasses a complete system. The system comprises the four categories of Vehicle Technology, Energy and Environment, Charging Infrastructure and Urban Planning and Intermodality. In addition, education, standards and information and communication technology (ICT) are crucial preconditions for the system. The NPE’s specific vision is to create a robust “electric mobility system” until 2020 that enjoys widespread public acceptance, guarantees high availability, reliably meets individual mobility needs (private and commercial transport) and facilitates the marketing of technologically sophisticated and profitable products. This vision was published in 2013 together with the Systemic Approach Roadmap, bringing together the work of the individual NPE working groups. Together with international benchmarking, it has served as a key monitoring instrument ever since.

3.1.1 User perspective

The potential users of electric vehicles are at the core of the Systemic Roadmap. Valuable information about user behaviour is being obtained from the federal government’s model regions and showcase regions. The results directly influence the selection of priority action areas. A comparison of different countries around the world indicates that wherever you go, the key factors influencing the use of electric mobility services are price, range and access to charging infrastructure.
**Price**

Vehicle purchase decisions are strongly influenced by the vehicle’s price. Recent market studies reveal that people are prepared to pay a small premium for electric vehicles, although this is subject to significant variation depending on the user group and the vehicle segment. According to a study of market evolution scenarios carried out by the Fraunhofer Institute for Systems and Innovation Research (ISI), the “interested/no purchase intention” group, which accounts for about fifty percent of the market, would be prepared to pay a premium of around ten percent due to their enthusiasm for electric mobility (see Figure 2).

![Graph: Extent and distribution of private buyers' willingness to pay a premium for EVs (2013)](image)

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**Range**

The average driving performance in Germany is about 22 kilometres a day. Field studies carried out by universities and research institutes have shown an electric vehicle’s range is sufficient to cover approximately 90 percent of all planned journeys. For entirely battery-driven electric vehicles (BEVs), the remaining ten percent of journeys will need to be covered either by ensuring the availability of charging infrastructure or by using complementary mobility services. For example, drivers might use a conventional vehicle instead of an electric vehicle for longer journeys, or they might complete their journey using local public transport and the long-distance rail network. Meanwhile, plug-in hybrids (PHEVs) and range-extended vehicles (REEVs) are able to cover 100 percent of journeys. Even in rural areas, customers are gradually increasing the distance they travel in their electric vehicles as they gain experience of using them. In addition, smartphone apps support and encourage controlled charging and help customers to find the nearest charging point. The showcase regions and model regions have shown that range does not, in fact, pose any real problems for the vast majority of current electric mobility users.
Charging infrastructure
According to the latest user surveys carried out as part of the parallel research into the showcase projects and model regions, the subject of range and access to public charging infrastructure for BEVs is one of the major issues throughout Germany. Since many potential customers have no previous experience with electric mobility, concerns about the range of electric vehicles may prevent a purchase. An easy-to-use and reliable charging infrastructure makes electric vehicles a more practical alternative. Charging infrastructure and mobility and communication service operators are continuously improving parking and charging comfort by facilitating the location of charging points, increasing their availability and reliability and simplifying payment procedures.

3.1.2 Vehicle technology

Power-train technologies and vehicle integration
Throughout the initial pre-market phase, the NPE’s work was focused on research and development in industry as well as numerous joint projects with universities and research institutes. Following the publication of the NPE’s Third Report in 2012, the implementation of the detailed technology roadmaps for the power-train technologies and vehicle integration flagship projects was started, focusing on the thematic areas of highly-integrated drive systems, electric motors and power electronics. Based on the content of the roadmaps, several joint research and development projects were launched, supported by federal government funding. The results will be published once the projects have been concluded.

The selection of projects outlined below is indicative of the principal research priorities (sample projects; further details in the glossary):

- In the field of power-train systems, the focus is on the integrated optimisation of powertrains in terms of their efficiency, cost, weight and volume, as well as their reliability for different topologies (MEHREN).
- In the field of electric motors, the focus is on the key goals of efficient, high-performance and cost-effective motor designs and materials (Sphin(x)).
• In the power electronics thematic area, specific R & D project goals include a significant improvement in power density and reliability as well as better electromagnetic compatibility within the system (EMiLE, InTelekt, InSeL).

• In the field of electric motor manufacturing technology, the priority is to design manufacturing processes that allow greater flexibility as to production run sizes (HeP-E).

• In the field of systems integration, work is being carried out on cost-effective manufacturing of plug-in hybrids using a scalable modular construction system (electric drive system, transmission, power electronics, operating software) (BEREIT).

In addition to the R & D topics outlined above, the drive technologies flagship project is also addressing the goal of connecting cars to the transport and energy systems. One of the drive technologies and vehicle integration projects is looking into the design of a common vehicle interface (INEES).

The work carried out to date and the additional projects planned for the future all support the NPE’s goal of global supply leadership. Some of the issues identified in the roadmaps need to be substantiated. Furthermore, new research priorities for the forthcoming market ramp-up phase have been identified for the technology cluster (Roadmap 2.0) and cross-cutting themes. Examples include research into alternative materials and new winding technologies for electric motors, maximising integration of power electronics and the continued development of vehicles’ onboard charging technology (inductive charging). The objectives for power-train technologies for 2020 remain unchanged (see Chapter 4.3.3).

Due to the huge efforts of industry in the field of vehicle technology, 17 production models made by German manufacturers will be available on the market by the end of 2014. The range of vehicles on sale includes BEVs, PHEVs and REEVs.

### Vehicle segment

| Minis | smart fortwo electric drive, VW e-up! |
| Small cars | BMW i3 |
| Compact class | Audi A3 Sportback e-tron, Ford FOCUS Electric, Opel Ampera, VW Golf GTE, VW e-Golf |
| Luxury | MB S 500 PLUG-IN-HYBRID, Porsche Panamera S E-Hybrid |
| SUVs | Porsche Cayenne S E-Hybrid |
| Sportwagen | BMW i8, MB SLS AMG Coupé Electric Drive, Porsche 918 Spyder |
| Mini-Vans | Ford C-MAX Energi, MB B-Klasse Electric Drive |
| Utilities | MB Vito E-CELL |

| Figure 7: German manufacturers’ production models by vehicle segment |

None of the other major automotive nations can currently boast such a wide variety of models across all the different segments. Moreover, Germany’s automotive industry will continue to significantly expand its product portfolio with the launch of brand new models – a further twelve electric vehicle models have been announced for 2015. Unlike private cars, commercial vehicles and buses have a huge variety of different...
forms and uses. It is clear that the use of electric vehicles for commercial purposes has considerable potential, for example as delivery and trade vehicles. Accordingly, the continued development of innovative products that are both attractive and profitable should be supported.

Battery technology

Batteries are one of the most important components in terms of achieving the goal of supply leadership. As one of the main elements of an electric vehicle’s drive system, the battery has an impact on key features such as performance or range. Furthermore, the battery’s technology, size and system design will go a long way towards determining the weight and overall cost of an electric vehicle.

In battery technology development such as cell and battery system safety, raw material availability and recycling issues must be taken into account. In recent years, Germany has made significant advances in the development of traction batteries, particularly with regard to storage medium technology and efficiency. While modules and battery systems are currently manufactured in Germany, battery cell production only accounts for a small fraction of the total German market.

The battery’s share of a vehicle’s total value-added can amount up to 40 percent. However, this figure varies depending on the power-train technology employed. In plug-in hybrids, for example, the battery’s share of value-added is substantially lower, since these vehicles generally have electric-only ranges of less than 50 kilometres. Since it was first introduced in both hybrids and exclusively battery-driven electric vehicles, lithium-ion battery technology has become increasingly popular, currently providing the best operating performance. Thanks to the ongoing development of first- and second-generation cells and battery systems, batteries are now capable of energy densities of around 160 Wh/l at a cost of approximately 380 euros per kW/h. However, further improvements will be required if electric mobility is to achieve market success.

The main research and development areas where advances and optimisations in battery systems, cells and systems integration have been achieved are outlined below:

• The latest second-generation battery systems (materials and cells) have been deployed in recent electric vehicle models. Overall, significant progress has been made with regard to battery housings, cell integration, battery cooling and electronics.

• In the field of safety design and testing methods for guaranteeing the functional safety of battery systems, Germany is the global leader.

• Crash behaviour and transport safety have already attained a high standard and are being continuously enhanced.

• It has been possible to ensure that battery systems can be mounted in the optimal position within the vehicle as specified by the manufacturer. This is true both for the current production models of German automotive manufacturers and for vehicles that are still under development.

• The R&D projects have built up a high level of know-how in the areas of modelling and analytics. Particular attention has been paid to battery life testing, battery models and electrochemical reactions.

• Significant advances have been achieved in the following battery chemistry R&D fields: development of enhanced cell bonding designs, optimised cell materials such
as new cathode and anode materials and electrolytes and separators. An electrolyte lab is currently being built in Münster in order to ensure that these issues are addressed systematically.

- Cost-optimised manufacturing processes have been developed and implemented in the field of process engineering for the mass production of battery systems. Process engineering and quality assurance innovations have also been introduced.
- A research battery cell manufacturing facility has been opened in Ulm.

As the number of batteries increases, it will be necessary to continue researching and implementing enhanced manufacturing and safety processes.

**Lightweight design**

Ever since the NPE began its work, the reduction of the mass of individual vehicle components has been a key priority. It has been possible to put a halt to the steady increase of vehicles’ weight. Alongside the advances required in battery and power-train technology, systematic lightweight design – using e.g. modern carbon-fibre reinforced plastics (CFRPs), fibre-reinforced thermoplastics or CFRP hybrid materials such as polyurethane and high-performance steel – is crucial for the achievement of attractive ranges, load capacities and handling performance. R&D efforts have therefore focused on the optimisation of existing composites, combinations of materials and components as well as the development of new ones. It will also be necessary to create lightweight structures for electric vehicles as well as resource-efficient manufacturing and assembly processes suited to high-volume production.

The “function-integrating lightweight engineering in multi-material design” approach was employed in certain aspects of the R&D work. Examples include numerous projects, such as the SMiLE project, aimed at developing and combining new materials as well as developing the relevant manufacturing processes. The Research and Demonstration Centre for Resource-Efficient Lightweight Structures for Electric Mobility (FOREL, see also the NPE’s Third Report) – which was proposed by the NPE – has also been successfully launched. The Centre facilitates a pre-competitive, project-based dialogue between all the relevant partners as well as systemic coordination of research projects. A technology centre is to validate the results of this development work and combine different process chains in order to eventually create a comprehensive network.
3.1.3 Charging infrastructure

The conditions required to enable nationwide charging coverage already exist throughout Germany. According to the NPE’s calculations, private charging points account for around 85 percent of the required charging infrastructure. The remaining 15 percent are accessible to the general public (see Chapter 4.2.2), although the construction of charging infrastructure in this area has faltered since 2012 owing to a lack of adequate business and financing models.

