IPHE Workshop
Report

Governmental Programs on E-Mobility

Ulm, Germany
June 15, 2010

International Partnership
for Hydrogen and Fuel Cells
in the Economy

Federal Ministry
of Transport, Building
and Urban Development

WBZU

Acknowledgements

The International Partnership for Hydrogen and Fuel Cells in the Economy would like to thank the co-organizers of the workshop, the Fuel Cell Education and Training Center – Ulm (WBZU) and the German Federal Ministry of Transport, Building and Urban Development, for their support and assistance in organizing the event. IPHE would also like to thank all of the workshop presenters and participants for their time and thoughtful contributions to the discussion.

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Graphics support: SENTECH, Inc., now part of SRA International, Inc.

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Introduction

The International Partnership for Hydrogen and Fuel Cells in the Economy (IPHE) is holding a series of workshops designed to facilitate information exchange and discussion on current topics relevant to the development of markets for hydrogen and fuel cell technologies. The first workshop was held in February 2010 in Sacramento, California and focused on hydrogen infrastructure. This workshop was the second in the series and focused on governmental programs on electric mobility, meaning drive trains using electric power stored either in batteries or as hydrogen. Governments worldwide are pursuing both battery electric and fuel cell electric drive trains as essential elements of their future transportation portfolios as they strive to combat climate change and urban pollution while continuing to support personal mobility. IPHE views collaboration and information sharing between countries as a critical part of advancement and commercialization of electric mobility (e-mobility) technologies, and has created this forum to facilitate that process.

Workshop Purpose and Format

Purpose

This workshop was organized by the IPHE within the framework of the Ulm ElectroChemical Talks 2010. It focused on governmental programs that endorse e-mobility applications based on all relevant drive train technologies including battery electric drives, plug-in hybrids, and fuel cell vehicles. Although E-Mobility technologies can be applied to all forms of transportation including rail, shipping, and heavy duty trucks, this workshop focused on the light duty vehicle market. Workshop participants examined topics including advantages and challenges of batteries and fuel cells in future mobility, overcoming barriers to market entry, common interests and actions, and lessons learned from existing programs.

Intended outcomes of this workshop were sharing of information regarding mobility programs throughout the world, recognition of areas of common interest for future collaboration, and identification of next steps for the various stakeholders.

Workshop Format

The one-day workshop consisted of two presentation sessions followed by a guided discussion. The first presentation session featured government experts on e-mobility programs from selected countries. The second session addressed industrial programs and expectations of government from industry, delivered by professionals from leading industries. The guided discussion focused on clarifying the role of government in promoting e-mobility solutions and preparing markets, identifying proven techniques in these areas, and identifying next steps for all stakeholders.

Presentation Summaries

This section summarizes the presentations made during the two presentation sessions of the workshop. The full presentations are available on the IPHE website at http://www.iphe.net/workshops.html.

Introduction from Germany

Dr. Veit Steinle, Director-General, Environmental Policy and Infrastructure, Departmental Policy Issues, Federal Ministry of Transport, Building and Urban Development

Dr. Steinle welcomed the workshop participants and introduced the topic at hand by outlining the challenges that tomorrow's mobility will need to meet. In the European Union (EU) today, just over 70% of all transport, and 90% of road transport, is dependent on petroleum. Transport is responsible for 20% of all EU carbon emissions. Dr. Steinle emphasized that despite these issues, mobility is essential to the economy and to society, and identified today's challenge as simultaneously ensuring the long-term supply of energy for mobility, heating and electricity; ensuring that mobility is available to and affordable for everyone; and reducing carbon dioxide (CO_2) emissions. Dr. Steinle then outlined the German Federal Government's strategy for alternative and innovative drive train technologies, which focuses on battery and fuel cell powered vehicles. The government is using a technology-neutral approach that aims to improve efficiency while diversifying the available range of technology options. Specifically, Germany is focusing on petrol and diesel efficiency, blending of biofuels, and hybrid drivetrains, as well as on battery and fuel cell technology.

"Sustainability and prosperity are not opposites. They are merely two sides of the same coin. Climate change forces us to consider new approaches, but it also creates new market opportunities."

