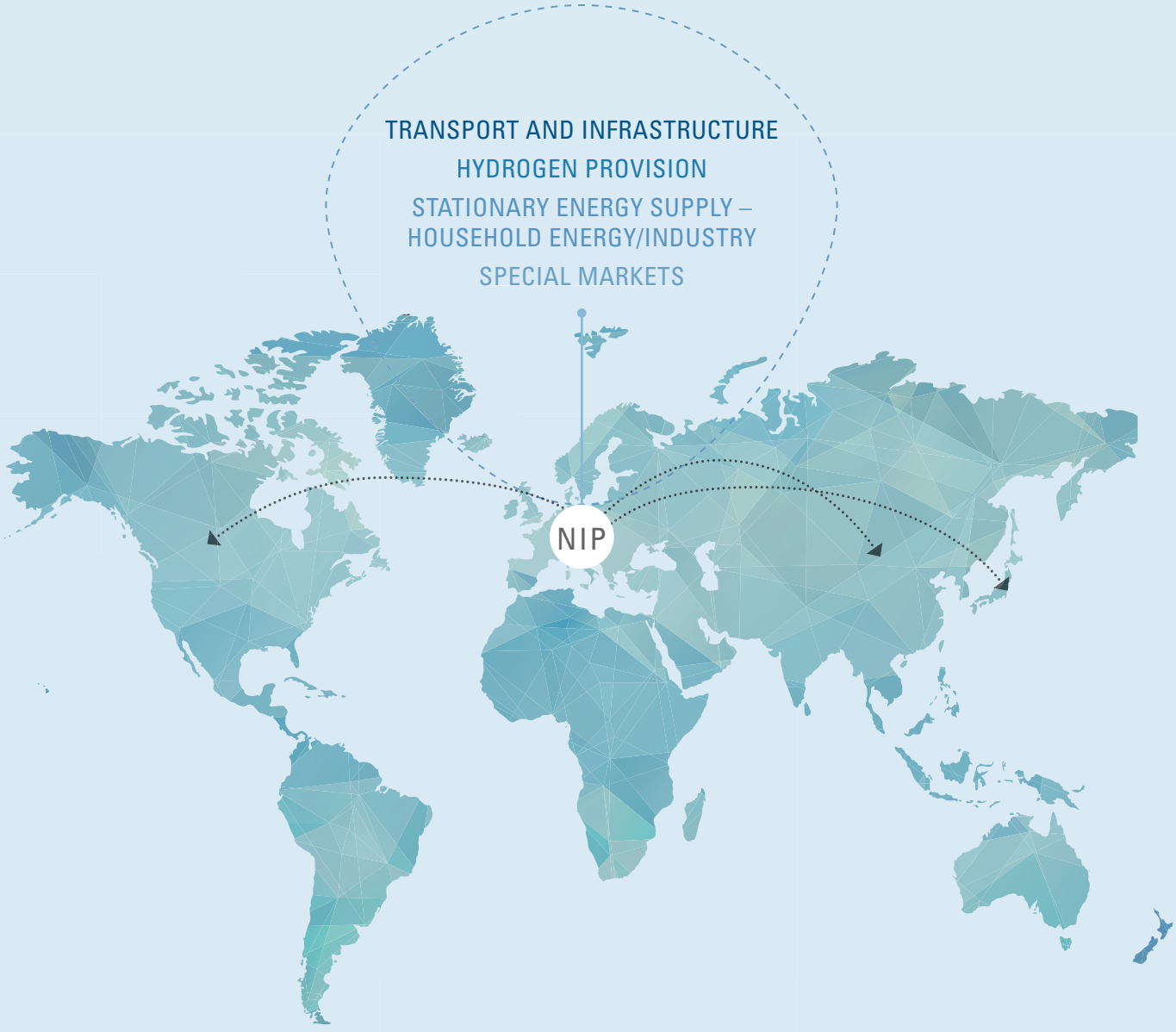



# **10** Years NIP – **2007** to **2016**

NOW
National Organisation
Hydrogen and Fuel Cell Technology

# **10** Years NIP – **2007** to **2016**

# **Forewod I** Dr. Klaus Bonhoff, NOW, Managing Director (Chair)

Dear reader,

In 2016, the 10-year National Innovation Programme Hydrogen and Fuel Cell Technology (or NIP I) ended. Building on NIP I, NIP II must serve as a framework for cooperation between politics, industry and science for the further development of hydrogen and fuel cell technology *(see interview with Dr. Oliver Weinmann, Chairman of the NOW Advisory Board, page 29)*.

In this latest NIP magazine, we review and take stock of NIP I. Those who have long been actively engaged with the topic will remember BREZEL and HYBERT: two research and development networks where needs for research in the area of hydrogen and fuel cells were discussed at the beginning of the century. In conjunction with further initiatives, including importantly, those from the federal states, the two platforms became the National Strategy Council for Hydrogen and Fuel Cell Technology. With the exchange between industry, politics and science, the strategy council was the right forum in which to formulate a joint development plan on the contribution of hydrogen and fuel cells to climate protection and on that basis to establish a national innovation programme in 2006. Two years later, on 18 February 2008, the National Organisation Hydrogen and Fuel Cell Technology, NOW, was founded by the federal government as a programme management association for NIP.

The stable structure of NIP – with its 10-year term, a total investment amount of 1.4 billion euros and the support of four federal ministries – has given rise to an industry with around 500 actors, which in addition to manufacturers of end systems, includes many suppliers, scientific institutions and downstream also numerous small and medium-sized companies. Over the past few years, this group has succeeded in significantly advancing products from essential application areas. Critical to the reliable and at the same time flexible structure of NIP, which for example allows the inclusion of additional work priorities, is the NOW Advisory Council. Here all participating industries as well as the political side, on federal and state levels, are represented, in order to continuously update the NIP development plan as a strategic guideline for the operative programme work.

In the area of road transport, the NIP lighthouse Clean Energy Partnership *(page 12)* is well established, as is the Callux *(page 18)* joint project in stationary energy supply. Through the testing of the technology by customers in everyday life along with the interaction of all participating sectors, a development level has been achieved in both areas that now enables the products to move to the commercial market. One of the key successes of NIP is that today technically-mature innovative hydrogen/fuel cell products are contributing to climate protection goals because they are efficient and emission-free.There is no question that the technologies' claim to the market needs further measures. The purchase of fuel cell vehicles and the construction of hydrogen refuelling stations are still too expensive. The same applies to fuel cell systems in household energy supply. The expectation is that the manufacture of greater numbers of units will help to reduce costs. This will be one of the main focuses of NIP II going forward.

Parallel to this we must support application areas towards technical maturity that adopted the technology over the course of NIP I, for example shipping, air transport, uninterruptible power supply or intralogistics. These areas have huge $CO_2$ savings potential, and are also attractive in terms of exporting environmental technologies. Spanning the individual application areas, hydrogen plays another decisive role in the context of climate protection goals: it is a key technology for linking sectors, which is necessary for eliminating fossil fuels from the energy system. Sector-linking has at least two major dimensions in this task: first the intelligent, flexible linking of all energy sources and consumers in terms of higher overall efficiency, and secondly, electricity or hydrogen as a new currency for vertical (source-consumption) and horizontal (flexible between the sectors) energy transfer.

With this in mind, I hope you enjoy reading our brochure and together with my team, stand readily available to answer your questions or discuss any of the above issues.

Yours,
Dr. Klaus Bonhoff

# NIP FROM 2007 TO 2016


The National Innovation Programme Hydrogen and Fuel Cell Technology (NIP) was established as a ten-year programme for the market preparation of hydrogen and fuel cell technology. The funding regulatory implementation of the projects within NIP was conducted by project administrator Jülich (PtJ – Projektträger Jülich). NOW was founded as the programme management association on 18 February 2008, for the implementation. The official NIP Funding Guideline was published on 23 June 2008.

Together with funding from the BMVI and the BMWi, this represented the starting signal for more than 400 projects from approximately 200 supported companies and scientific bodies to be conducted by the end of 2016. Overall, German industry was thereby encouraged to make investments totalling up to 4.5 billion euros in research and development as a result of the NIP. This not only ensured and created corresponding highly qualified jobs, but also contributed to shaping a technological global leadership in this segment. On the backdrop of climate protection goals, it is today clear that hydrogen and fuel cell technology is at the cusp of broad market introduction.

In this first NIP phase (2008-2016), the suitability of hydrogen and fuel cell technology and its fundamental marketability in various areas of application was successfully demonstrated. In the programme's four large lighthouse projects – **Clean Energy Partnership (CEP)** – transport, **CALLUX** – household energy, **e4ships** – industry/maritime and **Clean Power Net (CPN)** – off-grid supply of power – the technological maturity of fuel cell vehicles, fuel cell heating devices and systems as well as fuel cell-based emergency power supply systems could be confirmed in everyday conditions. The insights gained in further individual NIP projects led to the development of approaches and strategies for diverse aspects of hydrogen and fuel cell technology in various areas of application. The results of NIP projects show that fuel cells and hydrogen have the potential to make a decisive contribution to a sustainable and integrated energy system: they use renewable energies, conserve resources, are user-friendly and low maintenance as well as being robust and easy to use.