According to a study by the German Association of Energy and Water Industries (BDEW), there was a total of approximately 4,800 public charging points by mid-2014, around 100 of which were DC fast charging points. The majority provide AC charging up to 22 kilowatts using Type 2 connectors. Around 60 charging points currently offer both DC charging using Combo 2 connectors and AC charging with Type 2 connectors. Consequently, approximately 900 new charging points have been built since December 2012, equivalent to an increase of about 23 percent. As can be seen in Figure 9, this means that the growth in the number of charging points has slowed significantly compared to previous years. Following an initial spate of charging point creation by the energy industry, the growth in electric vehicle numbers is now comfortably outstripping the growth in charging infrastructure. Despite this, at 24,000 vehicles to 4,800 charging points.
points, the ratio of electric vehicles to public charging points is still well within the 10:1 ratio established by the EU for the whole of Europe. To date, the expansion of the charging infrastructure has occurred primarily in highly-populated areas that have received funding support, meaning that full, nationwide coverage has not yet been achieved. Nevertheless, the basic charging infrastructure required for the forthcoming market ramp-up phase has been built. It is now necessary to expand the public charging infrastructure in a functional, needs-based manner that keeps pace with the growth in electric vehicle numbers (see Chapter 4).

The showcase regions and model regions have launched numerous initiatives geared towards the construction and upgrading of the public charging infrastructure (AC and DC) and the development of potential financing strategies. A number of additional projects funded by local, regional and central government as well as the EU were being planned in 2014, although the majority of these initiatives cover only a limited geographical area. No financing model has yet been developed in Germany for the key goal of building a nationwide public charging infrastructure (see Chapter 4.3.1). Work is currently ongoing on the other action areas outlined in the Systemic Approach Roadmap, for example the definition of charging infrastructure in energy law and the security and protection of vehicle and personal data during charging. Over the course of the forthcoming market ramp-up phase from 2015 to 2017, the charging infrastructure category will continue to focus on charging infrastructure construction and usability. A variety of different charging infrastructure access and payment methods can already be found on the market (see Figure 10):

- card-based systems using Radio-Frequency Identification (RFID)
- mobile phone-based systems using smartphone apps or text messages and telephone hotlines
- cable-based Plug and Charge systems
- additional methods such as debit and credit cards, ticket machines, cash and Near Field Communication (NFC)

In addition to long-term contracts, short-term “pay-as-you-go-solutions” have emerged as an increasingly popular customer-friendly payment model.

Another issue that arises in connection with access and payment methods is the establishment of EU-wide networks and cross-border interoperability. These questions are addressed under the ICT category (see Chapter 3.1.5).
In addition, mention should be made of the issues of data security and data protection. These topics are also being addressed by the NPE’s ICT sub-group, in close cooperation with the data protection authorities. In 2014, the German Commission for Electrical, Electronic & Information Technologies (DKE) established the interdisciplinary working group DKE/STD 1911.11.5 in order to address the issues of information security and data protection in the electric mobility infrastructure. The group works closely with the relevant committees on smart meters and also coordinates with cybersecurity experts from the network control and DIN NIA 27 committees. It will be necessary to implement practical solutions to these security challenges during the forthcoming market ramp-up phase.

The Charging Infrastructure Development Roadmap is described in detail in a separate publication produced by Working Group (WG) 3. The roadmap consists of the following elements:

- A vision for 2020 based on the systemic approach
- A review of data transparency throughout Germany’s public charging infrastructure compared to other countries around the world
- Estimates of charging infrastructure requirements up to 2020, based on the electric vehicle market evolution scenarios
- Recommendations for policymakers and business regarding both the financing of the required charging infrastructure and the content of guidelines for charging infrastructure development

### 3.1.4 Regulation and standardisation

Standards are key to opening up the electric mobility market. They ensure interoperability for users and provide a stable environment for investing in vehicles and charging infrastructure. Standards guarantee safety and security, quality and efficient use of resources, and likewise provide a basis for the implementation of new electric mobility innovations in the future. They act as a framework for the development of solutions in the market. Moreover, international standards and regulations ensure that electric vehicles can be easily charged anywhere in the world.

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#### Data security and data protection for user and vehicle data

#### Standardisation of mobility cards

#### Standardisation of connectors and sockets

#### Standardisation of vehicle-to-grid communication

Guaranteeing high-voltage safety of the battery and high-voltage systems on board vehicles

#### Standardisation of contactless inductive charging

#### Authentication and payment for vehicle charging

#### Metering to record quantity of electricity used during charging
As far as charging electric vehicles abroad is concerned, the NPE strives to establish the Combined Charging System (CCS) as the standard international system for both normal and fast charging. The CCS is based on open, universal standards for electric vehicles. It combines AC charging up to a maximum of 43 kilowatts with fast DC charging up to a maximum of 200 kilowatts. Moreover, single systems have the potential to achieve figures of up to 350 kilowatts in the future. The CCS charging stations currently on the market provide DC charging of up to 100 kilowatts.

In addition to the connectors and sockets, the CCS also incorporates all the control functions, as well as handling communication between electric vehicle and infrastructure. As such, it provides solutions for all the relevant charging scenarios.

The key elements of the Combined Charging System are as follows:

- **AC charging**
  - using an AC charging electrical interface for power transmission – including safety signalling – that complies with international standard IEC 61851-1
  - using Type 2 connectors that comply with international standard IEC 62196-2

- **DC charging**
  - using a DC charging electrical interface for power transmission – including safety signalling – that complies with international standard IEC 61851-23
  - using Combo 2 connectors that comply with international standard IEC 62196-3

- The communication interface between the electric vehicle and the charging station, which is based on international standard ISO 15118

In principle, electric vehicles fitted with a Combo 2 charging socket provide customers with access to all current AC Type 2 and DC Combo 2 charging points, as illustrated in Figure 12.

The charging stations that are illustrated generically in Figure 12 can in principle exist in the following configurations: AC-only charging stations, combined AC/DC charging
stations or DC-only charging stations. These basic design configurations are shown in Figure 13.

It is important to remember that not all vehicles and charging stations will support all of these configurations.

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**The German Electric Mobility Standardisation Roadmap – Version 3.0**

In parallel to its other activities in the field of regulation and standardisation, the NPE is also continuously working on the German Standardisation Roadmap. Version 3.0 will be published together with the NPE’s Fourth Progress Report at the end of 2014. The German Electric Mobility Standardisation Roadmap sets out Germany’s standardisation strategy whilst also serving as a global discussion paper for promoting international cooperation on electric mobility with countries such as the US and China.

Version 3.0 of the German Standardisation Roadmap will provide active support for the market ramp-up phase. The recommendation to develop common standards for “high-quality services” – e.g. in the fields of authorisation, billing, load management and feeding electricity back into the grid – continues the standardisation work that has been carried out to date whilst also continuously developing the holistic approach with the aim of creating an integrated system.

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**Europe**

One significant outcome of the NPE’s work is the adoption of the CCS in Europe thanks to the EU Directive on the “Deployment of Alternative Fuels Infrastructure”. The Directive contains a binding requirement to use the Combined Charging System CCS for public charging points. The CCS, in conjunction with Type 1 connectors for AC charging and Combo 1 connectors for DC charging, is also set to be adopted as the standard in the US. Negotiations are currently ongoing with China, Japan and other partners in the hope of convincing them to adopt the CCS in order to establish a global standard. It will also be necessary for industry and government to continue to work closely together.

Germany will have completed the transposition of the EU Directive into national law by the beginning of 2015. The Combined Charging System infrastructure is then to be built as rapidly as possible based on the provisions of this new legislation. It is therefore...
necessary to ensure that the required financing arrangements are in place. During the pre-market phase, the principal focus of standardisation work at both the policy and the technical level was to enable AC and DC charging using the Combined Charging System. Now that the EU Directive has come into force, this priority goal has been successfully delivered. Nevertheless, we will continue to support future developments in this area and make sure that the necessary actions are taken. This will include, for example, support to ensure that the CCS is widely publicised and implemented, both nationally and globally.

United States
Since 2013, Europe and the United States have been negotiating a Transatlantic Trade and Investment Partnership (TTIP). The successful conclusion of this free trade agreement is particularly important to Germany's automotive industry. The idea is to boast new technologies that have not yet been launched and thus to penetrate the US market. The German Institute for Standardisation (DIN) is therefore working hard to promote international cooperation on technical regulations. Given the fact that ISO and IEC standards are not widely accepted in some parts of the US, DIN is also seeking to cooperate directly with US actors such as the Society of Automotive Engineers (SAE). The joint development of the Combined Charging System CCS is one example of this cooperation. The US and Europe already use the same control mechanisms, however, connector types are slightly different – the European system is based on Type 2 connectors, while the US system uses Type 1 connectors. Drawing on DIN SPEC 70121, the Americans have incorporated the European communication interface requirements for vehicle charging into SAE specifications J2847 and J2931. Since work on ISO 15118 is also being carried out in pursuit of the same goal, the adoption of a standard communication interface can be expected in the not-too-distant future.

The Sino-German EV Charging Project
If electric mobility is to become successfully established, it will be essential for different countries around the world to share their experience. This is especially true of cooperation with regard to charging infrastructure. As a result, several different cross-border partnership projects have already sprung up. One particularly notable example is the Sino-German EV Charging Project which is funded by the German and Chinese governments. The project, which is coordinated by the Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ), aims at developing effective solutions for private and public electric vehicle charging. It addresses a broad spectrum of topics, from customer requirements, technical standards, installation processes and energy questions to regulatory aspects and potential business models. For the first time, private users in China are participating in the development of charging systems together with scientific and business actors from the automotive and energy industries and other sectors. The automotive manufacturers involved in the project include Audi, BAIC, BMW, Brilliance, Changan, Daimler, Denza, Volkswagen and ZINORO. The research and implementation partners are Tsinghua University, CATARC, TÜV Rheinland and the Spiegel Institut. The project was officially inaugurated by Federal Chancellor Angela Merkel and the Chinese Minister of Industry and Information Technology in July 2014.
China
In 2013, the German and Chinese governments signed an agreement to strengthen their cooperation in the field of electric mobility. The first step in this new partnership involves comparing the German and Chinese standardisation roadmaps in order to identify common ground and areas with potential for harmonisation. The outcomes of this analysis will be further developed at both the strategic and technical levels before being implemented. The associated standardisation work will primarily be carried out by the German-Chinese electric mobility sub-group that was established in 2011. This group brings together numerous experts to work on a wide variety of standardisation initiatives. Some partial successes have already been achieved with regard to the harmonisation of AC charging. Awareness-raising and discussion of the CCS also forms part of this regular dialogue with China.

Japan
The German and Japanese governments have created a structure that includes representatives of German and Japanese industry bodies and standardisation committees in order to facilitate a dialogue regarding the harmonisation of the DC fast charging components of the European CCS and Japanese CHAdeMO systems. The discussion centers on potential ways of bringing the two DC charging standards closer together, as well as other harmonisation requirements. The results of this work will initially be set out in a joint roadmap prior to their subsequent implementation.

The Combined Charging System provides a global approach to charging interface standardisation. Figure 14 illustrates where things currently stand in terms of charging interface standardisation and identifies potential areas for further harmonisation.

