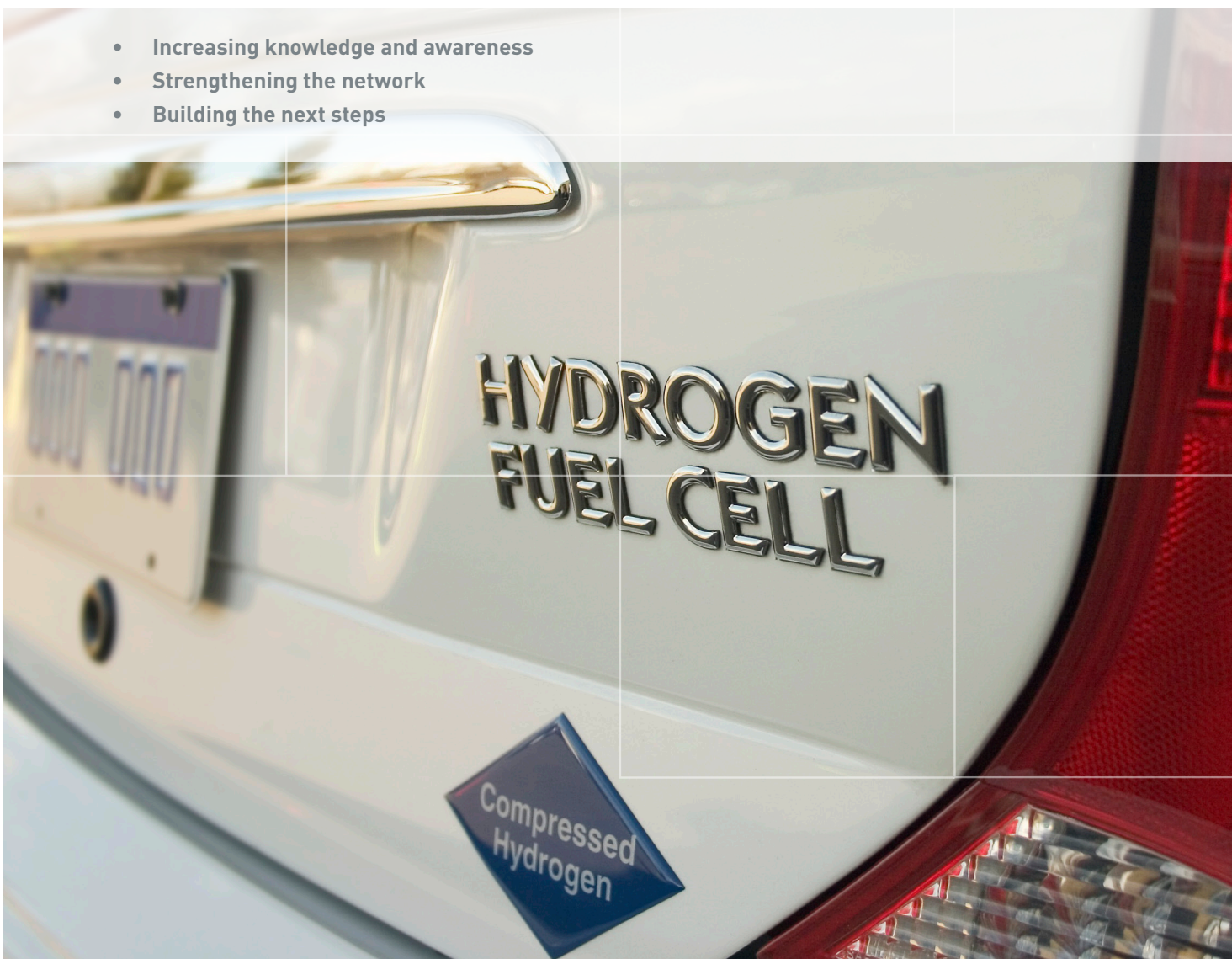


Advancing the Nordic Hydrogen Innovation Network

- Increasing knowledge and awareness
- Strengthening the network
- Building the next steps