## » The costs of a hydrogen refuelling station, for example, have halved from two million euros in 2008 to one million euros in 2014. «

Through the coordinated activities of the applied research and development along with large-scale demonstration projects, the technology has significantly developed in terms of lifetime, reliability and cost-effectiveness. Most manufacturers of hydrogen and fuel cell products have completed the research and development phase and are now optimising their applications in demonstration projects. First German manufacturers are now offering products suitable for everyday use in the heating industry as well as in the area of critical power supply such as for emergency services radio. Fuel cell vehicles and the associated hydrogen refuelling infrastructure have been introduced to the market since 2015. Furthermore, in early 2015, the automotive, gas and petroleum industry founded a joint infrastructure company for the coordinated establishment of hydrogen refuelling infrastructure. NIP has proven that the technologies are suitable for everyday use and that they fulfil the market demands in terms of the technical parameters. The costs of the technology could be reduced by 50-75% depending on the application. The costs of a hydrogen refuelling station, for example, have halved from two million euros in 2008 to one million euros in 2014.

Industry partners of all sizes and from all sectors as well as players from the state and federal public sector work together within the scope of tNIP. In the development of hydrogen and fuel cell technology in Germany, this has the effect that the project activities complement each other in terms of content and strategic objective to thereby ensure a markedly optimised implementation of the overall programme. New national industry players (particularly small and medium-sized enterprises – SMEs) could also be introduced to the technology. Today, a sector with more than 500 firms has been established. Scientific expertise could thereby be retained and partly strengthened in Germany. In addition, further measures for qualification and continued training along with jobs could also be preserved or created.

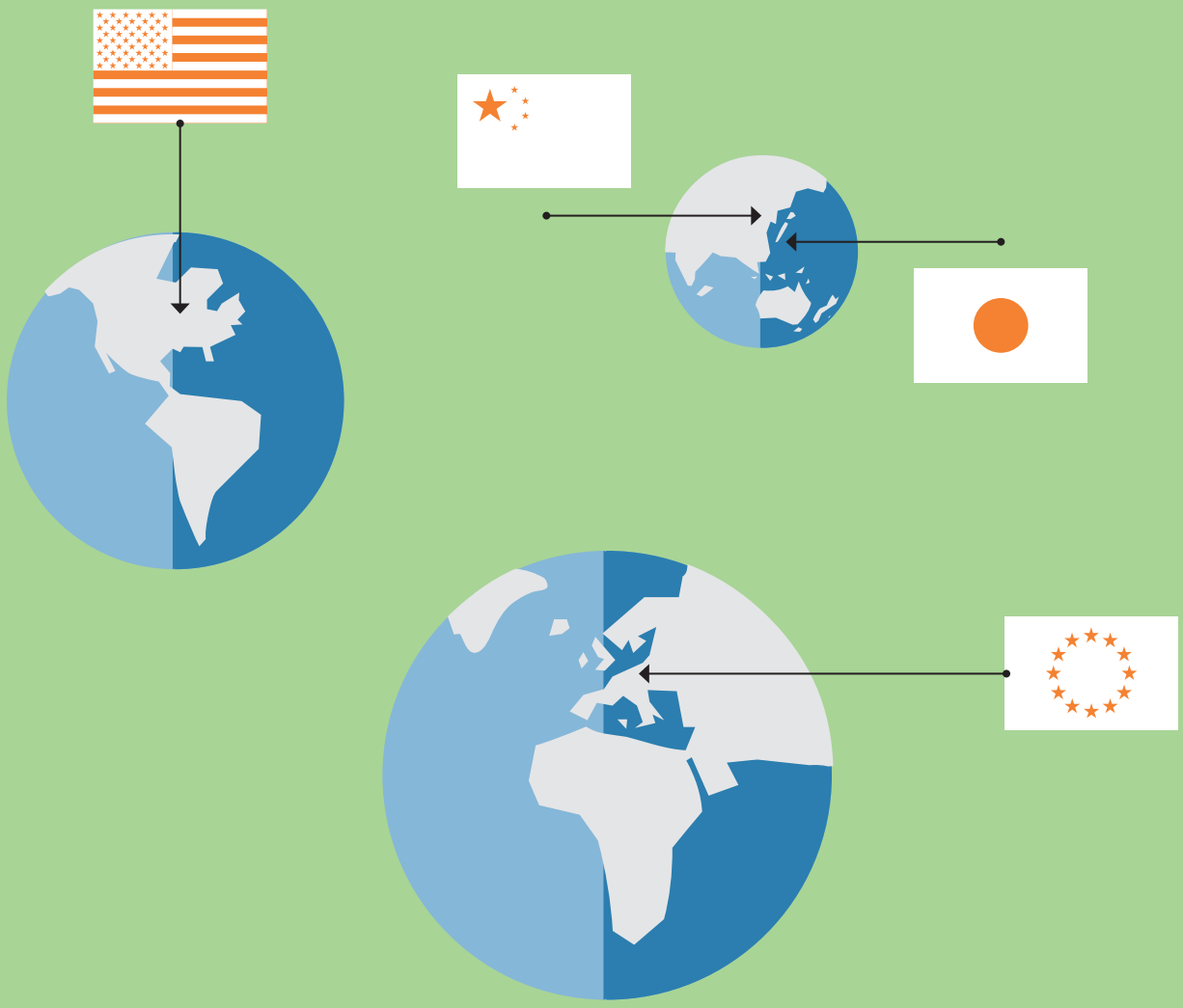
As such, with the National Innovation Programme Hydrogen and Fuel Cell Technology (NIP), the technological foundation was established between 2008 and the end of 2016, upon which Germany can build on over the coming years to expand the industrial value creation of hydrogen and fuel cell technology for greater international competitiveness.

## NOW AS THE NIP PROGRAMME MANAGEMENT ASSOCIATION

Upon its establishment, the primary task of the NOW GmbH (National Organisation Hydrogen and Fuel Cell Technology) programme management association was the coordination and management of NIP, which was organised into four programme areas – Transport & Infrastructure, Hydrogen Provision, Stationary Applications with Household Energy & Industry and Special Markets – in order to initiate, evaluate and bundle projects tailored to these specific areas. This ensured the effective and efficient deployment of funding and enabled as many synergy effects as possible to be exploited. An Advisory Board of experts supports NOW and provides strategic advice for implementation. The Advisory Board is comprised of representatives from the involved ministries, states and industry sectors as well as from science.

NOW evaluates the submitted project outlines especially based on their respective contributions to the energy and climate policy goals of the federal government and on their sustainable job creation potentials. Also assessed in the evaluation are: the innovative content in an international context; the contribution to the establishment of value-added chains especially in consideration of SMEs; the cost-reduction potentials; the commercialisation plans and prospects of success. At the same time, international networking is promoted through interdisciplinary functions, and the awareness and acceptance of the technologies and associated products is enhanced through target group-specific communication measures. As the programme management association, NOW has proven itself – domestically and internationally – in the sector as a neutral platform, and is the recognised specialist organisation for hydrogen and fuel cell technology along with electric mobility. Due to the comprehensive specialist knowledge NOW staff possesses, the organisation, which is at the interface between the players, is capable of bundling the relevant subjects for fast, well-informed decisions.

# 10 YEARS OF INTERNATIONAL COOPERATION IN NIP



From the very beginning, the National Innovation Programme Hydrogen and Fuel Cell Technology was followed by neighbouring countries and those beyond with great interest. It rapidly advanced to become a model for numerous hydrogen and fuel cellactivities throughout the world. Besides work in international and European committees, NOW also maintains bilateral relations with numerous organisations on a European level as well as in the USA, Japan China and other countries.

## EUROPE: FCH-JU AND THE EUROPEAN COMMISSION

On a European level, NOW maintains regular contact with the Fuel Cell and Hydrogen Joint Undertaking (FCH-JU) in Brussels concerning the current status of programme implementation. Within the scope of the partnership, NOW was involved in the FCH-JU-supported studies entitled "Fuel Cell Distributed Generation Commercialisation Study", "Energy Storage Study" as well as "Fuel Cell Bus Commercialization Strategy for Fuel Cell Electric Busses in Europe".

In addition, NOW also maintains relationships with the Hydrogen Europe industry association as well as with representatives of the Directorates-General ENER (energy), RTD (research and innovation), CLIMA (climate protection) and MOVE (transport) of the European Commission, which are involved in the field of hydrogen and fuel cell technology.

## GOVERNMENT SUPPORT GROUP

Established in 2013, the Government Support Group (GSG) was founded on a governmental level as an informal association of European countries in which exchange takes place on subjects concerning alternative fuels. In the past, the development of various national strategy policy frameworks in the context of the AFID were accompanied very closely by the GSG members. Separate working groups for the alternative fuels electricity, hydrogen and CNG/LNG exist in which current regulatory issues can be discussed. NOW supports the GSG activities within the scope of the BMVI and acts as the secretariat. By the end of 2016, the GSG could establish itself as an important informal platform for exchange, both due to the half-yearly steering meetings as well as through the telephone and web conferences that take place year-round.

## USA AND JAPAN

Since the foundation of NOW, very close connections have existed with the Department of Energy (DoE) and the California Fuel Cell Partnership hydrogen and fuel cell in the USA. Longstanding connections also exist to Japan. The similar developmental approaches taken by German and Japanese automobile manufacturers for fuel cell vehicles as well as the German CALLUX and the Japanese ENE FARM funding programmes for the deployment of fuel cell heating systems, led to the signing of a joint Memorandum of Understanding (MoU) back in 2010 between NOW and the New Energy and Industrial Technology Development Organisation (NEDO). Both organisations thereby agreed upon the mutual exchange of information.