Figure 14: Overview of charging interface standardisation internationally
3.1.5 Information and communication technology (ICT)

The main challenge and priority in this area is to develop technical solutions that make customers’ experience of accessing the public and semi-public charging infrastructure as simple and comfortable as possible and above all provide them with the fullest possible coverage. According to the experts, successful delivery of this goal will have a significant impact on users’ long-term acceptance of electric mobility.

The key factor as far as users are concerned is the ability to use whatever means of authentication they possess to charge their vehicle at any charging station in Germany or abroad. From the mobility service provider’s perspective, there may therefore be advantages in not having to sign separate contracts and build separate interfaces for every single charging station operator. The use of roaming platforms and bundlers reduces the number of interfaces and contracts required and also reduces the costs for charging station operators who wish their stations to be available to all users.

In 2011, the German charging station landscape was still characterised by a large number of competing standalone solutions, the majority of which could not be used by customers of other providers. In practice, this severely restricted the user-friendliness of electric vehicles. The introduction of roaming platforms allowed charging station operators to reduce the entry barriers to the use of the public and semi-public charging infrastructure, making it possible for customers to charge their electric vehicles throughout Germany’s different regions. The network that now links the showcase regions demonstrates that there are no technical barriers to connecting different roaming platforms to each other. Furthermore, the availability of remote activation mechanisms means that in addition to contract-based charging it is now also possible for customers to charge their electric vehicles on a pay-as-you-go-basis.

As a result, it is already possible today for customers to drive e.g. from Berlin to Munich using either a single contract or simply paying as they go, charging their vehicle and making their payments at charging stations belonging to several different providers. The necessary technology is already available on the market and is being used even outside of the showcase regions. Accordingly, the development of future networks
Progress Report 2014
Review of progress to date

Roaming between the showcase regions

There are various initiatives to test and develop billing and authentication processes that can be used across different showcase regions. These include projects such as “Connected eMobility Services for B2B customers (VeMB)”, “Combined Charging System: Development and Demonstration of Rapid Charging Systems – CCS Berlin” and “Technik, Umsetzbarkeit, Akzeptanz der DC- Ladung auf der Kernachse A9 (München – Nürnberg – Leipzig) [Technology, Feasibility and Acceptance of DC Charging on the A9 Major Trunk Road (Munich – Nuremberg - Leipzig)]”. These projects include the deployment of cross-provider roaming-enabled systems.

Several different roaming platforms that provide a networked charging infrastructure already exist. However, a solution for integrating large numbers of discrete roaming platforms once the showcase regions have expired has not yet been developed. In practice, it has become apparent that pay-as-you-go offers an attractive alternative billing method to contract-based EV charging. There are a number of different pay-as-you-go methods, including credit card payment via mobile apps and payment using NFC (Near Field Communication).

Since the technical feasibility of roaming platforms has already been demonstrated, market forces and competition for customers can be expected to ensure their ongoing development.

As long as the market shows signs of providing simplified customer access to different charging infrastructure systems in the not too distant future, there will be no need for government intervention to regulate the roaming system. At present, there is nothing to suggest the emergence of a monopoly in Europe, since both national and international roaming platforms are open to all providers as well as being networked with other European roaming platforms. Moreover, public charging points are increasingly providing pay as you go facilities.

In order to ensure the success of electric mobility over the medium term, it will be necessary to continue working to maximise the customer-friendliness of public charging points and minimise the restrictions on their use.

NPE recommendation on ad-hoc charging:

- As of mid-2015, newly built charging infrastructure will be designated “publicly accessible”, making it available for ad-hoc use by customers. Ad-hoc use refers to spontaneous, open system charging using a medium that enables access to charging and (where relevant) suitable payment options directly at the charging station (e.g. mobile phones or smartphones, special charging cables, parking tickets, card terminals, etc.).
- The NPE recommends that the existing public charging infrastructure should be upgraded with ad-hoc charging functionality as rapidly and cost-effectively as possible. If necessary, the relevant hardware should be replaced.
- There is nothing to prevent a charging station from having other types of access in addition to ad-hoc access.
- In the event of RFID cards or mobile points of sale being used for access, the NPE recommends that the individual mobility service providers should sign agreements...
with each other or via roaming platforms in order to provide customers with nationwide e-roaming.

Various different alternatives exist as far as the organisation and structure of the roaming platforms is concerned. Essentially, however, there are two basic platform types that can be used to create a wide range of different hybrid systems. Several different platforms are currently competing in Germany. Although they all have different organisational structures, this does not affect or impede their interoperability from a technical perspective.

**Platform type A** is characterised by a single contractual framework for all participating operators, thereby enabling unrestricted, cross-provider use of the charging infrastructure belonging to all of the charging station operators that have signed up to the platform. All the mobility service providers are contractually required to comply with the same technical and commercial minimum standards and all of them charge the same basic price. However, they can differentiate based on the type of charging infrastructure they provide (AC or DC), and may also negotiate bilateral discounts with other mobility service providers.

**Platform type B** functions as a data hub without stipulating the commercial relationships between the individual market players. The platform contract merely specifies the minimum requirements with regard to data quality, query cycles or role definitions, for example. There is thus no contractual obligation between the individual market players themselves – it is up to them to conclude bilateral agreements with each other.

Which of these organisational structures eventually prevails in the market remains to be seen over the course of the next few years and will depend on a number of economic and practical considerations. Ultimately, the most important thing as far as the end customer is concerned is a system that is easy and comfortable to use in an everyday context.
From an ICT perspective, it will be important to ensure the use of a standard Europe-wide classification system, e.g. for provider and operator IDs or the minimum attributes to be exchanged. This will be a key requirement for trouble-free cross-border charging. It would therefore be advisable to define standard use cases in order to facilitate cross-provider usability of the charging infrastructure. These would include, for example, standard information procedures in the event of a charging point being closed down or moved to another location.

On the grounds of both quality and cost, it is recommended that open, European Business-to-Business (B2B) platforms (data hubs) should be employed in order to provide end customers with a Europe-wide e-roaming service for the public charging infrastructure. Common communication and quality standards will send a positive signal to investors, government and the end users of electric vehicles. The NPE recommends further standardisation of technologies and services, as well as non-discriminatory access for both providers and users.

### 3.1.6 Energy and environment

Electric mobility can make a significant contribution to cutting CO₂ emissions from transport and ending our dependency on fossil fuels. As such, it is a crucial element of Germany’s energy transition. The systemic deployment of electric mobility can also make a lasting contribution to the implementation of the energy transition in the electricity industry. Firstly, the direct use of locally self-generated electricity – for example from domestic solar panels – is principally possible, without needing to feed it into the public grid. Secondly, the deployment of controllable smart charging infrastructure will allow electric mobility to help balance out future smart grids. This can be achieved by resorting to a load shifting system: Electric vehicles are charged at times when much renewable electricity has been fed into the grid or when charging EVs can help to reduce a local grid overload.

Even with Germany’s current electricity mix, electric vehicles boast a climate advantage.
However, in order to leverage the benefits even further it will be necessary to add more renewable energy to the mix. In other words, rather than charging electric vehicles with renewable electricity that has simply been diverted from other uses, additional renewable electricity must be generated to power them.

The main focus of the “Energy and Environment” category is to ensure optimal deployment and integration of renewable energy into electric vehicle charging systems. Successful implementation of the different priorities is heavily dependent on a number of regulatory issues and energy law questions. Accordingly, several different initiatives have been launched both in some of the showcase regions and in a variety of additional projects.

Another priority for the “Energy and Environment” category is to ensure that electric vehicles are properly integrated into the new energy system landscape that will result from Germany’s energy transition. A number of research projects running until 2016 will be carrying out in-depth studies aimed at developing load management strategies. Field trials are also being conducted in parallel, in order to explore ways of integrating electric vehicles into decentralised energy management systems (smart homes). To this end, it will also be necessary to develop business and data processes suitable for the mass market, possibly define incentive mechanisms, and discuss and enhance the underlying framework.

| The world’s first active house was built in Stuttgart’s Weißenhof Estate as part of the “LivingLab BW mobil” showcase project. The active house produces twice as much renewable electricity as it needs for its own consumption. The surplus electricity is used to power two electric cars and the Weißenhof Museum. Both energy production and consumption as well as other building research data are being continuously recorded throughout the project’s lifetime and analysed by researchers at the University of Stuttgart. | B10 Aktivhaus Plus Stuttgart |

### 3.1.7 Urban planning and intermodality

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<td>Amendments to regional planning regulations and the Town and Country Planning Code</td>
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<td>Installation of financial and staffing resources</td>
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<td>Integration of electric vehicles into local government housing and mobility strategies</td>
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<td>Procurement of electric vehicles by local government and local government enterprises</td>
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<td>Electric mobility as part of intermodal services and sharing schemes</td>
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<td>Amendments to road traffic regulations for parking and loading</td>
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Several German towns and municipalities have already taken the first steps towards integrating electric mobility into their local mobility and urban development strategies. The issue is steadily moving up the local government agenda, although there is still considerable variation in the scope and depth of the activities being undertaken in different parts of Germany. According to a survey of local councils published by the German Institute of Urban Affairs (Difu) in 2014, despite the existence of a number of highly engaged “pioneer municipalities”, many other towns and local authorities are still adopting a rather cautious stance. Nevertheless, the initiatives funded by the federal government have resulted in a clear and widespread increase in activity in this area, even among councils that are not actually participating in a project themselves.

The topic of electric mobility has now filtered down to local government agendas in Germany

The interest electric mobility currently meets with at local government level is demonstrated by the most recent findings of the parallel research into the “electric mobility model regions”. Four out of a total of seven thematic areas address issues directly relevant to local government actors: “Cities and Transport”, “Regulation”, “Fleet Management” and “Infrastructure”.

The principal motivation for local government action in the field of electric mobility are climate protection, local air and noise pollution control planning and the promotion of the energy transition. In addition to these factors, increasing the location’s attractiveness and improving local quality of life also play an important role. With the exception of some of the larger municipalities, the city states and a handful of smaller communities, the promotion of electric mobility is not generally regarded as a local government goal or as an economic development measure. Instead, it is seen as an integral part of developing sustainable transport systems or as factor in an efficient mobility concept. In rural areas, the motives for using electric mobility primarily involve its integration into the energy system, e.g. by using energy from solar panels or recurring to it in the field of commuter transport or for the design of new tourism services.

