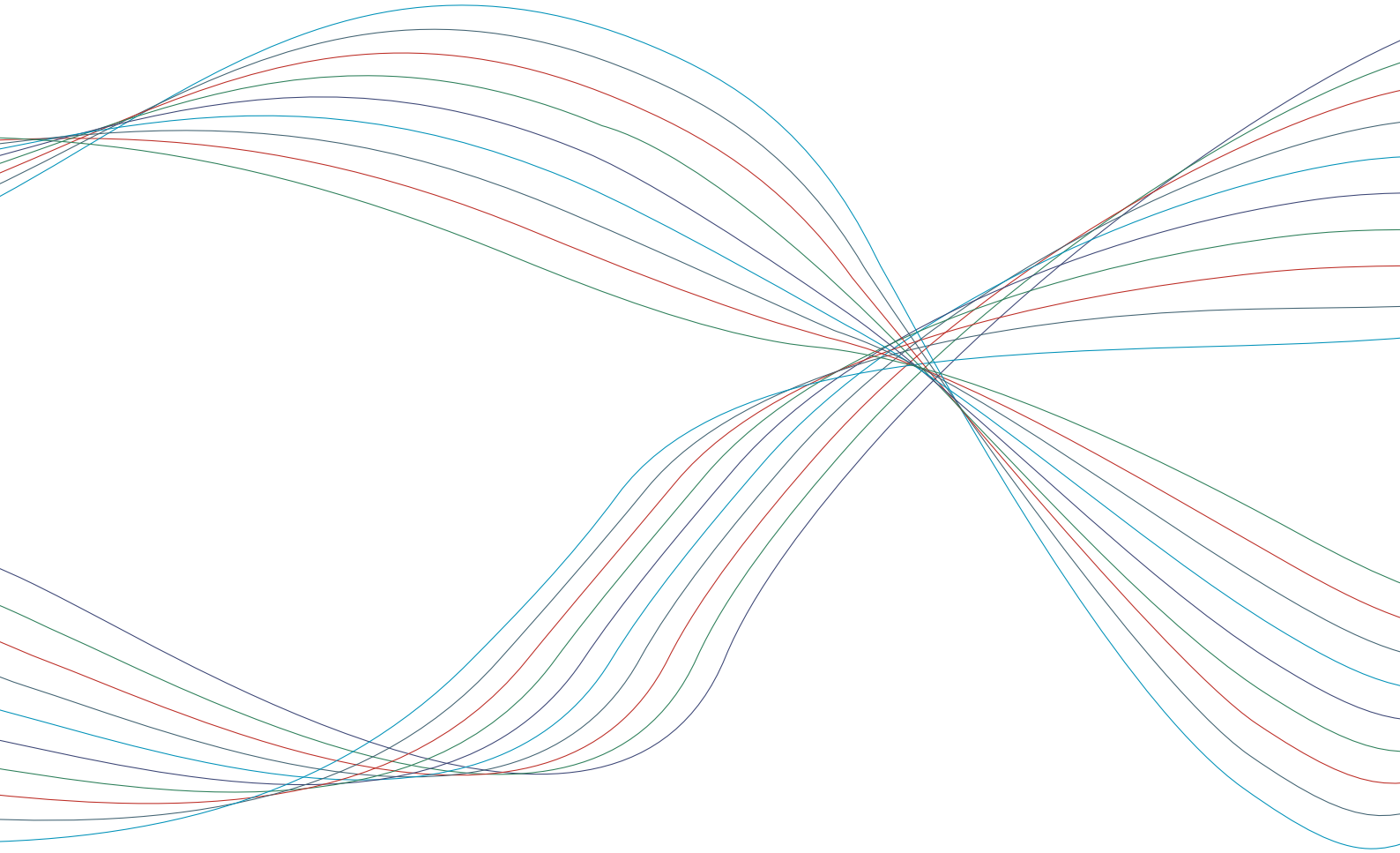
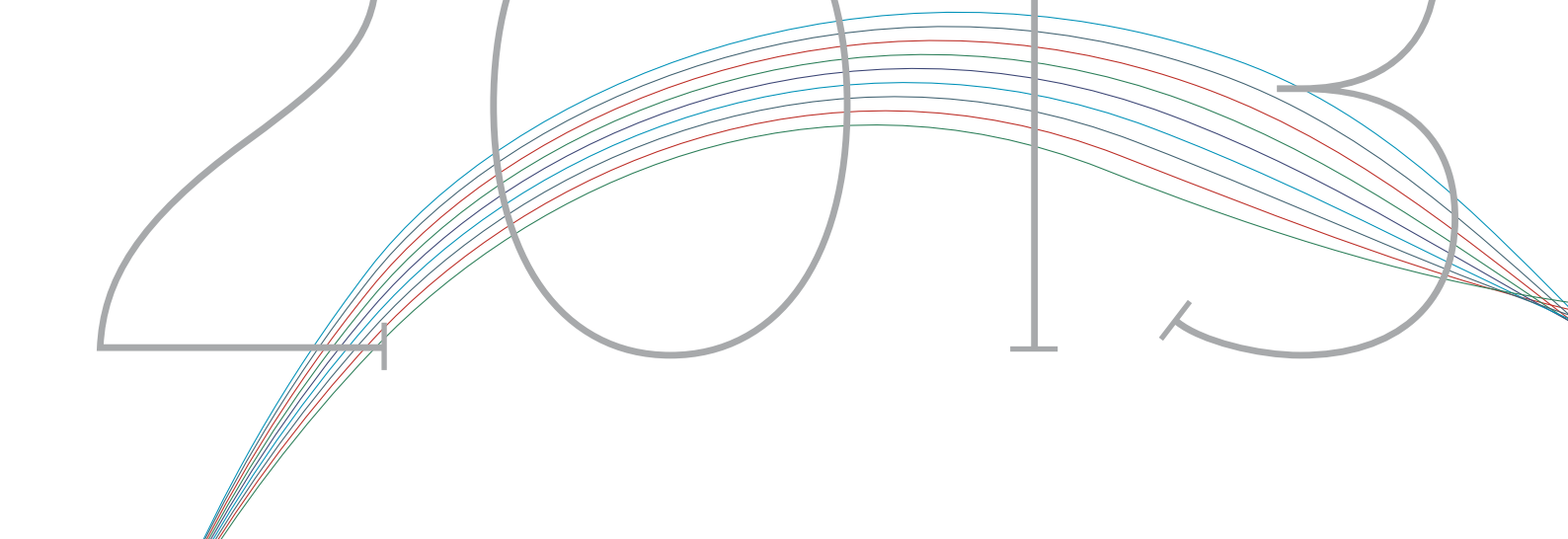
NOW
National Organisation Hydrogen and Fuel Cell Technology



ANNUAL REPORT

2013



www.now-gmbh.de

NOW MAGAZINE

2013

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Foreword by Alexander Dobrindt

INTERIM GOAL ACHIEVED – ORGANISE MARKET LAUNCH

Innovation is the key to a successful energy turnaround. Without doubt, the goals of the federal government in this central policy objective are ambitious: greenhouse gas emissions are to be cut 40 percent by 2020 compared to the levels of 1990. Mobility plays a decisive role in this regard. Transportation currently accounts for around 30 percent of total energy consumption and must therefore make a sizable contribution towards achieving this aim.

But the energy turnaround cannot occur at the expense of mobility. It is and remains a key driver of growth and prosperity. The energy turnaround can therefore only be achieved when all players on federal, state and local levels as well as those from business, research and society all work together on viable mobility concepts.

This also includes developing and providing alternatives to conventional fuels for the commercial market. We are therefore promoting research and development as well as the market entry of alternative drives. For the federal government, the support of both battery-electric mobility and hydrogen fuel cell technology continues to enjoy a position high up on the agenda. The aspiration remains to ensure Germany becomes the leading market and leading provider of electromobility. The continuously growing number of vehicles that have been designed here demonstrates that the market is developing strongly.

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The Federal Ministry for Transport and Digital Infrastructure (Bundesministerium für Verkehr und digitale Infrastruktur) supports electromobility across its entire spectrum – from plug-in hybrid through battery to fuel cell technology. And we take in all modes of transport: road and rail as well as waterways and in the air. Our ministry's projects on battery-powered electromobility are primarily supported as part of the »Electromobility Model Regions« and in the »Showcases« (Schaufenster). More than 440 projects have been realised in the model regions by my department since 2009. Practical tests and demonstration projects that illustrate the added value and suitability for day-to-day use of electromobility comprise a main focus. The insights that we have gained from this work are to be used for the impending widespread market launch of electromobility.

Besides battery-powered electromobility, we have been supporting research, development and demonstration projects since 2007 through the National Innovation Programme Hydrogen and Fuel Cell Technology (NIP). The federal government has allocated a total of 700 million euros for this purpose. Industry has invested an equal amount. The results following seven years of

support for research and development are impressive: fuel cells for both mobile and stationary applications have largely reached the level of suitability for everyday use and technological market maturity. Hydrogen and fuel cell technology may therefore soon become a link between the decentralised, renewable production of energy and the likewise decentralised production of hydrogen.

Whoever wishes to successfully introduce and establish new technologies to the market requires good deal of patience and perseverance. From the very beginning, the National Organisation Hydrogen and Fuel Cell Technology (NOW GmbH) has accompanied and supervised the BMVI programmes. It is a strong and respected partner for all players from business, research and government. We intend to expand and strengthen NOW over the coming years as a centre of competence for the introduction of alternative drive technologies.

Alexander Dobrindt MdB

Federal Minister of
Transport and Digital Infrastructure

Foreword by Dr. Klaus Bonhoff

CONTINUED SUPPORT OF R&D NECESSARY TO PROTECT THE TECHNOLOGICAL BASIS

Forward-thinking, non-polluting mobility and efficient alternatives for the provision of heat and power in buildings is becoming a reality. This is not at least due to the fact that important interim goals could be achieved in 2013 in the fields of hydrogen, fuel cell and battery technology, which now pave the way for introducing these technologies on the commercial market and into the everyday lives of consumers.

Forward-thinking, non-polluting mobility and efficient alternatives for the provision of heat and power in buildings is becoming a reality.

Progress was made in the expansion of the hydrogen infrastructure, which is imperative for the market launch of fuel cell vehicles in Germany. The partners of the industry-based H_2 Mobility Initiative – in which NOW is involved – agreed on an action plan for the expansion of a hydrogen refuelling station network in Germany: the number of public hydrogen refuelling stations is to rise to approximately 400 by 2023. Total investments arising from this initiative will amount to around 350 million euros. The partners intend to establish a separate company for the construction of the hydrogen refuelling stations. The first car manufacturers commenced offering fuel cell vehicles on a commercial basis in 2013 – and more will follow in the years to come. The vehicles produce no carbon emissions during operation and demonstrate their suitability for everyday use in the Clean Energy Partnership (CEP).

The first manufacturers of stationary fuel cell systems for the production of heat and power in buildings have also entered the home straight in the race towards commercial products. The systems are not only more environmentally friendly than conventional burners, due to their high level of efficiency – their overall efficiency of power and heat comprises 85 percent – they also promise to provide cost savings for consumers in the long term. These power and heat producing fuel cell devices, which have proven themselves in the Callux field test, must now be brought to the market at competitive prices.

In the area of battery-powered electromobility, the focus in 2013 within the framework of the Electromobility Model Regions of the Federal Ministry for Transport and Digital Infrastructure (BMVI – Bundesministerium für Verkehr und digitale Infrastruktur) was placed on the key subject areas affecting all players. To complement this, government funding activities were broadened: besides projects in the existing model regions, BMVI model projects commenced in further regions.

↗ »Wasserstoff- und Brennstoffzellentechnologien – Tragende Säulen der Energiewende 2.0« (Hydrogen and Fuel Cell Technologies – key pillars of the energy transition 2.0), www.now-gmbh.de/de/publikationen.html

WORK IN THE NIP AND IN THE MODEL REGIONS

A total of 78 million euros of NIP funding was drawn upon in 2013, comprising 55 million euros from the BMVI and 23 million euros from the Federal Ministry for Economic Affairs and Energy (BMWi – Bundesministerium für Wirtschaft und Energie). The funds were deployed in the programme areas transport (62 percent), stationary fuel cells (22 percent), special markets (9 percent), hydrogen provision (4 percent) and for interdisciplinary tasks (3 percent). Funding totalling 35 million euros for BMVI Electromobility Model Regions projects was drawn on during 2013.

CHALLENGES AHEAD

The approaching phase of market introduction presents us with new challenges. Besides continuing the support of research and development to safeguard the technological basis, we must also organise the commercial introduction of technologically marketable products. For this purpose it is necessary for government and industry to agree on suitable measures and thereby create a reliable political framework. Corresponding suggestions from representatives of industry and research were contained in a strategy paper that was submitted to the NOW Advisory Board. In the government's coalition agreement, the CDU/CSU and SPD set themselves goals that also head in this direction. One thing is clear: only with the concerted efforts of all players can hydrogen, fuel cells and batteries be successfully deployed for the good of the environment and the security of jobs in Germany as a centre of technology.

ANNUAL REPORT

The 2013 Annual report you are reading gives information on the implementation status of the National Innovation Programme Hydrogen and Fuel Cell Technology (NIP) and the Electromobility Model Regions of the Federal Ministry for Transport and Digital Infrastructure (BMVI – Bundesministerium für Verkehr und digitale Infrastruktur). The National Organisation Hydrogen and Fuel Cell Technology (NOW) is responsible for the coordination of both of these programmes.

Dr. Klaus Bonhoff

Managing Director (Chair) NOW GmbH
National Organisation Hydrogen and
Fuel Cell Technology

ABOUT NOW

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 (today the Federal Ministry of Transport and Digital Infrastructure – BMVI). The task of NOW involves the coordination and management of two federal development programmes – the National Innovation Programme Hydrogen and Fuel Cell Technology (NIP) as well as the Electromobility Model Regions of the BMVI. Both programmes serve to advance the market preparation of the corresponding technologies to ensure that mobility and the supply of energy in the future is efficient and environmentally friendly. A main focus of support is on research and development activities as well as demonstration projects that present the deployment of the technologies under everyday conditions.

NOW is responsible for the evaluation and bundling of projects within the respective programmes and acts as the interface between government and the involved partners from research and industry. Central coordination of the projects enables individual partners to exchange experiences within the framework of an integrated process and to exploit existing synergies. The project administrator Jülich (PtJ) undertakes the concrete handling of the BMVI funding.

Besides targeted market preparation activities of electromobility as well as hydrogen and fuel cell applications via various demonstration and research projects, NOW undertakes active public relations activities to raise awareness and acceptance of these technologies among users.

Representatives from politics, industry and science are a part of NOW committees. The advisory board counsels the organisation regarding the implementation of the NIP, especially with regard to current market demands. Because sustainable mobility represents a global challenge, NOW also promotes cooperation on an international level, such as the International Partnership for Hydrogen and Fuel Cells in the Economy (IPHE), which brings 17 nations and the European Commission together under one roof in order to advance the development of hydrogen and fuel cell technologies throughout the world.

ABOUT THE ELECTRO-MOBILITY MODEL REGIONS

Model Regions Electromobility

Federal Ministry of Transport and Digital Infrastructure

With the Electromobility Model Regions funding programme, the Federal Ministry of Transport and Digital Infrastructure (BMVI – Bundesministerium für Verkehr und digitale Infrastruktur) supports cross-sector cooperation between industry, research and the public sector to promote and entrench electromobility in day-to-day life. Supplementing the federally funded Showcases, the regional context is a predominant issue due to the involvement of municipalities. In the various individual projects – which are aligned to take the specific local conditions and requirements into account – the aspect of how electromobility can be applied and deployed in the public domain is examined and the measures necessary to be undertaken in regional and urban development as well as transport policy are assessed.

The support of electromobility extends across all key fields of action. The individual projects are therefore complemented through accompanying scientific research on superordinate topics. All aspects of electromobility are considered here, including: user perspectives, the continued development of drive and vehicle technology, the subjects of safety and infrastructure, the integration of electromobility in public and commercial vehicle fleets, as well as questions dealing with regional and urban development along with the regulatory framework. The various subject areas enable an in-depth exchange of experiences and the networking of strategic-conceptual partners.

Further information on the programme is contained in the attached programme report.

ELECTROMOBILITY MODEL REGIONS – SECTORS OF APPLICATION
(AS AT DECEMBER 2013*)

SECTOR OF APPLICATION	BUDGET IN THOUSANDS OF €	FUNDING IN THOUSANDS OF €
ORGANISATION / PROJECT HQS	4,747	2,374
INTERNATIONALISATION	3,387	3,027
ERA NET	3,335	3,138
PUBLIC TRANSPORT – RAIL	6,654	3,143
DRIVE / TECHNOLOGY TESTING	11,913	6,381
AIR TRANSPORT	13,071	6,799
ACCOMPANYING RESEARCH	7,338	6,953
INFRASTRUCTURE	13,288	7,318
PUBLIC TRANSPORT – BUSES	18,706	10,514
PUBLIC TRANSPORT – INTERMODAL	24,894	16,287
COMMERCIAL TRANSPORTATION	55,392	28,168
PERSONAL TRANSPORTATION	65,646	39,560
TOTAL	228,371	133,662

* Figures refer to BMVI funding for projects from 2009 onwards.

ABOUT NIP

National Innovation Programme
Hydrogen and
Fuel Cell Technology

The sustainable, low-emission supply of energy requires a shift from a reliance on fossil fuels in the long term. This means that the role of hydrogen and fuel cell technology will continue to grow into the future. In order to accelerate the development of this forward-looking technology towards market maturity, government, industry and research initiated the National Innovation Programme Hydrogen and Fuel Cell Technology (NIP) in 2006 which is scheduled to run over ten years. Total programme funding volume amounts to 1.4 billion euros. The federal government – the Federal Ministry of Transport and Digital Infrastructure (BMVI – Bundesministerium für Verkehr und digitale Infrastruktur) together with the Federal Ministry of Economic Affairs and Energy (BMWi – Bundesministerium für Wirtschaft und Energie) – provides half the funds, with the balance made up by participating industry. The NIP continues to be supported by the Federal Ministry for the Environment, Nature Conservation, Building and Nuclear Safety (BMUB) and the Federal Ministry of Education and Research (BMBF). All four of the federal departments are represented in both the NOW Advisory and Supervisory Boards.

The NIP is divided into four programme areas in order to advance the possibilities for various products and applications of hydrogen and fuel cell technology in equal measure and to address market-specific challenges in a targeted manner. Research and development activities as well as demonstration projects are thereby implemented according to the areas of Transport and Infrastructure, Hydrogen Provision, Stationary Energy Supply or Special Markets.

The respective technologies are tested under real day-to-day conditions and competencies bundled in so-called Lighthouse Projects together with several partners. The Lighthouses bridge the gap between R&D and the future markets and also ensure that the products and services connected with the topic of hydrogen and fuel cells are made more widely known to the public. Furthermore, the strengthening of the supplier industry is also explicitly promoted in all programme areas to pave the way for future series production.

Further information on the details of individual NIP projects can be found in the attached programme report.

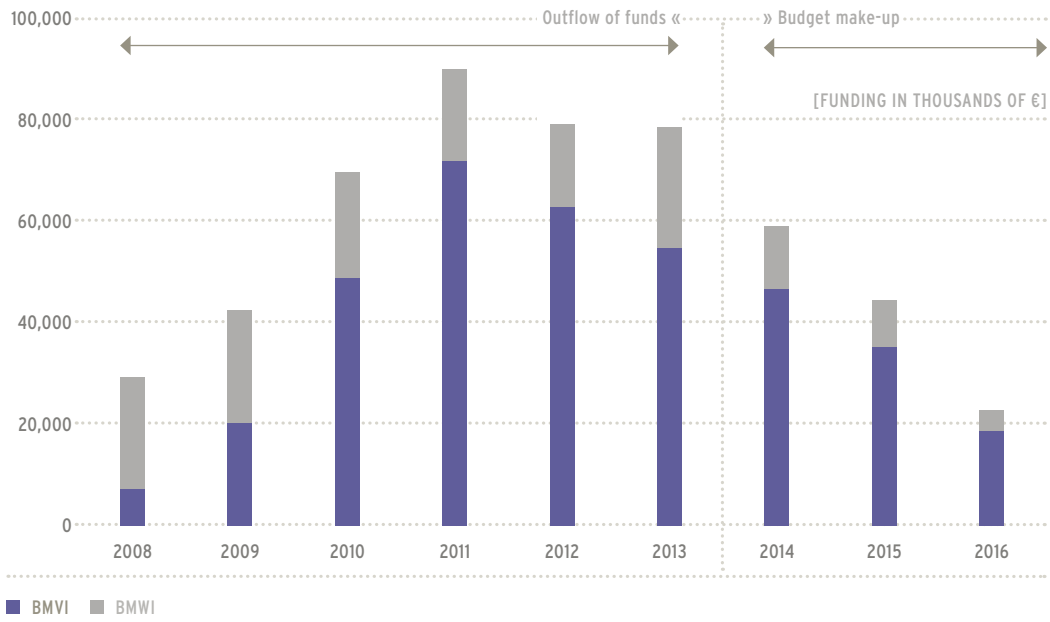
Federal Ministry
of Transport and
Digital Infrastructure

Federal Ministry
for Economic Affairs
and Energy

Federal Ministry for the
Environment, Nature Conservation,
Building and Nuclear Safety

Federal Ministry
of Education
and Research

NIP – SOURCE OF FUNDING
DEMONSTRATION (BMVI) AND R&D (BMWi)*



ENERGY STORAGE FUNDING INITIATIVE

The growing share of renewable energies in the generation of electricity must go hand in hand with the development of efficient energy storage. The Federal Ministry of Economic Affairs and Energy (BMWi – Bundesministerium für Wirtschaft und Energie), together with the Federal Ministry for the Environment, Nature Conservation, Building and Nuclear Safety (BMUB – Bundesministerium für Umwelt, Naturschutz, Bau und Reaktorsicherheit) and the Federal Ministry of Education and Research (BMBF – Bundesministerium für Bildung und Forschung) started an initiative together in 2011 to promote R&D in the area of storage technologies. Projects on the development of a large range of storage technologies for electricity, heat and other energy carriers will be supported. In the process, many synergies within the field of the field of hydrogen and fuel cell technology will be produced, which will be coordinated together with NOW.

Under the »Energy storage funding initiative«, the three ministries have allocated a funding amount of over 190 million euros to projects in an initial phase. From this around 43 million euros are allotted to the subject of hydrogen from wind, and the funds for methanation come to almost an additional 53 million euros.

* All data until 2013 refers to approved projects. Data from 2014 to 2016 include approved projects, LOI and projects being processed.

Federal Ministry
of Transport and
Digital Infrastructure

THE FEDERAL MINISTRY OF TRANSPORT AND DIGITAL INFRASTRUCTURE IN THE NIP

The Federal Ministry of Transport and Digital Infrastructure (BMVI) established the NIP together with the Federal Ministries of Economic Affairs and Energy (BMWi), Education and Research (BMBF) and the Environment (BMUB). The programme is part of the High-tech Strategy for Germany and is integrated in the federal government's Fuel Strategy. The total share of the BMVI in the NIP amounts to 500 million euros.

The NIP offers a joint framework for numerous hydrogen and fuel cell research projects from research and industry. The public-private partnership (PPP) is scheduled to run for ten years. The federal government and industry are setting aside a total funding volume of 1.4 billion euros for research, development and demonstration projects until 2016.

NIP – SECTORS OF APPLICATION (AS AT DECEMBER 2013*)

[** Letter of Intent]

PROGRAMME AREAS	BUDGET IN THOUSANDS OF €	FUNDING IN THOUSANDS OF €	IN DISCUSSION IN THOUSANDS OF €	APPROVED, LOI**, APPLICATION IN PROCESS AT PTJ IN THOUSANDS OF €
TRANSPORT	579,058	276,755	38,394	238,361
HYDROGEN PROVISION	44,002	2,795	7,003	14,792
STATIONARY INDUSTRY	91,302	47,667	17,764	29,904
STATIONARY HOUSEHOLD	140,171	65,557	10,494	55,063
SPECIAL MARKETS	137,767	67,219	15,518	51,700
INTERDISCIPLINARY THEMES	31,777	16,299	9,475	6,824
INNOVATIVE DRIVES	15,439	7,411		7,411
TOTAL	1,039,516	502,703	98,648	39,644

* The information refers to BMVI funds for projects since 2008.

Federal Ministry
for Economic Affairs
and Energy

THE BMWi SUPPORTS APPLICATION-BASED R&D PROJECTS WITHIN THE FRAMEWORK OF THE NIP

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

NIP – SECTORS OF APPLICATION (AS AT DECEMBER 2013*)

PROGRAMME AREAS	BUDGET IN THOUSANDS OF €	FUNDING IN THOUSANDS OF €
TRANSPORT	200,897	104,840
HYDROGEN PROVISION	732	732
STATIONARY INDUSTRY	42,134	20,019
STATIONARY HOUSEHOLD	84,488	39,342
SPECIAL MARKETS	19,616	11,098
INTERDISCIPLINARY THEMES	40,768	26,523
TOTAL	388,635	202,554

* The information refers to BMWi funds for projects since 2008.

INTERNATIONAL COOPERATION

Efforts to transform our energy system show great promise and are not limited to the national level. In order to fully exploit the potential of renewable energies and be able to meet the rising demand for them, then aside from efficient storage media and flexible applications we also need cross-national cooperation and intensive international exchange.

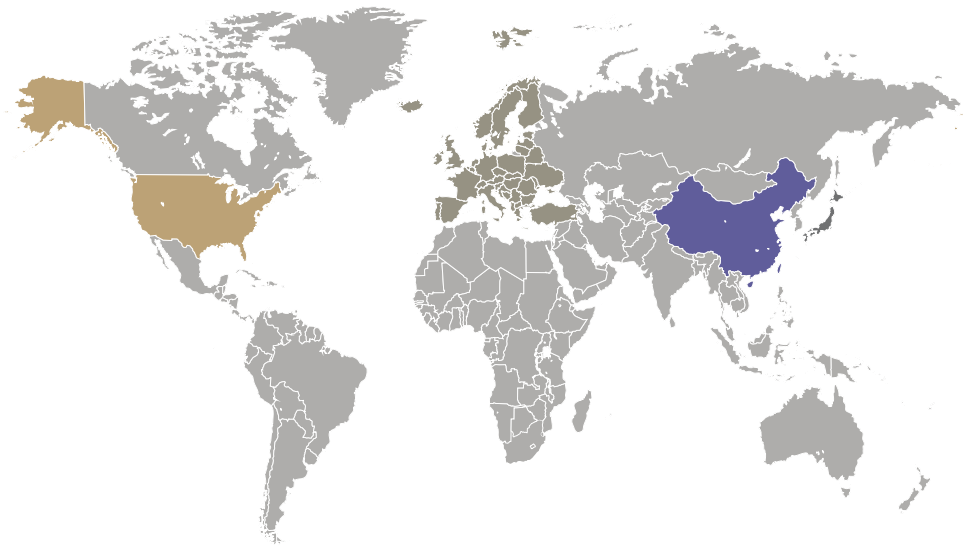
In this context NOW has continued and expanded international cooperation in addition to its national activities in 2013 as international cooperation and common strategic direction are essential in order to successfully commercialise hydrogen and fuel cell technology and establish it in future as an integral part of a global energy economy.

EUROPE

International cooperation is particularly vital for the development of a European hydrogen infrastructure for the transport sector. In contrast to the situation in the USA or Japan, where an almost closed market can be developed, for Germany it is essential to establish cross-national partnerships within the EU and expand national activities in order to successfully accelerate the set-up of a comprehensive hydrogen infrastructure. An important step towards coordinated development within the EU was the work of the European Parliament on the proposal for a directive on the deployment of alternative fuels infrastructure. This is a cornerstone for the further roll-out of a hydrogen infrastructure within the EU and reflects the importance of this technology on the European level. In this context a Governmental Supporting Group (GSG) was established in 2013 in cooperation with the Federal Ministry of Transport and Digital Infrastructure (BMVI – Bundesministerium für Verkehr und digitale Infrastruktur), in which further European activities, focusing on hydrogen, will be jointly agreed upon and implemented. Currently the GSG is composed of partner countries France, Netherlands, UK, Sweden, Denmark and Germany.

In the area of hydrogen mobility, a Memorandum of Understanding was signed between the Clean Energy Partnership (CEP) and the Scandinavian Hydrogen Highway Partnership (SHHP) in the course of the first international conference on hydrogen infrastructure and transport in 2013, in order to be able to advance the developments in the area of transport together.

Furthermore, collaboration with the Fuel Cell and Hydrogen Joint Undertaking (FCH JU) also successfully continued this year. In addition several bilateral meetings took place with partners from France, Denmark and Norway. For the first time a joint study trip was organised to Oslo in the areas of battery-electric mobility and fuel cell vehicles in cooperation with the AHK Norway.



JAPAN

NOW and NEDO (New Energy and Industrial Technology Development Organization) already signed a Memorandum of Understanding on mutual exchange of information back in 2010. On this basis, collaboration with Japan was continuously extended. In 2013 NOW represented Germany not only at relevant events and discussions in Japan, but also provided support for countless visits from Japanese companies and governmental organisations to Germany. As a consequence of the Fukushima catastrophe, Japanese firms' interest in hydrogen infrastructure has considerably increased. Germany is viewed as a centre of competence in this area and actively sought out as a partner.

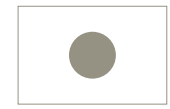
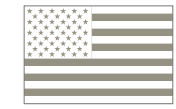
USA

The USA is an important cooperation partner for NOW. As in the previous year, NOW staff participated in the Annual Merit Review of the U.S. Departments of Energy's Fuel Cell Technology Program in May 2013. Cooperation between the Clean Energy Partnership (CEP) and the California Fuel Cell Partnership has been established and was also successfully continued in 2013.

CHINA

On the basis of the »Joint Communiqué on comprehensively promoting strategic partnership between the Federal Republic of Germany and the People's Republic of China«, signed in July 2010 by Federal Chancellor Angela Merkel and the Premier of the State Council of the People's Republic of China, Wen Jiabao, collaboration in the electromobility area was further deepened. A common declaration on cooperation in the areas of sustainable mobility, energy efficiency and emission reduction and innovative transport technology between the Federal Ministry of Transport, Building and Urban Development of the Federal Republic of Germany (BMVBS) and the Ministry for Science and Technology of the PR China (MOST) was signed by Minister Dr. Peter Ramsauer and Minister Prof. Wan Gang. In the course of this declaration many activities also took place in 2013 between the model regions Rhine-Ruhr, Bremen/Oldenburg and Hamburg and the corresponding partner cities Wuhan, Dalian and Shenzhen.



1. INTERNATIONAL WORKSHOP ON H_2 INFRASTRUCTURE AND TRANSPORTATION

In cooperation with the US Department of Energy, the Japanese New Energy and Industrial Technology Development Organization (NEDO), the European Fuel Cell and Hydrogen Joint Undertaking (FCH JU), the European Commission as well as the Scandinavian Hydrogen Highway Partnership (SHHP), NOW organised an expert workshop in June 2013 on the technical challenges of hydrogen refuelling station technology. Specifically, the international expert groups dealt with the implementation of certain refuelling protocols, hydrogen quality measurement, calibration of hydrogen during the refuelling process as well as with different parts and components of a hydrogen refuelling station. At the end of the year a public webinar took place, in which the results of workshops were presented in compact form. The large demand for the workshop as well as the high international participation in the webinar illustrates the need for international exchange in this area. For this reason more expert workshops followed by a public webinar for the broad dissemination of results will take place in future. The next workshops are already planned in the USA and Japan.

IPHE

The IPHE is a consortium of 17 member states and the European Commission with the goal of seeing through and advancing the commercialisation of hydrogen and fuel cell technologies. After a three-year period in office as chair of the International Partnership for Hydrogen and Fuel Cells in the Economy (IPHE), Germany handed this role over to Japan in May 2013. The USA and Germany continue to assume the tasks of vice-chair. In the course of the 19th Steering Committee Meeting in London, the extension of the IPHE was decided upon in a second phase until 2023. Following New Zealand's exit the IPHE was able to gain Austria as a new partner and welcome it as an official member in London. During the 20th Member Assembly in Fukuoka in 2013, an Educational Encounter and a workshop on »Commercial-ready Hydrogen Refuelling Stations – Design and Social Acceptance« took place. The **Educational Encounter** and the workshop drew great interest and a high number of visitors and provide the motivation to also further promote this format in future. During the 20th SC Meeting the **Terms of Reference** (TOR) for the second phase of the IPHE until 2023 were adopted. The goal is to establish a permanent secretariat for this purpose as soon as possible in order to be able to better address the growing tasks of the IPHE.

↗ More information on the IPHE can be found here: www.iphe.net

STRATEGIC PROGRAMME MANAGEMENT

THE ADVISORY BOARD

After more than five years running, the National Innovation Programme for Hydrogen and Fuel Cell Technology (NIP) can boast considerable success. The associated National Development Plan (NEP – Nationaler Entwicklungsplan) provides the guidelines for its implementation. It was developed by the Advisory Board and is regularly updated. In a subsequent phase from 2016, the implementation and the market launch of fuel cell technology in the stationary and mobile areas will form the focus of activities. This includes the setting up of the relevant charging and refuelling station infrastructure. Subsequently the NOW Advisory Board will, together with the programme organisation, integrate the new activities in the development plan in a timely manner.

According to the statute, the Advisory Board is composed of four representatives of the participating federal ministries: Transport and Digital Infrastructure (BMVI – Bundesministerium für Verkehr und digitale Infrastruktur), Economic Affairs and Energy (BMWi – Bundesministerium für Wirtschaft und Energie), Environment, Nature Conservation, Building and Nuclear Safety (BMUB – Bundesministerium für Umwelt, Naturschutz, Bau und Reaktorsicherheit) and Education and Research (BMBF – Bundesministerium für Bildung und Forschung), a coordinator of the federal states as well as representatives of all industry branches and research institutions related to the topic. After a maximum of three years, the members must be newly appointed. In 2013 this led to six new replacements. The Advisory Board's chairs and their representatives were re-elected for the new period.