In joint hydrogen infrastructure workshops that are meanwhile conceived and organised annually by DoE, NEDO and NOW, participants work on and discuss issues regarding the practical implementation of international standards and norms. The issues being discussed may include, for example, hydrogen quality, refuelling protocols or the measurement of hydrogen volume.

## CHINA

Within the scope of bilateral electric mobility projects, NOW has nurtured contacts to China's Ministry of Science and Technology (MOST) as well as to the China Automotive Technology and Research Center (CATARC) since 2011. With the adoption of the 13$^{th}$ 5-year plan in 2015, hydrogen and fuel cell technologies have increased in importance in China. On this backdrop, NOW and CATARC signed a joint Memorandum of Understanding in spring 2016 envisaging the exchange of information in the area of electric mobility with hydrogen and fuel cells. The activities are integrated in both the NIP as well as in the electric mobility funding programme.

## INTERNATIONAL PARTNERSHIP FOR HYDROGEN AND FUEL CELLS IN THE ECONOMY (IPHE)

Germany is a founding member of the International Partnership for Hydrogen and Fuel Cells in the Economy (IPHE). NOW supplements the BMVI in the Steering Committee. With the BMVI, Germany took on the role of the Chair of the IPHE from 2010 to 2012. During this time, NOW acted as the secretariat on behalf on the BMVI. Besides the Steering Committee Meetings that are conducted twice annually, in 2012 – under the chairmanship of Germany – the first International Stakeholder Roundtable was held in Berlin, with substantial participation by industry.

## INTERNATIONALE ENERGIAGENTUR IEA

In cooperation with industry, NOW supports the German contents of the IEA Hydrogen Roadmap and is engaged in the Hydrogen Implementation Agreement.

# 10 YEARS OF NIP TRANSPORT AND INFRASTRUCTURE PROGRAMME AREA

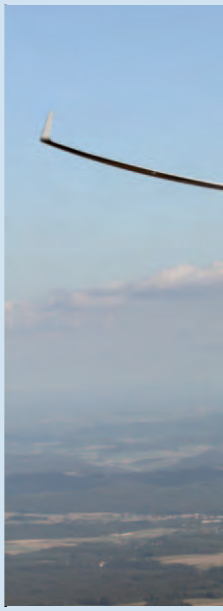
The transport and infrastructure programme area bundles all NIP activities that involve the use of hydrogen and fuel cell technologies for road, rail and air transport modes using passenger cars, commercial vehicles, trains and airplanes. In addition to this are different cross-cutting themes such as education and learning programmes as well as the (social) scientific accompaniment of various projects. It was continually examined over the course of NIP whether and how the awareness and acceptance of hydrogen and fuel cell technologies is developing for public transport use. Around 60 per cent of the funding over the entire NIP period was made available to the transport and infrastructure programme area.

## CEP LIGHTHOUSE

From the beginning the lynchpin of the programme area in NIP was the Clean Energy Partnership (CEP) lighthouse project with its 20 industry partners from the energy, technology, car manufacturing and transport sectors. Within the Clean Energy Partnership the everyday suitability of hydrogen mobility in combination with the fuel cell vehicle, refuelling with hydrogen, manufacture of hydrogen and use through test customers was and is being investigated.

Since the beginning of NIP over 200 cars were field tested in Berlin, Hamburg, Stuttgart, Düsseldorf und Frankfurt in the CEP. Parallel to this hydrogen buses were tested on scheduled service public transport operations in Berlin, Hamburg and Stuttgart. The activities of NIP and the CEP led to the development of a pure fuel cell carsharing fleet with 50 vehicles, which has been on the road in Munich since the summer of 2016.

Moreover the CEP paved the way for the establishment of suitable hydrogen infrastructures for transport requirements as well as the development of the first hydrogen refuelling station network in Germany. Within the CEP the industry has pledged that at least 50 per cent of the hydrogen that is consumed in the CEP fuel cell vehicles must come from renewable energies. A programme for the construction of a total of 50 refuelling stations was begun using funds from NIP in a research and development context in 2012 and with it the establishment of the industry joint venture H2Mobility for the further development of hydrogen refuelling stations in a pre-commercial environment. Thanks to the activities in the CEP, fuel cell cars can today be reliably and conveniently refuelled in a matter of minutes. Through work in the CEP in close collaboration with international partners worldwide, the fuelling standard for passenger cars was set at 700 bar. With the support of the CEP and other partners, NOW promotes standardisation activities for hydrogen refuelling stations on international and European levels within NIP. Further information can be found at: **www.cleanenergypartnership.de**

Apart from the CEP lighthouse projects, individual projects on component development for demonstration projects in road transport were funded in the programme area. These include projects on new or further development of hydrogen tanks in the vehicle, the development of suitable valve and metering systems for hydrogen, a new type of compressor technology for 700 bar refuelling, optimised power electronics for FC vehicles or the development of catalysts for automotive fuel cells.

Even though road transport is the main transport mode, technological developments and demonstration projects for rail and air will also be considered under NIP.

## RAIL TRANSPORT

In the area of rail transport, the development of a fuel cell battery electric multiple unit train run on hydrogen was allocated funding, and was presented for the first time at the InnoTrans trade fair in Berlin in September 2016. Parallel to this it was also demonstrated in the NIP-funded study on hydrogen infrastructure in rail transport that the use of fuel cell battery electric multiple unit trains was economically feasible in principle and the refuelling with hydrogen as a by-product (from industrial processes) would already now be economically more efficient than diesel. Nevertheless the right framework conditions must be created during the introduction phase.

## AIR TRANSPORT

In the area of aviation, developments are funded which have the potential to make air traffic more climate-friendly through the use of hydrogen and fuel cell technologies. The projects range from the development of fuel cell systems for on board electricity supply to multi-functional fuel cell systems in large commercial airplanes right up to the use of fuel cell electric drives for small and light passenger planes. The first test flight with a small, hydrogen-operated airplane for four passengers began from Stuttgart airport in September 2016. Support from NIP in the run-up played a crucial role in its development.

# 10 YEARS OF HYDROGEN PROVISION UNDER NIP

In the hydrogen provision programme area, projects were considered and funded which deal with the generation, distribution and provision of hydrogen, primarily in transport, and thereby account for the entire value chain of the energy source. Using NIP funds, several scientific studies and individual projects investigated how hydrogen, which in the past was used exclusively for industrial purposes, can be technically and economically transferred to future mobility applications.

One of the focuses of the work in the hydrogen provision programme area was the topic of power to gas, or the generation of hydrogen by means of electrolysis using renewable energies, particularly wind power. The first demonstration projects were funded under

Initial demonstration projects funded under NIP showed how surplus wind energy for the production of hydrogen by means of electrolysis can be used and stored as well as supplied to hydrogen refuelling stations. Building up electrolytic capacities, wind-hydrogen systems and the hydrogen feed into the gas grid are particularly important aspects and were examined separately. The production of hydrogen to regulate fluctuating wind energy was also a subject dealt with early on under NIP. Beyond the programme area, expert discussions on the prospect and energy industry categorisation of hydrogen as a storage medium and fuel were proposed and supported on national and European levels. It is in this context that NOW supported the establishment of the hydrogen alliance Performing Energy at the end of 2011.

# 10 YEARS OF NIP PROGRAMME AREA: STATIONARY ENERGY SUPPLY – HOUSEHOLD ENERGY/INDUSTRY

## HOUSEHOLD ENERGY – CALLUX LIGHTHOUSE

The CALLUX lighthouse project was to household energy stationary applications, what the Clean Energy Partnership is to the transport and infrastructure programme area. The demonstration project on the installation and operation of fuel cell heating devices for domestic use began on 23 September 2008 and was completed at the end of 2015. In the largest practical trial nationally, in which leading partners from the energy industry and the heating appliance industry came together, the energy-saving and climate-protecting technology of fuel cell heating devices in everyday use was operated and data measured and collected. All experience gained in the project was fed directly into the further development of the devices. Almost 500 heating devices were installed and have collected over five million operating hours in the field test under real-life conditions. In order to perform remote maintenance and operation and to operate systems as virtual power stations, a standardised interface was developed for fuel cell heating devices for the first time, the so-called CALLUX Box. Business models for the commercialisation of energy services for fuel cell heating devices were examined under CALLUX. Furthermore CALLUX was involved in vocational training, market research and communication. With a comprehensive online information programme as well as a range of lectures, CALLUX prepared the trade industry early for market launch. Through networking with educational


institutions, expert users and partners were able to be introduced to fuel cell techno-logy early on. Seven manufacturers have devices on the market already.

In developing fuel cell heating devices, the heating industry founded the Fuel Cell Initiative (Initiative Brennstoffzelle (IBZ)). Since 2011 manufacturers have promoted the important issue of international standards within this structure with NIP funding.

The BMWi has initiated funding for end users with the 433 kfW programme "Energy-efficient construction and renovation" 2016, with the goal of supporting fuel cell heating devices for market ramp-up. The goal is to bring over 100,000 devices to the market over the coming years.

In the area of stationary applications in industry, there were two priorities under NIP – maritime applications and combined heat and power in large properties.

