NOW
National Organisation Hydrogen and Fuel Cell Technology

ANNUAL REPORT 2011

ELECTROMOBILITY MODEL REGIONS BMVBS TRANSPORT AND INFRASTRUCTURE HYDROGEN PROVISION STATIONARY ENERGY SUPPLY SPECIAL MARKETS

NOW MAGAZINE

ANNUAL REPORT 2011

FOREWORD BY DR. PETER RAMSAUER

Federal Ministry
of Transport, Building
and Urban Development

Dr. Peter Ramsauer, Member of the Bundestag
Federal Minister of Transport, Building and Urban Development

Questions concerning energy efficiency and climate protection are without a doubt among the most challenging in regard to transport and housing policies. The Federal Government has set itself the target to develop Germany as the leading market for electromobility by 2020. Substantial efforts have already been undertaken on the path to achieving this goal. The Federal Government and in particular the Federal Ministry for Transport, Building and Urban Development (BMVBS), have been supporting research in the electrification of transport for many years. We simultaneously wish to ensure that mobility remains affordable – and electromobility plays a decisive role to this end. It is within this context that the Federal Ministry for Transport, Building and Urban Development supports comprehensive programmes for the advancement of battery as well as hydrogen and fuel cell technologies. Initial results can already be seen in the electromobility model regions and research in these showcases of electromobility all around the country are continuing. Our funding activities aim to ensure long-term planning horizons for companies and promote the market preparation of promising solutions. The suitability for daily use has been supported with 130 million euros of funds for the electromobility model regions. Links between partners from industry, science and local municipalities were established to enable concerted efforts for the expansion of electromobility – in local public transport, intra-urban delivery services or in so-called carsharing models. Furthermore, the National Organisation Hydrogen and Fuel Cell Technology (NOW) facilitated the regular exchange of experiences between the model regions to enhance learning. For this, my special thanks go out to all involved.

Our motto on our course to electromobility is: the promotion of open technology. Only in such a manner can we also gather experience in the area of hydrogen and fuel cells to help attain our goals. We are supporting this area within the framework of the National Innovation Programme for Hydrogen and Fuel Cell Technology (NIP), which runs until 2016. The mid-term review in this past year has been positive: the fuel cell has proven itself technically for the supply of power and heat in households. This technology is bringing us a giant leap forward for energy efficiency in buildings. Fuel cell vehicles from the Clean Energy Partnership have also been technically tried and tested. Hydrogen technology also plays a key role in the current transformation of the energy sector – especially in regard to the storage of energy. NOW also coordinates and manages the so-called »performing energy – Bündnis für Windwasserstoff« (Wind Hydrogen Alliance), in which industrial companies, research institutions as well as organisations from the areas of environment and technology funding have joined forces. Through the introduction of hydrogen to the transport sector as both a storage medium for energy and a fuel, the aim of the alliance is to put an end to our reliance on finite sources of energy. The very encouraging results of the funding programmes to date instil me with confidence that politics, industry and science will together reach the ambitious goals set in the future-oriented battery, hydrogen and fuel cell technologies.

FOREWORD BY DR. KLAUS BONHOFF

Dr. Klaus Bonhoff,
Managing Director (Chair), NOW GmbH National Organisation
Hydrogen and Fuel Cell Technology

Transformation of the energy sector
The development of hydrogen and fuel cell technology along with battery technology are key components in the overall context of achieving climate goals and for the transformation of the energy sector. Already today, many products bearing an energy efficient or low carbon emission label have been developed using such technologies. The National Innovation Programme for Hydrogen and Fuel Cell Technology (NIP) of the federal government and the electromobility model regions of the Federal Ministry of Transport, Building and Urban Development (BMVBS) provide the central framework for the comprehensive testing of such products under real conditions to prepare for successful market entry in the coming years.

Electromobility model regions with thematic trans-regional platforms
Over 200 individual projects across eight electromobility model regions were executed with funds from the second German economic stimulus package »Konjunktur II«. The BMVBS allocated 130 million euros for expansion of electromobility in areas such as infrastructure, vehicles and public transport as well as intermodal transport or public transport links. Project partners included cities, transport services, automobile manufacturers, energy supply companies and suppliers from various areas – among which were many small and medium-sized firms. Besides the formation of alliances and fostering the growth of knowledge locally, the hallmark of the model regions is the scientifically supported exchange of experiences between the regions and project partners that is regularly undertaken as part of the trans-regional thematic platforms.

2011 – Halftime in the ten-year NIP programme
2011 represented halftime if the ten-year NIP programme. Projects amounting to 689 million euros (subsidy 357 million euros) have been approved since its inception. Last year alone, projects valued at 87 million euros (subsidy 42 million euros) were newly approved. The outflow of BMVBS funds in the NIP during 2011 was more than 94 million euros. If one assumes that relatively high budgets will be necessary 2011 – 2014, and lower funds called upon at the beginning and end of the programme, the NIP is running in line with expectations (the total 2006 – 2016 budget amounts to 1.4 billion euros). Since the NIP was established, hydrogen and fuel cell products in several application areas could be brought significantly closer to commercial market readiness. This applies, in particular, to fuel cell vehicles and stationary fuel cell heating systems. In the near future, the questions of market validation for these areas of application will need to be tackled in detail to assess the conditions necessary for a successful commercial start-up.

Mobility with hydrogen
From a technical perspective and that of customer comfort, road behaviour, range and refilling time, hydrogen as a fuel for the use in fuel cell vehicles is market ready. This was proven by comprehensive tests conducted under everyday conditions in Berlin, Hamburg, North Rhine-Westphalia, Baden-Württemberg and the State of Hesse. Over the next years, focus will be placed on improving production technologies and reducing the cost of vehicles through series production. A sufficient refilling infrastructure must also be in place when vehicles are brought to market in 2014/2015. At the beginning, such filling stations will not be operating to full capacity. It is therefore important that industry and government find a way to jointly overcome the question of initial investment risks.

Hydrogen for storage – linking the energy and transport sectors
The search and development of suitable energy storage options goes hand-in-hand with the expansion of renewable energies. For the long-term storage of large amounts of energy, hydrogen is unrivalled. For this reason and within the framework of the NIP, the foundation was laid in 2011 to commence with projects within the context of large-scale wind-hydrogen systems. Linking the energy and transport sectors through hydrogen as an energy storage medium is especially significant for the future-orientated transformation of the energy sector and the development of new value-added chains in Germany.

Power and heat from the fuel cell
As part of Europe's largest field trial, fuel cell heating systems for the generation of power and heat in the home were tested within the framework of the NIP. Insights gathered from these trials provide manufacturers the basis to prepare for market entry from 2014. Here too, it is necessary for government to develop a framework in which these highly-efficient fuel cell heating systems (with 30 percent less CO_2 emissions than conventional units) are assisted beyond the initial hurdle of cost, enabling them to be commercially established.

Fuel cells as back-up systems for the supply of power
Around 70 German firms from the fields of IT, telecommunications, industrial process automation and control systems, traffic-control systems as well as energy supply, see immense potential in using fuel cell systems in the area of uninterruptible power supplies. Several projects were already commenced in 2011 and activities are expected to expand further in 2012.

With its coordinating role for the NIP and electromobility model regions, NOW considers itself as the interface connecting politics and business. Only with the concerted efforts of politics, industry and science can efficient and low-emission technologies be developed that are real alternatives – which ultimately can contribute to reaching set climate goals, developing new markets and creating jobs.

Yours,

Klaus Bonhoff

NOW AND ITS PROGRAMMES

NOW is …

NOW GmbH (National Organisation Hydrogen and Fuel Cell Technology) was founded in 2008 by the Federal Government, represented by the Federal Ministry of Transport, Building and Urban Development (BMVBS). The task of NOW is to coordinate and manage two federal funding programmes: the National Innovation Programme for Hydrogen and Fuel Cell Technology (NIP) as well as the Electromobility Model Regions of the BMVBS.

The most important function of NOW is the initiation, evaluation and bundling of projects. In addition, cross-cutting themes such as production technologies, education and further training, communication at the interface of government and industry as well as active public relations all contribute to raising the profile of these technologies and their products. Representatives from politics, industry and science sit on NOW committees. The advisory board counsels the organisation regarding the implementation of the NIP, especially with regard to current market demands. Participating partners bring their specific knowledge to the table and within the framework of an integrated process, work to formulate political goals, organise technological funding and prepare the market.

The concrete handling of the Federal Ministry's funding is undertaken by the project administrator Jülich (PtJ). Furthermore, as the adoption of clean and economically sustainable technologies is a global challenge, NOW also supports international collaborations. The International Partnership for Hydrogen and Fuel Cells in the Economy (IPHE) involves governments around the world in these discussions. Germany has chaired the IPHE since 2010, the secretariat situated at the NOW offices.

The Electromobility Model Regions are …

The BMVBS Electromobility Model Regions Programme has the objective of promoting battery-electric mobility and developing it from a regional focus (clusters). This will position Germany as a lead market.

The Federal Ministry of Transport, Building and Urban Development (BMVBS) is providing €130 million of funding, coming from the second economic stimulus package of the federal government (Konjukturpaket II), for the Electromobility Model Regions Programme to promote the targeted building and operation of an electromobility infrastructure over the period 2009 to 2011.

The programme should serve to anchor electromobility in the public sphere and develop it from selected model regions. NOW coordinates and manages its implementation in the eight model regions of Berlin / Potsdam, Bremen / Oldenburg, Hamburg, Munich, Rhine-Main, Rhine-Ruhr, Saxony and the region of Stuttgart. Vehicle fleets and relevant infrastructure that are easily visible to the public will be particularly promoted. Activities in the model regions are embedded in regional funding structures, and superordinate sustainability and transport strategies.

Further information on the programme and the eight model regions an be found from page 2 onwards.

Federal Ministry
of Transport, Building
and Urban Development

NOW AND ITS PROGRAMMES

National Innovation Programme
Hydrogen and
Fuel Cell Technology

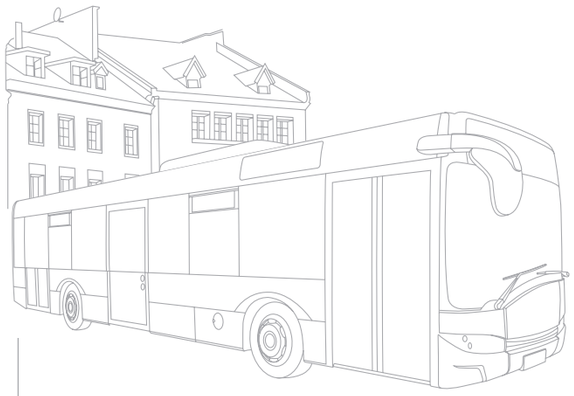
The NIP is …

Hydrogen and fuel cell technology will play an essential role in the future of mobility and energy supply. In order to guarantee the further development of these technologies, in 2006 government, industry and science began a strategic alliance called the National Innovation Prgramme for Hydrogen and Fuel Cell Technology (NIP). NIP is intended to speed up the process of market preparation of products based on this future-oriented technology. The total budget of NIP invested over a period of ten years until 2016 amounts to € 1.4 billion. The Federal Ministry of Transport, Building and Urban Development (BMVBS) and the Federal Ministry of Economics and Technology (BMWi, Bundesministerium für Wirtschaft und Technologie) provide half of this sum, while the other half is funded by participating industry.

Besides large-scale demonstration projects, NIP also focuses on research and development projects. The demonstration projects are grouped into comprehensive lighthouse projects and take place under real conditions. Project partners thus work together and more efficiently on issues and challenges, which they otherwise would have to face alone, and with considerable individual effort.

NIP is divided into four programme areas in order to advance in equal measure, numerous hydrogen and fuel cell technology product and application options, and to be able to address in a targeted way the market-specific challenges of market preparation. The particular programme areas are: »Transport and Hydrogen Infrastructure«, »Hydrogen Provision«, »Stationary Energy Supply«, and »Special Markets«. With an eye to series production of components, the explicit focus in all programme areas is on the strengthening of the supply industry.

Further information on the precise content of projects under NIP can be seen from page 82 onwards.



Federal Ministry of Transport, Building and Urban Development

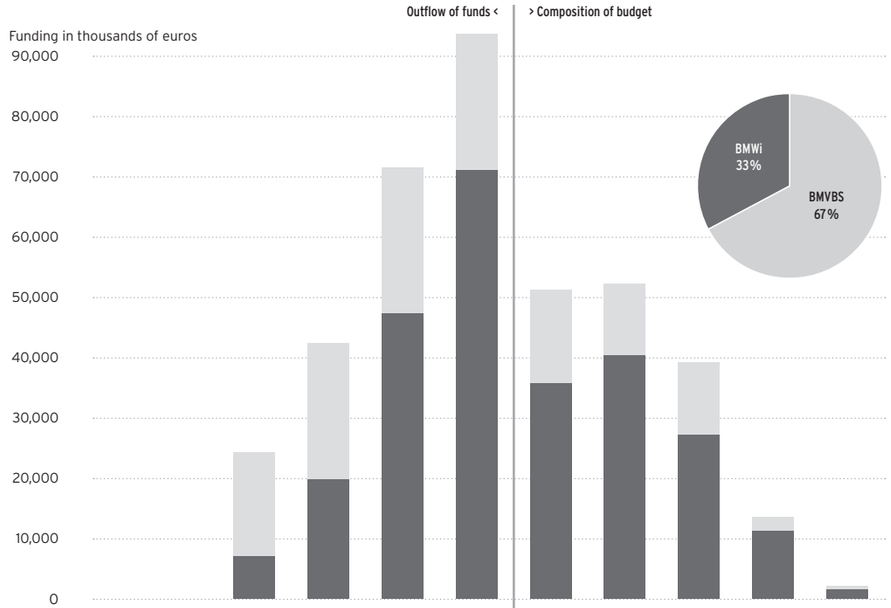
Federal Ministry for the Environment, Nature Conservation and Nuclear Safety

Federal Ministry of Economics and Technology

Federal Ministry of Education and Research

NOW AND ITS PROGRAMMES

NIP – Source of funds Demonstration (BMVBS) and R&D (BMWi)



	2008	2009	2010	2011	2012	2013	2014	2015	2016
BMWi	17,508	23,270	23,505	22,738	15,184	12,024	11,965	2,218	25
BMVBS	7,173	20,076	48,000	71,297	36,075	40,190	27,208	11,205	1,689

NIP – Areas of application (As at December 2011)

BMVBS funds

Programme area	Budget € K	Funding € K	In discussion € K	Apporved, LOI, application being processed € K
Transport	437,116	209,842	52,662	157,180
Hydrogen provision	31,557	15,554	216	15,338
Stationary industry	96,661	46,232	12,629	33,604
Stationary household energy	114,117	54,878	4,075	50,803
Special markets	122,190	58,445	22,391	36,053
Cross-cutting themes	26,623	12,852	1,958	10,893
Total	**828,263**	**397,803**	**93,932**	**303,871**

FEDERAL MINISTRY OF ECONOMICS AND TECHNOLOGY (BMWi)

The Federal Ministry of Economics and Technology (BMWi) funds projects with a focus on research and development, within the framework of the NIP

With the 6th energy research programme »Research for an environmentally friendly, reliable and affordable energy supply«, the federal government is setting the guidelines and points of focus of its support for the coming years. Funding initiatives for selected fields that are important for the future supply of energy in Germany are being developed together with other responsible departments.

In the area of hydrogen and fuel cell technology, the BMWi is supporting application-based R&D projects aiming to improve components and systems. In addition, several fundamental investigations and studies are being financed. The scope of support thereby spans the entire application area of the technology: from transport and infrastructure, stationary fuel cells for household energy supply as well as for industrial applications, to special markets for fuel cell technology.

New funding initiatives in energy storage

Due to the constantly growing share of energy from renewable sources, the storage of this energy will take on an increasingly important role in the medium to long term. Only with suitable energy storage methods can a high portion of the overall energy demand be secured from renewable sources. For this reason, the BMWi together with the Federal Ministry of Environment as well as the Federal Ministry of Education and Research have jointly started an initiative to support research and development in the area of energy storage technology. In a first phase the three departments are allocating up to 200 million euros in total until 2014 for the »energy storage funding initiative« and ensure targeted and efficient funding due to joint management of the programme. Research projects will be supported to develop a wide range of storage technologies for power, heat and other forms of energy. Consequently, comprehensive synergies can be realised across themes common to hydrogen and fuel cell technology.

Transport
- Polymer Electrolyte Membrane Fuel Cells (PEMFC)
- Peripheral components
- Drive technology
- Solid Oxide Fuel Cells (SOFCs) for onboard power supply in vehicles

Hydrogen generation and infrastructure, hydrogen storage

Stationary applications in household energy supply
- Reformation
- Low-temperature PEMFCs
- High-temperature PEMFCs, SOFCs

Stationary industrial applications
- Molten Carbonate Fuel Cells (MCFCs) and SOFCs
- Components
- Subsystems
- Series production manufacturing methods

Special markets for fuel cells
- Emergency power supply
- Warehouse vehicles
- Onboard power supply for the leisure market

Federal Ministry of Economics and Technology

The following BMWi NIP projects were approved in 2011:

Keyword
Kleingeräteprogramm (Small appliances programme)

Commencement	Conclusion	Recipients	Funding ratio %	Funding budget €
01.08.11	31.07.12	Sabo Elektronik GmbH	50.0	38,706
01.12.11	31.08.12	DMT Produktentwicklung AG	50.0	51,997

Keyword
SOFC

Commencement	Conclusion	Recipients	Funding ratio %	Funding budget €
01.07.11	30.06.14	ElringKlinger AG	50.0	1,746,056
		Forschungszentrum Jülich GmbH (Research Centre)	80.0	1,597,815

Keyword
AMORPHEL

Commencement	Conclusion	Recipients	Funding ratio %	Funding budget €
01.05.11	30.04.14	Fraunhofer-Gesellschaft zur Förderung der angewandten Forschung e. V. (FhG)	90.0	789,636

Keyword
HORIZONT

Commencement	Conclusion	Recipients	Funding ratio %	Funding budget €
01.06.11	31.05.15	European Institute for Energy Research Electricité de France/Karlsruhe Institut für Technologie	75.0	600,758
		Forschungszentrum Jülich GmbH (Research Centre)	90.0	810,383
		Rheinisch-Westfälische Technische Hochschule Aachen (RTWTH Aachen University)	90.0	534,107
		ElringKlinger AG	50.0	246,885

Keyword
SOEC

Commencement	Conclusion	Recipients	Funding ratio %	Funding budget €
01.06.11	31.05.15	KERAFOL Keramische Folien GmbH	60.0	543,537
		Siemens Aktiengesellschaft	50.0	454,622
		Forschungszentrum Jülich GmbH (Research Centre)	48.0	168,902

Keyword
VERITAS

Commencement	Conclusion	Recipients	Funding ratio %	Funding budget €
01.08.11	31.07.13	SFC Energy AG	50.0	540,256

FEDERAL MINISTRY OF ECONOMICS AND TECHNOLOGY (BMWi)

Keyword
SMART

Commencement	Conclusion	Recipients	Funding ratio %	Funding budget €
01.06.11	31.05.14	CeramTec GmbH	50.0	233,971
		ElringKlinger AG	49.8	2,947,819
		European Institute for Energy Research Electricité de France/Karlsruhe Institut für Technologie	70.0	426,260
		Sulzer Metco Woka GmbH	47.1	337,295

Keyword
MetalFuel

Commencement	Conclusion	Recipients	Funding ratio %	Funding budget €
01.06.11	31.05.14	Fraunhofer-Gesellschaft zur Förderung der angewandten Forschung e. V. (FhG)	80.0	541,243
		VARTA Microbattery GmbH	50.0	1,050,918
		FLEXIVA automation & Robotik GmbH	60.0	298,229
		Grillo-Werke Aktiengesellschaft	48.1	174,991

Keyword
BEST

Commencement	Conclusion	Recipients	Funding ratio %	Funding budget €
01.09.11	31.08.13	Fraunhofer-Gesellschaft zur Förderung der angewandten Forschung e. V. (FhG)	100.0	332,572

Keyword
EnerSta

Commencement	Conclusion	Recipients	Funding ratio %	Funding budget €
01.12.11	30.11.13	AEG Power Solutions GmbH	50.0	180,328
		EADS Deutschland GmbH	50.0	251,459

Keyword
Bestkat

Commencement	Conclusion	Recipients	Funding ratio %	Funding budget €
01.01.12	30.06.14	Daimler AG	48.0	569,938
		BASF SE	40.0	908,124

Keyword
NEKat

Commencement	Conclusion	Recipients	Funding ratio %	Funding budget €
01.12.11	30.11.14	Daimler AG	48.0	356,317
		Umicore AG & Co. KG	48.0	717,007
		SolviCore GmbH & Co. KG	48.0	435,332

INTERNATIONAL COOPERATION

In order to successfully commercialise hydrogen and fuel cell technology (H_2FC) and establish it as an integral part of the energy industry, international cooperation and a common strategic direction is needed. Companies operate worldwide, and so governments must integrate the global approach into their policies. This not only entails the systematic exchange of information about national programmes, projects and their results, but also coming to a global agreement on political framework conditions.
In the technological area of hydrogen and fuel cells, Germany is leading the way as a centre of development. Through its implementation of the NIPs it demonstrates its belief in these technologies as well as in their economic and environmental potential. NOW communicates this conviction and success to the international community. It also intensifies international cooperation and exchange of experience in a wide variety of areas such as research and development, programme management, building infrastructure, market launch strategies and politics.

Bilateral Activities 2011
In May 2010, NOW and the Japanese government agency NEDO signed a Memorandum of Understanding with the aim of enhancing both the information exchange as well as the existing relationships with NEDO and the partners of the Japanese H_2FC programme. Both NOW and NEDO are convinced that international cooperative ventures are essential for commercialising H_2FC technology, promoting the development of fuel cell vehicles, stationary fuel cells and for building hydrogen infrastructure. In a common workshop in June 2011, high-ranking representatives from politics and industry from both countries discussed project experiences and results in the area of mobile and stationary applications. They also identified potential cooperation opportunities as well as concrete courses of action to bring about a successful market launch.
In addition to Japan, the US is an important cooperation partner for NOW. As in the previous year, NOW representatives participated in May 2011 in the Annual Merit Review of the US Department of Energy's Fuel Cell Technology Platform. The collaboration between the Clean Energy Partnership (CEP) and the California Fuel Cell Partnership established itself and was continued in 2011 through lively information exchange in bilateral webinars.
On a European level, NOW cooperates with the European Commission's Fuel Cell and Hydrogen Joint Undertaking (FCH JU). The goal is to align research and development as well as the German demonstration programmes with those of the European Union. Possibilities for a common collaboration on existing projects are currently being evaluated.
The ene.field project would be suitable for development on a European level. On the initiative of NOW, a European consortium was founded in the area of stationary residential energy consisting of 27 partners from the heating appliances and energy industry. The structure and work content of the ene.field project are modelled on the Callux lighthouse project. The project application is being currently prepared, and when positively evaluated, could begin in the summer of 2012.

16th IPHE Steering Committee 18.11.2011, Berlin

Multilateral Activities 2011
Since 2010, Germany holds the chair of the International Partnership for Hydrogen and Fuel Cells in the Economy (IPHE) and coordinates their activities. The IPHE is a consortium of 17 member states and the European Commission, with the goal of accompanying and advancing the commercialisation of H_2FC technologies. Germany will hold the chair of the partnership including the administration of the IPHE Steering Committee until the end of 2012. NOW acts as the IPHE secretariat for this time period.
Under German leadership, the efforts to concertedly stimulate and promote exchange of experiences and international cooperation between the IPHE members have been extremely successful. In November 2011, Germany (Berlin) was not only host to the 16th IPHE Steering Committee but also to an international meeting of high-ranking experts on the topic of H_2FC technology – the IPHE Roundtable Meeting with Stakeholders. Around 80 prominent representatives from industry, research and politics participated and held a lively exchange with the aim of identifying global challenges to the market launch of H_2FC technologies and formulating guidelines for the IPHE. An additional IPHE project, which will be implemented under the leadership of the European Commission and with the support of the IPHE secretariat, is the coming workshop on the topic »Hydrogen as a storage medium for renewable energies« in November 2012 in Seville, Spain. NOW is making a decisive contribution here to the success of IPHE activities and their implementation, and specifically uses its role as German representative in this body to strengthen international exchange and cooperation.

NOW – THE ADVISORY BOARD

Intelligent control

»A stable, affordable and sustainable energy supply is essential for the German economy. In order to secure this when generating energy from fluctuating sources such as wind and sun, economical storage technology must be developed. Hydrogen … is one option … thanks to its many possible uses.«

From the National Development Plan (NEP – Nationaler Entwicklungsplan) Version 3.0

The Fukushima catastrophe and the ensuing change in energy policy meant that the National Innovation Plan (NIP) for hydrogen and fuel cell technology gained additional, vital importance. Previously, hydrogen was mainly seen as a fuel of the future by the auto industry. Now hydrogen also has a key role to play in storing electricity generated from the fast-growing volume of fluctuating renewable sources. This development throws up fascinating synergies, which are now addressed in the updated National Development Plan (NEP) Version 3.0.

The drawing up and recent updating of the National Development Plan is one of the central tasks of the NOW advisory board. The advisory board coordinates the interests of all players from business, science and politics, and enables strategic direction of the complete long-term innovation programme with its total budget of more than € 1.4 billion.

»Representatives of four ministries – the Federal Ministry of Transport, Building and Urban Affairs (BMVBS), the Federal Ministry of Economics and Technology (BMWi), the Federal Ministry for the Environment (BMU) and the Federal Ministry of Education and Research (BMBF) – and a coordinator representing the federal states have worked with experts from all relevant sectors of industry and research institutes, coordinating the programme effectively over the last five years. The professional implementation by programme management association NOW, the company founded for this purpose, in cooperation with project administrator Jülich, has enabled us to achieve results which meet top international standards in a short time«,

summarises Dr. Georg Menzen, Chairman of the Advisory Board.

By the end of 2011, more than 114 projects with a total budget of € 570 million had been started. The focus was on so-called »lighthouse« projects, designed to help new technologies achieve market-readiness as part of a holistic approach. As well as hydrogen and fuel cell projects, NOW has coordinated development in battery-powered mobility as part of the »Funding programme for model regions for electromobility« (part of the federal government's economic growth programme, Konjunkturpaket II), testing the everyday viability of vehicles and infrastructure in eight regions.

»Besides the successes, there is one area where we still need to do a lot of work. That is the question of instruments to bring the new technologies to the market. Japan and the USA are ahead of us on this, and we need to be careful not to fall too far behind«,

explains Prof. Werner Tillmetz, also Chairman of the Advisory Board. This area should be a focus for the future.

The many impressive results were presented to and discussed with stakeholders at two fully booked conferences in November 2011 – the Results Conference of the Electromobility Model Regions and the full meeting of the NIP Advisory Board.

The signs are good that commercial success will be achieved, in particular when the constantly expanding international cooperation is considered, for example through the IPHE.

All players are working together as partners towards an intelligent, electro-mobile, sustainable energy supply for the future.

THE ADVISORY BOARD IN DETAIL

The board is comprised of representatives from the following 18 interest groups:

GOVERNMENT

Federal Ministry of Transport, Building and Urban Affairs (BMVBS)
Stefan Schmitt

Federal Ministry of Economics and Technology (BMWi)
Dr. Georg Menzen (Advisory Board Chairman)

Federal Ministry for the Environment (BMU)
Wolfgang Müller

Federal Ministry of Education and Research (BMBF)
Karsten Hess

Representatives of the federal states
Dr. Heinz Baues, Heinrich Klingenberg
(without voting rights)

SCIENCE

Helmholtz Association for Research & Development
Prof. Detlef Stolten

Research & Development Institutes/Universities
Prof. Ulrich Wagner

Education
Prof. Jürgen Garche

INDUSTRY/APPLICATION

Mobility – Passenger cars
Dr. Sabine Spell

Mobility – Commercial vehicles
Peter Fröschle

Domestic energy supply
Joachim Berg

Industrial applications
Johannes Schiel

Specific applications
Prof. Werner Tillmetz
(Advisory Board Chairman)

Fuel cell components manufacturing
Dr. Silke Wagener

INFRASTRUCTURE

Fuel industry
Patrick Schnell

Hydrogen production
Dr. Oliver Weinmann

Hydrogen delivery
Dr. Joachim Wolf

Network supply
Andreas Ballhausen

PRESS AND PUBLIC RELATIONS 2011

FEBRUARY

PORSCHE E BOXSTER HANDOVER

Electromobile sports car: With the rollout of the E Boxster, Dr. Ing. h.c. F. Porsche AG, Stuttgart, marks the beginning of a field trial within the large-scale initiative: »Electromobility Model Region Stuttgart«. Dr. Veit Steinle, Head of Department at the Federal Ministry for Transport, Building and Urban Development (BMVBS), Dr. Klaus Bonhoff, Spokesperson and Managing Director (Chair) of NOW GmbH National Organisation Hydrogen and Fuel Cell Technology (NOW) as well as Dr. Walter Rogg, Managing Director of the Stuttgart Region Economic Development Corporation (WRS) are impressed with the vehicle and put the first noiseless metres behind them in the sporty research model.

Transport Minister Dr. Peter Ramsauer was also able to experience the sporty battery version of the Boxter at the International Transport Forum.

MARCH

NOW AT TOKYO FUEL CELL EXPO

Asian exchange: It has now become an annual event that NOW represents itself at a joint German exhibition stand at the world's largest hydrogen and fuel cell trade fair »FC Expo« in Tokyo. The International Partnership for the Hydrogen Economy (IPHE) uses the platform and organises a workshop in advance on stationary applications of fuel cells, in order to present current developments in governmental policy as well as in industry in the area of stationary fuel cells. Information gathered at the workshop allows international exchange of knowledge and assists other countries in the introduction of stationary applications of fuel cells. Such events also help to promote the market introduction of this technology.

APRIL

HANOVER FAIR/JOINT HYDROGEN AND FUEL CELLS EXHIBITION STAND/MOBILITEC

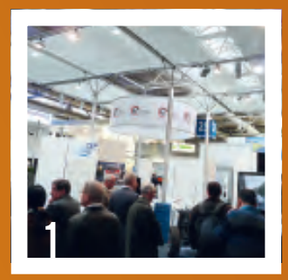
Visibility: Following last year's positive response, NOW presents itself at the common hydrogen/fuel cells exhibition stand as well as, for the first time, at MobiliTec. Together with partners from both programmes (National Innovation Programme for Hydrogen and Fuel Cell Technology (NIP) and Electromobility Model Regions of the Federal Ministry of Transport, Building and Urban Development), information on implemented demonstration projects and participants is displayed over almost 170 square metres. With 13 international flagship trade fairs, the 2011 Hanover Fair brings together key industrial technologies. State Secretary Rainer Bomba (BMVBS), EU Commissioner Günther Oettinger as well as many more guests visit the fair and discuss, together with Dr. Klaus Bonhoff, NOW, the status quo as well as other projects.

1 Avid interest at the joint exhibition stand of NOW, the Model Regions and CEP at MobiliTec

2 Dr. Veit Steinle, Head of Department at the Federal Ministry for Transport, Building and Urban Development (BMVBS), visits MobiliTec

3 EU Commissioner for Energy Günther Oettinger informs himself at the exhibition stand of the Fuel Cells Initiative (IBZ)

4 NOW at the Fuel Cells joint exhibition stand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APRIL

FAZ WORKSHOP WITH JOURNALISTS

Hydrogen as an economic factor: The topic »Emissions and investments« is the focus of the workshop in F.A.Z.'s (a Frankfurt newspaper) headquarters in Frankfurt. Experts from industry, science and politics discuss together with journalists to what extent hydrogen acts as an impetus for economic growth. Major partners from the Rhine-Main region such as Deutsche Bank, Adam Opel AG and Fraport present their ideas on the topic. State Secretary Rainer Bomba (BMVBS) and Dr. Klaus Bonhoff, NOW, close proceedings by inviting journalists to visit the first Hessian hydrogen fuelling station in the Höchst industrial park.

HOPPECKE BATTERY TEST CENTRE

Opening ceremony: Hoppecke together with the Parliamentary State Secretary Jan Mücke (BMVBS) launches the new battery research and development centre. It provides 1,500 square metres of space for conducting experiments, prototype-building and tests in comprehensively-equipped laboratories and workshops.

Jan Mücke, Parliamentary State Secretary at the Federal Transport Ministry (BMVBS), opens the development centre for batteries in Zwickau

MAY

VANCOUVER HYDROGEN & FUEL CELLS

Canada as host: NOW GmbH takes part in the international conference and exhibition »Hydrogen and Fuel Cells« at the German pavillon. The IPHE coordinates its 15th workshop in the margins of the event.

CHALLENGE BIBENDUM IN BERLIN TEMPELHOF

Mobility challenge: NOW participates in the Challenge Bibendum for the first time. Aside from the NOW-organised school newspaper competition, the accession of Air Liquide and Honda to the CEP is a particular highlight. With these new partners, the Clean Energy Partnership (CEP) gains an additional two global companies for the development of hydrogen mobility in Germany.

Patrick Schnell, CEP spokesperson, Patrick Bachmeier, Honda Germany, Jan Mücke, Parliamentary State Secretary at the Federal Transport Ministry, Dr. Klaus Bonhoff, Managing Director (Chair) of NOW GmbH

HYTRUST CITIZENS' CONSULTATION

Citizens' perspective: »The use of hydrogen in the transport area makes sense when it is generated free of CO_2«. That is the main conclusion of a citizens' consultation that was compiled as a part of the NIP-funded project HyTrust, and presented to the Federal Ministry of Transport, Building and Urban Development at a press conference. HyTrust is a long-term scientific study on the acceptance of hydrogen in society.