Participants:

Sweden

Hydrogen Sweden

Sven Wolf

Managing Director

Norway

Statoil

Hilde Ström

Business Development Manager

Denmark

H2 Logic

Mikael Sloth

Business Development Manager

Finland

VTT

Annele Eerola

Senior Research Scientist

Iceland

Icelandic New Energy

Jón Björn Skúlason

General Manager

Title: Advancing the Nordic Hydrogen Innovation Network		
Nordic Innovation Centre project number: 07029		
Author(s): Sven Wolf, Hilde Ström, Mikael Sloth, Annele Eerola, Jón Björn Skúlason		
Institution(s): Hydrogen Sweden, Statoil, H2 Logic, VTT, Icelandic New Energy		
Abstract: Enabling a future widespread use of sustainably produced hydrogen as fuel for transport requires a complex transformation of science and technologies into workable hydrogen vehicles and a far reaching hydrogen infrastructure of filling stations. The Scandinavian Hydrogen Highway Partnership (SHHP) works towards establishing an early infrastructure of hydrogen filling stations by 2015 that enables driving hydrogen fuelled vehicles in Scandinavia. Reaching this goal is important in paving the way for a major commercial roll out of hydrogen vehicles and infrastructure post 2015. It is the main hypothesis of this project that the success of advancing hydrogen for transport and of realizing the SHHP goals is mainly depending on securing an effective user-driven colorant triple helix innovation process between industry, academic and governments on multiple levels in terms of actors from local, regional, national and international level, thus demanding cross-border collaboration.		
Topic/NICE Focus Area: Nordic environmental and energy solutions		
ISSN: -	Language: English	Pages: 51
Key words: Hydrogen Economy, Hydrogen, Fuel Cells, Innovation Network, Nordic collaboration, Early markets, Demonstration		
Distributed by: Nordic Innovation Centre Stensberggata 25 NO-0170 Oslo Norway	Contact person: Sven Wolf, Managing Director Hydrogen Sweden Drottninggatan 29 SE-41114 Gothenburg Sweden Tel. +46 31 334 37 70 Fax. +46 31 711 77 70 www.vatgas.se	

Executive Summary

Background

The big challenge to reduce our society's dependence on fossil energy requires measures of many different kinds and within many different areas. It is likely that the introduction of new technology will be one of the more important among these measures. One new technology that is looking very promising in the medium to long term is hydrogen and fuel cells. A long-term commitment to hydrogen as an energy carrier is motivated by the improvements it may contribute to in the areas of environment and health, economy and growth as well as energy security and efficiency.

These were also the reasons for the launch of the Fuel Cells & Hydrogen Joint Undertaking program (FCH-JU) of 950 million Euros by the European Commission (EC) in 2008. Main focus is to increase the impact of industrial level activities in Europe in this field and accelerate the market introduction of hydrogen and specifically fuel cell technologies. In the Nordic context, the Nordic H2 Energy Foresight study suggested that the Nordic actors should take an active role in promoting the successful introduction of hydrogen energy and thereby exploit the anticipated business opportunities in this area.

Reinforced by these developments, the Nordic actors have stepped up the efforts in research, development, demonstration and commercialisation. The Scandinavian Hydrogen Highway Partnership (SHHP) was created in 2006 as a collaborative initiative aiming to accelerate the introduction of hydrogen as a vehicle fuel. Iceland has been very visible in the hydrogen community since 1999 with ongoing demonstrations since the world's first commercial hydrogen refuelling station was opened in 2003. In Finland, preparations are now being made to launch demonstration projects also in the area of road transport.

With this as background, the project described in this report was set up to increase the number of active organisations involved in the SHHP demonstration activities, and to pave the way for an extended collaboration between the Scandinavian countries and Finland and Iceland within this field.

