SUMMARY

BACKGROUND

Electric mobility is developing around the world at a seemingly unstoppable pace. Every self-respecting vehicle manufacturer is busy developing hybrid and/or full electric vehicles. Expectations are high and the ambitions with regard to the adoption of electric vehicles are far-reaching. Governments intend electric mobility to play a major role in achieving their climate targets and improving air quality.
The Dutch government asked D-INCERT to conduct a study into the state-of-the-art with regard to the technological strengths and weaknesses of electric road transport and the expertise available in the Netherlands in this field. Following from this study, D-INCERT was also asked to collaborate with knowledge institutes and the business community to draw up a 2010-2020 innovation agenda for electric mobility in the Netherlands. This report describes this Netherlands innovation agenda.
The 2010-2020 innovation agenda for electric mobility focuses on the potential of electric mobility to contribute to strengthening the Netherlands' economic position and growth. In light of the considerable investments in the development of electric mobility being made by EU countries such as Germany, France, Spain and England, it is of the utmost importance that innovational steps taken in the Netherlands be effective, efficient and distinctive in comparison with the developments in Europe and the rest of the world. Another key question is whether there are innovation opportunities for specific Dutch companies or institutions. The resulting innovation agenda builds on existing competencies in Dutch businesses and knowledge institutes and can count on widespread support and commitment, thanks to the participation of experts from the business community, knowledge institutes, government and user organisations.

VISION ON ELECTRIC TRANSPORT IN THE YEAR 2020

On the basis of literature research and intensive workshops held with more than 80 Dutch experts and stakeholders, an inventory was made of the major developments, driving forces and objectives for electric transport in the Netherlands for the period 2010 to 2020. A vision for the future was then formulated that will serve to focus and demarcate the development of the innovation spearheads. This vision is summarised in the box at the bottom of this report.

ELECTRIC TRANSPORT IN 2020

By 2020, the large-scale implementation of electric transport should have resulted in a marked improvement in the quality of life in the Netherlands, particularly with regard to the urban climate. This involves improving air quality (reduction of particulate and NOx emissions) and a reduction in noise pollution caused by vehicles, particularly in the inner cities. The widespread introduction of electric transport will also contribute to reducing local and regional CO2 emissions. As a result, by 2020 the Netherlands will have one of the most efficient, clean and safe transport systems in Europe.
The widespread use of electric vehicles in combination with the availability of smart electricity grids will provide the Netherlands after 2020 with buffer capacity in the energy infrastructure and so create the potential for an even more sustainable energy supply.
The fluctuating generation of solar and wind energy can be absorbed with this buffer capacity which will enable this production to be upscaled. This will make it possible to further reduce dependency on unstable foreign countries for the supply of energy. The implementation of electric transport in the Netherlands will also have led to economic growth of Dutch businesses through the development of innovative product/service combinations and successfully marketing these.

To realise this ambition, the safety, reliability, user-friendliness and price-quality ratio of PHEV (plug-in hybrid) and EV (all-electric) vehicles, and the associated charging technologies, will need to be improved whereby the needs of the users will be defining. So in 2020, EV and PHEV vehicles will perform like a Porsche and be as quiet as a Rolls Royce. EVs will be more comfortable, safe and practical than conventional vehicles and, more importantly, they will be 'cool' and 'fun' to drive. EV and PHEV vehicles will be built of strong and light materials and offer reliable, low-maintenance and carefree mobility. EV and PHEV vehicles and the associated charging infrastructure will be smart and safe. The user will no longer have to worry about how much, when and where the battery is charged and so will not have to spend any extra time travelling. EV and PHEV vehicles will be cheaper to run than internal combustion engine vehicles in 2020 and transparent financing and payment systems will ensure an unambiguous total cost of ownership.