HYBRID BUS DELIVERY BY THE TRANSPORT MINISTER

Electromobility you can experience: On the occasion of the International Transport Forum in Leipzig, the Federal Transport Minister Dr. Peter Ramsauer presented ten hybrid-operated low-floor busses to each of the transport authorities of Leipzig and Dresden. The goal: to gradually develop the vehicles into busses with extended electric drive operation. They will be driven by a serial hybrid system which facilitates a partly emission-free, fully electric operation. At the ITF, NOW presented itself at the common exhibition stand of the BMVBS.

Dr. Klaus Bonhoff, Managing Director (Chair) of NOW GmbH with Dr. Peter Ramsauer, Federal Minister of Transport, Building and Urban Development, MP, at the ITF in Leipzig

MODEL REGION HAMBURG

Electromobile green capital: The Parliamentary State Secretary Enak Ferlemann (BMVBS) assesses funded projects in the Hamburg model region; a vehicle convoy through the city demonstrates the spectrum of the electric fleet (busses and cars) already in operation as well as the charging infrastructure.

Dirk Inger, Head of the Subdivision for Climate and Environmental Protection Policy BMVBS, receives the HyTrust Study

Dr. Peter Ramsauer, Federal Minister of Transport, Building and Urban Development, MP, at the allocation of hybrid busses in the Saxony model region

JUNE

H2EXPO

International Conference: In Hamburg, NOW participates in the conference and trade fair for hydrogen, fuel cells and electric drives. NOW is represented with an exhibition stand. The organisation's work is outlined by Dr. Klaus Bonhoff, NOW, through panel discussions and presentations. Further information and talks are offered at the exhibition stand at the accompanying fair.

BSR TESTS HYDROGEN PROTOTYPE

Quiet city cleaning: State Secretary Rainer Bomba (BMVBS), together with Dr. Klaus Bonhoff, NOW, hands over a vehicle to Berlin's city cleaning and waste disposal company (Berliner Stadtreinigung (BSR)). Around 20 per cent of fuel will be saved with the hydrogen prototype, which will be in operation for two years.

1 Jan Mücke, Parliamentary State Secretary at the Federal Transport Ministry, at the joint journalists' workshop of the model regions

2 Dirk Inger, Head of the Subdivision of Climate and Environmental Protection Policy at the Federal Transport Ministry, together with Shell Germany CEO Dr. Peter Blauwhoff and Dr. Klaus Bonhoff, Managing Director (Chair) of NOW GmbH, test the new hydrogen fuelling station on Berlin's Sachsendamm

3 Rainer Bomba, State Secretary at the Federal Transport Ministry in front of the hydrogen protoypes of Berlin's city cleaning company (BSR)


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JULY

JOURNALISTS' WORKSHOP

Exchange: Together with the eight model regions, NOW hosts a journalists' workshop in the Heinrich Böll Foundation in Berlin. Under the heading: »Electromobility – quo vadis? The concept of model regions at the interface of technology, politics and industry« and in cooperation with the F.A.Z., leading journalists from the Spiegel, Zeit and Wirtschaftswoche are invited, among others, to discuss developments and perspectives with Parliamentary State Secretary Jan Mücke (BMVBS) and Chair of the NOW Advisory Board Prof. Werner Tillmetz at the technology journalism forum. WWF, the Boston Consulting Group and Frauhofer IFAM also present their views on the topic. Test drives round off the diverse workshop programme.

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AUGUST

OPEN DAYS AT THE TRANSPORT MINISTRY

A free pass: The model regions as well as the CEP hydrogen fleet are again represented in 2011 at the NOW exhibition stand during the Open Days of the Federal Transport Ministry. Vehicles are test-driven by visitors and experts are on hand for explanations of the technology.

Jan Mücke, Parliamentary State Secretary at the Federal Ministry, at the NOW exhibition stand

Rainer Bomba (State Secretary at the Federal Transport Ministry), Günter Elste (Chairman of the Board of Management at Hamburger Hochbahn AG), Olaf Scholz (First Mayor of Hamburg) and Hartmut Schick (Head of Daimler Busses) at the allocation of new fuel cell hybrid busses to Hamburger Hochbahn AG

SEPTEMBER

INTO THE FUTURE

Vision: Together with the Federal Transport Ministry and the Fraunhofer IAO, NOW hosts the »Electromobile city of the future« conference in the BMVBS. At numerous talks, visitors learn about various developments and visions for the future in electromobility. Prior to this a competition was tendered. The aim was to present ideas in four future areas, in which current developments and trends are further developed.

1 Preparation of a graphic protocol at the »Vision – Electromobile city of the future« conference

2 Rainer Bomba, State Secretary at the Federal Ministry of Transport, Building and Urban Development and Dr. Klaus Bonhoff, Managing Director (Chair) of NOW, award the winners of the »Vision – Electromobile city of the future« competition in the Federal Ministry of Transport, Building and Urban Development


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SEPTEMBER

CLEAN TECH MEDIA AWARD

Green carpet: The Clean Tech Media Award is conferred in the European Green Capital of Hamburg. At the accompanying exhibition in the Hamburger Curiohaus, guests from the worlds of politics, media and industry learn about the model region concept as well as hydrogen/fuel cell issues at the NOW exhibition stand. Electric vehicles are available for shuttle service.

F-CELL IN STUTTGART

The electromobility range: As in previous years, NOW presents the issue of electromobility with hydrogen/fuel cells and batteries as priority areas. At a large exhibition stand, visitors inform themselves about the NOW programmes. In addition, Dr. Klaus Bonhoff and Programme Managers Wolfgang Axthammer and Thorsten Herbert presented at the conference.

Christoph Müller (Nokia Siemens Networks), Prof. Dr.-Ing. Hans-Peter Beck (TU Clausthal), Dr. Gunnar Bender (Member of the Executive Board, E-Plus), Dr. Karsten Menzel (E-Plus Group), Rainer Bomba (State Secretary BMVBS) and Wolfgang Axthammer (Programme Manager NOW Special Markets)

NOVEMBER

NIP HIGHLIGHTS IN BERLIN

Successful programme: Opened by the State Secretary Rainer Bomba (BMVBS), the NIP general assembly took place on 7 th and 8 th of November. In the plenary as well as in three parallel sessions, over 90 delegates presented the results and successes of their NIP-funded projects in the areas of transport/hydrogen provision, stationary applications as well as special markets. By means of a previously formalised presentation structure, the audience was able to easily compare the presentations and projects. In total, around 350 people participated in the assembly.

1 Dr. Klaus Bonhoff, Managing Director (Chair) of NOW

2 Rainer Bomba, State Secretary at the BMVBS and Prof. Dr. Werner Tillmetz, Chairman of the NOW Advisory Board

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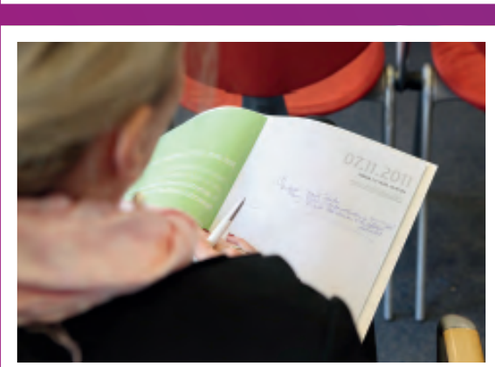
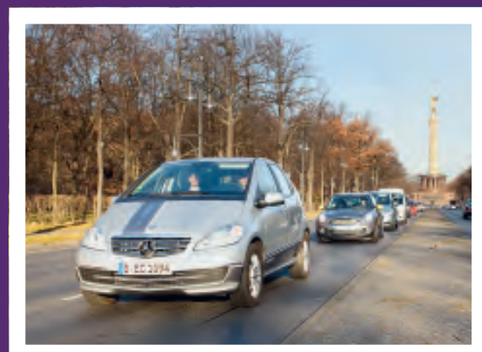


NOVEMBER

ELECTROMOBILITY IN THE MODEL REGIONS – RESULTS AND OUTLOOK

Results conference: The Transport Ministry hosts the presentation to the public of valuable insights following two years of hard work in the model regions. Experts from all countries and platforms get involved in the two-day event in Berlin. The active participation of State Secretary Rainer Bomba, Andreas Scheuer as well as Enak Ferlemann demonstrates the political relevance of the topic of electromobility. The fully-booked conference is accompanied by a press conference. A further highlight is a convoy, displaying the range of all electric vehicles in the programme, travelling from the Ministry to the event location. Leading regional representatives from the model regions, who also participate in the podium discussion, travel in the convoy.



1 Rainer Bomba, State Secretary at the BMVBS in discussion with state representatives from the model regions

2 Roundtable on the role of the regions with state representatives from the model regions

DECEMBER

INDUSTRY AND RESEARCH INTRODUCE THE »PERFORMING ENERGY – WIND HYDROGEN ALLIANCE« INITIATIVE

The »performing energy – Wind Hydrogen Alliance« initiative kicks off in early December with renowned representatives from industry, science as well as organisation from the areas of environment and technology funding. Aim of the initiative, in which NOW served as a neutral platform during the establishment process, is to conduct initial trials that determine the prerequisites for the future economic integration of hydrogen storage systems in the energy industry.

Hydrogen is cheaper than petrol

Alternative drive technologies | Fuel cells can secure the future of the automotive industry

by Klaus G. Wertel

The energy revolution is one of the most talked-about topics right now. The fact that hydrogen is rarely mentioned does not bother Klaus Bonhoff, Managing Director (Chair) of the National Organisation Hydrogen and Fuel Cell Technology (NOW). »We have leaned from the hydrogen hype in the late 1990s, which ended in disappointment,« Bonhoff explained at the Forum for Technology Journalists in Frankfurt. »We are now careful not to promise anything we cannot deliver.« The implicit criticism of the battery-powered rivals is clear. The two technologies are competing for millions of euros of public research grants.

One of the people deciding who these research funds should be allocated to is Rainer Bomba, State Secretary in the Federal Ministry of Transport. And he is quick to emphasise that the federal government considers ideas for renewable energy and alternative fuels »without prejudice, and is open to all technologies«. This also applies to funding requests and project choices of the National Platform for Electromobility. »There is still a long way to go,« says Bomba. »It would be quite wrong to play the battery off against the fuel cell or vice versa.«

German automotive manufacturers gear up with alternative drive technologies:
The Mecerdes-Benz B-Class F-CELL at a hydrogen filling station (left)
(Photo: Daimler)

Production can commence soon

As far as the use of hydrogen and fuel cells is concerned, economically-viable mass production should be possible in the near future. Two or three years ago, fuel cell vehicles had a reputation for unreliability, and they could not be produced at a price consumers would be willing to pay. Today, Uwe Peter Deller, Opel manager in charge of a test fleet of fuel cell vehicles, says his fleet are covering well over 100,000 km without having to replace fuel cell components. For example, an Opel HydroGen 4 is in use as a repair and recovery service vehicle in Berlin by the ADAC, Germany's biggest automobile club. The car is being pushed hard every day and there have been no problems.

Deller brought a HydroGen 4 to the Frankfurt forum. It is large, practical and looks and feels ready for mass production. The fuel cells hum quietly. Filling the tank is no longer a major undertaking. It takes only three minutes to pump 4.2 kg of hydrogen into the 700 bar tank – enough for 400 km at a cost of just 40 Euros. Moving a two-ton vehicle is scarcely cheaper using diesel.

Deller was remarkably relaxed when asked about the price of hydrogen-powered cars: »We have to be competitive, and are looking to price alongside similarly-sized diesel-hybrids of comparable horse-power.« The Opel manager did not deny that such prices will mean that costs will not be covered in the first few years of production.

Electric cars will be made in Asia

Johannes Töpler, chairman of the German Hydrogen and Fuel Cell Association (DWV) insists that this complex technology makes sense for German automakers, despite the cross-subsidies: »This is a question of the survival of our industry – battery-powered cars use simple technology, and will be produced mainly in China and other low-cost countries.«

Supply of hydrogen is not a problem for Germany or other developed nations. »The hydrogen produced as an industrial by-product in Germany alone would be enough to power 500,000 to 600,000 fuel cell vehicles,« confirms NOW Managing Director (Chair), Bonhoff. The chemical and petro-chemical industries produce much more hydrogen than they can find a use for. And supply could be increased by using excess wind and solar power to produce hydrogen by electrolysis.

The network of hydrogen filling stations is small but expanding: it has doubled to 25 stations over the last two years. Hydrogen is mostly available at existing petrol stations, generally near industrial hydrogen producers.

Linde and Daimler working together to improve infrastructures

In June, the carmaker Daimler and the industrial gas specialist Linde agreed to cooperate to expand the infrastructure for hydrogen-powered vehicles: they plan to add at least 20 more filling stations to the network in the next three years. These stations will complete north-south and east-west axes, and expand hydrogen-clusters in and around Stuttgart, Berlin and Hamburg. The high-pressure containers and pumps will be installed at selected existing filling stations run by various oil companies.

In contrast to fuel cell cars, non-mobile fuel cell generators are already competitive and do not need public funding or cross-subsidies. These extremely quiet, zero-emission generators are already replacing diesel aggregates to provide emergency power capacity for hospitals, data centres and other places where a continuous supply of electricity is essential. Fuel cells are replacing batteries on forklifts and other vehicles operating indoors or in enclosed spaces. The advantage is that fuel cells do not need a long break for recharging. Frankfurt Airport is one company that is switching from batteries to fuel cells for its on-site logistics.

Mixing hydrogen and natural gas

Hydrogen could soon also play a greater role in industrial-scale energy production. Werner Diwald, Board Member of the Brandenburg energy company, Enertrag, sees an increase in the proportion of hydrogen added to natural gas as an option. Germany currently allows natural gas to contain 5 % hydrogen. Increasing this proportion to 10 % is possible »without affecting machines or systems«. Diwald also points out that in years gone by, town gas used to contain 50 % hydrogen.

»It would be quite wrong to play the battery off against the fuel cell or vice versa.«

Rainer Bomba (CDU), State Secretary in the Federal Ministry of Transport

But hydrogen could also be used pure to provide energy, says Diwald – and to store excess wind power. Enertrag is currently building the world's first hybrid power station in Prenzlau, in which wind and methane will work alongside hydrogen. When the windmills are producing more power than required, this will be converted to hydrogen. And when there is no wind, this hydrogen will be mixed with methane to power the hybrid plant.


callux
Verbundnetz Gas AG
HEXIS
E·MOBI
Fahre mit Wasserstoff
Wasserstoff – H2
BRENNSTOFFZE
Wir regeln das mit
H2

PROGRAMME AREA

ELECTROMOBILITY MODEL REGIONS BMVBS

02

NIP – TRANSPORT AND INFRASTRUCTURE

82

NIP – HYDROGEN PROVISION

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NIP – STATIONARY ENERGY SUPPLY

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NIP – SPECIAL MARKETS

110

ELECTROMOBILITY MODEL REGIONS BMVBS

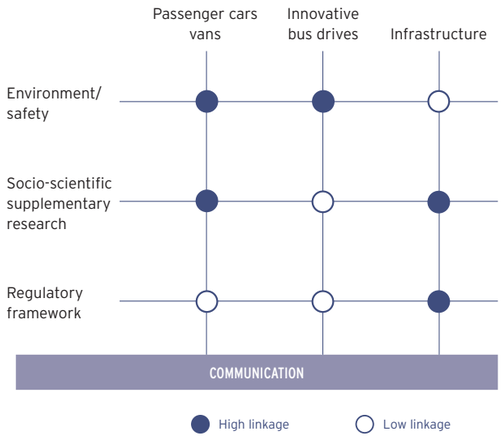
Implementing electromobility with batteries in the area of transport as an alternative to drive using fossil fuels such as diesel and regular petrol, is a shift that can play an important role in reducing CO_2-emissions harmful to the environment.

With its funds, the Federal Ministry for Transport, Building and Urban Development (BMVBS) supports the testing of electromobility with batteries under everyday conditions and market preparation within the framework of the electromobility model regions. Coordinated by NOW, the establishment of eight electromobility model regions across Germany was commenced by 2011. The project partners additionally exchanged information and experiences across trans-regional thematic platforms.

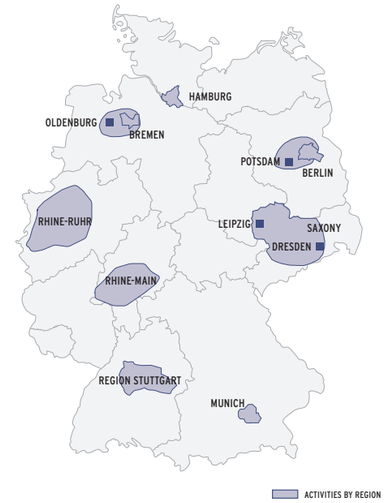
The federal government is supporting electromobility with 500 million euros as part of its economic stimulus package »Konjunkturpaket II«. Of this amount, the BMVBS provided 130 million euros for the electromobility model regions. More than 200 projects have been undertaken for which energy providers, vehicle manufacturers, public utility companies, research institutes along with numerous suppliers and small and medium-sized firms were involved in their development. This enabled more than 2,000 electric vehicles and the requisite recharging infrastructure to be tested under day-to-day conditions.

Building on the electromobility model regions scheme, the suitability of the vehicles for daily use will continue to be examined in the model regions. The extension of these activities is in accordance with the funding guidelines of 16.06.2011, and will be coordinated by NOW until 2014.

CROSS-LINKING OF THE PLATFORMS



THE EIGHT BMVBS MODEL REGIONS



ELECTROMOBILITY MODEL REGIONS BMVBS

Results

OF THE ELECTROMOBILITY MODEL REGION FUNDING PROGRAMME

The model regions comprise the most comprehensive German funding programme for everyday suitability of battery electric mobility. This applies equally to its economic significance, the effective implementation structure, number of deployed vehicles, installed infrastructure, thematic breadth and diversity of participating partners. The programme has delivered valuable insights for the further development of electromobility – especially in regard to areas of activity concerning private transport, public transport, fleet usage, business transport, infrastructure and urban development. The supplementary research has established a unique pool of data pertaining to the fields of environment, user acceptance and safety. What has been collectively accomplished in the eight model regions to date can be described as being decisive for further developments in electromobility.

Research and development – open to all types of technologies – into battery-electric vehicles was promoted within the model regions. The vehicles could be demonstrated and tested in situations close to real life and across user-oriented scenarios. The programme succeeded in bringing together numerous participants from the relevant industries as well as stakeholders from research, associations and the public sector in order to foster the development of local and regional partnerships. New forms and concepts of mobility could be developed and implemented locally.

A significant positive effect on the environment through electric vehicles is anticipated in conjunction with the expansion of renewable energies and increasing numbers of vehicles. To support this, the funding programme has laid foundations important for the future market launch. Various potential user benefits for electrically powered vehicles could thereby be identified and initial business models could be developed and tested upon this basis.

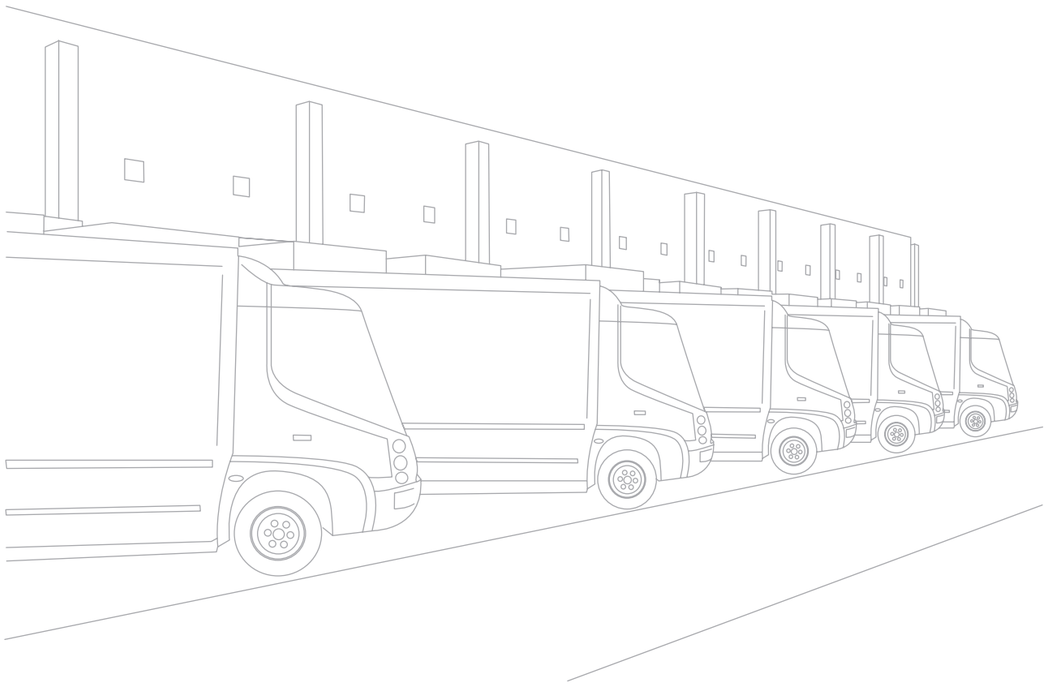
Business transport has emerged as the first potential profitable area of application for electromobility. This field of action may become a major catalyst for further development. The hybrid buses deployed in the public transport networks convinced with their high availability, significant energy savings and environmental advantages. The operating companies and users alike also positively evaluated the field trials. For private use, electric vehicles will establish themselves in the medium term. An initial field of application is for urban and commuter use. It was also shown that the vehicles could be integrated into classic car sharing services very well – but in terms of use under everyday conditions, further demonstration projects are still required. Contrary to expectations, the resonance of electromobility in rural regions proved to be very positive. Overall, the user surveys conducted showed very realistic expectations for electromobility and good evaluations of the vehicles and their attributes, even after longer periods of use.

For the needs-based establishment and expansion of public infrastructure, the model regions developed programmatic approaches to solutions despite the uncertainties that continue to exist in both the private and public domains. Semi-public infrastructure attracted considerable attention as it can amalgamate the advantages of public and private locations. The latter can essentially be set up without problems even when taking into account the fact that technologies can differ according to the type of charging and use. In addition, lively and intense discussions were undertaken in regard to technical developments.

The subject of electromobility will be continued by the BMVBS with the first projects in 2012. This will include the continuation of the user-oriented demonstration with a nationwide cluster approach in accordance with regional strategies. Superordinate thematic platforms with topics that include socio-scientific supplementary research, internationalisation, regulatory frameworks, safety, environmental aspects, infrastructure and integrated mobility concepts remain an integral part of the overall concept.

THEMATIC PLATFORMS

Thematic platforms are a fundamental element of the programme alongside the geographical regions. NOW coordinates the work of project partners, representatives from the regional project headquarters and the BMVBS who work interlinked on daily use and user-oriented demonstration projects covering the key issues across eight model regions. In this way, important insights for the development of electromobility can be jointly compiled.



PLATFORM SOCIO-SCIENTIFIC SUPPLEMENTARY RESEARCH

The programme's socio-scientific supplementary research focused on two issues: what expectations and experience do private and commercial users have of electromobility in everyday life? And which goals, requirements and challenges exist on the part of the local municipalities? Only in-depth knowledge of both points of view will enable the long-term establishment of appropriate basic parameters able to shape the dynamic development of electromobility in a way that is desirable in terms of transport policy. For this purpose, with the participation of more than 20 scientific institutions in all the model regions, the users of the electric vehicles in operation were questioned in line with previously-defined standards. A nationwide city survey was also carried out and all the data collected was evaluated as a whole. The key results of the work of this platform are the publication »What do future users expect of electric vehicles« and the road-maps »customer acceptance« and »electromobile city«. Fresh ideas and a lively exchange were also generated by the competition »Vision – Electromobile City of the Future« as well as the conference of the same name held in September 2011. The platform socio-scientific supplementary research was headed by NOW while the Fraunhofer Institute for Systems and Innovation Research ISI and the Fraunhofer IAO were responsible for the professional realisation.

The largest survey of electric vehicle users to date, with a total of approx. 2,500 standardised data sets, provides a comprehensive overview of the convincing aspects of electromobility and the areas in which the user feels that some catching up needs to be done. The general picture is positive and the users are very enthusiastic about the electric vehicles: the survey respondents specified that these are beneficial for everyday life and easy to operate both in terms of driving and charging. They especially value the driving pleasure as well as the positive public image and the environmental compatibility of their vehicles.

There is room for improvement in particular with regard to costs and the operating range of the electric cars: the users in the model regions perceive the current acquisition costs of the vehicles to be too high. Accordingly, many of them would like the purchasing price to be subsidised or tax concessions offered. The limited range of the vehicles is also seen to be a problem. In this case, the respondents would like to see considerable improvements, as well as the development of the charging infrastructure.

When asked if they had any concrete future purchasing plans following the model region projects, the responses were reserved. However, the users rated the future potential of electromobility as positive: the respondents are convinced that electric vehicles will establish themselves on a permanent basis. In particular, it is anticipated that the combination of different transport carriers (intermodality) will have a positive impact.

The city survey succeeded in establishing a comprehensive overview of the requirements and plans in the cities and local municipalities. In addition to a positive impact on the environment, electromobility is associated with an upswing of alternative transport concepts. The persons responsible in the cities look very favourably on alliances with the local public transport system and sharing-concepts. When electric vehicles are already in operation, it is usually in the context of fleets of cars or tourist offers. Concepts for the introduction of electromobility are frequently promoted in connection with development plans, for example in the transport and environment sectors.

The business models for the commercial fleet operation of electric vehicles also need to be developed in the future, as does a comprehensive acceptance profile for this sector. A continuation of the networking activities between the local municipalities and the commercial agents of electromobility is recommended. In addition, a survey that is as extensive as possible should be carried out to assess the degree of implementation for electromobility in differently-sized cities.

PLATFORM INNOVATIVE DRIVE BUS

The platform »Innovative drive bus« examined the activities and findings centred around the operation of hybrid buses in all of the model regions, including those with serial, parallel and power-split hybrid drive systems. The platform comprises numerous bus operators, manufacturers and bus component manufacturers. Scientific institutions, the Federal Ministry of Transport, Building and Urban Development (BMVBS), representatives from the project coordination centres in the model regions and the Verband der Deutschen Verkehrsunternehmen (Association of German Transport Companies – VDV) also participated in the platform. The operating data of the buses deployed in the model regions formed the basis of the work. In addition, supplementary test runs were included in the analysis. Furthermore, surveys were carried out to assess the acceptance of the technology on the part of bus drivers and passengers. The experience and test results collected in this way form a unique data pool in the sector diesel-hybrid technology and for the first time enable a systematic analysis of its practical feasibility and impact on the climate. The platform was organised by NOW and HySolutions.

The driving performance and period of operation generated by the buses deployed achieved almost the same values as conventional buses. During the period of operation, the availability also came close to the usual value of 90 %. There were mixed results in terms of fuel efficiency. On one hand savings of up to 20 percent were achieved, however on the other hand there were also companies that recorded increased consumption. This was the result of different factors, for example company management, the characteristics of the route or the air conditioning and hence these aspects were immediately subjected to initial, more conclusive testing.

In the areas of ecology and climate protection, the main focus was on an analysis of the life cycle of two diesel-hybrid buses, including possible additional production-related work and expenses. In the case of most of the parameters analysed (e.g. CO_2-emissions), the hybrid technology amortises itself after just one year of operation. After two years at the latest, an amortisation of all the analysed environmental influences was achieved. As a further area of research, measurements were made of noise emissions, which were usually lower than the levels of conventional diesel buses, especially in the purely electric operational mode. In the course of the acceptance surveys, 250 bus drivers and approx. 1,400 passengers and passers-by in the model regions were questioned about their impressions. The main focus of the questions asked of the drivers concerned their handling of and readjustment to the new vehicles, while the passengers were primarily questioned about how they perceive the driving noise levels. Overall, the evaluation of the hybrid technology was positive.

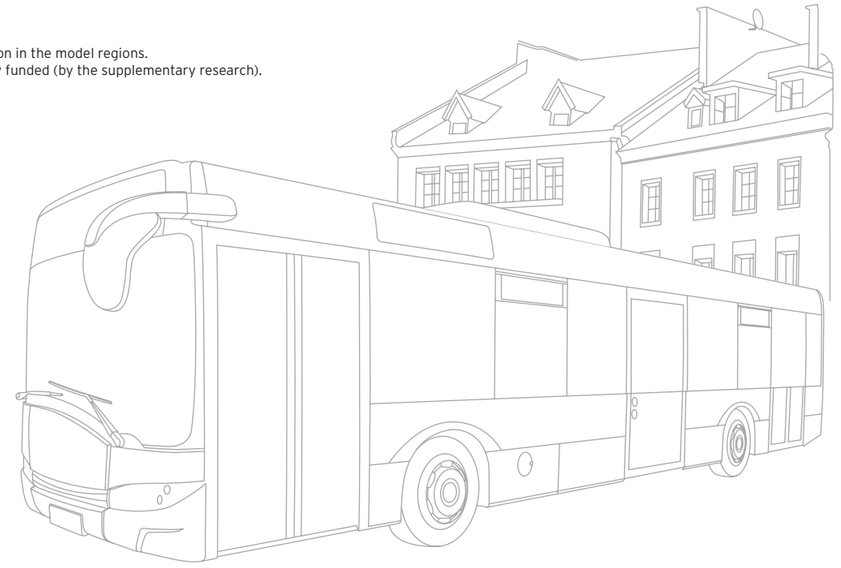
One issue that materialised as significant for the bus platform was the education and further training of specialist staff. A VDU publication was issued on this topic, which provides suggestions for the introduction of hybrid buses from the perspective of their maintenance and repair.

The bus platform determined a need for research in a variety of areas. Hence the scope for optimisation ascertained while the buses were in operation is a good starting point for further improvement in the areas of fuel consumption and availability, aspects that to some extent have already been broached or implemented. It is recommended that the data collection should be continued on a regular basis, as this was a positive experience and serves to highlight the aspect of economic viability. Last but not least, it seems that it would be advantageous to continue with the operating phases and the respective communication measures, in order to ensure the acceptance of the technologies among the population and the transport companies.

MANUFACTURER	EVOBUS	HESS	MAN	SOLARIS/ ALLISON	SOLARIS/ VOITH	VOLVO	VDL
Type of bus	Articu-lated bus	Articu-lated bus	Solo bus	Articu-lated bus	Articu-lated bus	Solo bus	Solo bus
Hybrid technology	Serial	Serial	Serial	Power-split	Parallel	Parallel	Serial
Type of energy storage	Lithium-ion battery	Supercap	Supercap	Nickel-metal hydride	Supercap	Lithium-ion battery	Supercap
Number of vehicles	30	17	2	7	3	1	3
Operation in	Hamburg, Bremen, Munich, Rhine-Ruhr, Saxony, Stuttgart	Rhine-Ruhr, Saxony	Rhine-Ruhr, Munich	Rhine-Ruhr, Munich, Saxony	Rhine-Ruhr	Rhine-Ruhr	Rhine-Main

FIG: OVERVIEW OF THE VEHICLES*

* A total of 63 hybrid buses are in operation in the model regions.
59 of these buses are actively or passively funded (by the supplementary research).
These comprised the basis for the data.



PLATFORM
CAR/TRANSPORTER: SUPPLEMENTARY RESEARCH ENVIRONMENT

The goal of the platform supplementary research environment was to assess the environmental impact in the model regions, in particular the CO_2-emissions, and also highlight the prospective requirements of an environmental and climate-friendly form of electromobility. About 40 representatives from the participating research institutions as well as automobile manufacturers, retrofitters and energy suppliers were involved in the work of the platform. It was jointly coordinated by NOW and Energie-Agentur.NRW, while the Wuppertal-based institute was responsible for the professional and technical management.

In order to ascertain the energy consumption levels and the impact on the climate, a uniform data set was compiled using statistics from all the projects. In this way, the deployment of about 350 vehicles with a total driving performance of approx. 530,000 kilometres and around 30,000 charging procedures were consolidated in an integrated analysis. One key finding is that the vehicle limitations posed by the range and battery capacity by no means caused restrictions to everyday use.

In order to evaluate the environmental impact, the vehicles were divided into three categories and in each case the driving data was used to calculate the average fuel consumption. Finally, using different methods of calculation, these were contrasted with the fuel consumption and CO_2-emissions of conventional vehicles. If one takes the current fuel mix in Germany as a basis, the CO_2-emissions generated by electromobility, for example, seem to be comparable with those of conventional vehicles. In the long term, this ratio will shift very clearly in favour of electromobility by 2030, assuming that the energy supply will be based increasingly on renewable energy. When, to what extent, and under what circumstances it is possible to ascribe the traction current directly to a regenerative form of electricity generation is currently the subject of debate.

In addition to the impact on the climate, the noise and exhaust fume levels generated by electromobility were analysed in more depth. Although it goes without saying that the noise emission levels of individual electric vehicles are lower, the research shows that one cannot initially count on a tangible reduction of the traffic noise as the conventional vehicles will continue to determine the noise levels. However, potentially it can be anticipated that the electrification of the delivery vehicles, as well as buses, utility vehicles and two-wheelers will have the greatest impact. The polluting and particle emissions generated by electric vehicles are low. However, additional relief for the environment is not a very relevant issue as the maximum levels for conventional vehicles are already low.