Electric mobility is an integral part of urban development, transport and construction project planning

Nevertheless, there are a number of barriers that often need to be overcome before measures to promote electric mobility can be actively implemented in towns and municipalities. These include inadequate financial resources, insufficient decision-making powers or policy guidelines, inadequate networking with regional actors or a lack of experience in implementing the relevant planning instruments for electric mobility integration. Legal uncertainty and regulatory requirements also play a key role. The formulation of integrated mobility strategies by towns and municipalities can address these problems and help to promote electric mobility. Some of the areas that are particularly suitable for the use of electric vehicles include intermodal and sharing-based services, but there are also opportunities elsewhere, for example cities’ internal logistics strategies and the integration of electric mobility in the construction of residential and commercial properties.
A number of federal government-funded pilot projects have been carried out in both urban and rural areas over the past few years under the auspices of the electric mobility model and showcase regions. Initiatives undertaken at local government level include (samples):

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<th>Current initiatives to integrate electric mobility into local government transport and urban development planning</th>
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<tr>
<td><strong>Aachen</strong>: Integration of electric mobility into transport development planning.</td>
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<tr>
<td><strong>Berlin</strong>: A comprehensive intermodal strategy including different vehicle rental systems as part of the “Berlin-Brandenburg” showcase project.</td>
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<tr>
<td><strong>Dortmund</strong>: Institutional networking of local actors via an “electric mobility steering committee”, local council procurement strategy, strategy for siting charging stations (SIMONE).</td>
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<tr>
<td><strong>Hamburg</strong>: strong emphasis on commercial transport and local vehicle fleets, local government procurement and integration into the local public transport system (Wirtschaft am Strom, e-Quartier).</td>
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<tr>
<td><strong>Mecklenburg-Western Pomerania</strong>: Electric bus service combined with pedelec rental system for local services and tourism (INMOD).</td>
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<tr>
<td><strong>Leipzig</strong>: “Stromticket” (e-charging ticket) fashioned after the model of local public transport smartphone tickets.</td>
</tr>
<tr>
<td><strong>Stuttgart</strong>: Regional, cross-sectoral strategy for networking passenger and goods carriers, including comprehensive charging infrastructure.</td>
</tr>
<tr>
<td><strong>Saxony</strong>: Adaptation and expansion of existing urban/local development project in Markkleeberg to provide 100% electric bus service.</td>
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<tr>
<td><strong>Lower Saxony</strong>: Integration of individual components to create a comprehensive mobility service known as the “mobility card”.</td>
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In order to encourage more widespread adoption of electric vehicles, it is necessary to integrate the individual elements of electric mobility into urban development, transport and construction project planning, ideally in conjunction with (smart) mobility services such as e-carsharing. Electric mobility should be integrated into existing plans or local government strategies in such a way as to enable optimal delivery of targets relating to noise, CO₂ and NOx reduction and parking management. Sometimes, however, implementation can be hindered by differences in the timetables contained in the original plan and the updated version. Longer lead times are therefore necessary in order to ensure that electric mobility is effectively and comprehensively integrated into urban and transport development and mobility planning strategies.

A number of voluntary initiatives have been implemented under the existing building and planning regulations. Nevertheless, in order to maximise effectiveness it will be necessary to establish whether any changes need to be made to Germany’s Federal Building Code and regional planning regulations, and if so what form these changes should take. There is a particular need for road traffic regulations granting electric vehicles special rights – especially with regard to parking and loading – and these are therefore currently being enacted by the federal government under the Electric Mobility Act. Government support must be sought to deepen the dialogue initiated to exchange knowledge and experiences in the integration of electric mobility into local government transport and mobility planning. The wealth of experience from showcase regions and model regions could prove extremely valuable to interested municipalities and can be tailored to meet the particular needs of users in their own catchment areas.
Current trends indicate that particularly people in congested major cities are increasingly likely to use intermodal, personalised and on-demand mobility services. Mobility cards have an extremely important role to play in this scenario. They make it simple to use different mobility services at short notice – e.g. local public transport and electric vehicle carsharing – by storing all the necessary information on the different transport options in a single place and making it easy for customers to book and pay for their journeys.

In addition to overcoming the technical challenges involved in creating a single, centralised access medium for a wide range of different mobility services, a well-designed implementation is essential for the success of mobility cards. This will ensure that all the different mobility service providers participate in the mobility card scheme. It is of fundamental importance to resolve important questions regarding customer data protection and financing models to the satisfaction of all the participants. Existing mobility card schemes should be kept adjustable to allow the adding of new mobility services at a later date.

The following publications were published in 2014 under the auspices of the electric mobility model regions:

- Elektromobilität in der Stadt- und Verkehrsplanung (Electric Mobility in Urban and Transport Planning)
- Elektromobilität in Kommunen – Handlungsleitfaden (Electric Mobility in Local Government – Practical Guidelines)
- Genehmigungsprozess der E-Ladeinfrastruktur in Kommunen (Licensing Procedures for E-Charging Infrastructure at Local Government Level)
- Öffentliche Ladeinfrastruktur für Städte, Kommunen und Versorger (Public Charging Infrastructure for Cities, Municipalities and Providers)

Other publications currently in preparation include the brochure “Elektromobilität im städtischen Wirtschaftsverkehr – Chancen und Handlungsspielräume in den Kommunen” (Electric Mobility in Urban Commercial Transport – Opportunities and Options for Local Government), the report containing the results of the 2014 Difu survey of local councils “Elektromobilität in Kommunen” (Electric Mobility in Municipalities) and a set of practical guidelines for local government strategies and planning instruments.

A nationwide survey of local councils carried out in early 2014 by the German Institute of Urban Affairs (Difu) on behalf of the federal government found that the topic of electric mobility has now moved right up the local government agenda in Germany. The vast majority of local councils are already working on integrating electric mobility into their strategies, have at least one electric vehicle in their council fleet – or intend to acquire one in 2014 – and/or have already built at least some charging infrastructure. Most of the respondents did not perceive electric mobility “as an additional burden”, seeing it instead primarily as a “climate-friendly, green means of transport” and “a strategic area that affects society as a whole”. Local authorities believe that electric mobility has particular potential in the fields of noise pollution mitigation and climate protection. They also saw it as a way of improving the image of the areas under their control.
3.1.8 Education and training

The growing importance of electric mobility and the associated construction and upgrading of the necessary infrastructure are posing new challenges with regard to the training of qualified personnel. Training for the relevant skilled professions – e.g. in the motorcar, cycle and bicycle and electrical trades – has already been modified to incorporate the necessary content on electric mobility. Good progress has also been made with regard to the development and modification of continuing professional development (CPD) provision geared towards updating the knowledge of skilled workers in industry, the relevant trades and small and medium-sized enterprises. To ensure that people continue to acquire the required skills in this area in future, it will be necessary to provide additional investment in order to address the projected high demand for suitable facilities at educational establishments, especially inter-company vocational training centres. The federal government-funded programme “spannende Ausbildung” (Exciting Training) represents a successful first step towards delivering adequate facilities and validating the training content. In 2013, a total of five million euros was thus allocated to inter-company training centres throughout Germany.

In the field of academic education, new content relevant to electric mobility has already been incorporated into existing engineering courses in areas such as automotive engineering, mechanical engineering, electrical engineering and information technology. A sound basis has thus already been established for the provision of appropriate education and training in order to secure an adequate supply of new graduates and ensure the continuing development of skilled workers. Increasing numbers of specialised Master’s courses can be found, either in the shape of separately accredited courses or in a structured modular format.

Notwithstanding the progress achieved with regard to basic academic education, there remains an urgent need for postgraduate CPD provision for engineers in the field of electric mobility. Although some universities of applied sciences are already offering in-service Master’s courses, the more traditional universities currently lack any relevant provision. Consequently, there is still much work to be done in this area.
One of the aims of the showcase regions is to highlight outstanding education and training programmes that are potentially transferable. The first initiatives have been rolled out primarily in the field of vocational training and CPD, although some projects are designed for academic education.

In addition, the project "Netzwerk Qualifizierung Elektromobilität" (NquE – Network for Electric Mobility Education and Training) aims to improve networking between the relevant actors in different industries. The project plans to identify best practice examples based on a review of current electric mobility education initiatives in the fields of vocational and academic education and CPD in Germany. To this end, specific criteria have been developed in consultation with education and industry experts that will initially form the basis of a survey. The issues to be addressed include process reliability, consistency of goals and content, innovativeness and certification, target group requirements, use of different methods and media, active and process-based learning, sustainability, innovation and the equipment of educational establishments.

A more in-depth study of the education and training measures thus identified will subsequently be carried out in order to confirm the classification as best practice. The documentation of the most outstanding education initiatives will be posted on the project website which is due to go online at the end of 2014 (www.nque.de). This will enable best practice standards for education to be set, and help to promote networking between the relevant actors in different industries. The project will be complemented by the Conference on Electric Mobility Education, to be held on 23 and 24 February 2015, where all the topics described above will also be addressed. The conference participants are to identify any gaps in current education and training provision and develop possible solutions. They will also be asked to highlight problems regarding the interfaces between study courses so that new solutions can be created to facilitate switching between courses. The NPE will use the outputs of this process to inform the ongoing development of its Competency Roadmap.

The DRIVE-E programme offers students the opportunity to learn about the different aspects of electric mobility in a systematic and creative manner. DRIVE-E aims to inspire young people to research new technologies and develop innovative solutions. The DRIVE-E Academy provides students with an insight into this seminal field through lectures, workshops and field trips. The most innovative papers, projects and theses are awarded the DRIVE-E prize.
3.2 Showcase regions electric mobility

In April 2012, the federal government selected four German regions as “showcase regions electric mobility”. The German parliament subsequently passed a bill for the promotion of R&D into alternative power-train systems within these regions. 90 projects combining a total of 334 individual initiatives are currently being funded in the showcase regions. The Federal Government’s financial contribution amounts to approximately 157 million euros.

A range of large-scale regional demonstration and pilot projects are being carried out in order to test the operation of electric mobility at the interface between the energy system, vehicles and the transport system. High public visibility of individual projects is intended to raise awareness and increase the citizens’ acceptance of practical electric mobility applications. The projects provide a clear demonstration of the positive impacts that electric mobility has on the urban environment and transport system. The showcase regions are being implemented in conjunction with the “electric mobility model regions”. The parallel research commissioned by federal government for the showcase regions electric mobility is also required to incorporate findings and information from the model region projects. A comprehensive central data monitoring function collates the outputs of all the research projects funded by the central and regional governments. The showcase regions will therefore make an important contribution to highlighting Germany’s profile as a leading supplier in the field of innovative (vehicle) technology and converting this technology into marketable products and systems. Moreover, the specific measures proposed with regard to underlying factors such as standardisation, technical training or essential amendments to administrative and statutory regulations will also help pave the way towards an international lead market.

- Intermodality and multimodality (transport strategies combining different means of transport such as local public transport, cars and pedelecs)
- Infrastructure and IT-based networking (charging method and business model trials)
- Smart grids (charging strategies, integration with electricity grids, grid load, connection of electric mobility with the buildings sector), production of energy storage devices
- Commercial transport (commercial vehicles, fleet and charging management, CO₂ reduction and noise control, new logistics strategies)
- Local public transport (charging and power transmission technologies for electric buses)
- Carsharing (technical aspects and business models)
- Education and training (vocational and academic)
- Public relations
**Showcase region electric mobility Berlin-Brandenburg**

With some 30 projects, more than 100 partners and project funding to the tune of around 90 million euros, this showcase project – which includes electric vehicles, commercial vehicles and pedelecs from almost every manufacturer – is in full flow. In total, 1,800 electric vehicles are on the road. The e-carsharing fleet alone comprises more than 400 electric cars, while couriers and parcel services are using electric vans and delivery bikes for deliveries. Battery-powered vehicles are being used for waste collection and welfare services are testing electric cars for every-day use.