Composed of the most important players from politics, industry and science, the Advisory Board discusses and defines the strategic orientation of the lighthouse projects as well as the relevant funding priorities. The market preparation of the new technologies should be approached in a holistic manner. The Advisory Board is accordingly involved to a considerable extent in the strategic management of the overall long-term innovation programme, the total budget of which amounts to around 1.4 billion euros until 2016. Projects with an overall budget of over one billion euros were initiated by the end of 2013.

An important task in 2013 was the preparation of a strategy paper, in which needs and core themes for the further development of the NIP beyond 2016 was outlined. The foundations for the further development of the NIP must be laid at the beginning of the new legislative period, in order to avoid losing out in international innovative competition.

The NIP general assembly is, aside from numerous NOW events, the central meeting of all stakeholders invited by the Advisory Board. Within a two-day conference, current projects were presented to 330 participants from the areas of mobility, stationary applications, special markets as well as hydrogen production.

THE ADVISORY BOARD IN DETAIL (SINCE OCTOBER 2013):

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

GOVERNMENT

BMVI: Stefan Schmitt (Vice-Chair)
BMWi: Dr. Georg Menzen (Advisory Board Chairman)
BMBF: Dr. Karsten Hess
BMUB: Alexander Folz
Representatives of the federal states: Stefan Gloger, Heinrich Klingenberg (without voting rights)

SCIENCE

Education: Prof. Jürgen Garche (Vice-Chair)
Research & Development Helmholtz Association: Prof. Ulrich Wagner
Research & Development Institutes/Universities: Prof. Alexander Michaelis

INDUSTRY / APPLICATION

Mobility – Passenger cars: Dr. Sabine Spell
Mobility – Commercial vehicles: Dr. Jürgen Friedrich
Domestic energy supply: Andreas Ballhausen
Industrial applications: Johannes Schiel
Specific applications:
Prof. Werner Tillmetz (Chair)
Fuel cell components manufacturing:
Dr. Uwe Maier

INFRASTRUCTURE

Fuel industry: Patrick Schnell
Hydrogen production: Dr. Oliver Weinmann
Hydrogen delivery: Markus Bachmeier
Network supply: Markus Seidel

The Advisory Board also advocated the continuation and support of international activities, such as the FCH JU, the H_2 Roadmap of the IEA or the IPHE. The work of the NOW can thus thematically and organisationally be linked first and foremost to the plans of the EU, USA, Japan and Korea.

Dr. Georg Menzen, BMWi (Chair)

Prof. Werner Tillmetz, ZSW (Chair)

CONTINUED DEVELOPMENT OF THE NIP

HYDROGEN AND FUEL CELL TECHNOLOGIES – KEY PILLARS OF THE ENERGY TRANSITION

THE ADVISORY BOARD

The transition of the energy system is occurring within a complex environment that is subject to energy-economic as well as industrial and climate-political framework conditions. Conflicts of goals arise here, for example between innovation risk and security of investment, business costs and economic benefit, which can be dissipated with goal-oriented interlinking of different technologies, as well as a cross-sector optimisation of the entire energy system. This challenge was answered with the initiation of the National Innovation Programme Hydrogen and Fuel Cell Technology (NIP) in 2006.

The first stage of proving the everyday suitability and technological marketability in vehicles and in the power and heat supply for buildings has been reached. Cars and buses with fuel cells have covered millions of kilometres under very different climatic and topographical conditions. From the 50 hydrogen fuelling stations planned in the first phase until 2015, over 20 are in operation. More than 500 fuel cell heating appliances have run reliably for over 4 million hours of operation. Its broad programmatic focus, the networking of different industry sectors as well as the implementation structure of the NIP over an independent programme organisation have proved their worth for the realisation of these goals. The long-term NIP support framework is regarded both in Europe and globally as a success model to be emulated.

Our task is now to organise the second stage to commercial market breakthrough. Over the past years businesses and governments worldwide have bolstered their investments in the development of hydrogen and fuel cell products. The remaining technical and economic challenges up to commercialisation are widely understood, though not all are overcome. In Germany many products and applications are nearing market readiness thanks to the common initiative of enterprise and politics. In order to minimise the market risks of the next phase up to market entry, the federal government will continue its successful involvement and adjust and supplement the current framework for research, development and demonstration projects with the aim of accelerating market introduction. To this end new initiatives and competitive instruments geared towards the important applications will be the focus, in order to achieve critical quantities of fuel cell heating appliances, fuel cell cars or buses. In the coalition agreement, the federal government is committed to the role of NOW for the implementation of fuel cell technology for stationary and mobile applications.

Representative of industry and research have tabled a paper in the NOW National Organisation for Hydrogen and Fuel Cell Technology Advisory Council on the continued development of the NIP. The strategy paper names the following goals for the respective markets with a view to 2025:

Emission-free mobility with fuel cells for electric vehicle drives and a comprehensive hydrogen infrastructure:

» more than 500 public hydrogen refuelling stations nationally,

» over half a million fuel cell passenger vehicles on the roads

» 2,000 fuel cell buses in scheduled operations within the public transport system

Hydrogen generation from renewable energies and integration in the energy system as a link between sustainable mobility and energy supply:

» electrolysers with 1,500 MW capacity for the generation of hydrogen from renewable energies

» definition and implementation of successful business models for power to gas

» development of hydrogen storage mechanisms to store renewable electricity

Fuel cells for stationary energy supply by using decentralised combined heat and power systems in the supply for households and buildings, industry and for a secure power supply such as for public safety communication systems, telecommunications:

» more than a half a million fuel cell heating systems in operation

» fuel cell combined heat and power systems with more than 1,000 MW in operation

» more than 25,000 secure power supply installations in place

In these application areas, a commercially sound market with around 30,000 new jobs, economic growth, as well as competitive cost structures in international business will be achievable by 2025.

In order to realise the remaining technical and economic optimisation potentials and thereby actively exploit the associated added-value chains in Germany, these areas should be accompanied by continual research and development. This is to be underpinned by suitable instruments for market activation to ensure good products are also taken up by the market.

»Decisive for long-term success is dependable, close cooperation between industry, research and government, which is fortified through a mutual, long-term strategy,« explains Prof. Werner Tillmetz, Chair of the NOW Advisory Council. »Over the past seven years, we could impressively demonstrate this and have thereby now laid the foundation for the second stage comprising the broad industrialisation of these technologies of the future.« In the area of hydrogen and fuel cell technology, Germany has achieved a leading international position due to the application and market-oriented support provided within the framework of the NIP. But other countries have also realised the significance that environmentally friendly energy has as a key for the prosperity and well being of future generations. Asian and North American competitors have already developed highly dynamic domestic markets in fuel cells and are now beginning to tap into the international market. For example, thousands of fuel cell vehicles are coming onto the roads in the Far East over the coming years. In Japan there were already 40,000 fuel cell heating systems installed in 2013. In the USA there are 500 fuel cell systems for power and heating with several hundred megawatts installed capacity in operation. Upon this backdrop, the continuation of support for hydrogen and fuel cell technology is not only imperative for reasons of climate policy but also as due to its important contribution in ensuring that Germany remains a leading industrial centre into the future.

2013

1 ANNUAL REVIEW OF EVENTS 2

21 JANUARY 2013
ELECTROMOBILITY IN DUSSELDORF:

The E-Carflex Business project begins in Dusseldorf. Supported with 2.24 million euro from BMVI funding, a pool of 31 vehicles is acquired, including the latest models such as the E-Smart, Citroën C-Zero and the Mitsubishi I-MiEV. After an initial phase for exclusively business use, the new electric cars can also be rented by staff members of the project participants outside business hours and at weekends. In the subsequent project phase the electric vehicles will be made available to all citizens of Dusseldorf. To this end the existing 40 charging poles in the Dusseldorf urban area will be supplemented by 30 additional charging stations.

23 JANUARY 2013
STAUFERLAND ELECTRIFIED:

The goals of Emis – Electromobility in the Stauferland, are to strengthen electromobility in the rural area and in a topographically challenging area. A total of 20 electric cars and two hybrid waste collectors will be deployed in the two medium-sized cities of Gmünd and Göppingen. At the same time there is also potential for the deployment of a further 60 electric vehicles by private users. An infrastructure of 30 charging stations will be created for the fleet.

Dr. Veit Steinle, Director-General at BMVI, presents his Ministry's funding grant of 1.9 million euro to Richard Arnold (Mayor of Schwäbisch Gmünd) and Guido Till (Mayor of Göppingen).

14 FEBRUARY 2013
SEVEN AT ONCE:

The presentation of the funding grants by Dr. Veit Steinle, BMVI signalled the starting shot for seven demonstration schemes in the Rhine-Main Electromobility Model Region. With 17 different partners, the schemes comprise different projects, but all focus on the establishment of fleet solutions in electromobility – from implementation of intelligent booking options for electric vehicles for leisure and event transport, to the development of a mobility management system for in-house electric car fleets. The BMVI is funding these projects with a total of around 10 million euro.

18 FEBRUARY 2013
CABLE-FREE:

Rainer Bomba, BMVI State Secretary presents a funding grant for 3.3 million euro to the PRIMOVE Mannheim project at the VDV conference »Electric buses – market of the future?« in Berlin.

In the research project electric buses will be recharged cable-free when passengers alight and board at bus stops.

Rhine-Main Electromobility Alliance

20 FEBRUARY 2013
HYDROGEN FROM BIOMASS:

NOW presents methods and technologies for preparing hydrogen on the basis of biomass at a specialist workshop. Dr. Klaus Bonhoff, Managing Director (Chair) at NOW says: »The transport sector must be decarbonised in the long-term. Different technologies will be drawn upon to achieve this. Automotive manufacturers will launch hydrogen-operated vehicles commercially. Biomass provides a way of generating hydrogen from renewable energy. With this study (Hy-NOW: Evaluation of the methods and technologies for the provision of hydrogen on the basis of biomass) we want to take a closer look at this generation path and its potential.«

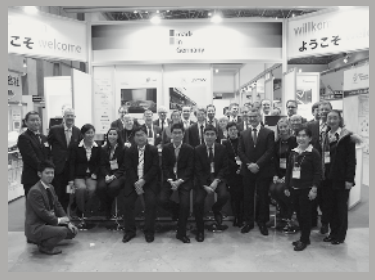
Link to the study (German language version only):
http://www.now-gmbh.de/de/publikationen.html

21 FEBRUARY 2013
LEARNING FROM ONE ANOTHER:

The aim of the EU-funded scheme ene.feld is to install up to 1,000 micro combined heat and power systems (CHPs) in European homes. In order to benefit from the experiences that the German fuel cell-based micro CHP system sector has gathered, project partners exchange experiences with participants of the NIP lighthouse project Callux at a meeting in Berlin.

27 FEBRUARY – 01 MARCH 2013
THE VIEW BEYOND THE HORIZON:

The FC Expo in Tokyo is the world's largest conference with a hydrogen and fuel cells fair. NOW participates at the German common exhibition stand. Dr. Klaus Bonhoff, NOW, emphasises in his keynote speech the role of the NIP for hydrogen and fuel cell technology in Germany.



2013

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11 MARCH 2013
INTELLEGENTLY NETWORKED:

The aim of the BodenseEmobil project in Friedrichshafen is to improve the local public transport system through an intelligent networking of electric cars into the public transport system, in the energy grid and the vehicles with each other by means of modern information and communications technology. The bridging of the so-called »last mile« is also a focus, such as the development of intermodal transport chains by public transport on rail, road, water and air. Project partner Deutsche Bahn is providing up to 30 electric cars for the implementation. In addition 40 charging poles will be constructed by the city and the Lake Constance district (Bodenseekreis).

Presentation of the funding grant for 3.6 million euro to the partners of the BodenseEmobil project

14 MARCH 2013
SELF-SUFFICIENT:

In Stuttgart the test operation of the first hydrogen refuelling station in Southern Germany officially begins. Hydrogen will be produced on site by electrolysis. The EnBW research fuelling station is funded under the NIP.

Patrick Schnell (CEP Chairman), Dirk Inger (Deputy Director-General BMVI) and Franz Untersteller (Environmental Minister Baden-Württemberg) at the commissioning

12 MARCH 2013
IN GOOD CONSCIENCE:

People are ready for the hydrogen car – that is one of the central findings of the NOW-commissioned study: »HyTrust – acceptance of hydrogen in society«. According to the results of the study, in which more than 2,500 citizens were surveyed about their opinion on hydrogen and fuel cell technology in the mobility sector, three out of four of those surveyed expect to be able to buy a hydrogen car within the next ten years. Link to the study (German language version only):

http://www.now-gmbh.de/de/publikationen.html

hytrust

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18 MARCH 2013
SUSTAINABLE TRAVEL:

Electromobility and tourism

The topic of sustainability is also continuing to grow in importance in the tourism sector. Two projects take account of this development. In the north of the state of Hesse, the project »FREE – Leisure and event transport with intermodal bookable electric vehicles« begins, in which the local public transport sector is supplemented by an electric bus, 18 electric cars, two KVG electric mobile workshops as well as 40 e-bikes over the coming two and a half years.

In the »EMOTIF – electromobility in Thuringia« project eight electric vehicles are available for tourists at the train stations in Eisenach, Erfurt, Weimar and Jena, in order to facilitate visiting the local attractions that are in part, poorly connected to local public transport.

08 APRIL 2013
MEETING POINT:

NOW attends the HMI for the fifth time. Visitors inform themselves at the hydrogen and fuel cell group exhibit. In addition NOW supports the stand of the Federal Government on the topic of electromobility in the framework of MobilTec with exhibits from the model regions.

NOW at the hydrogen and fuel cell group exhibit

Dr. Klaus Bonhoff at the group exhibit's public forum

The NOW currywurst reception is now almost a real tradition at the HMI

2013

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27 APRIL 2013
DOUBLE REACH:

High reach: fuel cell vehicles and the basketball players from Alba Berlin

For the winners of NOW's Facebook campaign there are two highlights: after a trip with the fuel cell vehicles of the Clean Energy Partnership's partners TOTAL and Volkswagen, it's off to the semi-final of Alba Berlin against BBC Bayreuth.

With Sven Schultze, Captain of the Albatrosses, on the court

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02 MAY 2013
HAND IN HAND:

At the official launch event of »Hamburg – economy on the current« (Hamburg – Wirtschaft am Strom), representatives from the federal government and the Hamburg Senate, as well as project partners from industry, science and administration, present the largest nationwide fleet project to date in the Automuseum Prototyp of the port city. Hamburg companies and municipal institutions demonstrate how uncomplicated, efficient and profitable for industry and the environment the changeover to electric cars can be. The goal is to deploy up to 740 electric vehicles to companies of all sectors and sizes as well as to public authorities, state offices and municipal companies.

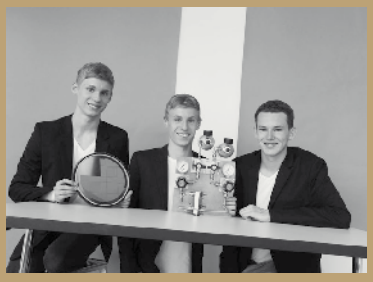
Launch event of ›Hamburg – economy on the current‹

19 MAY 2013
GREEN HORSEPOWER:

Under the slogan »Green hp«, NOW is partner of the Oseander race at the racetrack in Hoppegarten

6

01 JUNE 2013
PRIZEWORTHY:



Since 2011 NOW annually endows the Youth researches special prize: »Hydrogen, fuel cell and battery-electric drives« on federal state level. The prize is remunerated with 250 euro.

04 JUNE 2013
HYDROGEN AS A STORAGE MEDIUM:

Under the motto »Hydrogen as an efficient and clean storage medium«, experts from politics, science and industry meet at the fuel cell forum in Frankfurt. NOW participates with a stand at the accompanying exhibition and informs visitors about the activities of the federal government.

Hessian State Minister for the Environment, Energy, Agriculture and Consumer Protection Lucia Puttrich at the NOW stand

10 JUNE 2013
GREENER AIRPORT:

Frankfurt airport is facing the challenges of the future: With the electromobility project »Green aircraft handling – e-port«, handling emissions will be decreased through the use of electromobile vehicles. For this, the project receives the »lighthouse« grade of the federal government. At present already around ten percent of fleets are electrically operated, including special vehicles for aircraft handling. With BMVI funding of 8.1 million euro, this portion is to be increased further.

2013

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17 / 18 JUNE 2013
HYDROGEN AND FUEL CELL STATE OF PLAY:

The regularly-held NIP general assembly is the occasion to report in a detailed way on projects in the individual programme areas with the relevant industries and the public. The NOW Advisory Board Chair Prof. Dr. Werner Tillmetz from the Centre of Solar Energy and Hydrogen Research takes stock of the situation: »NOW has positioned itself excellently for the strategic management of hydrogen and fuel cell basis innovations. Germany has received international acclaim for the NIP and its implementation and we are able to say that this is a successful cooperation model of all stakeholders to meet the great challenges of market preparation.«

Musical entertainment at the evening reception under the open sky

The participants in the plenum: Dr. Marc Zoellner, Managing Director of Hoppecke GmbH, Andreas Ballhausen, Management Board of Ceramic Fuel Cells B.V., Dr. Klaus Bonhoff, Managing Director (Chair) of NOW, Prof. Herbert Kohler, Head of Company Research and Sustainability, Chief Environmental Officer of Daimler AG, Veit Steinle, Federal Ministry of Transport and Digital Infrastructure (BMVI), Presenter Jürgen Pfeiffer, Prof. Werner Tillmetz (ZSW), Chair of the NOW Advisory Board and Dr. Georg Menzen (BMWi), Chair of the NOW Advisory Board

About 350 conference participants take this opportunity – 55 talks were given about NIP projects over two days.

Representatives from politics and industry at the NIP general assembly

2013

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24 JUNE 2013
TOPPING-OFF CEREMONY:

Enak Ferlemann, Parliamentary State Secretary at the Federal Ministry of Transport and Digital Infrastructure, Olaf Scholz, Mayor of Hamburg, and Matthias Boxberger, Chairman of E.ON Hanse AG, together turned the first sod at the power to gas facility in Reitbrook. The facility will convert wind electricity into hydrogen by means of so-called PEM electrolysis and feed it directly into the natural gas network. This technology will solve two key challenges of the energy changeover: the lack of storage media for renewably-generated electricity and the capacity bottlenecks in the electricity grids.

E.ON's power to gas facility is funded through the NIP with 6.5 million euro.

24 JUNE 2013
INTERNATIONAL:

NOW, the Department of Energy (USA) and NEDO (Japan) invite trade experts from industry to a joint workshop. The topic is hydrogen infrastructure and transport. The goal of the international workshop is the exchange of knowledge and practical experience that has been gathered in the market preparation projects in these countries.

7

19 JULY 2013
EXEMPLARY:

With the inauguration of innovative energy and charging management, the metropol-E project moves into its next phase. For the first time a system for fleet management of electric vehicles in combination with locally-generated solar energy will be tested in the scheme. The innovative storage solution facilitates the use of decentrally-produced eco-electricity for the electric vehicles fleet. The energy management system of the project thus promotes energy independence and relieves the burden on the local distribution network.

BMVI funds the metropol-E project with four million euro under the Electromobility Model Regions.

8

24 AUGUST 2013
COME ON IN:

Under the heading »Invitation to a state visit«, the Federal Transport Ministry opens its doors and allows citizens to take a look behind the scenes of the federal ministry. NOW is represented with an exhibition stand and together with the Clean Energy Partnership and the project network BeMobility, offers test drives with fuel cell and battery vehicles.

24 AUGUST 2013
DISTINGUISHED:

NIP-funded projects win in the energy and aviation categories.

At the GreenTec awards, Europe's largest environmental gala, two companies with projects funded by NIP are awarded prizes: CFC with the BlueGEN microgenerator based on fuel cells and Airbus with a multifunctional fuel cell system for the generation of electricity and heat in ground operation of airplanes.

2013

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19 SEPTEMBER 2013
WIND-HYDROGEN:

Substation with innovation project RH_2-Werder/Kessin/Altentreptow

Promptly coinciding with the beginning of autumn, the demonstration and innovation project RH_2-Werder/Kessin/Altentreptow (RH_2-WKA) is launched with the celebratory commissioning of the substation. What is special about the wind park is its double function as supplier and storer of energy: in this way the wind energy facilities supply clean electricity for around 125,000 households, and at the same time electricity without carbon dioxide emissions can be stored through the installed wind-hydrogen system. This development work on sustainable electricity storage is funded by the BMVI with approx. 4.5 million euro.

30 SEPTEMBER 2013
COMPREHENSIVE COVERAGE:

H_2 Mobility – With the signing of a basic agreement, six partners of the H_2 Mobility Initiative – Air Liquide, Daimler, Linde, OMV, Shell und TOTAL – have come to an agreement on a concrete action plan for the set-up of a nationwide hydrogen refuelling station network for fuel cell vehicles. By 2023 the public hydrogen infrastructure in Germany will be expanded to around 400 refuelling stations. In this way a demand-driven supply of electric vehicles with fuel cells – which are to come onto the market over the next few years – will be guaranteed.

Demand-driven expansion of hydrogen refuelling stations
The NOW website »H_2 – Approval Guidelines« goes online. The website offers assistance to applicants and authorising bodies.
Link to the website:
http://www.h2-genehmigung.de/

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04 NOVEMBER 2013
INDUSTRY DIRECTORY:

With the official launch event in the Permanent Representation of Lower Saxony in Berlin, the nationwide competence atlas for hydrogen, fuel cell and battery technologies BUKA goes online. BUKA provides profiles of companies, research institutions and service providers from the areas of sustainable mobility, efficient electricity and heat provision as well as infrastructure and storage technologies for renewable energies.

BUKA
BUNDESWEITER KOMPETENZATLAS
für Wasserstoff-, Brennstoffzellen- und Batterie-Technologien

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02 DECEMBER 2013
CEP GROWS:

Stuttgarter Straßenbahnen AG (SSB) officially joins the Clean Energy Partnership (CEP), the most important project for testing the everyday suitability of hydrogen mobility in Europe. The contribution of the SSB to the CEP will initially be the deployment of three latest-generation hydrogen buses on a bus route in Stuttgart.

Following the admittance of the SSB to the CEP, with Dr. Veit Steinle (BMVI), Mayor of Stuttgart Fritz Kuhn, Patrick Schnell (Chairman of CEP, TOTAL Deutschland GmbH)

HYDROGEN REFUELLING STATIONS: PUSHING AHEAD NETWORK EXPANSION

Auto Bild .de
www.autobild.de

Six companies intend to establish a total of 400 hydrogen refuelling stations within ten years. 100 of these within four years.

14 October 2013 / By Stephan Bähnisch

Things are moving ahead in the expansion of the hydrogen refuelling station network: the six partners of the so-called »H_2 Mobility« initiative – Air Liquide, Daimler, Linde, OMV, Shell and Total – have agreed on a plan of action for the expansion of the national hydrogen refuelling station network for fuel cell vehicles. The public hydrogen infrastructure in Germany is to increase from the current 15 stations to around 400 by the year 2023. The first 100 hydrogen stations are earmarked to be operational within the next four years. The companies intend to invest a total of 350 million euros for this purpose.

According to the initiators, this ensures »a demand-oriented supply of energy for fuel cell electric vehicles«, as long as the required approvals are granted. The new refuelling pumps will not only be set up in metropolitan areas and main arterial roads but will also ensure a reliable supply of hydrogen in rural areas. The goal is to establish a hydrogen refuelling station at least every 90 km of motorway between metropolitan areas. According to the plan, a minimum of ten hydrogen refuelling stations will be available in each metropolitan region by 2023. Only the corresponding cars are now missing. But if you believe what the founders of the joint venture say, first manufacturers have announced the commercial introduction of fuel cell vehicles on the German market for 2015. Mercedes has been preparing a fuel cell vehicle for series production over many years and has several B-Class test vehicles on the roads, while Toyota is also working on market-ready hydrogen vehicles.

↗ **Source:** www.autobild.de/14.10.2013

Süddeutsche Zeitung

Heat and Power from the Boiler Room

07 February 2013 / By Ralph Diermann

US economist Jeremy Rifkin pronounced that the technology will »herald in a new energy era«. Then the noise on the topic of fuel cells died down for quite some time. Now, the breakthrough might just be at the doorstep.

Ten years ago, US economist Jeremy Rifkin proclaimed the dawning of the »Hydrogen Economy«: one day, millions of decentralised fuel cell systems would break the stronghold of the energy companies. Hydrogen reacts with oxygen in fuel cells to produce power, with water and heat being by-products.

The technology will »herald in a new energy era«, is what Rifkin pronounced. Then the noise on the topic of fuel cells died down for quite some time. Wind farms and solar energy plants were in the limelight and revolutionising the production of energy.

But now, the breakthrough just might be at the doorstep – taking a detour through the home's boiler room: several companies are currently developing fuel cell heaters for houses and apartment blocks. Manufacturers and energy suppliers are examining their suitability for day-to-day use and reliability in field tests being conducted in 300 buildings across Germany.

»Overall, the experiences made so far have been very good,« says Project Coordinator Werner Tillmetz from Germany's Zentrum für Sonnenenergie- und Wasserstoff-forschung Baden-Württemberg (ZSW – Centre for Solar Energy and Hydrogen Research Baden-Württemberg).

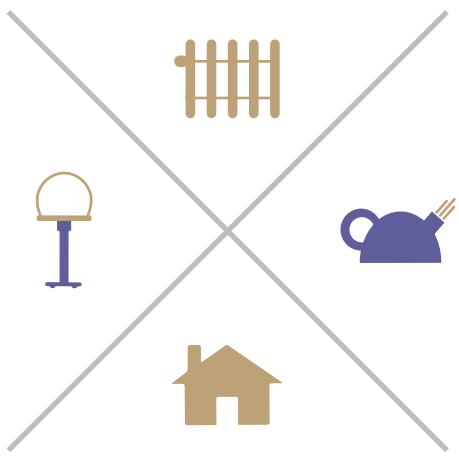
The use of fuel cells for heating purposes initially sounds absurd as the devices are chiefly designed to produce power. But they are not intended to replace the normal heater, rather compete with so-called combined heat and power plants that are available for detached houses. Here, a motor that is usually run on natural gas uses a generator to produce electricity that can either be utilised in the house or fed into the electricity grid.

Heat is also a by-product in these systems and can be stored in a tank and later used by the home residents. Fuel cell-based systems work similarly. Many produce the required hydrogen autonomously from natural gas. Yet per cubic metre they produce more electricity and less heat.

»The plants are extremely efficient, boasting an electrical efficiency of 40 to 60 percent,« explains Tillmetz. The remainder is almost entirely transformed to heat. In contrast, plants with a gas motor available today convert only around 25 percent of the energy into electricity.

More power from the same amount of natural gas: that's what makes the fuel cell a striking candidate for the virtual power plants that some energy suppliers are currently trialling. Many combined heat and power plants can be connected together. This lets energy companies offset shortfalls in the power supply, due to, for example, lulls in wind at wind farms, by switching on the mini power plants remotely from a command control centre and feeding the required electricity into the grid. High prices can be obtained on the market for such balancing energy.

The higher the electricity yield of each plant, the lower the likelihood of the connected heat tank overflowing and having to disconnect from the network.



COMMENCEMENT OF SERIES PRODUCTION MUST FIRST SUCCEED

Yet turning this into reality is still a long way off. Manufacturers must first succeed in commencing series production. »Another three to five years will almost certainly pass before the first mass produced products will be available on the market,« explains Jochen Paulus, Head of Fuel Cell Development at Vaillant. The prices should also fall to competitive levels over this period.

Today the devices – which are virtually handmade and produced in small numbers – still cost several ten thousands of euros. »As with all innovations, the costs reduce from one developmental generation to the next,« says Managing Director of the National Organisation for Hydrogen and Fuel Cell Technology, Klaus Bonhoff. The establishment of a supplier industry with competing providers will further help to reduce costs.

Meanwhile, ZSW researcher Werner Tillmetz is asking for government assistance to support the market introduction. »We often find it difficult in Germany to industrialise emerging new technologies. Enough such examples exist in the areas of information technology and mobile communications. We must do what we can to ensure this same fate is avoided in the area of fuel cells.«

↗ www.sueddeutsche.de/wissen/brennstoffzellen-waerme-und-strom-aus-demheizungskeller-1.1594029

Source: SZ; 07 February 2013/mcs

Hydrogen Takes Off

BIZZ energy today, October 2013

Hydrogen refuelling station expansion of network announced

Auto Bild, October 2013

Mobility of the future: Electric vehicles the most environmentally friendly

WiWo Green, December 2013

New Electro

Tagesspiegel, December 2013

The Fuel Cell Comes of Age

Stuttgarter Zeitung, September 2013

600 new charging stations for electric vehicles

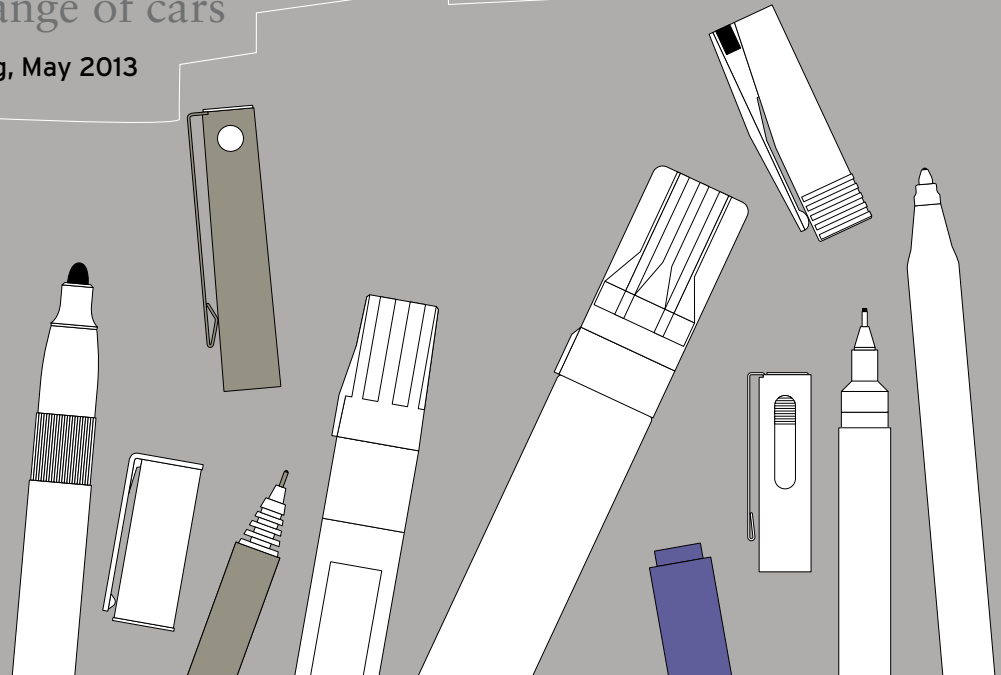
BZ, December 2013

Hydrogen – the magic for energy storage

Die Welt, September 2013

Electromobility – more than a mere change of cars

Greenmotorsblog, May 2013



s:

The Future of Mobility – Tomorrow is Electric

auto.de, March 2013

Heating: Fuel cells supply households

WiWo Green, January 2013

Wave

Hydrogen Cycling on the Horizon: The Fuel Cell Pedelec

Handelsblatt, September 2013

400 Hydrogen Refuelling Stations – Alliance Reveals Plans for Refuelling Network by 2023

Tagesspiegel, October 2013

One Million Electric Vehicles by 2020: Merkel Remains Committed to Goal

Frankfurter Allgemeine Zeitung, May 2013

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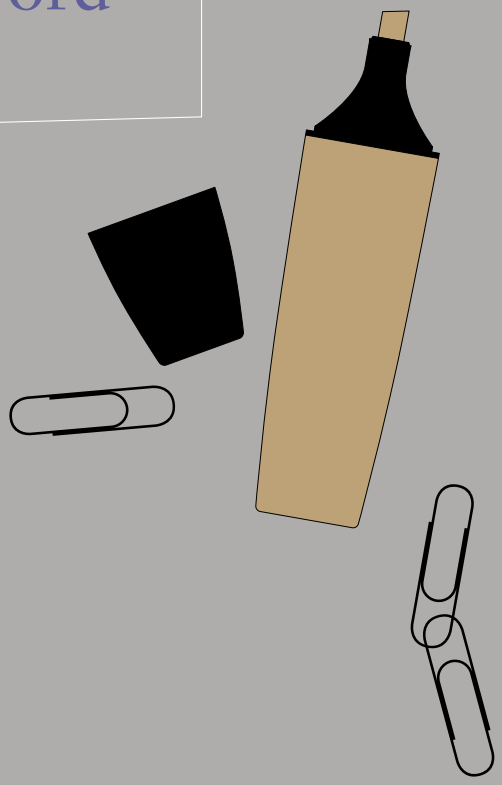

New vehicles, more refuelling stations: hydrogen comes of age

Tagesspiegel, October 2013

Trend researchers anticipate imminent breakthrough of e-vehicles

Zeit Online, October 2013

Funding by:

Federal Ministry
of Transport and
Digital Infrastructure

following a resolution by
the German Bundestag

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NOW coordinates the National Innovation Programme Hydrogen and Fuel Cell Technology of the federal government and the Electromobility Model Regions of the BMVI.

The following provides detailed information of projects newly approved in 2013 as well as those concluding in 2013.