NINE INNOVATION SPEARHEADS, NINE CHALLENGES

Innovation is a prerequisite to be able to realise the vision for electric transport in 2020, and nine innovation spearheads have been identified that build on the competencies of Dutch businesses and knowledge institutes and that have the most potential to create economic growth and strengthen the competitive position.
The following nine innovation spearheads are distinguished:

1. **Integral electric mobility**

   The challenge lies in providing integral mobility solutions for the urban environment made up of seamlessly integrated products (vehicles, charging points, etc.) and services (mobility, energy and information). The focus for the coming five years will lie on solutions for the business sector such as additional public transport, goods transport, distribution and staff transport (e.g. company fleets, lease vehicles and taxi services).
   The private consumers' market will be developed in a later phase. The business market consists of a multitude of niche markets. Made-to-measure solutions will be required to convince the actors in these niches to switch to electric mobility. Knowledge of these niches and the specific user demands and mobility requirements is crucial for developing consistent, user-friendly and affordable mobility concepts and solutions. Insight into the niche user of today and tomorrow (market knowledge and customer insights) is the starting point for this innovation spearhead.

2. **Affordable electric mobility**

   The central challenge of this innovation spearhead is making electric mobility affordable. Which innovations are required to ensure that electric vehicles are cheaper to run than conventional vehicles in 2020? And what needs to be done to stimulate a transparent cost and pricing structure for the market? This innovation spearhead concentrates not so much on lowering the cost price of the technical components of the vehicles, but rather on developing business model innovations. This is considered as a definite economic opportunity for Dutch businesses and institutions.

3. **Connected EV**

   Developments in ICT will make it possible to drastically improve the interaction between the vehicle and its environment. This could include improved active safety and traffic flows, downloading information and entertainment, GPS and navigation, diagnosis, maintenance and repairs and safeguarding mobility concepts. This innovation spearhead is already developing rapidly in the Netherlands, mainly driven by HTAS, the Dutch Automotive Innovation Programme. Although connectivity also entails a huge improvement for conventional vehicles, for electric

vehicles it is absolutely vital. Connectivity is an important weapon against so-called range anxiety, the fear held by users of EV vehicles of being stranded without power.
It is also a powerful means of regulating traffic flows and the associated problems (congestion, parking, etc.). Important product/service combinations in this theme are driver guidance systems that, alongside the route and destination, also monitor the charging infrastructure, the actual availability and consumption of energy, the energy price and the parking facilities.

4. **Smart charging**

The development of a user-friendly, reliable and safe charging infrastructure is the main challenge for this innovation spearhead. The first generation charging infrastructure - which started being installed in a few European cities in 2010 – does not meet the above-mentioned requirements. Key issues that must be taken into account in the development of the next generation, large-scale charging infrastructure must be charging speed, user friendliness and compatibility with the routines of the users. By 2020, the charging process en route will be fast (deductive/inductive/battery change) and semi-fast or normal at home and at work (inductive/ wireless). Smart charging also means that the charging process takes optimum account of electricity supply and demand, whereby the power is obtained locally whenever possible.

5. **Battery management**

To create more reliable and affordable battery technology, the battery management systems (BMS) that control charging and discharging must be improved.
A BMS that is better at monitoring the battery's ageing process and controlling charging and discharging to slow down the degradation process will contribute to a higher residual value and longer battery life and thus lower write-off costs. Moreover, improvements to BMS can lead to greater vehicle ranges.

6. **Fit-for-use drivetrains**

The rapid and large-scale introduction of electric vehicles is hampered by the current limitations with regard to aspects such as range, weight, cost and long charging cycles, which are all restraining factors for consumer acceptance. The greatest improvements can be realised in the core of the electric vehicle system: the drivetrain. Electric vehicles with optimised drivetrains for specific user group drive cycles (possibly in combination with efficient range extenders) are essential for increasing the present limited range and matching the performance of the vehicles to the users' expectations. What is needed is an optimal hybrid or other drive technology (components and integral drivetrains), range extender technology and optimal energy management systems for the entire vehicle.

7. **Safe electric vehicles**

Current EV and PHEV vehicles are often converted conventional vehicles, and this will be the case in the future as well. Many experts indicate that there is some uncertainty regarding the safety of these vehicles. In the present transition phase however, safety must be paramount; in the first place to prevent accident victims and material damage, but also because public opinion could quickly turn against these vehicles if an unexpected calamity or accident occurred. Specific new safety aspects regarding electric vehicles are the high voltages involved in assembly and disassembly and during interventions by emergency services, the influence of the huge mass of the batteries in accidents and undesirable chemical reactions that occur when certain components come into contact with water (when a fire is extinguished or the vehicle is submerged in water).