Meanwhile, the largest 100% electric truck approved for use on public highways anywhere in the world is delivering goods around the city. An electric bus service featuring inductive charging runs between Berlin’s Zoo and Südkreuz railway stations, the latter being converted into a multimodal “station of the future” using renewable energy. A “micro smart grid” and wind power load management system are being tested. Significant numbers of both AC and DC charging points are being added to the public charging infrastructure. The appropriate education and training is being provided through a “mobility driving school”, together with training and CPD measures in the automotive and electrical trades.

*For more information, visit [www.emo-berlin.de](http://www.emo-berlin.de)*

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**Showcase region electric mobility Baden-Württemberg: LIVINGLAB BWmobil**

More than 100 partners from industry, the research community and the public sector are involved in Baden-Württemberg’s showcase region LivingLab BW² mobil. The 37 individual projects in the Stuttgart region and the city of Karlsruhe have a total budget of around 110 million euros and are funded by the federal government, the government of the state of Baden-Württemberg and the regional government in Stuttgart. To date, the various projects have succeeded in putting more than 1,000 electric vehicles onto the road and building around 800 charging points.

The nine thematic areas are: intermodality, fleets and commercial transport, energy, infrastructure and ICT, electric mobility at home, urban and transport planning, vehicle technology, communication and participation and education and training. Together with research at the overarching project level, these thematic areas provide targeted coverage of the entire electric mobility system. In tandem with the leading-edge cluster Elektromobilität Süd-West, LivingLab BW² mobil has created a dynamic innovation process in Baden-Württemberg.

As well as providing the public with a visible demonstration of how electric mobility can be successfully implemented in everyday scenarios, the LivingLab BW² mobil projects have also highlighted areas where further research and development is required both in terms of technology as of the underlying conditions in which it is deployed.

*For more information, visit [www.livinglab-bwe.de](http://www.livinglab-bwe.de)*
In Bavaria and Saxony, some 40 projects involving more than 100 partners are investigating the issues of long-distance mobility, urban mobility, rural mobility, international mobility networks and training and CPD. Thanks to funding from the federal government and the state governments of Bavaria and Saxony, the first results of these projects can already be seen on the streets. In 2014, for example, a network of CCS fast charging stations was installed and opened along the A9 motorway, whilst work also began on the construction of an “Energie-Speicher-Plus-Haus” (energy storage plus house). Around 3,000 electric vehicles are on the road in Bavaria and Saxony. In addition to the use of electric vehicles by local waste disposal, delivery and bus services (from 2015), several hundred electric cars have been acquired by carsharing schemes, company vehicle fleets and other commercial and private multipliers. Future technologies as batteries, power electronics, renewable energy or smart grid control are crucial parts of a synergetic system. A car dealership, for instance, is testing a solar system combined with a puffer storage to charge around 30 rental cars. The project’s findings are being communicated to schools, companies and higher education institutions through training and CPD provision.

For more information, visit www.elektromobilitaet-verbindet.de

The Hannover-Braunschweig-Göttingen-Wolfsburg metropolitan region is promoting electric mobility as part of a sustainable transport and energy policy. A number of companies located in the region are involved in the development and manufacture of vehicles and components for the global market. A significant increase is also being targeted in the number of electric vehicles in everyday use on the region’s roads. By the beginning of September 2014, around 1,700 fully electric vehicles had been registered in the metropolitan region, which has a total population of 3.8 million. Some 80 municipal and district authorities and local government enterprises are currently adding electric cars to their fleets as part of the electric mobility showcase project. Buses fitted with inductive charging technology, electric motorcycles in tourist regions and a fast cycle lane for electric bicycles are good examples of the range of different electric mobility initiatives that exist within the metropolitan region. Germany’s most northern showcase region is also placing particular emphasis on the production and storage of renewable energy for charging electric vehicles. In addition, the impact of electric mobility on the labour market is being investigated and the relevant training and CPD provision is being developed.

For more information, visit www.metropolregion.de/emobil
4 Market ramp-up

Number of electric vehicles
From 2014 to 2020

Number of public charging points
From 2014 to 2020
Based on current knowledge and projections, there will be around half a million electric vehicles on Germany’s roads by 2020. The NPE believes that in order to achieve the target of one million electric vehicles, it will be necessary to modify the current conditions. In addition to the introduction of a special depreciation allowance for business users and the removal of barriers to the everyday use of electric vehicles – such as those encountered by workplace charging facilities – the NPE also recommends the construction of approximately 70,000 public AC charging points and 7,100 public DC charging points by 2020. The NPE also believes that additional R&D will be required in order to become the world’s leading supplier.

### 4.1 Goals

Looking ahead to the forthcoming market ramp-up and mass market phases, the NPE remains firmly committed to the goal of making Germany the world’s leading supplier and lead market and putting one million electric vehicles on the road by 2020. This goal has huge economic significance and was reaffirmed in the coalition agreement between the CDU, CSU and SPD in December 2013. The market ramp-up phase from 2015 to 2017 will therefore be key to the rapid growth of the electric mobility market.

In order to achieve the goal of becoming the international lead market, the following issues will need to be addressed as a matter of priority during the forthcoming market ramp-up phase (see Figure 20):

- Development of the electric vehicle market
- Creations of favourable preconditions
- Coordinated establishment of a functional and need-based charging infrastructure
- Research and development based on the Systemic Roadmap and technology roadmaps

**Figure 20:** Target curve for market evolution 2010–2020 (incl. priorities for market ramp-up phase)
4.2 Forecasts

In order to obtain an accurate panorama of likely future developments, the Fraunhofer ISI produced a range of electric vehicle market evolution scenarios for the NPE in 2013. Whilst these were based on previous NPE simulations, they also incorporated more recent findings from user studies. The Fraunhofer ISI’s Total Cost of Ownership (TCO) model provides a basis for forecasting future charging infrastructure requirements. These were calculated in a study carried out for the NPE in 2014 by the German Association of Energy and Water Industries (BDEW) and A.T. Kearney.

4.2.1 Forecasting the market evolution of electric vehicles

According to the Fraunhofer ISI study, even today electric vehicles could already be the most cost-effective option for customers with high electric driving shares and high annual mileages – and this will apply to even more people in the future. The study confirms the NPE’s previous projections – in the “medium scenario”, which is considered the most realistic based on current experience and knowledge, the electric vehicle market will comprise around 500,000 vehicles by 2020.

Based on the current status, the electric vehicle market will comprise around 500,000 vehicles by 2020.

Figure 21: Market evolution scenarios (Total number of electric vehicles)

Assumptions: affordable infrastructure costs, limited vehicle availability and willingness to pay a premium (year-end figures) including uncertainty range.

The NPE considers that the common goal of one million electric vehicles cannot be achieved without changes in the underlying conditions. Purely commercial fleets and company cars – which account for around 60 percent of the new car market – are a particularly promising area. The driving profiles of these vehicles often feature predictable routes, while purchase decisions are heavily influenced by cost-effectiveness. According to the Fraunhofer ISI’s calculations, the introduction of a special depreciation allowance would therefore constitute a cost-effective instrument for delivering the desired results, although the effectiveness of such a measure would depend on when it was introduced.
In contrast to the NPE’s previous assumptions, all of Fraunhofer ISI scenarios indicate that the market share of PHEV/REEV models is likely to grow compared to other power-train technologies. By 2020, they are now expected to account for about three-quarters of all electric vehicles in Germany (in 2010, the NPE projection was just 55 percent). BEVs are expected to dominate the small cars market up to 2020 owing to the typically lower mileages of this type of vehicle. However, the higher annual mileages of medium-sized and luxury cars mean that this market will mainly consist of PHEVs and REEVs.

This change in the market evolution scenarios compared to previous forecasts has direct repercussions on the expansion of the charging infrastructure, since a higher proportion of PHEVs and REEVs will reduce demand for public charging infrastructure.

4.2.2 Forecasting charging infrastructure requirements
As illustrated in chapter 3, the charging infrastructure will play a decisive role for the achievement of the goal of one million electric vehicles. In its Second Report, the NPE recommended that rather than rushing into expanding the charging infrastructure, a functional, market-based approach should be employed to best meet the necessary demand. This means aligning to customer benefits and the increase in vehicles in an approximate ratio of one public charging point to every ten electric vehicles. It will thus be necessary to find economically viable solutions whilst at the same time also supporting the market ramp-up. A basis for future action is provided by the study on charging infrastructure requirements carried out for the NPE by the BDEW and A.T. Kearney. This study was based on the market evolution scenarios described above. Although the NPE currently believes the “medium scenario” to be the most realistic, a conscious decision was taken to use the “pro-EV scenario” in order to obtain a more accurate forecast of the charging infrastructure requirements for one million electric vehicles.
The study’s key findings are as follows (see Figure 23):

- In 2020, 85 percent of the required charging infrastructure will be in the private domain, a further ten percent will be in the semi-public domain and only five percent of the total charging infrastructure – i.e. 70,000 AC charging points – in the public domain.
- In the same scenario, it is forecast that 7,100 fast charging points will be required. This is in keeping with the forecast contained in the NPE’s Second Report in 2011.
- Even in the event of high demand, there is little realistic prospect of the public charging infrastructure being run profitably in the period up to 2020, since the specific full cost per kWh for this type of charging point is about twice as high as for domestic charging points, for instance.

If the charging infrastructure is expanded in line with demand, the following use case scenarios might be expected to emerge on the market:
A total requirement of approximately 300 DC fast charging points was forecast for the first 100,000 electric vehicles. 600 CCS charging points are currently being planned as part of the SLAM research project (see Infobox on page 54). Around 60 CCS charging points are already in use in the showcase regions of Bavaria, Saxony, Berlin, Brandenburg and Lower Saxony. A further 200 or so charging points that use different charging systems (Tesla, CHAdeMO) are likewise in operation.
4.3 Required actions

In order to become the international lead market, it will be necessary to create an electric mobility system that incorporates vehicles, energy supply and transport infrastructure and is both attractive and visible to users. Thanks to its Systemic Roadmap, Germany is well on the way to meeting its objective. Nevertheless, the most realistic current market evolution scenario indicates that – despite the existence of technologically attractive products, services and solutions – additional measures are still required if the goal of one million electric vehicles is to be achieved. If existing hurdles are swiftly removed, effective monetary and non-monetary incentives are introduced and the charging infrastructure is expanded in a functional, need-based manner, it should still prove possible to meet the original target of getting one million electric vehicles on the road in Germany by 2020. In contrast to the last Progress Report in 2012, we now have a greater wealth of experience and data with regard to user behaviour which can be used to make targeted changes to the underlying conditions. The next step is therefore to roll out this targeted set of measures. Failure to meet the target of 500,000 vehicles by the end of 2017 would result in the need for extremely costly measures in order to deliver the goal of one million vehicles by 2020. The 2013 coalition agreement announced a number of incentives for EV users. In order to achieve the goal of supply leadership and build a lead market, the NPE recommends that the following measures be taken during the forthcoming market ramp-up phase:

<table>
<thead>
<tr>
<th>Lead market goal</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Introduction of a special depreciation allowance for business users (amounting to an annual loss in tax revenue of around 0.2 billion euros).</td>
</tr>
<tr>
<td>2. Rapid implementation of the set of legislative measures for promoting electric mobility.</td>
</tr>
<tr>
<td>4. Implementation of the EU directive on alternative fuels, including the expansion of the charging infrastructure in accordance with the recommendations of the Standardisation Roadmap Version 3.0.</td>
</tr>
<tr>
<td>5. Roll out of private and public procurement initiatives.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Leading supplier goal</th>
</tr>
</thead>
<tbody>
<tr>
<td>6. Continuing research and development into new topics and securing its funding through Federal Government support (public funding of approx. 360 million euros p.a.).</td>
</tr>
<tr>
<td>7. Joint research into and promotion of the establishment of a cell manufacturing facility in Germany.</td>
</tr>
</tbody>
</table>

4.3.1 Providing the right market incentives for electric vehicles

Some market incentives are already featuring in the government’s electric mobility programme. These include an extended road tax exemption for fully electric vehicles, measures to counteract the tax disadvantages for users of electric company cars and a legislation allowing transferable licence plates. Nevertheless, further targeted measures will be required in order to drive the market ramp-up.
These actions include the introduction of a standard vehicle labelling system, together with special access and parking regulations for electric vehicles. Electric vehicle procurement programmes should also be rolled out for both public and commercial fleets. In 2012, for example, the federal government launched an initiative to ensure that more than ten percent of its new vehicle purchases are eco-friendly models. A guideline on the acquisition of electric and hybrid vehicles was published to support the implementation of this initiative. In addition, some companies are rolling out their own actions in this area (see the example in the Infobox).