-Dr. Veit Steinle

Session 1: Electro Mobility Programs in Selected IPHE Countries

Germany

Dr. Klaus Bonhoff, National Organisation Hydrogen and Fuel Cell Technology

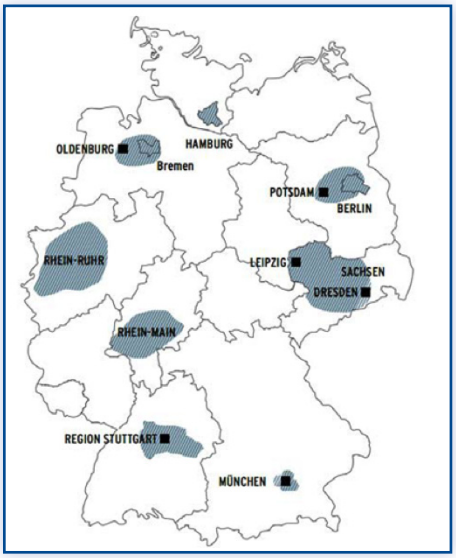
Dr. Rolf Reiner, The Stuttgart Region Economic Development Corporation

Dr. Klaus Bonhoff presented activities taking place in Germany under the guidance of the National Organisation Hydrogen and Fuel Cell Technology, which include federal activities in the fields of battery technology (the E-Mobility Model Regions program) and hydrogen and fuel cells (the National Innovation Program). Germany aims to have 1 million battery-powered vehicles and 500,000 fuel cell vehicles on the road by 2020, and projects the mass marketing of fuel cell powered vehicles to start in 2015.

The E-Mobility Model Regions program is funded through Germany's second economic recovery package, which provides €500 million for battery-powered mobility activities from 2009-2011. The program aims to make Germany a lead market for electromobility within the next ten years, and consists of R&D activities covering the entire value chain as well demonstration projects clustered in 8 pilot regions throughout the country. The focus of the program is on getting technology into the commercial market and creating an environment where new business models can be successful. On the hydrogen and fuel cell side, the National Innovation Program (NIP) was launched in 2006 and provides €1.4 billion over ten years (including €700 million in industry funds) to prepare the market for hydrogen and fuel cell technologies. In the area of transport, the NIP's activities focus around the Clean Energy Partnership, a lighthouse project that includes hydrogen vehicles, refueling infrastructure, and sustainable hydrogen production and delivery. Dr. Bonhoff also discussed the H_2 Mobility Initiative, a partnership of key industry stakeholders that is planning to jointly build hydrogen infrastructure in Germany as a lead market.

Dr. Rolf Reiner then presented an overview of activities in the E-Mobility Pilot Region of Stuttgart. The region works with many partners including universities, industry, municipalities, and urban transport companies to achieve its goal of preparing the region for the era of

The planned fueling station in Hamburg.



Germany's e-mobility model regions.

e-mobility and preserving automotive value creation in the region. Projects include a pilot of 700 electric scooters with tracking systems including 500 private and 200 public charging points, a trial of 5 hybrid buses, a demonstration of 50 electric light trucks, construction of a full electric Porsche Boxster, integration of electric vehicles into car sharing programs, and a pilot of 450 electric rental bikes integrated into the public transport system.