Federal Ministry
for Economic Affairs
and Energy

THE FOLLOWING BMWI NIP PROJECTS WERE APPROVED IN 2013:

PROJECT	COMMENCEMENT	CONCLUSION
Small appliances programme II	01 March 2013	31 August 2014
HyMotion5	01 August 2012	31 July 2016
KOSEL	01 June 2013	31 July 2014
SealS	01 March 2013	29 February 2016
Hymod	01 May 2013	30 April 2016
ELGA	01 September 2013	31 January 2015
Optigaa 2	01 October 2013	30 September 2016
HEMCP	01 June 2013	30 September 2014
MinimAI-Luft	01 July 2013	30 June 2016
STEP	01 October 2013	30 September 2016

PARTNERS	FUNDING RATIO [%]	FUNDING BUDGET [€]
Dorstener Drahtwerke H. W. Brune & Co. GmbH	60	97,428
Volkswagen AG	48	2,507,913
Umicore AG & Co. KG	48	1,798,355
Freudenberg FCCT SE & Co. KG	48	1,809,672
ElringKlinger AG	48	1,029,004
KERAFOL Keramische Folien GmbH	50	126,080
Karlsruher Institut für Technologie (KIT)	100	398,203
Fraunhofer-Gesellschaft zur Förderung der angewandten Forschung e. V.	80	607,404
ElringKlinger AG	46	518,426
Bayerische Motoren Werke AG	45	1,646,270
Industrieanlagen-Betriebsgesellschaft mbH	45	537,038
P + Z Engineering GmbH	45	441,984
Technische Universität München	75	240,311
Deutsches Zentrum für Luft- und Raumfahrt e. V. (DLR)	75	860,041
Fraunhofer-Gesellschaft zur Förderung der angewandten Forschung e. V.	100	738,375
Hexis GmbH	50	89,343
Freudenberg FCCT SE & Co. KG	50	380,680
Daimler AG	50	433,506
Math2Market GmbH	50	37,500
Fraunhofer-Gesellschaft zur Förderung der angewandten Forschung e. V.	70	286,871
Technische Universität München	90	265,068
Zentrum für Sonnenenergie- und Wasserstoff-Forschung Baden-Württemberg (ZSW)	90	477,173
Helmholtz-Zentrum Geesthacht Zentrum für Material- und Küstenforschung GmbH	100	732,000
Fraunhofer-Gesellschaft zur Förderung der angewandten Forschung e. V.	70	420,434
ElringKlinger AG	50	622,431
Forschungszentrum Jülich GmbH	100	1,060,907

NIP – TRANSPORT AND INFRASTRUCTURE

ALL PROJECTS ARE MARKED WITH I / 01 – I / 14 ON THE FOLLOWING PAGES,
COMPLETED PROJECTS ARE MARKED WITH 🏁.

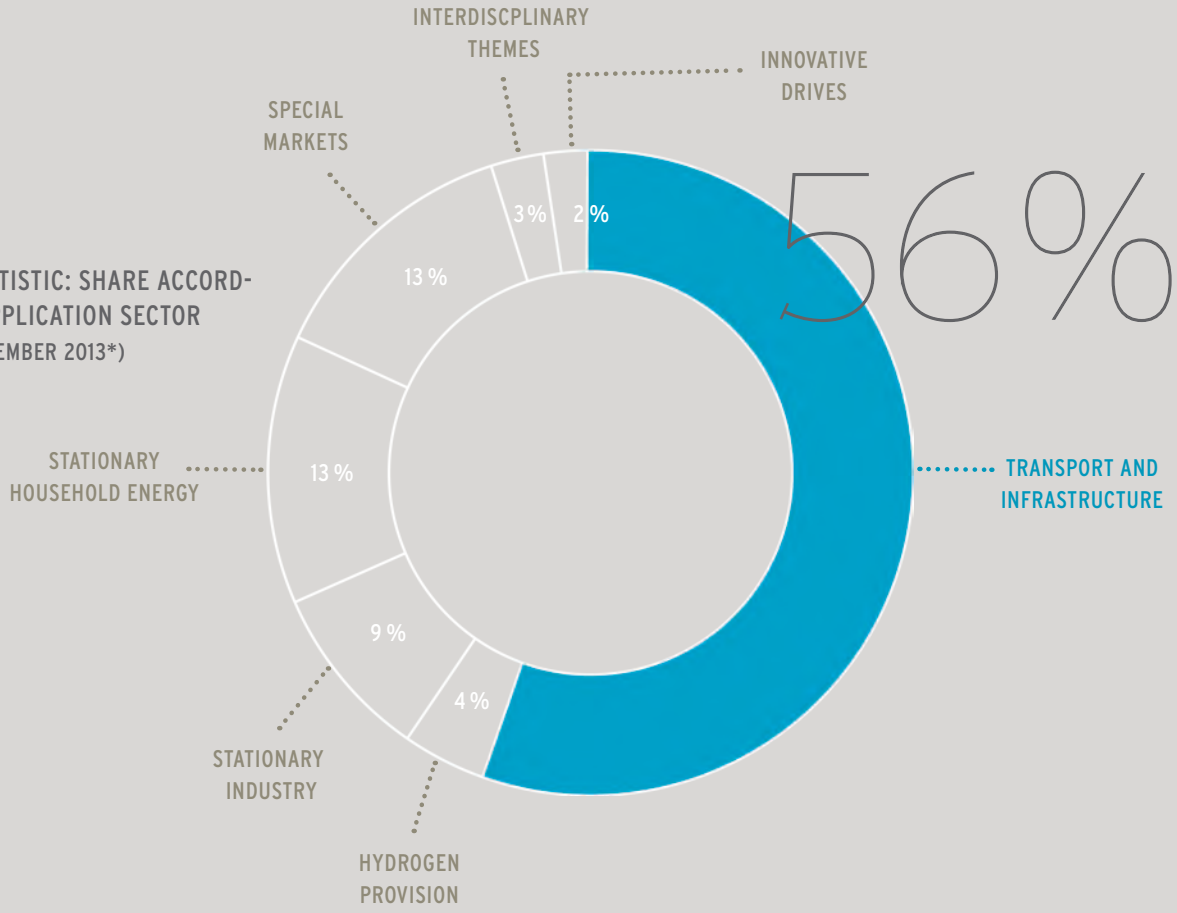
NIP – TRANSPORT AND INFRASTRUCTURE

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.

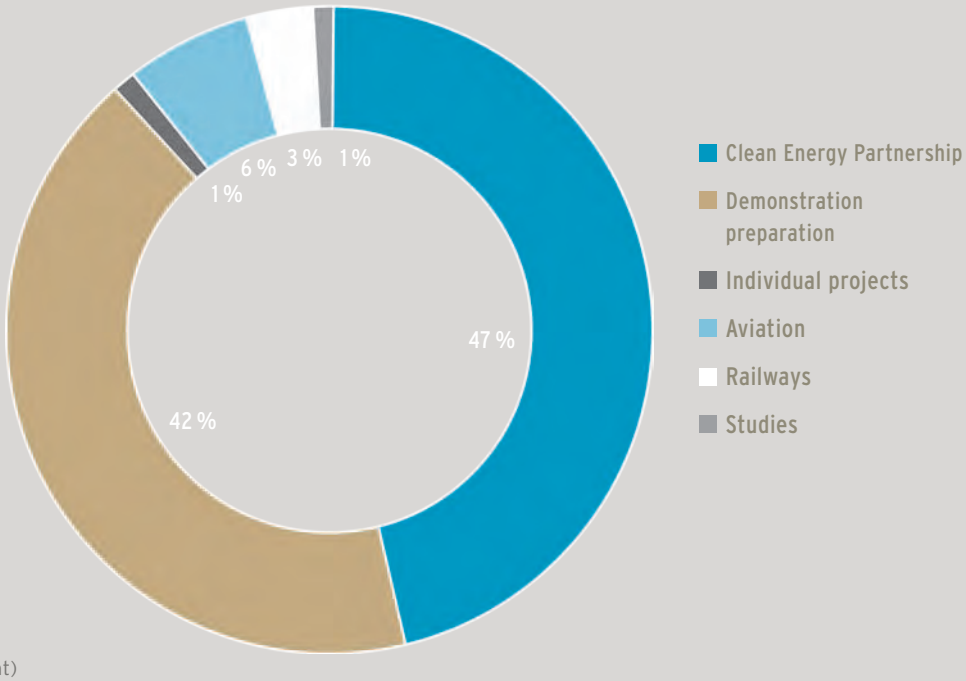
In terms of vehicles, its scope extends from R&D activities to fuel cell drives for cars and buses and the on-board power supply for various transport applications such as aircraft. Complete drive systems and key components such as polymer electrolyte membrane fuel cells (PEMFC) and the storage of hydrogen 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 infrastructure, the focus 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 and infrastructure concerns demonstration projects that can validate the implemented technology under everyday conditions and prepare the market by increasing user acceptance. To enable this, NOW initiates and coordinates comprehensive accompanying research activities. Furthermore, hydrogen-run fuel cell vehicles are being tested in comprehensive collaborative projects spanning both personal transportation and local public transport applications across several key regions, which also encompasses trialling the filling station infrastructure.

NIP – STATISTIC: SHARE ACCORDING TO APPLICATION SECTOR
(AS AT DECEMBER 2013*)



NIP – TRANSPORT AND INFRASTRUCTURE: ALLOCATION BY APPLICATION AREA
(AS AT DECEMBER 2013)



* The diagram incorporates projects at planning stage at NOW, being processed by PtJ, LOI (Letter of Intent) as well as those approved.


WOB HY 301

The Clean Energy Partnership (CEP) takes a holistic view of hydrogen mobility and develops solutions spanning the areas of sustainable hydrogen production, the development of the hydrogen infrastructure network and the use of hydrogen in vehicles.

HYDROGEN ON THE MOVE – CLEAN ENERGY PARTNERSHIP (CEP)

PRACTICAL TESTS OF HYDROGEN AS A FUEL

Fuel cell vehicles provide the possibility to enjoy virtually emission free mobility without restrictions in range. The Clean Energy Partnership (CEP) takes a holistic view of hydrogen mobility and develops solutions spanning the areas of sustainable hydrogen production, the development of the hydrogen infrastructure network and the use of hydrogen in vehicles. Since 2002, the demonstration project has provided a platform for companies to conduct joint research and development on hydrogen mobility. In 2008, the CEP became a lighthouse project of the National Innovation Programme Hydrogen and Fuel Cell Technology (NIP) and has now progressed to become Europe's most important demonstration project in the area of hydrogen mobility.

The CEP entered its third and final project phase in 2011, which is to conclude in 2016 with market preparation. The wide scale operation of hydrogen vehicles and the expansion of the refuelling station network is the current project focus. The CEP vehicle fleet has together travelled some two million kilometres since 2005 – free of any noteworthy incidents. Among the approx. 100 fuel cell vehicles currently on the road within the project are the following models: Mercedes-Benz B-Class F-CELL, Ford Focus Fuel Cell, Honda FCX Clarity, Toyota FCHV-adv, Opel HydroGen4, VW Tiguan HyMotion and Audi Q5 HFC. In addition, two Hyundai ix35 Fuel Cell vehicles joined the CEP fleet mid 2013.

HYDROGEN BUSES FOR STUTTGART

Stuttgart public transport authority Stuttgarter Straßenbahn AG (SSB) joined the CEP as a new partner at the end of 2013. Three latest-generation Citaro FuelCELL hybrid buses from Mercedes-Benz are going into regular scheduled service there. Testing of the buses will take place within the framework of the CEP. »We are delighted to welcome another partner from the area of public transport that will also contribute to the dialogue and exchange of experiences on the deployment of fuel cell technology in buses,« said CEP Chairman Patrick Schnell at the accession ceremony that took place in the Stuttgart Town Hall. »We now can make a direct comparison within the project between the deployment in cities that feature different topography and infrastructure.« At CEP partner Hochbahn in Hamburg, buses with an identical construction have already been in service for two years.

Together with the SBB, the partnership now counts 18 companies, which include technology, mineral oil and energy companies as well as the majority of leading car manufacturers and local public transport providers. Only through practical tests such as those being conducted as part of the CEP and other NIP projects, can real insights into the suitability of the technology for everyday use be obtained. The buses in Stuttgart also benefit from 3.2 million euros of funding made available within the framework of the NIP. This amounts to around 50 percent of the total cost of the project, which is scheduled to run for three years.

INTERNATIONAL COOPERATION FOR FUEL CELLS

In order to establish itself successfully in the market, fuel cell technology must be made available at a competitive price. Fuel cell system costs could already be reduced in the CEP by 90 percent. But further reductions in price are still necessary. Leading car manufacturers forged international alliances for hydrogen and fuel cell technology in 2013. BMW and Toyota, Daimler, Ford and Nissan as well as GM and Honda are together developing the next generation of fuel cell systems. By standardising development and increasing the production volume, the goal is to achieve economies of scale and therefore reductions in costs.

Things are moving toward market preparation in the area of refuelling station technology, too. The Federal Transport Ministry and leading industrial firms agreed on the expansion of Germany's refuelling station network in June 2012. A national network of 50 publically accessible hydrogen refuelling stations is to be in place

by the end of 2015. This will make Germany one of the world's first countries with a basic national supply network. The partners of the H_2 Mobility Initiative will continue this expansion and announced that the network will count around 400 stations in 2023. Ensuring the expansion of the network does not stop at the national border, international cooperation between the Scandinavian Hydrogen Highway Partnership (SHHP) and CEP was revealed at the International Workshop on H_2 Infrastructure and Transportation, which was organised by NOW in 2013. The goal: to coordinate and accelerate market preparation of hydrogen and fuel cell technology in the area of mobility and to extend the infrastructure corridor into Scandinavia.

For more information on the CEP, please visit
www.cleanenergypartnership.de

H_2 MOBILITY INITIATIVE

400 HYDROGEN REFUELLING STATIONS BY 2023 – LEADING COMPANIES AGREE ON ACTION PLAN FOR THE EXPANSION OF THE HYDROGEN REFUELLING STATION NETWORK IN GERMANY

Fuel cell powered electric vehicles can make a significant contribution for establishing Germany as the lead market for sustainable mobility solutions and efficient technologies. A prerequisite for the commercial introduction of fuel cell powered electric vehicles is, however, a nationwide network of hydrogen refuelling stations. With the establishment of the cross-industry H_2 Mobility Initiative, leading industrial enterprises committed themselves in 2009 to expand the hydrogen infrastructure. Germany has now come a further step forward in this regard: The six partners in the H_2 Mobility initiative – Air Liquide, Daimler, Linde, OMV, Shell and TOTAL – have established a specific action plan for the construction of a nationwide hydrogen refuelling network for fuel cell powered electric vehicles. By the year 2023, the current network of 15 refuelling stations in Germany's public hydrogen infrastructure shall be expanded to about 400. As a first step, the deployment of 100 hydrogen stations in Germany over the next four years is intended. This ensures that a needs-related supply for fuel cell powered electric vehicles is introduced into the market over the next years. Representatives of all the partners involved have signed an agreement in principle.

In addition to plans for a nationwide refuelling station network, the agreement includes the principles for the procurement and distribution of the necessary hydrogen. Following the foundation of a joint venture, gradual expansion of the national refuelling station network will commence in 2014. This means that a supply of hydrogen suitable for everyday use shall be created not only for densely populated areas and main traffic arteries, but also for rural areas. The objective is to offer a hydrogen station at least every 90 kilometres of motorway between densely populated areas. According to this plan, drivers of fuel cell powered vehicles in metropolitan areas will have at least ten hydrogen refuelling stations available from 2023. Thus zero tailpipe emission hydrogen mobility is becoming increasingly attractive for customers. The H_2 Mobility Initiative anticipates a total investment of around 350 million euros for this future-oriented infrastructure project.

First manufacturers have announced the commercial launch of fuel cell powered production vehicles on the German market for 2015. In addition to attractive purchase and operating costs for the vehicles, a need-related number of hydrogen refuelling stations is one of the major preconditions for market success. Accordingly, the planned H_2 Mobility joint venture will work closely together with the automobile industry.

Particularly in view of the high costs of such innovative technology, advances in hydrogen and fuel cell technology are at least as important. Continuation of the innovation and research activities in this field, which

are envisaged in the mobility and fuel strategy of the German Federal Government, plays a decisive role in this respect. In particular, the continuation of the National Innovation Programme Hydrogen and Fuel Cell Technology (NIP) is necessary to support market establishment.

STATEMENTS OF THE PARTNERS INVOLVED:

Thomas Pfützenreuter, Managing Director of AIR LIQUIDE Deutschland GmbH:

»The signing of this agreement is a decisive step towards the construction of a network of hydrogen stations in Germany. Air Liquide is proud to take an active part in the German H_2 Mobility Initiative that aims to substantially contribute to the national ambitious objectives for electromobility. As an expert of the entire hydrogen energy chain including production and hydrogen refuelling stations, Air Liquide is actively involved in allowing the widespread use of hydrogen as a clean energy source. Hydrogen energy is an innovative solution that offers a response in the short term to the challenges of sustainable mobility thus contributing to the preservation of the environment.«

Prof. Thomas Weber, Member of the Board of Management of Daimler AG, Group Research & Mercedes-Benz Cars Development:

»Hydrogen is the most common element in the universe. However, refuelling stations for this environmentally friendly alternative fuel are still scarce. The H_2 Mobility Initiative wants to change this. By 2023, there should be more hydrogen refuelling stations in Germany than there are conventional petrol stations along motorways today. That is why we are creating a comprehensive infrastructure for the everyday use of fuel cell technology, step by step.«

Prof. Wolfgang Reitzle, Chief Executive Officer of Linde AG (until 2013):

»Linde has been a pioneer in the further development of hydrogen technology for many years. Especially with respect to the series production of hydrogen refuelling stations, we have achieved major advances over the last few years. The time is now right to roll out this environmentally friendly technology on a nationwide basis.«

Dr. Gerhard Roiss, Chairman of the Executive Board and CEO of OMV AG:

»Achieving the EU's Energy Roadmap goals will only be possible with innovative new technologies. Hydrogen is set to also play a key role in the way we get around in the future. Setting up the infrastructure for hydrogen refuelling stations is our contribution to a future of emission-free motoring.«

Peter Blauwhoff, Chief Executive Officer German Shell Holding:

»Shell already operates a network of hydrogen refuelling stations based on the very latest technology in Germany and California – including the world's largest hydrogen refuelling station in Berlin. Following the foundation of the joint venture, Shell will play a significant role in the development of the future hydrogen retail station network in Germany. Hydrogen is an important component for the mobility of the future.«

Hans-Christian Gützkow, Chairman of TOTAL Germany:

»Out of the 15 hydrogen refuelling stations existing in Germany today, we already run five – another TOTAL multi-energy-station will soon commence operation close to Berlin's future airport. We will continue contributing to the expansion of infrastructure. TOTAL reinforces its pioneering role whilst building up the hydrogen network in Germany and in terms of research when it comes to produce green hydrogen from renewable sources.«

NO MARKET MATURITY WITHOUT A HEALTHY SUPPLIER INDUSTRY

According to the current plans of the federal government, our CO_2 emissions are to be reduced by more than half by 2050. In order to reduce emissions further, we must do away with fossil fuels completely. But there is a long road ahead before we reach this point: practically every commonplace energy system, including those producing energy for electricity or buildings, is based on fossil fuel material. Despite it being possible to produce power from renewable sources – such as is the case on a large scale with wind energy – the nationwide, uninterruptible supply of such energy it is still a far way off. But also in terms of mobility – which is an important prerequisite for our social and economic systems – we are entering a phase of transition. Scientists, engineers, researchers and developers are searching for solutions that will be in place after the era of petrol and diesel.

Besides storage concepts that are based on power-to-gas and batteries, the fuel cell represents a key component in the future of energy supplies. For this reason, a spirit of optimism currently pervades in the fuel cell sector. Initial successes can also be seen: a continuous supply chain for cell components and stacks now exists in Germany. The supplier industry hereby takes on a decisive role as it provides important components for all applications. Various car manufacturers have already announced models with emission free fuel cell drives for 2015. Vehicles produced in small batch production runs are already on our roads today and material handling vehicles such as forklifts and also fuel cell heating systems are being trialled in field tests – all with numerous components from renowned suppliers. For the technology to catch on, however, prices must drop, incentives for continual demand must be created and innovative systems must be developed and produced – with many German supplier companies assuming responsibility for the latter.

WHEN COMPETENCIES COMPLEMENT EACH OTHER

Examples of specialist companies that have been involved in this sector include ElringKlinger AG – a developmental partner and series supplier to the automotive industry; the Freudenberg Group – a partner and supplier to the automotive, engineering, textile, telecommunications as well as the oil and gas industries; and SolviCore GmbH & Co. KG – a company specialised in the continued development, production and marketing of membrane electrode assemblies (MEAs), which are the heart of a fuel cell. All three companies initiated research projects within the framework of the NIP and are today manufacturing under series conditions. They provide what is required for the inexpensive manufacture of fuel cell systems: a solid industrial background, mass production know-how along with a comprehensive understanding of the technology, the implemented materials and required processes.

The Freudenberg Group develops gas diffusion layers (GDLs) that take on numerous complex tasks in the stack to ensure optimal interaction with the adjacent components. Within the NIP-funded OptiGAA project conducted together with Daimler AG, for example, fundamental insights could be drawn for the optimisation of the gas diffusion layer for the application of fuel cells in vehicles. These insights enabled a GDL production facility to be created that is unique in the world, which can develop materials with the precise profile of characteristics required for the specific respective application.

This investment allows reel-to-reel processing and builds on fundamental developments of the past 15 years. It underlines the Freudenberg claim of not only aiming to be a leading GDL developer, but to also establish itself as one of the leading GDL manufacturers in the world with a production site in Germany. Besides the development of the GDL product itself, the establishment of a sturdy series production process enabling customers to receive a high quality product with extremely homogenous and performance-based properties, is the core challenge.

Over the past years, Freudenberg has also been active in the development sealing solutions, developing fundamental technologies as well as materials, and implementing these according to market demands.

SolviCore, a joint venture of the companies Solvay and Umicore, based in Hanau, focuses on research, development, production and the sale of MEAs for hydrogen, reformer and direct methanol fuel cells as well as PEM water electrolysis. The company can look back on 20 years of research and development history in the area of fuel cells and benefits from Umicore's worldwide leading position in the area of metal management and recycling of precious metal products and Solvay's experience in the area of polymer chemistry. Through the support provided by several NIP projects, Solvicore has invested in production facilities and capacities over the last years that have enabled series production.

As part of the MEA-KORREKT project, an innovative, competitive MEA production process was developed enabling the automated handling of all materials. This enables productivity of the entire production process to be enhanced along with a significant reduction of reject rates. Besides automation, the reduction of costs is also a key prerequisite for series maturity. Already today, Umicore commands over processes for precious metal recycling that ensure the precious metal used in the MEA can be recovered, thereby closing the cycle.

ElringKlinger AG produces metallic bipolar plates for PEMFC stacks. Besides cost advantages, they also provide benefits in terms of power density, which is particularly important for mobile applications. Furthermore, they enable the cold start of fuel cells. Today, Elring Klinger already produces bipolar plates in a fully automated, interlinked manufacturing process – in highest quality and on series production lines. Furthermore, ElringKlinger also produces end plates, media modules and enclosures for stacks. The portfolio is supplemented with the integration of system components on the stack. This saves costs and space. In addition to stack components, PEMFC and SOFC stacks for various applications are also produced. In the NIP project Fuel Cell Module 5 kW Class, modules are being developed for industrial applications and their suitability for mass production is a key focus. The company can fall back on extensive know-how in the area of metal and plastics processing, expertise in materials and automation as well as in-house tooling capabilities. Customers are accompanied from the initial idea through construction and prototype creation, testing and securing and right up to cost-optimised series production – even in small batches.

STRONG SUPPLIER INDUSTRY FOR MOBILITY OF THE FUTURE

These examples show that Germany's supplier industry in on the right track. At all three companies, the productions facilities could run at full speed – with the requirements for this having being created and continually developed further over the past years. Financial risks could be buffered through public funding by the NIP. These successes must now be emulated on a wider base and investments for the commercialisation of hydrogen and fuel cell technology must also be made attractive for other small and medium sized firms. Fuel cell technology is extremely complex and can ensure added value for Germany's supplier industry over the long term. Reliable framework conditions, in particular also in terms of national and European support, are therefore necessary to secure the supplier industry that has developed to date. Besides supporting the expansion of infrastructure and vehicle fleets, the support of this technology will remain necessary over the coming years in order to come closer to achieving the goal of cost effective fuel cell series production.


TOTAL
TRUCK DIESEL
DIESEL
DIESEL
SUPER E10
SUPER
SUPER PLUS
AUTOGAS
ERDGAS
excellium
BURGER KING
Café bonjour
TOTAL
W sh
ERDGAS
EWE
TOTAL

CO_2-neutral hydrogen refuelling station from TOTAL at Berlin-Brandenburg Airport

I / 01

» CRYOGENIC PRESSURE TANK SYSTEM AND REFUELLING – VALIDATION TO STANDARDISATION RECOMMENDATION – CRYOCODE «

Electric drives belong to the future of emission-free mobility. For short distances in urban operation, electric energy is best stored in a high-voltage battery. For longer distances and short refuelling times, chemical storage in the form of hydrogen and its subsequent conversion into electricity in a fuel cell on board the vehicle is suitable.

The status of the technology now in hydrogen vehicle storage is the capacity to store 700 bar of compressed hydrogen at ambient temperature (CGH_2). Through the refuelling and storage of cryogenic gaseous hydrogen in a cryogenic pressurised storage unit at up to 350 bar (CcH_2), the energy density of a 700 bar storage unit can be raised by more than 50 %. At the same time the cooling of the fuel cell drive can be improved through the cold stored in the cryogenic pressure tank, thus guaranteeing high continuous performance.

Standardising CGH_2 storage up to 700 bar is already far advanced. A comprehensive database comprising validation processes is available.

The aim of the CryoCode project is to prepare standardisation and type approval of hydrogen cryogenic pressure storage technology through extensive validation tests. In the process, the required functions, operational reliability and system performance of the tank system and of refuelling will be established and a standard recommendation will be developed.

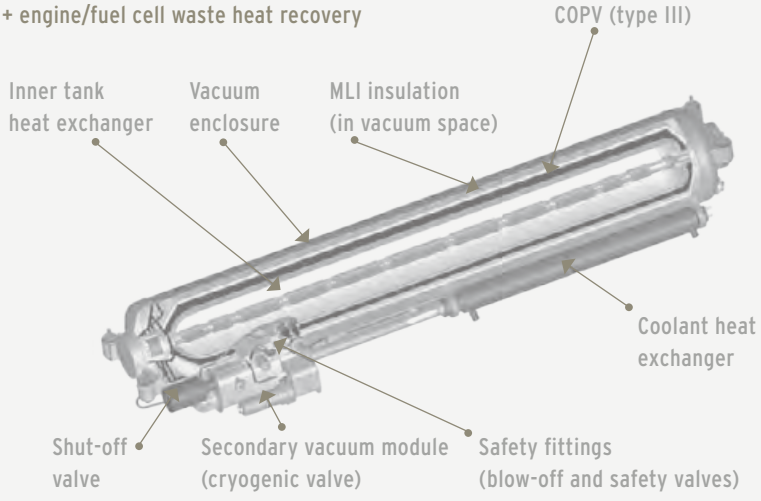
PARTNERS:	PROJECT BUDGET/€:	PROJECT FUNDING/€:
Bayerische Motoren Werke AG	6,853,743	3,289,796
Linde AG	201,670	96,802
Bundesanstalt für Materialforschung und -prüfung (BAM)	147,503	70,801
ET GmbH Gesellschaft für innovative Energie und Wasserstoff-Technologie	88,376	42,420

COMMENCEMENT: 01 January 2013
CONCLUSION: 31 December 2015

SUPER INSULATED PRESSURE VESSEL FOR CRYO-COMPRESSED HYDROGEN STORAGE

Max. usable capacity	CcH_2: 7.1 kg (237 kWh) CGH_2: 2.3 kg (76 kWh)
Operating pressure	15 – 350 bar
Vent pressure	350 bar
System weight (incl. H_2)	160 ± 5 kg
Refuelling pressure	CcH_2: 300 bar CGH_2: 320 bar
Refuelling time	< 5 min
H_2 loss	
Leakages:	< 3 g day
Standing loss:	3 – 10 g/h (CcH_2)
Infrequent drivers:	< 1 %/year

+ active tank pressure control
+ load carrying vehicle body integration
+ engine/fuel cell waste heat recovery



I / 02

» CRYOFUEL VISIONARY VEHICLE FOR EMISSION-FREE PREMIUM MOBILITY FOR LONG ROUTES – CRYOFUEL «

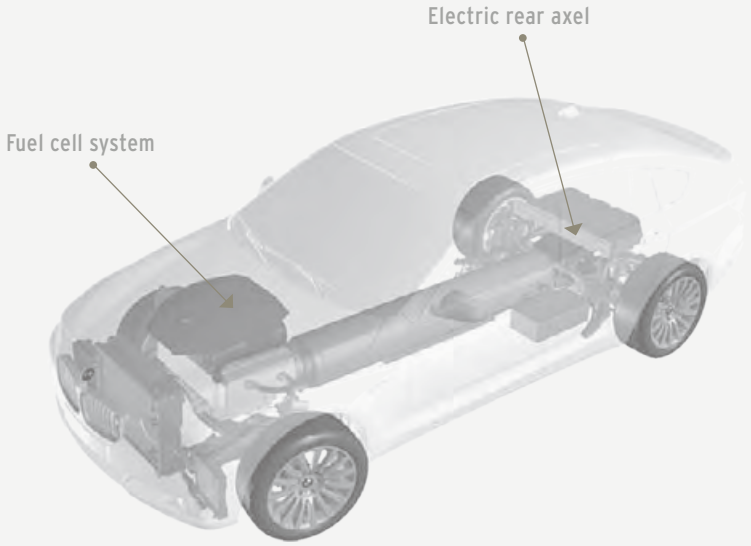
The CryoFuel project will develop and construct a first test vehicle with a powerful fuel cell electric drive and hydrogen cryogenic pressure storage unit, in order to establish the everyday suitability of cryogenic pressure technology following subsequent approval for road-worthiness. The goal is to prove that emission-free high-comfort driving is possible over long distances and with faster refuelling in just a few minutes also for larger passenger cars in higher performance classes.

PARTNER:	PROJECT BUDGET/€:	PROJECT FUNDING/€:
Bayerische Motoren Werke AG	20,534,271	9,856,450

COMMENCEMENT: 01 January 2013
CONCLUSION: 31 December 2015

BMW VISIONARY VEHICLE FOR EMISSION-FREE, LONG-DISTANCE PREMIUM MOBILITY

CO_2 Emissions	0
Range	700 km
Refuelling	< 5 min
Acceleration (0 – 100 km/h)	< 8 sec
Top speed	180 km/h
Comfort	Typical premium comforts » high energy availability for comfort functions » unimpeded interior and loading space



Central, load-carrying cryo-pressure tank (max storage capacity > 7 kg H_2)

I / 03

» STIMULATION OF THE SUPPLIER LANDSCAPE FOR THE DEVELOPMENT OF COST-OPTIMISED FUEL CELL SYSTEMS – F-CELL LUK «

The provision of environmentally-friendly, reliable and affordable energy is one of the great challenges of the 21st century. It can only work through innovative concepts and technological advances. Fuel cell technology, with its high degree of efficiency, and hydrogen, as a climate-neutral secondary energy source, will in future represent the foundation for sustainable and low-emission energy supply and mobility.

As a leading global company in the development and production of fuel cell systems, NuCellSys is sparing no effort in fulfilling the requirements of pollutant-free and sustainable mobility. The goal of this project is to strengthen the leading position of German suppliers and engineering service providers and gain more suppliers for future-oriented fuel cell technology, in order to best position them for global competition. In addition, the main components of the fuel cell system will be optimised in close cooperation with the supply industry and the service providers through many technological innovations, such as taking on additional, overall functions, new and alternative materials and new production methods and processes for a cost-effective, economically viable manufacture of large quantities. With the development of new concepts in the areas of hydrogen recirculation, new simulation models for the description and characterisation of fuel cell system components and the monitoring of hydrogen, important steps forward will be taken on the road to commercialisation.

PARTNER:	PROJECT BUDGET/€:	PROJECT FUNDING/€:
NuCellSys GmbH	8,333,333	4,000,000

COMMENCEMENT: 01 January 2013
CONCLUSION: 31 December 2013

» The provision of environmentally-friendly, reliable and affordable energy is one of the great challenges of the 21st century. «

» A main focus will also be on ensuring any hydrogen boil-offs are completely utilised. «

I / 04

» ESTABLISHMENT AND OPERATION OF A HYDROGEN REFUELLING STATION FEATURING 300 BAR CRYO COMPRESSION TECHNOLOGY (CcH_2) AND 700 BAR HIGH-PRESSURE TECHNOLOGY (CGH_2) – HRS DETMOLDSTRASSE «

Building on its previous cooperation with BMW AG and within the framework of the National Innovation Programme Hydrogen and Fuel Cell Technology (NIP), TOTAL will re-equip and continue operating the liquid hydrogen refuelling station in Detmoldstrasse, Munich, which was originally established in 2006. Besides 700 bar high-pressure technology (CGH_2), cryo compression technology (CcH_2) – which was jointly developed by BMW and its partners – will be tested and offered for sale for the first time here.

During the construction and operational phases, both refuelling station technologies and operational processes will be specifically tested, developed further and optimised. The main research objectives of the project encompass the areas of network development, technology development and the development of operational and supply concepts along with sustainability and customer acceptance. A main focus will also be on ensuring any hydrogen boil-offs are completely utilised. From the operator perspective, necessary know-how for the successful expansion of hydrogen infrastructure will be built up.

The HRS Detmoldstrasse project is a part of the 50 refuelling station programme. In June 2012, the BMVBS and various industry partners signed a letter of commitment in this regard. It outlines the development, operation, testing and comprehensive evaluation of a supply network comprising at least 50 hydrogen refuelling stations in Germany by 2015 to ensure the prerequisites are met for the successful market introduction of hydrogen vehicles.

PARTNER:	PROJECT BUDGET/€:	PROJECT FUNDING/€:
TOTAL Deutschland GmbH	2,894,610	1,389,413

COMMENCEMENT: 01 October 2013
CONCLUSION: 30 June 2016

I / 05

» ESTABLISHMENT AND OPERATION OF EIGHT HYDROGEN REFUELLING STATIONS – HY8 «

TOTAL has operated hydrogen refuelling stations for more than ten years. Throughout this time it has accompanied various demonstration projects and in doing so has been a reliable partner to car manufacturers and producers of industrial gases. The aspect of sustainability has played a significant role at all times. Within the framework of this project and in cooperation with Daimler AG and Linde AG, TOTAL will construct and operate an additional eight new hydrogen refuelling stations in various locations across the country, adding to the five stations already in operation. There are currently 15 publically accessible hydrogen refuelling stations in Germany.