There is also a fire hazard involved if charging procedures are not followed correctly and there is some uncertainty about electromagnetic compatibility.
There are also hazards for other road users because of the lack of audible engine noise at low speeds.

8. Sustainable smart power grids

To make large-scale electric transport possible by 2020 and to realise this as sustainably as possible, improvements will need to be made to the electrical infrastructure and the electricity network. To create a sustainable mobility system, the energy that is used should be generated sustainably too. The most obvious clean sources are solar and wind energy. Creating a reliable combination between a sustainable power generation system and an electric mobility system is a major challenge and crucial if we want to realise zero emissions of CO2, particulate and NOx by vehicles. This places new demands on the electricity network with regard to coordinating and balancing energy supply and demand, especially considering the fact that solar and wind energy are variable (intermittent) power sources. Furthermore, if electric transport is to be implemented on a large scale, it will be important to take account of peak network loads caused by the simultaneous charging of many vehicles. These peak loads are not expected to occur on a wide scale before 2015, however higher concentrations of charging points and vehicles after 2015 will cause this to become a relevant issue. The prevention of these peak loads in itself also places new demands on the electricity network and the task of balancing supply and demand. Both the developments in supply (sun and wind) and demand (charging and vehicles) will make a smarter power grid necessary.

9. Efficient batteries

The careful and efficient recycling of large numbers of batteries and the creation of a buffer in the electricity grid are product/service combinations in which Dutch parties can play an important role. Alongside the import of new batteries via the mainports, the Netherlands can also use its logistical expertise to play a leading role in the international recycling and reuse of batteries. Firstly, when batteries have finished their useful life in electric vehicles, they can still be reused for other applications. For example, these used batteries could be used as static buffer capacity in the smart power grids. This will make electric vehicles and in particular their batteries more affordable. Dutch parties are currently developing second life applications to this end.
There is a huge potential for second life products and services. For example, mini storage systems could be designed for public or private use; located in a street, neighbourhood or industrial estate, or in your own garage. Services such as financing and payment concepts are another example.
Once the battery is no longer suitable for second life use either, it must be efficiently recycled and the valuable materials must be salvaged. This particularly applies to the precious metals used in the battery.

CONCLUSIONS AND RECOMMENDATIONS

The 2010-2020 innovation agenda for electric mobility in the Netherlands concentrates specifically on electric mobility in the urban environment, a user-friendly charging infrastructure coupled with a sustainable energy supply and user-friendliness focusing on the demands and routines of the end-user. Using this as their starting point, the Dutch business community and knowledge institutes can gain a unique position in the electric mobility market. Nine high-potential innovation spearheads are identified in the innovation agenda.

The innovations resulting from the innovation spearheads are not all expected to penetrate the market with the same speed and success. The size of the markets also differs for the different product/service combinations to be developed in each spearhead. Furthermore, the available competencies in the Netherlands differ per innovation spearhead. Based on these criteria, it was agreed that of the nine innovation spearheads, five should be deployed in the short term. The results are summarised in the table below.

		Adoption rate	Market size	Competencies	Average
1st priority: Short term (→ 2010)	1 Integral electric mobility	+ +	+ +	+ +	++
	2 Affordable electric mobility	+ +	+ +	+ +	++
	3 Connected EV	+	+ +	+ +	++
	4 Smart charging	+ +	+ +	+ +	++
	5 Battery management	+	+ +	+ +	++
2nd priority: Long term (→ 2015)	6 Fit-for-use drivetrains	+	+ +	+	+
	7 Safe electric vehicles	+	+	+ +	+
	8 Sustainable smart power grids	+	+	+ +	+
	9 Efficient batteries	+	+	+ +	+

Close collaboration between market parties, knowledge institutes and government bodies is a precondition for the successful development of the innovation spearheads. Such collaboration has already been initiated for a number of these innovation spearheads and R&D projects are currently underway. Four recommendations follow to strengthen collaboration and increase the critical mass:

1. The innovation agenda strongly advocates focusing on urban areas. The influence of the transition to electric mobility will be most effective here in the short term. Policy-making with regard to the improvement of urban air quality is an important stimulant for the development of electric mobility in the Netherlands. The results of the electric transport pilots can provide an important impulse to the developments within the innovation spearheads.
   Furthermore, the ambitions and policies of the major cities with regard to electric mobility provide an excellent and necessary context for the formulated innovation agenda.
   We recommend placing an even greater emphasis on urban development and redevelopment as the focus of the innovation spearheads.
   Knowledge exchange between the business community and knowledge institutions concerning the activities of the four major cities (Amsterdam, Rotterdam, The Hague and Utrecht) should be given an impulse by establishing learning circles. In a learning circle, the pilot projects are not only monitored and the bottlenecks identified, but these bottlenecks are also immediately coupled to a party that potentially has innovative solutions for them. In other words, in a learning circle, opportunities for new innovations can stem directly from the pilot projects and so the experience gained in these pilots is used more efficiently. D-INCERT sees an important role for itself here as initiator and mediator.

2. We recommend forming expert groups for each of the five prioritised innovation spearheads in 2011.
   The experts will be found in knowledge institutes, the business community and government bodies. The task of the expert groups will be to monitor and evaluate international and national knowledge development. The expert groups will make recommendations for the Dutch and European research and innovation agenda and identify innovation projects for potential collaborations. The expert groups will be the hubs of the Dutch innovation cluster. The currently active working groups, such as the Electric Mobility Platform (BOVAG/RAI), Formule E-team and D-INCERT's working groups can be merged with these expert groups.
   Together with its partners, D-INCERT has taken the lead by establishing an expert group for the Smart Charging innovation spearhead. The other innovation spearheads are to follow. Because the electric mobility theme is developing so dynamically, it will be important to update the innovation agenda every year on the basis of the findings of the expert groups. This will result in annual innovation calendars.
   Consistent direction and facilitation by the government will be required to achieve the full potential of the innovation spearheads. The support of the national government for the above-mentioned learning circles in relation to the pilot projects and expert groups is considered a prerequisite for the success of the innovation spearheads.

3. The financial resources available for innovation in the Netherlands are modest in comparison with countries like Spain, Germany, France and England. However, there are considerable resources available at the European level (7th Framework Programme, Green Cars, etc.). Dutch companies, government bodies and knowledge institutes are very active and successful in the European consortia. However, there is much room for improvement with regard to electric mobility, and fragmentation is a real threat. Calls (including European) are typically specific, preferably mono-disciplinary and mainly technology-driven. There is a lack of focus on the user and the context of the use. A more integral approach needs to be stimulated. This is advocated in the innovation agenda, where the innovation of made-to-measure solutions is proposed (products/services/business models). Moreover, the Netherlands must emphasise its prioritised innovation spearheads more emphatically during the formulation of the European framework programmes. NL Agency and the involved ministries can play an important role here.

4. The preparatory activities carried out for the innovation agenda have already lead to a number of projects which in part implement the innovation spearheads (within the framework of the HTAS-EVT programme and the ERANET Electromobility+ call). These projects are, however, all limited by their budgets and terms.
   The innovation spearheads 1 and 3 (see table) could be linked to the HTAS2 programme, innovation spearheads 2 and 4 to the FES programme 'Next Generation Infrastructures', and spearhead 5 to the ADEM programme. However, these innovation programmes are due to end in the short term and it is unsure whether there will be any follow-up. To strengthen the innovation spearheads and facilitate their realisation, it would thus be worthwhile linking the electric mobility innovation agenda to the 'Top Sectors' programme. In particular, embedment in the 'High Tech Materials and Systems' Top Sector is of importance for getting innovation on the agenda and safeguarding it for the long term. The implementation of the R&D challenges formulated in this innovation agenda also need to be included in the agendas of the current R&D programmes of the main technological institutions (ECN, TNO), universities and universities of applied sciences.
   D-INCERT has already taken the first step by involving relevant experts from these institutions in the preparation of the innovation agenda.

If the above-described recommendations are followed, which are mainly intended to create focus, strengthen collaboration, learn intensively from practical experience and make better use of the European resources for innovation, it is expected that innovation in electric mobility in the Netherlands will lead to a better living environment and improved economic growth.

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