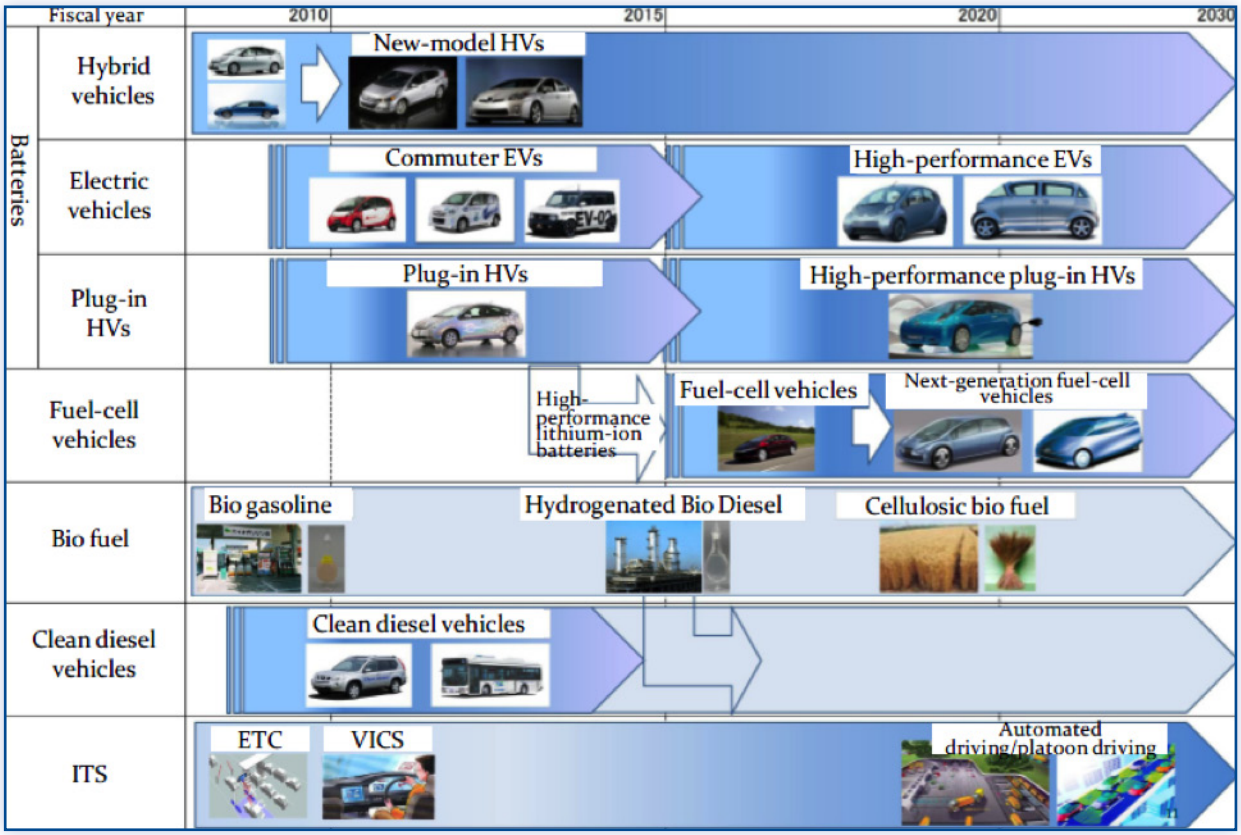
A fuel cell bus deployed in Milan as part of the Clean Hydrogen in European Cities (CHIC) project.

European Commission (EC)

Beatrice Coda, Directorate-General for Research – Energy Conversion & Distribution Systems

Ms. Coda discussed the EC's actions in the e-mobility sector, which focus around three public priorities: security of energy supply, climate protection, and competitiveness. The EC coordinates activities at a European level, and supports the introduction of alternative transportation technologies through the use of market introduction tools such as public procurement of clean and energy efficient vehicles; market regulation, for example of pollutant emissions (including CO_2); and funding for demonstrations and R&D. The Green Cars Initiative provides €4 billion in loans for transport projects which reduce CO_2 emissions, as well as €500 million in R&D funding (matched by industry and member states) for research on electrification of road transport and efficiency improvements. In addition, demand side measures such as reducing taxes and fees for low CO_2 vehicles are being implemented.

The main funding vehicle for hydrogen and fuel cell technology is the Fuel Cells and Hydrogen Joint Undertaking, a public private partnership which aims to accelerate development and market deployment for commercialization in the 2015-2020 timeframe and provides €940 million from 2008-2013 (including 50% industry cost share). Ms. Coda also discussed a few current demonstration projects in the EU: the H_2 Moves Scandinavia project, which is rolling out 17 hydrogen vehicles and linking the Scandinavian Hydrogen Highway with the European network; and the Clean Hydrogen in European Cities (CHIC) project, which will encompass 5 cities and deploy 28 fuel cell buses and 10 fueling stations.