With these eight new refuelling stations, TOTAL continues to invest in establishing a hydrogen infrastructure in Germany. During both the construction and operational phases, refuelling station technology and operational processes will be specifically tested, developed further and optimised. The main research objectives of the project encompass the areas of network development, technology development and the development of operational and supply concepts along with sustainability and customer acceptance. From the operator perspective, necessary know-how for the successful expansion of hydrogen infrastructure will be built up.

This project is a part of the 50 refuelling station programme for which BMVBS and various industry partners singed a letter of commitment for in June 2012. It outlines the development, operation, testing and comprehensive evaluation of a supply network comprising at least 50 hydrogen refuelling stations in Germany by 2015 to ensure the prerequisites are met for the successful market introduction of hydrogen vehicles.

PARTNER:	PROJECT BUDGET/€:	PROJECT FUNDING/€:
TOTAL Deutschland GmbH	4,547,508	2,182,803

COMMENCEMENT: 01 September 2013
CONCLUSION: 30 June 2016

» The main research objectives of the project encompass the areas of network development, technology development and the development of operational and supply concepts along with sustainability and customer acceptance. «

I / 06

» UPGRADE AND CONTINUED OPERATION OF THE HYDROGEN REFUELLING STATION IN HOLZMARKTSTRASSE IN BERLIN – HY-UWE «

As part of the 20 refuelling station initiative of Linde and Daimler, TOTAL will upgrade and its existing liquid hydrogen refuelling station located in Holzmarktstrasse in Berlin to 700 bar high pressure technology (CGH_2) and continue operations at the site.

With this move, TOTAL continues its activities for the development of hydrogen infrastructure in Germany. During the construction and operational phases, refuelling station technologies as well as start-up procedures will be specifically tested, developed further and optimised. The main research objectives of the project encompass the areas of network development, technology development and the development of operational and supply concepts along with sustainability and customer acceptance. From the operator perspective, necessary know-how for the successful expansion of hydrogen infrastructure will be built up.

The HyUWE project is a part of the 50 refuelling station programme commitment from June 2012 of the BMVBS and various industry partners for the development, operation, testing and comprehensive evaluation of a supply network comprising at least 50 hydrogen refuelling stations by 2015 to ensure the prerequisites are met for the successful market introduction of hydrogen vehicles.

PARTNER:	PROJECT BUDGET/€:	PROJECT FUNDING/€:
TOTAL Deutschland GmbH	725,075	348,036

COMMENCEMENT: 15 October 2013
CONCLUSION: 30 June 2016

I / 07

» ESTABLISHMENT OF A FULLY INTEGRATED PUBLIC HYDROGEN REFUELLING STATION IN SCHNACKENBURGALLEE, HAMBURG «

As part of its hydrogen programme, Shell is establishing a series of refuelling stations of various sizes. A new facility will be established in Hamburg in the course of 2014. It is part of the national 50 refuelling stations programme, which aims to ensure the supply of hydrogen in core regions in Germany. In this instance, the refuelling station will be built in the highly frequented Schnackenburgallee arterial road, located in the immediate vicinity of the A7 motorway.

Shell is responsible for the planning, construction, start-up and operation of the complete station. The hydrogen will be produced on site via electrolysis at the new facility in Hamburg. Using a highly effective and largely maintenance-free PEM electrolyser, the company aims to investigate an innovative process for the production of hydrogen. The refuelling station will participate in the German electricity balancing market and therefore will also contribute to ensuring the stability of the electricity network.

As is the case in the two existing hydrogen facilities in Berlin-Schöneberg and Hamburg-Bramfeld, Shell is pursuing the goal of obtaining further insights in regard to the production, processing, storage and delivery of hydrogen as a fuel through the implementation and testing of latest technologies. Furthermore, research into various operating modes and maintenance strategies during the operational phase are a particular focus of this site.

PARTNER:	PROJECT BUDGET/€:	PROJECT FUNDING/€:
Shell Deutschland Oil GmbH	3,060,483	1,469,032

COMMENCEMENT: 15 October 2013
CONCLUSION: 30 June 2016

The Shell hydrogen refuelling station on Schnackenburgallee in Hamburg

I / 08

» CONSTRUCTION AND OPERATION OF A WIND HYDROGEN PRODUCTION FACILITY AND THE WORLD´S FIRST CARBON NEUTRAL REFUELLING STATION – H_2-BER «

With the construction the world's first carbon neutral refuelling station (»multi-energy station«) near the site of Berlin-Brandenburg International Airport (BER), TOTAL sets an important milestone for the integration of wind energy in the transport sector. The project aims to test and demonstrate the feasibility of supplying energy based on renewable sources in a safe, reliable and sustainable manner. For this purpose, the associated companies will construct and operate a wind park with 40 wind turbines, a wind hydrogen production facility as well as the world's first carbon neutral refuelling station on land provided by TOTAL in the direct vicinity of BER airport.

Depending on network loads, power produced by the wind park will be partly used for the production of carbon free hydrogen. Besides the wind park, the multi-energy station also incorporates an on-site wind hydrogen production facility (electrolysis, compression, storage) with a modular extendable capacity from 0.5 t to 1 t of hydrogen per day. The hydrogen production facility thereby serves as a demonstration facility for optimised load and uptake management of the fluctuating wind energy from a purpose-built wind park. The hydrogen stored on site will primarily be used for refuelling vehicles in the adjacent TOTAL refuelling station. As such, the project integrates seamlessly into the strategic plans of the H_2 Mobility Initiative and the Clean Energy Partnership (CEP) for the step-by-step expansion of hydrogen infrastructure.

Furthermore, as part of an integrated load management system, the stored hydrogen can be alternatively delivered to other customers by trailer, or even be used for heating and electricity of the facility in the combined heat and power plant. A solid hydrogen storage container of a size never before delivered by manufacturer McPhy, will enable the intermediate storage of up to 100 kg of hydrogen and therefore ensure the combined heat and power plant from manufacturer 2G is supplied with sufficient amounts of renewably produced gas. The thermal performance of the mixed gas combined heat and power plant will be used to heat the refuelling station building and the water of the affiliated carwash and washing bays.

The associated companies combine their respective competencies within this project and thereby enable the integration of several current topics of the future in a single facility. ENERTRAG supplies its experiences in the areas of wind energy and electrolysis, Linde is responsible for the area of hydrogen handling and storage, while TOTAL contributes its extensive experience in the construction and operation of hydrogen refuelling stations.

The technological, economic and organisational prerequisites for the commercial operation of wind hydrogen systems in the medium term will be identified and evaluated within this project. Besides integrating wind hydrogen in the existing energy infrastructure, the involved partners particularly aim to promote the conceptual and technological system development of an economical provision of energy for fuel cell vehicles, within this project.

As such, the participating companies are advancing the following primary aspects in the project:

- Demonstration of regional energy supply structures, particularly with the aim of decarbonisation and the consolidation of renewable energy
- Coupling of renewable energy and innovative mobility applications through the production of hydrogen as a fuel from wind energy
- Demonstration of the dynamic operation of electrolysis, compression of hydrogen and storage depending on the prevailing wind
- Joint testing of the interaction between individual facility components
- Assessment of strategies to stabilise the electricity network through the storage of excess wind energy and the demand-oriented reconversion in combined heat and power plants
- Expansion of the possibilities for energy storage and distribution by connecting to electricity and gas networks allowing the feeding in of wind hydrogen produced via electrolysis

» Identification and realisation of technological and operational optimisation potentials of the technical facilities for dynamic operation

» Development and testing of operational and marketing strategies

» Standardisation and definition of interfaces between the plant components in order to establish modular concepts at BER airport

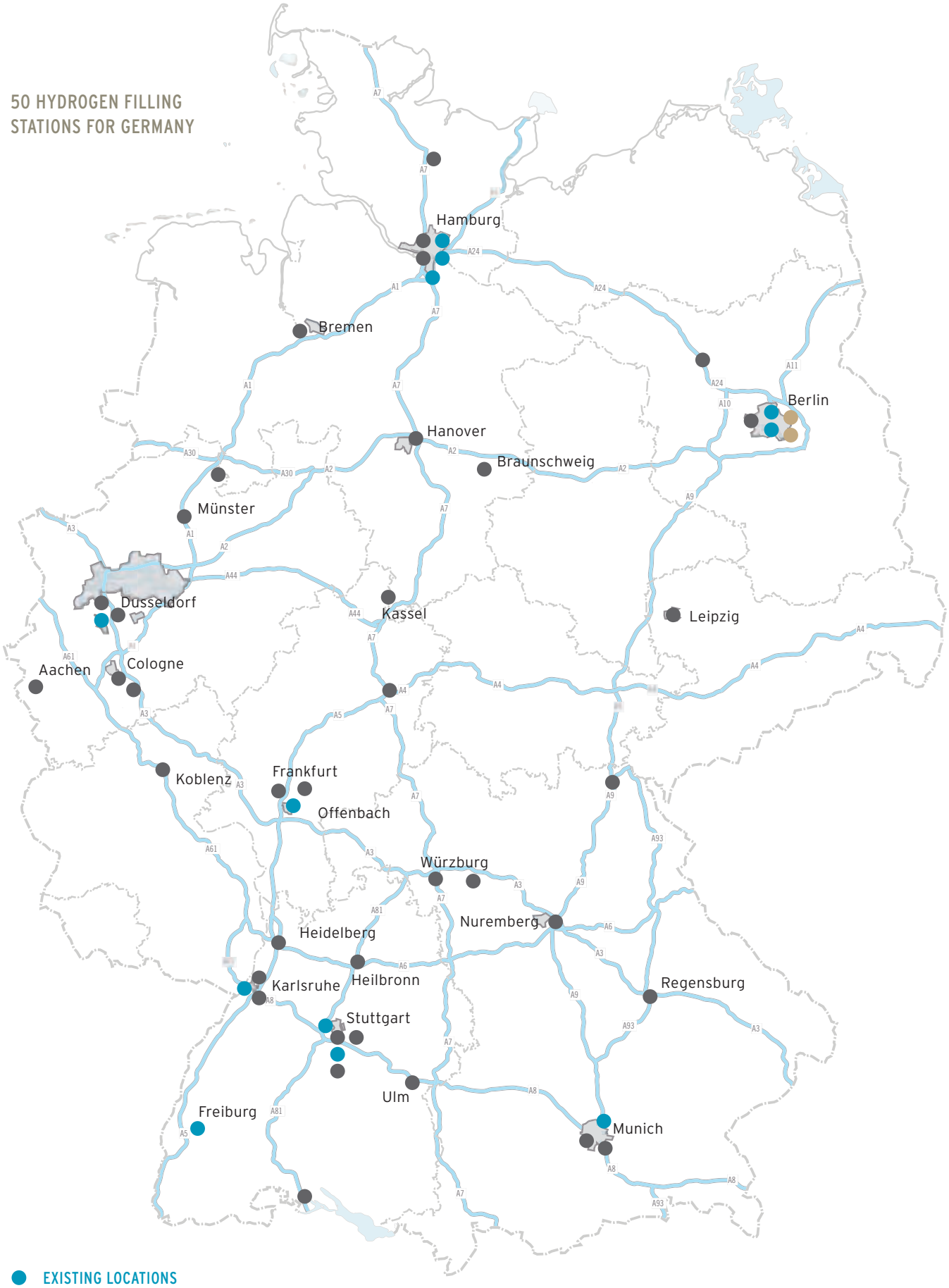
» Fostering the acceptance of this new type of technology through its demonstration in a project with a high degree of public exposure

PARTNERS:	PROJECT BUDGET/€:	PROJECT FUNDING/€:
TOTAL Deutschland GmbH	3,186,432	1,529,486
Linde AG	2,597,198	1,246,654
ENERTRAG AG	332,599	159,645
2G Energietechnik GmbH	988,896	474,670
McPhy Energy Deutschland GmbH	3,238,127	1,554,301

COMMENCEMENT: 01 January 2013
CONCLUSION: 30 June 2016

» The project aims to test and demonstrate the feasibility of supplying energy based on renewable sources in a safe, reliable and sustainable manner.«

50 HYDROGEN FILLING STATIONS FOR GERMANY



- EXISTING LOCATIONS
- LOCATIONS UNDER CONSTRUCTION
- LOCATIONS PLANNED


Shell
V-Power
Performance Fuels
Select
Shell
V-Power
SFC 306
GG HY 400
K FV 34

CEP refuelling station
on Sachsendamm
in Berlin

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» COMPRESSOR MODULE FOR THE CATHODE GAS SUPPLY OF FUEL CELL VEHICLES «

The basic focus of the project is the research and development of an electrically-driven turbocharger for a fuel cell unit used in a vehicle. The main aim is to develop a turbocharger with less mass, volume and cost, and through adapted parameters, to raise the degree of efficiency of the fuel cell unit and thus the efficiency of the system, particularly in the area of the partial load range.

To achieve these goals the following priorities were identified, which will be developed further within the project:

» Thermodynamics of the turbocharger

» Electric motor and its control (frequency converter)

» Oil-free storage

The project has three phases:

Phase 1:
Development and testing of an evaluation model A on the component test bench

Phase 2:
Development and testing of an evaluation model B on the component test bench

Phase 3:
Testing and optimisation of evaluation model B in a fuel cell laboratory system and fuel cell unit and specification of the requirements to an evaluation model C

The overall aim of the project is incorporated in the fuel cell activities of the Volkswagen Group. The results flow into the ongoing work of the company's research arm of Volkswagen AG. Furthermore through the development of the necessary competence and experience at BorgWarner Turbo Systems Engineering GmbH, the foundation will be laid for the development of the relevant fuel cell components in terms of the technology and cost requirements of the automotive industry.

PARTNERS:	PROJECT BUDGET/€:	PROJECT FUNDING/€:
Volkswagen AG	1,429,297	686,063
BorgWarner Turbo Systems Engineering GmbH	3,472,946	1,667,014

COMMENCEMENT: 01 August 2013
CONCLUSION: 31 December 2015

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» DEVELOPMENT AND CONSTRUCTION OF 10 HYDROGEN REFUELLING STATIONS «

Fuel cell powered electric vehicles have today already reached a high level of development. The wide scale market introduction, however, is dependent on various factors: besides the vehicle itself, the political environment, a competitive supplier industry and most importantly a sound infrastructure are key areas of focus for market preparation activities. Providing an additional impulse for the development of the hydrogen infrastructure in Germany, Daimler AG and Linde AG have agreed on a joint initiative for the establishment of 10 hydrogen refuelling stations each, in Germany. With these 20 additional stations, both companies are thereby ensuring the reliable supply of hydrogen produced exclusively using renewable energy for a constantly growing number of fuel cell vehicles on the roads. This initiative bridges the gap between the existing Clean Energy Partnership and H_2 Mobility infrastructure projects and is being supported via the National Innovation Programme Hydrogen and Fuel Cell Technology (NIP). The initiative is simultaneously part of the 50 refuelling stations programme. The main focus of the research and development work will be on the supply for vehicle fleets and the expansion of the refuelling station network in Germany.

The increased expansion of the hydrogen infrastructure is essential for the successful commercialisation of hydrogen-based fuel cell technology.

The first centres in urban agglomerations such as Berlin and Hamburg have already been established. Five to ten stations are all that are required to ensure an initial customer-friendly coverage in large cities. The connection between such urban centres – like Berlin and Hamburg, Stuttgart and Munich – with corridors on the main arterial roads, represents a significant step forward towards the nationwide expansion of a publically accessible hydrogen infrastructure.

The goal is to use the existing, favourably located sites of various mineral oil companies. This will enable, for the very first time, all places in Germany to be reached by fuel cell vehicles.

Furthermore, this project makes a decisive contribution to raise the level of customer acceptance towards hydrogen-based fuel cell technology in general.

PARTNER:	PROJECT BUDGET/€:	PROJECT FUNDING/€:
Daimler AG	14,460,710	6,941,141

COMMENCEMENT: 01 October 2012
CONCLUSION: 30 June 2016

Hydrogen in the tank – Mercedes-Benz B-Class F-CELL

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» NATIONAL VALUE-ADDED CHAIN FOR HYDROGEN COMPONENTS OF FUEL CELL SYSTEMS – NIP-ANODE «

Germany is facing the challenge of accelerating the transition to a new era of environmentally friendly, reliable and affordable energy supply. This also includes promoting the development of innovative concepts and advances in technology to ensure sustainable mobility with electrically powered vehicles. Besides hydrogen as a storable and extremely versatile secondary energy source, an integral aspect of sustainable mobility is fuel cell technology. With its high efficiency, the fuel cell has the potential to guarantee the provision of a reliable, competitive and environmentally friendly source of energy.

As the world's leading company for the development and production of fuel cell systems, NeCellSys is going to great lengths to ensure the expectations and demands for emission free, sustainable mobility are met. In the NIP Anode project, NuCellSys pursued the goal of developing components for the anode and hydrogen circuits of fuel cell systems. The technological simplification of the anode module was paramount in order to create a basis on which large numbers could be economically manufactured: this was achieved through innovation, a higher degree of integration, fewer overall components, easier assembly and optimised production processes. A further focus was the involvement of German firms in the research and development activities in order to retain the innovative power along with the associated technological and manufacturing competencies within Germany as well as initiating competition.

Based on the insights gained from and the results of the preceding generation of individual anode circuit components and taking into account the demands for operational stability, service life and anticipated costs, new innovative concepts were developed, analysed and evaluated. Using suitable simulation models, by ascertaining the interrelationships between disturbance variables and system functions and by carrying out tests series, the foundations for fulfilling the requirements were laid down.

The technological targets defined at the commencement of the project for the anode module in regard to the reduction of weight and volume could be reached and even exceeded, respectively. The number of interfaces could be reduced by up to 60 % while the service life of the entire module could be doubled. With the integration of further components in the operations management software of the anode module, resistance against disturbance levels and thereby the overall operational stability of fuel cell systems could be substantially improved. In addition, specific services for the diagnosis of various types of operating states are now available. Furthermore, the project funding was also an incentive that helped motivate more suppliers to support the development of fuel cell technology. All results and insights form a basis that will ultimately lead towards the mass production of fuel cell system technology.

PARTNER:	PROJECT BUDGET/€:	PROJECT FUNDING/€:
NuCellSys GmbH	13,108,647	6,292,151

COMMENCEMENT: 01 April 2010
CONCLUSION: 31 December 2013

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» MEA COST REDUCTION THROUGH DEVELOPMENT OF AN INNOVATIVE PRODUCTION PROCESS – MEA-KORREKT «

An important factor for the successful market penetration of fuel cell products is the development of a cost effective production process.

The membrane electrode assembly (MEA) is the electrochemical core of the proton exchange membrane (PEM) and represents the component having the largest influence on the cost structure of fuel cell systems. Prices are currently still a long way from the targets set for the widespread deployment of stationary and mobile fuel cell systems. One of the fundamental reasons for this is the continued high number of manual steps within the MEA manufacturing process. As part of the MEA-KORREKT project, Solvicore developed and tested concepts to automate MEA manufacture for mass production. Goal of the concept developed by Solvicore was to look for new paths for MEA manufacture and increase productivity through a continual production process and also significantly reduce reject rates.

Working together with German suppliers, an innovative and competitive MEA production process could be developed that can become a substantial component of the PEM fuel cell value added chain in Germany.

Based on the largely manual or semi-automated processes implemented on a pilot scale, continuous processes were examined and simultaneously developed with quality assurance methods specifically for MEA manufacture. The focus of work was on the value adding processes throughout MEA production. These include the areas of dispersion technology, coating technology and assembly/automation. The flow of materials and process cycle times were aligned with one another, interfaces between processes were developed and quality assurance tools (such as online load monitoring) were established and implemented for process management. Separate production lines for the manufacture of anode and cathode dispersions were established and scaled up. A technology for continual coating was first tested in a pilot project and then established on a larger scale. The automated handling of all materials as so-called reel materials as well as isolation (Pick & Place function) and assembly were implemented as an overall plant and automation concept.

At the end of the project, a new type of technology platform had been developed by Solvicore to prepare for the establishment of a complete, internationally competitive, automated MEA mass production system.

PARTNER:	PROJECT BUDGET/€:	PROJECT FUNDING/€:
Solvicore GmbH & Co. KG	5,745,56	2,757,963

COMMENCEMENT: 01 April 2010
CONCLUSION: 30 September 2013

» The focus of work was on the value adding processes throughout MEA production. «

The transport sector in Germany is characterised by sustained growth and increasing CO_2, NO_x and soot particle emissions. The swift implementation of low emission drives such as the fuel cell as well as hydrogen as a very promising energy storage medium is therefore of major importance.

Cities such as Hamburg are using hydrogen in their local public transport services.


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BF ALTONA
1142

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» DEPLOYMENT OF FUEL CELL MIDIBUSES IN THE UNIVERSITY MEDICAL CENTER HAMBURG-EPPENDORF – MIDIBUS «

The transport sector in Germany is characterised by sustained growth and increasing CO_2, NO_x and soot particle emissions. The swift implementation of low emission drives such as the fuel cell as well as hydrogen as a very promising energy storage medium is therefore of major importance. On this backdrop, buses have the advantage that they are deployed daily and generally for significantly more operational hours than a passenger car. For this reason, they are particularly suitable for testing hydrogen and fuel cell technology in practice and identifying the areas still requiring optimisation to subsequently develop the vehicles towards market maturity.

The project aimed to test a fuel cell midibus from Hydrogenics on the grounds of the University Medical Center Hamburg-Eppendorf. Klinik Logistik Eppendorf deployed the bus on its circle line on which visitors, patients and students could reach the clinic's various facilities and centres. Goal of the project was to establish the suitability of such a vehicle under everyday conditions across seasons and assorted operational demands. The establishment of a small, mobile refuelling facility and the corresponding interfaces complemented the testing of the fuel cell bus.

Besides having an electric motor and fuel cell as primary energy sources, the hybrid midibus also includes an additional battery unit to cover peak loads. An integrated energy management system controls the selection of the appropriate source of energy and the required power level. This operates autonomously without the need of any input from the driver. Through the recovery of braking energy (recuperation), the battery is recharged and the consumption of hydrogen is reduced. With slight seasonal variations, the fuel consumption is approx. 3 kg of hydrogen per 100 km.

Over the course of the project period, the fuel cell midibus travelled a total of 14,600 km and conveyed around 16,000 passengers around the clinic grounds in scheduled operation. Seasonal restrictions to operations in terms of the midibus' technical availability were not recorded throughout the project. Due to the early definition of interfaces for the refuelling facility, refuelling procedures were also completed without a hitch.

The fuel cell midibus project can be considered an overall success. The bus and integrated drive concept could completely meet the operational and technical demands for deployment by Klinik Logistik Eppendorf. As such, this project represents a reference for the implementation of fuel cell hybrid systems in midibuses for future areas of application in regular or shuttle transport services.

PARTNERS:	PROJECT BUDGET/€:	PROJECT FUNDING/€:
hySOLUTIONS GmbH	36,483	17,511
KLE Klinik Logistik Eppendorf GmbH	666,845	320,085

COMMENCEMENT: 01 July 2009
CONCLUSION: 31 December 2013

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» ACCOMPANYING SOCIOSCIENTIFIC RESEARCH OF THE NATIONAL INNOVATION PROGRAMME HYDROGEN AND FUEL CELL TECHNOLOGY – HYTRUST «

The HyTrust project researched the effects on society resulting from the introduction of hydrogen and fuel cell technology in the mobility sector. The project focused on questions regarding the acceptance of the technology and about the trust that the public places in the players driving this technology. It was undertaken by a consortium comprising the Unabhängige Institut für Umweltfragen (UfU – Independent Institute for Environmental Issues), the Innovationszentrum für Mobilität und gesellschaftlichen Wandel GmbH (InnoZ – Innovation Centre for Mobility and Social Change), the GCF – Global Climate Forum, Spilett New Technologies and the Institute for Transportation Design (ITD).

Overall more than 2,500 citizens as well as other relevant stakeholders of society were involved in the project. Opinions and perceptions on the subject were examined through surveys, focus groups and individual interviews. Moreover, a citizens' conference provided opportunity for interested parties to engage in discussions and exchange ideas on the subject, supported by experts. The climate protection potential of hydrogen vehicles and economic incentive mechanisms for the purchase of such vehicles were modelled. Finally, suitable images, visions and day-to-day scenarios for communicating the technology to the public were developed.

It could be shown that the German population boasts a general openness towards hydrogen mobility. The general public opinion of the subject is one of innovation and environmental friendliness. From the public's point of view, the environmental friendliness aspect of hydrogen vehicles is the key added value over conventional vehicles. The hydrogen used must therefore be »green« from the outset. Currently, the general public in Germany has no safety concerns towards hydrogen vehicles or hydrogen filling stations. Yet they are also currently not prepared to pay a premium for a hydrogen vehicle compared to a conventional vehicle.

PARTNER:	PROJECT BUDGET/€:	PROJECT FUNDING/€:
Unabhängiges Institut für Umweltfragen – UfU e. V. (Independent Institute for Environmental Issues)	1,699,974	1,699,974

COMMENCEMENT: 01 September 2009
CONCLUSION: 31 August 2013

How will we travel tomorrow? Thorsten Herbert, Head of the NIP Transport and Infrastructure area discusses issues concerning the future of mobility with the general public.

NIP – HYDROGEN PROVISION

ALL PROJECTS ARE MARKED WITH II / 01 ON THE FOLLOWING PAGES,
COMPLETED PROJECTS ARE MARKED WITH 🏁 .

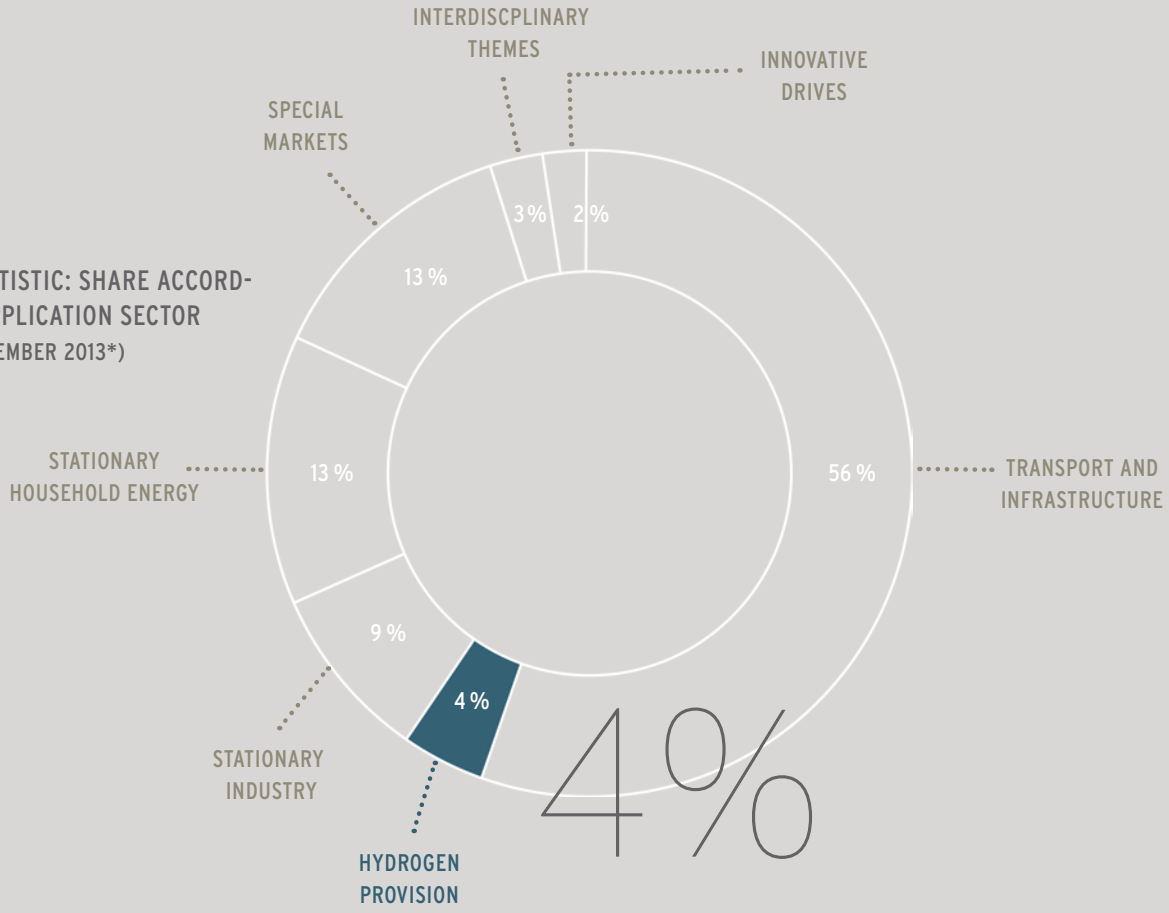
NIP – HYDROGEN PROVISION

Demonstration projects and studies on the production, storage and distribution of hydrogen as a fuel for fuel cell vehicles are conducted within the Hydrogen Provision programme area in the National Innovation Programme Hydrogen and Fuel Cell Technology (NIP). In the intermediate term and in the course of the so-called energy turnaround, hydrogen will also become increasingly important as a medium for storing large amounts of fluctuating renewable energy. Thus, the multifaceted energy carrier of hydrogen will open up new opportunities to bring the transport and energy sectors closer together – an important task that is not only highlighted through the federal government's mobility and energy strategy. The examination of the potentials for hydrogen to integrate the transportation and energy industries is therefore developing into a further assignment within the programme area.

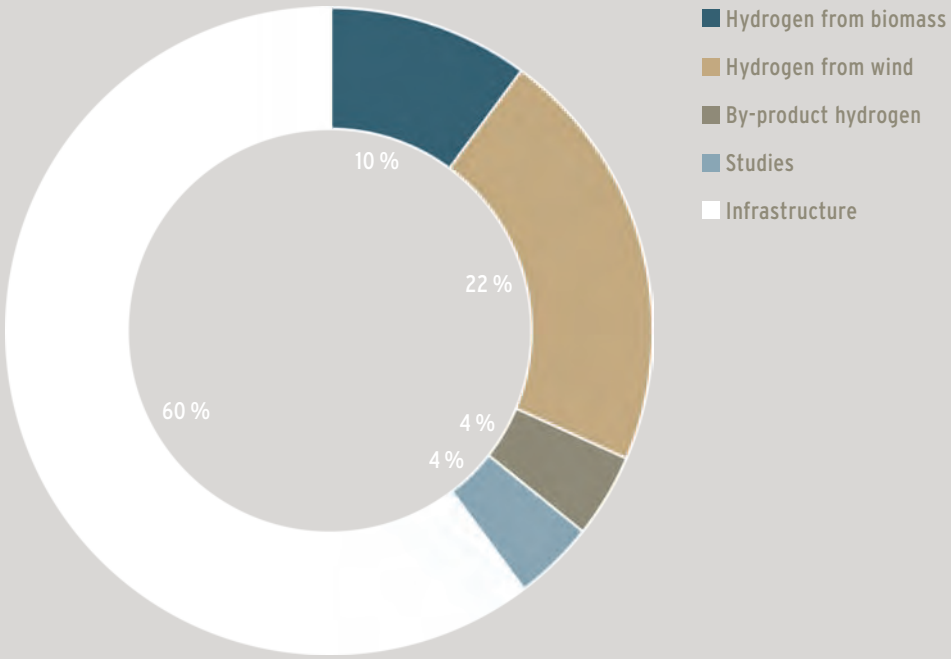
Hydrogen production via the highly efficient water electrolysis method, chiefly from excess wind energy, is at the core of the programme area. There are several electrolysis methods with different levels of suitability for particular applications, at diverse stages of development and boasting varying levels of developmental potential. Water electrolysis is regarded as a key technology for the integration of renewable energy in the areas of transportation and energy. New and growing markets for hydrogen lay the foundation for exploiting the significant development potential that is inherent in all electrolysis technologies. The tried and tested alkaline electrolysis method is today the most common method of producing hydrogen electrolytically. Meanwhile, the promising »young« alternative of PEM electrolysis is substantially gaining in importance. A large wind-hydrogen system, which besides alkaline electrolysis also enables the storage and reconversion to power on a needs basis, is also being supported in the programme area. A new demonstration project involves wind-hydrogen production based on a new type of PEM electrolyser in the performance range of one megawatt, with the subsequent feeding in of hydrogen into the natural gas grid network.

Hydrogen from biomass as well as a by-product of industrial processes is also significant for the supply of fuel. During the production of hydrogen from biomass, comprehensive evaluations are necessary that take all relevant technical, ecological and economic factors into account. In the case of by-product hydrogen, it must be examined to what extent its use can bring about advantages in terms of climate protection over the provision of hydrogen from fossil-based energy. The aspects of evaluating sustainability and incorporating hydrogen in the transportation and energy industries are important overall themes in the programme area, which is reflected in the studies commissioned.

NIP – STATISTIC: SHARE ACCORDING TO APPLICATION SECTOR
(AS AT DECEMBER 2013*)



NIP – HYDROGEN PROVISION: ALLOCATION BY APPLICATION AREA
(AS AT DECEMBER 2013)



* The diagram incorporates projects at planning stage at NOW, being processed by PtJ, LOI (Letter of Intent) as well as those approved.

WIND HYDROGEN AND POWER-TO-GAS PROJECTS ESTABLISH FEASIBILITY

RH_2 WERDER/KESSIN/ALTENTREPTOW

The NIP-supported RH_2 Werder/Kessin/Altentreptow demonstration and innovation project by the company WIND-project went into operation in September 2013. The alkaline electrolyser is run by surplus wind power that exceeds the intake capacity of the available electricity networks. The produced hydrogen is compressed, temporarily stored in gas cylinders and reconverted to electricity in combined heat and power plants upon demand. As soon as power is required – even when there is no breeze – the hydrogen combustion engines start and produce electricity via a generator. The stored amount of hydrogen is sufficient to run the combined heat and power plants at full power for two days and can thereby cover the own electricity requirements of a neighbouring wind park. As such, this project enables the perpetuation of wind power in electricity networks to thereby pave the way to allow the continual, large-scale feeding in of power made using renewable energy, in the medium term. An expansion of the current project to incorporate a facility to feed in hydrogen to the natural gas network is being considered.