With regard to the eco-balance (cumulative energy demand for the entire life-cycle), the vehicle and battery production of electromobility still show quite negative results. Furthermore, potential supply shortfalls have been discussed, particularly with regard to the raw materials, nickel and lithium. However, the expected difficulties posed by the provision of fossil fuels are perceived to be more serious. These apply to both the (negative) contribution to the carbon footprint and the overall security of supply.

The supplementary research environment platform has made concrete recommendations for action and research. They have explicitly stressed the need for more in-depth knowledge with regard to the eco- and transport-systematic impact of electric vehicles as well as the open-ended research on the incorporation of vehicles in an energy industry that is based largely on renewable energy.

MODELS INCLUDED – IN SEGMENTS	
SEGMENTS	**MODELS**
Minis/microcars	smart ed; THINK City; Mitsubishi I-MiEV; Fiat 500 Electric; CITYSAX; e-WOLF DELTA 1
Small cars	Stromos
Compact class	Mercedes A-Class E-Cell; VW Golf blue-e-motion
Medium size	Renault Fluence Z. E.
Utility vehicles (small)	Renault Kangoo Z. E.; Fiat Fiorino Electric; Ford Transit Connect BEV; Goupil G3
Utility vehicles (large)	Mercedes Vito E-Cell; Ford Transit BEV; Modec

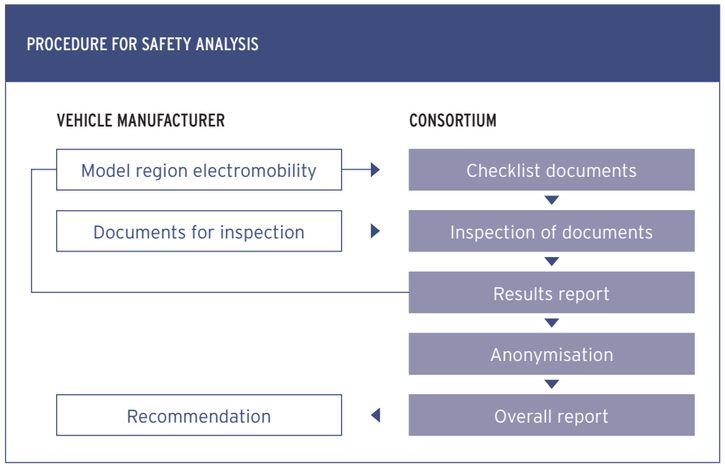
FIGURE: IN ACCORDANCE WITH GUIDELINES BY THE FEDERAL OFFICE FOR REGULATION OF MOTOR VEHICLES

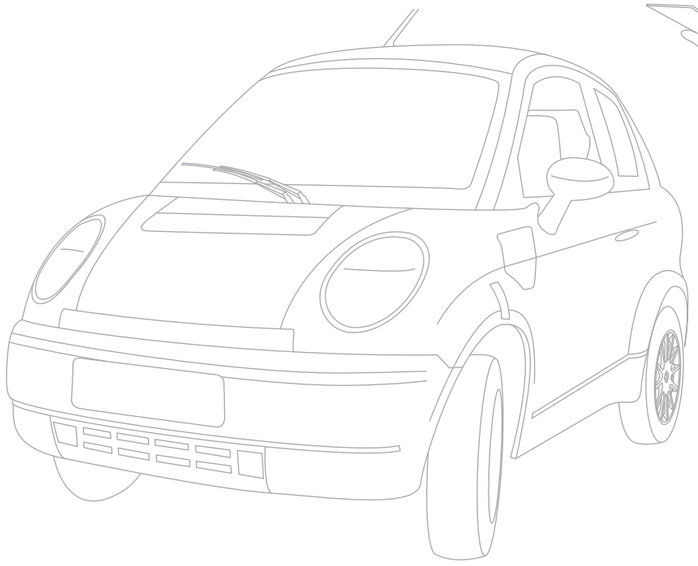
PLATFORM
CAR/TRANSPORTER: SUPPLEMENTARY RESEARCH SAFETY

The platform for supplementary research safety concerned itself with all the safety aspects of the electric vehicles deployed in the model regions. The goal of the platform was to review the operational safety of the vehicles in real service with particular emphasis on the safety of the traction battery and the high-voltage system. For this purpose, a test concept was developed and used to evaluate the projects accordingly. Scope for improvement could be deduced from this document inspection. In addition, throughout the entire project duration, malfunctions and failures were detected and analysed – improvements in the safety and reliability of the battery system could be ascertained here too. The platform was coordinated by NOW and the EnergieAgentur.NRW.

The recorded findings show that all the manufacturers involved in the analysis completed safety documentation and fulfilled the required safety regulations. Furthermore, some manufacturers carried out even more extensive testing procedures (standard tests), although these are not necessary or mandatory due to the small quantity of vehicles on the streets. These inspections go hand in hand with the increased expectations of the safety and quality standards, in order to recognise potential sources of danger in good time. The technical standard of the vehicles deployed in the model regions was persistently very high. The monitoring of the malfunctions showed that there were almost no failures that would have led to a complete halt in vehicle operations or would have represented a potential danger for the user. On no occasion was a person endangered. Many of the errors were user-related or of a mechanical-technical nature. About 30 % of the documented malfunctions were due to general vehicle faults, which were not connected to any features particular to electric vehicles.

A continuation and extension of the analyses is recommended in the context of future demo programmes. Among other things, these were to be used as a basis for working on the particulars of a standardised inspection catalogue. An extension of the monitoring to cover a longer period of time is recommended. In addition, there is a need for research with regard to the life-cycle analysis of the individual components, in order to reassess the belief that the malfunctions and their frequency will be reduced if the periods of analysis are extended.





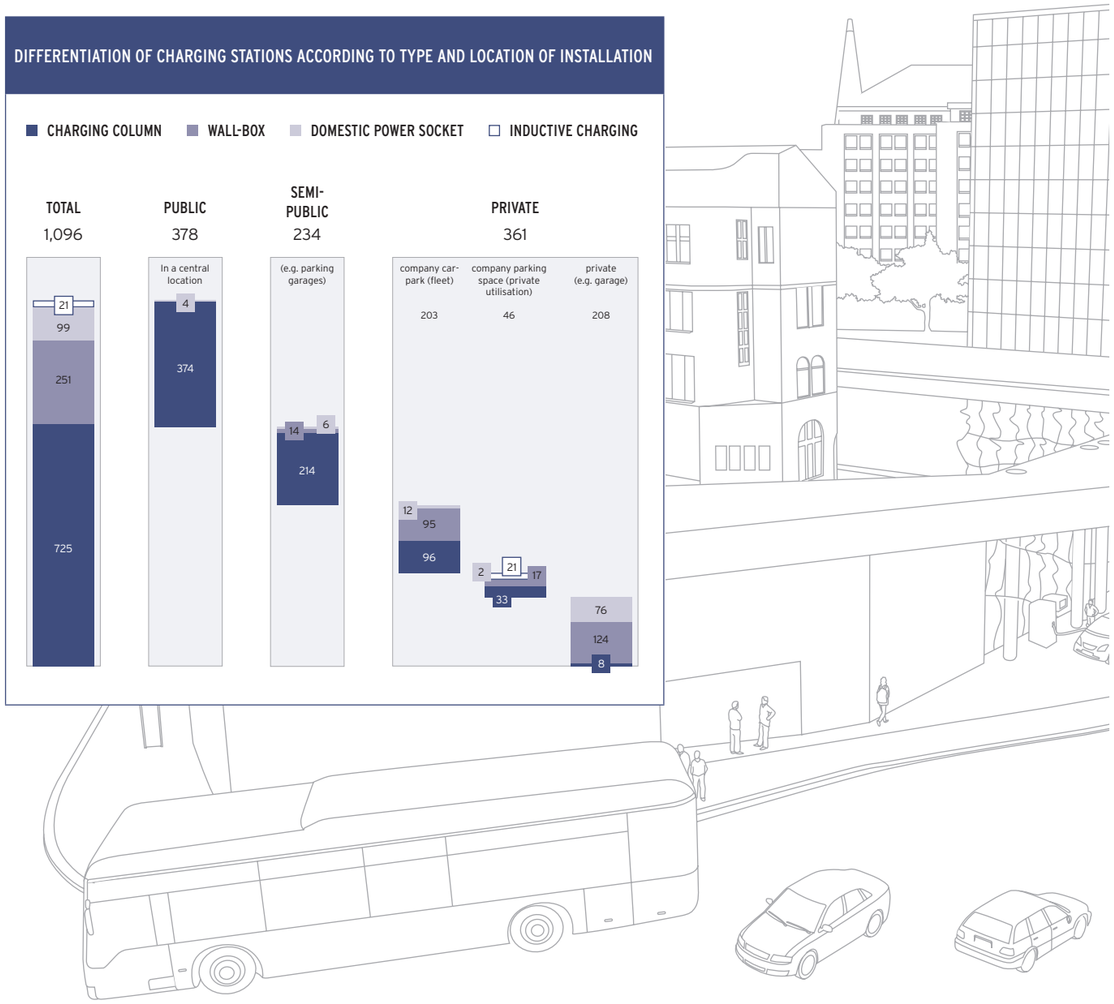
PLATFORM
INFRASTRUCTURE

The development of an infrastructure was an integral part of most of the project consortiums. The infrastructure was established both in the public and semi-public sector. In the course of the two years of the programme, there was a shift in many of the projects from public to semi-public and private charging infrastructures.

In the superordinate »Platform Infrastructure«, an established group of 30–40 members from all the model regions met regularly. A basis for the collaborative work was the quantitative and qualitative monitoring of the development of an infrastructure in the model regions, which was carried out in 2010 and 2011. In addition, there was a lively exchange with the group »Platform Regulatory Framework«. The »Platform Infrastructure« was organised and coordinated directly by NOW.

It was discovered that in the model region projects there are a large number of possibilities for implementing different charging technologies: private users still rely very much on the domestic power socket in order to charge their electric vehicle.
In companies, wall-boxes are much more widespread, while in public spaces charging columns prevail. With regard to the charging technology, in the model regions the standard charging procedure (up to 31 A) predominates. The most frequently used types of plug are the Schuko sockets and IEC 6219 Type 2 plugs. Less than 10 percent of the charging columns provide rapid charging. Cable-free, inductive charging has been tested in just a few projects. Great potential is anticipated here in the future, however, the performance and feasibility must still be tested further.

Scope for development was ascertained above all in the area of public charging stations. There are still many uncertainties regarding the interaction between public authorities and commercial infrastructure operators. Assistance is provided by practical implementation guidelines published by the platform. Further conceptual development is also required for business models as well as access control and accounting systems. In future, the exchange of experience regarding transport planning and business models with parties abroad should be intensified.



PLATFORM REGULATORY FRAMEWORK

The »Platform Regulatory Framework« was comprised primarily of representatives of local municipalities, universities, public utility companies, trans-regional energy providers and charging infrastructure operators. The task was to initially identify regulatory framework issues and to compile a list of them and then in a second step to group together different approaches, solutions and best practices on a regional level and to use these as a basis for developing superordinate prospects and solutions. The platform was managed by the BMVBS and NOW.

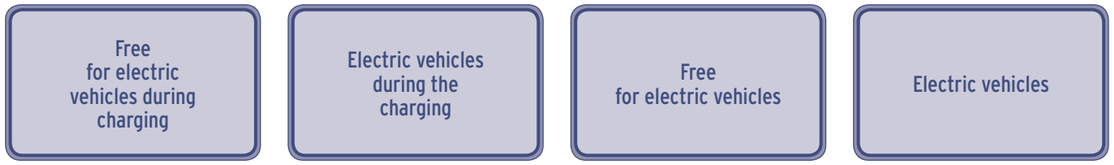
The addition of »special use« signs to the nationwide standard signage of parking spaces for electric vehicles is a concrete result of the key theme of »identification«, in line with the notification of the transport communiqué of the BMVBS from 15.3.2011. Furthermore, on the theme of the general identification of electric vehicles, a joint proposal was developed, which envisages an encoded classification in the vehicle documents. This classification must then be regulated by EU law. A supplementary system-compatible linking of electromobility with electricity gained from renewable energy is considered necessary.

Different incentive measures were also discussed in the course of the work. The model region Hamburg is a successful example of this. Here, a CO_2-emisson-related free-parking sticker is being tested in the city centre, which will be evaluated in the next years. Finally, compatibility with the Road Traffic Act (StVG) should also be checked.

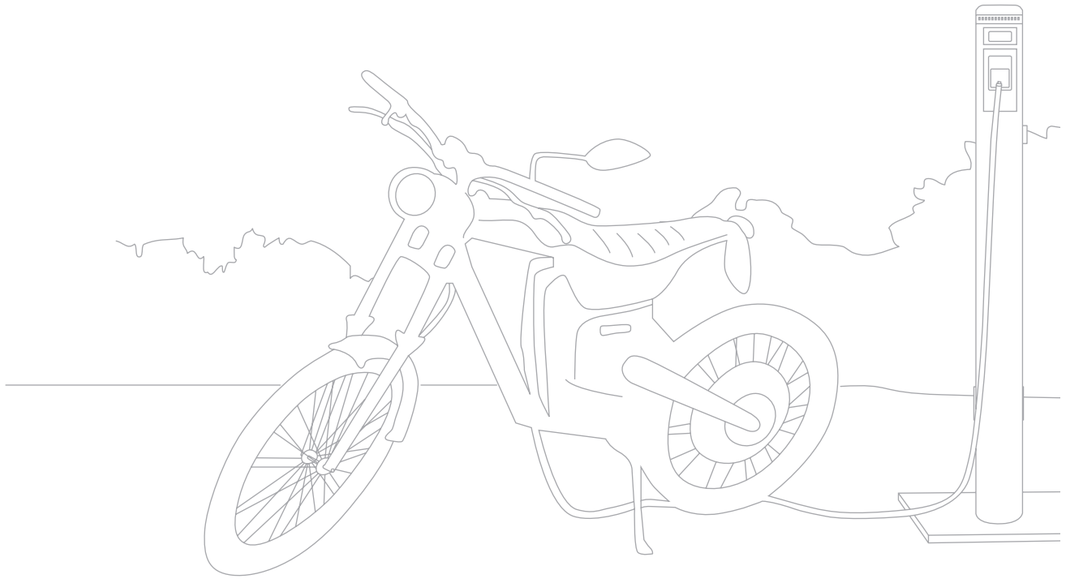
In the context of the topic electromobility and the city, the focus was particularly on carsharing as an instrument of sustainable transport policy development. Another important issue was the dynamic relationship between public parking spaces and the charging infrastructure, as well as the development of constructive criteria governing the awarding of concessions to private operators.

In regard to traffic safety, the theme of sounds and the danger to people with visual impairments was discussed as well as potential technical solutions. In principle higher danger levels caused by electric vehicles could not be determined, especially as modern conventional vehicles also have very low noise levels.

There is a need for research and development in particular with regard to the interaction between electromobility and urban traffic. One of the crucial questions is: how can electromobility relieve urban traffic long-term, without increasing the vehicle population and the existing high demand for parking spaces? Park&Ride and Bike&Ride concepts or carsharing provide scope for public roadspace. Fast lanes also provide a potential incentive for electric two-wheelers, as do public charging options in densely populated inner city quarters. Other open questions concern the charging infrastructure in the public space with regard to standardisation and safety. The topic of identification for two-wheelers and hybrid vehicles should also be examined more closely in future.



EXAMPLES OF POSSIBLE ADDITIONAL SIGNAGE FOR ELECTRIC VEHICLES



01
MODEL REGION HAMBURG

Regional project headquarters hySOLUTIONS GmbH

The regional project headquarters supported the projects in the model regions with coordinating the development of infrastructure and the running of vehicles. This included help with building up the public charging infrastructure, e.g. through discussion with local and district authorities. In its overarching role it was able to ensure the integration of all activities into a top-level strategy aimed at making electromobility a standing item on the region's agenda.

To this end the project headquarters also became involved in developing forward planning for the model region. For instance, it took soundings from the OEMs on the availability of electric vehicles and surveyed potential users on the possibility of their use, both basic requirements for getting the electric vehicle market flourishing as predicted. The focus here was on consistent portrayal of all activities and on ensuring the message was appropriate to the target audience, i.e. decision-makers in politics and business just as much as consumers.

At national level, the Hamburg regional project headquarters assumed control of the nationwide benchmarking of buses and became involved in the other five national platforms. This included contributing its expertise to the development of general parameters in administrative law and to the infrastructure, for example in the discussion around aspects of road traffic legislation. With the model of non-discriminatory access for all electricity distributors to the public charging infrastructure and of obligatory use of green electricity it also provided a fully developed, replicable approach for all regions and local authorities in Germany.

01 TRIAL OF FIVE SERIAL DIESEL HYBRID BUSES AT THE HAMBURG HOCHBAHN TRANSPORT COMPANY

The trial of the five serial diesel hybrid buses as part of the Hamburg electromobility model region can be seen as an overall success. The findings gained about the performance of individual vehicle components and their interaction within the complete system can be put to immediate use in the technical enhancement of future vehicles. In fact, this has already happened in the case of several buses that went into operation in 2011, which were fine-tuned in respect of the control system (AC converter etc.) and the integration of the ancillary components into the energy management system. The buses delivered in 2011 were thus able to achieve better average operational performance (currently around 4,000 kilometres more a month) than the first two buses that went into service in 2009. With top levels of up to 90 percent, their availability is also better.

Buses with a serial hybrid drive system were chosen above all because the profile of the Hochbahn bus company's operation is characterised by short distances between stops and much stopping and starting, where such hybrid systems can deploy their advantages better and thus contribute to a reduction in fuel consumption. The expected benefits were indeed achieved in the field test: a survey showed, for example, that the passengers noticed the lower level of noise. However, with the reduction in diesel consumption remaining at 7 to 15 percent this is still lower than expected.

Partner
Hamburger Hochbahn AG (Public Transport)

Vehicles
5 MB Citaro G BlueTec Hybrid serial diesel hybrid buses (18-metre articulated buses)

Project budget €	Funding budget €
2,525,786	1,262,893

»ACCESS FOR ALL ELECTRICITY SUPPLIERS TO THE PUBLIC CHARGING INFRASTRUCTURE«

02 HH = MORE – USE OF ELECTRICALLY POWERED CARS AND SET-UP OF A CHARGING INFRASTRUCTURE IN THE HAMBURG MODEL REGION

Partners	Project budget €	Funding budget €
hySolutions GmbH (consortium leader)	118,312	56,789
DB FuhrparkService GmbH	323,125	147,022
Hamburg Energie GmbH	1,010,767	485,168
Hamburger Hochbahn Aktiengesellschaft (Public Transport)	26,178	12,825
HVV Hamburger Verkehrsverbund GmbH (Regional Transport Association)	48,263	23,166
City of Hamburg	320,690	153,931
Vattenfall Europe Innovation GmbH	2,407,200	1,155,456
Daimler AG	422,038	211,019

Vehicles
50 Smart Eletric Drive, 18 Daimler A-Class E-Cell

Infrastructure
92 charging points on public land, 8 charging points at P&R car parks, 78 charging points on company sites

Companies in the Hamburg business community were approached to trial the use of electric vehicles in their fleets. Charging points were installed on the sites of the companies concerned and locations for further charging points along the public road network also identified.

In order to facilitate non-discriminatory access to the charging infrastructure for third-party electricity providers, the consortium created a one-off nationwide legally compliant contractual model for third-party access, which also ensured the use of green electricity. It was defined as a binding criterion in the project that the electricity must be sourced from renewable energy, which was agreed and coordinated with the relevant city authority.

In order to facilitate increased use of green electricity on the power grid side as well and to reduce generation peaks, the consortium ran, as an example, some initial trials of charging vehicles on company sites where the charging process was controlled on the basis of the load on the grid.

Integrating all public and private charging points into one central computer system enabled complete monitoring of the charging infrastructure in respect of any functional deficiencies. It also made it possible to keep a check on consumption levels and charging times in order to explore future development of this innovative charging method and its potential for easing the load on the grid.

03 HAMBURG PURE – PROJECT ON THE UTILISATION OF REGIONAL ELECTROMOBILITY IN HAMBURG

In the Hamburg electromobility model region, Renault is deploying 15 battery-powered vehicles from the light commercial vehicle sector. They are being examined in every operation for their technical suitability. In order that the vehicles can be serviced well locally, two Hamburg Renault dealerships have been equipped to carry out maintenance of electric cars. The dealerships' mechanics have also been trained in dealing with high-voltage components. The vehicles were also supplied via the dealerships.

The users were selected based on potential fleet use scenarios. In addition to large companies from the logistics sector (Hermes and HHLA), the consortium was also able to recruit retail and public service organisations (energy, water, airport) as participants in the project. The vehicles proved their technical suitability and the vehicle-to-charging-infrastructure interface also worked perfectly, even if a certain period of familiarisation was required for the users in dealing with the charging terminals and plugs. As all vehicles were deployed in commercial fleets with their own charging infrastructure, it was possible to ensure that the batteries were always adequately charged. The issue of limited range, that is often the subject of public debate, thus represented no problem in this project. Specific range experiments did, however, help to get a more in-depth understanding of battery capacity in real-world conditions, e.g. depending on weather and driving style. The consortium was able to establish the »User Meeting« initiated in the Hamburg electromobility model region as a forum for the fleet managers involved in the project to share experiences.

Partner
Renault Deutschland AG
(consortium leader)

Vehicles
15 Renault Kangoo Z. E.

Project budget €	Funding budget €
1,140,448	579,112

»SMALL AND MEDIUM-SIZED FIRMS AS BUSINESS PARTNERS«

04 HH = WISE – THE USE OF BATTERY-POWERED ELECTRIC VEHICLES IN COMMERCE

In the largest vehicle project in the Hamburg electromobility model region, 235 battery-powered vehicles of varying sizes were tested for technical suitability in everyday operation.

The vehicles' drive trains were converted to Karabag GmbH specifications, with technical optimisations and experiences from previous deployments being directly incorporated into the production process. It was important here to constantly monitor adherence to quality standards and firmly agreed delivery dates and, where necessary, to make readjustments. The consortium succeeded in achieving large-scale system optimisation in the conversion process (combined with significant cost reduction), which made it possible in the case of many of the vehicles subsidised in the project to supply them at monthly costs of under € 300.

The consortium also succeeded in recruiting German industrial and SME businesses as business partners. The electric motors, for instance, will in future be supplied by Linde Material Handling GmbH, the battery management system comes from I+ME ACTIA GmbH of Braunschweig, while locally based suppliers, such as Hamburg-based metal processors Graupe-Thews GmbH, will in future also be involved in the conversion process. A sales strategy, including downstream organisational processes, was also developed and a maintenance infrastructure built up at Karabag GmbH. The vehicles were delivered out to users in several tranches over the period of the project.

Partners
hySOLUTIONS GmbH
(consortium leader),
Karabag GmbH

Vehicles
160 Karabag New500E,
40 Karabag e-Ka,
20 Karabag Fiorino Electric,
15 Karabag Ducato Electric

Infrastructure
20 induction chargers

Project budget €	Funding budget €
160,736	80,368

02

MODEL REGION BREMEN/OLDENBURG

Regional project headquarters	Fraunhofer-Institut für Fertigungstechnik und Angewandte Materialforschung IFAM (Fraunhofer Institute of Production Technology and Applied Material Research – consortium leader), Deutsches Forschungszentrum für Künstliche Intelligenz (DFKI) GmbH (German Artificial Intelligence Research Centre)

The regional project headquarters took on the coordination of the activities of all regional players who were directly or indirectly involved as partners in the model region's projects. The project headquarters' declared aim is to provide long-term support to players in the field of electromobility. Coordinating the entire project's programme in the model region is done in close consultation with NOW GmbH. This includes the overarching management of all of the region's projects and also coordination with the federal states, districts and local authorities. An advisory council was appointed as the model region's central body, on which representatives from politics, research and business oversee activities.

The project leaders and consortium heads of the model region's projects also came together at regular intervals in the so-called »Project Leader Group« to discuss top-level issues of coordination, to coordinate platform activities and to establish interfaces between the individual projects.

The overarching management of press and publicity work (trade shows, information materials, events, etc.) is also a role performed by the project headquarters. This ensures a continual flow of information and that all individual projects have a uniform outward image.

Assisting the project partners with the project application – especially during the model region's initial phase – was also a key task of the project headquarters. The project headquarters' staff are also points of contact for other development projects in the field of electromobility.

01 PMC MODULE 1: SET-UP AND OPERATION OF A »PERSONAL MOBILITY CENTRE« FOR ELECTROMOBILITY

Partners	Project budget €	Funding budget €
Fraunhofer-Gesellschaft zur Förderung der angewandten Forschung e. V. (FhG)	2,510,196	2,510,196
Deutsches Forschungszentrum für Künstliche Intelligenz (DFKI) GmbH	1,374,357	1,305,640

Vehicles

5 electric cars (3 Think City, 1 Mega eCity, 1 Tazzari), 2 electric vans (Eco Carrier), 1 electric scooter (Vectrix), 5 pedelecs

The aim of the project, among others, was to establish the Personal Mobility Centre for electromobility (PMC) as a permanent facility. This created a central contact point for all electromobility issues in the Bremen/Oldenburg model region. The PMC employees offer advice and support to project partners, businesses, media representatives and the public. The PMC has a small fleet of vehicles available to potential e-vehicle users for test drives. These vehicles are also used for events, trade fair appearances and for training and educational purposes.

Since the model region was established, the PMC has organised and run a diverse range of functions and has represented the Bremen/Oldenburg model region at events as the participating partner.

The PMC also acts as support centre for operators of electric vehicles in the model region, for example for the »e-Car4all« project. In addition to procuring and licensing the vehicles, the PMC also gets them up and running and organises maintenance (vehicle checks, MOTs, winter tyres, etc.) and, if necessary, any repairs. Furthermore, the vehicles are fitted with sensors to ensure continual recording of data on distance travelled (dependent on vehicle type) and individual components of the drive train (battery, motor, inverter). Commissioning of the sensors and of the booking platform for »e-Car4all« was done through the PMC.

»EXAMINE USE AND CHARGING INTERVALS«

02 PMC MODULE 2: INTELLIGENT INTEGRATION OF ELECTROMOBILITY

Partners	Project budget €	Funding budget €
Deutsches Forschungszentrum für Künstliche Intelligenz (DFKI) GmbH	1,570,372	1,491,853
Fraunhofer-Gesellschaft zur Förderung der angewandten Forschung e. V. (FhG)	70,054	70,054
Der Senator für Umwelt, Bau und Verkehr Bremen (SUBV)	43,632	21,816

In the course of the project a comprehensive data capture and processing infrastructure was created as a central element. As such, a platform is now available for numerous evaluations and analyses using modern methods of artificial intelligence. It was also possible to implement basic tools for the pre-processing, preparation and interpretation of data.

Various software packages, so-called logic modules, were linked to the database for working on and evaluating the data. As a first step, an application was developed for decoding the vehicle-specific CAN bus data into individual measurements suitable for further processing. In other modules, the GPS coordinates together with the recorded geo-information are used to depict the route travelled on existing maps. Another logic module separates the vehicles' continually logged data into distances travelled, times spent parked up and charging and changes in the state of charge. The aim is to produce forecasts for usage and charging cycles.

Further specific applications and visualisations can also be found downstream of the database. The function of these tools is to present the data generated in the logic modules. Data can be accessed for this via a web back-end's interface and then displayed on the web front-end. This also makes it possible to use these tools on mobile devices.

03 PMC MODULE 3: VEHICLE FLEET TRIALS UNDER EVERYDAY CONDITIONS FOR PRIVATE AND COMMERCIAL USE

Partner
Fraunhofer-Institut für Fertigungstechnik und Angewandte Materialforschung (IFAM)

Vehicles
9 Think City, 11 Stromos, 6 eWolf, 1 Eco Carrier ES

Project budget €	Funding budget €
1,658,725	1,368,101

In two thematically separate fleet trials the Fraunhofer IFAM undertook examinations of the suitability for everyday use of the electric vehicles currently on the market. On the one hand, it was tested whether the vehicles satisfied the requirements of fleets run on a commercial basis, while on the other, it was examined whether e-vehicles were suitable for private car sharing. The vehicles used for the fleet trial for commercial use were two-seaters, four-seaters (four-door) and a small drop-side van.

The vehicles occasionally served alongside conventionally powered types in addition to existing fleets (e.g. at Bremer Straßenbahn AG), but were also deployed where the e-vehicle was the business' only company vehicle (e.g. at E-Werk Ottersberg).

The driving profiles were also different: while some of the vehicles were only used in the city, others were also driven in rural areas. The spectrum of usage thus covered the whole range of short-distance motoring and enabled conclusions to be drawn about the general suitability of electrically powered vehicles.

Private car sharing was also carried out using two- and four-seat vehicles. In addition to the obligatory data logger, some of the vehicles were equipped with an internet-based booking system. Alongside the testing of the vehicles, the Fraunhofer IFAM also examined how well the users managed with the electric cars in their daily life and what their experiences were with the self-organised shared use of vehicles.

»ELECTROMOBILITY BOOSTS IMAGE«

04 PMC MODULE 4: DFKI FLEET TRIAL WITH ACADEMIC ACCOMPANIMENT (FOCUSING ON BUSINESS AND PRIVATE USERS)

Partner
Deutsches Forschungszentrum für Künstliche Intelligenz (DFKI) GmbH

Vehicles
9 electric vehicles (Tazzari, Think, Delta 1, Vectrix and Eco Carrier)

Project budget €	Funding budget €
2,533,405	2,533,405

The vehicles were handed over to various companies in the region and used at locations including the port site in Bremerhaven and the environs of the regional business development and technology park. The companies' reasons for getting involved were largely to gain kudos through the ecologically positive image of electromobility.

The electric vehicles were tested on business journeys such as client visits, customer support journeys and deliveries. The private users were commuters with varying profiles in relation to distance and combined use with other modes of transport. To equip the company sites and home locations with charging facilities, outside sockets were installed, which posed no significant difficulties.

After initial scepticism, the majority of the users were thrilled. Many of those surveyed can now imagine, after the fleet trial, buying their own electric vehicles, including for private purposes. It is only the currently still very high price and limited availability and variety of models that are responsible for the fact that purchases are not being made in any noteworthy numbers.

Another positive fact that should be mentioned is that the users were able to use their electric vehicles during the winter without any limitations. The range did go down due to the low temperatures, but as the users are permanently informed of the currently available range, they were able to take this fact into account. The conscious planning of journeys with battery-powered electric vehicles proved to be a typical component of electromobility.

05 EWE ELECTROMOBILITY FLEET TRIAL

The fleet trial delivered some important findings in respect to the vehicle batteries' charging/discharging profiles and practical use of the charging infrastructure.

While prior to the start of the trial the vehicles' range was a mystery to most participants. Subsequently, 85 % described it as »modest but adequate« or even »convenient and thus fully adequate«. A change can be seen here in the perception of their own motoring requirements: the range that the participants thought they would need prior to the trial was on average 100 km more than the weekly distance that they actually travelled. Most of them were thus overestimating how far they drove.

In terms of examining the charging pattern, the trial showed that 95 % of charging procedures occurred at the place or work or at home. Nevertheless, the public charging infrastructure is a key instrument in relation to improving the participants' confidence in respect to the range issue and is thus essential to any significant roll-out of electromobility. Charging points at car parks where cars tend to be parked for a long time, such as at leisure facilities or shopping centres, would seem sensible in light of the charging times.

Finally, it can be concluded that in the course of the trials the participants developed a considerably more positive attitude to electromobility. It is only the high purchase price, limited variety of models and a high need of public education that is currently holding back greater market penetration of electric vehicles.

Partner
EWE AG

Vehicles
2 EWE E3, 5 Mitsubishi i-MiEV

Infrastructure
38 charging points

Project budget €	Funding budget €
2,063,787	1,031,893

»E-VEHICLES AUGMENT FLEETS«

06 PMC MODULE 6: SWB FLEET TRIALS – SET-UP, OPERATION AND FURTHER DEVELOPMENT OF THE CHARGING INFRASTRUCTURE IN BREMEN AND BREMERHAVEN AND THE RUNNING OF FLEET TRIALS

Partner
swb AG (single project)

Vehicles
2 C1 Ev'ie, Citroën,
4 Mitsubishi i-MiEV

Infrastructure
25 charging stations

Project budget €	Funding budget €
534,866	267,433

In order to ensure a uniform charging post standard in the model region, the charging post specification in respect to safety, TAB, current meter and RFID standards was defined in tandem with EWE.

The charging stations were set up on the existing car parks of partners that swb was able to recruit during the period of the project. These included, for example, car park management companies, shopping centre operators, businesses that use e-vehicles in their fleet or for car sharing and private car-sharing groups. The power provided at the charging posts was green electricity and it was supplied free of charge.

Compared to its predecessor the P3, the P4 version of the charging post currently being used has been improved in terms of ease of operation and data transfer reliability, and has been upgraded through the addition of a remote maintenance function. Participants generally had no problem using the charging stations. In order to avoid any overloading of the sockets or building circuitry, swb recommends a prior check for suitability by a trained electrician (»Infrastructure check«).

The vehicles are equipped with emergency cards that indicate to emergency services personnel where the electrical components of most importance to safety are installed. The vehicles' range is sufficient for the chosen uses and feedback from the users was very positive. During winter use, however, it was noticed that performance and range were highly dependent on the temperature. For reasons of safety and comfort, the vehicles should be fitted with supplementary heaters.