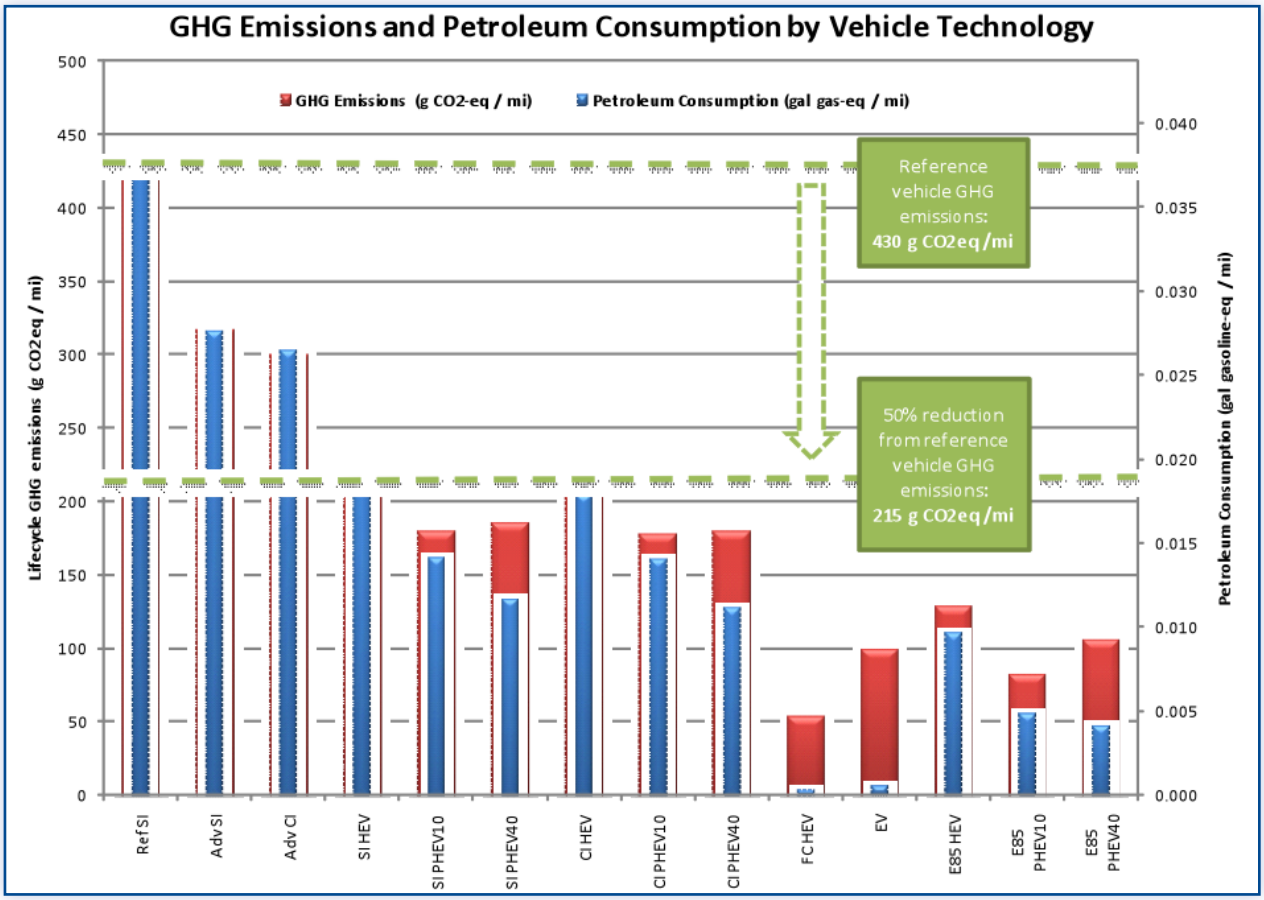
Japan's automobile technology roadmap.

Japan

Yoichi Iida, Chief Representative, NEDO Europe

Mr. Iida began by discussing the structural changes that the global automobile market will see in coming years, driven by emerging markets as well as consumer interest in fuel efficiency and low carbon vehicles. To accelerate commercialization of next generation vehicles, Japan has developed roadmaps in six areas: overall, batteries, natural resources, infrastructure, system integration, and international standards. Recently, the Japan Smart Community Alliance was established, which brings together over 250 member companies to coordinate smart grid and advanced transportation demonstrations in four focus regions, and acts as an umbrella program for many of Japan's electromobility demonstration projects.

Japan aims to have 5,000 quick chargers installed by 2010 and 2 million normal chargers by 2020, and also boasts a demonstration project for electric vehicles similar to German's electromobility program. Japan's fuel cell vehicle dissemination scenario envisions commercialization beginning in 2015, followed by a period of accelerated station building, with mass production of vehicles following.



U.S. analysis showing the GHG emission and petroleum consumption reduction potential of various vehicle technologies.