## MARITIME APPLICATIONS – E4SHIPS LIGHTHOUSE

Fuel cells are an environmentally-friendly alternative to conventional aggregates on board of ships. NIP built on this approach with the e4ships lighthouse project, which was approved in 2009. In this joint project leading German shipyards, fuel cell manufactur-

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ers, suppliers, research institutions and classification societies worked together with the goal of demonstrating that shipping emissions could be reduced with fuel cells and the maritime industry can, in this way, contribute to climate protection and to future sustainability. Aside from the technical aspects, questions on the economic efficiency and on the development of international safety standards and rules were answered in the project. The fuel cell systems tested in the project provide the option of highly-efficient combined heat and power on board ships as well. Compared to conventional systems operated with marine diesel or heavy oil, significantly reduced exhaust and noise emissions were demonstrated. The modular approach also provides a flexible and secure structure on board. The project findings have been fed into the development of international regulations in order to generally facilitate the use of alternative fuels and fuel cells in international shipping. The first project phase was successfully completed in September 2016.

The results in the lighthouse project were gained in two separate subordinate projects Pa-X-ell and SchIBZ. In the Pa-X-ell project, the use of high-temperature PEM fuel cells with methanol on a passenger ship was tested. The basis for this was standardised modules for the generation of electricity, heat and cooling, that could be scaled up to the desired output sizes by connecting them together. The focus of the SchIBZ project is the development and testing of an integrated diesel-operated, hybrid fuel cell system with an output capacity of up to 500 kilowatts for seafaring ships. The FC system, as the main energy source, is to take over the electricity supply for all types of seagoing vessels in the medium term.

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In addition to the e4ships lighthouse project two additional implemented projects dealt with ship applications for goods transport and passenger transport in the inland area. For the first time the use of fuel cells for propulsion of ships was examined (fuel cells as range extenders in a push boat and the integration of a fuel cell in the hybrid system of a river cruiser).

## INDUSTRIAL APPLICATION – COMBINED HEAT AND POWER

In the combined heat and power area, projects were initiated and funded which dealt with electricity and heat energy supply by means of fuel cell systems for large properties such as hospitals, hotels, office buildings as well as production and storage facilities. The fuel cell system developed up to 2008 for this purpose on the basis of MCFC was abandoned by manufacturers in 2011 for various corporate strategic reasons. The projects already approved at this point in time had to be discontinued. Even though the market potential of CHP systems with fuel cells in an output range of some hundred kilowatts up to a few megawatts is definitely there, a concrete implementation of projects in the first phase of NIP proved problematic.

In May 2015 the NIP funding guideline "Fuel cells for highl-efficiency combined heat and power systems" ("Fuel cell CHP funding guideline") was published. On the basis of the guideline, seven funding applications were approved by the BMVI for the acquisition of a total of 1,292 commercially-available fuel cell-based CHP systems for use in the industrial and in the household energy area.

# 10 YEARS OF NIP SPECIAL MARKETS PROGRAMME AREA

In the special markets programme area, all activities under NIP were bundled together which involved hydrogen and fuel cell technologies for energy supply in very specific fields of application. Primarily these include energy supply for leisure applications such as motor- and sailboats or camper vans, logistics applications and use in industrial trucks as well as the energy supply of critical infrastructures (telecommunications, traffic-control systems, data centres) independent of the electrical grid or for emergency power supply.

In the area of leisure applications, numerous research and development projects using various fuel cell types such as direct methanol fuel cells (DMFC) were implemented using NIP funds and the use of different fuels like propane, butane or methanol was examined.

## LIGHTHOUSE – CLEAN POWER NET (CRITICAL POWER SUPPLY/UPS)

It was mainly the potential associated with the off-grid or network-independent energy supply that led to the establishment of the Clean Power Net (CPN) lighthouse in the special markets programme area in 2010 under NIP. Manufacturers and operators work

together in this network to achieve climate-friendly, efficient and thus more intelligent energy supply for industrial users. The network is an open, national and cross-sectoral consortium of 23 companies and R&D institutions along the entire value chain. The focus of the project is the use of fuel cell systems for critical and off-grid power supply, for example in telecommunications. Apart from implementing various demonstration projects for the power supply of safety-related infrastructures such as emergency services communication systems, it was examined to what extent fuel cell-based network-independent supply systems could be combined with virtual power plants and used for the generation of minute reserves and to reduce peak loads. Systems for data centre operation were examined in order to use more flexibly or even reduce the infrastructural techno-logy provided there for emergency power supply, to subsequently decrease the overall energy requirement.

In addition to demonstrating the technology, the long-term view of the economic efficiency of fuel cell systems compared to other emergency power systems was considered within the projects.

Further information can be found at: **www.cleanpowernet.de**


## INTRALOGISTICS FIELD OF APPLICATION – INDUSTRIAL TRUCKS

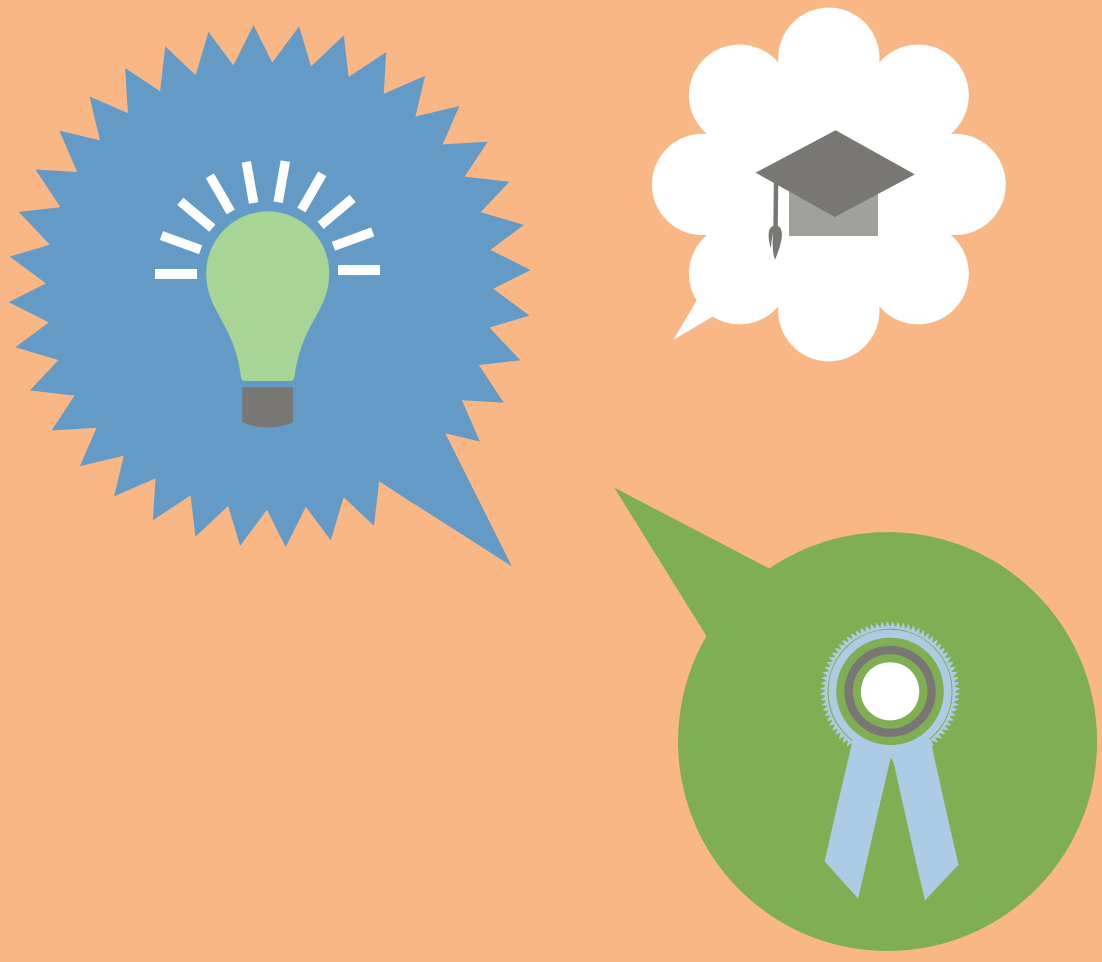
Within NIP, NOW supports the use of fuel cell systems in industrial trucks such as fork-lifts. In the area of warehouse logistics, industrial trucks were developed, constructed and examined in everyday use in factories in various projects. Like battery-operated vehicles, fuel cell systems in industrial trucks have the major advantage of being drivable in closed warehouses. Furthermore they can be quickly refuelled so that their smooth deployment in multiple-shift operation is assured. In addition to the development of the vehicles, issues such as the further development of the drive and refuelling system, the development of a service infrastructure with the associated staff training, dissipation of handling concerns about hydrogen fuel and the creation of acceptance in the work-force are also the focus of the NIP intralogistics projects.


## AIRPORT FIELD OF APPLICATION – AIRPORTS WORKING GROUP

With the goal of involving several German airports for a fuel cell large-scale demonstration and fleet project and gaining cross-sectoral cooperation between airports, NOW began initial talks with airport representatives and the relevant associations in 2010. The fuel cell initiatives of the federal states were also involved. For more than six years the airports of Hamburg, Dresden, Leipzig, Stuttgart, Frankfurt, Cologne/Bonn, Düsseldorf, Berlin and Munich as well as AIRBUS have been active in the working group. The focus of the work has been expanded over the last few years to pure battery-electric technologies.