POWER-TO-GAS FÜR HAMBURG

The Power-to-Gas für Hamburg project, for which construction commenced in June 2013, is a power-to-gas project in its proper sense. The project, which is supported by the NIP, involves using a PEM electrolyser to convert wind power to hydrogen and then feeds this into the natural gas network. Two key challenges of the energy turnaround are thereby being tackled simutaneously: the lack of storage options for renewably produced power and the capacity bottlenecks in the electricity grid. The overall investment amount totals 13 million euros. Project participants include E.ON, Hydrogenics, SolviCore, Deutsches Zentrum für Luft- und Raumfahrt (German Aerospace Centre) and the Fraunhofer-Institut für Solare Energiesysteme ISE (Fraunhofer Institute for Solar Energy Systems). The project is supported as part of the NIP with approx. 6.5 million euros. Construction is anticipated to take 1.5 years and regular operations should commence in 2014.

With this project, Hamburg acquires the world's most advanced power-to-gas plant. The electrolyser is particularly innovative. With a performance level of one megawatt it represents the largest PEM electrolyser system to date. PEM electrolysis has huge potential: the so-called stacks, which comprise the core of the electrolyser, take up just a fraction of the space that would be required for alkaline electrolysis. The facility in Hamburg makes a mark due to its compact dimensions and performance while simultaneously promising significant advantages during deployment under changing load conditions. The high energy demands of the metropolitan region and its location between the windy coastlines of the North and Baltic Seas makes Hamburg the ideal site to deliver a decisive impulse for the energy turnaround.

The highlight of power-to-gas technology is its ability to use renewable energy significantly more efficiently than before. With wind turbines being reliant on the wind and photovoltaic plants depending on sunshine, large fluctuations in green energy supply exist. As such, the aspects of energy storage and energy transport capacities have become the bottlenecks of the energy turnaround. With the new power-to-gas facility, the energy from surplus renewable power is converted to hydrogen. The gas can then be fed directly into the existing natural gas network. Here, large volumes of the energy can be transported across the country and can even be stored over extended periods. In the future, this may allow the natural gas grid to become a so-called bypass for the over-capacity high voltage electricity grid – and as such transform itself into a virtual battery for green electricity.

PARTNERS:	PROJECT BUDGET/€:	PROJECT FUNDING/€:
E.ON Gas Storage GmbH	4,386,005	2,105,282
Hydrogenics GmbH	3,812,244	1,829,877
SolviCore GmbH & Co. KG	2,353,668	1,129,761
Deutsches Zentrum für Luft- und Raumfahrt e. V. (DLR)	951,731	456,831
Fraunhofer-Gesellschaft zur Förderung der angewandten Forschung e. V.	2,285,830	1,097,198

COMMENCEMENT: 01 November 2012
CONCLUSION: 31 October 2015

Power-to-Gas masters two key challenges of the energy turnaround simultaneously: the lack of storage options for renewably produced power and the capacity bottlenecks in the electricity grid.

While the electrolysis technology and hydrogen target the aspect of stationary energy storage in this project, both components could easily also be used to provide hydrogen for transport and industrial applications. For many years, Hamburg has already been deeply involved in the Clean Energy Partnership and operates numerous fuel cell cars and buses; here the utilisation of wind hydrogen from the neighbouring State of Schleswig-Holstein, including its use for cavern-based storage or industrial purposes are intensively discussed topics.

This is where the project comes full circle for the multifaceted provision and use of wind hydrogen – and brings the NIP programme area aim of integrating the transportation and energy sectors, one step closer in Hamburg.

HYDROGEN: A VERY PROMISING OPTION FOR ENERGY STORAGE

Hydrogen has long been regarded as a fuel of the future in the transport sector. Over the past several years, hydrogen has now also been considered across sectors as one of the most promising mediums to store energy. This renewed interest in a gas that the chemical industry has used for more than a century is also a result of the energy turnaround, which was proclaimed by the federal government in 2011. Since the definitive withdrawal from nuclear power, interest on the topic of energy storage has grown sharply as a continued reliable supply of energy can only guaranteed in the future if renewable energy can stored long-term.

Renewable energy, in particular solar and wind power, are often described as fluctuating forms of energy. It is not produced continually due to its dependence on weather conditions, which in most areas are inherently irregular: solar power is only generated when the sun shines; wind power can only be produced when a wind blows. As a result, a large amount of renewable energy is produced on sunny, windy days. Yet if consumer demand for power is not simultaneously high, the clean power may need to be sold below its value or the wind turbines may even need to be switched off.

Currently, surplus renewable energy generated during off-peak times can only be stored for later use to a limited extend. This occurs, for example, in mountainous regions of Germany where water is pumped up hills at pumped-storage hydroelectric power plants. At times when power is required, the water can flow downhill where turbines generate electrical energy. An underground compressed air reservoir is also operational in Germany that works on a similar principle: in instances where sufficient cheap power is available, air is compressed using this surplus energy. Upon demand, the air can be released to drive turbines and thereby enables a portion of the previously stored energy to be regained. The capacity of such storage processes is, however, limited and these types of plants cannot be scaled up infinitively. Most experts do not expect that such technologies alone will be capable of covering the total fast-growing future demand for energy storage in Germany.

Batteries of a scale allowing the storage of enough power for days and weeks of consumption are not available. Even the combined storage capacity of several million battery-run vehicles would be insufficient to store enough renewably generated power that would be required to bridge several days without wind or sunshine. But hydrogen can do this.

Hydrogen can store »green power« over long periods. Moreover, it is possible to store large amounts of hydrogen. It is also for this reason that the interest in hydrogen as an energy storage medium has reignited. Hydrogen is a rather inconspicuous, colourless and very light gas. Compressed and stored in pressure tanks, however, it can store large amounts of energy for its weight. It is rarely found in nature in its elementary form or pure gas. Hydrogen must therefore first be harnessed from other chemical compounds – which may happen using several methods – before it can be used as a storage medium.

The analysis and testing of various paths of hydrogen production and use are major subjects of the NIP Hydrogen Provision programme area. Projects research and examine, for example, all technologies involved with wind-hydrogen systems – from electrolysis, through storage, to on-demand reconversion. The goal is to support technologies towards market maturity that ensure the safe, reliable and affordable use of hydrogen as both a fuel and stationary energy storage medium.

Demonstration projects, which are partly scientifically supported, are therefore conducted. Potential problem areas can thereby be identified early and suitable countermeasures taken, if required. Studies regarding the production, storage and distribution of

Since the definitive withdrawal from nuclear power, interest on the topic of energy storage has grown sharply.

hydrogen highlight the overall subject not only from a technical and ecological perspective, but also from the economic standpoint in order to ensure the sustainable, future-oriented technologies are also affordable. The large-scale storage of hydrogen in salt caverns represents a challenge, especially in view of the fact that this must be dealt with in an energy-efficient and thereby costly manner. In addition, a time-to-market of at least ten years will need to be taken into account to enable the numerous steps to be completed, spanning the planning, approval and construction processes. Even if large-scale storage systems were not to be required until 2025, concrete steps towards realisation would already need to commence today.

WATER ELECTROLYSIS

One of the most important fields of work for the provision of hydrogen is water electrolysis. In this chemical process, water is broken down into its components of hydrogen and oxygen using electrical energy. If the required power is derived from wind power or photovoltaic, this process is completely emission free and with an efficiency factor of around 70 percent also very resourceful. For several years now, the development of electrolysis technology has accelerated as the growing use of hydrogen as a fuel, storage medium and carbon-neutral industrial gas indicates. Furthermore, electrolysis has also clearly gained in importance in the context of young and dynamic power-to-gas initiatives. As the »Stand und Entwicklungspotenzial der Wasserelektrolyse zur Herstellung von Wasserstoff aus regenerativen Energien« (»Status and development potential of water electrolysis for the production of hydrogen from renewable energy«) study from NOW shows, further potential for optimisation exists, which should certainly be tapped into.

STORAGE IN SALT CAVERNS

Hydrogen can be stored in underground salt caverns for months on end. As part of the NOW study entitled »Integration von Wind-Wasserstoff-Systemen in das Energiesystem« (»Integration of wind hydrogen systems in the energy system«), a modelled cavern could take on 4,000 tons of hydrogen as gas with an energy content of 133 gigawatt hours. Despite the energy required for compression while feeding the gas into the cavern and subsequent gas drying on release, the efficiency factor of cavern storage is relatively high.

Practical experience in the use of salt caverns for hydrogen storage has been gained in the USA and the UK. The NOW study mentioned above showed that hydrogen caverns can also be used in Germany, at any location where suitable salt structures are found (e.g. northern Germany). The further prerequisites are that technical developments continue to advance, economic incentives for the establishment of storage facilities are provided and that safety specifications are defined in a timely manner.

REFUELLING HYDROGEN VEHICLES

Hydrogen that has been renewably produced and stored in caverns can be used in the transport sector. As such, hydrogen refuelling stations selling the fuel to the end consumer filling their hydrogen-run vehicles are potential direct customers of cavern operators. Alternatively, the sustainably produced gas can be supplied to stationary generators (e.g. fuel cell power plants, hydrogen motors) that produce power to feed into the public electricity grid. Also conceivable is the use of the hydrogen as an industrial gas.

FEEDING HYDROGEN INTO THE GAS GRID

Feeding hydrogen into the existing natural gas network is also an option that is both possible and promising. The German gas grid measures over 450,000 kilometres and can store vast volumes of energy. One single 900 mm gas pipeline can transport as much energy as six high-voltage power lines. As gas can be compressed, the entire network can absorb variations on both the supply and the demand side.

Considered on a global scale, hydrogen can today already be admixed with natural gas up to a high single digit percentage – without fear of adverse effects on the existing natural gas infrastructure. Naturally, each actual situation must be considered on a case-by-case basis, as lower amounts of the hydrogen admixture may only be possible in some individual instances. Demonstration projects are currently being conducted that examine in detail the very promising possibilities of feeding hydrogen into the gas network. By exploiting overcapacities, initial pilot plants have been able to boast efficient operation, and can now test the interaction of various necessary components as well as analyse their suitability.


4161a

To enable its commercialisation, it is necessary for economical production paths for sustainable hydrogen to be developed.

It is anticipated that through scaling up, large-scale plants will in future be capable of producing hydrogen at competitive prices in comparison to conventional production paths.

II / 01

» PRODUCTION OF GREEN HYDROGEN THROUGH GLYCERINE PYROREFORMING «

A significant benefit of hydrogen technology is its potential to cut greenhouse gases. To enable its commercialisation, it is necessary for economical production paths for sustainable hydrogen to be developed. This project demonstrated the production of hydrogen with low CO_2 emissions for supply of energy for fuel cell electric vehicles, based on the liquid, biogenic base material glycerine, in an initial pilot facility. By using a by-product of biodiesel, conflicts with food production are avoided. The project contributed particularly to achieving the aim of promoting the sustainable, low emission production of hydrogen within the framework of the National Innovation Programme Hydrogen and Fuel Cell Technology (NIP).

In the pilot facility, crude glycerine was first purified and subsequently converted at high temperature to a hydrogen-rich syngas through pyrolysis. This gaseous mixture is further processed with conventional means in a steam reforming plant. Following a final purification process, the hydrogen can be delivered to the consumer in a hydrogen fuel tanker truck. This innovative pilot facility was established by Linde in Leuna, a hub for industrial gases in Germany, at which the conventional, existing production process for hydrogen were integrated.

Within the framework of the testing campaigns, the technical set-up parameters for glycerine purification and pryoreforming were optimised. Furthermore, a method to remove any potential carbon deposits that may occur due to the biogenic character of the base material utilised was developed and its use established. As such, this method enables greater flexibility in terms of the base material quality while simultaneously ensuring stable operations.

It is anticipated that through scaling up, large-scale plants will in future be capable of producing hydrogen at competitive prices in comparison to conventional production paths. In addition, through an optimised thermal configuration of the process, further optimisation can be expected resulting in an 80 % reduction of CO_2 emissions compared with conventional production methods. In terms of the NIP, the project therefore contributes in preparing sustainable and, in future, competitive hydrogen production technologies for market introduction.

PARTNER:	PROJECT BUDGET/€:	PROJECT FUNDING/€:
Linde Gas Produktionsgesellschaft mbH & Co. KG	2,737,537	1,314,018

COMMENCEMENT: 01 September 2009
CONCLUSION: 31 December 2013

NIP – STATIONARY ENERGY SUPPLY

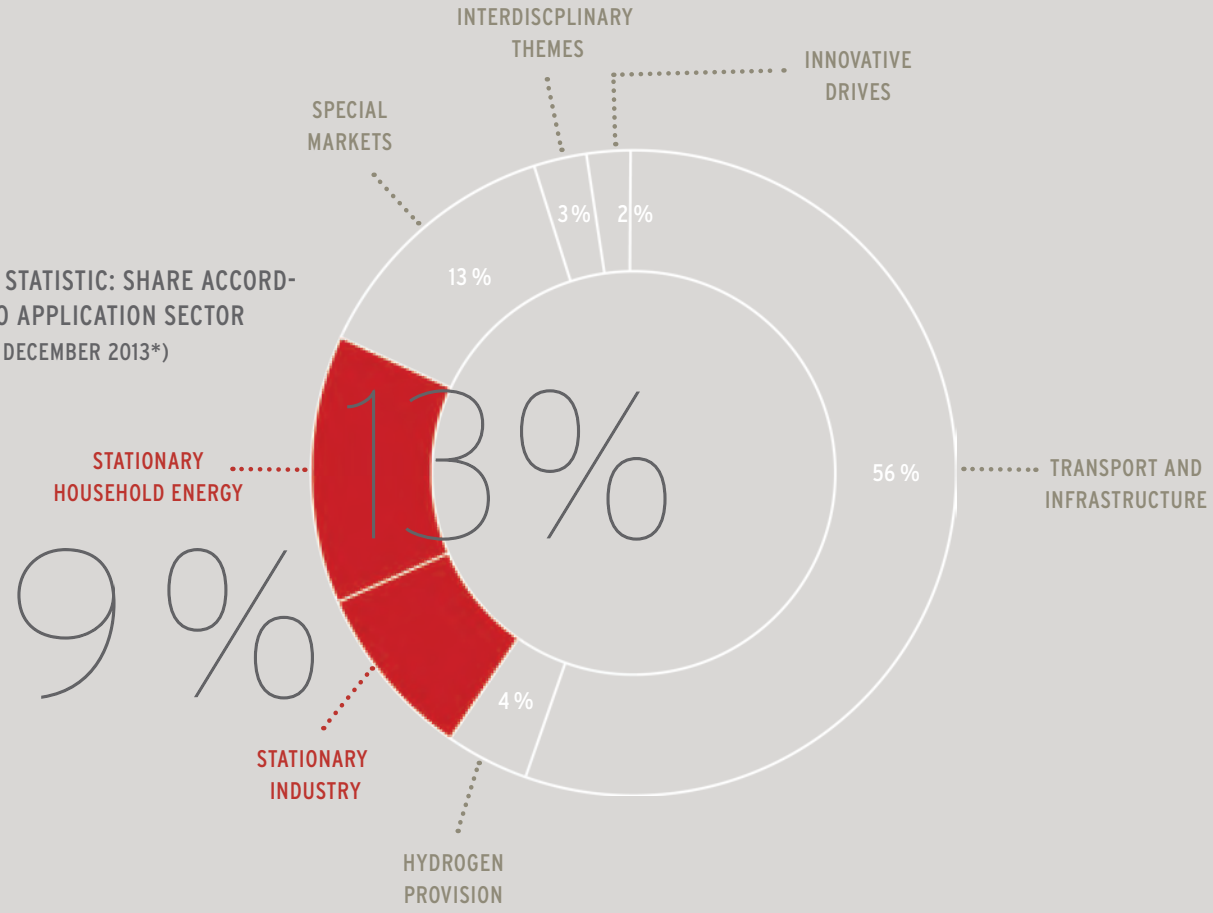
ALL PROJECTS ARE MARKED WITH III / 01 – III / 07 ON THE FOLLOWING PAGES,
COMPLETED PROJECTS ARE MARKED WITH 🏁 .

NIP – STATIONARY ENERGY SUPPLY

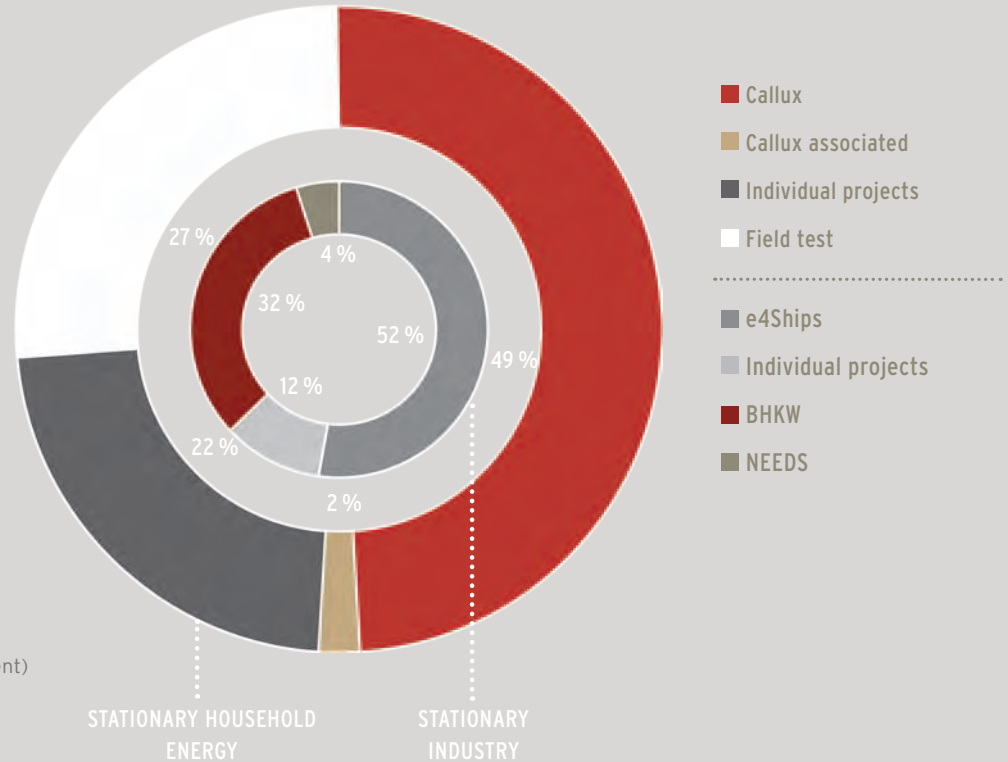
The Stationary Energy Supply programme area in the National Innovation Programme Hydrogen and Fuel Cell Technology (NIP) includes systems from a lower capacity range of one kilowatt to five kilowatts for household energy, and extends up to plants with some ten kilowatts to a few megawatts in industrial use. The simultaneous generation of heat and power via fuel cells facilitates high overall efficiency rates of more than 85 percent. This enables CO_2 savings of between 25 and 35 percent 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 is 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 to high-temperature polymer electrolyte membrane fuel cells (PEMFCs) and solid oxide fuel cells (SOFCs) will be used in this area. For fuel cell facilities in the industrial and shipping areas, SOFC technology is mainly used. However, high-temperature PEMFC technology is also becoming an important issue. In total there are several hundred fuel cell combined heat and power plants with a power capacity of 100 kilowatts and above in use worldwide.

NIP – STATISTIC: SHARE ACCORDING TO APPLICATION SECTOR
(AS AT DECEMBER 2013*)



NIP – STATIONARY APPLICATIONS: ALLOCATION BY APPLICATION AREA
(AS AT DECEMBER 2013)



* The diagram incorporates projects at planning stage at NOW, being processed by PtJ, LOI (Letter of Intent) as well as those approved.

E4SHIPS – FUEL CELLS IN MARITIME APPLICATIONS

Pollutant emissions from the auxiliary components of seafaring vessels, such as cruise liners and ferries, have a significant impact on air quality in port cities. With the introduction of stricter environmental regulations such as the Emission Control Areas (ECA) in the North and Baltic Seas or the coastlines of North America, as well as being a measure to maintain the appeal of shipping services, the maritime industry is aiming to substantially reduce these emissions.

On board fuel cells can make a significant contribution for the transition to an environmentally friendly power supply in the medium term. The advantages stem from a higher level of efficiency due to the coupling of electrical and thermal energy. If required, thermal energy can also be used for cooling. Moreover, pollutant emissions are radically cut. Using installations featuring a decentralised arrangement, redundancies are significantly increased and thereby also the reliability of the on board power supply (Safe Return to Port). Further advantages include reductions in both noise emissions and vibrations.

Aim of the e4ships lighthouse project is the targeted development of fuel cell systems for maritime deployment and tests aboard seafaring vessels. High temperature fuel cells are used for this purpose and the employed fuels may include methanol, natural gas (CNG, LNG) or diesel. With the selection of these energy carriers, the goal of significantly reducing pollutant emission is further supported. Within the framework of this project, suggestions and initiatives are being developed to assist in the creation of international guidelines for marine fuels, which are currently being drafted. Besides the systematic implementation on various vessel types and integration in the energy supply systems, the major technical challenges include deriving the technical standards for system types and performance classes. Moreover, the path must be prepared towards higher performance systems in the future.

Two demonstration projects for fuel cell applications on board ships are being conducted within the e4ships lighthouse project.

The Pa-X-ell project involves the testing of high temperature PEM fuel cells on a passenger ship and is led by the Meyer Werft shipyard in association with further project partners. The system is based on standardised 19-inch modular units that can be scaled up to any performance range by interconnecting the modules. In the first phase, a 30 kW demo plant will be constructed that will demonstrate the production of power, heating and cooling. This is the basis for a 120 kW system that will be installed on a passenger ship parallel to the conventional energy system and will be fed into the onboard power supply. The system will initially be run on methanol via internal reforming. A natural gas reformer will be integrated on board the ship in a first step. This will be followed in a second phase with the testing of a decentralised energy network with several systems.

The SchIBZ project is being conducted by a consortium led by ThyssenKrupp Marine Systems. At the core of activities is the development of an integrated fuel cell system with a performance level of 500 kW for seafaring ships. The system is to comprise the main energy source for the supply of power on all types of ocean-going vessels. Low sulphur diesel will be deployed as the fuel, as used by trucks on the roads. An adaptation of the system for natural gas is being aspired to in the medium term. Within this efficient hybrid system, a powerful Li-ion battery balances out differences in the dynamics of the fuel cell and the onboard network. Furthermore, the thermal energy from the exhaust air is exploited. A 100 kW system housed in a container on the ship will be built for practical testing running for 12 months on the high seas. Supplementing the test projects, the partners have joined together in an overarching module that considers questions regarding various issues including: the effects on climate protection; cost effectiveness; safety standards; and market introduction strategies – especially where this applies to non-typical fuels. The specific objectives of this strategy module are:

» Comparison and evaluation of existing ship energy supply systems with the hydrogen and fuel cell systems implemented in the research project, taking the aspects of ecological sustainability and energy efficiency into account

» Establishment of the required investment and operating costs of fuel cell systems and derivation of future potentials for optimisation as well as examining the economic impact of changes to various parameters

» Outlook towards the technical usage and expansion strategies in regard to typical space, weight and performance demands

The activities also include involvement in making contributions towards the drafting of international regulations and standards for the certification and installation of fuel cells as well as the use of low emission fuels such as LNG or methanol on ships and the provision of such fuels in ports. A main focus here is the coordination with the International Maritime Organisation (IMO).

More information on e4ships can be found at:
wwww.e4ships.de

callux (nip)
Fuel cell field tests for the home

INNOVATIVE SUPPLY OF HEAT AND POWER FOR THE HOME – CALLUX ON THE HOME STRAIGHT

With more than 350 installations to date and a total of 500 planned fuel cell heating systems, Callux, Germany's largest practical test for such stationary plants, goes into the last round which will directly lead to the market introduction phase. The expectations of being able to open a new chapter in heating technology have been met. Many small successes along the way have laid the foundation for series production.

IN OPERATION FOR 256 YEARS

Thanks to the concerted efforts of both government and industry, the Callux lighthouse project could amass 2.3 million hours of operational experience – which is equivalent to 256 years. The amount of power produced to date exceeds 1.3 million kilowatt hours. The test subjects use the power either in their own homes or it is fed into the electricity grid. Callux developed the required infrastructure within the framework of the project. Using the Callux-Box, the systems not only can be monitored but also controlled remotely – which is especially necessary for their operation as a virtual power plant. This allows the fuel cell heating systems to simultaneously feed the produced power into the electricity grid after receiving this command, thereby providing enhanced stability and additional capacity in the electricity network.

PASSED THE TEST FOR DEPLOYMENT IN DAY-TO-DAY OPERATIONS

To be successful in practice, fuel cell heating systems must be comparable with conventional plants in terms of their serviceability and reliability. Thanks to the enhanced dependability of stack operational periods, the number of maintenance procedures could be halved. As such, a level reliability has been achieved that needn't fear a comparison with conventional heating systems. Regular surveys from market research association GfK in Nuremburg confirm that the homeowners value this reliability. 98 percent of respondents were satisfied

with their systems, and nine out of ten would recommend such a system to friends with a similar housing situation.

CO_2 EMISSIONS CUT BY A THIRD

System reliability and customer satisfaction were subject to various technical optimisations. Continuous measurements throughout the entire course of the project provided data on numerous technical parameters. Improvements were attained in electrical efficiency, for example, which could be raised to 34 percent. Overall efficiency could also be boosted to 96 percent. In terms of CO_2 emissions, a reduction of one third in comparison to conventional condensing boilers and mains power could be attributed to the fuel cell-based systems.

A COMPLETELY NORMAL HEATER

Over the course of time, fuel cell heating systems have increasingly become more similar in design and size to their conventional counterparts. Physical dimensions have reduced and the weight has halved. This, together with the improved integration in existing heating technology, has simplified the instalment of such equipment by the trade into buildings. Operation of the plants, meanwhile, bears all the hallmarks of the respective manufacturers and also boasts a similar operational concept to other equipment. In terms of their look and operability, fuel cell heating systems are no longer different to other free-standing devices on offer by the companies.

COST REDUCTION TARGETS MET

The Callux practical test defined the binding quantities and cost targets in advance. This resulted in a 60 percent reduction in costs for the manufacture of the plants. Expenses for service and the stocking of spare parts could even be reduced by 90 percent.

GOOD PROSPECTS IN THE HEATING MARKET

According to GfK, these innovative heating systems producing both heat and power fundamentally have good chances of achieving market success. The market research clearly shows that fuel cells can be positioned in a manner demonstrating their advantage over other heating systems available in the market. The heating trade sector, the most important point of contact for homeowners during refurbishments and new installations, has also been prepared for the introduction of this new technology. Through the provision of training materials and the establishment of an educational network at vocational schools, Callux is supporting the spread of specialist knowledge in the heating trade area.

More information on Callux can be found at:
www.callux.net

FUEL CELLS IN THE HOME: HOW DO THEY WORK?

Fuel cells for the supply of household energy use the hydrogen contained in natural gas for the production of heat and power. In contrast to conventional natural gas heaters, fuel cells convert the energy in an electrochemical process, not via combustion. This results in a comparably high level of efficiency and lower CO_2 emissions. At the core of the system is the »stack«. Here several fuel cells are lined up to form stacks, as the name suggests. Two technologies have established themselves: the polymer electrolyte membrane fuel cell (PEMFC) and the solid oxide fuel cell (SOFC). The combined production of heat and power takes place here. With its two electrodes, one anode and one cathode, the fuel cell resembles a battery on a technical level. The anode and cathode are separated by an electrolyte, which allows the permeation of ions but not gases. With the addition of oxygen and hydrogen, which is contained in natural gas, a reaction occurs resulting in both current and heat simultaneously being created between the electrodes. Both products can be used for the supply of energy in the home.

The stack comprises the component that – as is also the case for every other heating technology – must be integrated in the heating system. The manufacturers have progressed in the development of these devices to the point where hardly any differences can be seen between fuel cell-based and conventional heating systems, and even installation effort is comparable, overall. Operation is via a control panel that principally works in the same manner as other heaters, with the addition of the further power generation function.

Different manufacturers have developed systems that are deployed as either full heating systems or auxiliary systems. While full heating systems take care of the complete supply of heat with either a coupled or integrated condensing boiler, the auxiliary devices can be attached to existing or new heating systems enabling these to take on a large portion of the warm water supply. Depending on the performance capacity, areas of application can range from the modernisation of the heating system to a completely new installation.

Nothing changes for the homeowner in terms of operating comfort through the deployment of a fuel cell. Heat is available on demand and the generated electricity is used either in the household itself or fed into the electricity grid. Thanks to the electrochemical energy conversion process, fuel cells operate more quietly than motor-driven combined heat and power plants. Most manufacturers make use of the possibilities of remote maintenance, which enables disruption reports to be immediately forwarded to the relevant heating specialist, manufacturer or energy supplier. The control of the plant from afar is also possible – which is especially useful when the energy supplier uses the fuel cell as part of a virtual power plant. This then allows the coordinated feeding in of power to the electricity grid together with other fuel cells in the virtual power plant, whenever this is required to ensure or stabilise power supply. Specific maintenance procedures may also be initiated remotely, such as switching off the device at the required time.

III / 01

» RAISING ENERGY EFFICIENCY IN HOME ENERGY SUPPLY – FUELCELL@HOME PHASE 2 «

Together with the Australian-German manufacturer Ceramic Fuel Cells (CFC) and Gebrüder Bruns Heiztechnik (Bruns), the northern German energy service provider EWE VERTRIEB GmbH (EWE) is testing fuel cell heating systems in north-western Germany. The aim of the two phases of the field test is to prove the technological maturity and to prepare for the market introduction of highly efficient micro CHP systems on the basis of fuel cell technology. Building on the successful first phase of the project, units from the new beta 2nd generation will be tested in the second phase.

With predominantly detached homes in building stock in northwestern Germany, there is great potential for raising energy efficiency through the use of innovative micro CHP technology. Through the simultaneous production of electricity and heat and its direct use in buildings, a considerable contribution can be made to climate protection, as the primary energy used is converted more efficiently compared to conventional electricity and heat supply. Natural gas as an energy source provides an environmentally-friendly basis for this purpose, which can be further optimised through the use of biogas. In this respect CFC fuel cell technology offers a very good opportunity to increase energy efficiency, as it has a very favourable ratio of electric to thermal capacity.

CFC, with its location and production facilities in Heinsberg, North Rhine-Westphalia, develops and produces the fuel cell heating units together with the heating technology manufacturer Bruns from Saterland in Lower Saxony. Regional tradespeople also involved in the project are getting to know this new efficient technology at an early stage through the field test and can bring their experiences to product development as well as advancing their own skills. Along with other activities in the area of stationary fuel cell applications, such as the lighthouse project Callux, the project constitutes an important building block in the National Innovation Programme for Hydrogen and Fuel Cell Technology.

PARTNER:	PROJECT BUDGET/€:	PROJECT FUNDING/€:
EWE VERTRIEB GmbH	3,554,558	1,706,187

COMMENCEMENT: 01 April 2013
CONCLUSION: 30 June 2016

»Through the simultaneous production of electricity and heat and its direct use in buildings, a considerable contribution can be made to climate protection.«

» The ability to provide the complete coverage of base load requirements for the supply of electricity and heat in households, at the highest levels of efficiency and cost-effectiveness, makes Elcore 2400 unique.«

III / 02

» HOME ENERGY SYSTEMS FIELD TEST «

In the home energy systems field test project, 50 examples of the Elcore 2400 fuel cell heating unit were installed and tested with end customers. What is unique about the Elcore 2400 is the complete coverage of the base load requirement for electricity and heat supply of detached homes at the highest efficiency and cost-effectiveness. Already in this phase of the field test it can be proven that the Elcore 2400 exhibits the highest economic viability of all the combined heat and power systems by the substantial savings in detached homes in terms of electricity and gas consumption.

In the project, the focus is on testing the operating hours and the own consumption of electricity and heat in the detached house. The units have currently reached a cumulative running time of over 100,000 operating hours, whereby reliable system operation and systematic coverage of the base load requirement in the detached homes can be proven.

Within the project, skilled trade was also closely involved, which reported particularly positive feedback regarding the simple installation of Elcore 2400 in new and existing home energy systems.

PARTNER:	PROJECT BUDGET/€:	PROJECT FUNDING/€:
Elcore GmbH	1,745,943	838,053

COMMENCEMENT: 01 September 2012
CONCLUSION: 31 December 2014

III / 03

» ENDURANCE TEST FOR SERIES PRODUCTION-READY STEAM REFORMER – LDT «

Reformers of various types are an integral part of all micro combined heat and power plants and represent the link between the fuel cell and the existing natural gas network. In PEM fuel cell systems, steam reforming with CO-shift and subsequent chemical CO removal has established itself.

Building on FLOX reforming technology, »Selective Methanisation« (SelMeth) was developed in the course of the project as a cost-effective solution to achieve the requisite level of hydrogen purity. The complete reformer system was also subjected to extensive endurance tests of a practical nature. As such, WS Reformer is therefore the world's first known manufacturer capable of providing this technology with evidence of an extended lifetime. The project thereby contributes to securing a leading technological position and assists in efforts for market introduction in Germany.

To begin, basic experiments were conducted to ascertain the operating characteristics of the »SelMeth« catalyser. Next, the critical states in practice were defined, in close cooperation with the catalyser manufacturer. The main task involved the equipment-based and thermal integration of the SelMeth reactor in the existing design of the FLOX reformer. The technological key was found in the patented heat management system of the reformer, which enables operation in the catalyser's extremely narrow temperature range without active adjustments and only the most minimal equipment requirements. Cost advantages can thereby be attained over the conventional »Preferential Oxidation« technology, for both medium quantities and in mass production.

Test benches specifically developed for this purpose were able to provide proof of functionality (CO=0 ppm) for over 15,000 hours of operation and 2,000 start-stop cycles in the 1 Nm^3/h and 5 Nm^3/h hydrogen production performance class. Simultaneously, suitable auxiliary systems (water pumps, blower units, valves, etc.) could be tested and identified for series production.

Building on the positive results, the original project scope could be expanded to include the development of a complete LT-PEM fuel cell system in the 1 kW class. In combination with a commercially available stack, the reformer system could be tested for more than 9,000 hours in a real heater environment. To date, no significant degradation effects where identifiable in practice-relevant operating data, output performance and consumption.