Some companies are already setting ambitious targets for their fleets. One such example is the CO₂-neutral mobility strategy known as “SAP E-Fleet”. The software company SAP is aiming to cut its CO₂ emissions to its 2000 level by 2020. To this end, SAP is planning to replace at least 20 percent of its company car fleet with electric vehicles over the course of the next six years. Assuming that the overall company car fleet size remains at current levels, it would then be containing over 4,000 electric cars by 2020. SAP is taking active measures to encourage its employees to switch to electric cars. The cost of the vehicles’ batteries is paid for almost entirely by the company and it also takes advantage of the tax breaks available to employees who opt for an electric company car. In addition, the company is currently developing a management system in order to create a network of electric cars and charging stations that best meets employees’ mobility requirements.

There are two key measures promising particular efficiency in rapidly increasing electric vehicle registrations and thus accelerating the market ramp-up. These should be addressed as a matter of priority:

• The introduction of a special depreciation allowance for electric vehicles purchased for commercial purposes (50 percent depreciation allowance in the first year)
• The construction of a need-based public charging infrastructure, covering the whole of Germany and providing a user-friendly experience (see Chapter 4.3.1).

Regulations covering the following points should also be introduced:

Commercial customers

• Changes to V.A.T. law in order to counteract the disadvantages affecting private users of electric company cars
• Simplified reimbursement of electricity costs incurred by employees charging their company cars at home
• Exempting employees’ use of companies’ charging infrastructure to charge company cars from the non-cash benefit status
• Special rights and privileges for EV users – regulations for easier parking, stopping and loading
• Adaption of current weight limits for electric vehicles covered by Type B driving licences in order to compensate for their lower load capacity
Private customers

- Exempting charging of private vehicles at the workplace from the non-cash benefit-rule
- Changes to residential property and tenancy law to facilitate the installation of charging points
- Introducing the mandatory requirement of prerequisites for charging infrastructure in new and refurbished buildings into state building regulations

Depending on the progress of the market ramp-up phase, other actions to help develop the market may also be necessary:
- "KfW loans" for electric vehicles from the Kreditanstalt für Wiederaufbau (government-owned development bank)
- Extension of the motor vehicle tax exemption of PHEVs and REEVs
- Changes to vehicle tax regulations for electric vehicles

It is local authorities that determine both the setting and the pace in which electric mobility develop. In order to create a more favourable overall framework for electric mobility, the NPE therefore recommends the implementation of additional support measures at local government level:
- Electric mobility should be integrated into spatial planning strategies with the aim of increasing its visibility, for example by parking space or charging point signage
- Resources should be created and contact people appointed at local government level, for example officers for sustainable mobility
- Local government information campaigns and starter packs should be created, addressing e.g. the Electric Mobility Act, the special rights enjoyed by electric vehicles or the charging infrastructure
- Long-term sustainable mobility strategies should be developed

4.3.2 Building a need-base charging infrastructure

One of the priorities for the market ramp-up phase is to build a need-based, functional charging infrastructure. In the semi-public domain, there are a handful of vehicle charging business models that are not based on the amount of electricity sold. Semi-public charging infrastructure is expected to constitute about ten percent of the total, whereas just five percent of the charging infrastructure will be needed in the public domain, e.g. for carsharing fleets. However, very few (semi-)public charging points are as yet operating profitably.
- It is crucial to analyse traffic movements and select the best sites in order to maximise usage.
- Cost degression can be achieved by using standard hardware, this, however, requiring the production of high quantities.
- At selected sites, the charging points can be marketed either as advertising space or as a facility that adds value to car parks.
- A cost reduction pathway is required for maintenance, servicing and billing.
- Faster planning approval procedures will help cut planning costs.
- Customer loyalty and higher sales can be achieved through special park and charge offers (e.g. at retail outlets/restaurants).
- Access should be opened up – private companies’ in-house charging infrastructure could be made available to third parties during daytime and to people prepared to leave their cars to charge up overnight away from their homes.

As can be seen in the table below, the expansion of the charging infrastructure currently involves high investment and operating costs. One of the reasons is that charging points are still being manufactured in small numbers only. Also, charging points are only used a few times a day. This accounts for it having been hitherto impossible to operate them profitably with time-based charging models or models based purely on the amount of electricity sold.

<table>
<thead>
<tr>
<th>Charging technology</th>
<th>Wall box chargers (public street lights)</th>
<th>Charging point</th>
<th>Fast charging-enabled</th>
</tr>
</thead>
<tbody>
<tr>
<td>Power supply</td>
<td>AC</td>
<td>AC</td>
<td>DC</td>
</tr>
<tr>
<td>Smart meter and energy management</td>
<td>no</td>
<td>yes</td>
<td>no</td>
</tr>
<tr>
<td>Charging points</td>
<td>1</td>
<td>2</td>
<td>1</td>
</tr>
<tr>
<td>Power rating [kW]</td>
<td>3.7</td>
<td>11/22.2</td>
<td>22–50</td>
</tr>
<tr>
<td>Full charging station hardware</td>
<td>2,200 €</td>
<td>6,000 €</td>
<td>20,000 €</td>
</tr>
<tr>
<td>Communications hardware</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Billing and control software</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Installation/construction costs + connection costs if applicable</td>
<td>300</td>
<td>4,500</td>
<td>7,150</td>
</tr>
<tr>
<td>Total investment</td>
<td>2,500 €</td>
<td>10,500 €</td>
<td>27,150 €</td>
</tr>
<tr>
<td>Special use permit</td>
<td></td>
<td>150 €</td>
<td></td>
</tr>
<tr>
<td>Service costs</td>
<td>350 €</td>
<td>500 €</td>
<td>2,000 €</td>
</tr>
<tr>
<td>Communication costs</td>
<td>200 €</td>
<td>200 €</td>
<td>200 €</td>
</tr>
<tr>
<td>Metering/billing</td>
<td>375 €</td>
<td>375 €</td>
<td>375 €</td>
</tr>
<tr>
<td>IT system</td>
<td>250 €</td>
<td>500 €</td>
<td>500 €</td>
</tr>
<tr>
<td>Operating costs [€/a]</td>
<td>1,175 €</td>
<td>1,725 €</td>
<td>3,075 €</td>
</tr>
<tr>
<td>Overheads [€/a]</td>
<td>Not included</td>
<td>Not included</td>
<td>Not included</td>
</tr>
<tr>
<td>Depreciation period</td>
<td>7.5 years</td>
<td>7.5 years</td>
<td>7.5 years</td>
</tr>
</tbody>
</table>

Figure 25: Net public charging infrastructure costs (2013)

Source: NPE charging infrastructure roadmap

Notwithstanding the above, it is still necessary to expand the charging infrastructure throughout Germany in order to meet the target of 70,000 AC charging points and 7,100 DC charging points. The TCO models and the charging infrastructure development study suggest that, based on today’s technological standards, the total investment required to finance the public charging infrastructure up to 2020 will not exceed
550 million euros. This amounts to an annual investment figure of approximately 110 million euros between 2016 and 2020.

The details of how the public charging infrastructure will be financed over the next few years should be finalised as soon as possible. The conflicting expectations that exist with regard to the charging infrastructure are reminiscent of the energy triangle. While people wish the charging infrastructure to be expanded in order to provide comprehensive coverage, the incentives available currently only provide for isolated solutions and a limited fast charging infrastructure.

The NPE recommends the adoption of a comprehensive strategy that shares the costs of a nationwide charging infrastructure among several different actors and includes government start-up funding. It is necessary to develop a model for financing investment costs that

- leads to the construction of a public charging infrastructure that caters to users’ needs,
- allows business models to compete freely,
- is cost-effective and manageable,
- is simple and unbureaucratic for applicants,
- does not need any new (bureaucratic) administrative structures,
- ensures that the infrastructure is built where it is required,
- can become self-sustaining in the medium term, and
- includes both normal and fast charging points.

It is the NPE’s view that the required financing can be delivered through a smart combination of several different elements. For example, financing could be provided through an investment programme, parking management measures, franchising, B2B partnerships and the integration of existing national and European funding programmes.
In addition, the NPE recommends the adoption of regulatory measures for promoting the development of the charging infrastructure:

- Changes to residential property and tenancy law to facilitate the installation of charging points
- Introducing the mandatory requirement of prerequisites for charging infrastructure in new and refurbished buildings into state building regulations
- Expediting and simplifying the planning approval procedures for charging infrastructure
- Legally compliant signage for the public charging infrastructure
- Simplification of tax legislation to enable employers to provide their employees with a charging point in their homes and a flat-rate reimbursement for the electricity used (non-cash benefit)
- Rules and regulations requiring the designation of assigned parking facilities with the relevant charging infrastructure, e.g. for new roads and residential developments as well as at petrol stations, motorway services, airports and railway stations

In principle, the NPE recommends that developments should provide for the future installation of charging infrastructure right from the planning stage. Figure X and the NPE’s charging infrastructure and standardisation roadmaps can act as a guideline for the planning process.

In order to ensure a customer-friendly and interoperable charging infrastructure that provides barrier-free, open system access, the NPE recommends that all public charging points should meet the following requirements:

- CCS-compatible coupling systems: this means Type 2 connectors for (single- and three-phase) AC charging points and Combo 2 connectors for DC charging points
- Charging points should be remotely controllable via the Internet (feasible as of late 2014, to be implemented by 2016)
- Back-end connection
- Ad-hoc access (see Chapter 3.1.5)
The rapid construction of a fast charging infrastructure will be absolutely essential in order to allay potential customers’ fears regarding the suitability of electric vehicles for longer journeys. To this end, fast charging points are already being built e.g. in the showcase regions, as part of Hamburg’s charging infrastructure master plan, along the A9 motorway and as part of various cross-border projects under the auspices of the Trans-European Transport Network (Ten-T). The SLAM project is investigating both the expansion of the fast charging infrastructure and the implementation of the CCS standard.