United States

Jason Marcinkosky, US Department of Energy

Mr. Marcinkosky discussed the United States' clean energy goals, which include reducing greenhouse gas emissions 83% by 2050. U.S. analysis has shown that advanced vehicle technologies can contribute to this goal, and research at the Department of Energy (DOE) is focused on making these technologies cost-effective in the near- to mid-term. In 2010, the DOE committed $311 million for Advanced Vehicle Technologies and $307 million for Fuel Cell Technologies, with additional support from other programs including the Advanced Technology Vehicles Manufacturing Loan Program and the American Recovery and Reinvestment Act ($1.5 billion for advanced battery manufacturing, $500 million for electric drive components, and $400 million for transportation electrification).

The administration's goal is to have one million plug-in hybrid vehicles on the road by 2015, and the DOE Vehicle Technologies Program is currently conducting R&D focused on cost reduction and improved abuse tolerance of batteries, as well as on-road testing to demonstrate the market readiness of electric vehicles. The US has tested over 1,600 electric drive vehicles over a total of 15 million miles while collecting operational performance and cost data. The U.S. is also exploring the use of fuel cells to increase energy efficiency and resource diversity while reducing greenhouse gas emissions and air pollution. The Fuel Cell Technologies pro-

gram is focusing on R&D to address technology barriers in fuel cells, hydrogen production, storage and delivery, in addition to addressing non-technical barriers such as safety codes and standards, and education. Technology validation projects have deployed 23 hydrogen stations and 144 fuel cell vehicles traveling over 2.5 million miles, as well as a fleet of hydrogen buses. There are also significant activities happening at the state level – for example the California Fuel Cell Partnership is currently assessing the potential to deploy 4,000 vehicles by 2014 and 50,000 by 2017.

Session 2: Industry Perspectives

Evaluation and Commercialisation of Hydrogen Fuel Cell Vehicles – Overview of Industry Analysis

Dr. Martin Linder, McKinsey & Company

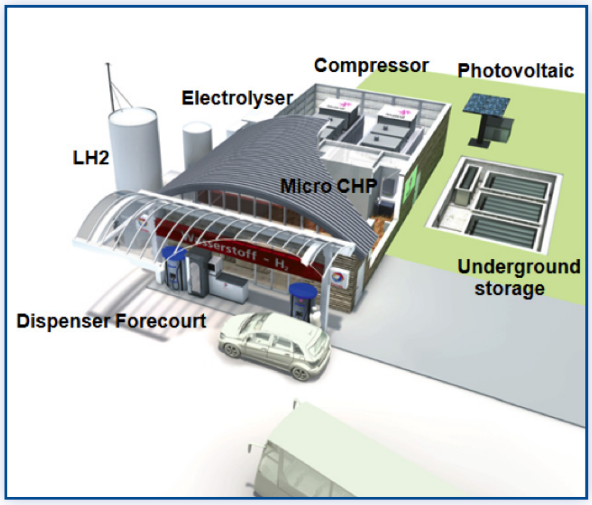
Dr. Martin Linder presented on overview of McKinsey's recent study on the future economic, performance, and carbon reduction potential of a number of different power train options, including fuel cell vehicles, battery electric vehicles, plug-in hybrid vehicles, and internal combustion engines. The study was sponsored by a group of over 30 stakeholders with the goal of producing an honest evaluation of the various technologies across the entire value chain using proprietary data from the participating companies.

The study found that BEVs and FCEVs have the greatest potential to reduce carbon emissions, that the total cost of ownership of all powertrains may converge in the next 10 to 20 years, and that costs for electrical and hydrogen infrastructures are comparable and affordable. There will be an evolution from today's ICE towards a portfolio of powertrain technologies, in which BEVs are specifically attractive in the small car segments and urban mobility patterns, whereas FCEVs show significant potential in the medium to large car segments with longer driving distances.

TOTAL's Activities towards Sustainable Mobility – Hydrogen Infrastructure: Existing Projects, Green Sources and Ramp-up Scenarios

Carsten Retzke, TOTAL Deutschland GmbH

Mr. Retzke presented an overview of TOTAL's hydrogen activities, which include participation on the station side in several demonstration programs. By participating in these projects, TOTAL hopes to contribute to technical improvement, gain experience in operating hydrogen stations, evaluate the costs involved, and study end-user behavior. TOTAL participated in the HyFleet:CUTE project as a fuel provider and is a part of the Clean Energy Partnership, having dispensed over 13,000 kg of liquid hydrogen and over 2,400 kg of gaseous hydrogen since 2007 at their station in Berlin Heerstrasse. As part of the CEP, TOTAL recently opened a new fully integrated hydrogen fueling station in downtown Berlin at Holzmarkstrasse. This station offers both 700 and 350 bar fueling for cars and buses, 24/7 self service, and production of hydrogen using electrolysis powered by an on-site PV system. The station also features a liquid hydrogen dispenser with boil-off management and a micro CHP system that heats a small conference center at the station.