»400 DRIVERS TRAINED FOR HYBRID BUS«

07 PMC MODULE 7: TRIAL OF TWO ARTICULATED BUSES WITH DIESEL/ELECTRIC DRIVE AND ELECTRICAL STORAGE AND COMPARISON WITH CONVENTIONALLY POWERED BUSES IN SCHEDULED OPERATION

Partner
Bremer Straßenbahn AG BSAG
(Bremen Tramways)

Vehicles
Citaro G Blue Tec Hybrid, EvoBus,
Referenzfahrzeug: Urbino 18,
Solaris

Project budget €	Funding budget €
1,319,275	659,637

To begin, the hybrid buses were procured and integrated into BSAG's existing bus fleet. For this purpose, 400 drivers were educated in their use, workshop personnel (electricians) trained and the vehicles demonstrated to the police and fire service. Since 11 July 2011, they have been in scheduled use. The two hybrid buses and the two reference buses are being used on line 26, a very busy line that runs right through the middle of the Bremen city centre and the low-emission zone. The hybrid and reference buses are deployed in daily rotation on four further selected routes.

As part of the trial, a survey was conducted among the driving staff and the passengers on the hybrid bus and at bus stops on line 26. The results were given to PE International for analysis. Distances travelled, days in use and fuel data were collected on the virtual »bus platform« and are also being analysed by PE International.

A comprehensive analysis of the data collected has yet to be received. However, some initial findings are already available. These include that the drivers' assessment of the hybrid buses is positive. They contend that they are no different to operate than a diesel bus and that there are also no problems regarding familiarisation with the hybrid bus. They also note that acceleration is smooth and quick and that overall the vehicles produce less noise.

08 PMC MODULE 8: LIGHT VEHICLES FOR SHORT URBAN MOTORING IN THE FIELDS OF TOURISM AND CIVIC INFRASTRUCTURE

Partner
H_2O e-mobile GmbH

Vehicles
14 H_2O e-mobile Elano 1. Go,
1 H_2O e-mobile cruiser

Infrastructure
5 charging stations

Project budget €	Funding budget €
448,940	269,364

The vehicles have proven to be attractive to users, as they have an appealing design and are efficient in use. For vehicles of this class, the payload capacity is unusually large. After initial scepticism, the drivers were quickly able to adjust themselves to the vehicles' particular features and rated the driving experience as very attractive, overall.

The capacity of the AGM lead batteries, which were used due to their low cost and simplicity, was not adequate – especially in cold weather. In urban stop-and-go traffic with frequent stops at which the batteries can regenerate, ranges of up to over 50 km were achieved with one charge. However, in cold weather this dropped significantly.

It was only possible to start fitting lithium iron phosphate batteries towards the end of the period and this is still being evaluated. However, the cost-benefit ratio compared to lead batteries is unacceptable, as the additional capacity does not justify the added cost (three times the power for five times the price). Instead of striving for vehicles with an increased range, efforts should therefore be made to achieve a cost structure that is improved all round, with lower base costs for the vehicles.

Through enhanced specifications, new partners and simplified systems, it was possible to greatly reduce the cost of some of the components. The fact that the conversion components could be produced to a very high professional standard locally in Varel had a particularly positive effect.

»CARSHARING WITH ELECTROMOBILITY«

09 PMC MODULE 9: MOVE ABOUT – ELECTROMOBILITY IN PLACE OF VEHICLE OWNERSHIP

Partner
Move About GmbH

Vehicles
3 Pkw, Think City, 1 Pkw, City EL
6 electric scooters, Govers S.1.2

Infrastructure
1 public charging station, 1 swb charging station, access to all swb charging stations

Project budget €	Funding budget €
456,598	273,959

Besides setting up funding tools and insurance contracts, Move About GmbH developed a functioning workshop infrastructure for the project partners and its own business activity.

For renting out the vehicles, it was necessary to integrate on-board computers and card readers in the vehicle electronics. For the hiring out of scooters, work is being underaken on especially inexpensive solutions that can be used on the move. One challenge is the cost-efficient set-up of a functioning logistics system for spare parts while unit numbers are still low.

The trial of the electric vehicles took place in different scenarios. A THINK City along with two e-scooters were used as car-sharing vehicles at the »Galileo Residenz« international student hall of residence on the Bremen University campus. The other vehicles were used as customer courtesy cars, for public events and for creating workshop diagnosis systems. In a few cases, private individuals who commute to their place of work used the vehicles exclusively, including over several weeks. In order to service private and business requests for electromobility in the best way possible, a customer relationship management system from the German company SAP was set up and used. On the initiative of the ADAC, Move About compiled information on the THINK City of relevance to safety and included this on an emergency card for the emergency services, a copy of which was put in every vehicle in the model region.

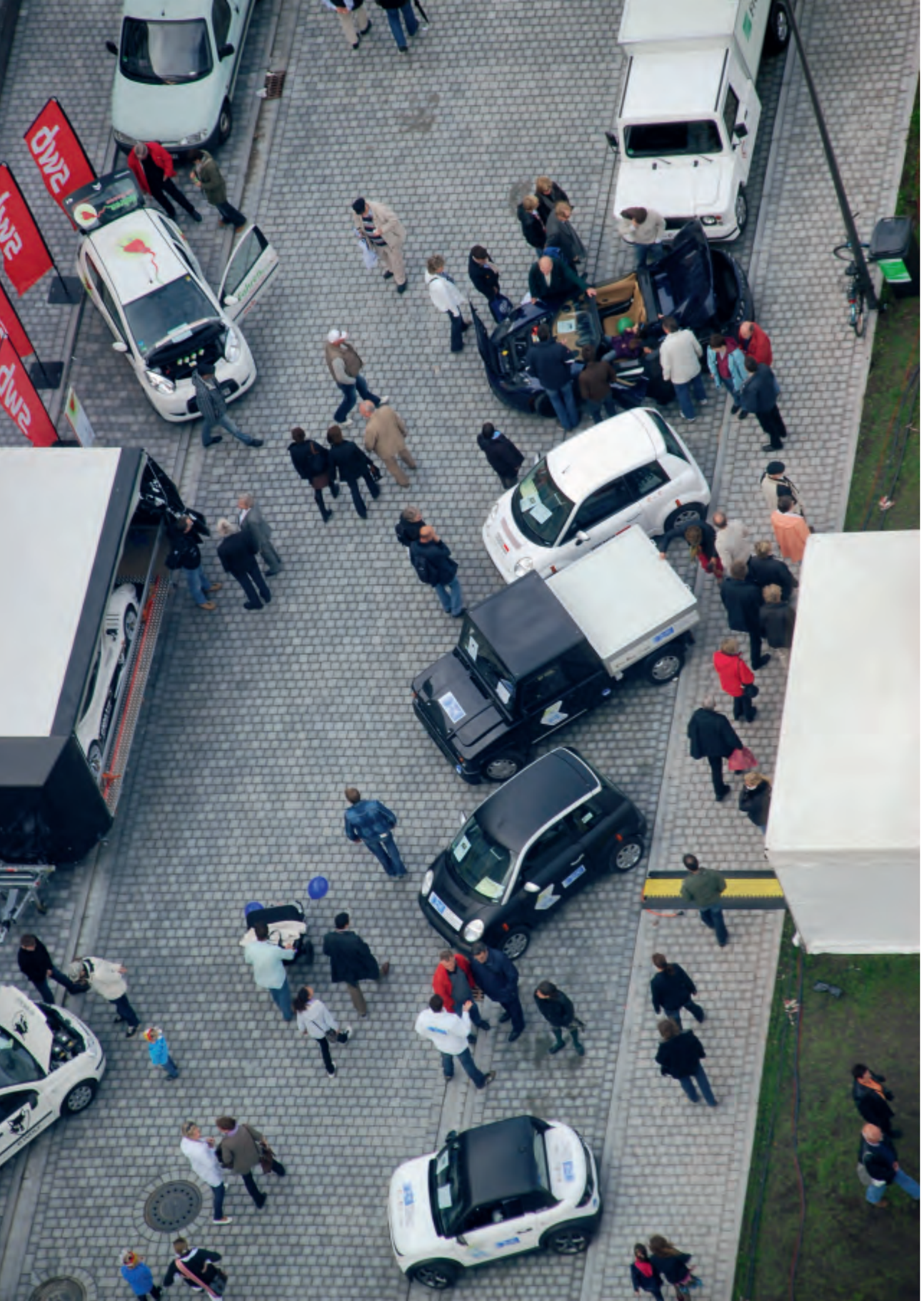
10 PMC MODULE 10: TRAFFIC CONCEPTS AND BUSINESS MODELS

Partners	Project budget €	Funding budget €
Deutsches Forschungszentrum für Künstliche Intelligenz (DFKI) GmbH	92,082	87,478
Jacobs University gGmbH	378,954	378,954
BIBA – Bremer Institut für Produktion und Logistik GmbH	221,182	221,182
OFFIS e. V.	220,049	220,049
Verein zur Förderung der wissenschaftlichen Forschung in der Freien Hansestadt Bremen e. V. (VFwF)	108,490	108,490
Der Senator für Umwelt, Bau und Verkehr Bremen (SUBV)	45,567	22,783
Fraunhofer-Institut für Fertigungstechnik und Angewandte Materialforschung IFAM	57,904	57,904
Universität Bremen	146,342	146,342

A survey was conducted in the Bremen/Oldenburg model region to assess which demographic groups were potential users of electric vehicles and how different groups currently perceived and rated electromobility. In this way it was possible to determine the needs of different potential users, which, looking at the operators and infrastructure, facilitated the development of electromobility business models and traffic concepts.

Within the framework of the everyday driving habits of the people surveyed, most found electric cars perfectly acceptable in terms of their range. The majority of users could also even charge the batteries at home. Due to the short distances, car sharing and Car2Go form a good basis here for establishing electromobility in an urban context. Use in rural areas, for example as a second car, leads to faster amortisation of the purchase price due to the longer distances being travelled here on average – which is nevertheless already within the range of today's electric vehicles. The rural environs in the Bremen/Oldenburg model region generally have a rather thinly spread local public transport network.

As part of the project, a simulation model for planning and management was developed to determine the potential of different infrastructure layouts, especially in relation to the distribution of charging stations.



»SURVEY OF POTENTIAL USERS FOR THE PREPARATION OF BUSINESS MODELS«

03
MODEL REGION BERLIN/POTSDAM

Regional project headquarters TSB Innovationsagentur Berlin GmbH

The regional project headquarters answered a multitude of enquiries and provided interested parties with information on the model region and the ongoing project activities. The centre regularly gave presentations, both in the region and on a national and international scale.

A series of discussions with potential project partners, national associations and international delegations led to a closer interlinking with the different players in the electromobility field and also to jointly carrying out measures with the other model regions and NOW. Two »Berlin-Brandenburg electromobility« seminars were staged in order to provide the regional industry public in-depth information concerning the status of work in the model region and on possible follow-up activities.

The project headquarters also took on a supporting role in the project development process. In consultation with project administrator Jülich (Pt.J), NOW and the Berlin State Administration for Urban Development, the centre was able to accompany multiple projects through to approval, together with its partners.

The formation of the Berlin Agency for Electromobility (eMO) in the second half of 2010 saw a further pooling of strengths in the region, a process in which the project headquarters was also involved.

The »Electromobility – Berlin 2020« programme of actions produced in collaboration with the centre, which was presented in March 2011, sketches out the path that Berlin will be taking to achieve its objectives in the field of electromobility and defines various areas of action. Over the course of the year, the programme was translated in partnership with the State of Brandenburg into a concrete action plan.

01 BERLIN ELEKTROMOBIL (FOR SHORT: BEMOBILITY)

Partners	Project budget €	Funding budget €
DB FuhrparkService GmbH (consortium leader)	5,372,251	2,444,374
Technische Universität Berlin	601,311	601,311
Robert Bosch Car Multimedia GmbH	367,825	158,164
RWE Effizienz GmbH	157,350	67,660
Innovationszentrum für Mobilität und gesellschaftlichen Wandel (InnoZ) GmbH	2,187,170	1,093,585
Contipark Parkgaragengesellschaft mit beschränkter Haftung	174,796	75,162
Vattenfall Europe Aktiengesellschaft	416,350	179,030
SOLON SE	205,719	98,745
HaCon Ingenieurgesellschaft mbH	482,926	241,463

Vehicles
50 electric and hybrid vehicles (eCarsharing)

Infrastructure
15 rental stations, 25 charging points

According to the research made, electric vehicle users generally match the following profile: mainly male, approx. 40 years old, high level of education, working with an above average income, smartphone access, diverse forms of mobility. Initial analyses indicate high general interest in using the service, but a lack of willingness to pay significantly more than for traditional car sharing. The buyers of the mobility card are also of this user type. The improvements primarily desired include more charging stations and a reduction in the number of cards.

The locations chosen for the stations proved successful. The vehicles' range is viewed as adequate in everyday use, as a whole. Due to a lack of standardisation of the charging infrastructure, to date, there are no charging stations for pedelecs in public areas. In the case of the first generation electric conversion vehicles, there were also some technical weaknesses that impaired reliability in car-sharing use. Furthermore, gaps in data interfaces between the suppliers require these to be bridged in both technical and organisational terms. On the regulative level, the approvals procedures for setting up the parking spaces also proved to be time consuming. On the organisational level, the collaboration between different companies proved key.

Preparations have been made through international contacts to transfer the concept for use in similar environments abroad. Due to the differing conditions, however, this will represent a challenge.

»RANGE IS CONSIDERED SUFFICIENT«

02 AUE-MOBILITY – ACOUSTIC CHARACTERISTICS OF ELECTROMOBILITY

Partner
Angelo D'Angelico

Project budget €	Funding budget €
142,458	113,962

The project uncovered structural errors in the standard measurement method for acoustic comparisons of electric vehicles with those using internal combustion engines. The project undertook the demanding task of designing its own measuring system. The measurements taken using this new method revealed considerable differences in the acoustic pattern of approaching electric and conventional vehicles.

A universally valid acoustic structure was identified in the case of vehicles with internal combustion engines. Based on this structure, an artificial driving noise was developed that electric vehicles can emit using an audio generator. It was evident that road users noticed the modified vehicles much better than standard electric vehicles, even if the audio volume was low and the modification only switched on when approaching: clearly the type of sound plays a more decisive role than its volume.

The research was unable to find any documented accidents that are directly attributable to electric vehicles' lack of noise. In an online survey, experienced users were asked for their assessment of the risks of electric vehicles. This enabled, among other aspects, descriptions of critical situations to be recorded, which are being incorporated into the examination of measures to increase safety.

The communication between partners from different model regions should be improved for future projects, as it was apparent that cross-project synergies were not being sufficiently realised until late in the project.

»FIELD TEST FOR COURIER AND EXPRESS E-VEHICLES«

03 E-CITY LOGISTICS

Partners	Project budget €	Funding budget €
Fraunhofer-Gesellschaft zur Förderung der angewandten Forschung e. V. (FhG)	862,765	862,765
Meyer & Meyer Transport Services GmbH	611,333	305,666
Deutsche Post DHL Research and Innovation GmbH	478,438	239,219

Vehicles
3 Iveco daily electric, 3.5 t (DHL), 2 MAN retrofi vehicles, 11 t (Meyer & Meyer)

Infrastructure
Charging infrastructure suitable for vehicles in the operator depots

The Meyer & Meyer and DHL sub-projects pursued the objective to review the feasibility of operating their respective logistics processes using fully electric vehicles.

Meyer & Meyer:
- A commercial vehicle converted to electric power fulfilled the requirements of regular goods distribution motoring
- The use of electric power did not require any change in route planning
- The battery technology is susceptible to faults, expensive and curtailed vehicle availability during the test
- The battery charging infrastructure is not able to cope with the capacity or time-related needs of a large commercial vehicle in operational use
- A cost-efficient level of usage of the very expensive electric commercial vehicle can only be achieved through multi-shift operation, for which a replaceable battery system is required

DHL:
- The operational requirements for delivering parcels are fulfilled in the same way as with conventionally powered vehicles
- Public charging stations are of little importance from the drivers' point of view, as the time spent in charging bays is generally under 10 minutes
- In contrast to textile logistics, courier and parcel delivery services offer only minor potential for rescheduling
- Although courier and parcel delivery vehicles are perceived to have a high presence on public roads, the distance that they actually travel tends not to be that great. This explains the fairly modest overall ecological effect of electrifying such vehicles, although when looking at a fleet, the effect remains significant.

04 EXAMINATION OF THE POTENTIAL FOR REDUCING THE STRAIN ON THE ENVIRONMENT THROUGH INCREASED USE OF SMALL BATTERY-POWERED ELECTRIC VEHICLES AS PART OF THE »E-MOBILITY« PROJECT

Analysis of current patterns of private car usage shows that everyday journeys can generally be handled without any problem by a purely electric vehicle. Less frequent long journeys, on the other hand, represent the greatest problem. In the relevant »mini« to »compact« segments, long distances were only possible in up to 13 % of cases using a battery-powered electric car without alternative mobility options. The potential in commercial vehicle fleets is between 53 % and 81 % depending on the segment. The theoretical total potential for battery-powered electric cars in Germany is around 4 million vehicles.

Over 30 fleet operators were surveyed on the suitability and acceptability of electric vehicles. The results show that the most important procurement criteria are purchase and operating costs. Companies that attribute a high level of importance to the environmental characteristics of their fleet and a »green« company image would accept a cost premium of 10–20 %.

The electricity demand was portrayed on a precise hourly basis for various scenarios based on typical private and commercial car usage patterns. The results show that the total electricity demand through to 2030 is relatively low. However, without any system of charge management new load peaks could occur sooner. Furthermore, while simulations show that electric vehicles may in future become so-called »flexible consumers« of temporary excess renewable energy, their power demand, however, will not be sufficiently or completely covered in this manner.

Partner
Öko-Institut

Project budget €	Funding budget €
325,069	325,069

04
MODEL REGION RHINE-RUHR

Regional project headquarters EnergieAgentur.NRW

With its projects, the Rhine-Ruhr model region focused on three areas:
1. The use of electric vehicles (cars, commercial vehicles and two-wheelers), refuse collection vehicles with hybrid drive systems and hybrid buses in local public transport, in order to test the vehicles in everyday operation, to ascertain the current state of electromobility technology and to deduce areas of potential for technical optimisation and development.
2. Setting up and testing a charging infrastructure tailored to the respective use, including appropriate billing systems, and developing suitable business models for different areas of use.
3. Providing academic support to the projects (including examination of user behaviour, vehicle acceptance, technical issues, required training for emergency services and technical support staff, etc.) in relation to conceiving and evaluating more far-reaching development programmes both at national and federal state level.

Due to the general conditions that exist in the Rhine-Ruhr model region (i.e. industrial conurbation conditions), the focus of the projects was primarily on the use of vehicles at commercial and fleet customers:

- Pool and fleet traffic in the local authority field
- Cross-mode commercial traffic in conurbations (civic utilities, energy suppliers, local authorities and local authority services, etc.)
- Inner-city distribution traffic
- Modern drive system and traffic concepts for local public transport

In total, 50 partners used and tested around 200 electric vehicles and 500 charging points. The distance travelled by the vehicles used was well over a million kilometres. The 23 hybrid buses alone travelled more than 690,000 km.

01 COLOGNE-MOBIL

Partners	Project budget €	Funding budget €
Ford-Werke GmbH (consortium leader)	10,369,429	4,472,335
Universität Duisburg-Essen	1,784,415	1,784,415
RheinEnergie AG	2,248,391	1,103,173
City of Cologne	1,095	1,095

Vehicles
10 Transit BEV trial vehicles Transit BEV, 10 Transit Connect pre-production vehicles Transit Connect, 5 Focus Electric

Infrastructure
16 charging stations with 32 charging points

After a project term of 24 months, over 70,000 kilometres travelled and around 1,800 charging events, one of the key findings from the cologneE-mobil project is that electric vehicles can already be integrated into commercial vehicle fleets without any problems.
The results of the fleet trials and the accompanying research showed that the limited range of electric vehicles compared to conventionally powered types leads to no restrictions of any kind in everyday operation. In the case of 50 % of the urban trips, the daily power consumption was in fact only 4 kWh, meaning that with a battery capacity of 20 kWh there is not even any need to charge the battery every day. These results coincide with the wishes of potential customers, who would ideally like to charge their vehicle at home or at their place of work.

Extensive surveys of potential customers have shown that, in principle, they have a positive attitude towards electric cars. Key reasons for considering a purchase are environmental friendliness and independence from oil. In the area of urban delivery, analyses have shown that battery-powered electric vehicles are already an economically attractive alternative.

With the help of measurements and experiments on noise perception it was also possible to obtain empirical data to confirm the suspicion that electric vehicles are subjectively noticed less quickly. It was apparent, however, through a direct comparison with modern petrol vehicles with a similarly low level of noise, that innovative solutions will be necessary in this area in the future for more than just electric vehicles alone.

»ELECTRIC VEHICLES CAN TODAY ALREADY BE INTEGRATED IN COMMERCIAL FLEETS WITHOUT PROBLEMS«

02 ELECTROMOBILITY IN COMMUTER TRAFFIC

Partners	Project budget €	Funding budget €
RWE Effizienz GmbH (consortium leader)	3,662,937	1,831,468
Renault Deutschland AG	2,954,069	1,477,034
Rheinisch-Westfälische Technische Hochschule Aachen	495,324	495,324
fka Forschungsgesellschaft Kraftfahrwesen mit beschränkter Haftung Aachen	421,143	210,571

Vehicles
30 Renault pre-production vehicles, (25 Kangoo Z. E., 5 Fluence Z. E.), 42 converted Fiat vehicles

Infrastructure
306 charging points

As part of the large-scale fleet trial, the consortium could test the functionality of the charging infrastructure, especially in respect to the robustness of the technology applied and the ease of use in everyday operation. Based on the findings obtained, the technical interfaces between e-vehicle and charging infrastructure were improved.
During this process, challenges arose both in legal and technical terms: delays sometimes occurred in developing the charging infrastructure due to the absence of any standard approvals procedure and belated approval of power grid connections from the respective distribution grid operators.

Looking at the users of electric vehicles, it was apparent that they use the private, semi-public and publicly accessible charging infrastructure for charging and would like to see these facilities universally available. Due to the different user requirements and areas of use, it will also be necessary to add to the range of products provided by the charging infrastructure, e.g. by adding easily integrated home charging systems or also ultra-fast charging systems at selected locations. It was further established that the early adopters are predominantly fleet customers at relatively small companies and also within larger groups.

03 E-AIX – »ELECTROMOBILITY REGIONAL CENTRE AND RURAL REGIONS« FEASIBILITY STUDY

Partners	Project budget €	Funding budget €
STAWAG, Aachen Public Utilities, consortium leader	722,703	361,351
Innovationszentrum für Mobilität und gesellschaftlichen Wandel (InnoZ) GmbH (Centre for Innovation in Mobility and Social Change)	188,438	94,219
City of Aachen	230,156	184,125
Rheinisch-Westfälische Technische Hochschule Aachen	1,652,315	1,652,315
Hans Hess Autoteile GmbH	127,082	63,541
City of Aachen	97,968	34,690
HOPPECKE Advanced Battery Technology GmbH	122,121	61,061
Rheinisch-Westfälische Technische Hochschule Aachen	481,123	481,123
STAWAG, Aachen Public Utilities	179,299	83,768
Hans Hess Autoteile GmbH	127,082	63,541
DB Rent GmbH	168,648	76,735
City of Aachen	70,125	56,100
Rheinisch-Westfälische Technische Hochschule Aachen	29,167	29,167

Vehicles
6 electric vehicles, 6 electric scooters, 20 pedelecs

Infrastructure
3 pedelec stations, 3 battery change stations, 14 charging stations, 1 DC-Charger

An aim of the project was to take a complete look at electromobility, paying special attention to urban infrastructure models, in order to subsequently be able to support the conception of different traffic models based on structural data.

The first step was a network analysis, in which estimates were made for the topological network requirements over the next four decades. Building on this data and incorporating various different scenarios in relation to the spread of electrically powered vehicles, an estimate was made of the need for the necessary expansion of the charging infrastructure in the Aachen urban area. Various manufacturers' different electricity charging posts were then examined and evaluated in respect to their suitability for optimised operation in terms of energy supply.

In a further step, an ecological assessment was carried out based on the findings obtained. This enabled the consortium to assess the increase in quality of life achieved through a higher proportion of electric vehicles.

A model of mobility appropriate to the requirements of urban traffic was conceived and implemented as part of the »Two-wheel« sub-project, which was dedicated to the integration of electrically powered two-wheel vehicles. To establish a suitable infrastructure, three pedelec rental systems and three electric scooter battery change stations were set up in Aachen.

»USERS WANT AVAILABILITY OF NATIONWIDE CHARGING«

04 USE OF HYBRID BUSES IN THE VRR – RESEARCH SUPPORT FOR THE USE OF HYBRID BUSES ON THE RHINE-RUHR PUBLIC TRANSPORT NETWORK

Partners	Project budget €	Funding budget €
Rheinisch-Westfälische Technische Hochschule Aachen	240,000	240,000
TÜV NORD Mobilität GmbH & Co. KG	485,423	221,789
Verkehrsbund Rhein-Ruhr (Public Transport Association)	235,832	117,916

Vehicles
21 hybrid buses

In this articulated bus comparison (hybrid vs. conventional), the direct emission of NO_2, which is of particular importance to the emission situation within cities, was reduced through the use of hybrid buses by 74.9 %, on average. At the same time, there also tended to be a reduction in total NO_x emissions. Depending on use, the CO_2-emissions are also up to 10.3 % lower than for conventional vehicles. For solo buses it is only possible to make a comparison with earlier measurements on a conventional bus in Hagen. Average reductions of NO_2 can be seen here at 53.9 % and of CO_2 at 21 %, with a slight increase in NO_x at 6.2 %.

As part of the tests, the consortium characterised the pattern of noise vibration harshness (NVH) in the passenger area of standard diesel buses and hybrid buses and also analysed the external noise emissions for pulling up at and away from bus stops. Depending on the specific driving and operating conditions, it is possible to show for hybrid buses compared to standard diesel buses a reduction of peak acoustic pressure levels in the passenger space of up to 10 dB(A) and in terms of external noise emissions of up to 12 dB(A).

It can consequently be stated that the potential for a reduction in emission levels and an increased level of acceptance is proven. However, more far-reaching development optimisation is still needed in order to be able to permanently utilise this potential in the future for the entire spectrum of driving and operational situations in scheduled bus service use.

»REFUSE COLLECTOR WITH HYBRID DRIVE«

05 DEMONSTRATION USE OF FOUR REFUSE COLLECTION TRUCKS WITH HYBRID DRIVE IN KREFELD

Partners
GSAK (Krefeld City Cleaning and Waste Management), consortium leader, 100 % subsidiary of SWK STADTWERKE KREFELD AG (Krefeld Public Utilities Company)

Vehicles
4 hybrid refuse collection trucks with Rotopress system

Project budget €	Funding budget €
920,911	460,455

During the demo use of the hybrid refuse collection trucks, a significant reduction in noise emission was recorded. The noise pollution for the surrounding area, the driver and the operator of the lifting and tipping device was considerably reduced compared to a conventional vehicle. It was perceived as having been halved (a reduction of more than 10 dB(A)) and consequently the reactions from workers and residents were always very positive.

The results so far also permit expectation of reasonable potential for reducing fuel consumption and thus also CO_2-emissions.

06 ACQUISITION OF TWO ARTICULATED BUSES WITH PARALLEL HYBRID DRIVE IN THE COURSE OF THE »SOLARIS/VOITH« PROJECT FIELD TRIAL

Due to the short tender invitation period, an application had to be made for a project extension, which was approved. During daily refuelling of the vehicles an automatic fuel data capture system is being used. These figures, along with statistics on locations, breakdowns and periods of use, are relayed to PE International, where they are evaluated.

The manufacturers are currently fine-tuning the operational concept in order to further improve the vehicles' performance. The collaboration with the manufacturers is running very satisfactorily. Further workshop personnel are continually being trained. Involvement in the cross-region »Buses« forum is enabling experiences to be exchanged with manufacturers, financial backers and colleagues.

Partner
Bochum-Gelsenkirchener Straßenbahnen AG (BOGESTRA)

Vehicles
2 hybrid buses

Project budget €	Funding budget €
254,384	127,192

»ARTICULATED BUSES WITH PARALLEL HYBRID DRIVES«

07 ELECTROMOBILITY'S SUITABILITY FOR EVERYDAY USE – BUILDING BLOCKS FOR A TECHNOLOGY ROADMAP: INFRASTRUCTURE, VEHICLES AND RELIABILITY

Partners	Project budget €	Funding budget €
Ruhr-Universität Bochum (consortium leader)	480,997	480,997
Delphi Deutschland GmbH	125,202	62,601

Vehicles
1 Stromos, 1 EV Adapt Fiat 500EV, 2 Think City, 2 Mitsubishi i-MiEV

Infrastructure
6 charging posts (3 from own funds)

Using six vehicles, over 50 test drivers of all ages travelled more than 45,000 km within a short period. They were very enthusiastic about the electric vehicles. Using survey questions, the consortium was able to record increases in their acceptance levels and in their trust in the cars' range and technology as a result of their personal experience with the vehicles.

The test drivers for the field trial were deliberately selected from a very wide spectrum of working environments and had varying usage profiles and socio-economic backgrounds. In combination with the chosen technology matrix, which featured consideration of normal and fast charging and of varying vehicle concepts (including converted vehicles with manual transmission, limited edition models and mass-produced vehicles), the necessary breadth was achieved for representative results and findings.

Analyses show that the range of the vehicles currently available is totally adequate for a large number of the users, as distances of less than 30 km at a time are largely those being covered in most instances. In order to also enable people who drive very often or commute long distances to switch to electromobility, efforts should be made to push on with the expansion of the fast-charging infrastructure and improved integration of electromobility into the local public transport system. On the technical side, clear potential for improvement can be seen in relation to energy recovery when braking (recuperation) and in the selection and control of auxiliary power trains.

08 E-MOBILE NRW

Partners	Project budget €	Funding budget €
SWD, Dusseldorf Public Utilities, consortium leader	1,499,553	749,776
Wuppertal Institut	302,489	287,365
Landeshauptstadt Düsseldorf – Stadtbetrieb Zentrale Dienste	166,489	108,218
Drive-CarSharing GmbH	45,367	22,684
Lufthansa Technik Aktiengesellschaft	20,439	10,219
Brühl Public Utilities	50,875	25,437
Emmerich Public Utilities	44,319	22,159
Fröndenberg Public Utilities	75,318	37,659
Hilden Public Utilities	72,762	36,381
MEGA Monheimer Elektrizitäts- und Gasversorgungs GmbH	54,574	27,287
Oelde Energy Supply	47,443	23,721
Schwerte Public Utilities	37,456	18,728

Vehicles

7 Mitsubishi i-MiEV, 1 Stromos, 1 Sam, 2 Think, 1 Mega Truck, 2 Citysax, 2 El Moto, 3 Inno Scooter, 1 Vectrix, 6 electric Scooter Kreidler, 1 e-spirit Silenzio 45, 3 E-Max 110s, 1 Goupil G3, 1 Maximilian 11, 19 additional vehicles at partner Drive CarSharing

Infrastructure

58 charging posts

The great majority of private participants in the pilot trial show the typical attributes of pioneering users: they are predominantly men of an »active« age with above average formal education and above average income. They are generally interested in technology, have a pragmatic affinity with cars and are moderately environmentally aware. In the case of the car users, their positive expectations were sometimes even exceeded by their experiences with the electric vehicles. Their willingness to use an electric car or scooter in their everyday lives in future is high, despite the attendant restricted flexibility. However, for the period through to 2015, the respondents could more likely imagine using a plug-in hybrid or a vehicle with a range extender and then for the period thereafter probably use a battery-powered electric vehicle.

In the case of business uses of electric cars and light commercial vehicles, differing fields of use and areas of potential substitution are emerging that are of significant scale and if fully exploited allow us to expect corresponding ecological effects. In the pilot calculations, the levels of potential in the fleets examined as examples run at between 15 and 40 % of the current conventional vehicle fleet, depending on assumptions. Lufthansa Technik (Lufthansa Engineering) represents an exception, where due to very special and uniform requirements applicable to the vehicle fleet, the potential for substitution is almost 100 %.

»EARLY ADOPTERS: CAR-SAVVY AND MODERATELY ENVIRONMENTALLY CONSCIOUS«

05 MODEL REGION SAXONY

Regional project headquarters SAENA GMBH (Saxony Energy Agency)

The project partners in the State of Saxony are working together to promote local public transport through the use of innovative and environmentally friendly technology and developing it into a competitive alternative to individual motoring. The »SaxHybrid« project was deliberately designed with a long-term strategy beyond the period of the report in order to prompt the development path from the previous state of technology with diesel/electric hybrid systems through to predominantly electrically recharged hybrid buses.

Through the joint project on fleet operation with electric vehicles, the basis was created for the establishment of individual electric motoring (primarily in company fleets), including the associated infrastructure. The results form the foundation for a follow-up project (provisionally due to commence in October 2012), in which the aim is to create the link between individual motoring and local public transport, including through the use of uniform billing and car-sharing systems.

An essential aspect of the successful implementation of electric drive systems on our roads is the constant enhancement of battery technology. This is taken account of within the model region by the project on the development of process and production technologies for energy storage systems, which is also being supported by the project headquarters. In addition to this, the centre was also able to recruit new project partners for more far-reaching research and development projects.