**SLAM project: a fast charging network for major trunk roads and cities**

This federal government-funded research project is a joint initiative of BMW, DAIMLER, DG Verlag, EnBW, PORSCHE, RWTH Aachen University, the University of Stuttgart and Volkswagen. Its goal is to create a comprehensive fast charging infrastructure throughout major cities and along major trunk roads. To this end, it is formulating recommendations for sustainable business models and for the siting of fast charging points according to people’s need. The goal is to install at least 600 charging points with standard access and billing systems by 2017. The project partners and associate investors are allowed to use the research findings and can apply for research funding.

The project is intended to prepare the ground for electric mobility in order to achieve rapid market penetration in Germany. In accordance with the EU directive, all DC charging stations use the Combined Charging System CCS standard. Next to piloting the expansion of the fast charging infrastructure, the project also seeks to ensure charging point interoperability, for example by promoting technical standardisation among the participating automotive manufacturers.

The establishment of an interoperable interface between vehicle and charging point – e.g. using a “Golden Test Device” – and access and billing system standardisation (e-roaming) are also being tested. Other SLAM project goals include formulating a siting strategy for DC/AC fast charging points, investigating sustainable operating and business models and carrying out user studies.
4.3.3 Continued research and development on new topics

The concerted research and development effort during the pre-market phase has been at the root of the progress already made in pursuit of the supply leadership goal. During the forthcoming market ramp-up phase, electric mobility research projects will require continued support in order to secure and increase the technology's competitiveness vis-à-vis conventional power-train systems and ensure that German technology can compete sustainably on the global market.

A total R&D project budget of around 2.2 billion euros is required up to the conclusion of the market ramp-up phase at the end of 2017 for the three major priority areas identified in the Systemic Approach and technology roadmaps. Assuming an average public funding share of 50 percent, the State will need to provide funding to the tune of approximately 360 million euros per annum. This public funding will be crucial in attracting private investment. The R&D requirements can be broken down as follows:

The illustration above does not include the potential continuation of demonstration projects such as the showcase regions.

Secure and stable funding of R&D in the field of electric mobility and the resulting high-quality projects involving partners from research and industry will pave the way for Germany to become a global leader. It is therefore essential that a consistently high level of R&D funding should be sustained throughout the market ramp-up phase and beyond.
R & D flagship project Vehicle technology

Cooperation between research and industry in the field of power-train technologies and vehicle integration has already led to the launch of a variety of joint initiatives.

In the future, it will be necessary to build on past research priorities and address the topics that will be key to the next generation of electric vehicles. Accordingly, an updated version of the pre-market phase roadmap has been produced (Roadmap 2.0). Its main focus is to identify and set out the details of additional R & D issues in existing or new priority areas. As a result, the NPE will be able to draw on separate, revised roadmaps for the thematic areas of electric motors, power electronics, and power-train systems during the market ramp-up phase. The requirements are also increasing with regard to the cross-cutting themes of noise, vibration, and harshness, electromagnetic compatibility, functional safety, and reliability, giving rise to a significant need for additional research and development in these areas.

The principal focus of the roadmaps alluded to above is on systems integration. Other research priorities include the use of alternative materials, lightweight designs, and integrated energy and thermal management. It will also be necessary to develop platform strategies and component toolkits for power-train systems in order to ensure their cost-effectiveness. The long-term goal in the field of power electronics is to reduce and prevent losses in the drivetrain. In the medium term, thermal management will also be a key issue in terms of extending the service life of parts and components.

Electronic systems research is the key to smart, sustainable mobility. It incorporates power electronics, sensor technology, automated functions for efficient electric driving and thermal and battery management. Higher-performance, ultra-reliable, miniaturised electronic systems or innovative solutions based on these electronic systems help to lower power consumption and increase electric vehicles’ real-world range. In addition, this type of innovation simultaneously strengthens German industry’s symbiotic value chains that enable the cooperation of automotive manufacturers with the electronics industry in order to achieve the rapid innovation and competitive advantage that will ultimately make Germany the world’s leading supplier.

Continued research is essential in order to achieve the goals that have been established for the field of power-train technologies and vehicle integration. These goals continue to include the following points:

- A two-thirds reduction in system costs
- Increased power density (kW/l) and a lower power-to-weight ratio (kg/kW)
- An increase in average operational efficiency of more than five percent
- Enhanced reliability and quality

These measures will help to achieve the NPE’s overall goals of making Germany the world’s leading supplier and lead market for passenger cars and light commercial vehicles by 2020.
Lightweight design
Resource-efficient lightweight design solutions remain as important as ever. Lightweight design helps to reduce electric vehicles’ weight, thus also increasing their range. All automotive manufacturers employ lightweight design solutions for their electric vehicle models, e.g. for the vehicle’s chassis, wheel rims or interior. The new materials and associated technologies employed in the field of electric vehicles are also having a major impact on conventional vehicle technology and thus have the potential to make a huge contribution to meeting climate protection targets.

The NPE recommends that the multi-material approach should continue to be used in future. This approach combines a variety of different material groups and also involves competition between different materials. It must now be ensured that this approach is maintained in future R & D initiatives and that the benefits of this competition are being reaped. A systemic approach should be adopted to ensure that any gaps in the technology and value chains are rapidly identified so that targeted measures can be taken to close them. This will be key to enabling the practical simulation and design and efficient mass production of the composites and combinations of materials. Germany needs to deliver world-leading electric mobility solutions. The future federal government-funded materials research programme “i-WING” will explore different ways of realising this goal.

R & D flagship project Batteries
In order to promote the increased use of electric mobility, the focus during the forthcoming market ramp-up phase will continue to be on the energy storage system as the core component of the value chain. Lower total prices combined with higher battery energy density will support the market ramp-up and encourage a greater take-up of electric mobility solutions.

In terms of cathode development, there will be a growing trend towards high-voltage and high-energy materials. Nevertheless, both the continued development of lithium-based systems and research into post-lithium technologies will be key to achieving higher energy densities and thus increasing the range of electric vehicles.

In terms of the development of third- and fourth-generation battery system technology, the goal is to double energy density by volume to somewhere between 280 and 300 Watt-hours per litre (Wh/l) by 2025. Furthermore, larger production runs and improved cell chemistry will allow battery system costs to be reduced to under 200 euros per kilowatt-hour. In future, it will be possible to more than double the range of current electric vehicles to 400 kilometres without any increase in battery costs. Alternatively, battery costs could be reduced by more than half whilst retaining the current range of around 200 kilometres.
The NPE has identified the following key objectives for future battery research and development:

- Number of charges: batteries should offer a minimum of 1,200 charge cycles.
- Fast-charging capability: it should be possible to achieve an 80 percent charge in less than 15 minutes.
- Future battery materials should permit the use of high-voltage spinel, for example.
- "Smart" cell chemistry: R&D should turn its attention to electrolyte additives, solid-state ionics and solid-state electrolytes.
- Cathodes: materials with higher energy and power densities should be developed for low-temperature performance.
- The falling prices and increased energy densities of lithium-ion batteries should not be allowed to compromise the compliance of battery system safety and reliability with the highest industry standards.
- Although recycling of the current crop of batteries is not a problem, as attention turns to new cell and battery processes it will be necessary both to continue researching and optimising recycling processes and to formulate appropriate re-use strategies.
- The German Association of the Automotive Industry (VDA) is continuing its efforts to drive cell module standardisation.

R&D flagship project ICT & Infrastructure

Research into a wide variety of charging infrastructure types will continue in Germany during the forthcoming market ramp-up phase. The focus will be on the following themes:

- User-friendliness: work is continuing on the development e.g. of cable-free inductive
charging and system interoperability. There have not yet been any large-scale applications in the public domain, e.g. on bus services.

- Electrical power: efforts are ongoing to reduce charging time by increasing charging power, while fast charging facilities on motorways are being tested and expanded.
- Cost: research is required into economies of scale in fast charging, as well as affordable charging solutions in the public domain – e.g. use of street light charging points, system sockets and smart cables – and in the private domain. This is necessary in view of the very high operating costs that currently exist in some cases.
- Energy management: charging infrastructure should be integrated into future smart buildings and connected to solar PV systems. An appropriate local demand-side management system should be developed.
- Power grid integration: the impacts on the power distribution grid are being simulated and the relevant requirements for smart grids are being tested. At present, the notion of sharing the suburban railway network’s power grid remains only a theoretical possibility. It is therefore necessary to investigate the real-world feasibility of this idea and initiate a pilot project.
- Efficiency: it is necessary to further reduce the internal power consumption of charging solutions.
- It is important to establish prerequisites for future charging systems such as inductive charging.

Urban planning and intermodality

The issues in this field are being addressed by the “General Framework” working group. The group will use concrete examples to focus on the operationalisation of electric mobility, as well as the identification and removal of barriers to implementation. It is also collecting feedback on the operational business aspects of electric mobility from actors such as architects, the housing industry, the residential construction trade, municipal and local governments and the transport authorities. This is supplemented by best practice examples from the showcase regions.

In terms of concrete actions, it will be important to launch pilot projects or add pilot schemes to existing projects, since these provide practical examples that help to promote acceptance and the more widespread use of electric mobility. The first pilot projects are still being implemented under the current building and planning regulations. However, in order to achieve a more widespread impact it will be necessary to modify the Federal Building Code and regional planning regulations. This should be a priority for the legislative package for the promotion of electric mobility announced by the German government.

In order to ensure successful and sustainable implementation at local government level, it will be necessary to create the relevant positions, for example special electric mobility officers. Action should also be taken to drive progress towards the government’s self-imposed target of ensuring that eco-friendly vehicles make up ten percent of its fleet. Based on current figures, much work still remains to be done before this target can be met.
4.3.4 Integrated cell and battery manufacturing in Germany

The battery value chain comprises materials and electrochemicals, components, cells, batteries and battery management systems. It remains one of the core components of electric vehicles and is a key enabler of their success. The main focus in this area is on integrated cell and battery manufacturing, since this accounts for 30 to 40 percent of the total value-added. Another crucial aspect is the management of the entire system. The challenges in this context relate to packaging, safety and the reduction of the cost of both the cells and the system as a whole.

The market will continue to be dominated by the current second- and third-generation lithium-ion battery technologies up to 2020 and beyond. At present, the Li-ion cells used by German battery manufacturers are sourced mainly from Asia. As things currently stand, this does not constitute an obstacle to the market ramp-up of electric mobility in Germany. German-manufactured Li-ion cells currently only account for a small share of the total market. In 2013, there were approximately 200,000 electric vehicles worldwide, with around 20 million cells. Current forecasts expect this figure to double annually. Nevertheless, at the moment the supply of cells on the market is at least partly outstripping demand. Consequently, further investment in second-generation cell manufacturing facilities is not recommended.