Objectives

The project has successfully fulfilled the following four main objectives:

1. Identify and motivate triple helix actors on multiple levels in SHHP countries
2. Identify and motivate fourth helix actors in terms of end-users in SHHP countries
3. Align and gather actors in “hydrogen innovation HUB’s” in a cross-border EU supported Lighthouse Project
4. Identify collaboration possibilities and synergies with the present non-SHHP countries Iceland and Finland

Method

Enabling a future widespread use of sustainably produced hydrogen as fuel for transport requires a complex transformation of science and technologies into workable hydrogen vehicles and a far reaching hydrogen infrastructure of filling stations. In Scandinavia most activities within hydrogen for transport is coordinated in the Scandinavian Hydrogen Highway Partnership (SHHP) which is constituted by national hydrogen transport network bodies in Norway (HyNor), Denmark

(Hydrogen Link) and Sweden (Hydrogen Sweden). SHHP works towards establishing an early infrastructure of hydrogen filling stations by 2015 that enables driving hydrogen fuelled vehicles in Scandinavia. In Iceland, Icelandic New Energy (INE) has been the key player functioning mostly as an enabler for the hydrogen technology, i.e. providing infrastructure with partners, demonstrating vehicles and coordinating most of R/D/D activities connected to hydrogen. In Finland, the key players in the field of hydrogen and fuel cells R&D are Tekes, VTT and the Fuel Cell Finland Industry Group, with activities so far mainly in research, development and societal studies.

It has been the main hypothesis of this project that the success of advancing hydrogen for transport and of realizing the SHHP goals is mainly depending on securing an effective user-driven colorant triple helix innovation process between industry, academic and governments on multiple levels in terms of actors from local, regional, national and international level, thus demanding cross-border collaboration.

The partners achieved the project objectives by:

- Compiled a comprehensive list of relevant actors throughout the Nordic countries
- Carried out a huge number of meetings with and visits to interested actors and users
- Co-organised three networking conferences in Iceland, Finland and Norway
- Presented or in other ways represented the project at 46 seminars and exhibitions
- Distributed targeted invitation leaflet to key network actors
- Qualified the current collaboration possibilities between SHHP, Iceland and Finland and secured integration hereof in the subsequent project activities
- Contributed to the initiation of R/D/D projects by putting relevant actors together
- Enabled a successful Scandinavian application for a EU-supported lighthouse demonstration project

Main Results and Conclusions

In a time where hydrogen and fuel cell technologies are on track for mass market introduction in the transport sector by 2015, the SHHP Innovation Networks project has played an important role to stimulate and support Nordic actors to take advantage of, and contribute to, this exciting and important development. Considering the results, as described in this report, it is clear **that the key achievement of the project is the combined Nordic springboard effect that has been generated** by advancing the Nordic hydrogen and fuel cell innovation system. It has increased the capacity of the Nordic actors, opening for new research and business opportunities as well as started the mobilisation of early users. The international view of the Nordic actors as strong partners in the area of hydrogen and fuel cells has been significantly strengthened.

Building on the outstanding progress already made regarding demonstration activities, in particular in Iceland and within the SHHP, there is arguably **a compelling case for moving forward in the Nordic countries concerning large scale deployment activities of fuel cell vehicles and hydrogen stations** onwards a possible market introduction beyond 2015.

Recommendations

During the progress of the project, the partners have identified a number of interesting and important areas where further work should be done to accelerate the developments in the Nordic

region. The activities are concentrated around ensuring a transformation from the present demonstration projects to large scale deployment of vehicles and roll out of stations onwards a later market introduction.

Expand and strengthen collaboration with car manufacturers and energy companies

When commencing on deployment activities, strong collaboration and active involvement of car manufactures and energy companies are important as these respectively are to provide vehicles and stations.

Define a detailed roadmap for infrastructure and vehicle roll-out

A specific next step could be a joint Nordic research and analysis project with the intent of formulating a roadmap for hydrogen infrastructure and vehicle onwards 2025 potentially with scenarios onwards 2050.