The activities of the programme area were supplemented by the comprehensive analysis of market obstacles in the market introduction of fuel cells in special markets. In addition, over the course of NIP numerous workshops for and with different target groups were organised which deal with different aspects of fuel cell applications in special markets such as the development of a suitable supplier base.

# NIP EDUCATION PROGRAMME



Aside from technological development, construction and testing of prototypes as well as extensive demonstration projects, one of the focuses of NIP was education and training in the area of hydrogen and fuel cell technologies. The approach thus far still remains one of involving the younger generation – pupils, students and apprentices – early on in the technical and professional developments of hydrogen and fuel cell technologies. In this way, on the one hand, they become multipliers, bringing the topic out into the wider public. On the other hand trainees must be informed and qualified early enough so that there is enough expert knowledge and qualified personnel at the market introduction phase of different hydrogen and fuel cell products not only to guarantee the operation, service and maintenance of the different systems, but also to secure technology and product development for the future.

In various projects over the course of NIP, information and instruction materials along with learning and train ing modules were developed particularly for pupils of different grades as well as trainees and students in various fields. These include teaching materials for grade 7 – 11 as well as ETUDE learning products. NOW has also supported the national youth research competition, Jugend forscht, with a special award since 2010.

## YOUTH RESEARCHES (JUGEND FORSCHT) – HYDROGEN, FUEL CELLS, BATTERIES

NOW has been a sponsor of the *Jugend forscht* foundation since 2010 and awards the special prize "Hydrogen, fuel cells and battery-electric drives" every year on state level. A national winner is also selected by a NOW jury at regular intervalls. In previous years the prize winners have been invited by NOW to the NIP general assembly in Berlin, where the young researchers are presented with the prizes on stage by BMVI and NOW representatives in front of the expert audience.

## TEACHING MATERIAL ON BATTERIES AND FUEL CELLS

NOW has developed a study pack for the schoolroom, designed for that target group. The cross-grade and interdisciplinary study pack "Batteries and electric drives/Hydrogen and fuel cells" is designed as secondary level teaching material and makes the introduction to future energy technology easier for both teachers and pupils. The teaching material consists of information documents for teachers and pupils as well as a CD and covers the four topic areas of hydrogen, fuel cells, batteries and electric drives. The study pack was designed to intersect different subjects and can be used in chemistry and physics as well as biology, political education or geography. Schools can avail of an inexpensive and comprehensive study pack with which teaching staff can further educate themselves in the topic area and pupils can be introduced to the innovative technology.

## ETUDE

ETUDE is the key education and training project under NIP. In total over the course of the project three learning products were developed and presented for practically oriented youth development as well as education and further training.

The education modules are split into the "Mobile with hydrogen" learning and information software. This provides an insight into the world of technology and ideas with hydrogen mobility. A particular focus is on the societal context, motivation to change and the challenges of a societal and technological system changeover in the transport area. Another module is the technology kit "HyDrive". It facilitates a practically oriented insight into the energy management of electric drives. Using a model vehicle that is connected to a test stand, energy flows from different driving situations and energy system designs can be represented in the relevant software environment for use in class or study. The last module is a powertrain module in which realistic efficiency level analyses can be carried out "from fuel to wheel" for different technological concepts of electric mobility. The university-level education system can be run in battery-electric operation as well as a fuel cell-battery hybrid. The parameters of the integrated software models can be adjusted to simulate different vehicles and driving situations.
Further information can be found at w**ww.etude-online.de**

**Interview with NOW Advisory Board Chairman Dr. Oliver Weinmann**

# OUTLOOK FOR NIP CONTINUATION

## 1. Why do we need a continuation of NIP?

The success of the energy transition relies not only on developing renewable energy sources, but also requires a successful market launch of new and efficient energy technologies for system-wide integration of the electricity, heat and transport energy sectors. Hydrogen and fuel cells are an important component of this technology portfolio. Their spectrum of application ranges from efficient combined heat and power with a high share of electricity generation using fuel cells in stationary energy supply, simple storing of fluctuating, excess renewable energies in the form of hydrogen, right up to emission-free mobility for individuals, freight as well as local public transport. Hydrogen and fuel cells will make important contributions to preventing emissions in future ($CO_2$, pollutants, noise) as well as go a long way towards protecting resources, thus directly supporting the goals of the energy transition.

NIP II is tasked with connecting the contribution of fuel cell and hydrogen technology with the Grrman and European climate policy targets and requirements as well as with the opportunities emerging due to the broad market launch for German industry competing internationally.

### 2. What obstacles and challenges remain after 10 years of NIP?

Allow me to first take a look at the first 10 years of NIP. Major technical advancements were made during this time and the operational capability of the various hydrogen and fuel cell technologies in everyday operation was demonstrated. Over the next 10 years we must now resolutely pursue market introduction, on the one hand in order to facilitate the decarbonisation of the entire energy system, on the other to strengthen Germany as a technology centre.

Take for example stationary fuel cells: the first products are available on the market today. However high prices, mainly due to low production numbers, as well as a lack of basic infrastructure, prevent a dynamic market development. Further cost reduction of the technology through research and development continuity (incl. demonstration of overall systems in everyday use) and through higher production numbers is needed, which will be triggered by the market incentive programme for these products. In addition to the successes already achieved internationally in terms of market preparation, including through funding initiatives, the ambitious industrial policy goal of developing Germany into not only one of the largest markets, but also the most competitive supplier of sustainable products and applications in mobility and the energy industry cannot be achieved without undertaking additional measures. Reinforcing the domestic market is a specific prerequisite for ensuring products in demand here can also compete internationally. Additional action is required in establishing acceptance for new technologies.

### 3. How will this be addressed in NIP II and what are the priorities compared to NIP 1?

With respect to the coalition agreement of the federal government, work in NIP II will concentrate on the market activation of particularly promising products and applications. The focus will be on those applications which indicate promising market introduction by 2025 at the latest from an industrial policy perspective.

The continuation of NIP II will remain a joint programme of industry, science and the public sector. Investments from industry will be flanked by public funds. In this way gaps along the value chains will be filled by German manufacturers and small and medium-sized businesses in particular will also be included.

While research and development activities will continue to target cost reduction, industry and science are focusing on the following priorities in the market activation area:

- Setting up a supply-oriented hydrogen refuelling infrastructure and the associated sustainable generation of hydrogen, as well as its systematic linking into the energy system,
- Fuel cell systems for use in sustainable and climate-friendly mobility, above all in public transport,
- Stationary fuel cells for households and industry as combined heat and power systems as well as secure electricity supply to safety-critical facilities and systems
- Specific measures to strengthen the German supplier industry

Existing structures in the industry (e.g. fuelling infrastructure, supplier base) as well as NOW GmbH as a proven authority in holistic, programmatic coordination and implementation under one roof should be exploited in these activities.

### 4. Why will NIP II be divided into two funding priorities "Research & development" and "Market activation and development of demand"?

The objective of the measures in the continuation of NIP is to create the framework conditions in Germany to enable commercial use of this technology. The activities of NIP II thus focus on two aspects "Research & development" and "Market activation and development of demand".

R&D activities in NIP II concentrate on cost reduction through economies of scale, decreasing the weight and volume of the fuel cell as well as reducing the general system complexity. Furthermore reliability, service life and efficiency will be increased and operating conditions improved. In demonstration projects, technology validation of reliable products under everyday real life conditions and market preparation will be achieved. Another priority is customer acceptance and supplier industry motivation. In the area of energy technology, the production of hydrogen through electrolysis and from biomass as well as its storage in larger quantities is an objective for the establishment and development of the hydrogen chain.

Within market activation in NIP II, aside from enhancing the expertise of German industry in developing competitive products, the development of the demand side is paramount. NIPII supports the areas where German industry is already now in the market ramp-up investing the heaviest. These include fuel cell drives for road transport as well as the setting up of a reliable hydrogen supply infrastructure including the development of uniform norms and standards. Hydrogen generation from renewable energies represents another pillar, covering electrolysis/electricity-based fuel as well as waste and non-food biomass for system-wide integration of the energy sectors. Additionally highly-efficient

decentralised power generation such as combined heat and power with fuel cells for household energy supply and industry as well as electricity supply are key focus areas. It is also important to ensure added value for fuel cells and system components in Germany is expanded.

Besides reaching target costs for fuel cell products, investments also serve to achieve critical mass at market entry and in infrastructure development, such as refuelling stations. Direct-acting financial market activation instruments are economically sensible, if the market alone cannot yet achieve a viable result, but can be expected to do so within a reasonable period of time. This allows the potential for cost reduction to be raised more rapidly and the insufficient competitiveness of fuel cell applications in both the national market and international market to be overcome. A goal-oriented market activation will set the path towards achieving the goals of the federal government for more sustainable mobility, safeguarding European framework specifications on air quality as well as climate protection and added value in Germany.

### 5. How is industry getting involved in NIP II?

Under NIP II German industry is planning privately-funded investments in fuel cell and hydrogen technology totalling over two billion euros over the next 10 years (2016 – 2025). This includes maintaining research and development capacities in Germany as well as the financing of measures necessary for product introduction, for example, in the supply industry area or production capacities.

## FOCUS AREAS IN NIP II

### H2FC IN ROAD, RAIL, SHIPPING AND AVIATION

The focus of market activation in the transport area is on fuel cell drives for rail and road transport. Besides railcars with FC drives for railways, the focus in road transport is on passenger vehicles, light commercial vehicles and city buses as well as a reliable hydrogen supply infrastructure for the supply of the necessary fuel.