As the anticipated market ramp-up progresses both in Germany and abroad, it will become necessary to rapidly build additional manufacturing capacity. At this point, it will be worthwhile manufacturing cells in Germany so that German industry can benefit from the growing global Li-ion battery market and profit by the expected positive impact on employment. This will also create a better balance in what is currently a geographically very one-sided global supply chain. Indeed, this applies not only to the cells themselves but to the entire value chain.

Competitive third- and eventually fourth-generation cell technology will be key to establishing a successful and sustainable cell manufacturing capability in Germany. This competitiveness can be achieved by bringing together the expertise that exists in Germany in order to optimise the technology and its production. The capability to...
manufacture several million cells would require a total investment of at least one billion euros, depending on the exact global market share being targeted. Whether, how and when a battery cell manufacturing capability can be established in Germany is a matter to be discussed in detail by all the stakeholders under an economic angle as well as in terms of competition law provisions and policy considerations. This issue will be addressed by the NPE’s roadmap on integrated cell and battery manufacturing in Germany that is due to be published in 2015. Once it has been verified and the technological details have been settled, the value creation and employment model should be jointly implemented.

However, the preconditions for the successful establishment of a competitive cell manufacturing capability in Germany should be created right away. A dialogue should therefore be launched as soon as possible in order to formulate detailed plans that can act as a basis for ongoing strategic decision-making.

Accordingly, the NPE recommends that research and development into cell technology and manufacturing should be intensified. The NPE has already taken the first step by helping to build up expertise in the field of production research. A closer integration of current activities into a comprehensive scheme can set off the efficient and rapid development of manufacturing processes, establishing the basis for an economic scale towards the profitable mass production of the cells. The NPE recommends co-financing the ongoing development of this manufacturing capability through a partnership programme between the private sector and government.

Global battery technology trends will continue to be closely monitored. The strategy in this area may need to be adapted in the light of any new information.

In addition to focusing on the cells themselves, Germany should also support the continued development of expertise and manufacturing capacity along the rest of the value chain, from materials to the development and production of battery systems. The overall goal is to supply products that feature world-leading technology in terms of the key indicators of energy and power density, battery life, safety and cost.

4.3.5 Extending the showcase regions electric mobility without any increase in budget
Owing to the delayed start of some of the showcase regions, the NPE recommends that the duration of certain projects be extended by one year to 2016 without any increase in their budget.

4.3.6 Continuing the work of the German National Platform for Electric Mobility
The NPE will continue to support the development of electric mobility in Germany and monitor the implementation of its recommendations during the forthcoming market ramp-up phase, at least until the end of 2017. The unique cross-sectoral dialogue within the NPE distinguishes it from other platforms and will be key to achieving the goals of Germany becoming the international lead market and leading supplier.
5

The NPE: current status and outlook
The successful roll-out of electric mobility in Germany requires continuous work and united commitment. Numerous cross-sectoral strategies need to be formulated, checked and potentially adapted before being developed further. This requires all the relevant actors to act in concert, based on a systemic and market-based approach not tied to any particular technology.

In view of the above, the German National Platform for Electric Mobility was established in 2010 by the federal government and industry in order to generate momentum and provide advice. Since then, 150 high-level representatives of government, industry, the research community, the trade unions and civil society have been cooperating in the seven – soon to be six – working groups of this novel form of cross-sectoral dialogue. They have been working together to identify the economic, social and environmental potential of electric mobility and make recommendations to policymakers and business leaders. In addition to identifying the relevant R&D themes, their remit includes both coordination of the overall requirements for establishing the international lead market and monitoring and evaluation of national and international activities. The NPE has produced its own roadmaps for the systemic approach, regulation and standardisation, education and training as well as scientifically modelled market evolution scenarios. It is therefore well equipped to monitor, evaluate and oversee the actual evolution of electric mobility in Germany.
The NPE will continue to work systematically on the relevant challenges during the market ramp-up phase from 2015 to the end of 2017. In terms of its structure, it continues to comprise a steering committee as its decision-making body and working groups meeting throughout the year (see Figure 31). The number of working groups is to be reduced from seven to six. Following the success achieved in the field of lightweight design, the decision was taken to continue the work on materials and recycling by integrating these topics into WG 1 "Vehicle Technology" (formerly "Power-train Technologies") and WG 2 "Battery Technology". In future, WG 6 “General Framework” will place increased emphasis on the topic of “urban planning and intermodality”. It is possible that some of the remaining working groups could be disbanded once they have successfully concluded the work on their roadmaps. The NPE’s monitoring activities will also include a close dialogue with the actors responsible for the parallel research and evaluation of the showcase regions and the centralised parallel research for the model regions.
### Overview of the evolution of electric mobility in Germany

<table>
<thead>
<tr>
<th>Year</th>
<th>Event</th>
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<tbody>
<tr>
<td>2007</td>
<td>The German government’s Integrated Energy and Climate Programme (IEKP) identifies electric mobility as a key component in the delivery of climate protection targets.</td>
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<td>2008</td>
<td>The key content of a national electric mobility development plan is agreed at the “National Strategic Conference on Electric Mobility.”</td>
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<td>2010</td>
<td>Adoption of the “Joint Declaration” of the federal government and industry and establishment of the German National Platform for Electric Mobility. The Platform’s fundamental goals are defined in the NPE Interim Report (First Report). The first Standardisation Roadmap 1.0 is produced.</td>
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<td>2011</td>
<td>Conclusion of the first phase of the federal government demonstration projects under the auspices of the Second Economic Stimulus Package; the comprehensive package of measures outlined in the Second NPE Report is used to inform the Government Programme for Electric Mobility; the first “National Education Conference for Electric Mobility” is held with the aim of establishing a comprehensive national education and training network in the field of electric mobility.</td>
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<td>2012</td>
<td>Establishment of four showcase regions electric mobility by the federal government and publication of the first NPE Progress Report (Third Report). The Standardisation Roadmap is updated to Standardisation Roadmap 2.0 and the education competency roadmap is published; launch of Phase II of the model regions.</td>
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<tr>
<td>2013</td>
<td>The progress achieved to date is reviewed at the first International Conference for Electric Mobility; details of the systemic approach are set out in a roadmap; the electric mobility market evolution scenarios are updated.</td>
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<td>2014</td>
<td>Publication of the 2014 NPE Progress Report (Fourth Report) and the Standardisation Roadmap 3.0; the federal government announces additional legislative measures to support the development of electric mobility; adoption of the EU Directive on the Deployment of Alternative Fuels Infrastructure.</td>
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<tr>
<td>2015</td>
<td>Progress to be reviewed at the National Conference of the Federal Government; Second “National Education Conference for Electric Mobility” to update the education competency roadmap; electric mobility guidelines for local government; value creation and employment model to be updated.</td>
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<tr>
<td>2016</td>
<td>Second International Conference on Electric Mobility of the Federal Government, aimed at promoting international cooperation.</td>
</tr>
<tr>
<td>2017</td>
<td>Publication of the third NPE Progress Report; decision to be taken on the NPE’s future.</td>
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6 Members of the steering committee and editorial team
Chairs and members of the steering committee:

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7
Glossary and references
**Glossary**

**AC**
Alternating Current

**ARENA 2036**
Active Research Environment for the Next Generation of Automobiles (federal government research campus initiative)

**BDEW**
German Association of Energy and Water Industries

**BEREIT**
Federal government-funded project on “affordable electric range through modularity”

**BEV**
Battery Electric Vehicle

**BMBF**
Federal Ministry of Education and Research

**BMC**
Baseboard Management Controller

**BMUB**
Federal Ministry for Environment, Nature Conservation and Nuclear Safety

**BMVI**
Federal Ministry of Transport and Digital Infrastructure

**BMWi**
Federal Ministry for Economic Affairs and Energy

**CCS**
Combined Charging System

**CEN**
Comité Européen de Normalisation (European Committee for Standardization)

**CHAdeMO**
Trade name of a standard, cross-brand electrical interface for electric vehicle battery management systems, developed in Japan.

**CSC**
Cell Supervision Circuit

**DC**
Direct Current

**DoE**
United States Department of Energy

**DIN**
German Institute for Standardization

**DIN SPEC**
This is a specification rather than a standard (the difference is that specifications are drafted more rapidly than standards)

**EMILE**
Federal government-funded project for testing electric mobility in commercial vehicles

**EUREF**
European Energy Forum (federal government research campus initiative)

**FCEV**
Fuel Cell Electric Vehicle

**GB/T**
(Recommended) Chinese national standard
GGEMO
Federal government’s Joint Agency for Electric Mobility

GIZ
Deutsche Gesellschaft für Internationale Zusammenarbeit (federal enterprise, which supports the German Government in achieving its objectives in the field of international cooperation for sustainable development)

HeP-E
Federal government-funded project on ultra-flexible manufacturing systems for more efficient electric traction drives

HEV
Hybrid electric vehicle

IEC
International Electrotechnical Commission

IEKP
Federal government’s Integrated Energy and Climate Programme

ICT
Information and communication technology

INEES
Federal government-funded project on the smart connection of electric vehicles to the power grid in order to provide system services

InSel
Federal government-funded project on inherently low-noise power electronics

InTeLekt
Federal government-funded project on an integrated testing environment for power electronics

ISO
International Organization for Standardization

Li-Ionen Technology
Lithium-ion technology, also lithium-ion accumulator or lithium-ion secondary battery

KBA
Federal Motor Transport Authority

KFV
Kreditanstalt für Wiederaufbau (government-owned development bank)

SME
Small and medium-sized enterprises

MEHREN
Federal government-funded project on multi-motor electric vehicles with maximum space and energy efficiency and uncompromising driving safety

NFC
Near Field Communication (International transmission standard for contactless data exchange using short-range wireless technology)

PHEV
Plug-in Hybrid Electric Vehicle

PLC
Powerline-Communication

PWM
Pulse Width Modulation (modulation technique used for transmitting signals, in which the voltage is switched between two values)

OEM
Original Equipment Manufacturer (in this context, automotive manufacturer)

OHLF
Open Hybrid LabFactory (federal government research campus initiative)

REEV
Range Extended Electric Vehicle
**RFID**  
Radio-Frequency-Identification  
(identification using electromagnetic waves)

**SAE**  
Society of Automotive Engineers

**SLAM**  
Schnell Laden Achsen Metropolen  
(Fast Charging for Major Trunk Roads and Cities) (research project)

**Sphin(x)**  
Federal government-funded project on highly-integrated, scalable electric vehicle drives based on a high-speed electric motor

**TCO**  
Total Cost of Ownership  
(costing model that includes all the costs associated with capital goods, e.g. operating and maintenance costs)

**TEN-T**  
Trans-European Transport Network  
(EU programme)

**TTIP**  
Transatlantic Trade and Investment Partnership

**VDA**  
German Association of the Automotive Industry

**Wallbox**  
Wall-mounted electrical charging point
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2 Kunert et al. (2012): Auto-Mobilität. Fahrleistungen steigen 2011 weiter. In: DIW Wochenbericht 47/2012, p. 13, Fig. 9 (available for download at http://www.diw.de/documents/publikationen/73/diw_01.c.411735.de/12-47.pdf)

Progress Report
2014

Review
of Pre-Market Phase
Progress Report 2014 –
Review of Pre-Market Phase