Mobilise vehicle end-users and secure deployment mechanisms

To reduce costs, mobilising of end-users and joint purchasing is necessary to increase volume as well as deployment mechanisms to cover the extra cost that still will be associated with fuel cell vehicles and infrastructure in the deployment phase.

Harmonise early market policies in the Nordic countries

To keep and to strengthen the Nordic region's position in Europe, the Nordic countries would benefit greatly from harmonising the early market policies and incentives for zero-emission vehicles powered by renewable energy.

Content

PREFACE.....	1
INTRODUCTION.....	2
BACKGROUND.....	2
<i>Hydrogen and Fuel Cells.....</i>	<i>2</i>
<i>EU FCH JU.....</i>	<i>2</i>
<i>Nordic H2 Energy Foresight.....</i>	<i>3</i>
<i>Scandinavian Hydrogen Highway Partnership.....</i>	<i>4</i>
<i>SMART-H2.....</i>	<i>5</i>
<i>TEKES Fuel Cell Program and DEMO2013.....</i>	<i>6</i>
PURPOSE.....	7
OBJECTIVES.....	7
<i>1. Identify and motivate triple helix actors on multiple levels.....</i>	<i>7</i>
<i>2. Identify and motive fourth helix actors in terms of end-users.....</i>	<i>7</i>
<i>3. Align and gather actors in “hydrogen innovation HUB’s” in a cross-border EU supported Lighthouse project</i>	<i>8</i>
<i>4. Identify collaboration possibilities and synergies with the present non-SHHP countries Iceland and Finland...8</i>	
METHODOLOGY.....	9
CONTEXT.....	9
APPROACH.....	9
COMMUNICATIONS AND OUTREACH.....	10
<i>Target groups</i>	<i>10</i>
<i>Communication activities for information to all target groups.....</i>	<i>10</i>
<i>Communication activities for specific target groups.....</i>	<i>10</i>
ACHIEVEMENTS.....	12
INCREASING KNOWLEDGE AND AWARENESS	12
<i>Exhibitions, seminars and conferences.....</i>	<i>12</i>
<i>Web and print.....</i>	<i>12</i>
STRENGTHENING THE NETWORK	13
<i>Networking Conference in Reykjavik, Iceland.....</i>	<i>14</i>
<i>Networking Conference in Espoo, Finland.....</i>	<i>14</i>
<i>Networking Conference in Oslo, Norway.....</i>	<i>15</i>
<i>Individual meetings.....</i>	<i>16</i>
BUILDING THE NEXT STEPS.....	16
<i>Initiated and supported projects</i>	<i>16</i>
<i>Areas for collaboration possibilities between SHHP, Iceland and Finland.....</i>	<i>16</i>
<i>Application to become European Lighthouse Project.....</i>	<i>17</i>
EVALUATION.....	18
ASSESSING THE RESULTS.....	18
ASSESSING THE PROCESS.....	19