PARTNER:	PROJECT BUDGET/€:	PROJECT FUNDING/€:
WS Reformer GmbH	886,434	425,488

COMMENCEMENT: 01 January 2009
CONCLUSION: 30 June 2013

III / 04

» ESTABLISHING MEA CHARACTERISATION METHODS FOR THE OPTIMISATION AND COST REDUCTION OF CERAMIC CELLS (MEA) FOR APPLICATIONS IN ENERGY TECHNOLOGY – SOFCONVERT «

Because of its high overall degree of energy efficiency, fuel cell technology can contribute significantly to the reduction of CO_2 emissions and ensure a secure, competitive and environmentally-friendly energy supply in the long term. For the breakthrough of the solid oxide fuel cell (SOFC) to the market, qualities such as performance, robustness and costs are of crucial importance, and these are the aspects which form the focus of this project.

The aim of the project was to raise the performance of the cells manufactured at Kerafol by developing them further and thus reduce costs. In addition, Kerafol staff were trained in Siemens AG at MEA test benches in order to carry out independent measurements. Two test stands were comprehensively modernised and transferred to Kerafol in a newly-installed hydrogen laboratory including the associated infrastructure at the end of the project. Thus Kerafol is in a position to guarantee the quality of the cells manufactured and continue to develop them further.

A benchmark test showed clear room for improvement of the output cells with almost 70 % higher resistance compared to competing cells. To further improve the electrodes, existing paste formulations and their preparation were optimised. In existing uLSM cathodes the polarisation resistance was substantially reduced in this way. In addition the use of new materials was tested and partly established in cell manufacture. In this way cathodes with LSCF were developed, and their considerably lowered resistance yields good cell performance. With self-synthesised LSXM cathode powders of an additional B-level element, homogenous and fine microstructures are achieved at high firing temperatures through a lower sintering activity. Through this the polarisation resistance of the cells were lowered despite higher firing temperature. However the LSXM cathode activated less strongly than the uLSM cathode, so that the cell resistance was not considerably reduced.

On the anode side, through adapted solid contents and the rheology of the pastes the undercoating was made thinner and more impervious. The use of new anode materials through an improved microstructure yielded a considerably enhanced anode performance, lowered polarisation resistance and greater ageing resistance. With cells of the optimised anode and LSCF cathode, an overall resistance of about 250 $m\Omega cm^2$ was achieved. Stable long-term testing of over 2,500 h and a lower degradation of less than 0.5 % per thermal or redox cycle could be established. With the optimised LSM and LSCF cathodes as well as the Ni-YSZ and Ni-GDC anodes, Kerafol offers three different electrode variations for high performance ESCs, which can be applied to different electrolyte materials and are competitive.

PARTNER:	PROJECT BUDGET/€:	PROJECT FUNDING/€:
KERAFOL Keramische Folien GmbH	1,725,733	828,351

COMMENCEMENT: 01 June 2010
CONCLUSION: 31 May 2013

III / 05

» DEVELOPMENT OF A FUEL CELL MODULE FOR COMBINED HEAT AND POWER – ELCORE 1 «

In the ELCORE 1 project, a low-cost, highly efficient high temperature polymer electrolyte fuel cell (HT-PEM) was developed based on innovations designed by Elcore. These include the creation of a cost-efficient stack technology which takes into account the special features of HT-PEM technology; a low-cost and highly efficient reformer technology which can convert natural gas into a hydrogen-rich gas containing <1% CO; straightforward and highly efficient heat integration with optimal management of thermal flows on system levels and a closed water balance; and a clear philosophy regarding control and regulation technology that leads to stable system behaviour with the expectation of long service life. The overall efficiency of the unit is about 99 %, the highest degree of efficiency in combined heat and power units.

The development aspects mentioned above were demonstrated in comprehensive tests and (electrically) scaled in a 5 kW performance range. Compared to today's solutions, the result represents a significantly simplified system design and drastic cost reduction, leading to the potential to commercialise fuel cell-based CHP units.

PARTNER:	PROJECT BUDGET/€:	PROJECT FUNDING/€:
Elcore GmbH	5,082,566	2,439,632

COMMENCEMENT: 01 October 2009
CONCLUSION: 31 July 2013

»Compared to today's solutions, the result represents a significantly simplified system design and drastic cost reduction, leading to the potential to commercialise fuel cell-based CHP units.«

III / 06

» ACCOMPANYING FIELD TEST PROJECT: OPTIMISATION OF A FIELD SYSTEM – INHOUSE5000PLUS «

Aim of the project was to use all the available information and know-how arising from the inhouse field test, which was running simultaneously, for the development of a fuel cell system suitable for series production. A focus of the work was on improving system efficiency, robustness and costs.

Project partners SolviCore GmbH & Co. KG (SC), inhouse engineering GmbH (IE) and Riesaer Brennstoffzellentechnik GmbH (RBZ) worked together over several years to develop the PEM stack and system of the inhouse5000 fuel cell heater, which is currently being tested in the inhouse field test within the framework of the National Innovation Programme Hydrogen and Fuel Cell Technology.

The responsibilities were distributed among the project partners as follows: RBZ was responsible for system integration in the project along with the development and optimisation of the reformer module. IE developed and optimised the PEM stack, the fuel cell module and the control system. SC was responsible for the development and optimisation of the membrane electrode assembly (MEA). This enabled the respective strengths of each project partner to be fully exploited and allowed for three main areas of focus for household energy supply

» PEM stack and cell components;

» reformer and gas processing; and

» system optimisation

to be effectively executed. A value added chain for the PEM fuel cell and the complete system could thereby be established in which the manufacture of the key components occurs in Germany.

Process technology analyses as well as reliability analyses were conducted on the basis of the available inhouse field test data. Key focal points for development in the project were thereby defined. New systematic operational parameters and new individual components were subsequently developed or optimised. Through the application of newly developed measuring methods for the diagnosis of PEM stacks in operation as well as new methods for post-mortem analyses, additional insights could be gained that contributed decisively to the project's success.

A new MEA generation could be developed that led to a 10 % performance increase in the PEM stack while simultaneously reducing catalyser load by around 37 %. Combined with an improved operating mode of the system, the degradation rate could also be reduced to 5 µV/h. Moreover, system costs could be reduced by 17 %.

Cold start-up times were reduced to just below one hour and at return temperatures of under 40°C the system could operate water self-sufficiently.

The outcomes are integrated in the new inhouse-5000plus system. This is to be trialled in further practical tests in Germany and across Europe and in turn make the transition to small series production.

The key conclusion is that necessary efficiency increases and cost reductions can be achieved by considering and developing the core components more as a whole. It is furthermore noteworthy that the general conditions for combined heat and power plants are not clearly defined in the case of apartment buildings. As such, questions regarding their economic viability can currently not always be satisfactorily answered. This means that there is a need for immediate action for successful market entry, especially in regard to international competition with North American and Japanese manufacturers who are already introducing significantly larger numbers on the market due to targeted national support.

SPECIFICATIONS INHOUSE 5000PLUS FUEL CELL COMBINED HEAT AND POWER UNIT	
Model	inhouse5000plus
Country of designation	Germany
Hydrogen generation	Steam reforming of natural gas
Fuel cell type	NT-PEM-FC with reformate operation (natural gas)
Inverter	Single phase, grid-connected
Q_N	Approx. 7.5 kW
$P_{el\ max.}$	5 kW gross
Power modulation	30 to 100 %
Electrical efficiency	28 to 32 %
Total efficiency	82 to 92 %
Protection class	IP42
Dimensions (WxHxD)	750 x 1,550 x 1,159 mm^3
Applications	Apartment houses, small businesses

PARTNERS:	PROJECT BUDGET/€:	PROJECT FUNDING/€:
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	278,924	133,884

COMMENCEMENT: 01 July 2010
CONCLUSION: 31 December 2013

» DEVELOPMENT OF A CFY STACK PLATFORM TECHNOLOGY FOR STATIONARY SOFC SYSTEMS IN A 5 TO 50 KW PERFORMANCE RANGE – SOFC20 «

Hydrogen and fuel cell technology will play a considerable role in future when it comes to energy supply. In order to decisively speed up the market preparation of products based on SOFC (Solid Oxide Fuel Cell) high temperature fuel cells in the stationary energy market, efficient and stable systems must be demonstrated. To achieve this, the testing parameters of a stable system operation were set at over 1,000 h with an electrical output ≥ 5 kW at a system efficiency of ≥ 50 % as an overall objective for the project. Using a CFY stack platform technology for the 5 to 100 kW+ performance range, a SOFC system was configured with higher efficiency and performance in line with the objectives outlined, in which the following priorities were pursued:

» Construction of a module with several, serially-connected CFY stacks

» Internal reformation

» Pre-reforming with steam from high temperature anode gas recycling

Through the development and use of new materials (interconnectors, protective coatings, MEA electrodes, glass solders) and the optimisation of the manufacturing process, CFY stacks can be built in a reproducible way with an increased stack performance of up to 850 W per stack. At the beginning of the project, 800 W per stack was the technical standard. Robustness and service life were proven in ongoing endurance tests. During a test period of 18,000 h to date, a degradation of < 0.7 %/kh at 35 A and a combustion gas consumption of 75 % has been determined. The stack module, which supplies the required voltage level as well as the necessary power, was a completely new development. By means of the simulations carried out at AVL GmbH and the Forschungszentrum Jülich, a particularly simple and efficient system could be designed through the use of hot anode gas recirculation (up to 600°C), among others. BoP components (e.g. ignition boilers, reformers, etc.) were successfully built, tested and finally integrated in the system. In particular the very compact blowers for the anode gas recirculation as well as for the cathode-side air supply achieve a high efficiency and service life and were tested for the first time globally in system operation. The required number of start/stop cycles of hydro-dynamic blowers (up to 120,000 U/min) was thus successfully proven. After three iteration stages and a component optimisation, the system was operated for over 1,000 h without degradation. The operating data of all system components were very much consistent with the results of the individual tests. The net peak capacity of 5.1 $kW_{el,DC}$ as well as a net efficiency of 46 $\%_{el,DC}$ were demonstrated. An additional system analysis showed that the increase in stack module efficiency, the decrease in heat losses and the recirculation rate will lead to over 50 % efficiency. The system costs for mass production were evaluated by partners. The simplicity of the system and the minimal number of components will provide in future for inexpensive system manufacture.

PARTNERS:	PROJECT BUDGET/€:	PROJECT FUNDING/€:
Plansee Composite Materials GmbH	2,405,260	1,154,525
Fraunhofer-Gesellschaft zur Förderung der angewandten Forschung e.V.	3,917,991	1,880,635
AVL Schrick GmbH	1,710,693	821,133
SCHOTT AG	523,955	251,498
Forschungszentrum Jülich GmbH	391,529	187,934

COMMENCEMENT: 01 April 2010
CONCLUSION: 30 June 2013

NIP – SPECIAL MARKETS

ALL PROJECTS ARE MARKED WITH IV / 01 – IV / 07 ON THE FOLLOWING PAGES,
COMPLETED PROJECTS ARE MARKED WITH 🏁.

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 deployed in the special markets is large, as are the diverse types of implemented fuels and fuel cell technologies.

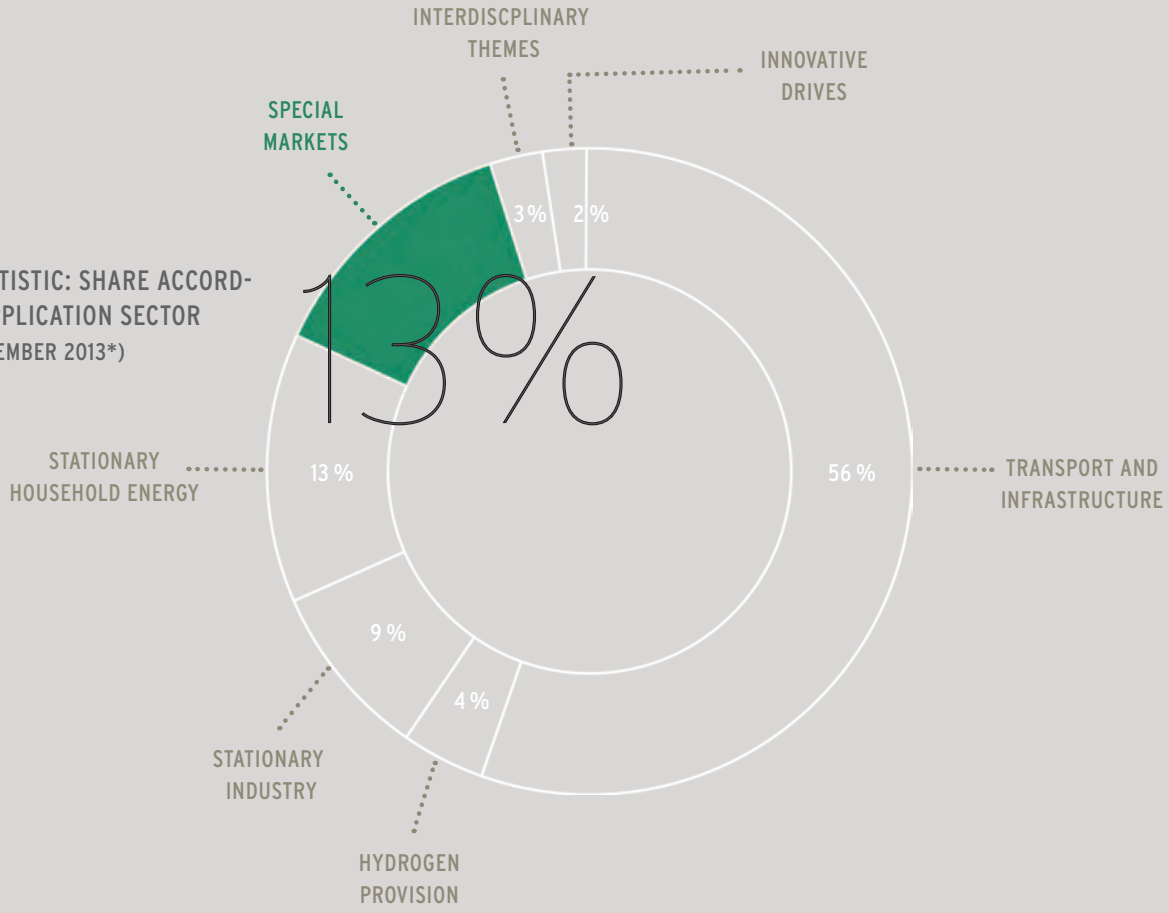
The special markets also utilise many of the components that are also deployed in fuel cells for vehicles and stationary applications. The power range of applications extends from just a few watts for micro fuel cells, through several 100 watts for on-board power supplies, up to several ten kilowatts for special vehicle applications. Hydrogen, methanol, ethanol, bio-ethanol and LPG in conjunction with a reformer, are employed as fuels. Various systems are in use for the supply of hydrogen: from gas cylinders and cartridges with metal hydrides or hydrogen generators based on chemical hydrides, to methanol with existing infrastructure and logistics for distribution. The establishment of small hydrogen filling stations is also foreseen. In terms of fuel cell technologies, the spectrum covers polymer electrolyte membrane fuel cells (PEMFC), high temperature polymer electrolyte membrane fuel cells (HT-PEM), direct methanol fuel cells (DMFC) and solid oxide fuel cells (SOFC).

The special markets incorporate fields of application that include:

» Power supply for business (emergency power supply, UPS, off-grid power supply, autonomous/hybrid power supply, emergency power systems)
» Power supply for leisure (on-board power supply and drives)
» Warehouse vehicles (forklifts, haulers, tuggers, baggage tractors at airports)
Special vehicles (refuse collection vehicles, small trucks with fuel cell range extenders)
» Electric light vehicles/boats
» Micro fuel cells (industrial sensors, small device supply)

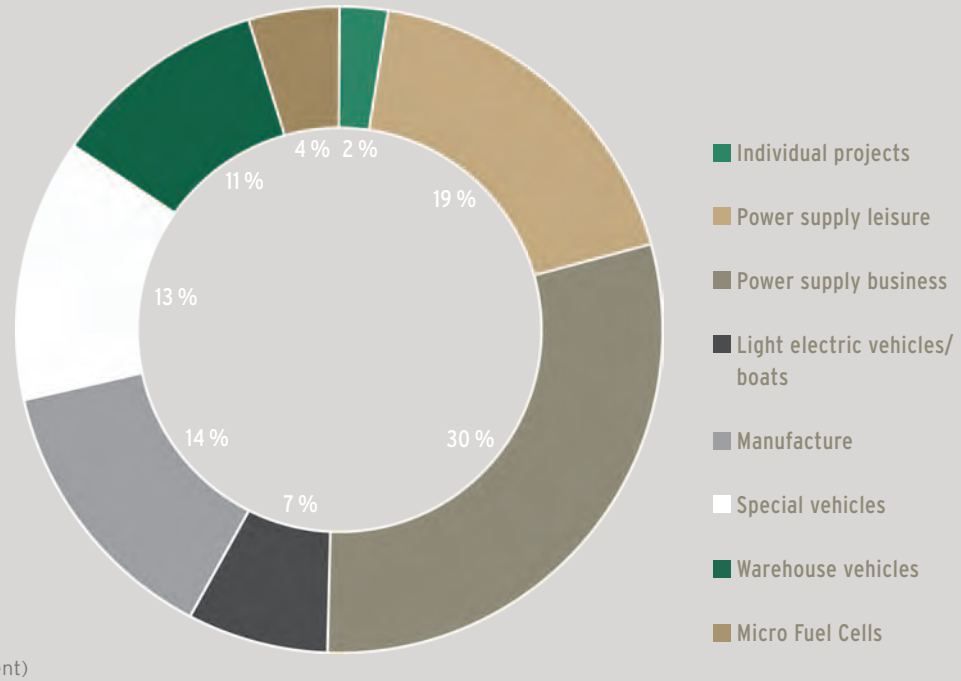
NIP – STATISTIC: SHARE ACCORDING TO APPLICATION SECTOR

(AS AT DECEMBER 2013*)



NIP – SPECIAL MARKETS: ALLOCATION BY APPLICATION AREA

(AS AT DECEMBER 2013)



* The diagram incorporates projects at planning stage at NOW, being processed by PtJ, LOI (Letter of Intent) as well as those approved.

clean power net
Brennstoffzellen in Industrie und Business

EMERGENCY POWER SUPPLY WITH FUEL CELLS – CLEAN POWER NET: A LIGHTHOUSE PROJECT OF THE NATIONAL INNOVATION PROGRAMME HYDROGEN AND FUEL CELL TECHNOLOGY (NIP)

In our modern world today, the reliable supply of power is more important than ever. Whether in hospitals, monitoring/control centres, data centres or in the area of telecommunications – we depend on the fail-safe supply of power. But this provision of power must simultaneously occur in an environmentally friendly manner in order to achieve the goals of the energy turnaround.

Fuel cells can make a significant contribution here, especially in regard to critical infrastructure, as they boast longer run times across a broader range of temperatures in comparison to batteries. For this reason, the Federal Ministry of Transport and Digital Infrastructure (BMVI – Bundesministerium für Verkehr und digitale Infrastruktur) is supporting the Clean Power Net (CPN) network over a period of three years, commencing July 2013. The network is an association of 23 companies and R&D institutes within the fuel cell industry and an officially supported lighthouse project of the special markets programme area of the NIP. According to CPN, the current methods of supplying the energy for uninterruptible power supplies (UPS) in the telecommunications and other industry sectors must be revised: »Hydrogen and fuel cell technology are an important option that can contribute to the required changes in our energy systems,« explains network spokesperson, Henrik Colell. Work has already commenced in this regard by the telecommunications sector and energy industry, with the initial individual projects demonstrating the successful implementation of fuel cell systems for emergency power supplies. »The time has come to actively push ahead the deployment of fuel cells in the global mobile phone and TETRA digital radio networks. Major export opportunities for German fuel cell providers are emerging here.«

Over the coming years, fuel cell manufacturers in Germany not only anticipate continued rapid development in the area of fuel cell technology itself but also in terms of the associated infrastructure and logistics. For the first time, the technology now has the real chance to be introduced to the commercial market and to become established. Besides fuel cell technology applications in the area of UPS, the CPN network also focuses on the development of energy management systems, ensuring energy balancing through the networking of decentralised energy producers into an efficient overall system, as well as the deployment of fuel cells in remote, off-grid areas. Mobile phone base stations set up in such rural off-grid locations, construction site protection systems or road pricing systems are examples of instances where the required power is today still generally provided via batteries or diesel generators. The fuel cell provides and environmentally sound and economical alternative.

It is important to recognise, however, that obstacles must still be overcome for the market preparation and introduction of the fuel cell in industrial and business applications to succeed. With the CPN as an open, nationwide and cross-sector association, the goal of a more efficient and intelligent climate-friendly supply of power for industrial users is to be realised and a corresponding supplier industry strengthened.

More information on Clean Power Net can be found at **www.cleanpowernet.de**

The time has come to actively push ahead the deployment of fuel cells in the global mobile phone and TETRA digital radio networks.

IV / 01

» INDUSTRIAL DIRECT METHANOL FUEL CELL MODULE FOR EMERGENCY POWER APPLICATIONS AND OFF-GRID ENERGY SUPPLY FOR CRITICAL INFRASTRUCTURE – INDUSTRIAL DMFC «

Existing DMFC-based fuel cell products are today deployed in the low performance, under 500 W, range. Due to the higher energy demands in many industrial applications, significant potential exists for DMFC systems in this market. An increase to the power output of a DMFC module to 500 to 1000 W and the development of a cascading system allow the DMFC to be deployed for energy supply solutions of 0.5 to 5 kW.

A DMFC solution in the lower kW range closes the gap between the performance range of hydrogen fuel cells and the DMFC systems available until now. The advantages of the liquid fuel methanol – easy logistics and a long shelf life – can simplify market entry of the fuel cell in many industrial applications. The comparably high acquisition costs of DMFC systems can be depreciated over five, ten or more years. As such, the purchase costs for systems in the single-digit kW range do not represent an insurmountable hurdle for market entry. Rather, substantial cost savings and significant other advantages can be attained with practical implementation including the inherent easy handling characteristics of the fuel methanol in running operations.

Because of the exceptional efficiency of a DMFC to produce direct current from fuel, the DMFC can even hold its own when compared with the fuel costs of a conventional generator – yet it only emits minimal noise and boasts the advantage of being maintenance free over many years. By packaging the fuel cells in types of casings that customers are familiar with, customers are not only provided with a new technology but also a standardised solution.

PARTNER:	PROJECT BUDGET/€:	PROJECT FUNDING/€:
SFC Energy AG	1,814,746	871,078

COMMENCEMENT: 01 May 2013
CONCLUSION: : 31 December 2015

» Because of the exceptional efficiency of a DMFC to produce direct current from fuel, the DMFC can even hold its own when compared with the fuel costs of a conventional generator. «

IV / 02

» DEPLOYMENT OF HYDROGEN-RUN MATERIAL HANDLING VEHICLES HANDLING FOR INTRALOGISTICS UNDER PRODUCTION CONDITIONS – H_2INTRADRIVE «

The project goal is to trial the use of material handling vehicles such as forklifts run on environmentally, efficient hydrogen, under real production conditions and to develop these further towards series maturity. Besides sustainability, a key focus is on recharging cycles and maintenance. In conventional vehicles of this type with batteries, these aspects result in relatively high downtimes due to the necessity to change the lead-acid batteries. In contrast, the fuel cell hybrid system for forklifts and haulers is low maintenance and also boasts refuelling procedures that are completed within just a few minutes. The vehicles therefore attain higher rates of availability, particularly in multi-shift operations.

Germany's first indoor hydrogen refilling station was established at the BMW production facility in Leipzig for the construction of the BMW i vehicle body. Linde Material Handling provided the hydrogen-run fuel cell vehicles for material handling used in this project, which with four tugger trains and five forklifts comprised part of the vehicle fleet used in the production facility. The Lehrstuhl fml (Institute of Materials Handling, Material Flow, Logistics) at the Technical University of Munich will provide scientific support and evaluation in terms of ecological and economic sustainability. BMW will test the technology under everyday conditions within a real production environment, using hydrogen that was produced CO_2-free.

PARTNERS:	PROJECT BUDGET/€:	PROJECT FUNDING/€:
Bayerische Motoren Werke AG	2,954,767	1,418,288
Technische Universität München	244,576	117,396
Linde Material Handling GmbH	2,302,405	1,105,154

COMMENCEMENT: 01 December 2012
CONCLUSION: : 30 April 2016

Hydrogen forklift at the BMW i production site

IV / 03

» ACCOMPANYING MEASURES FOR FUEL CELL LOGISTICS AND COMMUNICATION IN THE AREA OF BUSINESS ENERGY SUPPLY (UPS/EMERGENCY POWER SUPPLY) – OVERARCHING SYNERGY MODULE IN THE CLEAN POWER NET LIGHTHOUSE PROJECT «

The aim of the project is to increase public awareness and measures in the area of communication for the Clean Power Net (CPN) lighthouse project as an »umbrella« across all individual projects in the area of business power supply (UPS/emergency power supply) and the development of a design tool for fuel cell logistics for critical, decentralised power supply. For the latter, technically feasible logistics solutions for fuel cells are to already be compared and assessed, taking economic aspects into account, during planning. Fuel cell system providers should therefore be supported during a precompetitive phase. Communication is a key factor for market preparation of fuel cell systems for uninterruptible power supply (UPS). Within the CPN, this should be bundled through mutual measures across numerous companies in order to bring about greater acceptance for the fuel cell and to generate multiplier effects through reference projects and applications. According to estimates by experts, sales through the deployment of fuel cells in the area of critical and uninterruptible power supply should reach up to US$1.7 billion by 2017. Today, the foundation towards this development is being laid through CPN. Another core CPN issue is the demonstration and market preparation of fuel cell technology for efficient and innovative applications.

PARTNER:	PROJECT BUDGET/€:	PROJECT FUNDING/€:
Zentrum für Brennstoffzellen-Technik GmbH	358,413	172,038

COMMENCEMENT: 01 July 2013
CONCLUSION: : 30 June 2016

» A core CPN issue is the demonstration and market preparation of fuel cell technology for efficient and innovative applications. «

» TEST OF A FUEL CELL SYSTEM WITH ALTERNATING CURRENT OUTPUT TO BACKUP THE ON-SITE FIRE DEPARTMENT, MEDICAL STATION AND CRISIS CONTROL ROOMS – OSIRIS «

Aluminium Norf GmbH (Alunorf) operates a large rolling and casting plant as a joint venture with the German subsidiaries of two internationally active aluminium companies (Hydro Aluminium Rolled Products GmbH and Novelis Deutschland GmbH). As part of the National Innovation Programme Hydrogen and Fuel Cell Technology (NIP), Alunorf is testing the deployment of fuel cell systems for the emergency power supply for the on-site fire department, medical station and crisis control room. The OSIRIS project aims to demonstrate the advantages fuel cells can provide over conventional emergency power supply systems, such as batteries and diesel generators. The examination looked particularly at the aspects of technical usability in large industrial enterprises, energy efficiency and the costs of such a system.

Until the commencement of the project, no integrated experiences had been recorded on emergency power supply systems based on hydrogen fuel cells in such large industrial enterprises. As such, this project entered into virgin territory. The operational and financial risks in the case of project failure could be limited through the public funding made available.

A commercially developed fuel cell system from the company Rittal comprised the basis for the test. Diverse components were added to this existing system to enable the optimal integration with the Alunorf infrastructure. The first project year involved detailed planning, the construction of the demonstrator and fundamental tests of all components of the overall system.

The following technical issues needed to be addressed:

» Takeover of the power supply by the fuel cell (starting time)

» Transmission behaviour of the inverter

» Online exchange of hydrogen cylinders

» Dynamic loads

» System behaviour during drop in hydrogen pressure

» Hydrogen consumption under various load scenarios

» Effect of temperature/weather conditions (summer/winter)

» Continuous operation

» Maintainability/reliability

Need for improvement exists primarily in hydrogen cylinder management (the emptying of residual liquid), battery monitoring and in overall operating efficiency (relevant for extended operating times). The aspects of maintainability and reliability gave no rise to any criticism, whereby this must continue to be confirmed over more years in service.

A comparative analysis of the total lifetime costs was also undertaken within the framework of the project. This showed that fuel cell systems are currently only competitive in a small-scale corridor (< 5 kW) and for longer bridging times (> 8 h) when compared with conventional systems (USP battery, diesel). For the realisation of other, similar projects, the results and recommendations of this project should be observed as the practical scaling and operation of a system thereby becomes significantly simplified.

PARTNER:	PROJECT BUDGET/€:	PROJECT FUNDING/€:
Aluminium Norf GmbH	367,839	176,562

COMMENCEMENT: 01 February 2010
CONCLUSION: : 31 January 2013

IV / 05

» FUEL CELL SYSTEM DRIVE FOR ROTOPRESS REFUSE COLLECTION TRUCK «

Heliocentris Energy Solutions AG and FAUN Umwelttechnik developed a fuel cell hybrid refuse collection truck with significantly lower noise and exhaust emissions for Berlin's municipal waste disposal company, Berliner Stadtreinigung (BSR).

The rubbish collection vehicle incorporates a fuel cell energy system that is run by hydrogen. This enables the main drive (diesel engine) to be switched off during rubbish loading and compacting procedures. Rubbish is emptied into the truck's 20 m^3 drum by using a lifter to raise the rubbish bins. The waste is then compacted using electrical energy, emitting only minimal noise. In this way, up to three litres of diesel fuel are saved per hour, which translates to a reduction in diesel consumption of almost 30 %. CO_2, NO_x and fine particle emissions are also reduced as a consequence.

The energy produced from the 32 kW fuel cell unit can also be temporarily stored in super capacitors to cover peak loads. The hydrogen tank system consists of two 350 bar pressure canisters to store a total of 10 kg of compressed, gaseous hydrogen.

Germany's largest municipal waste disposal company, the BSR, has been a pioneer for the testing and implementation of innovative environmental protection measures for several years. The reduction of fleet CO_2 emissions is an important measure in this regard.

The electrification of auxiliary systems and units is an interesting market for fuel cell technology for several reasons:

» The switch to electrical power significantly reduces noise of exhaust emissions

» Fuel cell systems are significantly lighter than corresponding battery-based solutions

» Deployment in fleet operations is possible, thereby making the introduction of new vehicle concepts and the development of the necessary hydrogen infrastructure economically more feasible.

Hydrogen as a subject for the Children's University in Berlin, July 2012

Besides the development of the prototype vehicle, extensive tests under real operating conditions (vibrations, dirt) to prove the system's functional capabilities were undertaken in various weather conditions (heat, dampness, frost, etc.), as part of the project.

Test operations proved the overall operational suitability compared with conventional vehicles. Over the course of the project, the system's winter hardiness could be substantially improved. Energy efficiency could also be continuously enhanced through the implementation of an automatic start-stop mechanism and the optimised alignment of the auxiliary systems to the specifics of the electric drive. Outstanding issues for a wider market introduction include the increase of payload to over 11 t and the improvement of the small series availability of components such as:

» Starters for heavy-duty commercial vehicle applications in refuse collection

» Electric lift systems for receptacles

» Integration with propulsion drivetrain (hybridisation)

» Electrification of the air conditioning (place of work), oil pump, etc.

In addition, the energy management system must be improved and reductions in cost must be realised.

PARTNERS:	PROJECT BUDGET/€:	PROJECT FUNDING/€:
Berliner Stadtreinigungsbetriebe (BSR)	1,197,345	574,725
Heliocentris Academia GmbH	297,335	142,720
FAUN Umwelttechnik GmbH & Co. KG	159,882	76,743

COMMENCEMENT: 01 April 2010
CONCLUSION: : 30 September 2013

» Energy efficiency could also be continuously enhanced through the implementation of an automatic start-stop mechanism and the optimised alignment of the auxiliary systems to the specifics of the electric drive. «

IV / 06

» ECPD – FROM PROTOTYPE TO SERIES MATURITY – STEP2 «

The innovative ECPD method (electrochemical pulse deposition), which enables platinum deposition of catalysts to be reduced by the factor of 10, could be successfully transferred from the prototype phase to series maturity. The insights gained throughout the project now allow investments to be made in production facilities for the manufacture of electrodes and membranes to produce membrane electrode assemblies (MEA). These permit the target costs of €0.25/W for the MEA of a high temperature polymer electrolyte membrane (HTPEM) fuel cell to be achieved, thereby also providing advantages for fuel cell heating devices.

As part of the initial project focus, electrode production based on the ECPD method could be successfully further developed and then transferred to automated manufacturing technology. The quality of production could also be substantially improved: an almost 100 % quality level without defects could be attained in the relevant production steps.

As such, the HTPEM can therefore be reliably manufactured. Besides the development of the electrode, the membrane is the second pillar for successful and economical MEA production. Here, the manufacturing process could also be reduced from five to two days, thereby leading to further substantial reductions in costs.

PARTNERS:	PROJECT BUDGET/€:	PROJECT FUNDING/€:
elcomax GmbH	14,615,787	7,015,577
Truma Gerätetechnik GmbH & Co. KG	1,368,155	656,714
SFC Energy AG	4,070,760	1,953,965

COMMENCEMENT: 01 July 2010
CONCLUSION: 31 December 2013

STEP2: analysis of the manufactured catalysers

» CERTIFICATION BODY FOR STANDARD-COMPLIANT TESTING OF FUEL CELLS IN THE AREA OF SPECIAL MARKETS – BZERT «

Goal of the BZert project, together with the partners Fraunhofer ISE and VDE Institut, was the establishment of a testing lab to conduct safety tests on, and certification of, fuel cell systems. The R&D insights hereby gained were to flow back into both continued development of fuel cells at both manufacturers and for corresponding standardisation activities.

To begin, the relevant standards or draft standards (IEC 62282) were analysed in regard to their objectives and specifications. This particularly involved the standardisation of safety tests for portable and micro fuel cell systems as well as for the fuel cell cartridges used with micro fuel cell systems. The specification, development and acquisition of standard-compliant testing facilities occurred subsequently as well as the establishment of corresponding processes. Testing objectives and the effort involved were then assessed in terms of their ability to achieve safety goals, increase simplification, minimise costs and to avoid competitive distortion. The insights gained were then incorporated in ensuing activities and presented to the standardisation committees. Due to this increase in knowledge, interested manufacturers of fuel cell systems and their components could receive advice and consultation on standardisation. And conversely, questions from the manufacturers could also be taken up and forwarded to the standardisation committees.