01 DEVELOPMENT OF PROCESS AND PRODUCTION TECHNOLOGIES FOR ENERGY STORAGE SYSTEMS IN INDUSTRIAL APPLICATIONS IN THE FIELD OF ELECTROMOBILITY

Through the project entitled »Development of process and production technologies for energy storage systems in industrial applications« run as part of the electromobility model region activities, Hoppecke developed expertise in the field of lithium-ion technology. The following results were achieved:

- Establishment of an innovative, universal test infrastructure for electrochemical storage systems and peripheral components for electrochemical and chemical characterisation and analysis.
- Based on the electrochemical cells tested for application-specific requirements and validated for use, a new kind of modular energy storage concept was developed and created that can be used for practically all voltage ranges and can be interconnected.
- Compared to individual, application-specific developments, an economic advantage is in particular achieved when interconnecting modules up to 400V.
- Unique integration of the specifically developed peripheral components, such as the battery management system (BMS), the various cooling concepts and the modular communication system.
- A new form of development of a modular concept for the highly varied levels of electrification in the field of electromobility: the »high-power« version for hybrid drive systems and the »high-energy« version for fully electric types.
- Through the development of innovative processes it was possible to demonstrate that the module could be economically produced for new niche markets with small unit numbers.

Partner
HOPPECKE Advanced Battery Technology GmbH

Project budget €	Funding budget €
5,241,367	2,620,683

02 SAXHYBRID – SERIAL HYBRID BUSES WITH PARTIALLY PURE ELECTRIC DRIVE OPERATION

Partners	Project budget €	Funding budget €
Fraunhofer-Gesellschaft zur Förderung der angewandten Forschung e. V. (FhG)	319,006	319,006
DVB, Dresden Public Transport, consortium leader	4,142,168	2,071,084
LVB, Leipzig Public Transport	4,246,783	2,123,391

Vehicles
11 EvoBus 18-metre hybrid buses, 9 Hess/Vossloh Kiepe 18-meter hybrid buses

The use of the vehicles showed that the optimisation of drive systems is only possible in actual scheduled service operation. Using measurement results it was possible to give recommendations for optimising the systems that could be practically implemented and to improve fuel efficiency, within the scope of the project. The standardised operating cycles for hybrid buses and the adaptation of the vehicle models are intended to serve as a recommendation for evaluating such drive concepts. The project laid the foundations for a subsequently envisaged field trial using buses capable of quick charging:

- Gaining of experience from fleet use of serial hybrid buses on different lines with varying terrain and differing operating conditions
- Objective and independent accompanying analysis of the scheduled service deployment, focusing on fuel consumption
- Generation of standardised operating cycles for hybrid buses, which take comprehensive account of their characteristics
- Creation of vehicle simulation models for deriving deployment recommendations for other lines
- Utilisation of the vehicle simulation models for optimisation of the vehicles to be used
- Working up of principles for an »auto-learning« energy management system
- Deriving specifications for the later conversion of vehicles for recharging operation, including storage system sizing
- Planning the technology and infrastructure to be used for electricity supply points as preliminary work for the subsequently planned field trial

03 SAXMOBILITY – FLEET OPERATION USING ELECTRIC VEHICLES AND FLEET MANAGEMENT GEARED TO ELECTROMOBILITY IN THE SAXONY MODEL REGION

Partners	Project budget €	Funding budget €
KEMA – IEV Ingenieurunternehmen für Energieversorgung GmbH (consortium leader)	240,165	120,082
Leipzig Public Utilities	365,190	182,595
Telekom AG – Hochschule für Telekommunikation Leipzig (Leipzig Telecommunications College)	294,450	294,450
Leipzig Public Utilities	642,540	321,270
Dresden Public Utilities	430,933	215,466
ENSO NETZ GmbH	240,943	120,471
Hochschule für Technik und Wirtschaft Dresden (Dresden College of Technology and Business)	405,749	405,749

Vehicles

3 City Sax, 3 Tazzari Zero, 18 Mitsubishi i-MiEV, 3 Citroën C-zero, 1 Audi A1, 1 e-SMART, 1 Opel Ampera, 8 electric scooters (EVT, Peugeot, Solar Scooter), 3 pedelecs

Infrastructure

60 charging stations, 155 charging points

- The production vehicles' suitability for everyday use in the areas of reliability, user satisfaction and environmental compatibility was proven.
- With the conversion of individual vehicles to lithium-ion batteries and the enhancement of the battery management system, increases were achieved in performance and range.
- Regulatory decision makers in the model region's local authorities were made more aware of the issue of electromobility and it was possible to channel the set-up of the public charging infrastructure into one process.
- The power grid measurements (energy balance, stand-by losses) and studies show that with a low percentage of electric vehicles no supply bottlenecks or performance limitations need be foreseen in the electricity supply networks.
- As part of the accompanying research, surveys were carried out with potential market partners, customers and users. The results show that the press and publicity work done succeeded in raising perception and acceptance of electromobility. As business users, fleet operators want an electric vehicle with a range of approx. 200 km and the certainty of being able to recharge at any time within a reasonable radius; plus they are prepared to pay a maximum of 10 % more than for comparable conventional vehicles and are interested in leasing models. Based on the results, a market strategy was developed.

»EVERYDAY SUITABILITY IN TERMS OF SAFETY, USER SATISFACTION AND ENVIRONMENTAL IMPACT SUBSTANTIATED«

06
MODEL REGION RHINE-MAIN

Regional project headquarters Stadtwerke Offenbach Holding GmbH (Public Utilities)

Experience from the projects so far shows that the greatest obstacle to widespread introduction of electromobility is the comparatively high purchase price of vehicles and the charging infrastructure. In order to enable the use of a high number of electric vehicles, it is thus essential to look at electromobility in an integrated way within innovative systems of mobility and smart grids.

At the current stage, a prerequisite for the sustainable introduction of electric vehicles is the creation of an opportunity to »try them out« and thereby generate visibility and confidence in the »new« technology. Broad acceptance needs to be achieved among the public and the technology must be brought into line with user needs through trials in everyday situations. It is further shown by initial socio-scientific studies that the residents of Hesse could cover 90 % of their need for mobility through the use of electric vehicles and to a large degree have the ability to charge such a vehicle at home or at work.

A requirement of the city of the future and of the organisations based within it is therefore not just to create the regulatory framework for electromobility, but in particular to provide services with easy access. This relates both to fleet solutions at businesses and to mobility solutions connecting to local public transport and leads to a new business model, enabling electromobility to be presented as an economically efficient long-term option. However, it is precisely this aspect that is proving to be a current challenge, as many players from extremely varied fields need to work intensively together. Research areas – such as our model region – are important platforms in this regard for bringing the participants together and enabling synergies to be utilised.

01 FLEET TRIAL OF ELECTRICALLY POWERED COMMERCIAL VEHICLES – USE OF ELECTRICALLY POWERED PARCEL DELIVERY VEHICLES IN URBAN DELIVERY SERVICES WITH AN EMPHASIS ON CENTRAL AREAS IN ELECTROMOBILITY MODEL REGIONS

Despite some initial reservations about the new technology, acceptance among the drivers and operations managers was good overall. The customers, too, reacted very positively to the electric mobile delivery service from the outset. In terms of the general public, there was also great interest, especially at the start of the project period.

There was also no evidence that low operating noise has any negative effects: during the course of the project there were no reports of any dangerous situations nor did any accidents occur. Conventional vehicles can be completely replaced by electric types if certain basic conditions exist, such as in respect to delivery volume and density of delivery addresses in the destination area. Integration of electrical vehicles into typical courier industry processes and the vehicle's technical features also require corresponding adaptation to operational workflows and equipment.

Looking at life cycle costs shows that even with optimistic assumptions the vans originally designed as electric vehicles cannot be expected to be economically competitive this decade.

In addition to technical faults, the maintenance complexity observed is also significant in evaluating their use, especially from a technical design perspective. Some parts of the accompanying research work had to battle with compatibility problems and a lack of availability of suitable analysis data.

Partner
United Parcel Service Deutschland Inc. & Co. OHG

Vehicles
6 delivery vehicles

Infrastructure
6 external charging stations

Project budget €	Funding budget €
178,307	89,153

»BUILDING TRUST – MAKING ELECTROMOBILITY VISIBLE«

02 FIELD TESTS INTO DEVELOPING AND SUPPORTING THE STANDARDISED USE OF ELECTRIC CARS, SCOOTERS AND PEDELECS, PLUS CHARGING STATIONS AND BILLING SYSTEMS

Partners	Project budget €	Funding budget €
Mainova AG	691,185	345,592
ABG FRANKFURT HOLDING GmbH	209,979	99,898

Vehicles
2 Citroën C1, 1 Tesla, 25 Mitsubishi i-MiEV, 50 pedelecs of various makes

Infrastructure
40 public charging stations

Working in collaboration with ABG Frankfurt Holding, Mainova AG developed a charging infrastructure for public use in parking bays and multi-storey car parks that is unique in Germany. All users of electric cars can use the charging stations – without pre-registration or any base fees.

Mainova AG also proposed converting one of Lufthansa Engineering's electric vehicles to inductive charging and subsequently carried out the conversion. By operating the infrastructure the energy supply company hopes to gain insights into efficiency, user acceptance and characteristic radiation values. The components for inductive charging were developed by Bruchsal-based firm SEW-Eurodrive GmbH. Far-reaching visions also see the charging inductors integrated into the road carriageways.

Pedelec stations for automatically securing and charging pedelecs:
Within the scope of the group proposal, a customer-friendly, open electricity charging infrastructure was successfully developed, built and tested. The »Frankfurt Model« is of particular interest to local authorities. They are able to build on an existing distributed infrastructure for billing and on multi-storey car parks and parking ticket machines in central urban areas. The need for identification is done away with, due to the traditional parking ticket. Pedelecs can supplement an ecological system of mobility on residential estates, combined with local public transport and car sharing. As part of the project, pedelec stations for securely parking and charging pedelecs were selected, built and tested.

03 GREEN MOVE – HYBRID BUSES IN DARMSTADT

Partners	Project budget €	Funding budget €
HEAG mobilo GmbH (consortium leader)	1,024,823	512,411
Technische Universität Darmstadt	418,529	418,529
VDL Bus & Coach Deutschland GmbH	1,063,750	531,875
Vossloh Kiepe GmbH	228,750	114,375

Vehicles
3 VDL Citea SLF-120/hybrid

Within the scope of the Green Move project, the consortium succeeded in integrating hybrid technology into a standard bus for use in scheduled urban service. As a prerequisite for use in scheduled service, homologation for obtaining type certification was achieved within a very short time. The consortium also created a modern drive concept that uses an electric portal axle with hub motors. For this they adapted the hardware and software in the power electronics and in the diesel engine's management system as required. In enhancing the drive controls and energy management, regulating the EEV-format diesel engine represented a particular challenge. There is still potential here for further development, as the consortium was not able to achieve a satisfactory outcome within the research period. They did succeed, however, in improving the operation of electric auxiliary consumers such as fans, pumps (cooling system) and power steering pump in respect to noise generation and energy consumption. They also compared different energy management systems, e.g. trajectory operation, output tracking and best point operation. By stipulating an energy management system inclusive of stop/start function that is location dependent and delivers optimum energy efficiency, the hybrid technology became something that passengers could really experience. The simulation calculations carried out in parallel, in which the reference bus' results were compared with the hybrid drive system's theoretical results, produced fuel consumption savings in every driving cycle performed.

04 PUBLIC UTILITY VEHICLES WITH HYBRID DRIVE TO REDUCE HARMFUL EMISSIONS – THE HYBRID REFUSE COLLECTION VEHICLE

The consortium sees the use of hybrid technology as a groundbreaking technological enhancement in the area of drive systems for domestic refuse collection vehicles. In this project, the pre-production VarioPress DualPower vehicle from Faun Umwelttechnik GmbH & Co. KG is being used for the first time on a long-term basis within the normal operations of a refuse collection organisation.

Two power trains are combined in this model: for the journey to the refuse collection area the power train used is a standard diesel truck engine with automatic transmission and an output of 213 KW. Within the collection area itself an electric motor is then used that is powered via a diesel generator and a high-capacity energy store, known as the »Super Caps«.

As due to the nature of its work a refuse collection vehicle regularly spends over three quarters of its time collecting rubbish, the effect of this diesel/electric drive system has a clear impact. It is also expected that due to the energy recovery through electrical braking, wear on the brakes will be much less than on comparable vehicles. Electrical braking also avoids the energy-intensive consumption of compressed air.

Compared to conventional vehicles, the following results can be recorded:
- Approx. 30 % fuel saving in refuse collection mode
- Approx. 20 % less payload
- Significantly less generation of noise
- Vehicle regarded very positively by crew and public

Partners
ESO Offenbacher Dienstleistungsgesellschaft mbH (consortium leader), Fraunhofer IWES, Kassel, Fachhochschule Frankfurt am Main (Technical College)

Vehicle
A refuse collection vehicle with diesel/electric hybrid drive system

Project budget €	Funding budget €
240,408	120,204

»TESTING E-BIKES IN DEMANDING TOPOGRAPHICAL REGIONS«

05 PILOT: PEDELEC IDSTEINER LAND ON TOUR

Partners	Project budget €	Funding budget €
Süwag Energie AG (consortium leader)	662,285	331,142
Storck Bicycle GmbH	430,670	215,335

Vehicles
Approx. 150 pedelecs

Infrastructure
4 solar charging stations and 8 grid-connected charging stations

The rechargeable batteries used in the project have a capacity of 10 Ah and are boosted by so-called recuperation mechanisms (power recovery) in order to increase their range. On the drive system prototype, the fitted controller circuit boards became damaged by the flow of energy produced at excessive speed. The circuit boards were adapted to the loads and the drive housing optimised to take the spokes better. Manufacture of the motors was also moved from China to Europe.

As a result, two types of charging post were developed: the solar charging post is independent of the electricity supply grid. It can therefore be set up, for example, in tourist areas away from any development. The charging process is performed on the pedelec itself via direct current. The grid-connected charging locker, on the other hand, facilitates safe charging via an earthed socket. In both cases the charging points are enabled using RFID chips.

The accompanying socio-scientific research showed that the batteries' range is adequate for the current user group. Greatest demand came from the »50 plus« clientele. The major criterion in deciding to use a pedelec is actually trying one out, as it is the positive experience from doing so that first conveys the bike's benefits. The price, by contrast, seems to play a subordinate role. Widening the use of pedelecs in the business environment as a substitute for commuter car journeys requires an extensive promotional campaign and is achieved less well by targeting car drivers in their private environment.

06 ELECTRIC CHARGING STATION OUTSIDE OF COMPANY HQ

Partner
Stadtwerke Offenbach Holding GmbH (Public Utilities)

Vehicles
2 electric vehicles, 2 pedelecs

Infrastructure
Schuko, IEC Typ II, CHAdeMO

Project budget €	Funding budget €
106,777	53,388

The range of the batteries being used is currently one of the most critically discussed aspects of electric vehicles. Although one battery charge is sufficient for over 80 % of the daily trips driven, situations do arise where a greater range must be reliably guaranteed. Stadtwerke Offenbach Holding GmbH is therefore running a trial of two fast-charging technologies in order to be able to drive purely on electric power even in the event of longer journeys arising. The group's delivery vehicles generally need an average daily range of 50–70 km and in any case not more than 170 km. Not all journeys, therefore, can be made on a purely electric basis using the electric car models currently on the market – especially if auxiliary consumers such as heating and lights are switched on or the outside temperature is low and battery capacity thus drops.

Against this backdrop the group installed two different fast-charging technologies in the trial. Using the DC fast-charging method the user is able to charge the vehicle battery back up to 80 % within 25 minutes. This is being tried out in the project with the Mitsubishi I-MiEV, which in addition to this connector has another for gentle charging of the battery overnight from a domestic electricity socket. For comparison purposes, AC charging, the method primarily favoured in Germany, was tried out with the Stromos vehicle. The electric car charges through an intelligent control system between vehicle and charging infrastructure at up to 32 A and 400 V. The charging process takes up to 3 hours. The plug used is an IEC type II, which is currently going through the standardisation process.

»REDUCTION OF HARMFUL EMMISSIONS«

07 BIKE + BUSINESS 2.0 – PEDELECS AS A COMPONENT OF BUSINESS MOBILITY MANAGEMENT

Partner
Regionalverband Frankfurt/Rhein-Main (Regional Association)

Vehicles
151 pedelecs

Project budget €	Funding budget €
600,214	291,194

Feedback from the project participants has so far been overwhelmingly positive. This suggests that over the next few years pedelecs will play a much more significant role in company fleets and on the journey to work. Concrete results will be available when the socio-scientific and technical research projects have been completed. Being undertaken by the Fachhochschule Frankfurt/Goethe-Universität Frankfurt and the Fraunhofer-Institut IWES respectively, these are currently still ongoing.

Collecting data via questionnaires, diaries and interviews, the socio-scientific research is focusing on the employees' patterns of use of the pedelecs and on the factors that influence this. Using equipment such as GPS-compatible computers and energy loggers, the technical research project ensured regular capture of data.

The collaboration between the FrankfurtRheinMain Regional Association, acting as project leader, and project partner riese und müller worked very well. The same also applies to the collaboration with the participating institutions, local authorities, businesses and research institutes.

08 USE OF THE HYBRID DRIVE SYSTEM ON MUNICIPAL VEHICLES TO REDUCE HARMFUL EMISSIONS

Partners	Project budget €	Funding budget €
EAD, City of Darmstadt Municipal Services – consortium leader)	427,086	213,548
Institut für Verbrennungskraftmaschinen (VKM) der Technischen Universität Darmstadt (Institute of Internal Combustion Engineering)	79,011	79,011

Vehicles
A hybrid refuse collection vehicle, a self-propelled road sweeper

Use of the hybrid refuse collection vehicle under real conditions showed that, in part, the technology is not yet fully developed and that some is even still at the development stage. Operation of the drive system's complex add-on unit required the user to have a thorough understanding of the technology. The reduction in payload compared to conventional refuse collection vehicles (at 26 tons permitted total weight, down by around 1 ton) is one of the main areas of criticism. However, the reduction in fuel consumption and the lower noise level do open up the possibility of using such vehicles at marginal times, which would bring with it several advantages.

To analyse the stock of vehicles it proved sensible to divide the existing municipal fleet into vehicle groups based on permitted total weight. Using reference vehicles it was thereby possible to establish which vehicles showed potential for savings. From here, specific options for handling the management of the fleet could be derived.

To this end, a self-propelled road sweeper (Bucher Schörling City Cat 5000, weight category 7.5–12 tons) was fitted out in a complex procedure with a total of 16 sensors in order to record all hazardous substances produced during real driving operations – auxiliary equipment simultaneously switched – which had previously never been done in this form.

09 »NEMO« (NORTH HESSE ELECTROMOBILITY) – IMPLEMENTATION OF A JOINT CONCEPT FOR DEVELOPING AND BUILDING UP A UNIFORM INFRASTRUCTURE ACROSS NORTH HESSE FOR CHARGING ELECTRIC VEHICLES

Partners

Bad Sooden-Allendorf Public Utilities, Eschwege Wolfhagen Public Utilities, EWF Energie Waldeck-Frankenberg GmbH, Kraftstrom-Bezugsgenossenschaft Homberg, Witzenhausen Public Utilities (joinedend of 2010), Städtische Werke AG Kassel (Municipal Services) consortium leader

Vehicles

9 electric vehicles, 3 electric scooters, 25 pedelecs

Infrastructure

61 charging points

Project budget €	Funding budget €
455,338	227,669

In March 2011, the first of 23 Mennekes charging posts so far supplied went into operation. The same charging technology is now being used in seven different power grid areas. The EBG, Langmatz and emco charging equipment is still included in the test, as is the Tesla charging box.

The RFID charging cards are now being managed by the newly formed Union of North Hesse Public Services (SUN), to which the NEMo partners belong.

The pilot system on Karlsplatz in Kassel has four charging spaces. Two of these are reserved for e-mobiles and two are charged-for parking spaces. In the period from June 2010 to August 2011, 2,516 kWh of electricity was discharged in 837 charging processes. The amount of power issued per charging point will probably go down as a result of other charging places coming on stream.

The power consumed by Kassel Municipal Services' two vehicles through to August 2011 was 3,340 kWh.

The total distance travelled was 13,850 kilometres. On cross-country trips both Stromos vehicles were also charged at other charging posts. It can be assumed that the Kassel Municipal Services' vehicles consume on average approx. 18 kWh per 100 kilometres.

10 MOREMA – INTEGRATION OF ELECTRIC VEHICLES INTO THE JUWI FLEET

In the course of the MOREMA project the partners examined how electric vehicles can be integrated into the everyday lives of their employees and into their fleets. Based on surveys, diaries and electronic driving profiles, they were able to determine what opportunities electromobility offers for juwi's fleet. The aforementioned project participants' results are being provided by them in separate reports.

juwi's main task was to provide the vehicles and the test participants for the field trials. Way back in October 2000, juwi was already integrating Germany's first non-pool company car into its fleet. Since January 2011, a total of ten employees have been driving a Mitsubishi I-MiEV as their company car. Contrary to the general assumption, difficulties were created in the beginning not just by the vehicle's limited range and long charging times, but also by tax disadvantages compared to conventional cars. On this score juwi contacted the relevant offices right at the start of the project with some initial suggestions and took the tax burden off their company car drivers through the so-called »juwi Package« (tax compensation and mobility guarantee).

During the period of the trial two fuel-saving studies were also conducted. They showed that through simply changing driving style it was possible to considerably reduce CO_2-emissions with conventional cars as well (average reduction over 20,000 km: 282.14 kg CO_2).

Partner

juwi R & D Research & Development GmbH & Co. KG

Vehicles

1 Mitsubishi i-MiEV right-wheel-drive,
9 Mitsubishi i-MiEV left-wheel-drive
3 Tesla Roadster,
1 USA Tesla Roadster,
1 EcoCraft Carrier,
10 Pedelec Diamant,
6 Pedelec Storck Multitask Raddar,
6 E-Scooter EVT 4000e,
3 E-Scooter SolarScooter Sport SCP 4040 Li.on

Project budget €	Funding budget €
1,086,553	543,276

»A COMBINATION OF SUBURBAN RAIL, E-BUS AND ELECTROMOBILE LINK TRANSPORTATION«

11 LINE 103 – ELECTROMOBILITY IN RHINE-MAIN

Partners	Project budget €	Funding budget €
Offenbacher Verkehrs-Betriebe GmbH (Transport Company) consortium leader	284,991	142,495
RMV Rhine-Main Transport Association	485,050	242,525

Vehicles

1 electric bus, 2 electric cars, 15 pedelecs

The trial of electric means of transport – both e-buses and electric vehicles for public hire – is helping to create broader public acceptance of the concept and is aiding with the technical advancement of electromobility so that a greater expansion of such systems also becomes economically sustainable. Acceptance and curiosity on the part of the users certainly exist: after just one month of opening, the »eMobil Station« already had over 100 registered customers and each month around 20 more signed up.

The second module of »Line 103«, the trial of Germany's first solely electrically powered bus in test operation, began just after the end of the funding period (mid-October 2011). The public presentation of the electric bus took place on 27 October 2011. The main aim of this whole project is the integration of electrically powered mobility into the public transport system. This makes it possible to take climate-neutral journeys using interconnected modes of travel and enables a significant contribution to be made to reducing noise and emissions in city centre areas. In combining both modules of »Line 103«, Offenbach is achieving an ideal electrically based travel chain: the »eMobil Station« is located right next to the central »Marktplatz« bus and metro hub. Anyone who has already travelled thus far without internal combustion engine, i.e. by electrically powered metro or bus, can continue their climate-friendly journey by electric car or pedelecs. A perfect combination is thus achieved of public and individually configurable mobility.

12 ACCOMPANYING SOCIO-SCIENTIFIC RESEARCH INTO ELECTROMOBILITY IN THE RHINE-MAIN MODEL REGION

Partners	Project budget €	Funding budget €
Fachhochschule Frankfurt am Main (Polytechnic)	239,450	239,451
Goethe-Universität Frankfurt am Main	254,402	254,403
e-hoch-3 GbR Darmstadt	106,427	85,142

Electric cars can be used for daily mobility, especially for the journey to work. An average electric car has a range of 100 km, even in unfavourable weather, while only 2 % of the users surveyed travelled longer distances on their way to work. Accordingly, 98 % of the users can use an electric car without any problem for their journey to work.

Although most of those surveyed drive less than 100 km a day, nearly two fifths of them indicate that electric vehicles would require a range of over 200 kilometres in order to be something that they would consider. It seems that a change in mobility behaviour is required, which ought to be conveyed to the potential users of the future.

For short distances, pedelecs are an alternative to the car, as 36 % of those surveyed travel a distance of 5 km or less to work. The data analysis shows that for their daily journey to work nearly half of all respondents could use a pedelec. The users of the Rhine-Main model region were very enthusiastic about the project and return rates were therefore practically 100 %. Using standardised questionnaires, a total of 399 users were surveyed. Taking initial, interim and final surveys together, 648 completed questionnaires were returned.

The users' positive expectations were largely fulfilled during the test period. However, only a few users are prepared to accept the high additional cost currently charged for an electric vehicle. Consequently many otherwise enthusiastic users would not make the switch. For example, of 146 people surveyed only around one sixth are prepared to bear additional costs of 20 % or more than the price of a car with an internal combustion engine.

13 ZUKUNFTERFAHREN – RESEARCH AND DEMONSTRATION PROJECT TO ASSESS AND INCREASE ACCEPTANCE AND MARKET POTENTIAL OF ADAPTED LIGHT ELECTRIC VEHICLES

The electric bicycles and light electric vehicles were in principle well accepted. The total distance travelled was approx. 70,000 km, with around 60 % of journeys replacing those by conventional car. The easy availability of the multifaceted array of vehicles made it simple to use one suited to the requirements of the trip. Technical and logistical solutions are being considered in respect to a precise forecast of (remaining) range, increased charging efficiency and extended battery life. Trials of these are to follow. During the period of the project it is, for example, possible through switching the vehicles from lead to lithium battery technology to demonstrate improved usability through increased range and payload and shorter charging times.

In general it can be said that adapted light electric vehicles represent a serious alternative to conventional types and are recognised by the public as such. They happily accept these vehicles, which require no great getting used to. An improvement in the road/cycle path and charging infrastructure would promote wider use.

Partner

Verein für Ökologie, Gesundheit und Bildung e. V., Kaufungen (Society for the Promotion of Ecology, Health and Education)

Vehicles

Pilot fleet with a wide spectrum of various new kinds of vehicles from the market segment between bicycle and car: pedelecs and special bikes with electric assistance (12 German and 1 British), hybrid velomobiles and electric scooters (3 German, 1 Danish), Electric buggies and small cars, from single-seater to 2+2 (2 German, 1 Italian and 1 Indian) and electric vans (1 German and 1 French)

Infrastructure

One public »park & charge« space per vehicle

Project budget €	Funding budget €
454,199	272,519

»RANGE: 98 PERCENT CAN USE E-VEHICLES FOR THEIR DAILY COMMUTE«

14 ELECTROMOBILITY MAINTENANCE DIAGNOSES ON THE FLY

Partners	Project budget €	Funding budget €
Fraunhofer-Gesellschaft zur Förderung der angewandten Forschung e. V. (FhG)	208,661	208,661
ALL4IP TECHNOLOGIES GmbH & Co. KG	286,187	188,883

Vehicles

2 pedelecs

When a new category of vehicle is launched, both user behaviour and the likely stresses placed on it in everyday use are unknown. In the case of pedelecs these factors differ significantly from those for traditional bicycles. For this project the stresses on the bike when in use are important, which is why they were examined in a series of trials. To this end, a pedelec was fitted with sensors in order to record the levels of stress on frame, yoke, handlebars and seat tube caused through use. A typical city course of 10.5 kilometres in length was chosen for the test journeys. At 20–22 km/h, the average speed of the journeys was around 40 % above the average speed of standard cyclists.

The second component in the project is the development of an embedded system for pedelecs that captures, automatically processes and relays relevant data via GSM/GPRS to the central maintenance diagnosis server. The system that was duly developed is compact and can be integrated into the swing arm of the rear wheel. The database on the maintenance diagnosis server enables a display to be provided online or on mobile devices. What is shown is dependent on the viewer. While users see the nearest pedelec available for use, maintenance personnel are able to identify which bikes need their attention. The internet front-end is an interactive map, on which the position and status of the pedelecs is shown.

The automatic relay of status data enables the vehicles' periods of downtime to be considerably reduced and the maintenance personnel to optimise servicing intervals.

07

MODEL REGION REGION STUTTGART

Regional project headquaters WRS – Wirtschaftsförderung Region Stuttgart GmbH (Regional Development Agency)

Around 500 people tested the vehicles made available by Energie Baden-Württemberg AG. In addition, around another 100 e-bikes for municipal fleets in the region were tested. It is worthy of note that there were no accidents attributable to the vehicles' silent movement. Two-wheelers are predominantly being used during the week for the journey to work as a substitute for the car.

The projects with an urban development character in Ludwigsburg and on the airfield in Sindelfingen/Böblingen are aimed at working up sustainable traffic concepts and preparing for the market launch of electric vehicles. Central elements here include developing the infrastructure and researching user behaviour and pre-competitive business models.

50 battery-powered Vito E-CELL vans are in everyday use all around Stuttgart. Tests are being done on their efficiency in respect to consumption and range and on their suitability for urban delivery work. Development of the Vito E-CELL and one other model was only possible thanks to model region funding. The Stuttgarter Straßenbahnen AG (Stuttgart Tram Company) also has five articulated buses with hybrid drive systems in scheduled service. Initial results show that the buses use 20-30 % less fuel than is currently used by the most economical diesel buses.

Stuttgart is upgrading its »Call a Bike« bicycle hire system to »eCall a Bike Stuttgart« with the addition of 100 DB rental pedelecs. The bikes can be hired out from 45 specially designed terminals. In addition, three fully electric Porsche Boxsters built for research purposes are also being tested in the region.

One special feature of project work in the region is EleNa, a project being run by automotive suppliers, who have jointly developed an electric drive retrofit kit, with which conventional vans can be fairly easily converted to (parallel) hybrid vehicles.

01 500 ELMOTOS FOR THE STUTTGART REGION

Over the two years, the electronauts travelled a total of around one million kilometres – practically without any accidents – and published over 4,000 entries on the »Electronauts' Blog«. During the project there were 13 public earthed plug-in charging points provided for two-wheelers spread around the city centre. 3,000 public charging processes were carried out. The total charge volume was 2,000 kWh and the total charging time 6,400 hours.

35 % of the electronauts lived within the Stuttgart city area, but not centrally: 25 % in suburbs, 22 % centrally within a town and 18 % in rural regions.

43 % of those questioned used the e-bike daily and 45 % one to three times a week. Also, 83 % rode it exclusively for personal use and of these 40 % used it as their primary means of transport. Following the fleet trial, only 10 % of the users would replace a traditional vehicle with an electric one, although 40 % would continue to use one. The factors seen as negatives were above all the high cost of purchase and the inability to carry passengers. Factors seen as positive included safety, ease of charging and low running costs. The fun of riding the e-bike and the attention attracted from other road users were also perceived as very positive.

The greatest challenge existed at the start in getting the vehicles finished in time. Furthermore, all needed to be fitted with data loggers to enable the up-to-date data to be put online on the electronauts' portal.

Partner
ID Bike GmbH

Vehicles
500 ELMOTOS,
100 electric scooters

Infrastructure
45 Stuttgart charging posts +
30 charging posts from the Karlsruher project MeRegioMobil
Online electromobility portal for the »electronauts« and visitors

Project budget €	Funding budget €
5,807,224	2,322,889

»500 ELECTRONAUTS EXPERIENCE ELECTROMOBILITY«

02 S-HYBUS – DIESEL HYBRID BUSES FOR STUTTGART

Careful preparation and management of the rollout proved to be the key factor to success, along with close collaboration with the manufacturer.

Compared to a vehicle of the very newest design with full air conditioning and particle filter, fuel consumption fell by approx. 18 %. Compared to a Euro 2 bus and older technology, it was down by as much as 30 % or more.

Measurements in real operation have shown that the emission values are appreciably lower than the saving in fuel. This is attributed above all to the smaller engine and its new operating concept. The level of noise developed when approaching, especially at bus stops, is viewed very positively. In order to deploy hybrid buses in a really energy-saving way, it is necessary to have precise knowledge of the route characteristics and vehicle attributes and to schedule the vehicle deployment accordingly.
During the term of the project, the vehicles proved to be far more reliable than the Stuttgart Tram Company had assumed. The hybrid buses are very well accepted by the drivers and preferred to diesel ones. This can be attributed above all to the handling qualities and reduced noise.

Maintenance of the hybrid buses is carried out within the workshop's normal workflow. The existing personnel were trained accordingly. In future, all Stuttgart Chamber of Trade and Industry vehicle mechanic trainees will obtain the basic qualification as part of their training.