The successful market ramp-up of fuel cell passenger cars requires economically viable products and services for end users and an extensive refuelling station network. Economies of scale are of critical importance for reducing costs on the vehicle side. Although specific market activation measures for commercial fuel cell passenger cars in NIP II are not planned, NIP II is essential for the introduction of fuel cell vehicles in Germany. This is the case not only in terms of building up the necessary infrastructure, but also for the further technological advancement of the entire fuel cell technology field – including the development of a competitive supply infrastructure and general acceptance by people, particularly regarding hydrogen as a fuel.

Successful market activation of fuel cell buses will be attained at around 1,000 public buses for German local public transport companies, although here different technological concepts like hybridisation or fuel cell range extenders could be used. At the moment the joint procurement of fuel cell buses is being prepared on European level. German activities could also be represented in this action, where appropriate. Nevertheless until 2020, it is likely that foreign manufacturers will dominate the market. In this respect national initiatives are also necessary in order to foster native manufacturers and the national market. Common funding goals include the increase of vehicle availability, functional expansion (including articulated bus capability, electric charging systems, optimised energy and temperature management) as well as equipping garages, educating and further training of skilled workers and building up the required refuelling station infrastructure.

The potential already demonstrated in NIP I of other transport modes like rail, shipping and air transport, will accordingly be taken into consideration in NIP II. In rail transport the fuel cell drive lends itself especially to non-electrified routes in regional transport and demonstrates its strengths through an efficient drive and zero emissions. Essential work is focusing on the development of a drive system suitable for railways, the expansion and validation of the refuelling infrastructure for rail transport, the validation of the prototype vehicles, licensing of vehicles according to the Ordinance on the Construction and Operation of Railways, construction of pre-series production and eventually, the series production as well as the scientific and technical accompaniment of the public test operation.

In the maritme area, equipping ships with the appropriate fuel cell systems for on board electricity supply offers a clear competitive advantage to native shipyards in a global context. Aside from technical development work, questions on economic feasibility, safety standards, market introduction strategy as well as climate effects have already been clarified. More research, development and demonstration activities are necessary on this basis in order to reach full marketability in scalable fuel cell modules as well as integrated energy.

In preparing concepts for the increased use of fuel cells in air transport, short-term development stages will be pursued under NIP II. These include the on board energy supply of large passenger airplanes (electrification of subsystems with heat and product water extraction) and hybridised fuel cell battery main drives for small airplanes (up to 50 passengers), each with several 100 kW capacity. A second approach to increase the sustainability of large passenger machines (from 100 passengers) is in the hydrogen-based generation of secondary energies electrics, hydraulics and compressed air.

## REGULATIONS, CODES AND STANDARDS (RCS)

For efficient and cost-effective implementation of hydrogen and fuel cell technologies in the existing energy and transport system, suitable laws (regulations), standards and processes are required. Almost all relevant regulations applicable to hydrogen and fuel cells today either are or must be based on European rules (directives or regulations). Also a significant proportion of the norms used today are based on international norms (ISO, IEC) or are harmonised with them. New standards are essentially only developed within ISO, IEC or CEN, CENELEC. The creation of standards and rules as well as coordination between the two is complex and requires concerted action. Therefore at the start of NIP II a strategy paper will be created in which a timetable is developed for how the necessary RCS coordination efforts should be implemented.

## HYDROGEN PROVISION

Electricity-based fuels play a key role in the mobility and fuel strategy of the federal government. Parallel to the market ramp-up of vehicles, sustainably-produced hydrogen must be provided. For the market ramp-up of, for example, electrolytic hydrogen produced from renewable energies, action is needed in the regulatory environment as well as, depending on the application, investment grants. The first economic prospects arise from the flexible use of hydrogen, particularly in the fuel sector, first as an admixture in the refinery process for conventional fuels and then, increasingly for the direct use at hydrogen refuelling stations. To further reduce costs of hydrogen production, national and also European targets are required, including for building up electrolysis capacity for exploitation of scale effects. Initially the facilities will not be deployed competitively however, thus a strongly degressive investment grant is needed until 2025.

## HIGHLY EFFICIENT HOUSEHOLD ENERGY SUPPLY

Decentralised electricity and heat supply in individual homes has huge potential. A technology introduction programme (TEP) supports the market introduction of fuel cell combined heat and power systems for household energy supply and thus has a direct effect on the $CO_2$-saving targets of the federal government. Fuel cell combined heat and power systems can achieve high natural gas and $CO_2$ savings in existing buildings at relatively low investment levels with limited construction measures. The good power to heat ratio make the systems appealing for new buildings. By the end of 2021 therefore a total of approx. 175,000 systems will be installed in single homes and apartment buildings as well as businesses. The TEP will enable manufacturers to industrialise supply chains, production processes, etc. in a manner which facilitates the market without additional investment support alongside the relevant reference technologies.

## SECURE ELECTRICITY SUPPLY

The aim of NIP 2 is to install over 100,000 fuel cell systems with a total of approx. 50 MW capacity for uninterruptible and grid-independent electricity supply for critical infrastructures (emergency services, transport technology, telecommunication, data centres and industry/ business) in Germany by 2025. Support is needed for the market ramp-up, which should be significantly accelerated by investment grants for users. This will lead to economic competitiveness (price will be halved) compared to conventional products by 2021. Parallel to this, hydrogen infrastructure will be developed for local distribution at decentralised or autonomous off-grid locations. The specific requirements of renewably-produced hydrogen must be taken into consideration for logistics and hydrogen quality.


INNOVATIVE
ZUKUNFT
MOBILITÄT
POWER TO GAS
飛行機
FLEET OPERATIONS
MARKET PREPARATION
LADESÄULEN
未来
ハイブリッドバス
E-CAR
WASSERSTOFF-TANKSTELLEN
WIND-WASSERSTOFF
LEISE
BATTERIEFAHRZEUG
持続的
RECHARGING INFRASTRUCTURE
ELECTRIC CAR SHARING
NOW

# LIST OF NIP PROJECTS

| NIP project | Commencement | Conclusion |
|---|---|---|
| PAN-HO7: MDM | 01.01.2008 | 31.12.2010 |
| Kleingeräteprogramm | 01.02.2008 | 30.04.2011 |
| Leichtmetallhydrid-Systeme | 01.02.2008 | 30.09.2011 |
| Begleitung BZH | 01.04.2008 | 30.09.2012 |
| Bussystem | 01.04.2008 | 31.08.2011 |
| Feldtest BZH | 01.04.2008 | 30.09.2012 |
| Freizeitfahrzeuge | 01.04.2008 | 31.12.2010 |
| HeP | 01.04.2008 | 31.12.2010 |
| Hybridanlage | 01.04.2008 | 31.12.2011 |
| HydroGen4 | 01.04.2008 | 30.06.2013 |
| MCFC-Entwicklung | 01.04.2008 | 30.06.2010 |
| MOFs | 01.04.2008 | 30.09.2011 |
| Reformkats | 01.04.2008 | 31.07.2012 |
| 700-bar-Betankungstechnik | 01.06.2008 | 31.12.2010 |
| Eurozelle | 01.06.2008 | 31.01.2013 |
| NEOKAR | 01.06.2008 | 31.12.2010 |
| CEP Phase II | 01.07.2008 | 31.01.2011 |
| DMFC-Antrieb | 01.07.2008 | 31.12.2010 |
| Einsatz VW | 01.07.2008 | 31.12.2010 |
| HT-PEM-Brennstoffzellenaggregat | 01.07.2008 | 31.07.2009 |
| Mobile Betankungseinrichtung Gradestraße | 01.07.2008 | 31.03.2009 |
| STEP | 01.07.2008 | 30.06.2010 |
| $H_2$-Tankstelle Margarete-Sommer-Straße | 01.07.2008 | 31.03.2010 |
| HT-FlexPEM | 01.07.2008 | 31.07.2010 |
| NaBuZ prep | 01.08.2008 | 30.06.2012 |
| Tankstelle Schöneberg | 01.08.2008 | 31.12.2014 |
| Wasserstoffdosierventil | 01.08.2008 | 31.12.2013 |
| HYSIM | 01.09.2008 | 31.12.2011 |
| OptiGAA | 01.09.2008 | 31.12.2012 |
| BZ-System Design-Validierung | 01.10.2008 | 30.04.2014 |
| ENSA II | 01.10.2008 | 31.03.2012 |
| HYDEE | 01.10.2008 | 30.09.2012 |
| SOFC20 | 01.10.2008 | 30.11.2008 |
| Speicherstadt | 01.10.2008 | 31.03.2009 |
| Fertigungsprozessen für Komponenten | 01.11.2008 | 31.07.2009 |
| Veranstaltungen 2008 | 01.11.2008 | 31.12.2008 |
| CEP Phase II – Holzmarktstraße | 01.01.2009 | 31.03.2014 |
| LDT | 01.01.2009 | 30.06.2013 |
| MÖWE II | 01.01.2009 | 31.03.2012 |
| Verbundvorhaben MÖWE II | 01.01.2009 | 31.12.2010 |
| BBH-MH II | 01.03.2009 | 31.08.2012 |
| FCEV | 01.03.2009 | 31.12.2011 |
| $H_2$CPI | 01.03.2009 | 31.01.2011 |