With the establishment and commencement of operations of the new laboratory for the safety and optimisation of performance of fuel cell systems and fuel cell cartridges, a wealth of knowledge and competence on tests and certification procedures is now available at Fraunhofer ISE and VDE Institut. Besides obtaining specialist advice regarding the relevant standards there, manufacturers can also conduct safety inspections for fuel cell systems, their components and fuel cell cartridges. In addition, detailed evaluations of fuel cell performance may be conducted under the influence of various factors, such as different climatic conditions. Manufacturers not only have the option to conduct complete certification tests at the end of the developmental process, they may also conduct tests throughout the development phase.

Uniform, recognised standards assist manufacturers in both development and construction while simultaneously giving customers peace of mind and the assurance of using tested and certified products boasting state-of-the-art technology.

PARTNERS:	PROJECT BUDGET/€:	PROJECT FUNDING/€:
VDE Prüf- und Zertifizierungsinstitut GmbH	246,842	118,484
Fraunhofer-Gesellschaft zur Förderung der angewandten Forschung e. V.	580,000	278,400

COMMENCEMENT: 01 October 2009
CONCLUSION: : 31 July 2013

BMVI – ELECTROMOBILITY MODEL REGIONS

ALL PROJECTS ARE MARKED WITH V / 01 – V / 13, ON THE FOLLOWING PAGES,
COMPLETED PROJECTS ARE MARKED WITH 🏁 .

ELECTROMOBILITY AS A DRIVING FORCE FOR THE ENVIRONMENT AND BUSINESS

FUNDING PRIORITY ELECTROMOBILITY

The National Development Plan Electromobility (Nationaler Entwicklungsplan Elektromobilität) represents an important step in the development of electromobility in Germany. The goal is to bring one million electric vehicles to the roads and turn Germany into the world's leading market for electromobility. The Federal Ministry for Transport and Digital Infrastructure (BMVI – Bundesministerium für Verkehr und digitale Infrastruktur) is pursuing a holistic approach open to all types of technologies including fuel cell electric drives with hydrogen as well as pure battery-electric drive technologies.

ELECTROMOBILITY MODEL REGIONS – TWO MAIN AREAS OF FOCUS

Supplementing the National Innovation Programme Hydrogen and Fuel Cell Technology (NIP), the Electromobility Model Regions funding programme focuses on research and development activities for battery-electric mobility and its integration in local mobility concepts. The strategic approach of the funding programme is divided into two main areas: the demonstration and examination of the suitability of electromobility under everyday conditions in the model regions as well as overarching scientific research that accompanies this. The demonstration projects explore the practical suitability of diverse electromobility applications with a regional emphasis. Technology and model projects not bound to a particular region supplement the programme and thereby ensure a multifaceted project portfolio. Local networks become established due to the ensuing contact and exchange between project participants from the areas of research, industry and government. The overarching, accompanying scientific research in various fields also facilitates the additional exchange of experiences across regions.

ESTABLISHMENT OF THE MODEL REGIONS WITH FUNDS FROM THE SECOND ECONOMIC STIMULUS PACKAGE (KONJUNKTURPAKET II, 2009 – 2011)

To promote battery-electric mobility, the federal government provided 500 million euros of support from funds stemming from the second economic stimulus package (Konjunkturpaket II) between 2009 to 2011, of which 130 million euros were allocated to the Electromobility Model Regions programme. Hereby, the value of the federal funding was to correspond with a private sector share of at least the same amount. Using the funds from the second economic stimulus package, more than 70 demonstration projects with more than 220 project partners from business, science and research as well as government were undertaken in the model regions between 2009 and 2011. With this funding it was possible to expand the competencies and systems of suppliers, strengthen regional networks and cooperation, boost the marketability of new technologies, develop and test new business models and not least promote the awareness and acceptance of electromobility in Germany. In addition, the potential of electromobility could be demonstrated in several contexts, including local public transport (diesel hybrid buses, electric buses, hybridisation of rail vehicles), electric passenger vehicles (PHEV, REEV, BEV), commercial and special purpose vehicles as well as for deployment on two wheels (eScooters and pedelecs).

SUPPORT OF ELECTROMOBILITY SINCE 2011

Building on these successes, electromobility will continue to remain a funding priority of BMVI until 2016. Projects in existing model regions will be supported along with model projects in emerging regions and technology projects. 220 individual projects in 65 project alliances are currently in progress. Know-how for electromobility in everyday use is being gained and applied locally in these projects.

As at the end of 2013, a total of 1,283 electric vehicles had been planned within the project alliances, of which 85 percent were in operation. Furthermore, around 59 percent of the 456 envisaged recharging stations were also built and operational by this time. Running parallel to the Electromobility Model Region, the Showcase Electromobility (Schaufenster Elektromobilität) funding programme was established in April 2012. With funding totalling 180 million euros over three years, the showcases bundle the most innovative elements of electromobility with a focus on roads and passenger vehicles in large regional demonstration and pilot projects, and make them more visible on an international level. Both funding programmes complement each other with regional specifics and various areas of project emphasis.

ACCOMPANYING SCIENTIFIC RESEARCH

The subjects and goals of the projects in the model regions span the entire spectrum of electromobility. To amalgamate the results of the individual projects from the regions on a programmatic level and to ensure experiences are adequately exchanged among the relevant players in the respective projects, seven overarching subject areas have been established within the framework of the accompanying scientific research building on the structures and insights already gained thanks to funding from the second economic stimulus package. These include: user perspectives; fleet management, innovative drives and vehicles; safety; infrastructure; urban development and transport planning; and regulatory framework.

Data and information from the model region projects are collected as part of the accompanying research, categorised according to the subject area and evaluated. The practical insights gained therefore serve to ensure a mutual exchange of experience that extends beyond the confines on a single region. Building on these evaluations, regional specifics can be taken into account, models that are particularly successful can be identified and potential synergies can be exploited in a targeted manner. The results of the accompanying research benefit all partners of the model regions.

IMPLEMENTING ORGANISATIONAL STRUCTURE

NOW is responsible for the implementation and coordination of the Electromobility Model Regions funding programme. Its duties also involve the definition and selection of programmatic areas of focus in conjunction with the BMVI, the coordination of the accompanying scientific research along with the management of individual projects. This encompasses the preparation of content for project selection, obtaining more detailed specifications of the project outlines from industry, research and municipalities, as well as developing project suggestions with regional project headquarters. The BMVI ensures the contents are coordinated with other activities of the federal government and aligned in a political context. Together with the federal government, it is thereby responsible for determining the focus of content in the area of electromobility and comprises the interface to the National Platform Electromobility (NPE). Projektträger Jülich (PtJ) is responsible for project administration and supports the programme with legal advice on public funding. Project headquarters (PLS – Projektleitstellen), conduct coordination tasks on a regional level. The project headquarters are comprised of regionally based players from the areas of business development, public utilities, energy agencies and from other public-private partnerships. Furthermore, they also ensure exchange takes place between project partners on location. Local and regional participation is thereby efficiently organised and the responsibility for programme implementation is promoted.

BMVI ELECTROMOBILITY MODEL REGIONS

SHOWCASES OF THE FEDERAL GOVERNMENT

REGIONS WITH BMVI MODEL PROJECTS

SUBJECT AREAS OF THE SUPPLEMENTARY SCIENTIFIC RESEARCH

SAFETY SUBJECT AREA

Coordination of the subject area:

» NOW in consultation with the Federal Ministry of Transport and Digital Infrastructure (BMVI – Bundesministerium für Verkehr und digitale Infrastruktur)

» Experts from the fields of vehicle and battery safety

» Centre for Solar Energy and Hydrogen Research (ZSW – Zentrum für Sonnenenergie- und Wasserstoffforschung)

Participants:

Coordinating entities (NOW and BMVI), scientific supervision by the Centre for Solar Energy and Hydrogen Research (ZSW) in cooperation with experts from the fields of vehicle and battery safety as well as exchange with the Kompetenznetzwerk Lithium-Ionen-Batterien e.V. (KLiB) and its members from the fields of research and development, battery materials and components, cell and battery manufacture, and OEMs.

Core focus/Issues:

Compliance with safety standards is a key requirement for the acceptance and market introduction of electric vehicles. The subject area thus addresses safety-related aspects and issues surrounding the electric vehicle. These comprise among others the subjects of battery safety, risk and safety evaluation for vehicles and infrastructure as well as the influence of electric vehicles on traffic safety, e.g. as a result of the reduction of vehicle noises at lower speeds.

Under funding from the Model Regions from 2009 to 2011, extensive safety documentation was compiled on the electric vehicles used in the Model Regions. In addition the failure and breakdown of vehicles and components was monitored.

Subjects/Projects/Content 2013:

This research forms the basis for identifying further research needs, such as the necessity of examining the safety of batteries and cells along the entire life cycle of a battery.

This examination of the life cycle integrates the areas of availability of raw materials, design and conception phase, production, storage and transport, up to the use and reuse of batteries with the relevant recycling on cell and battery levels. This investigation of battery safety will be compiled via the responsibilities mentioned in the form of a study.

Part of the utilisation phase is also the use of batteries in the vehicle and the evaluation of the safety aspects according to different application areas. Therefore the activities on vehicle safety will be pursued within the framework of a working group as a work package within the study. This includes the further examination and evaluation of failures and breakdowns.

The aim of the work within the subject area is to determine already existing knowledge, examine it, as well as identify and evaluate gaps. Through this process other results will be gained and recommendation action created for relevant stakeholders and entities (political actors, sciences and businesses).


SAP ARENA
Shaping Future Transportation
CleanDrive Technologies
BlueTec® - Hybrid
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FLEET MANAGEMENT SUBJECT AREA

Coordination of the subject area:
» Dominique Sévin, NOW
» Sabine Domke, Federal Ministry of Transport and Digital Infrastructure (BMVI – Bundesministerium für Verkehr und digitale Infrastruktur)
» Michael Lübke, Dornier Consulting/Michael Grausam, Städtebau-Institut der Universität Stuttgart (Stuttgart University Institute of Urban Development)

Participants:
Representatives of companies, local authorities and the scientific community

Core focus/Issues:
The subject area of fleet management deals with the entire spectrum of issues covering the use of electric vehicles in the fleets of local authorities and businesses. The following key aspects are addressed:

» How can fleets generally be classified?
» Where are the interesting applications for electric vehicles in the commercial area?
» What obstacles are particularly relevant for electric vehicles in which applications?
» What motivates organisations to procure electric vehicles? What prevents them?
» For which organisations are which measures especially relevant?

Subjects/Projects/Content 2013:
At the kick-off meeting in April 2013 it was first determined what the focus of the subject area should be. At the same time cooperation was sought in particular with the User Perspectives subject area. The theses to be investigated were, among others:

» The role of the development of public charging infrastructure for the use of electric vehicles in company fleets
» Potential public relations value through the use of electric vehicles
» Options for installing charging facilities on company premises
» Suitable and less suitable driving profiles and fleet compositions for deployment of electric vehicles

Furthermore a handbook for fleet managers was published. Based on interviews, the handbook primarily covers the following questions:

» Transfer of knowledge for the integration of electric vehicles in a company fleet (illustration of examples)
» Suitable fleet and driving profiles
» Procurement of electric vehicles
» Implementation and operation of the electric fleet including charging infrastructure

Further details on these subjects, new findings and prime examples will be discussed in subsequent meetings of the subject area in 2014.

INFRASTRUCTURE SUBJECT AREA

Coordination of the subject area:
» Johannes Pallasch, NOW
» Sabine Domke, Federal Ministry of Transport and Digital Infrastructure (BMVI – Bundesministerium für Verkehr und digitale Infrastruktur)
» Gerald Rausch, Robert Kuhfuss, Fraunhofer-Institut für Fertigungstechnik und Angewandte Materialforschung IFAM (Fraunhofer Institute for Manufacturing Engineering and Applied Materials Research) (Contact for accompanying research)

Participants:
Representatives of the Electromobility Model Regions, local authorities, municipal utilities and energy suppliers

Core focus/Issues:
The Infrastructure subject area focuses on issues surrounding the construction and operation of charging infrastructure, incorporated into the overall concept of electromobility. As regards content, it is closely linked to the subject areas Urban Development and Transport Planning as well as Regulatory Framework, where some issues dealt with are equally relevant to the subject of infrastructure. Within the subject area the primary aspiration is to work through the most urgent questions which concern the national (and sometimes international) stakeholders in a prioritised manner. Among the important thematic issues at present are the interoperability of charging infrastructure, demand-driven construction, costs and possible business models as well as the subject of DC fast-charging. To this end the results obtained from the model regions, but also the knowledge from external projects and from experts will be compiled and discussed by the circle of participants.

The goal is to derive concrete support from the results for stakeholders from local authorities, energy supply companies and municipal utilities for a low-threshold entry into electromobility. To achieve this, guidelines and information material for example, will be produced.

Subjects/Projects/Content 2013:
From the relevant issues mentioned the subjects of interoperability and demand-driven construction were examined more closely in 2013. In numerous meetings, mostly workshops, participants discussed the issues and content was prepared for guidelines published at the beginning of 2014 on the subject of public charging infrastructure for cities, public authorities and suppliers.


BlueEFFICIENCY

The goal is to bring one million electric vehicles to the roads and turn Germany into the world's leading market for electromobility.

REGULATORY FRAMEWORK SUBJECT AREA

Coordination of the subject area:
» Dominique Sévin, NOW
» Eva Schmitz-Michels, Federal Ministry of Transport and Digital Infrastructure (BMVI – Bundesministerium für Verkehr und digitale Infrastruktur)
» Ass. iur. Thomas Warnecke, Deutsches Institut für Urbanistik (Contact for accompanying research)

Participants:
Public authority representatives of the Electromobility Model Regions from different fields of responsibility

Core focus/Issues:
The Regulatory framework subject area comprises a broad spectrum of legal issues, promoting exchange between public authority participants and specifying the need for legislative action. These include road traffic law, transport legislation, building and zoning law and as well as other legal areas relevant in the context of electromobililty. A further example is the Energiewirtschaftsrecht (Energy Act).

In this subject area it is becoming ever more evident that municipal authorities are reaching their limits based on existing legislation. For example, the legally admissible designation of parking spaces in public areas for electric vehicles under powers currently available is not possible with the necessary degree of legal certainty. The setting up of an e-charging infrastructure in public spaces and the related approval procedures on the basis of road traffic law also require strategic preliminary considerations, in order to be able to sensibly employ the existing legal instruments.

Subjects/Projects/Content 2013:
Initially a prioritisation of legal questions was undertaken in the subject area meetings. Here it became clear that the clarification of certain legal issues is essential for the further development of electromobility in the municipalities and other questions are less significant.

The accompaniment of a Bundesrat initiative of the Free Hanseatic City of Hamburg is very important for the Regulatory framework subject area, which made particularly important changes to road transport law. Additionally a manual was developed on the approval process of e-charging infrastructure in public spaces, which in an integrated approach includes strategic preliminary considerations.

Furthermore the situation of e-charging infrastructure in private homeowner associations was discussed and the massive obstacles analysed in this area.

USER PERSPECTIVES SUBJECT AREA

Coordination of the subject area:
» Dominique Sévin, NOW
» Sabine Domke, Federal Ministry of Transport and Digital Infrastructure (BMVI – Bundesministerium für Verkehr und digitale Infrastruktur)
» Dr. Elisabeth Dütschke, Fraunhofer-Institut für System- und Innovationsforschung ISI

Participants:
University-based sciences, public and private institutions, the energy and automotive industries, energy agencies and consultancies

Core focus/Issues:
Electromobility only has a future if it finds users and beneficiaries in sufficient number. In this respect the analysis of the needs and expectations of early users of electric vehicles is essential in order to on the one hand, create appropriate vehicles and services, and on the other, identify promising target groups that can be catered to during the process of getting the market up and running. In addition political recommendations can thus be derived for the promotion of electromobility.

The aim of the work in the User Perspectives subject area is to interlink the individual programme projects with a view to these questions and to position the results obtained in an overview of user acceptance of electromobility. This happens on the one hand by bringing together experts from the projects in thematic workshops, and on the other by a common and standardised survey of all users in all projects.

Subjects/Projects/Content 2013:
Up to now over 650 users from Model Regions projects have been surveyed. Countless other participants are anticipated over the coming months. This research will be supplemented by further studies by Fraunhofer ISI. The main focus will be on the different user scenarios of electromobility, i.e. private users, commercial use as well as electric vehicles as part of an integrated transport system. In addition the question of necessary infrastructure from the user point of view will be analysed.

In 2013 a workshop of experts working in the subject area also took place on methodological issues of user research. Here it was discussed how actual willingness to pay for electric vehicles can be determined and what query methods are suitable. The participants were united in the view that determining willingness to pay presents a great challenge, as long as products have not actually achieved a certain level of market penetration. Another issue was vehicle range, as the limited range combined with long charging times represents one of the greatest disadvantages of electric vehicles compared to conventional ones. The research and experiences from the projects up to now show that certain user groups, who for example are attributed with having high technical competence, manage better with the limited range and make better use of this too. With more experience gained from the user the existing range will be also made better use of – this opens up possibilities for technical support e.g. through the appropriate indicators in the vehicle. Another subject is the design of surveys within the projects of the Model Regions, in order to motivate as many users as possible to give information about their experiences with the vehicles.

In another meeting the first findings were collected from the projects currently running and the central issues for the next months determined. Great potential but also significant challenges exist in the areas of commercial use as well as in integrated transport systems.

Building on experiences up to now, a consolidation of the state of knowledge for the commercial use area was created in the exchange between participants of the working groups. Key findings are that from the point of view of fleet managers, electric vehicles are not yet economically feasible. Moreover the limited range presents a core obstacle. A significant advantage of electric vehicles is the public relations value that comes along with its use. The newness of the technology does not pose big problems for the driver of the vehicles. Major training needs exist mainly in the area of maintenance and repair. Important open questions persist in the area of willingness to pay and range. It must be investigated more closely how fleet managers calculate the costs and uses of electric vehicles. With regard to the demands on range, it must be examined which ranges for which applications are necessary. In addition it remains to be clarified in which areas of commercial transport fast-charging and mixed vehicle pools can contribute to relativising the range problem.

For integrated user scenarios it has become clear up to now that users manage well with the vehicles and the intention is to use the services further. The groups of people who have used the services up to now is very homogenous – male, young, urban, highly-educated. It will be a challenge to identify other target groups.

URBAN DEVELOPMENT AND TRANSPORT PLANNING SUBJECT AREA

Coordination of the subject area:
» Dominique Sévin, NOW
» Dr. Christian Schlosser, Federal Ministry for Transport and Digital Infrastructure (BMVI – Bundesministerium für Verkehr und digitale Infrastruktur)
» Anne Klein-Hitpaß, Deutsches Institut für Urbanistik (Contact for accompanying research)

Participants:
Local authority representatives from the Electromobility Model Regions from different areas of responsibility as well as other stakeholders from the scientific world and industry

Core focus/Issues:
The promotion of electromobility is part of a development process on the road to post-fossil mobility. By analogy with vehicle technology, which gradually matures to suitability for practical use, products, procedures and knowledge through experience must also be consolidated for the urban transport system. At the moment this concerns local authorities and regions which could play different roles in relation to electromobility (regulator, provider, user, etc.). For example processes and structures in politics and administration must be adapted for the implementation of electromobility, and in some circumstances also newly created. Similarly local public transport companies, energy suppliers or businesses are needed.

In the framework of the accompanying research on the Urban Development and Transport Planning subject area important issues on the implementation of electromobility in cities and regions will be explored in depth with stakeholders from the model regions, in order to support local authorities in the implementation of electromobility.

In regular workshops and subject area meetings participants not only network but exchange experiences. Apart from concrete practical experiences, transport planning and integrated local mobility concepts are discussed with special regard to local authority needs. Local authorities will be assisted in identifying conducive and inhibiting factors for the implementation of electromobile services, as well as in identifying their own scope of action and ideally expanding it.

Subjects/Projects/Content 2013:
The thematic focus initially was on the themes of Urban Development/Urban Design and e-commercial transport. In the WG Urban Development/Urban Design questions concerning the demand-driven development of charging infrastructure in the urban space were considered pertinent. This is why a joint series of workshops took place in cooperation with the accompanying research on charging infrastructure, in order to discuss dimensioning and locating in the public space. The results of this WG are part of the publication of the accompanying research on infrastructure.

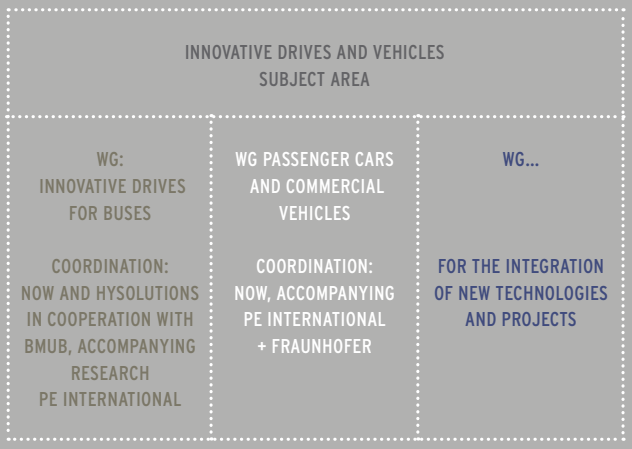
In the framework of the WG, e-commercial transport was presented in a workshop of different approaches to inner-city delivery transport and the significance of incentives and restrictions for an improved integration of electrically-operated vehicles in company fleets was developed. The WG will continue in 2014. In addition an interim result will be provided which reflects experiences thus far against the backdrop of local authority needs.

At two subject area meetings the results of the working groups were presented and other issues discussed. Here it was shown time and time again, that local authorities can play a constructive and key role in the introduction of electromobility, but there is little experience with respect to integrating electromobility into urban and transport planning and often this goes beyond the scope of project activities. Thus it is the goal of further activities to continue to promote local authorities in exchanging their experience. In the framework of a local authority survey a more exact state of knowledge of the different situations on the ground will be recorded, in order to gain knowledge about which other types of support (e.g. networking meetings, consulting services) are required.

INNOVATIVE DRIVES AND VEHICLES SUBJECT AREA

In the Innovative Drives and Vehicles subject area the vehicles and drive technologies in the electromobility funding focus of the Federal Ministry of Transport and Digital Infrastructure (BMVI) will be evaluated from a technical point of view. The focus lies on vehicles in real operation taking account of different user concepts.

The concrete contents of the subject area are the optimisation, technical further development and audit of the vehicles, vehicle components and batteries, with the goals of raising efficiency and acceptance, among other aims. In order to take account of the special features of the different transport modes and applications, individual working groups are working on the areas of bus applications as well as passenger cars and commercial vehicles. Other working groups may be supplemented as needed and as available.



WG INNOVATIVE DRIVES FOR BUSES

Coordination of the working groups:
» Oliver Braune, NOW
» Heinrich Klingenberg, hySOLUTIONS GmbH
» Representatives from the Federal Ministry for the Environment, Nature Protection, Building and Nuclear Safety (BMUB – Bundesministerium für Umwelt, Naturschutz, Bau und Reaktorsicherheit) and project-executing agencies of the Association of German Engineers (VDI – Verein Deutscher Ingenieure) and the Association for Electrical, Electronic and Information Technologies (VDE – Verband der Elektrotechnik, Elektronik und Informationstechnik)
» PE International with support from the Institut für Kraftfahrwesen (ika) der Rheinisch-Westfälisch Technischen Hochschule (RWTH) Aachen (Contact for accompanying research)

Participants:
Transportation companies, manufacturers and suppliers of scheduled service buses with innovative efficient technologies, the Association of German Transport Companies (VDV – Verband der deutschen Verkehrsunternehmen), representatives of other transport associations, organisations from the scientific world and consultancy, representatives from the BMUB, BMVI and BMWi as well as the appropriate responsible entities and project-executing agencies.

Core focus/Issues:
Against the backdrop of rising demands for air quality, noise avoidance and climate protection, there is a growing interest in alternative drive technologies by bus transport companies, particularly in metropolitan areas. The first results on diesel hybrid buses were compiled within the framework of the first funding phase of the Model Regions (2009 to 2011) within the platform: Innovative Drives for buses. The results and experiences are very important for the manufacturers and vehicle operators. The activities of this platform will be will be continued within the WG Innovative drives for buses. In this way the results of both funding activities can be consolidated and synergies exploited.

Subjects/Projects/Content 2013:
The working groups currently comprise 28 bus demonstration projects, in which around 180 buses are in use in different regions of Germany.

A = Articulated
S = Solo
M = Mini-/Midi-
Suffix E = Electro
Suffix FC = Fuel cell
Suffix P = Plug-in hybrid

28 projects
146 diesel hybrid buses
» 70 solo buses
» 76 articulated buses
25 electric buses
8 FC buses

FUNDING:
BMVI
BMUB
BMWi

As at 27.11.2013

Hybrid buses in Hannover
üstra (10 G) 05

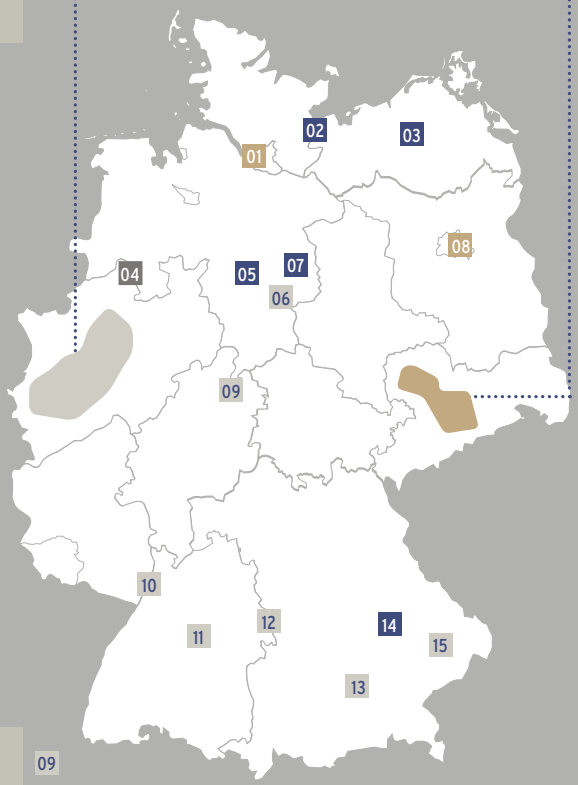
Hub Osnabrück
Stadtwerke Osnabrück AG (2 ME) 04

EMIL
Braunschweiger
Verkehrs-AG (1 SE, 5 GE)

EFBEL
Verkehrsverbund Rhein Ruhr
» Krefeld – SWK Mobil (4 G)
» Hagener Straßenbahn (2 S, 2 G)
» Dortmund – TRD Reisen (2 S)
» Bochum – Bogestra (5 G)

Stadtverkehr Lübeck (5 S, 5 G) 02

VB Hamburg-Holstein (10 S) 01
eBTO
Hamburger Hochbahn (5 G)
ErPaD
Hamburger Hochbahn (5 S, 15 G)
Held
Hamburger Hochbahn (3 SP, 3 SE)
SaHyb
Jasper (10 S), Südelbe Bus (5 S)
NaBuZ demo
Hamburger (4 S FC)



RegioHybrid
» Döbeln, Freiburg –
Regiobus Mittelsachsen (10 S)
» Dresden – DVB (3 S, 3 G)
» Leipzig – LVB (3 G)
Sax Hybrid
» Dresden – DVB (10 G)
» Leipzig – LVB (10 G)
Sax Hybrid Plus
Stadt – Verkehrsbetrieb (1 G)
Linie 79
Dresden – DVB (1 ME)
eBus Batterfly
Leipzig – LVB (2 ME)
eBus Skorpion
Leipzig – LVB (estimated 1 GE)

Hybrid bus trial
Münchener Verkehrsgesellschaft
(MVG) (2 S, 2 G) 13

Inmod
Mecklenburg-Western Pomerania
GBB (1 ME, BBW (1 S)
HS Wismar (1 S) 03

Hybridbus Wolfsburg
Wolfsburger Verkehrsgesell.
(3 S) 07

E-bus Berlin
BVG (5 SE) 08

Hybridbusse für Ingolstadt
Stadtbus Ingolstadt (3 S) 14

Primove Road
Pilsting (1 SE) 15

Elvo Drive
Voith AG (1 S) 12

Free
Kassel – Regionalmanagement
Nordhessen (1 ME) 09

Primove Mannheim
Mannheim – RNV GmbH (2 SE) 10

Hyline S
Stuttgart – SSB (5 GP) 11
S presso
Stuttgart – SSB (4 S FC)

The research focuses on the evaluation of optimisation measures in the already existing vehicles in operation as well as new technical developments in the area of diesel hybrid and fully electric driving. For the evaluation the following criteria were defined:

» Road capability and operability (daily use, availability of the vehicles and charging infrastructure, adaption of infrastructure)
» Efficiency (fuel and electricity consumption from endurance testing and individual measurements, the influence of auxiliary equipment)
» Ecology and climate protection (NO_x and CO_2 reduction, noise reduction, particulate pollution)
» Economic feasibility (lifecycle costs, break-even analysis with reference technology)
» Acceptance (public relations)

The application of the jointly agreed upon criteria facilitates a holistic evaluation of technologies on the national level with the help of information from long-term data acquisition and from test drives. Aside from consumption the exhaust emissions for different diesel hybrid drive concepts on different routes will also be determined in the test drives and the measurement readings compared of current diesel reference buses.
The regular meetings of working groups will each be based on a priority issue, e.g. diesel hybrid driving, electric drive and vehicle concepts, charging infrastructure, maintenance (training, infrastructure adaptations, spare parts). The results of the accompanying research will result in a joint final report and in a concluding technical seminar. They should contribute to the evaluation and development of future mobility strategies and provide recommendations for action for energy-efficient and environmentally-sustainable bus transport.

WG PASSENGER AND COMMERCIAL VEHICLES:

Coordination of the working groups:
» Oliver Braune, NOW
» Dr. Christian Schlosser, Federal Ministry of Transport and Digital Infrastructure (BMVI – Bundesministerium für Verkehr und digitale Infrastruktur)
» Michael Held, Fraunhofer-Institut für Bauphysik IBP and Dr. Michael Faltenbacher, PE International (Contact for accompanying research)

Participants:
Representatives from the vehicle and fleet managers, vehicle manufacturers, drive systems and components manufacturers (suppliers), test facilities and laboratories, sciences (universities and Fraunhofer-Gesellschaft)

Core focus/Issues:
In line with the issues, the passenger cars and commercial vehicles working group deals with recording the technological status and the suitability for daily use of currently available electric vehicles, their potential for technological further development and the environmental effects associated with electromobility.

These activities are incorporated in the overall Prax-PerformE project, which facilitates both the long-term data acquisition of the vehicles and their ecological evaluation. The ecological evaluation happens over the entire life cycle. The first screening results of the eco-audit are based on the average vehicle characteristics. In cooperation with the participating manufacturers, manufacturing and waste phases will be further customised in the future. In addition, the generic model developed allows consideration to be taken of the aggregated user data compiled by the data-compiling tool SoFi and provides an illustration of specific vehicle fleets, framework conditions and scenarios. Such an evaluation of the vehicles and technologies used is possible with respect to their performance and environmental parameters.

Subjects/Projects/Content 2013:
The results of the working group are consolidated in regular meetings and discussed with the participating stakeholders. In this way in 2013 all current projects running in the BMVI funding programme using vehicles and their detailed activities could be included. The core task of the work was the further development and agreement of the minimal data set developed in the second phase of the economic stimulus package as a basis for continuous data acquisition. Furthermore the individual accompanying research activities of the reviewed individual projects could be recorded. These can be arranged into the following subject areas: technology, social sciences, economics and ecology.

The intensive interlinking of the project-specific research bodies serves to better dovetail the different research and harmonise them in so far as is possible. This will also happen in a multidisciplinary manner.

In the area of environmental research/eco-audit the research group »Electromobility eco-audit« was also established. Its purpose is to facilitate exchange on methodological questions and the selection of framework conditions in order to achieve better comparability of the individual research findings through the most uniform establishment of these framework conditions. Through the involvement of external experts further coordination with other environmental accompanying research programmes will take place.

Current scientific research publications from the respective subject areas can be found at (German language version only):
www.now-gmbh.de/de/publikationen.html


678
01P
F-CELL

The National Development Plan Electromobility represents an important step in the development of electromobility in Germany.

V / 01

» DEFINITION AND IMPLEMENTATION OF COMBINED MOBILITY SERVICES FOR RESIDENTS OF A HOUSING DISTRICT IN HAMBURG USING ELECTRIC VEHICLES – EQUARTIER HAMBURG «

The project involves the development and testing of mobility services with electric vehicles to access both new housing districts as well as existing residential areas. Insights are to be gained in terms of an integrative approach for introducing electromobility in private households for future market development. The project will commence with planning and concept phases during which all the essential parameters for implementation and accompanying evaluation will be defined. Economically sustainable e-carsharing concepts for various residential districts and specific target groups will be developed in order to create viable business models. District-based carpooling vehicles or other vehicles deployed in public carsharing services are to be used. Through this improved access to electric vehicles, the modal split is to be encouraged to move towards sustainable mobility. Economic deployment of the electric vehicles as well as attention to pricing models and usage load factors are to be particularly assessed within the framework of closed and non-closed user groups. In terms of the business model, it is to be established who must make what financial contribution to ensure that the service becomes attractive enough overall – and is therefore made good use of – in order to make it commercially viable for the operator.