Partners
Stuttgarter Straßenbahnen AG (Tram Company) – consortium leader, TÜV Nord, PE International

Vehicles
5 Citaro BlueTec Hybrid articulated buses

Project budget €	Funding budget €
2,622,262	1,311,131

03 ELENA – ELECTRIC DRIVE RETROFIT KIT FOR DIESEL VANS

Partners	Project budget €	Funding budget €
Fraunhofer-Gesellschaft zur Förderung der angewandten Forschung e. V. (FhG)	377,456	377,456
ARADEX Aktiengesellschaft	274,867	137,433
Heldele GmbH	217,557	108,779
Esslingen University	315,377	315,377
Huber Automotive AG	620,640	310,321
Kompetenznetzwerke Mechatronik BW e. V.	43,409	26,045
Lauer & Weiss GmbH	149,998	74,999
Forschungsinstitut für Kraftfahrwesen und Fahrzeugmotoren Stuttgart (FKFS) (Institute of Automotive and Vehicle Engine Research)	132,657	119,391
Telemotive Aktiengesellschaft	199,332	99,666
WS Engineering GmbH & Co. KG	50,250	25,125
J. Eberspächer GmbH & Co. KG	48,423	24,211
TÜV SÜD Automotive GmbH	83,190	41,595

Vehicles

Development of a prototype electric drive retrofit kit for vans with internal combustion engines

In the project twelve partners developed an electric drive retrofit kit for conventional diesel engine vans and equipped a demonstration vehicle with it. The prototype can be operated purely by internal combustion engine, purely electrically or in hybrid mode. The driver selects the mode via an HMI touch-screen, which can display all key information on battery status, energy recovery and boost availability. The big advantage of this hybrid concept is the possibility of being able to operate the vehicle in the conventional way without any limitations on the motorway by using its internal combustion engine. With its electromotive energy recovery brake (recuperation) system, the vehicle also provides the possibility of charging the battery while on the move.
A battery charging station was also set up and checks made to ensure that the charging post communicated properly with the vehicle. Methods and training documents were also drawn up, with which vehicle workshops can be trained in respect of quality, efficiency and workplace safety related to the electrification of vehicles.

In order to ensure the safety of the newly developed retrofit kit, the project was constantly run taking into account the latest standards and norms. This included producing an integral safety concept. It incorporated a comprehensive dangers and risks analysis for all three available driving modes, a system analysis based on the specification sheets and ensuring the retrofit kit's functional and electrical safety. In all three driving modes all safety systems present in the original vehicle are fully available and thus also ensure a high level of safety after the conversion.

»E-RETROFIT KIT FOR CONVENTIONAL DELIVERY VEHICLES«

04 ELECTROMOBILITY CONNECTS FOR THE LONG TERM

Partners	Project budget €	Funding budget €
City of Ludwigsburg (consortium leader)	75,150	37,575
Ludwigsburg-Kornwestheim GmbH (Public Utilities)	72,388	36,194
Cargo-Logix GmbH	130,215	78,129
Universität Stuttgart	581,266	581,266
Fraunhofer-Gesellschaft zur Förderung der angewandten Forschung e. V. (FhG)	327,486	327,486

Vehicles

6 Mitsubishi i-MiEV, 1 Citroën Berlingo, 5 electric scooters, 7 pedelecs, 4 e-bikeboards, 2 Segways

Infrastructure

39 normal charging stations, 1 fast charging station

The acceptance of the public infrastructure by users is still low. Possible reasons for this are the modest spread of electric cars and the lack of the ability to do a quick charge at public charging stations.

A list of requirements for an automated parking/charging system for pedelecs was produced and possible approaches examined, including alternative methods for grasping and positioning.

For better utilisation of the vehicles in the municipal fleet increased centralisation in larger vehicle pools is advisable. The vehicles were generally well accepted by the employees. The cars used each travelled on average 990 km per month, scooters 165 km, pedelecs 70 km and Segways 93 km. Range appears to hardly present any problem in Ludwigsburg, as proved by residual charge levels of sometimes well over 60 %. There are differences in the quality of the vehicles and in servicing. Although the project tended to use high-priced vehicles, nearly all scooters needed some attention or repairs in the course of the project.

The attempt at integrating a relatively large number of charging stations into a multi-storey car park showed that the installation costs of individual charging stations increase appreciably if the connection work for numerous stations has to be done locally. On average, installation costs emerge of up to € 4,000 per normal charging station and € 10,000 per fast charging station.

05 IKON E – INTEGRATED CONCEPT FOR SUSTAINABLE ELECTROMOBILITY

Partners	Project budget €	Funding budget €
Daimler AG (consortium leader)	10,926,286	3,704,011
TÜV SÜD Automotive GmbH	527,206	263,603
EnBW Energie Baden-Württemberg AG	329,640	164,820
Fraunhofer-Gesellschaft zur Förderung der angewandten Forschung e. V. (FhG)	589,586	589,586

Vehicles
Approx. 170 Mercedes-Benz Vito E-CELL panel vans

Infrastructure
Infrastructure built up in actual customer depots and garages, charging stations as wall boxes, mode 3, 400 V/16 A, 3-phase, electricity charging over night, max. charging duration of 5 hours (0–100 %)
Construction of 4 prototype minibuses for evaluating commercial transportation of passengers

As far as customer acceptance goes, it was noticeable in the course of the driving sessions that the initial reticence turned into confidence in the new drive technology and the customers expressed increasing enthusiasm for the concept.
The driving trials' initial analysis results prove high product reliability and quality. Charging times here were relatively short and the average distances travelled were not more than 35 kilometres.

The high quality and good driving performance are confirmed by numerous awards. These include the »Postal Technology International Award 2010« in the category »Transport/Logistics Innovation of the Year«, the title »KEPTransporter des Jahres 2011« (Courier Van of the Year) in the category »Innovationspreis« (Innovation Prize) and the »International Design Award 2011« at the »Michelin Challenge Bibendum 2011«.

06 BOXSTER E – ELECTROMOBILITY IN A SPORTS CAR

Partner
Porsche Engineering Group GmbH

Vehicles
3 Porsche Boxster E with electric drive in fleet operation

Project budget €	Funding budget €
6,005,900	2,882,832

The development phase delivered some important findings for integration of the electric components into the vehicle, which could be housed within the existing constructed space without impairing the car's everyday capabilities. That applies both to the integration of the electric motors and power electronics, as well as to the battery. The latter, developed in house at Porsche and based on lithium iron phosphate cells, is fixed to the chassis structure in the same place as the internal combustion engine on the conventional Boxster S. This solution not only provides excellent protection for the battery in the event of an accident, but also offers the best conditions for preserving the base vehicle's good handling qualities. In addition, the vehicles were equipped with acoustic generators in order to test the possibilities and acceptance of generating driving sounds.

Using comprehensive measuring equipment in the vehicles, all relevant parameters are being recorded and evaluated in the field test. This enables energy flows, energy consumption, efficiency and user behaviour to be analysed.

Based on over 23,000 kilometres driven in the field test, results and verdicts from approx. 200 drivers are available so far. The project goals in the areas of performance, range and energy consumption have been confirmed and the vehicles were in total judged very positively. In addition, over the course of comprehensive driving trials, valuable findings in relation to energy recovery, operating and display concepts, noise generation, charging and usage profiles were also gained.

07 E-MOBILE CITY – INTEGRATION OF E-MOBILE CONCEPTS INTO CITY PLANNING

Partners	Project budget €	Funding budget €
Zweckverband Flughafen Böblingen/Sindelfingen (Airfield Association)	118,822	59,411
Universität Stuttgart	435,038	435,038
Langmatz GmbH	322,038	128,816
Max Holder GmbH	8,920	3,568
Böblingen City Marketing Society	40,639	12,191
Wirtschaftsförderung Sindelfingen GmbH (Development Agency)	36,499	10,949
Fraunhofer-Gesellschaft zur Förderung der angewandten Forschung e. V. (FhG)	171,185	171,185
FTG, Fernwärme Transportgesellschaft mbH (Community Heating Transport Company)	42,812	12,843

Vehicles
10 electric cars

Infrastructure
14 charging stations with 21 charging points

The vehicles supplied in the project were all in all very well accepted by the users and used for numerous journeys. Analysis of the distances travelled, charging patterns and user acceptance is not yet complete.

In stop-go traffic in the city the regenerative braking (recuperation) system could play a major role for electric vehicles. A simulator has been developed, programmed and assembled for future trials in respect of the effectiveness of different energy recovery methods.

Considerable delays had to be accepted at times in the vehicle procurement process. Various technical points of failure have been identified and partially remedied already. Despite newly agreed VDE application rules for the introduction of charging equipment, when it came to building up the charging infrastructure incompatibilities emerged between the different manufacturer's plug and communications concepts. As a strategy to resolve this issue, a system for communication between vehicle and charging infrastructure was conceived and installed in several prototypes. Locking mechanisms were also developed that take account of the different earthed plug-in systems. An evaluation of the user trials is not yet available. In the course of the project, the partners, including city administration departments, building firms and users, succeeded in establishing a cross-municipality network.

»GENERATING KNOWLEDGE FOR VEHICLES IN THE PREMIUM SEGMENT«

08 PEDELECS – E-CALL A BIKE STUTTGART

Partners	Project budget €	Funding budget €
City of Stuttgart (consortium leader)	1,166,535	1,166,535
DB Rent GmbH	1,123,021	561,510

Vehicles
100 rental pedelecs

Infrastructure
45 stations with combined terminals for hiring via touchscreen and with integrated charging function for electric bicycles at five satellites, plus two further charging points for electric vehicles

The project partners are pursuing the joint aim of encouraging even more residents, commuters and visitors than before to use the hire bikes and of making the system an integral part of local public transport. They want the Stuttgart system to become even more modern and customer friendly.
The City of Stuttgart is coordinating the civil engineering works for the station system. EnBW is installing and operating the terminals for the 45 stations. DB Rent is upgrading the existing »Call a Bike« system and adding a total of 100 pedelecs. As the operator of »Call a Bike«, DB Rent GmbH is able to call on many years of experience, especially in relation to users' everyday experiences, integration into the booking system and station selection. EnBW is able to build on experience from developing the charging infrastructure and operating the largest two-wheel fleets in Germany as part of the national government's KoPa II economic stimulus package.
For the first time ever, an automated public rental system for bicycles and pedelecs with terminals for the registration, hiring and bike return process, plus charging spaces for further (private) electric cycles is being developed, constructed and tested by customers in everyday operation. Within this process, the technical aspects of every component are being redeveloped (pedelecs, terminals, charging posts and communications components).

»TRIALLING VARIOUS CHARGING TECHNOLOGIES«

08
MODEL REGION MUNICH

Regional project headquarters Stadtwerke München GmbH (Public Utilities)

The aim in the Munich model region was to trial electromobility (vehicles and charging stations) in everyday operation and to prepare for a successful introduction of the concept into the market based on the findings. The three projects related to vehicles and charging stations made a major contribution in this regard. The project on a »Sustainable Municipal Electromobility Concept« provides information on how electromobility can develop between now and 2030 and what supporting measures can be taken by a city in this area. With the findings from the four projects pooled together, Munich is well equipped for the future of electromobility.

The key points that the project headquarters was able to contribute to the overall results are summarised here:
- Central support of the individual projects in the model region
- Organisation and running of regular project manager meetings
- Ongoing coordination of the individual projects
- Holding regular advisory council meetings
- Ongoing advice and information on the subject of electromobility, including promoting the further development of electromobility outside of the scope of the model region concept
- Acquisition of projects (with and without grants), which are being tackled after the end of the KoPA II economic stimulus package

01 PRACTICAL TRIAL OF A HYBRID BUS WITH DIESEL ENGINE AND SERIAL DRIVE AND COMPARISON OF THREE HYBRID BUS CONCEPTS

Fuel efficiency
The expected results in terms of fuel savings of 10 to 30 percent were only partially achieved by the hybrid buses. In the case of the MAN bus, fuel savings of around 20 percent compared to a conventional diesel bus can be achieved. A clear statement on fuel savings in the case of the Mercedes-Benz hybrid bus cannot yet be made, as it has so far only been in use for six months, which is too short a period.

Technical stability
The technical condition of the Solaris bus is stable, although the brake system requires improvement: the operating brake pressure needs to be increased for calculating the minimum braking ratio. In the case of the MAN bus, there are frequent malfunctions to report. Frequent problems are also noticed with the Mercedes-Benz vehicle, which are largely caused by not yet fully developed software.

The system comparison of the different hybrid technologies in respect to environmental aspects and economic efficiency and the analysis of fuel savings commenced on 13 April 2011, when the third bus went into operation. Here too, the period to date is too short in order to make any reliable statements.

Partners
Stadtwerke München GmbH (Public Utilities), Fraunhofer IVI Dresden, PE International

Vehicles and infrastructure
3 hybrid buses (Solaris, MAN, Mercedes-Benz)

Project budget €	Funding budget €
602,846	301,423

»DEVELOPMENT OF MUNICIPAL ELECTROMOBILITY CONCEPTS«

02 DEVELOPMENT OF A SUSTAINABLE MUNICIPAL ELECTROMOBILITY CONCEPT WITHIN THE FRAMEWORK OF THE MUNICH MODEL REGION, INCLUDING CONSTRUCTION OF AN APPROPRIATE CHARGING INFRASTRUCTURE

The future potential for electric vehicles was examined using three different scenarios including any possible impact on the environment as well as infrastructure. By looking at the results, it can be concluded that there is major potential in Munich for electric vehicles if certain general requirements are fulfilled.

In the best-case scenario, electric vehicles could replace around 80 % of Munich's cars by 2030. Key in determining the potential was the assessment of the significance of the individual influencing factors and the strength of their respective effects. It emerged here as sensible to divide these into changeable and given factors. While, for instance, the movement in the price of oil is determined by global parameters, other influential factors can be changed in a targeted way by public policy.

The relevant influencing factors for electric vehicle potential are:

- The range of electric vehicles available on the German car market
- Suitability for everyday use
- Cost efficiency

Taking into account the foreseeable available charging systems, the characteristics of the sites available for setting up the charging infrastructure and the vehicle users' mobility requirements, it can be assumed that home charging stations will form the basic framework for the gradual development of the charging infrastructure. These can be implemented quickly and easily and for the majority of typical journeys solve the problem of range and charging times.

Partners
SWM (Munich Public Utilities), City of Munich

Vehicles
40 MINI E

Infrastructure
32 public charging stations and 36 home charging stations

Project budget €	Funding budget €
979,292	489,646

04 A1 E-TRON FLEET MUNICH

Partners	Project budget €	Funding budget €
AUDI Aktiengesellschaft (consortium leader)	7,341,952	3,670,976
E.ON ENERGIE AG	1,438,704	719,352
Munich Technical University	638,732	638,732

Vehicles
20 A1 e-tron (Period in use: w/c 29/09/11 to w/c 24/12/12)

Infrastructure
The charging post infrastructure is being provided by E.ON and Munich Public Utilities.

Using market research, data logging and a vehicle application for the iPhone (OCU), the required data on usage patterns is currently being gathered. As the collection of data will continue until the end of 2012, no results are yet available. Within the project team, the user data is being collected in collaboration between Munich Technical University, E.ON and Munich Public Utilities.

»DIRECT CURRENT-BASED FAST-CHARGING SYSTEMS«

03 DRIVE E-CHARGED

Partners	Project budget €	Funding budget €
Bayerische Motoren Werke Aktiengesellschaft	3,002,356	1,321,637
Siemens Aktiengesellschaft	2,764,174	1,382,087

Vehicles
40 MINI E, 1 DC-test vehicle BMW Active E

Infrastructure
32 public and 36 home charging stations

Surveys
- For 96 % of private users the range of the MINI E is sufficient for daily use
- 82 % of the Bavarian Red Cross outpatient care service's daily journeys could be made using the MINI E
- For 88 % of private users, charging at a charging point is a more pleasant experience than going to a filling station
- 84 % of private users would like to charge their vehicles exclusively with electricity from renewable energy sources
- There are calls for a clear reduction in charging times at public charging posts

Charging system
A DC-based fast-charging system was developed and trialled: only one charging socket is required on the vehicle for AC or DC charging. This approach was presented to international standards bodies (IEC) in order to create corresponding areas of market potential through standardisation.
With consistent use of the current standardisation, no negative effects on power grid quality need be expected due to electro-mobility. The additional load on the grid from the demand and the required amount of power is transferable in the medium term (until 2025) within the scope of the usual development and rehabilitation measures.

Legal aspects
Providing suitable sites for public charging posts proved, in part, to be problematic. As at the time of the planning stage the general legal conditions did not permit the exclusive utilisation of car parks as charging points (non-discrimination), charging posts were set up in semi-public places. Sometimes significant costs were associated with this for space management.

09

CROSS-REGIONAL INITIATIVES

01 E-MOBILITY BERLIN/HAMBURG: CONSTRUCTION AND DEMONSTRATION OF BATTERY-POWERED ELECTRIC VEHICLES

The objective was to examine customer behaviour and acceptance levels in respect of the issue of electromobility. To this end, the use of electric vehicles and a charging infrastructure was tested in customer and everyday operation. The vehicles and infrastructure were monitored throughout the trial.

Daimler put more than 200 electric cars on the roads in Berlin and Hamburg. At the Daimler factory in Hambach, in addition to the conventional vehicles, the electrically powered version of the smart fortwo was built, while in the Rastatt factory the A-Class E-CELL was produced.

Based on focus groups, interviews, technical data and observations, it was possible to draw conclusions about customers and vehicles. In order to ensure that the data was saved and processed, it was relayed wirelessly to a database. An ongoing analysis of the data in respect to the load being put on components and customers' patterns of use, was then instigated.

Various scenarios representing the potential »electromobility worlds« of 2030 in Berlin and Hamburg were developed and described in expert workshops.

In the after sales area, the probable failure rates of vehicle and drive system components forecast in advance for both models were verified. The amount of work involved in the event of repairs was also assessed.

Partner
Daimler (consortium leader)

Vehicles
Berlin:
78 smart fortwo electric drive,
22 Mercedes-Benz A-Class E-CELL

Hamburg:
65 smart fortwo electric drive,
19 Mercedes-Benz A-Class E-CELL

Other model region:
34 smart fortwo electric drive,
58 Mercedes-Benz A-Class E-CELL

Infrastructure
Berlin: 220 RWE-charging points
Hamburg: 100 Vattenfall-charging points

Project budget €	Funding budget €
14,423,624	5,344,481

»FURTHER DEVELOPMENT OF PROTOTYPES«

02 ELMOS – ELECTROMOBILITY IN BUSES: DEVELOPMENT, TESTING AND PREPARATION OF THE TRIAL DEPLOYMENT OF AN INITIAL SMALL FLEET OF DIESEL HYBRID BUSES WITH ELECTRIC DRIVE CAPABILITY

By the end of 2010, a total of 16 buses had gone into operation in various client fleets across Europe. Production and servicing personnel received continual training in working efficiently and safely with the new technology.

During the reporting period, the vehicle concept, which had previously only been portrayed in prototype form, was further developed. As part of the hybridisation process, design adjustments were made to the drive system components, e.g. the axles. In order to reduce fuel consumption, hybrid-specific adaptations were made in relation to the control and optimisation of auxiliary unit management. Optimisation of the heating and cooling circuits, adaptation of the HV system in terms of cable runs and distributor system and also battery development were further project outcomes during the reporting period.

The serial hybrid bus vehicle concept proved its suitability in daily use for the project clients. For public use of the vehicles at Hamburger Hochbahn, specific approval needed to be obtained pursuant to clause 21 of the German Road Traffic Licensing Regulations (StVZO). An application for European type approval was also prepared.

Further significant outcomes of the project include the measured data on emissions and consumption, diverse test results, technical drawings and parts lists and corresponding documentation.

Partners
Daimler Buses, EvoBus GmbH

Vehicles
16 Citaro BlueTec Hybrid buses at various client firms

Infrastructure
Workshops of the respective bus operators equipped for hybrid vehicles

Project budget €	Funding budget €
15,487,124	7,743,562

03 ELMOS FLEET TEST

Insights gained into vehicle functionality and suitability for everyday operation were utilised to further develop the components and software and to enhance ease of maintenance.

The following work was carried out:
- Reworking of the bonnet concept for better access to components, reduction of the total height when opened and optimisation of the locking mechanism
- Integration of a plate heat exchanger into the heating circuit in order to utilise engine heat for interior heating
- Optimisation of the cable widths and runs
- Optimisation of the diesel engine in terms of resistance to wear in order to meet the demands of hybrid use
- Further development of the wheel hub axle, e.g. noise reduction and easier maintenance through integration of shut-off valves in the cold water supply
- Improvement of vehicle diagnosis capability through a software update
- Enhancement of the operating strategy in order to stabilise the entire control system, optimise consumption savings and validate different usage profiles
- Design and trial of an indicator concept for optimised-consumption driving
- Development of an automatic cold water refill mechanism and oil level measurement for improved ease of maintenance

European type approval and the Blue Environmental Angel award were also obtained for the Citaro BlueTec Hybrid.

The customer support concepts were improved in respect to personal and on-site contact with customers, technical information and fault feedback processes.

Partners
Daimler Buses, EvoBus GmbH

Vehicles
30 Citaro BlueTec Hybrid buses (CBTH)

Infrastructure
Workshops equipped for hybrid vehicles

Project budget €	Funding budget €
7,475,848	3,737,924

04 HYMEP – HYBRIDISATION OF MERCEDES-BENZ TRUCKS IN DEVELOPMENT AND PRODUCTION

Partners	Project budget €	Funding budget €
Daimler AG (HyMEP 1)	10,764,492	5,382,246
Daimler AG (HyMEP 2)	12,885,697	5,476,421
Mercedes-Benz Leasing GmbH (Atego)	2,943,753	1,471,876

Vehicles
68 Atego BlueTec Hybrid 1222

The project used a customer survey to ask drivers, fleet managers and general managers from the participating companies their opinion on hybrid technology and its cost-efficiency and reliability. While their responses in relation to expectations and fears prior to delivery of the Atego BlueTec Hybrid vehicles were – although overall positive – very varied, the surveys conducted after they had been using them for a certain period produced a generally high level of satisfaction. They praised, for instance, the vehicles' economic and environmental qualities and their handling.

The vehicles drove on average to eight loading stations a day, so were predominantly used in distribution operations. At the start, a few customers had problems with the hybrid truck's different new functions. However, once they had become familiar with these, the problems were quickly resolved. The drivers indicated that they were consciously utilising the fuel-saving options and said that the energy flow indicator on the hybrid display helped greatly with this.

Some haulage companies stated that for financial reasons they would not be in a position to buy a vehicle with an alternative drive system without a subsidy. Due to the high level of satisfaction it can therefore be assumed that more customers would buy trucks with hybrid drive systems if the purchase costs were not so high.

05 DIWA HYBRID PARALLEL DIESEL HYBRID BUSES

Partners	Project budget €	Funding budget €
Voith Turbo GmbH & Co. KG (consortium leader)	1,973,454	986,727
Solaris Bus & Coach S. A.	932,048	466,024

This project gave the drive systems producer Voith and bus manufacturer Solaris the opportunity to optimise bus hybrid systems in conditions other than just on a test bench: the pre-production vehicle was optimised and tested in real operation on site in the presence of future operator BOGESTRA.

The participating companies were able to acquire important expertise in developing and using the pre-production vehicle. The insights gained have already been successfully implemented at Voith and Solaris in the course of full production of 18 further buses of the same type. All of the participants now have the necessary experience in the areas of repairs, servicing and especially in respect to working with high-voltage equipment. During the long-term use of the bus in scheduled operation, BOGESTRA, as the operator of the pre-production vehicle, was able to test out the handling of such vehicles, to satisfy itself about their possible uses and to examine the potential for fuel savings, as well as to train safety personnel.

»TRANSNATIONAL DEVELOPMENT OF ELECTROMOBILITY«

06 CROME – CROSS BORDER MOBILITY FOR EVS

Partners
Daimler, Électricité de France (EDF), EnBW (consortium leader) Bosch, Karlsruhe Institute of Technology (KIT), Porsche, PSA Peugeot Citroën, Renault, Schneider Electric, Siemens

Planned vehicles
Daimler: 25 smart ed, 15 A-Class E-Cell in Germany,
30 smart ed in France (Moselle)

Porsche: 3 Boxster E, 2 Panamera Plug-in

PSA Peugeot Citroën: 25 to 30 iOn/C-ZERO, 10 Partner/Berlingo

Renault: 10 Kangoo ZE

Planned infrastructure
50 public charging stations Prototype for 4 fast-charging stations, Private/business charging stations, Overarching service platform

A joint CROME concept for mode 3 charging stations (3.5 to 22 kW) was agreed between EDF and EnBW and appropriate specifications drafted for the »dual type socket« charging stations. Additional specifications were defined for charging in mode 3 in France and tested for compatibility with vehicles and charging stations in Germany. On the German side the CROME charging stations are being delivered and installed. On the French side the public institutions are currently inviting tenders for the charging stations and installation can be expected at the end of the first quarter of 2012. It was agreed that an RFID-based method would be used for identifying users in the first stage of the project.

The basic services to be implemented in interoperable form by June 2012 were defined: site selection, charging, emergency solutions (lost cards, etc.), personal usage data, issuing and cancelling of ID cards, examination of user behaviour and the individual stations' charging processes. Other services to be implemented by December 2012 are preconditioning, booking, direct payment and fleet management.

07 BMW FOLDING PEDELECS AS PART OF AN OVERALL MOBILITY CONCEPT

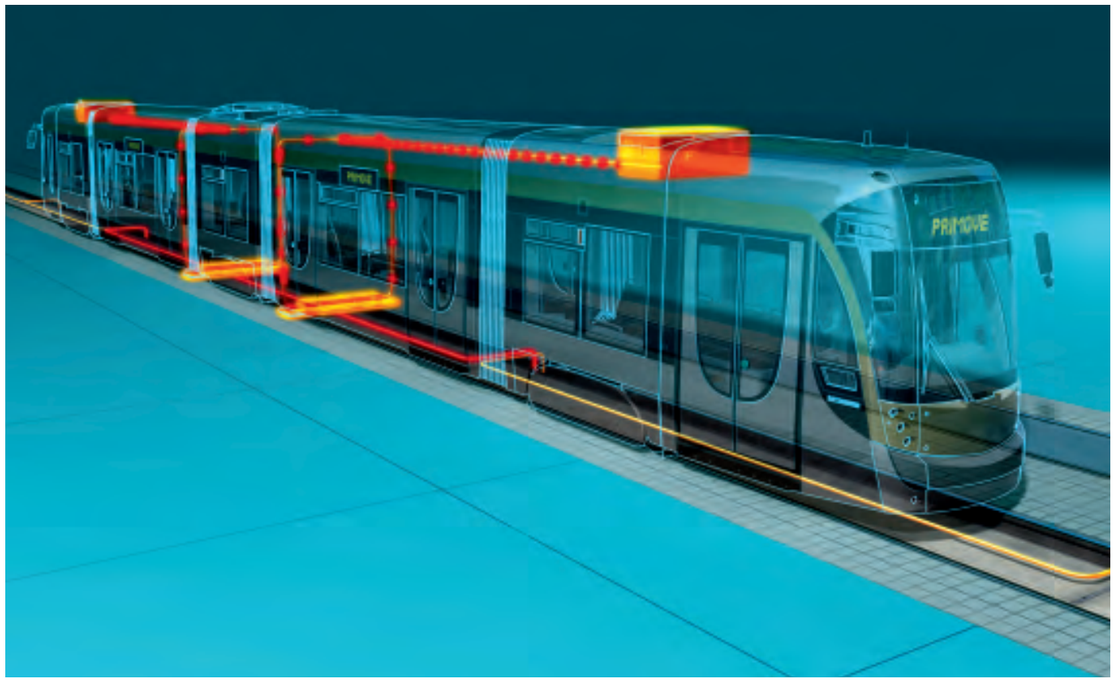
The prototype industrialisation process was implemented on schedule in the first half of 2011. A number of initial bicycles have been built and are currently in use. Thanks to the extension of the funding period it was possible to run the planned fleet trial through to the end of September. Based on this trial, the decision was taken to manufacture the pedelec on a full production basis. It can already be seen that in terms of quality, the model will mark the start of a totally new class of folding bicycles. Worthy of particular emphasis are the great frame rigidity and the style of ride that has previously been experienced only on bicycles with large wheels, which is why this pedelec will offer a much higher degree of road safety. In terms of ease of use and reliability, the new folding mechanism is also unique. This development has greatly surpassed all expectations and the research project is a complete success.

Partner
BMW AG

Vehicles
53 folding pedelecs

Project budget €	Funding budget €
1,270,114	635,057

»INDUCTIVE CHARGING«



08 DEVELOPMENT OF A BATTERY-POWERED ELECTRIC DRIVE UNIT FOR INTEGRATION INTO A COMPLETE SINGLE-TRACK BEV

Partner
BMW AG

Vehicles
2 maxi scooters (developed on the basis of an existing/in development ICE-scooter)

Project budget €	Funding budget €
2,525,423	1,261,449

Using the two prototypes it was possible to show that the chosen vehicle concept – an electrically powered maxi scooter – is indeed ideally suited as a vehicle for commuters who drive to work daily in urban conurbations or surrounding areas. The vehicle is on the one hand small enough to cope with parking and traffic problems in big cities and on the other powerful enough not to hold up traffic on main rural roads or motorways.

The trial confirmed the calculations on required battery capacity. Over the course of the trial the range of at least 100 km in practical use proved correct. This capacity gives users the freedom to charge in general at home or at places convenient to them without having to constantly be thinking about where the nearest charging station is located.

Summing up, these concept prototypes therefore fulfil the requirements that a potential customer could have of such a vehicle. However, in the course of developing and building the prototypes certain technical challenges were identified that would need to be comprehensively tackled before any implementation as a possible full-production project (in the case of the concept vehicles through appropriate measures such as vehicle training sessions and use on non-public test circuits only).

09 NILS – MICRO-MOBILITY PROJECT

Partner
Volkswagen AG – Group Research

Project budget €	Funding budget €
10,332,090	5,166,044

The project's emphasis was on carrying out research into an innovative concept of micro-mobility using electric traction, looking at cost-efficiency and new technologies for electric vehicles. The Nils was thus created from deliberations about an innovative car with an electric motor that fits into the space between velomobiles and both light electric and small conventionally powered vehicles. It opens up a market that covers 75 % of road-using commuters, who could make their journey to work with an innovative vehicle of this kind.

A summary of the vehicle concept's technological themes:

- Lightweight construction and new body structures
- System-level battery technologies
- Electric motors and drive system design
- Power electronics and control systems
- Energy management for low energy consumption concepts
- Safety concepts for very small vehicles
- Operating concepts for small electric vehicles

The new form of body structure in a lightweight design assures an extension of the vehicle's range through weight savings. Also contributing to this is the selected design of traction battery with a capacity of 5.3 kWh and the light electric motor, which weighs just 19 kg. Features such as the city emergency stop function and driver assistance systems also provide the necessary level of safety to achieve the safety-related objectives with this micro-vehicle. The digital instruments too were designed specifically to address the need to effectively control the electronic consumers in electric vehicles.

The project has answered a few important questions and objectives relating to small, innovative vehicle concepts, such as in respect to active and passive safety and methods of lightweight construction. However, some areas of potential for technical development still exist, which need to be researched, developed and differentiated further until such a vehicle concept is ready to go into full production. These include, for example, questions about the long-term durability of the traction battery and the vehicle's functional, client-specific electronic equipment.

10 »E-GOLF ELECTRIC MOBILITY« FLEET TRIAL

For selected users to personally »experience« electric vehicles, is an essentially new quality – in the literal sense of the word. All experiences by customers are thus not just assumptions and assessments, but represent the real customer experience. In the field of electromobility that is indispensable as a valid basis for customer surveys.

Numerous experiences were made in this way, in the area of wall box installation. The situations that the installers find on site differ in very varied ways. For example, it is a challenge to install a wall box for a business customer who only has a rented parking space in a multi-storey car park, as the agreement of the building's owner is also always needed. Surveying the customers also produced numerous valuable points for the ongoing full-production trial, which have also been passed on as a return flow of know-how to the developers of the current production projects.

Customers are very enthusiastic about driving these vehicles. Even though the final survey has yet to come as the vehicles are still in use, we can already report that the customers are wholly satisfied. So far, the Golf Blue-e-Motion has fully proved itself in everyday urban use – and even for four adults is a fully-fledged vehicle that through its qualities delivers substantial motoring joy and satisfaction.

Partner
Project responsibility:
VW Kraftwerk GmbH in close collaboration with Volkswagen AG

Project budget €	Funding budget €
20,618,644	9,887,982

»DEVELOPMENT OF NEW VEHICLES«

11 RESEARCH PROJECT: NON-CONTACT POWER TRANSMISSION FOR TRAMS – AUGSBURG PILOT PROJECT

Partners
Bombardier Transportation GmbH (consortium leader), City of Augsburg Transport Company

Vehicle
Variobahn type

Infrastructure
Implementation of the components for inductive energy transfer on a approx. 500 m section of track

Project budget €	Funding budget €
9,680,337	3,686,562

Experiences:
The test results to date prove the functionality of the system in a long-term test. The measurements to demonstrate environmental compatibility are positive. Various components of the inductive power transfer system are currently being optimised in relation to acceptance tests pursuant to the German Regulations on the Construction and Operation of Light Rail Systems (BOStraab).

Programming and technical challenges:
One particular challenge is that the existing standards for equipment approval for local public transport cannot always be applied to this innovative power transfer system. Solutions need to found here in consultation with the licensing authorities and expert inspectors.

12 DEMONSTRATION OF A HYBRID RAILWAY VEHICLE AND EVIDENCE OF SUITABILITY FOR EVERYDAY USE

Partners	Project budget €	Funding budget €
MTU Friedrichshafen GmbH	2,949,170	1,415,602
DB RegioNetz Verkehrs GmbH	1,163,541	558,500

Vehicles
The MTU hybrid power pack is being tested in a VT 642 railcar of the Westfrankenbahn.