CONCLUSIONS.....	20
EUROPEAN COMPETITIVENESS THROUGH NORDIC COMPLEMENTARITIES.....	20
THE IMPORTANCE OF A SELLING STORY.....	20
POLITICAL SUPPORT ACCELERATE DEVELOPMENTS.....	20
EXCEPTIONAL CHALLENGES CALL FOR EXCEPTIONAL INNOVATION.....	20
BATTERIES AND FUEL CELLS MAKE STRONG PARTNERS.....	21
RECOMMENDATIONS.....	22
EXPAND AND STRENGTHEN COLLABORATION WITH CAR MANUFACTURERS AND ENERGY COMPANIES.....	22
DEFINE A DETAILED ROADMAP FOR INFRASTRUCTURE AND VEHICLE ROLL-OUT.....	22
MOBILISE VEHICLE END-USERS AND SECURE DEPLOYMENT MECHANISMS.....	22
HARMONISE EARLY MARKET POLICIES IN THE NORDIC COUNTRIES.....	23
APPENDICES.....	24
APPENDIX A. NETWORK INVITATION LEAFLET.....	24
.....	24
APPENDIX B. RAISING AWARENESS AT EXHIBITIONS, SEMINARS AND CONFERENCES.....	26
<i>Exhibitions, seminars and conferences 2007.....</i>	26
<i>Exhibitions, seminars and conferences 2008.....</i>	26
<i>Exhibitions, seminars and conferences 2009.....</i>	28
APPENDIX C. NORDIC PROJECTS PUSHING THE DEVELOPMENTS FURTHER.....	29
<i>H2moves Scandinavia.....</i>	29
<i>ScanWays</i>	29
<i>PreparH2</i>	29
<i>Interreg ÖKS application.....</i>	29
<i>Nordic Supply Network Model for Hydrogen Refuelling Stations.....</i>	29
<i>VIP-event 30 Nov 2009.....</i>	30
<i>Working PEM.....</i>	30
<i>REFORMH2.....</i>	30
<i>DEMO 2013 Feasibility Study.....</i>	30
<i>FCH city buses for Finnish demonstration use.....</i>	30
<i>Regional/national H2roadmap.....</i>	31
<i>Wärtsilä SOFC.....</i>	31
<i>Cargotec.....</i>	31
<i>SOFCPower.....</i>	31
<i>TopDrive (Optimising topologies of fuel cell hybrid drive trains for working machines).....</i>	31
<i>Evaluation of alternative fuels.....</i>	31
<i>New research and energy.....</i>	31
<i>Regional collaboration project in Skåne.....</i>	32
<i>Refuelling station & vehicles for demonstration and testing in Gothenburg.....</i>	32
<i>CanDan2</i>	32
<i>LINK2009.....</i>	32

<i>CanDan1.5</i>	32
<i>HyLIFT-C3</i>	33
<i>How2use</i>	33
APPENDIX D. PROGRAM, ICELAND CONFERENCE.....	34
APPENDIX E. PROGRAM, FINLAND CONFERENCE.....	36
APPENDIX F. PROGRAM, NORWAY CONFERENCE.....	37

Preface

Since 1973 several attempts have been made by politicians and industry to advance hydrogen as an energy carrier. Only recently have such efforts gained political and public support as environmental and energy security issues have surfaced. There is still however a long way to go before hydrogen will become widely used as an energy carrier and a transportation fuel. Oil and gas will in many years to come be the most important energy source.

To propel the advancement of hydrogen it is necessary to bring its usefulness to the attention of policymakers, industry and the public in general. The present project is an effort in this direction. It highlights the different initiatives that have been launched in the Nordic countries over the past years. To the surprise of many of its readers, this report reveals an abundance of initiatives and projects which in sum comprises a strong knowledgebase for the Nordic countries in their continued pursuit of introducing hydrogen in everyday life.

As one of those who for many years have worked with the introduction and use of hydrogen as an energy carrier and transportation fuel and as part of this was involved in the establishment of the Icelandic New Energy as well as the Scandinavian Hydrogen Partnership it is with great satisfaction I take the results of this project into account. It confirms the interest by key industries and policymakers in the Nordic countries to advance hydrogen as an alternative to today's carbon based energy systems. With the Nordic countries' abundance of alternative energy sources such as wind, biomass, ocean waves etc. these countries could be frontrunners in the development of the technology required to realize the change to an environmentally friendly produced hydrogen as well as its introduction and use in society.

Christopher Kloed

Honourable member of the Norwegian Hydrogen Association

Co-founder of the Scandinavian Hydrogen Highway Partnership

Introduction

This chapter provides an introduction to the project by firstly outlining the hydrogen and fuel cell landscape, and secondly describing the purpose and objectives of the work done.

Background

Hydrogen and Fuel Cells

The big challenge to reduce our society's dependence on fossil energy requires measures of many different kinds and within many different areas. It is likely that the introduction of new technology will be one of the more important among these measures. One new technology that is looking very promising in the medium to long term is hydrogen and fuel cells. The activities and developments happening in the area today can be described in terms of a new innovation system.