| NIP project | Commencement | Conclusion |
|---|---|---|
| PaXell | 31.12.2011 | 31.12.2016 |
| USV | 31.12.2011 | 31.12.2011 |
| F-Cell Berlin | 30.06.2016 | 30.06.2016 |
| F-Cell Hamburg | 31.01.2015 | 31.01.2015 |
| Turbolader | 31.10.2011 | 31.10.2011 |
| Automatisierung der MCFC-Fertigung | 31.12.2010 | 31.12.2010 |
| Chemergy | 01.06.2009 | 31.05.2012 |
| EU-SKAB | 01.06.2009 | 31.12.2012 |
| Fuel Cell 4 Leisure | 01.06.2009 | 30.06.2012 |
| SchIBZ | 01.06.2009 | 31.12.2016 |
| Wasserstoffstation Hamburg | 01.06.2009 | 31.10.2016 |
| µMega | 01.07.2009 | 31.03.2013 |
| Berlin Gradestraße | 01.07.2009 | 31.03.2012 |
| CryoComp | 01.07.2009 | 31.12.2013 |
| DMFC – Herstellungsoptimierung | 01.07.2009 | 31.01.2011 |
| DMFC – Entwicklung | 01.07.2009 | 30.06.2012 |
| Hochtemperatur-Bipolarplatten | 01.07.2009 | 30.06.2012 |
| Hydrogen 7 | 01.07.2009 | 31.12.2012 |
| Midibus | 01.07.2009 | 31.12.2013 |
| Synergiepotenziale $H_2$ | 01.07.2009 | 31.10.2009 |
| Referenz-Messsystem | 01.08.2009 | 30.04.2012 |
| Herrstraße | 01.08.2009 | 31.05.2014 |
| Wasserstoffzwischenspeicher | 01.08.2009 | 31.12.2014 |
| $HyMotion_4$ | 01.08.2009 | 31.12.2016 |
| INHOUSE | 01.08.2009 | 30.06.2011 |
| NT-PEM-Brennstoffzellenaggregat | 01.09.2009 | 30.11.2011 |
| CryoSys | 01.09.2009 | 30.08.2014 |
| Entschwefelung | 01.09.2009 | 31.12.2013 |
| Glyzerin-Pyroreforming | 01.09.2009 | 31.10.2014 |
| Heavy-Duty-Brennstoffzellensystem | 01.09.2009 | 31.08.2013 |
| HyTrust | 01.09.2009 | 31.08.2011 |
| KOPA II | 01.09.2009 | 31.03.2010 |
| Markthemmnisanalyse | 01.09.2009 | 31.12.2012 |
| Neue MEA | 01.09.2009 | 31.12.2012 |
| USVProgas | 01.10.2009 | 30.06.2012 |
| 5-Lagen MEA | 01.10.2009 | 31.07.2012 |
| Bzert | 01.10.2009 | 31.12.2011 |
| Energiezentrale | 01.10.2009 | 31.03.2012 |
| FC-Dynamics | 01.10.2009 | 31.07.2012 |
| GCSFP | 01.10.2009 | 31.12.2011 |
| HySport | 01.10.2009 | 31.03.2013 |
| Kanad.-Dt. Brennstoffzellenkooperation | 01.10.2009 | 30.06.2013 |
| Next Gen MS SOFC | 01.10.2009 | 31.12.2016 |

| NIP project | Commencement | Conclusion |
|---|---|---|
| Wind-Wasserstoff-System | 01.10.2009 | 31.07.2015 |
| Anpassentwicklung Hot Module II | 01.11.2009 | 31.12.2010 |
| Wasserelektrolyse | 01.11.2009 | 31.05.2010 |
| MetaBPP | 01.12.2009 | 31.05.2013 |
| BRIST | 01.01.2010 | 28.02.2015 |
| Internationale Normung | 01.01.2010 | 31.12.2016 |
| Leuchtturm Hausenergie, Phase II | 01.01.2010 | 31.12.2014 |
| SOFC-BZHG | 01.01.1200 | 30.09.2015 |
| Osiris | 01.02.2010 | 31.01.2013 |
| VeGA 2000 | 01.02.2010 | 30.06.2014 |
| Antares H3 | 01.03.2010 | 31.12.2016 |
| GLASSeal | 01.03.2010 | 31.12.2012 |
| Testbetrieb | 01.03.2010 | 31.12.2010 |
| E-Boxster | 01.04.2010 | 30.11.2011 |
| HY 4 Anode | 01.04.2010 | 31.12.2013 |
| MEA-KORREKT | 01.04.2010 | 30.09.2013 |
| REX | 01.04.2010 | 31.12.2014 |
| Rotopress-Müllfahrzeug | 01.04.2010 | 30.09.2013 |
| SOFC20 | 01.04.2010 | 30.06.2013 |
| Technologieplattform | 01.04.2010 | 31.01.2014 |
| Modulare Energieversorgungslösung | 01.05.2010 | 31.10.2012 |
| Plakonexa | 01.05.2010 | 30.09.2014 |
| Speicherstadt Potsdam | 01.05.2010 | 31.12.2010 |
| FCPSGEN2 | 01.06.2010 | 31.10.2013 |
| HydroGen 4 | 01.06.2010 | 31.12.2012 |
| Infrastruktur ZBT | 01.06.2010 | 31.08.2011 |
| Normungsreisen | 01.06.2010 | 31.12.2016 |
| SOFConvert | 01.06.2010 | 31.05.2013 |
| Wasserstoff-Speicher-System | 01.06.2010 | 31.12.2012 |
| BOS-Digitalfunks Niedersachsen | 01.07.2010 | 30.06.2014 |
| DMFC-Gabelstapler | 01.07.2010 | 30.09.2011 |
| in5000plus | 01.07.2010 | 31.12.2013 |
| Mobilfunkstationen | 01.07.2010 | 30.06.2016 |
| PEM-Membranen | 01.07.2010 | 30.06.2013 |
| PEM-Membranen aus Polysulfonen | 01.07.2010 | 30.06.2013 |
| STEP2 | 01.07.2010 | 31.12.2013 |
| Kompaktreformer für Methanol | 01.08.2010 | 30.06.2013 |
| LPG-APU 2 | 01.08.2010 | 31.12.2013 |
| LPG-APU 2 | 01.08.2010 | 31.12.2013 |
| Ulmer Stromschachtel | 01.09.2010 | 31.10.2016 |
| ePowerSys | 01.10.2010 | 30.09.2015 |
| OVE | 01.10.2010 | 31.03.2013 |
| PEM Brennstoffzelle Phase3 | 01.10.2010 | 31.07.2013 |

| NIP project | Commencement | Conclusion |
|---|---|---|
| TREMOD | 01.10.2010 | 31.12.2012 |
| SOE | 01.11.2010 | 31.10.2013 |
| FC@Home | 01.12.2010 | 30.06.2015 |
| Ionische Verdichterstation | 01.12.2010 | 31.03.2014 |
| Public Incentives | 01.12.2010 | 30.06.2011 |
| Tankstelle München | 01.12.2010 | 31.08.2012 |
| CEP Phase III | 01.01.2011 | 31.12.2014 |
| Flotte Stuttgart/Frankfurt | 01.01.2011 | 30.06.2015 |
| Flottenbetrieb CEP Phase III | 01.01.2011 | 31.12.2014 |
| Lebensdauerprognosemodelle | 01.01.2011 | 30.04.2014 |
| PPE | 01.01.2011 | 31.03.2015 |
| H2Mobility Stuttgart | 01.02.2011 | 31.12.2016 |
| KryoFüll | 01.02.2011 | 31.12.2012 |
| NaBuZ demo | 01.04.2011 | 31.10.2016 |
| AMORPHEL | 01.05.2011 | 31.10.2014 |
| Biomasse | 01.05.2011 | 30.04.2012 |
| RCS-Studie | 01.05.2011 | 30.11.2011 |
| HORIZONT | 01.06.2011 | 31.05.2015 |
| MetalFuel | 01.06.2011 | 31.08.2014 |
| SMART | 01.06.2011 | 31.05.2014 |
| MetAPU | 01.07.2011 | 31.12.2014 |
| RoBiPo | 01.07.2011 | 30.06.2015 |
| SOFC | 01.07.2011 | 31.12.2014 |
| All-Electric-Yacht | 01.08.2011 | 30.09.2014 |
| CANBUS-ZSU | 01.08.2011 | 31.07.2012 |
| Integration Wind-Wasserstoff- Systeme | 01.08.2011 | 31.10.2012 |
| VERITAS | 01.08.2011 | 31.07.2013 |
| BEST | 01.09.2011 | 31.08.2013 |
| BZ-Modul 5 kW-Klasse | 01.09.2011 | 30.06.2016 |
| FCHV-adv Brennstoffzellenfahrzeuge | 01.09.2011 | 30.06.2016 |
| BICYCLE | 01.10.2011 | 31.03.2015 |
| BeBop | 01.12.2011 | 31.08.2012 |
| EnerSta | 01.12.2011 | 31.12.2014 |
| Heidestraße | 01.12.2011 | 31.12.2016 |
| NEKat | 01.12.2011 | 30.11.2014 |
| Begleitung BZH-Phase II | 01.01.2012 | 31.12.2016 |
| Bestkat | 01.01.2012 | 30.09.2014 |
| DEMO III | 01.01.2012 | 31.12.2016 |
| ELCORE 1 | 01.01.2012 | 30.06.2013 |
| ETUDE | 01.01.2012 | 31.08.2016 |
| H2BER | 01.01.2012 | 31.12.2016 |
| PumaS | 01.02.2012 | 31.01.2013 |
| 100MPaH2 | 01.03.2012 | 31.12.2015 |