In order to be able to correctly estimate the consumption potential, MTU Friedrichshafen developed a simulation model of the complete railway system specifically for the purpose.

Built in modular form, the model made it possible to dynamically calculate key operational values taking into account the relevant line details (journey times, line resistance, speed restrictions).

In order to check the computer model's accuracy, a series of test runs were conducted by a VT642 with a conventional diesel/mechanical drive system.

Test bench results
Material findings from the system simulation were confirmed on the system development test bench. In addition to power and consumption measurements, measurements were also examined in relation to vibration characteristics and the drive system's acoustics, while the software's different functions were also tested.

Electromagnetic compatibility compliancy with the relevant norms in the rail sector was also proven.

Vehicle integration
After detailed technical calculations and trials, extensive conversion and adaptation work was necessary in order to integrate the hybrid concept and the other innovative technical developments into the existing vehicle.

One focus in terms of implementing the new hybrid components into the vehicle structure is the optimum distribution of mass and adherence to the kinematic vehicle gauge.

The existing R 134a climate control system is also being replaced using compatible interfaces by the new environmentally friendly CO_2 climate control system. In order to achieve economic hybridisation of the existing vehicles, the top-level control system on the software side should be left as untouched as possible.

Material areas of emphasis of the preliminary investigations and subsequent simulations also included adherence to the permitted axle loads and evaluation of the vehicle's functional safety. At the same time the clearance profile and the handling characteristics of the vehicle were key factors in the subsequent decision to comprehensively change the structure of the vehicle's roof construction.

13 ZSW LABORATORY FOR BATTERY TECHNOLOGY (ELAB) AND BATTERY TESTING AND SAFETY CENTRE

Construction of the test centre was planned with the architects and specialist planners in accordance with the list of technical requirements that had been produced. What test and inspection facilities were needed was ascertained in collaboration with potential users and from analysing a variety of presentations. The building project was realised via a general contractor. Construction work, specification and correction were carried out by ZSW in close collaboration with the general contractor and largely completed after just ten month's of construction.

Any special appliances not matching the usual standards were developed in collaboration with the respective manufacturers. Procurement of equipment and appliances as well as their installation and commissioning should be finished by the end of the project in December 2011.

Partner
Zentrum für Sonnenenergie und Wasserstoff-Forschung Baden-Württemberg – ZSW (Centre of Solar Power and Hydrogen Research)

Project budget €	Funding budget €
15,411,331	13,870,198

»PRODUCT SAFETY TESTS FOR BATTERIES«

14 BATTERY TEST CENTRE P 10

Partner
SGS Germany GmbH

Project budget €	Funding budget €
1,364,696	682,348

In working up efficient test methods for traction batteries and their components the project team looked very closely at the specific aspects of safety at work and implemented concrete technical and structural measures in collaboration with fire safety experts.

A cyclical endurance test on a hybrid battery served as a pilot experiment for gaining experience with temperature control, current feed and time-critical monitoring of batteries with feedback to the charging generator. A thermo/vibration test bench with associated safety infrastructure and control elements was designed and the requirements for test equipment and safety infrastructure defined and planned.
An existing EMC test site was upgraded to the new high-voltage requirements and test object specifications of large traction batteries.

In order to record the test object characteristics in a clear, comprehensive and reproducible manner, existing methodological descriptions in standards are often inadequate. Here, the project team devised new approaches for improvements and tapped into areas of potential to increase effectiveness. Based on preliminary experiments and in dialogue with vehicle and battery manufacturers, the necessary processes, actions and requirement specifications of test sites and safety systems were defined. Based on an accompanying hazards and risks analysis, the project team defined key tests, which were run on cells or modules and on safety systems. Indicative tests can thus be run at early stages of the product creation process and the scope of elaborate tests on the complete battery reduced. Special event rooms inclusive of the necessary infrastructure for controlling any fires or explosions that may occur were also planned and built. The existing methods for evaluating battery safety concepts were enhanced in a manner aligned to real-world operation using approaches from machine safety and taking into account ISO 26262. The battery testing centre created in Munich will continue to expand after the end of this development project in order to then largely cover vehicle and battery manufacturers' testing needs.

15 BATTERY SAFETY LABORATORY FOR LITHIUM-ION BATTERIES FOR ELECTROMOBILITY

Partner
CETECOM ICT Services GmbH

Project budget €	Funding budget €
1,673,258	836,629

The aim in this project was to create test facilities and to validate the processes produced for checking batteries' safety against typical long-term loads and loads arising from »misuse«. After being set up, these facilities are particularly suited to enhancing the technology of batteries in respect of their structure such that loads do not lead to an uncontrolled disaster in real use on the open road.

A core issue here was constantly evaluating the attendant risk whenever tests are being run on a charged battery. These tests can therefore only be performed by controllable methods in fireproof rooms with increased monitoring sophistication and suitable extinguisher systems at the ready.

The test facilities set up are suitable for simulating the scenarios that could currently and in the foreseeable future be expected to endanger a battery. The facilities have already been available to industry for several months for running qualification tests, both for products at cell and module level and for complete systems.

One special area in the qualification of battery systems is without doubt the certification of drive system batteries. With a view to a simplification in the process of licensing electric vehicles, the safety of a drive system battery gets assessed here in respect to electrical and functional safety and electromagnetic compatibility in a neutral certification procedure. This assessment ultimately leads to a battery safety specification sheet, which summarises the important data for the battery's further use.

16 ELECTROMOBILITY AND INFRASTRUCTURE: ECONOMIC ANALYSIS OF ORGANISATIONAL AND OPERATOR MODELS, OF DEVELOPMENT AND FUNDING STRATEGIES AND OF REGULATORY ISSUES (EM-INFRA)

Allocative significance of coverage effects frequently gets neglected in the debate on public charging infrastructure (CI)
- A »guarantee« for electric vehicle users of available public CI has the potential to considerably reduce transaction costs
- Public CI can reduce costs of electric vehicles
- Public CI can consequently have an effect analogous to monetary incentives

Semi-public CI can be an effective partial substitute for public CI
- Efficient development without state incentives/requirements questionable
- Semi-public CI can significantly reduce transaction costs
- Requirements relating to the development of semi-public CI will, from a systems perspective, also be accompanied by inefficiencies

Central funding instruments can/ought to be worthwhile and should be linked to requirements relating to (marketing and other) standards
- Against the backdrop of public CI's option benefit, centrally established development incentives for local authorities/operators working in their areas ought to make sense
- With a view to limiting transaction costs (especially in sales), linking with requirements in relation to marketing and other standards should be considered

During the R&D stage, the public authorities should keep structural options open and generate knowledge
- Due to still high levels of uncertainty/more advantageous technologies and concepts, lock-in effects should be avoided
- The process of reaching decisions on establishing standardisation/regulation rules and subsidy/incentive rules in a few years time should be prepared now

Partner
Technical University of Berlin, Workgroup for Infrastructure Policy (WIP), Infrastructure Economics and Management Section (consortium leader)

»EXAMINATION OF THE ACCEPTANCE OF ELECTROMOBILITY IN SOCIETY«

17 ETRUST – MODELS AND FUTURE CONCEPTS OF ELECTROMOBILITY

In the results of the study entitled »eTrust – Models and future concepts of electromobility«, which was conducted on behalf of NOW GmbH, the essentially positive image of electromobility in society is apparent. Electromobility is associated, above all, with being environmentally friendly, free of emissions and low in noise. However, these positive attributes of electromobility scarcely generate any enthusiasm to buy among consumers. Personal benefits are missing both on a pragmatic and emotional level. Instead, potential users perceive the drawbacks of electric cars in a very clear, concrete way. Evidently the perceived satisfaction of needs by privately used conventional cars continues to form the frame of reference for judging electromobility. With the technology at its current state of development, the electric vehicle can't compete when compared this way. If electric cars are to gain approval in society, it is important to infuse them with emotional qualities that appeal to many user groups. It appears necessary to offer consumers much more than, as has been the case to date, merely opportunities to experimentally »experience« electric cars under everyday conditions.

The analysis clearly shows the discrepancy that currently exists between the possibilities in relation to a social change in mobility based on electric vehicles and the perceptions and requirements in terms of mobility shaped by conventional motoring.

Partners
Unabhängiges Institut für Umweltfragen e. V. (Independent Institute for Environmental Issues) consortium leader, Institute of Transportation Design, Braunschweig University of Visual Arts, Spilett New Technologies GmbH

NIP

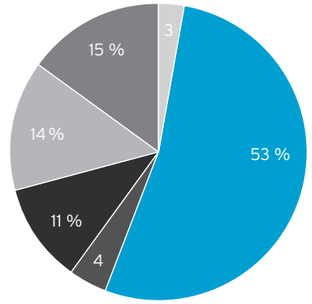
TRANSPORT AND INFRASTRUCTURE

The Transport and Infrastructure programme area in the National Innovation Programme for Hydrogen and Fuel Cell Technology (NIP) incorporates research and development (R&D), demonstration activities for hydrogen-fuelled vehicles on public roads as well as the corresponding necessary infrastructure.

In terms of vehicles, its scope extends from R&D activities to fuel cell drives and the on-board power supply for various transport applications – including drives for passenger cars, buses and the on-board power supply of aircraft, for example. Complete drive systems and key components such as PEM fuel cells and the storage of hydrogen are dealt with as a part of the various projects being undertaken. The aims include: reducing costs and weight, increasing service life and efficiency as well as improving reliability in day-to-day operation. In regard to these goals, the focus in terms of infrastructure is aimed at the continued advancement of compression technologies and the development of technology standards for hydrogen filling stations.

An important aspect in the NIP programme area of transport concerns demonstration projects that can validate the implemented technology under everyday conditions and prepare the market by increasing user acceptance. To enable this, hydrogen-run fuel cell vehicles are being tested in comprehensive collaborative projects across key regions by test customers, which also encompass the filling station infrastructure. In addition, the demonstration projects also incorporate the deployment of fuel cell buses in local public transport networks.

NIP Statistic:
Share according to application sector
As at December 2011



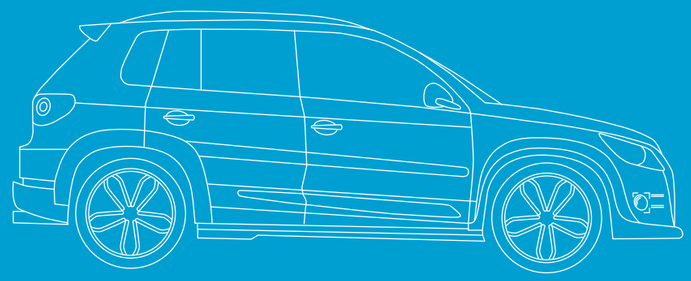
The chart comprises projects at planning stage at NOW, being processed by PtJ LOI (Letter of Intent) as well as approved projects.

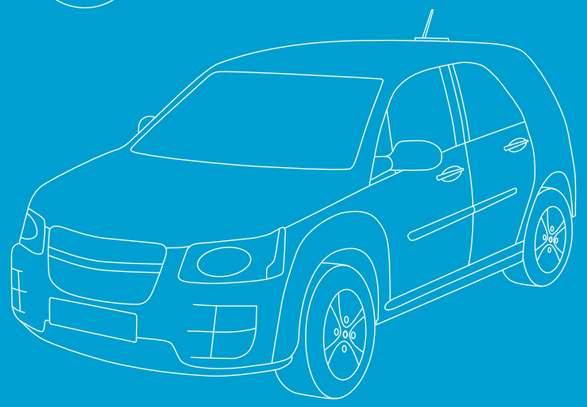
Programme area Transport and Infrastructure:
Allocation by application area
As at December 2011

48 %	Clean Energy Partnership
39 %	Demonstration preparation
12 %	Individual projects
1 %	Studies/surveys

NIP

TRANSPORT AND INFRASTRUCTURE





Hydrogen-powered fuel cell vehicles and refilling infrastructure

CLEAN ENERGY PARTNERSHIP (CEP)

In January 2011, the Clean Energy Partnership (CEP) began its third and final project phase that will culminate in the market introduction of series production vehicles in 2016. Market preparation therefore takes centre stage in Phase III with extensive operation of consumer vehicles in order to acquire a broad spectrum of knowledge about the interfaces between vehicle, consumer and infrastructure. The different fuelling station layouts within the project provided valuable data and information, enabling reliable and cost-effective ideas to be generated, which will already be implemented in 2012. New partners and additional regions have contributed to the growth of the Clean Energy Partnership in 2011 – and with it the fuelling station network and vehicle fleet.

In May, one of the world's largest events for sustainable mobility took place in Berlin: The Michelin Challenge Bibendum. The CEP presented itself at the event with an exhibition stand, at which interesting discussions with visitors took place. Many journalists sat enthusiastically behind the wheels of hydrogen cars for a spin around the former runway of Tempelhof Airport. The CEP welcomed two new partners at a press event: Air Liquide and Honda. Air Liquide is currently undertaking its first important CEP project with the construction of a 700-bar hydrogen fuelling station in Dusseldorf, which will go into operation in 2012. Honda is bringing its fuel cell car FCX Clarity to the project, which is much in demand at all events, including the Challenge Bibendum, where it was continuously being test-driven.

Around 200 visitors during the »Long Night of Sciences« in Berlin came to the hydrogen fuelling station in Holzmarktstrasse in order to experience hydrogen mobility first-hand. While younger visitors busied themselves playing with hydrogen model cars, their parents learned about the production, storage and transport of hydrogen.

Infrastructure construction has always been an important aim of the CEP. In June, another milestone was reached as the first hydrogen fuelling station of CEP partner, Shell, was opened on the Berlin's Sachsendamm, with launch speeches by Dr. Peter Blauwhoff (Shell), Patrick Schnell (CEP Chairman, Total Deutschland) and Olaf Reckenhofer (Linde). Among the guests were Dirk Inger (Head of the Subdivision for Climate and Environmental Protection Policy at the Federal Ministry of Transport, Building and Urban Development (BMVBS)) and Dr. Klaus Bonhoff (NOW GmbH).

The CEP vehicle fleet continues to be expanded. But also in the area of public transport, things are moving forward. Hamburg, the pioneer in the testing, employment and further development of hydrogen-operated fuel cell buses, sent the latest generation of zero-emission buses with hybrid technology onto the streets in August. The Hamburger Hochbahn deploys »clean buses« prominently in scheduled services in the city centre.

In September, the Federal State of Hesse joined the Clean Energy Partnership. With this step the Hessian state government is committing itself to hydrogen and fuel cell technology and its integration into the state's future energy and mobility concepts.

Time and again over the course of 2011 there were interesting meetings with national and international politicians. For example, Renate Künast from Alliance '90/The Greens visited the fuelling station in Holzmarktstrasse, as well as Dr. Wan Gang, Chinese Minister for Science and Technology. Numerous fuelling station tours for different interest groups ensured that the message spreads: hydrogen is not a future topic anymore – it is already happening.

The closer vehicles and fuelling stations come to market maturity, the more important it will become to also reach the broader public. Therefore the CEP has adopted an additional media route. Aside from the usual channels, you can find CEP contributions on Facebook, Youtube and Xing. If you want to know how fuel cell car sharing between neighbours might look like, then take a look at this film:

http://www.youtube.com/user/HalloHerrNachbar?ob=0

Internet: www.cleanenergypartnership.de
Facebook: www.facebook.com/cleanenergypartnership
Youtube: www.youtube.com/cleanenergypartner

Clean Energy Partnership
CEP

Ein Projekt im Nationalen Innovationsprogramm Wasserstoff- und Brennstoffzellentechnologie
nip

01 NATIONAL INNOVATION PROGRAMME HYDROGEN AND FUEL CELL TECHNOLOGY (NIP) AND SAFE HYDROGEN INFRASTRUCTURE

KEYWORD
RCS-study

Recipient
Ludwig-Bölkow-Systemtechnik GmbH

Project budget €	Funding budget €
148,441	148,441

Commencement	Conclusion
01.05.11	30.11.11

There are already prototype hydrogen powered cars on the roads all around the world. They promise zero emission motoring. However, for this they require a thoroughly new infrastructure, with there still being a lack of hydrogen filling stations and solutions for producing and providing the fuel. In order to develop these on a wide-scale basis, binding standards, rules and regulations are needed that can, above all, ensure operational safety.

The project's aim, therefore, is to collect the experiences gained on this subject in various major projects and field trials and to work them up into the development of a set of regulations. The work covers in particular the following activities:

- Recording and analysis of the infrastructure companies' existing findings, especially arising from experiences in the licensing process for hydrogen filling stations in Germany (in some cases Europe) and development of a harmonised procedure for such licensing (together with relevant industry partners).
- Analysis of safety-relevant parameters in relation to workshops and garages.
- Analysis of safety-relevant parameters and requirements arising from hazardous goods legislation, especially from regulations on driving through tunnels and underpasses.
- Clarification of requirements on the part of the fire services in German-speaking countries in relation to appropriate marking/identification of damaged hydrogen and fuel cell vehicles for safe recovery and rescue.
- Documentation of the experiences and advice in relation to more far-reaching committee work and support for NOW in defining the formats for disseminating the project results.

02 700 BAR SAE J2601 HYDROGEN FILLING STATION IN MUNICH

Keyword
Filling station in Munich

Recipient
Linde Aktiengesellschaft

Project budget €	Funding budget €
604,299	290,064

Commencement	Conclusion
01.12.10	30.04.12

As an important component of various demo projects, a multifunctional hydrogen filling station opened as early as 2006 at Linde's Unterschleißheim filling plant site to the north of Munich. The filling station is equipped to meet all requirements of vehicle technology of that time. The core elements are the pumps for liquid and gaseous hydrogen, which can be used for refuelling at a pressure of up to 350 bar. In order to keep pace with modern vehicle technology, the aim in the project is to retrofit the pumps to enable high-pressure refuelling at up to 700 bar.

Over the course of technical development, many vehicle manufacturers have now integrated 700-bar pressure tanks into their vehicles in order to increase their range. This has also changed the requirements in terms of filling pump systems. After completion of the 700-bar section, the Munich filling station will be equipped with leading edge cyropump technology, which enables vehicles to be refuelled in under 3 minutes in compliance with current industry standard SAE J2601, type A. The compression in this process of very cold liquefied hydrogen at 700 bar provides extreme energy efficiency and simultaneously requires minimal space at the filling station. This innovative project is thus underlining Germany's leading position in the field of hydrogen technology.

03 SUPERORDINATE CEP MODULE: »COMMITTEES, PROJECT COORDINATION, KNOWLEDGE MANAGEMENT, PUBLICITIY AND COMMUNICATION«

Keyword
CEP Phase 3

Recipients	Project budget €	Funding budget €
Adam Opel AG	406,901	195,312
Bayerische Motoren Werke Aktiengesellschaft	537,311	257,909
BVG (Berlin Public Transport)	334,433	160,528
Daimler AG	682,880	327,782
Ford-Forschungszentrum Aachen GmbH	510,401	244,992
Linde Aktiengesellschaft	551,095	264,526
TOTAL Deutschland GmbH	408,431	196,047
Vattenfall Europe Innovation GmbH	479,286	230,057
VOLKSWAGEN AKTIENGESELLSCHAFT	443,473	212,867
Hamburger Hochbahn AG (Public Transport)	343,156	164,715
Toyota Motor Europe N/V S/A	584,359	280,492
Statoil ASA	631,183	302,968
Shell Downstream Services International BV	411,415	197,479

Commencement	Conclusion
01.01.11	31.12.14

In the transport and hydrogen infrastructure section of the NIP programme, the Clean Energy Partnership (CEP) forms a focal point of its own. It was created in 2002 as a grouping together of international companies in order to demonstrate hydrogen's suitability as an everyday fuel in vehicles and to test out the refuelling infrastructure. In January 2011, the CEP entered its third phase.

The CEP is the largest pilot project of its type in Europe. It is running in five regions: Berlin, Hamburg, North Rhine-Westphalia, Baden-Württemberg and Hesse. At the start of 2011, over 60 cars were in daily use. The process of increasing the fleet to more than 120 vehicles by the end of 2013 has already begun. In several of the regions buses are also being used in the local public transport system. The CEP is also operating a constantly growing network of hydrogen filling stations. All 15 partners and NOW work together in the top-level module to coordinate the project. This superordinate module incorporates the following areas: project coordination, administration and representation, committee work, information management, communications and publicity. In this way, the vehicle manufacturers, oil companies, energy providers, gas industry and transport operators pool their work, exchange details of the results achieved and develop from this overarching guidelines that will in future be key for a wide-scale hydrogen market.

Subordinate in organisational terms to the top-level module are the individual CEP areas, which are grouped together based on links in the technical or other subject matter that they cover – vehicles, filling stations, hydrogen production, etc.

»FLEET TESTS WITH HYDROGEN-POWERED FUEL CELL VEHICLES«

04 SYSTEM VERIFICATION OF 700-BAR IONIC COMPRESSOR TECHNOLOGY TO SAE J2601

Keyword
Ionic compressor station

Recipient
Linde Aktiengesellschaft

Project budget €
1,484,442

Funding budget €
712,532

Commencement
01.12.10

Conclusion
31.07.12

The tank is of critical importance to the range of a hydrogen-powered vehicle. In addition to liquid gas, tanks manufacturers are today placing an emphasis on compressed gas containers that can store the fuel in modern vehicles in a highly compressed form at up to 700 bar. In order to be able to build up this compression efficiently at filling stations, new forms of technology are needed. This project is designed to perfect a new kind of ionic compressor.

The technology is based on the patented use of ionic liquids for the compression process. The specially modified liquid replaces the traditional, mechanical piston. Although ionic compressors are already being used in demonstration projects, as the number of hydrogen-powered vehicles is still low, the refuelling technology cannot be tested in a long-term, comprehensive manner in all workload scenarios. In order to bring these systems to technological maturity, which is needed for any development of wide-scale infrastructure and high vehicle numbers, a range of compressors are being operated on a long-term test-bench basis in this project, brought up to the fuelling volumes to be expected and optimised.

05 NABUZ – SUSTAINABLE BUS SYSTEM OF THE FUTURE/SUB-PROJECT DEMO/ TRIAL OF 7 FUEL CELL HYBRID BUSES

Trials with innovative fuel cell buses in a local public transport system have been running in Hamburg as part of the European CUTE and HyFLEET:CUTE projects since as early as 2001. In the follow-up NaBuZ demo project a total of seven newly developed fuel cell hybrid buses are being deployed, which feature considerable technological enhancements. For the first time ever in a commercial vehicle, fuel cell systems, a serial hybrid drive system with lithium-ion batteries and an optimised energy management system are being used together in these buses. Fuel savings of around 50 % are expected compared to older fuel cell buses. Brake energy recovery (recuperation) is also possible.

The field test is being used to check and evaluate the vehicles' suitability for everyday use and their performance in day-to-day operation. It also aims to develop an efficient overall system for the maintenance and upkeep of fuel cell hybrid buses, including the associated workshop infrastructure. The trials also allow manufacturers and operators to continually find ways in which improvements can be made to the vehicles, workshops, interfaces or processes. Assuming that they confirm an appropriate operational suitability and cost-efficiency in the field test, the intention is that the only vehicles procured as of 2020 will be these largely zero emission buses.

Keyword
NaBuZ demo

Recipients
Hamburger Hochbahn AG (Public Transport), Daimler AG and EvoBus GmbH

Project budget €
11,458,333

Funding budget €
5,500,000

Commencement
01.04.11

Conclusion
31.03.16

»FUEL CELL HYBRID BUSES IN PUBLIC TRANSPORT«

06 ANTARES H3 – AIRCRAFT WITH MODULAR FUEL CELL DRIVE

A successful cooperation between the German Aerospace Centre (Deutschen Zentrum für Luft- und Raumfahrt – DLR) and aircraft manufacturer and developer Lange Aviation resulted in the world's first manned and self-launching fuel cell aircraft – the Antares DLR H2.

Now, the Antares H3 aircraft is being developed on this basis, which will feature a significantly greater range and longer flying times. High-efficiency high and low temperature fuel cells will be integrated in the aircraft along with batteries (direct hybridisation). The Antares represents a unique platform for the development of technologies. It enables the airborne application of relevant fuel cell systems that have the potential to reduce emissions for wide-bodied aircraft to be tested quickly, easily and cost-effectively. At the same time, concrete customer interest exists for the aircraft in the areas of communication, surveillance and environmental protection (high-altitude platforms).

With the Antares DLR H3, zero emissions and the fascination of flight meet head on. It brings fuel cell technology closer to everyone and aims to become an ambassador for the green energy revolution in Germany.

Keyword
Antares H3

Recipient
Deutsches Zentrum für Luft- und Raumfahrt e. V. (DLR)

Project budget €
7,293,414

Funding budget €
3,500,839

Commencement
01.03.10

Conclusion
28.02.14

07 PRODUCTION PROCESS DEVELOPMENT (PPE – PRODUKTIONSPROZESSENTWICKLUNG) FOR FUEL CELL SYSTEMS

Keyword
ProductionProcessDevelopment (PPE) for fuel cell systems

Recipient
NuCellSys GmbH

Project budget €	Funding budget €
1,073,958	515,500

Commencement	Conclusion
01.01.11	31.03.15

A production process for a fuel cell system of the latest generation will be developed, implemented and verified within the framework of this project. As such, the world's first small series production of »automotive« fuel cell systems will be prepared and implemented. The production competencies for fuel cell systems will thereby be developed and established in Germany.

Taking account of innovations in the area of fuel cell systems, such as compliance with the requirements for cleanliness, as well as for handling hydrogen and working with high currents, the customary automotive production subjects will be dealt with:

- product design suitable for production and PFMEA
- assembly and testing concepts including screwdriving control units and manufacturing equipment
- flow of materials and information including the evaluation of quality data

In addition, the principles of a »lean« and automotive production will be taken into account. The prerequisites for the mass production of fuel cell systems including an analysis in terms of the level of automation and modularity will be identified within the framework of this project. As such, this project will make a decisive contribution to accelerate the market preparation of this future-oriented technology.

08 POWER ELECTRONICS SYSTEM FOR FUEL CELL VEHICLES/EPOWERSYS

Keyword
ePowerSys

Recipients	Commencement	Conclusion	Project budget €	Funding budget €
Daimler AG	01.10.10	31.05.15	475,070	228,034
SUMIDA Components & Modules GmbH	01.10.10	28.02.15	2,680,523	1,286,651
Robert Bosch GmbH	01.10.10	28.02.14	1,260,417	605,000

Battery-powered electric cars, fuel cell and hybrid vehicles share some common components that are needed for the high-voltage circuitry. Finding ways to exploit these potential synergies in the power electronics could be a key factor in further development, as multiple-use components could be manufactured in larger numbers and therefore most cost-effectively in future mass vehicle production. The aim of this project is to analyse and assess the power electronics in terms of modular construction in order to ultimately be able to use this flexibly in electric drive concepts.

It is not just »electric« vehicles that are electric. Fuel cell vehicles are as well, as in addition to the fuel cell they also have a traction battery on board. To regulate the electric currents in the vehicle power system DC-to-DC converters are required. The converter box contains these voltage transformers and supplies the traction drive and all other high-voltage consumers via an intermediate circuit. Transformers are sometimes also used between battery and vehicle electrics on purely battery-powered and hybrid vehicles.

Here, only the module for the battery path is required. Using automotive development methods, the intention is to optimise this and perfect it for modular use. A key component in this regard is a high-performance inductor module that needs to be newly developed. In addition, research is being conducted into new materials and innovative combinations aimed at halving volume, weight, cost and power loss.

The result is a power electronics system that regulates energy flow with great efficiency and has been proven to work in a test vehicle. That is a significant step towards full mass production.

»ZERO EMISSION MOBILITY WITH FUEL CELL VEHICLES«

09 HYDROGEN4 – DEMONSTRATION IN EVERYDAY USE

The project involves the operation of the HydroGen4 in Berlin, Hamburg and Frankfurt. Various users will test the vehicles under everyday conditions. Through the evaluation of driving data along with feedback from the users, important information will be relayed back into the development of future generations of fuel cell vehicles to enable optimisation and improvements. The HydroGen4 vehicles are a part of the Clean Energy Partnership fleet.

Keyword
HydroGen4

Recipient
Adam Opel AG

Project budget €	Funding budget €
5,365,290	2,575,339

Commencement	Conclusion
01.01.11	30.06.13

NIP

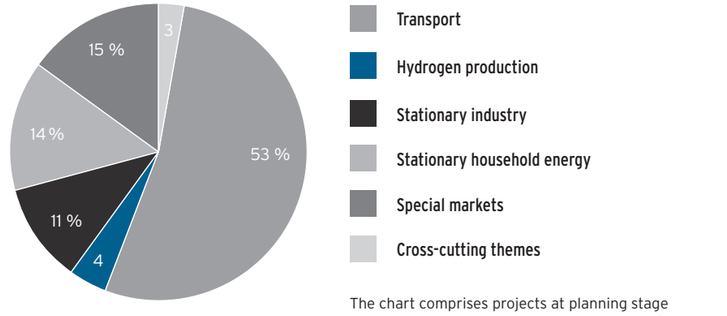
HYDROGEN PROVISION

The NIP's hydrogen production/provision programme area comprises R&D as well as demonstration projects and studies on the manufacture, distribution and supply/refuelling of hydrogen. Conceptual work is also essential for the integration of hydrogen into transport and the energy industry. Hydrogen storage – specifically in large quantities – requires further technological improvements and is generating a new focus. In the course of Germany's energy reform, the issue of hydrogen as a storage mechanism for the integration of renewable energies is becoming significantly more important.

At the core of the programme area is hydrogen production, primarily via electrolysis based on excess wind-generated electricity. Still greater development potential will be seen in the highly efficient process of electrolysis, which has several techniques, each at a different stage of development. The overwhelming majority of today's industrial production by electrolysis is based on alkaline electrolysis. Other methods include PEM and high-temperature electrolysis. The hydrogen that is produced can be used, for example, as a fuel in transport or as a storage medium for fluctuating renewable energies on a large scale.

In addition to this, the issues of hydrogen from biomass, and hydrogen as a by-product of industrial processes, are being worked on. A holistic logistical concept is needed in the case of hydrogen from biomass, which takes into consideration all relevant conditions ranging from the availability of biomass to the supply of hydrogen. In the case of hydrogen as a by-product, the potential for climate protection must be clearly determined.

NIP Statistic:
Share according to application sector
As at December 2011



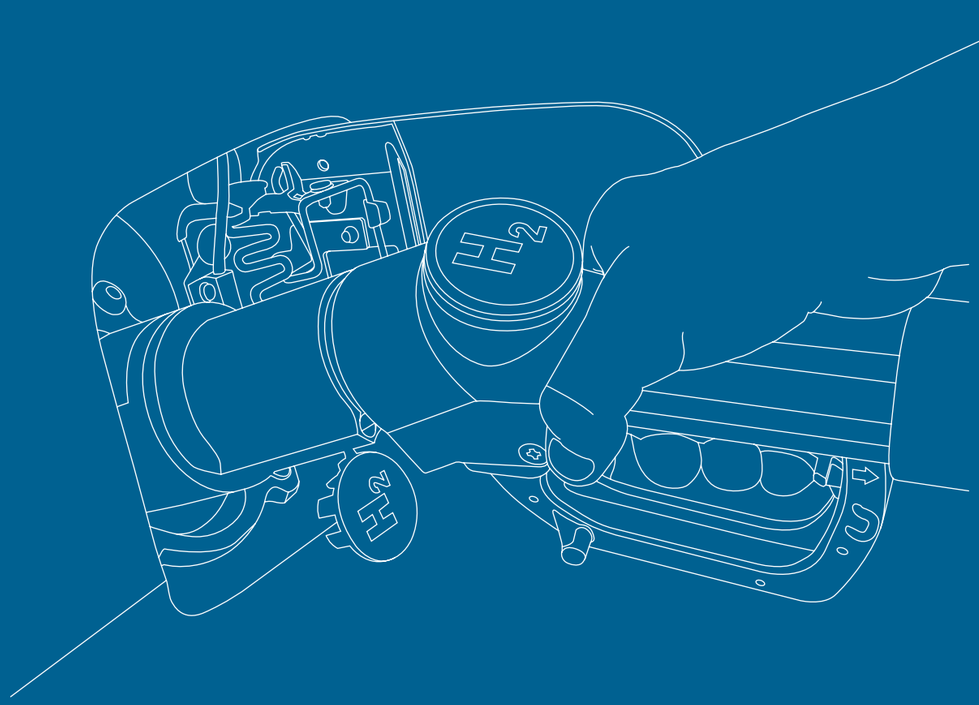
The chart comprises projects at planning stage at NOW, being processed by PtJ LOI (Letter of Intent) as well as approved projects.

Programme area Hydrogen Provision:
Allocation by application area
As at December 2011

14 %	Hydrogen from biomass
30 %	Hydrogen from wind
6 %	Hydrogen by-product
4 %	Studies/surveys
46 %	Infrastructure

NIP

HYDROGEN PROVISION



Industry and research establish wind hydrogen initiative

»PERFORMING ENERGY – WIND HYDROGEN ALLIANCE«

Effective energy storage is necessary in order to reach the goal as set out by the Federal Government to make a marked move to the broad implementation of renewable energy. Hydrogen has the potential to store renewable energy from wind in sufficient quantities. It was against this background that renowned representatives from industry, science and organisations from the areas of environment and technology funding established the »performing energy – Bündnis für Windwasserstoff« (Wind Hydrogen Alliance) initiative on 7 December 2011. Supporting the initiative are the Federal States of Brandenburg, Schleswig-Holstein and Hamburg. Initial test projects are intended to establish the prerequisites for the future economic integration of hydrogen storage systems in the energy industry.