Layout of TOTAL's new station at Holzmarktstrasse in Berlin.

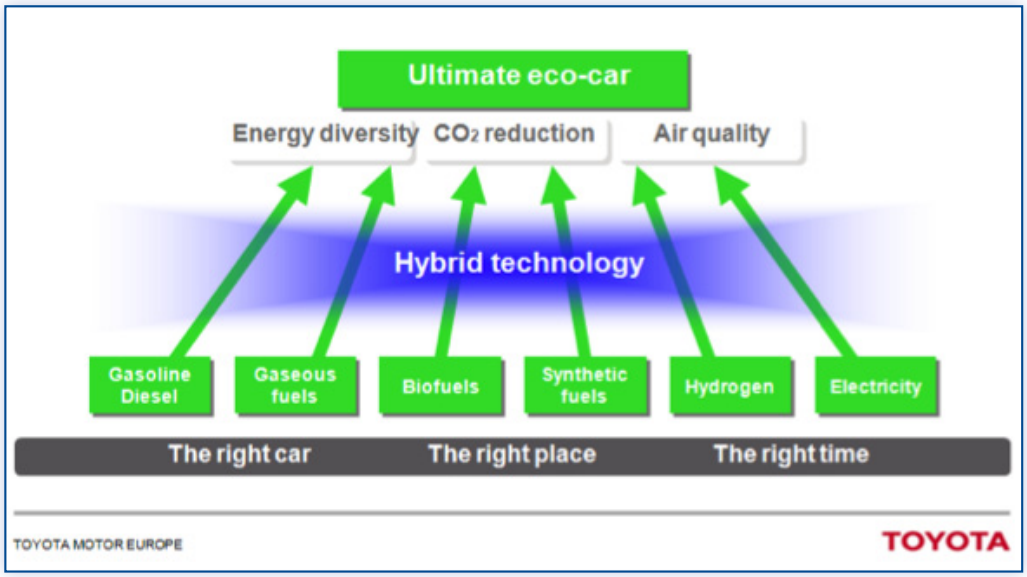
As part of its focus on renewable hydrogen production, TOTAL has partnered with Enertrag to study production from wind and biogas, and is building a CO_2-free hydrogen station at Berlin International Airport. TOTAL is a member of the H2 Mobility initiative, and is committed to deploying hydrogen stations in Germany as a pilot region, with the focus on Berlin and Hamburg.

The Toyota Way towards Sustainable Mobility – Hybrid Technology as Key to the Electrification of the Powertrain

Bernard Grünewald, Toyota Motor Europe

Mr. Grünewald presented an overview of Toyota's strategy for electromobility. Toyota views hybrid technology as the core of its powertrain electrification strategy, building on the success of the Prius. The company envisions a combination of drivetrains in their future vehicle portfolio, with small pure electric vehicles for short driving distances, and larger fuel cell vehicles for longer distances and greater payloads, supplemented by hybrid and plug-in hybrid ICE vehicles for intermediate driving distances. Current R&D is focused on battery development to overcome challenges such as cost and battery life, which is difficult to estimate.

Toyota aims to sell 1 million hybrid vehicles per year by the early 2010s, and to offer a hybrid version of every model it sells by 2020. Their target for fuel cell vehicle commercialization is 2015, fueled by an expected 90% reduction in cost through design and materials, followed by another 90% reduction from economies of scale at mass production.



Toyata's portfolio of automotive technologies.

Discussion

Common Challenges and Solutions for Global Markets – Role of Governments

Prof. Werner Tillmetz, Center for Solar Energy and Hydrogen Research, Baden-Württemburg (ZSW)

Prof. Tillmetz offered an overview of the challenges faced by society in the energy sector, including peak oil and climate change. He then led workshop participants in a discussion regarding the role that governments can and should play in utilizing electromobility solutions to help overcome these challenges.

Issues and Questions

During the discussion, workshop attendees mentioned several issues that need addressing in order for electromobility programs to be successful.