The specific goals of the project include:

»Linking renewable energy with electromobility in connection with a pioneering fast-charging infrastructure

» Assessment of potentials for the deployment of electric vehicles in connection with Energy Plus houses

» Practical implementation of a mobility concept in joint ownership communities (closed user group)

» Show practicable residential district operator models for the incorporation of electromobility and e-carsharing

» Inclusion of concepts for electromobility during the planning phase

» Optimisation of the reduced noise emissions arising from electromobility, through corresponding building planning requirements

» Validation of the practical effects of the integrated mobility concept on the real estate purchase decision

» Assessment of the effects of the specific electromobility concept on costs

The project promotes and investigates the integration of electromobility concepts in residential districts in Hamburg. Specific energy and mobility concepts will be developed and tested in a practical environment in up to ten model districts each featuring differing typologies. From a business-energy perspective, the focus lies on the development and testing of a new type of storage and recharging system as well as the assessment of potentials for deployment of electric vehicles in combination with energy self-sufficient buildings. In this regard, the concept and development of »Energy Plus« houses in connection with recharging equipment for electric vehicles is being undertaken in some selected district projects. The project commences by defining district-related typologies for the mobility and energy concept as a basis for subsequent conceptual and implementation steps. This is followed by the concept and planning for the development of an innovative recharging infrastructure and the provision of electric vehicles in the model district. The framework conditions for the energetic integration of the recharging infrastructure and the vehicle in the building will then be defined. The final practical phase will involve the collection and evaluation of data, comprising a part of the overall project evaluation process.

PARTNERS:	PROJECT BUDGET/€:	PROJECT FUNDING/€:
hySOLUTIONS GmbH	133,064	66,532
Aurelis Asset GmbH	110,271	55,135
D & K drost consult GmbH	552,936	276,468
DB Rent GmbH	294,510	147,255
GfG Hoch-Tief-Bau GmbH & Co. KG	362,550	181,275
HafenCity Universität Hamburg	499,684	499,684
Mindways GmbH	430,770	215,385
Sparda Immobilien GmbH	160,061	80,030
STARCAR GmbH Kraftfahrzeugvermietung	767,098	383,549
Vattenfall Europe Innovation GmbH	646,312	323,156
cambio Hamburg CarSharing GmbH	691,886	345,943

COMMENCEMENT: 01 February 2013
CONCLUSION: 31 March 2016

» Economically sustainable e-carsharing concepts for various residential districts and specific target groups will be developed in order to create viable business models. «

V / 02

» DALIAN – BREMEN ELECTRIC MOBILITY – DABREM «

Undertaken in cooperation between the partner cities of Bremen and Dalian in northeastern China, the project examines electromobility in terms of data logging and analysis with the help of new types of innovative concept vehicles. The goal is to not only evaluate the deployment of electric vehicles today in day-to-day use, but to also draw conclusions for the future. In Bremen, the German Research Center for Artificial Intelligence (DFKI – Deutsches Forschungszentrum für Künstliche Intelligenz) is also cooperating with the Fraunhofer Institute for Manufacturing Technology and Advanced Materials (Fraunhofer IFAM) in this project. Researchers from the DFKI are responsible for expanding the data monitoring systems as well as evaluating the data and developing four concept vehicles with autonomous capabilities. Fraunhofer IFAM will also work on the classification, certification and licensing methods of various technologies in the area of electromobility.

Since 2009, the Bremen-based DFKI Robotics Innovation Center research area has been closely involved in the electromobility model region of Bremen/Oldenburg where it has conducted testing, demonstration as well as the research and development on various technologies. Research includes the vigorous collection and analysis of data from the vehicles and on user behaviour, the development and evaluation of various electric vehicle concepts and technologies, as well as comprehensive fleet trials. Further work is undertaken in the area of recharging and the development of intelligent user interfaces and services.

As such, the project deals with three core subjects that partly involve a direct exchange with the project partners in Dalian, China. Test areas for fleet trials are earmarked in both partner cities. Within this framework it will be possible to test both vehicles approved for the roads and concept vehicles yet without approval, on these specially dedicated areas (so-called »gated areas«). The data will flow continuously into the evaluation at all times.

In both locations this will take place as follows: the field trials will be logged in detail using special data acquisition systems including data loggers for the electromobility and server infrastructure, and will be subsequently evaluated in order to arrive at conclusions in terms of both user behaviour and the acceptance of electric vehicles. At the same time, an exchange of data will take place as well as direct, joint planning for the standardisation of the data acquisition system in terms of data formats and infrastructure. Based on the information gained through this process, concepts for simulations and models will be derived that are to hereafter simplify the assessment of expected future vehicle usage.

Four innovative test vehicles will be modified and deployed in the so-called »gated areas«. The aim is to integrate fully autonomous concepts in vehicles currently permitted on public roads, so that these functions can be tested and may be included in vehicles such as car-sharing models, for more efficient use in the future. As such, vehicles will be equipped with sophisticated sensors, actuators and control logic functions, which when used in concert, will enable active path following enabling road train driving. Only one driver will be required to steer the vehicles – the individual vehicles can, however, be decoupled from the road train as required. Car sharing vehicles can thereby be distributed and deployed more efficiently in a particular area. The experiences gained from the fleet trials will later flow into a combined concept for a vehicle. This concept is to form the basis for continued cooperation between Bremen and Dalian.

A further task of the DaBrEM project is the comprehensive testing of technology. It involves the characterisation and approval of various electric vehicle components (including motors and powertrains). Aim of the work will be the development of testing methods for the approval of such components.

PARTNERS:	PROJECT BUDGET/€:	PROJECT FUNDING/€:
Deutsches Forschungszentrum für Künstliche Intelligenz GmbH Fraunhofer-Gesellschaft zur Förderung der angewandten Forschung e. V.	1,148,196 435,853	1,033,376 392,268

COMMENCEMENT: 01 July 2013
CONCLUSION: 30 June 2015

V / 03

» GREEN MOBILITY CHAIN «

Green from door to door: the Green Mobility Chain is being forged. Under the leadership of Saxony-Anhalt's public transport authority Nahverkehrsservice Sachsen-Anhalt GmbH (NASA), eight innovative companies have come together to turn the vision of climate friendly door-to-door transportation into reality in every city, its environs and regional surroundings via a Green Mobility Chain encompassing: electric vehicles, energy, information technology as well as the intermodal networking of public transport and car sharing.

The guiding principal is the attainment of more energy efficient, lower emission and affordable mobility in cities and their surroundings in which the aspects of home, work and leisure intersect. Besides electromobility, public transportation will play a key role.

The project is a part of the Electromobility Model Regions programme. It also pins great importance on the joint Initiative of the states of Saxony-Anhalt and Thuringia for the application of an Electromobility Showcase Mitteldeutschland (Central Germany). The lead partner of the Green Mobility Chain is NASA. The software companies HaCon and TAF mobile are responsible for the technical implementation. The Green Mobility Chain is demonstrated in the region by the Mittelthüringen (central Thuringia) transport association and Stadtwerke Halle (public utilities company) in Halle/Saale. Research looking into the integration of electromobility and living is being undertaken by ibh bauwerke and Thüringer Innovationszentrum Mobilität in Erfurt as well as by the Fraunhofer-Institut für Werkstoffmechanik IWM (Fraunhofer Institute for Material Mechanics) in Halle/Saale. The project is being coordinated by the IT consultancy of the mobility management company BLIC GmbH.

The project is also funded and supported by the Ministry for Regional Development and Transport (MLV – Ministerium für Landesentwicklung und Verkehr) and the Ministry of Economics and Science (MMW – Ministerium für Wissenschaft und Wirtschaft) in Saxony-Anhalt and Thuringia's Ministry of Building, Regional Development and Transport (TMBLV – Thüringer Ministerium für Bau, Landesentwicklung und Verkehr).

PARTNERS:	PROJECT BUDGET/€:	PROJECT FUNDING/€:
Nahverkehrsservice Sachsen-Anhalt GmbH	906,366	453,183
Verkehrsgemeinschaft Mittelthüringen GmbH	489,853	244,926
Stadtwerke Halle GmbH	706,753	353,376
HaCon Ingenieurgesellschaft mbH	844,480	422,240
TAF mobile GmbH	363,939	181,969
Fraunhofer-Gesellschaft zur Förderung der angewandten Forschung e. V.	285,353	256,817
Ibh bauwerke, Hans-Georg Herb	205,975	102,987
Technische Universität Ilmenau	420,112	420,112

VEHICLES: approx. 170 electric vehicles
INFRASTRUCTURE: approx. 64 charging stations

COMMENCEMENT: 01 October 2013
CONCLUSION: 31 March 2016

V / 04

» SINO-GERMAN ELECTROMOBILITY RESEARCH – INTERNATIONAL COOPERATION IN ELECTROMOBILITY – SINGER «

The objective of the SINGER project is to promote the level of exchange between specialists as well as the mutual testing and evaluation of electric vehicles by companies, research institutes and public authorities in the cities of Shenzhen, China, and Hamburg in Germany. Within the framework of this cooperation, relevant questions regarding the role of electromobility in the context of sustainable urban development will also be ascertained and evaluated for both cities. As part of the bilateral specialist exchange, both overarching strategic aspects are to be dealt with, as are the comparison of practical usage concepts and experiences in terms of best practice examples. The demonstration activities will be supplemented by joint examinations of new standards for materials of batteries in order to promote future uniformity and marketability.

Work will be conducted in 14 packages. The programme of work will be supplemented by the testing of small fleets of Chinese electric vehicles, which will be assessed for suitability in regard to local conditions and requirements, and preparations made for their transferability. A special field of application is public transport and airport operations with buses – where two electric buses are to be tested.

The results that will be gained are capable of being applied and transferred beyond the cities of Shenzhen and Hamburg. They will illustrate the potential of electromobility to safeguard quality of life and economic power in cities and simultaneously highlight the remaining areas of policy and administration where changes are required.

PARTNERS:	PROJECT BUDGET/€:	PROJECT FUNDING/€:
hySOLUTIONS GmbH	30,180	15,090
Hochschule für Angewandte Wissenschaften Hamburg	191,458	191,458
HafenCity Universität Hamburg	395,000	395,000
Universität Hamburg	110,000	55,000
Flughafen Hamburg GmbH	209,995	209,995
Verkehrsbetriebe Hamburg – Holstein AG	110,909	55,454

VEHICLES: 2 electric buses, various electric passenger vehicles
INFRASTRUCTURE: Recharging infrastructure for buses in the depots

COMMENCEMENT: 31 December 2013
CONCLUSION: 31 December 2016

» The results that will be gained are capable of being applied and transferred beyond the cities of Shenzhen and Hamburg. «

» Within the framework of the EcoTrain project, modular drive and storage technology is to be developed to the point of series production readiness. «

V / 05

» DEVELOPMENT OF NECESSARY MODIFICATIONS ENABLING AN EXISTING COMBUSTION-ENGINE RAILCAR TO PROVIDE SUSTAINABLE, ECOLOGICAL AND ECONOMICAL RAIL OPERATIONS IN THE REGION – ECOTRAIN «

Within the framework of the EcoTrain project, modular drive and storage technology is to be developed to the point of series production readiness. Among other aspects, this involves the merging of a timetable assistance system that was developed in-house and the energy management system of the train. The insights gained from test railcar from Westfrankenbahn in terms of required installation space, load distribution, rolling behaviour and, in particular, system availability will flow into the development of the EcoTrain project towards series maturity.

Forming the basis for further observations and assessments are comprehensive simulations and system analyses to reduce the number of options currently available and select the most suitable system components for rail deployment that will ensure highest system availability.

Work in the first project phase will extend across all areas and encompass the definition of all functional specifications, the description of interfaces and risk analyses.

PARTNERS:	PROJECT BUDGET/€:	PROJECT FUNDING/€:
DB RegioNetz Verkehrs GmbH	932,788	295,693
Fraunhofer-Gesellschaft zur Förderung der angewandten Forschung e. V.	112,921	101,629
Technische Universität Chemnitz	53,233	53,233
Technische Universität Dresden	50,000	50,000

COMMENCEMENT: 01 September 2013
CONCLUSION: 31 December 2014

V / 06

» STUDY TO ASSESS THE SAFETY OF LITHIUM-ION-BATTERIES «

The safety of batteries in electric and hybrid vehicles is a crucial prerequisite for the success of this technology. The entire battery lifecycle must be regarded – from its manufacture, throughout its use in the vehicle and finally to its disposal and recycling. Other topics requiring the attention of further research are aspects such as battery testing, storage, service and accidents. In many areas, sufficient safety-related activities exist. But in others, substantial improvements are still required such as is the case during the transport, storage and recycling of batteries of for their recovery following accidents involving electric vehicles. In a first step, the aim of this project is to assess the existing regulations and insights made to date and then identify gaps and evaluate these. The second step will involve developing recommendations to close these gaps and forwarding these to the relevant institutions (e.g. ministries, companies, etc.) to enable implementation of the suggestions.

The results of the study are to comprise a basis of information for all players in the area of electromobility. The Lithium-Ion Battery Competence Network (KLiB – Kompetenznetzwerk Lithium-Ionen-Batterien), together with representatives from ministries and public authorities, are involved in steering the project through the Advisory Council.

PARTNER:	PROJECT BUDGET/€:	PROJECT FUNDING/€:
Zentrum für Sonnenenergie- und Wasserstoff-Forschung Baden-Württemberg (ZSW)	329,378	296,440

COMMENCEMENT: 01 December 2013
CONCLUSION: 31 July 2015

V / 07

» EVALUATION OF THE PRACTICAL SUITABILITY AND ENVIRONMENTAL PERFORMANCE OF ELECTRIC CARS AND UTILITY VEHICLES – PRAXPERFORM E «

The accompanying research project PraxPerform E deals with the evaluation of electric and hybrid cars and light utilities in terms of their practical suitability and environmental performance. Long term data from the deployed vehicles, coming from various model regions and projects, are the basis for the evaluation. The main goal is to obtain important manufacturer-independent insights to operation from various hybrid and electric vehicle types covering a wide spectrum of deployment applications, and to then derive the ecological contribution of electromobility in the areas of individual and commercial transportation. Through the long-term data collection undertaken by PE International AG, the necessary pool of data regarding operational experiences is being compiled. A detailed assessment of vehicle type and fleet-specific user profiles, areas of deployment and business models additionally provide important insights on the required framework conditions for the practical suitability and ecologically sound implementation of the available electric vehicle concepts. The environmental assessment being undertaken by Fraunhofer IBP is conducted via the »eco-balance« method, which is based on the lifecycle assessment approach in which all environmental effects of the vehicle are taken into account – including the extraction of raw materials, the actual manufacture of the vehicle, its use as well as the aspects of recycling and disposal at the end of its service life.

PARTNER:	PROJECT BUDGET/€:	PROJECT FUNDING/€:
Fraunhofer-Gesellschaft zur Förderung der angewandten Forschung e. V.	743,788	669,409

COMMENCEMENT: 01 May 2013
CONCLUSION: 31 July 2015

V / 08

» CONVERSION OF A DIESEL-MECHANICAL RAILCAR TO A HYBRID-BASED EXPERIMENTAL VEHICLE – HYBRID-DRIVE TRAIN «

German Railways subsidiary DB RegioNetz GmbH Westfrankenbahn and Tognum subsidiary MTU Friedrichshafen GmbH have worked together on a pilot project to develop and test a hybrid drive system for an existing diesel-mechanical railcar – and have thereby broke new ground in Europe. Through the redevelopment of the drive system and by using innovative engineering to convert the railcar, evidence could be gathered for the first time that kinetic energy can be harnessed in a purely diesel-run vehicle.

The recuperation of energy arising from vehicle braking actions is fundamentally possible with various types of drive systems. Based on detailed simulations of the fuel savings to be anticipated in a railcar from the VT 642 series, MTU developed a diesel-mechanical parallel hybrid system, which was comprehensively tested on the company's own test bench. The new drive system enables the kinetic energy arising from braking actions to be converted via a generator, into electrical energy. This electrical energy is temporarily stored in Li-Ion batteries and can be expended again as required, for example, when driving through tunnels, entering stations or driving through densely populated areas. These energy reserves are not, however, used to operate the train but are rather employed for the auxiliary electrical devices such as the railcar's air conditioning.

To integrate the hybrid concept along with other innovative technical developments into the existing vehicle, detailed technical measurements and simulations needed to be carried out prior to the requisite, comprehensive modifications and adjustments. The innovative new developments in the drive system, the air conditioning system and the changes made to the interior design concept incorporating an infotainment system and conference area had to be integrated in the existing vehicle system of the VT 642 series railcar. Deutsche Bahn undertook the system-technical engineering necessary to make these changes along with the testing and development of the detailed modification plans for the vehicle.

Following the conversion it was necessary to conduct test drives to ensure suitability for the transport of passengers. All test drives relevant for obtaining the required certification and permission for passenger transportation have been completed with the exception of the EMC (electromagnetic compatibility) test drives. The EMC test drives scheduled for December 2013 were postponed at short notice due to technical difficulties. Through the use of the test vehicle, significant insights for the hybridisation of existing rail vehicles could be attained.

A further project, EcoTrain from DB RegioNetz Verkehrs GmbH – Erzgebirgsbahn, comprising the development of innovative drive, control and auxiliary consumables technologies in combination with a demand-oriented energy management system received a notice of support in 2013 from the project administrator Jülich.

PARTNERS:	PROJECT BUDGET/€:	PROJECT FUNDING/€:
MTU Friedrichshafen GmbH	3,924,517	1,883,769
DB RegioNetz Verkehrs GmbH	1,580,141	758,468

COMMENCEMENT: 01 March 2010
CONCLUSION: 31 December 2013

V / 09

» GERMAN-FRENCH FLEET TRIAL ALONG THE RHINE – CROME «

Europe's first fleet demonstration project CROME (CROss-border Mobility for EVs) set out to establish and test standardised, cross-border and user-friendly electromobility between France and Germany. Throughout the three-year project period, a non-discriminatory and sustainable infrastructure with around 100 charging points along the Rhine was established, linked and tested under everyday conditions by more than 100 battery-electric vehicles comprising 11 different models. The recharging infrastructure that was developed in precursor projects MeRegioMobil and the model region Stuttgart Region as well as the Kléber project on the French side were also integrated in CROME.

The cross-industry project partners (BOSCH, Daimler, EDF, EnBW, KIT, Porsche, PSA, Renault, Schneider Electric, SIEMENS as well as associated partners) jointly developed an integrated concept that took the demands of recharging station operators, electromobility providers and users of electric vehicles into account. A main focus was on finding a neutral and open technical solution with the goal of interconnecting the services of the various providers in a system free of barriers. Various dimensions of electromobility needed to be considered in this regard. The first step involved establishing an interoperable recharging infrastructure in France and Germany compatible with all BEVs and PHEVs available on the market. The project partners developed and tested access systems and cooperation models for the installation and operation of a roaming-capable recharging infrastructure and IT systems.

The second field test phase comprised the evaluation, optimisation and implementation of a roaming-capable B2B platform. Test participants could use billing and roaming functions across borders using an RFID charging card. The four associated public utilities companies – Stadtwerke Karlsruhe, Baden-Baden, E-Werk Mittelbaden and Rastatter Energiewerke – as well as the French project partners EDF, CUS and Région Moselle were successfully integrated as partners for a European electric mobility platform with Germany and France.

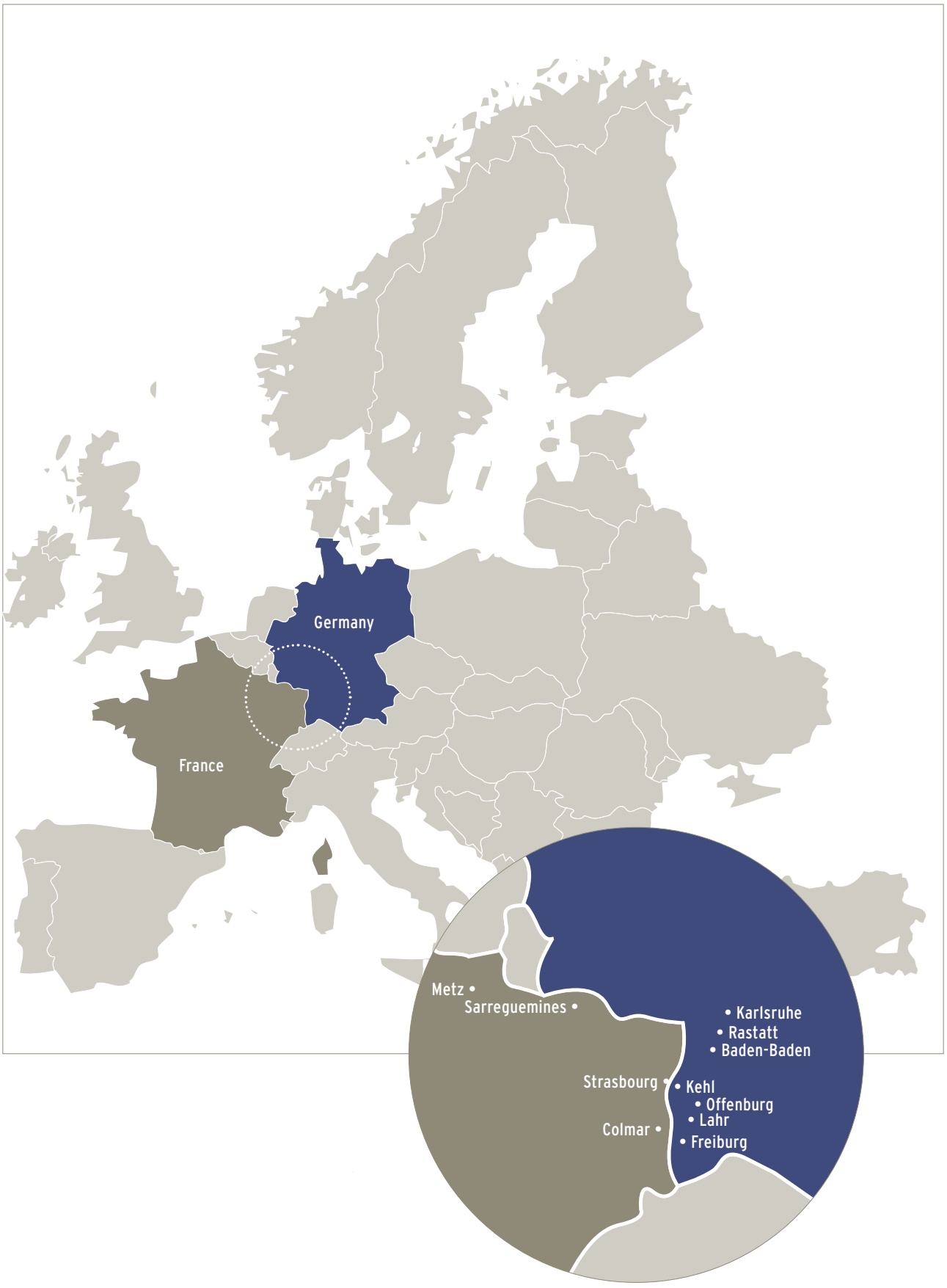
For the first time, cross-border roaming could be made possible in a research project – irrespective of location (France or Germany), vehicle type or recharging station operator. With more than 87,000 cross-border journeys and over 16,000 recharging procedures recorded since 2010 as well as several surveys, user behaviour could be comprehensively examined.

The insights gained now comprise the foundation for the development of new products and also flow into other scientific projects such as Green eMotion and the Showcases Electromobility Baden-Wuerttemberg and Berlin-Brandenburg. The results also allow recommendations to be made for the pan-European standardisation process of electromobility infrastructure and services.

PARTNERS:	PROJECT BUDGET/€:	PROJECT FUNDING/€:
EnBW Vertrieb GmbH	2,407,884	1,203,942
Porsche Engineering Group GmbH	2,004,139	801,656
Siemens AG	585,000	292,500
Bosch Software Innovations GmbH	1,668,712	667,485

VEHICLES: Citroën, Daimler, Peugeot, Porsche, Renault, Toyota
INFRASTRUCTURE: 100 (semi-) public recharging stations in Germany

COMMENCEMENT: 01 December 2010
CONCLUSION: 31 December 2013


Germany
France
Metz •
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• Karlsruhe
• Rastatt
• Baden-Baden
Strasbourg •
• Kehl
• Offenburg
• Lahr
Colmar •
• Freiburg

V / 10

» DEVELOPMENT AND DEMONSTRATION OF ELECTRIC CITY BUSES USING INDUCTIVE CHARGING ON A MULTIMODAL RECHARGING INFRASTRUCTURE – PRIMOVE ROAD «

Together with bus manufacturer Viseon, Bombardier developed and built a fully electric 12-metre bus featuring automatic inductive battery charging via the wireless PRIMOVE system from Bombardier. PRIMOVE onboard components were integrated in the bus for this purpose, primarily encompassing a power receiver system and a pick-up. Viseon developed a fully automatic lifting device for the pick-up coil with automatic air gap control and adjustment. In addition, the joint Bombardier-Viseon electric bus is equipped with Bombardier's newly developed electric drive system for buses. Bombardier developed this system, building on a century of experience in electric drive systems for rail vehicles. In May 2013, visitors to the »60th UITP World Congress and Exhibition« in Geneva could convince themselves of the efficiency and smooth ride the buses provide.

Following the initial successful tests in October 2012 for static recharging on the PRIMOVE test track for trams in Augsburg, the tests conducted in 2013 were primarily for dynamic inductive charging. Bombardier constructed the entire recharging infrastructure at the company's test location in Mannheim for this specific purpose. It facilitates both the dynamic (while driving) and static (while stationary) inductive recharging of the bus battery.

Unfortunately, the threat of impending insolvency at bus manufacturer Viseon meant the dynamic recharging tests could not commence in Spring at Mannheim as planned. In June 2013 Viseon could no longer avert bankruptcy, which has made the completion of tests impossible to date.

PARTNERS:	PROJECT BUDGET/€:	PROJECT FUNDING/€:
Bombardier Transportation GmbH	3,119,974	1,559,987
Viseon Bus GmbH	1,337,506	668,753

VEHICLES: Fully electric Viseon bus with PRIMOVE onboard components
INFRASTRUCTURE: Combined rail and road track for dynamic inductive recharging

COMMENCEMENT: 01 June 2011
CONCLUSION: 30 June 2013

Bombardier-Viseon bus at the UITP in Geneva

» OPERATIONAL AND TECHNICAL OPTIMISATION AND TRIAL OF THE HAMBURG HOCHBAHN AG DIESEL HYBRID BUSES – EBTO DIESEL HYBRID BUSES «

As part of its corporate strategy and as a move away from the reliance on fossil fuels, Hamburg public transport authority Hamburger Hochbahn AG (HOCHBAHN) plans to convert its bus drive systems to more environmentally friendly types with zero local carbon emissions, in the medium term.

Following the deployment of five serial diesel hybrid buses (18 m) from EvoBus in 2010, it became apparent that further technical optimisation was still necessary for complete suitability in everyday use. A four-step optimisation plan was therefore developed together with the manufacturer, and implemented within the framework of this project. Due to the definition of technical measures, improvements could be achieved that included greater vehicle availability and reduced fuel consumption. Among the measures was the optimisation of the vehicle's energy and operational management system. For example, the demand-oriented control of the ancillary components as well as the braking management system was successfully improved.

In addition, route-specific parameters relating to fuel consumption such as the distances between stops, average speed, etc., were closely assessed in order to optimally allocate buses with varying hybrid drive systems on correspondingly suitable routes in the future.

A software tool was developed for this purpose to enable a real comparison of the fuel consumption of the respective hybrid vehicles and their savings in respect to conventional diesel buses throughout the entire HOCHBAHN network. The tool allows a realistic estimate of fuel consumption to be made for a selected vehicle type (serial or parallel diesel hybrid buses, conventional diesel buses) on any HOCHBAHN route. It provides for important insights in the deployment of hybrid buses in regular scheduled HOCHBAHN services that feed back into strategic route planning activities as well as the further technical development of the hybrid buses.

Savings in fuel consumption of over 15 percent compared to conventional diesel buses could be recorded. The innovative drive concept registered operational availability of around 70 percent, which increased throughout the course of the project due to significant vehicle improvements. The operational and technical testing of the serial diesel hybrid buses can therefore be assessed as being successfully implemented.

PARTNER:	PROJECT BUDGET/€:	PROJECT FUNDING/€:
Hamburger Hochbahn AG	1,947,476	973,738

VEHICLES: **five serial diesel hybrid buses**

COMMENCEMENT: **01 October 2011**
CONCLUSION: **31 December 2013**

V / 12

» OPTIMISATION OF INDUCTIVE ENERGY TRANSMISSION COMPONENTS AND SYSTEM TESTING «

A major project goal was to assess the degree of optimisation of commercially available components that was necessary for these to be deployed in an inductive energy transmission system with a power range of up to 60 kW for the continual provision of traction energy and for the recharging of vehicle batteries. Furthermore, the question of whether energy can continue to be transferred even when the vehicle is moving at high speeds was to be examined. The project also aimed to ascertain which coil topologies were best to deploy for the roads and the vehicles. In determining the suitable coils, factors such as weight, volume, materials used and road construction needed to be taken into account. Technical and organisational interfaces as well as milestones were established, based on a project plan that determined the goals for each of the companies associated with the project. As part of regular recurring project status meetings, technical questions arising from project work in progress could be resolved and overall timing coordinated. The project schedule was thereby updated according to the progress made by all involved parties.

Diverse technical implementation methods were examined using numerical models and computer-aided simulations to assess their potential suitability. After defining an implementation method that appeared suitable (derived from the simulation results), various iteration steps were required on the path to an optimal configuration. At each iteration step, project partners consulted with one another in regard to any potential adjustments of the technical interfaces. At the conclusion of this iterative process comprising modelling adjustments, simulations and laboratory tests, it was shown that the simulation results and measured analyses recorded a high degree of conformity, both in terms of individual components and the complete system at the test circuit in Lathen, in the Emsland region of Germany.

The project results prove that inductive energy transmission for stationary and dynamic applications is also suitable for deployment at higher rates of energy transmission (up to 60 kW within the framework of this project), with minimal energy loss. Prototypes of coils for both the vehicle and roads as well as power electronic components for the road side supply of power and for connection to the energy storage on the vehicle side were designed, modelled, simulated, manufactured, assessed, integrated in vehicles and tested on a test track. The prototypes are available for further testing.

Within the framework of the special focus on examining technologies in the Bremen/Oldenburg model region, those involved in the project could show that inductive energy transmission represents a very good technical solution for the continual provision of traction energy for electric vehicles. The deployment of this technology appears to be particularly promising on fixed routes that include stationary intervals such as at bus stops, around intersections or at urban loading zones.

With the completion of the project, a test track for the practical field tests of components for stationary and dynamic induction energy transmission systems is now available. The test track and knowledge acquired throughout the project – especially by German companies – will help to simplify the technical design of forthcoming inductive energy transmission system components. Furthermore, these companies can now fall back on existing test capacities and need not necessarily invest in individual test benches. This represents a contribution to ensure that these companies maintain or increase their level of competitiveness in this field.

The project demonstrated that commercially available components – particularly power electronic modules – are not implementable for high performance inductive energy transmission systems without elementary changes or adjustments. To ensure efficient energy transmission and keep the number and volume of parts and materials required at a minimum, a relatively high frequency for the electromagnetic alternating field for energy transmission should be used. Current commercially available components usually do not meet these demands or are too costly. The search for suitable or customisable commercially available components has proven to be significantly more challenging than originally assumed. Citing price or timing issues, the majority of manufacturers approached could not deliver such adjusted components within the timeframe of the project. The accomplishment of the project goals was ultimately achieved through the extensive efforts of the associated project partners that customised the available components individually. A network of companies and institutional bodies has emerged as a result of this project, which can now answer many questions on the subject of inductive energy transmission systems.

The project partners have great interest in establishing together (or with the involvement of further companies) the suitability of dynamic inductive charging under everyday conditions in a follow-on project. Talks are currently in progress in regard to further activities.

PARTNERS:	PROJECT BUDGET/€:	PROJECT FUNDING/€:
Industrieanlagen-Betriebsgesellschaft mbH	1,955,727	977,863
Fraunhofer-Gesellschaft zur Förderung der angewandten Forschung e. V.	1,033,400	930,060
Alcatel-Lucent Deutschland AG	364,597	182,298
TRIDELTA Weichferrite GmbH	50,130	25,065
Max Bögl Bauunternehmung GmbH & Co. KG	140,925	70,463

VEHICLES: Test vehicle Atega and AUTOTRAM
INFRASTRUCTURE: Optimisation of the vehicle and roadside components already available on the market to enable inductive energy transmission systems of up to 60 kW and with an air gap of up to 20 cm, integration and practical testing on roads (test track) and vehicles.

COMMENCEMENT: 01 September 2011
CONCLUSION: 30 September 2013

» Within the framework of the special focus on examining technologies, those involved in the project could show that inductive energy transmission represents a very good technical solution for the continual provision of traction energy for electric vehicles. «

V / 13

» VOITH ELVODRIVE – SERIAL DIESEL HYBRID BUSES «

The project aimed to develop new technologies for serial diesel hybrid buses to such a point to allow for the subsequent test of the technology in everyday use and to measure the environmental effects in real scheduled service operations.

To enable this, a diesel hybrid bus with a serial diesel and electric motor (ElvoDrive Serial) was developed, built, tested and optimised in cooperation between Voith Turbo and Carrosserie Hess. Voith provided the know-how in the areas of drive motor, generator, converter, energy storage and software. HESS, meanwhile, developed the package and operational strategic system adjustments in the vehicle.

In order to verify the sustainability of the technology, specialist consultancy PE International scrutinised ElvoDrive using a lifecycle-based environmental performance evaluation.

The hardware and software components of the drivetrain that ensure optimised fuel consumption and driving comfort contain many new solutions and components. To name a few, these include: a more compact drivetrain with generator, electric motor and gearbox, a newly developed energy storage unit, new hardware and software solutions for power electronics and energy management. As such, optimal conditions have been created for minimal fuel consumption and low emissions for its deployment in city buses with many stops during scheduled services.

The many new technical solutions required to fulfil the demands of functional and electrical safety as well as sufficient availability in scheduled services, were a major challenge. The project findings obtained on the ElvoDrive drive technology level of maturity for reducing fuel consumption and its effect on emissions represent a new state-of-the-art for serial diesel hybrid buses.

PARTNER:	PROJECT BUDGET/€:	PROJECT FUNDING/€:
Voith Turbo GmbH & Co. KG	7,807,885	3,903,942

VEHICLES: Diesel hybrid buses

COMMENCEMENT: 01 November 2011
CONCLUSION: 30 June 2013

In order to verify the sustainability of the technology, specialist consultancy PE International scrutinised ElvoDrive using a lifecycle-based environmental performance evaluation.

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