- Hydrogen is the only form of energy that is capable of storing large quantities of energy from renewable sources over long periods. Special hydrogen caverns or elements of the existing gas network infrastructure can be used for this purpose.
- The stored hydrogen can be fed into the gas grid and used in gas-fired power plants as well as decentralised combined heat and power (CHP) plants, to balance out the fluctuations of renewable energy sources.
- The stored hydrogen can be used as an emission-free fuel for fuel cell vehicles and as such can form a common value-added chain from the energy to the transport sectors. Series production of hydrogen-powered vehicles is scheduled to commence in 2014.
- The provision of green hydrogen for industry enables significant levels of CO_2-emissions to be avoided.

The »performing energy« initiative partners intend to explore the technical and economic feasibility of large wind hydrogen systems, to test these under everyday conditions and bring these to market in the medium term. A joint funding application was submitted for three coordinated demonstration projects in Brandenburg and Schleswig-Holstein. The aim of the projects is to investigate and portray the complete value-added chain of wind hydrogen across the energy areas of power, heat and mobility.

Partners of »performing energy – Bündnis für Windwasserstoff«: Brandenburg Technical University, DBI Gas- und Umwelttechnik GmbH, Deutsche Umwelthilfe e. V., Deutsches Zentrum für Luft- und Raumfahrt e. V. German Aerospace Center (DLR) – Institute of Technical Thermodynamics, ENERTRAG AG, Fraunhofer Institute for Solar Energy Systems, GASAG Berliner Gaswerke Aktiengesellschaft, hySOLUTIONS GmbH, Linde AG, NOW GmbH National Organisation Hydrogen and Fuel Cell Technology, Siemens AG Industry and Energy sectors, TOTAL Deutschland GmbH, Vattenfall Europe Innovation GmbH and Vattenfall Europe Windkraft GmbH.

Demonstration project: Large-scale production of hydrogen and feeding into the gas network

Large-scale production of hydrogen from wind energy will occur using electrolysis. The hydrogen is to be temporarily stored and fed into the existing gas grid in order to provide a sustainable and CO_2-free supply for conventional power plants, CHP plants and high efficiency gas-burning technologies. Test fields shall be established for electrolysis where various electrolysis technologies can be tested and compared.
A grid integration undertaking (380 V) will accompany the project. Its aim is to enhance coordination between plants producing regenerative energy and conventional power plants.

Demonstration project: Production and reconversion of hydrogen

Hydrogen is to be regarded on the level of power generation in this project. Hydrogen produced using electrolysis is to be mixed with natural gas and reconverted in a gas turbine. The reconversion using gas turbines will play a central role in the future to regulate fluctuating feeds of renewable energy.

Demonstration project: Hydrogen storage in salt caverns

The aim of this demonstration project is the validation of solutions for the economic integration of offshore wind farms. In addition, the potential use of regeneratively produced hydrogen in industry to reduce CO_2-emissions is to be investigated.

Interdisciplinary topic: Hydrogen as a fuel

A component of all projects is the use of wind hydrogen in the transport sector. For this reason, all demonstration projects are associated with the Clean Energy Partnership (CEP) in Berlin and Hamburg. In Berlin alone, there are already around 50 electric vehicles with fuel cells in use, within the framework of the CEP. Series production of hydrogen powered fuel cell vehicles is scheduled to commence in 2014. The sustainable production of wind hydrogen will take on a key role in the question of expansion of hydrogen-based mobility in the future.

performing energy
BÜNDNIS FÜR WINDWASSERSTOFF


D 820
H2

01 RENEWABLE HYDROGEN PRODUCTION BY MEANS OF GLYCEROL PYROREFORMING

Keyword
Glycerol pyroreforming

Recipient
Linde AG – Gas & Engineering Division

Project budget €
2,737,537

Funding budget €
1,314,018

Commencement
01.09.09

Conclusion
31.12.13

Hydrogen technology has a significant potential to reduce greenhouse gases, for example, from road use. One of the main tasks required to achieve this is to develop sustainable production methods for hydrogen that are economically efficient and viable on an industrial scale. In an initial test facility, this project thus demonstrates how low emission hydrogen can be produced from glycerol, a form of biogenic waste.

Glycerol is a waste product that arises, for instance, in the production of bio diesel. In order to produce green hydrogen from it, the glycerol is first cleaned and then converted at high temperature (pyrolysis) into a hydrogen-rich synthetic gas. This gas mixture subsequently is further converted by conventional methods in a hydrogen reforming plant. After a final filtration, the hydrogen can be transported by special tanker to the end user. As fuel, the hydrogen can then, for example, power fuel cell vehicles or serve in stationary fuel cells as a source of power and heat.

It is expected that it will be possible in future to produce hydrogen by this method on an industrial scale at a competitive price. Compared to conventional production methods it offers the potential to cut down on up to 80 % of CO_2 if the thermal configuration of the process is further optimised.

02 HY-NOW; EVALUATION OF METHODS AND TECHNOLOGIES FOR SUPPLYING HYDROGEN BASED ON BIOMASS

Hydrogen could be one of the most important fuels of the future. A prerequisite for this is that it can be made available on a large scale in a sustainable, low emission way. The conversion of biomass into hydrogen represents one possible method. This project aims to work up recommendations for running further projects in the medium term to demonstrate bio-hydrogen production and in the course of doing so identify any need for further research.

To this end, it thoroughly analyses and evaluates various conversion methods using a variety of defined technical criteria. Being examined here are both thermochemical and biological supply paths for producing bio-hydrogen. Promising methods will subsequently be subjected to detailed analysis. Based on simulation models, the intention is to further examine technical, ecological and economic aspects. The individual results serve as the basis of an overall evaluation, from which concrete recommended actions can ultimately be derived.

Keyword
Biomass

Recipient
DBFZ Deutsches Biomasseforschungszentrum gemeinnützige GmbH (German biomass research centre)

Project budget €
204,323

Funding budget €
204,323

Commencement
01.05.11

Conclusion
30.04.12

»DEVELOPING SUSTAINABLE MEANS OF PRODUCTION FOR HYDROGEN«

03 INTEGRATION OF WIND-HYDROGEN SYSTEMS INTO THE ENERGY SYSTEM

The aim of the project is to ascertain the basic conditions under which wind-hydrogen systems can be operated in a technologically and economically feasible manner. The project will deliver the underlying principles for creating systems that help to stabilise fluctuating supplies of energy into the electric grid. (Excess) wind power gets chemically saved here in the form of hydrogen. This is made available as fuel or converted back into electrical energy by means of gas power stations or fuel cells. Providing a supply to two markets should enable synergies to be achieved. The project deals with systems of industrial scale in the three-digit megawatt range and underground storage of large quantities of hydrogen for bridging lulls. The horizon in terms of time is 2030.

The project can be roughly divided into four steps:

- First, the excess wind power storage requirements in 2020 and 2030 are calculated.
- The technical and economic characteristics of the components for wind-hydrogen systems are defined. In addition to an appraisal of the current situation, this also concerns the development prospects of relevant technologies.
- Building on this, the systems are then to be developed on an industrial scale.
- Finally, using an energy market model, estimates are made of the commercial potential of the fuel and reconversion options.

In practice these steps are closely interlinked and the procedure is iterative.

Keyword
Integration of wind-hydrogen systems

Recipient
PLANET – Planungsgruppe Energie und Technik GbR

Project budget €
261,955

Funding budget €
261,955

Commencement
01.08.11

Conclusion
31.08.12

NIP

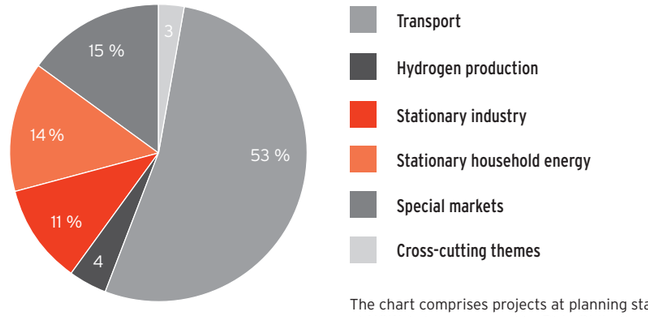
STATIONARY ENERGY SUPPLY

The programme area of stationary fuel cells in household energy and industrial facilities in the National Innovation Programme for Hydrogen and Fuel Cell Technology (NIP) comprises in a lower capacity range, systems from 1 KWel to 5 KWel in household energy, right up to plants of some 10kW to a few MW in industrial use. The simultaneous generation of heat and power via fuel cells facilitates high overall efficiency rates (>85 per cent). This enables CO_2 savings of between 25 and 35 per cent compared with modern conventional supply systems.

The systems in household energy supply work on the principle of combined heat and power and burn natural gas from existing pipelines. In the medium term, biogas and fluid renewable energies that are fed into the natural gas network will also be used. Fuel cell devices for household energy thus have the advantage of being directly usable without requiring investment in the surrounding infrastructure. Low- and high-temperature PEMFCs and SOFCs will be used in this area.

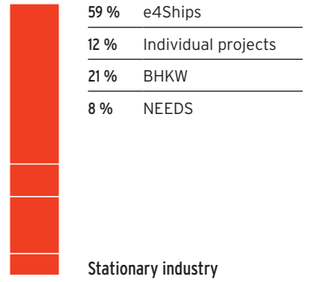
For fuel cell facilities in the industrial area, mainly SOFC technology will be used. However high-temperature PEMFC technology is also becoming an important issue. In total there are several hundred fuel cell combined heat and power facilities with a power capacity of 100 kW and above in use worldwide.

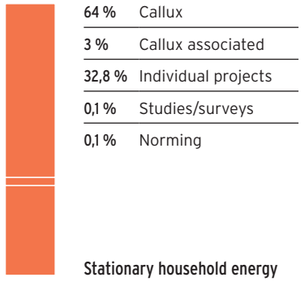
NIP Statistic:
Share according to application sector
As at December 2011



The chart comprises projects at planning stage at NOW, being processed by PtJ LOI (Letter of Intent) as well as approved projects.

Programme area Stationary Applications:
Allocation by application area
As at December 2011





NIP

STATIONARY ENERGY SUPPLY

Fuel cell heating appliances for the home

CALLUX BRINGS THE FUTURE HOME

The Callux lighthouse project, funded within the framework of the NIP and coordinated by NOW, brings fuel cell heating appliances to hundreds of individual and semi-detached houses. 200 units nationwide are already providing heat and electricity in an innovative way. On the road to series production, participants of the Callux project, which began in 2008, are not only involved in the installation, operation and further development of the appliances within the framework of the different work packages, Callux is also pursuing activities essential to market launch.

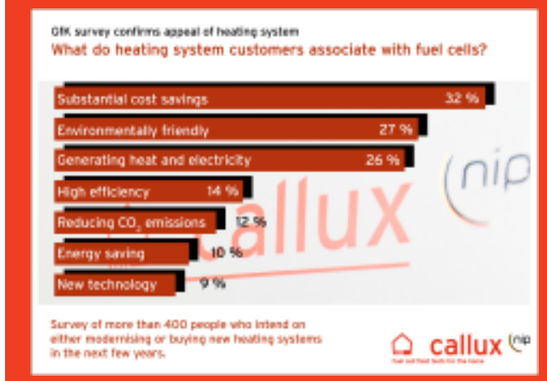
Fuel cell heating appliances information programme

In order to introduce the heating installation trades and the next generation of workers to the new technology, the interactive fuel cell heating appliances information programme has been developed, which is publicly available on the Callux homepage. The learning programme provides up to date access to the fundamentals of electricity-generating heating systems based on fuel cells.

How do homeowners see fuel cell heating appliances?

In the heating market, GfK investigated the acceptance of innovative heating appliances. It was found that of the 400 surveyed homeowners who were soon planning to buy a heating system, approximately half have considerable interest in new heating technology. Of these potential customers, 32 per cent associate fuel cells with cost savings, 27 per cent with environmental protection and 25 per cent with the ability to produce electricity and heat simultaneously. For a heating system still in market preparation phase, these are very encouraging results.

callux nip
Fuel cell field tests for the home



Fuel cell heating appliances offer advantages from the perspective of heating system customers.
Image: Callux

01 ACCOMPANYING FIELD TRIAL PROJECT FOR OPTIMISING AN »IN5000PLUS«

Keyword
inhouse5000plus

Recipients	Project budget €	Funding budget €
inhouse engineering GmbH	865,078	415,238
SolviCore GmbH & Co. KG	1,142,738	548,514
Riesaer Brennstoffzellentechnik GmbH Gesellschaft für Entwicklung und Anwendung innovativer Energiesysteme (Riesa Fuel Cell Technology Institute for Development and Application of Innovative Energy Systems)	330,530	158,654

Commencement 01.07.10
Conclusion 30.06.13

Fuel cell heaters produce both power and heat based on the principle of cogeneration and achieve very high levels of efficiency in the process. Field tests have shown the great potential of this technology for a future decentralised system of energy supply. The aim of this project is to develop and test a marketable follow-up model for the inhouse5000plus fuel cell system that is already at the trial stage.

By looking at the components, system and operating conditions together, it is possible to develop the system further into a marketable product. The central development aims here are the further improvement of the system's level of efficiency and service life. The objective is that, in the course of optimisation, the price of procurement should also come down significantly. The successful implementation of the project is contributing to the establishment of a fuel cell sector value added chain, along which production of the core components is located in Germany.

Division of responsibilities/sub-projects:
- Riesaer Brennstoffzellentechnik GmbH is responsible in the project for system integration and the development/optimisation of the reformer module.
- inhouse engineering GmbH is developing and optimising the PEM stack, fuel cell module and the control system.
- SolviCore GmbH & Co. KG is responsible in the project for the development and optimisation of the membrane electrode assembly (MEA).

02 FUELCELL@HOME – GREATER EFFICIENCY FOR YOUR HOME

In the north west of Germany detached houses characterise the housing stock. The energy efficiency of such houses could be considerably enhanced through the use of fuel cell heating systems. That is because these so-called micro-combination systems work on the cogeneration principle, simultaneously producing heat and power for immediate use in the building. A significant contribution can thus be made to climate protection, as compared to conventional power and heat supply, the primary energy gets converted more efficiently. As a fuel, natural gas offers an environmentally friendly basis for this, which can be further optimised through the use of green natural gas.

In the course of this field test, over 200 fuel cell heating appliances are being deployed and tested in northwest Germany. The aim is to prove that the technology is fully developed and to prepare for the market launch of highly efficient micro-cogeneration systems based on fuel cell technology. The project is supplementing the wide-scale field tests being run as part of the National Innovation Programme hydrogen and fuel cell technology by adding another core area.

Local specialist companies are being particularly involved in the project. The field test, for example, provides an early opportunity for local trade specialists to become familiar with a new energy-efficiency technology, to feed their own experiences into the product development process and to encourage them to train up their staff.

Consortium:
CFC, with its head office and production facility in the North Rhine-Westphalian town of Heinsberg, is developing and producing the fuel cell heating systems along with heating equipment manufacturer Bruns from Saterland in Lower Saxony. EWE ENERGIE AG and CFC have already been working successfully since 2005 on the development of fuel cell heating appliances.

Keyword
NIP-FC@Home

Recipient
EWE ENERGIE AG

Project budget € 4,521,727
Funding budget € 2,170,429

Commencement 01.12.10
Conclusion 28.02.15

03 INTERNATIONAL STANDARDISATION

Keyword
International standardisation

Recipient
Eckhard Schwendemann
Technical Management Consulting

Project budget € 92,212
Funding budget € 44,262

Commencement 01.01.11
Conclusion 31.12.11

»ENERGY EFFICIENCY WITH FUEL CELLS«

04 GASIFICATION OF EFFLUENT SLUDGE IN THE MOOSBURG/ISAR TREATMENT PLANT TO PRODUCE BIOGENIC HYDROGEN

Keyword
Moosburg/Isar sewage treatment plant

Recipient
h s Energieanlagen GmbH

Project budget €	Funding budget €
1,709,627	820,621

Commencement	Conclusion
01.08.10	31.12.12

Effluent sludge is a residual material that at present must generally be disposed of at great cost. In the future, this waste product could become a valuable raw material, as it is possible to turn it into a hydrogen-rich product gas. The project's aim is to develop a prototype of an effluent sludge gasifier for this purpose and to integrate it into the overall system of a waste treatment plant. A further aim is to show that at least the energy needs of the treatment plant itself can be completely covered by the gas obtained. In the future, a profitable power station, sparing on natural resources, could thus be created from the costly, energy-consuming waste treatment plant.

In the first stage of the project, the gasification unit is being defined, built and tested at the Moosburg waste treatment plant. The product gas obtained in the unit gets used in a micro gas turbine to provide the plant with power and heat. Alongside this, it can also be used as exhaust gas for hydrogen production. A suitable gas preparation system for this is to be developed in a second stage of the project.

The biomass gasifier required is a technical innovation, as it needs to be specially adapted to the high ash content in the effluent sludge. The technology permits local use in a low output range (500 kW fuel input – equivalent to the output of a small town's sewage treatment plant) and is suited to retrofitting treatment works.

Hydrogen is a zero emission carrier of energy. For that reason alone, using it for energy makes a contribution to protecting the climate and the environment. Afterwards, the valuable substances contained in the effluent sludge, such as phosphor or heavy metals, can also be recycled more easily than before. The remainder can be reused as aggregate for building materials and in road construction or can be disposed of in landfill.

05 DEVELOPMENT OF A CFY STACK PLATFORM TECHNOLOGY FOR STATIONARY SOFC SYSTEMS IN THE OUTPUT RANGE OF 5–50 KW/SOFC20

Keyword
SOFC20

Recipients	Commencement	Conclusion	Project budget €	Funding budget €
Plansee Composite Materials GmbH	01.04.10	30.09.12	2,405,260	1,154,525
AVL Schrick GmbH	01.04.10	31.08.12	1,710,693	821,133
Schott Electronic Packaging GmbH	01.04.10	30.09.12	523,955	251,498
Forschungszentrum Jülich GmbH (Research Centre)	01.04.10	30.09.12	391,529	187,934
Fraunhofer-Gesellschaft zur Förderung der angewandten Forschung e. V. (FhG)	01.04.10	30.09.12	3,917,991	1,880,635

By virtue of their high level of system efficiency and low associated emissions, solid oxide fuel cells (SOFC) will play an important role in future energy supply. The aim of the project is to develop a modular cogeneration base technology using SOFC in the output category of above 5 kilowatts. It will be possible in future to use this both for central and local supply of heat and power, for example, in the industrial sector.

The following product prototypes are being developed in the project:
- Robust and inexpensive CFY stacks with 30–40 repeater units
- Stack modules made up of CFY stacks with an output of >5 kWel
- A fuel cell system with an output of >5 kWel, potential for modular construction and a target electric efficiency level of over 50 %.

The aim with these prototypes is to deliver proof of stationary system operation of at least 1,000 hours and to demonstrate a degree of system efficiency of more than 50 %.

Consortium:
As specialists in powder metallurgical manufacture of extremely durable products made of refractory metals, Plansee develops and produces CFY interconnectors that are perfectly tailored to the properties of electrolyte-borne cells made of fully stabilised zircon dioxide (10ScSZ). The development of new bonding materials by Schott Electronic Packaging and the Fraunhofer IKTS is particularly aimed at thermo-mechanical compatibility with the CFY interconnectors. In addition to coordination of the overall project, the IKTS is handling stack construction and the joining and characterisation of the stacks. The insights gained from this are being incorporated into the development and optimisation of the individual components. Only perfect adjustment enables the strived for high cell power density and the cycle stability required for the areas of use. The small number of individual parts in the newly developed MK351 stack design makes assembly easy and suitable for automation.

The development of the fuel cell system, all the way from gas preparation through to inverter and integration of the stack module, is being carried out by AVL. Many peripheral components needed to be specially developed for this, such as the ignition boiler and a special anode residual gas recycling blower.

The Jülich Research Centre provided support, especially on the system design and on qualification of the desulphurisation materials to be used.

»HYDROGEN FROM BIOMASS«

NIP

SPECIAL MARKETS

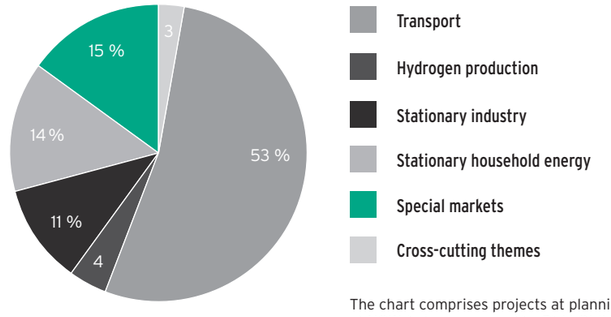
The special markets programme area of the National Innovation Programme Hydrogen and Fuel Cell Technology (NIP) incorporates a broad spectrum of applications. Likewise, the scope of power ranges is large, as are the diverse types of implemented fuels and fuel cell technologies. The special markets also utilise many of the key technologies that are required in the mass automobile and stationary fuel cell markets.

The power range of applications in the special markets extends from very low with just a few watts for micro fuel cells, through several 100 W for on-board power supplies, up to several 10kW for uninterruptible power supplies or range extenders for battery-electric special vehicle applications. Hydrogen, methanol, ethanol, bioethanol and LPG in combination with a reformer are employed as fuels.

Various systems are in use for the supply of hydrogen; from gas cylinders and cartridges within metal hydrides or hydrogen generators based on chemical hydrides, to methanol with a relevant infrastructure and logistics for distribution, but also the construction of hydrogen service stations is foreseen. In terms of fuel cell technologies, the spectrum covers the ranges from PEM, HT-PEM, DMFC to SOFC.

The special markets incorporate fields of application including: business power supply (emergency power supply, UPS, off-grid power supply, autonomous/hybrid power supply, emergency power systems), leisure power supply (on-board power supply and drives), warehouse vehicles (forklifts, haulers), special vehicles, electric light vehicles and micro fuel cells (industrial sensors, small device supply).

NIP Statistic:
Share according to application sector
As at December 2011



The chart comprises projects at planning stage at NOW, being processed by PtJ LOI (Letter of Intent) as well as approved projects.

Programme area Special Markets:
Allocation by application area
As at December 2011

1 %	Individual projects
9 %	Micro fuel cells
27 %	Power supply leisure
27 %	Power supply business
8 %	Electric light vehicles/boats
10 %	Special vehicles
7 %	Forklifts
5 %	Cross-cutting themes
6 %	Aiports lighthouse project

NIP

SPECIAL MARKETS

FUEL CELLS IN INFORMATION AND COMMUNICATION TECHNOLOGIES

ESTABLISHMENT OF THE CLEAN POWER NET STRATEGIC PARTNERSHIP

- Around 70 German companies – comprising both manufacturers and users – are working on the commercialisation of fuel cell systems for deployment in the areas of information technology, telecommunications, industrial process automation and control systems, traffic control systems as well as for energy supply.
- For these industry sectors, fuel cell systems are particularly appealing in the areas of emergency power supply, Smart Grid, uninterrupted power supply/backup systems, off-grid/autonomous power supply systems and virtual regulating power plants for minute reserves and the management of peak loads.

clean power net

Brennstoffzellen in Industrie und Business

The Clean Power Net (CPN) strategic partnership was established in August 2011. Consisting of 20 industrial enterprises and research institutions, the group signed a memorandum of understanding concerning the market preparation of fuel cells for deployment in uninterruptible power supply systems. The objective is to establish and strengthen the networks between relevant users and systems manufacturers in the sector and jointly develop the power supply system market using fuel cell technology.

Coordinated by NOW GmbH National Organisation Hydrogen and Fuel Cell Technology, the CPN partners have initiated comprehensive demonstration projects in which the day-to-day feasibility of the technology in this area is to be proven. For example, fuel cell systems that are being implemented as backups in telecommunications networks are being tested. Other projects involve the integration of renewable energy in autonomous base stations for mobile telephony stations, the reduction of costs for systems in the TETRA Network/BOS digital radio network, as well as the emergency power supply of a works fire brigade to substitute, for example, high CO_2-producing emergency diesel power generators. The projects are supported with funding of approx. €11 million within the framework of the National Innovation Programme Hydrogen and Fuel Cell Technology (NIP), financed by the Federal Ministry of Transport, Building and Urban Affairs (BMVBS).

In the specification sheet for fuel cells, user demands are to be recorded to enable system manufacturers and network equipment suppliers to be in the position to offer tailor-made, customer-focused solutions. Among the aims of the hydrogen infrastructure and logistics specification sheet are improved supply concepts for customers. Their objective is to offer assistance by providing concrete information regarding fields of application, quantities and diverse other parameters. Furthermore, work commenced on a catalogue containing relevant regulations for the set up and operation of fuel cell facilities.

More information on Clean Power Net can be found here:
www.cleanpowernet.de.

01 DEVELOPMENT OF MEA CHARACTERISATION METHODS FOR OPTIMISING AND REDUCING THE COST OF CERAMIC CELLS (MEAS) FOR APPLICATIONS IN ENERGY SYSTEMS – SOFCONVERT

Due to its high overall degree of energy utilisation, fuel cell technology can in future significantly contribute to reducing CO_2-emissions and to ensuring a safe and environmentally friendly supply of power on a long-term basis. In order to accelerate market success for the technology, this project is concentrating on the further development of inexpensive and flexibly usable solid oxide fuel cells (SOFCs). The aim is to be able to achieve lower manufacturing costs through improved production methods and at the same time to be able to manufacture more robust fuel cells with a higher power density on an industrial scale and assemble them into stacks. The intended outcome is for the development of reliable, long-lasting and cost-efficient energy generation systems.

The central focus of the development is, in part, on the fuel cells themselves. The priority is to demonstrate the robustness of the membrane electrode assembly (MEA) in respect to long-term stability, thermocycling capability and redox resistance. The aim is also to reduce the relative costs per kilowatt hour by improving the performance of the fuel cells produced.

Another point being examined is the production process: in order to enhance quality as regards to mass production, measurement stations are being set up for cell characterisation. Automated stack assemblers can thus be reliably fed from the live production process with cells of defined, guaranteed properties. The measurement stations are also key to future development work and are thus a long-term investment in the partners' competitiveness.

Keyword
SOFConvert

Recipient
KERAFOL Keramische Folien GmbH

Project budget €
1,725,733

Funding budget €
828,351

Commencement
01.06.10

Conclusion
31.05.13

»FUEL CELLS IN TELECOMMUNICATIONS«

02 SELF-SUFFICIENT MOBILE PHONE MASTS

Especially in rural areas, good locations for mobile phone masts are not necessarily connected to the power grid. Fuel cells promise to help here: in combination with renewable forms of energy, they facilitate a self-sufficient supply of green electricity even at sites that are difficult to reach.

Based on this technology, the aim in this project is initially to set up 13 new sites and test them in live network operation. The stations run on an innovative energy concept: a combination of solar energy and wind power, which is backed up by fuel cells and deep discharge batteries. The project is thus designed to show how mobile phone masts will in future be able to work on a fully climate-neutral basis.

The first base station was set up in Versmold-Loxten and is already reducing CO_2-emissions. Inside it, an energy controller regulates the supply of electricity and automatically manages the solar energy, wind power, fuel cell system and rechargeable batteries. The energy management system can be viewed and assessed via remote monitoring.

Keyword
Mobile phone masts

Recipient
E-Plus Mobilfunk GmbH & Co. KG

Project budget €
5,072,643

Funding budget €
2,315,662

Commencement
01.07.10

Conclusion
30.06.15

03 NATIONAL INNOVATION PROGRAMME HYDROGEN AND FUEL CELL TECHNOLOGY (NIP): PRACTICAL TRIAL OF POWER SUPPLY AND GRID BACK-UP SYSTEMS USING FUEL CELLS AT EMERGENCY SERVICES DIGITAL RADIO BASE STATIONS (BOS)

Keyword
Emergency services radio (BOS)

Recipient
Lower Saxony Police Headquarters

Project budget €	Funding budget €
365,912	175,638

Commencement	Conclusion
01.07.10	30.06.13

For the digital radio system used by the police, fire brigade and other emergency services, reliability is the top priority. Important base stations in the wireless network that is currently set up therefore incorporate an emergency power supply. This is an ideal field of use for fuel cell technology, as the systems work in an environmentally friendly manner and can reliably bridge power outages for up to 72 hours. The project covers the setting up of this alternative system of power supply at initially five sites in Lower Saxony.

The first site in Germany to be equipped with the new back-up system is located at Stadersand (Elbe) in the Lüneburg police district. In 2012, a second station is due to follow in Rinteln on the River Weser (Göttingen police district). The entire project has an all-in cost of around € 365,000.

Funding from the National Innovation Programme Hydrogen and Fuel Cell Technology (NIP) covers approximately half of the expenditure.

In total, around 4,500 base stations are being set up for the new radio network across Germany. In Lower Saxony, the number is around 430. The emergency power supply system tested in this project is particularly suited to remote locations that, for example, are difficult to reach in the event of snow, floods or storms.

04 STEP 2 – SFC-TRUMA-ELCOMAX-PROJECT – ECPD – FROM PROTOTYPE TO PRODUCTION READINESS

Keyword
STEP2

Recipients	Project budget €	Funding budget €
elcomax GmbH	10,163,689	4,878,570
Truma Gerätetechnik GmbH & Co. KG	1,395,236	669,713
SFC Energy AG	2,766,730	1,328,030

Commencement	Conclusion
01.07.10	30.06.13

Modern camping vehicles should offer complete comfort and convenience not just on campsites – but away from them as well. As a means of power supply independent of the grid, fuel cell systems have a series of significant advantages here compared to conventional generators: operation regardless of weather or time, high availability, low weight and minimal emission of noise or fumes. The aim of the project is to further develop a new membrane electrode assembly (MEA) and to test it in a reformer fuel cell system: the assembly helps to provide on-board electricity in recreational vehicles and works along with liquid gas, a proven and widely used fuel in the camping world.

The project work is based on a new, high-performance generation of MEAs.

The intention is to further develop these for use in different fuel cell systems (DMFC and HTPEM), to run trials and ultimately as a product ready for full production to contribute to a significant reduction in stack costs. The project follows on from the previous »STEP« project, in which the basic foundations for the central ECPD procedure (electrochemical pulse deposition) were already laid.

05 ALL ELECTRIC YACHT – AEY

Keyword
AEY

Recipients	Project budget €	Funding budget €
Woterfitz Wasserfreizeit Holtkamp + Partner OHG	568,646	272,950
Hochdruck-Reduziertechnik GmbH	442,524	212,412
FutureE Fuel Cell Solutions GmbH	528,944	253,893

Commencement	Conclusion
01.08.11	31.01.14

Fuel cells produce electricity silently and free of emissions – these qualities make them ideal for use in boats and waterborne craft of all types. They can even be used without problem in nature reserves and on especially protected waterways. The AEY (all electric yacht) project is therefore concentrating on fuel cell technology in houseboats. Following the system's technical development, the intention is to put these into normal charter use to demonstrate its capabilities.

The project kicked off on 1 August 2011 on the Müritz, the largest inland lake in Germany. Over a project period of 2.5 years, the aim is to develop an alternative hydrogen-based power supply system for houseboats. The fuel cell systems are being integrated into three »Voyager for 2« charter boats. Various different system compositions made up of fuel cells and electric motors are being used and tested. The boats are also being equipped with fuel cell systems of varying output capacity (0.5 and 1.4kW) and with lithium-ion batteries.

The aim is that propulsion power should be fully electric. Special attention is being paid to integrating hydrogen storage and high-pressure equipment with the fuel cell system. What will be produced as a result will be a hybrid system made up of fuel cell, hydrogen tank and battery that enables houseboats to be operated free of any harmful substances.

06 SFC ENERGY AG/SORTIMO INTERNATIONAL GMBH

Keyword
Modular energy supply solution

Recipients	Project budget €	Funding budget €
SFC Energy AG	2,967,000	1,424,160
Sortimo International Ausrüstungssysteme für Servicefahrzeuge GmbH	390,722	187,547

Commencement 01.05.10 **Conclusion** 30.04.12

Measurement and data processing equipment, tools or a mobile office: depending on industry and area of use, commercial vehicles get equipped with all sorts of different electrical devices. Fuel cells can supply these with power independent of the grid, generating the electricity, if required, in an environmentally friendly, zero emission manner on board. The aim of this project is to produce a modular system for on-board power supply that can be flexibly adapted to the respective requirements.

The individual modules, from fuel cell and lithium-ion batteries all the way to voltage transformers, are fully compatible with the already existing modular system of regulating vehicle equipment. The individual parts can thus then be quickly connected inside the vehicle or not until arrival at the place of use. Using a direct methanol fuel cell (DMFC) as the core component and a system of lightweight modules enables the power supply to be utilised in a flexible way. With the fuel cell as the supplier of energy, sufficient power is available at any time in any place for many days and weeks.

As an example of its use, the system is being tested in a German Railways (DB) mobile ticket sales vehicle, where it is providing power for a desk with wireless data communications, PC, printer and lighting.

07 ULMER STROMSCHACHTEL (FUEL CELL GENERATOR)

Keyword
Ulmer Stromschachtel (Fuel Cell Generator)

Recipient
SWU Stadtwerke Ulm/Neu-Ulm GmbH (Public Utilities)

Project budget € 1,900,292 **Funding budget €** 912,140

Commencement 01.09.10 **Conclusion** 31.08.13

»MODULAR ENERGY SUPPLY SOLUTIONS«

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E-MOBI
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