- *Codes and standards.* Participants mentioned that in some cases, progress on international standards is hindered by national interests. There is a need to find ways to keep this from happening.
- *Infrastructure.* In the case of both electric and hydrogen infrastructures, it is still an open question as to what sector will pay for the infrastructure development. If industry is to help pay, the first companies to invest will face a much larger risk than those who invest later on. Strategies need to be developed to reduce this risk for early investors.
- *Market preparation.* There was a discussion regarding whose role it is to decide when a technology is ready for commercialization. Some participants felt that this should be the role of the government, while others felt the markets and industry will be the ones to decide.
- *Subsidies and government support.* Although participants generally agreed that government policies are needed to support new technologies entering the market, there is an open issue regarding the criteria for such policies. Governments and countries will need to decide how much public money should be spent on preparing markets and subsidizing new technologies.
- *Technology choice.* Most participants agreed that governments should not select specific technologies for development, but there is an open question regarding how governments can effectively support all technologies simultaneously. Some participants felt that governments should provide general support for fundamental research, but let industry decide which topics should be pursued.
- *Recycling and end-of-life.* New technologies can have a different cost structure than existing technologies, and also utilize precious resources that have a cost premium. There is a need for rules regarding the lifecycle of products so as to prevent the cost of precious resources from escalating and ensure that cradle-to-grave costs are incorporated in the price of all technologies.

Government Roles

Participants identified the following expectations of governments:

- *Setting goals and developing a political framework.* Participants felt that governments are responsible for identifying a vision for the future and prioritizing goals, which can then be translated into policy frameworks that can trigger industrial action. Examples of such policy frameworks include:
  - Emissions reduction goals.
  - Regulations to secure the energy supply and support independence from imports.
- *Roadmapping.* Participants felt that governments are in a unique position to make good objective assessments of what actions are needed to realize their goals and identify what actions are needed from other stakeholders.
- *Supporting technology development.* Governments should fill the role of funding technology development (RD&D) to ensure that new technology options become available

Expectations of Governments:

- Set goals and develop political frameworks
- Perform objective assessments and create roadmaps
- Support technology development and market entry
- Educate citizens
- Facilitate codes and standards development

- *Fostering market entry.* Governments can help facilitate the transition to technologies that will help achieve their goals by ensuring that all options are available on the market, instead of selecting particular technologies. This includes putting policies (such as subsidies) in place, as well as providing support for public procurement and funding infrastructure development. The government has a role to act as a leader and provide confidence and support to industry as they work in an area involving increased risk.
- *Educating citizens.* Government can assist in further preparing markets by ensuring that citizens are well-informed about new technologies. Likewise, governments can help by managing public expectations.
- *Facilitating codes and standards.* Codes and standards can be a significant barrier to market entry and to affordable manufacturing of new products. Governments have a role to facilitate the development of new codes and standards, as well as the revision of existing ones as necessary, to assist new technologies in being deployed.

Next Steps

Participants also discussed the next steps that should be taken by various stakeholders to help ensure the success of electro mobility programs.

- *Create an overarching strategy.* Participants felt that it would be useful to develop an integrated long-term strategy with support from all stakeholders (including politics, industry, and academia) that could act as stable framework for next steps. Such a strategy could include:
    - The role and the perspective of electrified / electric vehicles in the context of the broad transportation market.
    - An impact assessment of life-cycle aspects of the technologies (e.g., battery-recycling, disposal).
    - A plan for the energy supply for the transportation sector (fuels / energy carriers) as part of / integrated into the overall energy system.
    - Commercialization timelines.
    - Business models with respect to cost reduction and cost sharing.

Recommended Next Steps for Governments, Industry, and Academia:

- Create an overarching, long-term strategy with support from all stakeholders
- Develop a policy framework to support market introduction of electric mobility technologies
- Increase international RD&D cooperation

- *Develop a policy framework.* Participants felt that viable policy frameworks ensuring environmental benefits and wide customer acceptance of electric vehicles are needed. Such frameworks could establish coherent programs and instruments for market preparation (R&D, demonstration) and market introduction depending on the commercial viability of different technologies.
- *Increase RD&D Cooperation.* Participants felt that R&D projects as well as demonstration projects should be transnational wherever possible. This cooperation distributes technology development geographically as well as creates additional market opportunities.

Conclusions and Next Steps

As the presentations from government representatives showed, several countries around the world have implemented ambitious programs for emobility, comprising both battery electric and fuel cell technologies. Likewise, companies in the automobile, energy, and other sectors are developing products and conducting research to support these programs and goals. However, as discussed by workshop participants, there remain significant barriers to widespread commercialization of these technologies, including significant investment risks for infrastructure, lack of harmonized codes and standards, and the need for multiple stakeholders to act in a coordinated manner.