| NIP project | Commencement | Conclusion |
|---|---|---|
| NEOKAR II | 01.03.2012 | 28.02.2015 |
| BOS-Digitalfunks Brandenburg | 01.04.2012 | 31.03.2017 |
| ENSA III | 01.04.2012 | 31.03.2015 |
| Katalysatoren | 01.04.2012 | 31.03.2016 |
| Kryopumpentechnologie | 01.04.2012 | 31.03.2014 |
| MÖWE III | 01.04.2012 | 31.03.2015 |
| Stress | 01.04.2012 | 31.03.2015 |
| Technisches Modul Ford FCEV | 01.04.2012 | 30.09.2016 |
| 10 Wasserstofftankstellen | 01.05.2012 | 31.12.2016 |
| Energiespeicher Leuchtturm Wind-H2 | 01.05.2012 | 30.09.2015 |
| HT-Dicht | 01.05.2012 | 31.08.2015 |
| Kleingeräteprogramm II | 01.05.2012 | 30.04.2015 |
| BZ-Flurförderfahrzeuge | 01.06.2012 | 31.12.2016 |
| miniBIP | 01.06.2012 | 30.06.2016 |
| SOFC-Bordenergieversorgungs- system | 01.06.2012 | 31.05.2015 |
| S-presso | 01.06.2012 | 30.09.2016 |
| AWAKOL | 01.07.2012 | 31.12.2014 |
| NG PEM-Stack | 01.07.2012 | 31.03.2015 |
| HyMotion5 | 01.08.2012 | 31.07.2017 |
| Kleingeräteprogramm II VOBS | 01.08.2012 | 30.06.2014 |
| proAir | 01.08.2012 | 30.06.2016 |
| Feldtest Elcore | 01.09.2012 | 31.12.2014 |
| 1 MW-PEM | 01.11.2012 | 30.09.2016 |
| MatFuel | 01.11.2012 | 31.12.2016 |
| H2IntraDrive | 01.12.2012 | 30.04.2016 |
| CryoCode | 01.01.2013 | 30.09.2016 |
| CryoFuel | 01.01.2013 | 31.08.2015 |
| F-CELL LuK | 01.01.2013 | 31.12.2015 |
| SealS | 01.03.2013 | 29.02.2016 |
| FC@Home-Phase 2 | 01.04.2013 | 30.06.2016 |
| Hymod | 01.05.2013 | 31.01.2017 |
| Industrie DMFC | 01.05.2013 | 30.06.2015 |
| HEMCP | 01.06.2013 | 30.09.2014 |
| KOSEL | 01.06.2013 | 31.07.2014 |
| BOS-Digitalfunk BW | 01.07.2013 | 30.06.2016 |
| MinimAI-Luft | 01.07.2013 | 30.06.2016 |
| Übergeordnetes Synergiemodul im Leuchtturm | 01.07.2013 | 31.12.2016 |
| Leonardo | 01.08.2013 | 31.12.2015 |
| Verdichtermodul | 01.08.2013 | 31.12.2015 |
| BetHy | 01.09.2013 | 31.10.2016 |
| ELGA | 01.09.2013 | 31.05.2015 |
| Hy8 | 01.09.2013 | 31.12.2016 |

| NIP project | Commencement | Conclusion |
|---|---|---|
| Marktvalidierung | 01.09.2013 | 31.07.2016 |
| ELAAN | 01.10.2013 | 30.06.2017 |
| HRS Detmoldstraße | 01.10.2013 | 31.12.2016 |
| Optigaa 2 | 01.10.2013 | 31.03.2017 |
| Hy-UWE | 15.10.2013 | 31.12.2016 |
| Schnackenburgallee | 15.10.2013 | 30.06.2016 |
| GenStore | 01.11.2013 | 30.09.2016 |
| Low Cost BiP | 01.05.2014 | 30.04.2017 |
| DemoHydra | 01.07.2014 | 30.06.2017 |
| MAS-TECH | 01.07.2014 | 31.10.2016 |
| MCFC | 01.07.2014 | 30.06.2017 |
| MCFC-Next | 01.07.2014 | 30.06.2017 |
| EXTRAMEA | 01.08.2014 | 31.07.2018 |
| H2plus | 01.08.2014 | 30.09.2015 |
| H2-Tankstellenversorgung | 01.08.2014 | 30.06.2016 |
| HyNine | 01.08.2014 | 31.12.2016 |
| TFE | 01.08.2014 | 31.12.2016 |
| HyTrustPlus | 01.09.2014 | 31.12.2016 |
| SFHH | 01.09.2014 | 31.12.2016 |
| AltHyPTank | 01.10.2014 | 30.11.2016 |
| LSSOFC | 01.10.2014 | 31.12.2017 |
| 50 Tankstellen Begleitforschung | 04.11.2014 | 30.06.2017 |
| ALASKA | 01.12.2014 | 31.05.2017 |
| BeZel | 01.12.2014 | 31.12.2016 |
| LPG-mKWK | 01.12.2014 | 31.01.2017 |
| Thermelin | 01.12.2014 | 30.11.2018 |
| FOSUS | 01.01.2015 | 31.12.2017 |
| HyLoad | 01.01.2015 | 31.12.2016 |
| MontaBS | 01.01.2015 | 30.04.2017 |
| PRECOAT | 01.01.2015 | 31.12.2017 |
| RiverCell | 01.01.2015 | 31.12.2016 |
| HyLIGHT | 02.01.2015 | 31.12.2016 |
| BZ-BusGen4 | 01.03.2015 | 31.12.2016 |
| Elcore 2,5 kW | 01.03.2015 | 31.12.2016 |
| Hy4OMV | 01.03.2015 | 31.12.2016 |
| HydrogenSystems | 01.03.2015 | 31.12.2016 |
| CEP Phase III 2 | 01.04.2015 | 31.12.2016 |
| H2-NEO-LEAK-SENS | 01.04.2015 | 30.09.2016 |
| Industriepark Höchst | 01.04.2015 | 31.12.2016 |
| Phase 1a | 01.04.2015 | 31.12.2016 |
| WestfalenHy | 01.04.2015 | 31.12.2016 |
| BZ-NEA-BOS-BY | 01.05.2015 | 31.12.2016 |
| MeMo | 01.05.2015 | 31.12.2016 |

| NIP project | Commencement | Conclusion |
|---|---|---|
| METHAPEM | 01.05.2015 | 30.04.2017 |
| NEST Pel | 01.05.2015 | 30.04.2018 |
| QUALIFIX | 01.05.2015 | 30.04.2018 |
| HyRRES | 01.06.2015 | 31.12.2016 |
| SOFC-QS | 01.06.2015 | 31.12.2016 |
| F-CELL-PREP | 01.07.2015 | 31.12.2016 |
| Home-Backup | 01.07.2015 | 31.12.2016 |
| Leonardo II | 01.07.2015 | 31.12.2016 |
| SeFoG | 08.07.2015 | 31.03.2017 |
| Alterung SoHMuSDaSS | 01.08.2015 | 31.07.2018 |
| HRS-Moni | 01.08.2015 | 31.12.2016 |
| SMART II | 01.09.2015 | 31.08.2018 |
| Luftmo | 01.10.2015 | 28.02.2017 |
| ZeroE | 01.10.2015 | 30.11.2016 |
| H2Schiene | 05.10.2015 | 31.07.2016 |
| BigPPsBip | 01.11.2015 | 31.03.2019 |
| DESS2020+ | 01.11.2015 | 31.10.2018 |
| ecoPtG | 01.11.2015 | 31.10.2018 |
| H2-Neo-Kat | 01.12.2015 | 31.05.2017 |
| Hydro-Meter | 01.12.2015 | 28.02.2018 |
| EZENERGIES | 01.01.2016 | 30.06.2017 |
| GreenH2 | 01.01.2016 | 31.12.2018 |
| HyINTEGER | 01.01.2016 | 31.12.2018 |
| KontiFlex | 01.01.2016 | 31.12.2017 |
| RCS-Roadmap | 07.03.2016 | 06.12.2016 |
| PtTM-HGS | 01.04.2016 | 31.03.2019 |
| BrezelPioniere | 16.05.2016 | 30.06.2017 |
| EfficienCity | 01.06.2016 | 30.11.2016 |
| H2Sachsendamm | 01.06.2016 | 31.12.2016 |
| Shell5Hy | 01.06.2016 | 31.12.2016 |
| BzinTKL | 01.08.2016 | 31.12.2016 |
| BZRADBLUE | 01.08.2016 | 30.06.2017 |
| KerSOLife | 01.09.2016 | 31.08.2019 |
| KerSOLife100 | 01.09.2016 | 31.08.2019 |
| SILA-PEM | 01.09.2016 | 31.08.2019 |
| Efficiencity2 | 01.10.2016 | 31.12.2016 |
| Efficiencity3 | 01.12.2016 | 31.12.2016 |


The NIP results conference held 14 & 15 December 2016 entitled “Clean mobility with hydrogen and fuel cells” summarised the results of the funding programme incorporating many research & development as well as demonstration projects.


The technological developments and market preparation activities achieved in the various fields of application over the past 10 years were impressively highlighted via numerous presentations, the accompanying exhibition as well as through panel discussions with representatives from politics, industry and business.

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