In order to continue down the path to commercialization and ensure that electromobility technologies reach their potential, additional steps must be taken jointly by all stakeholders. Participants in the workshop recommended that stakeholders work together to develop an overarching strategy for emobility deployment that could act as a framework for generating additional next steps; that countries develop effective policy frameworks; and that stakeholders involved in RD&D projects strive for multilateral cooperation. Within the framework of IPHE, this speaks for a need to continue sharing information and strategies regarding development and assessment of policy frameworks and techniques, to facilitate the flow of information from technical resources to policy makers and assist with the policy development process where possible, and to support the development of codes and standards.

Appendix A: Agenda

Location
Edwin-Scharff-Haus
Silcherstrasse 40
D-89231 Neu-Ulm

Introduction

09.30 - 09.45 **Introduction** by Dr. Veit Steinle, Director-General, Environmental Policy and Infrastructure, Departmental Policy Issues, Federal Ministry of Transport, Building and Urban Development

SESSION 1: Electro Mobility Programmes in selected IPHE countries

09.45 - 10.30 **Germany** – Dr. Klaus Bonhoff, National Organisation Hydrogen and Fuel Cell Technology

Germany – Dr. Rolf Reiner, The Stuttgart Region Economic Development Corporation

10.30 - 10.50 *Coffee Break*

10.50- 11.20 **European Commission** – Beatrice Coda, DG Research Energy Conversion & Distribution System

11.20 - 11.50 **Japan** – Yoichi Iida, NEDO Europe

11.50 - 12.20 **USA** – Jason Marcinkoski, U.S. Department of Energy

11.20 - 13.45 *Lunch*

SESSION 2: Industry Perspectives

13.45 - 14.30 **McKinsey & Company, Inc.** – Dr. Martin Linder, Associate Principal – Evaluation and Commercialisation of Hydrogen Fuel Cell Vehicles – Overview of Industry Activities

14.30 - 15.00 **TOTAL Deutschland GmbH** - Carsten Retzke, Head of Special Projects/Hydrogen – TOTAL's Activities towards Sustainable Mobility – Hydrogen Infrastructure: Existing Projects, Green Sources and Ramp-up Scenarios

15.00 - 15.20 *Coffee Break*

15.20 - 15.50 **Toyota Motor Europe** - Bernard Grünewald, Senior Manager External Affairs – The Toyota Way towards Sustainable Mobility – Hybrid Technology as Key to the Electrification of the Power train

Final Discussion

15.50 - 16.45 **Final discussion and conclusion** is led by Dr. Werner Tillmetz, Zentrum für Sonnenenergie- und Wasserstoff-Forschung Baden-Württemberg – "Common Challenges and Solutions for Global Markets – Role of Governments"
Summary and Closing Remarks

17.30 **Reception** – Dr. Klaus Bonhoff, NOW GmbH / Dr. Christian Mohrdieck, Daimler AG Get Together and Welcome for all participants of Tutorial, IPHE Workshop and Conference at Edwin-Scharff-Haus, Neu-Ulm

Appendix B:

List of Participating Organizations

3M

ADS Tec GmbH

André Martin Consulting

Automotive Fuel Cell Cooperation

Ballard Power Systems

Bar-Ilan University

BASF Future Business GmbH

Chemetall GmbH

Daimler AG

Damm

DANA Sealing Products

E-mobil BW

EnergyRegion.NRW

Federal Ministry of Transport, Building and Urban Development

FKFS - Forschungsinstitut für Kraftfahrwesen und Fahrzeugmotoren Stuttgart

Ford Aus- und Weiterbildung E.V.

Fraunhofer ICT

Honda R&D Europe GmbH

Hydrogen Council of Norway and Hynor

MAN Nutzfahrzeuge AG

McKinsey

MGC Consulting

NOW GmbH

NEDO & NEDO Europe

Paul Scherrer Institut

Power Cell

RWTH Aachen

Stadtwerke Ulm

Toshiba Corp.

Total Deutschland GmbH

Toyota Motor Europe

TU Darmstadt

TU München

U.S. Department of Energy

Umicore

Wacker Chemie AG

Wirtschaftsförderung Region Stuttgart GmbH

Yokohama National University

ZSW Baden Württemberg

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