A long-term commitment to hydrogen as an energy carrier is motivated by the improvements it may contribute to in several areas.

Environment and health: Zero emission vehicles provide better local environments, and depending on how the hydrogen is produced, also minimal release of carbon dioxide. Engine noise is decreased radically.

Economy and growth: It decreases the need for importing oil and opens for vehicle fuels being produced locally. It complements and strengthens wind, wave and solar energy and energy from biomass, all growing industries in the Nordic countries. All in all this means more qualified jobs within the sustainable energy sector.

Energy security and efficiency: In the longer perspective, it is possible to improve the households' and the industry's energy security by using hydrogen as energy storage in a more distributed energy system and to improve the effectiveness in the use of energy.

When hydrogen and fuel cells replace fossil fuels and traditional combustion engine technology, new business opportunities arise. It creates demand for new components, systems and market solutions. The possibilities for new jobs are substantial and early initiatives increase the Nordic countries' opportunities to become leaders in the future. Already today, it is expected that the number of companies and organisations involved in hydrogen and fuel cells in the Nordic countries, exceed 100 unique entities.

EU FCH JU

In October 2008 the Fuel Cells & Hydrogen Joint Undertaking program (FCH-JU) was officially launched by the European Commission (EC)¹. Main focus is to increase the impact of industrial level activities in Europe in this field and accelerate the market introduction of hydrogen and specifically fuel cell technologies to address the major three European policy targets (1) energy diversity, (2) mitigation of greenhouse gas (GHG) effect and (3) enhance European industry's competitiveness, the percentage increase of renewable energies being the aim.

One focus area in the FCH-JU program, promoted and principally supported by the European Commission and European industry, is to reduce the environmental impact of European passenger cars which currently contribute 12 % to total CO₂ emissions in Europe. Correspondingly, a significant part of the total FCH-JU budget of approx. 950 M€ has been earmarked to support the

¹ See http://ec.europa.eu/research/fch/index_en.cfm for more detailed information on the Fuel Cells and Hydrogen Joint Undertaking (FCH-JU).

road transport sector initially and subsequently also other transport sectors to demonstrate the potential of hydrogen and fuel cell vehicles and the corresponding hydrogen refuelling infrastructure.

The document known as the Implementation Plan (IP)², which reflected industry's strategy to develop and deploy vehicles and infrastructure, as well as address technical and economic development objectives and define benchmarks, was used to structure demonstration and R&D activities under FCH-JU and has in the meantime evolved to a Multi Annual Implementation Plan (MAIP) and multiple Annual Implementation Plans (AIP)³. A major goal of the IP was to expand the EU's hydrogen and fuel cells supplier base. Therefore, a double track approach has been adopted which in the first FCH-JU call aims at conducting:

1. one Lighthouse Project (LHP) location to sample meaningful performance data at large scale, and
2. European hydrogen vehicle demonstration tours to attract public visibility of this technology Europe wide and deploy a realistic picture of how industry and the regions intend to introduce this new technology.

Nordic H2 Energy Foresight

The Nordic Hydrogen Energy Foresight was launched in January 2003 by 16 partners from academia, industry, energy companies and associations from all five Nordic countries. A wide range of additional Nordic and European experts from research, industry and governments participated in the various steps of the foresight process⁴.

The aim of the foresight was to provide decision support for companies and research institutes in defining R&D priorities and to assist governmental decision-makers in making effective framework policies for the introduction of hydrogen energy. The foresight exercise also provided a means for developing Nordic networks to gain critical mass in a wider international context. The overall intention was to find long-term and promising ways for Nordic stakeholders of exploiting hydrogen in the drive to meet the 3E's: energy security, economic growth and environmental protection. The diversity among the Nordic countries as well as established political and economic collaboration in research, innovation and energy represent some unique and interesting opportunities for exploring different pathways to the hydrogen economy. By setting ambitious targets for hydrogen in the Nordic energy system, we can best examine the future societal options and industrial opportunities available when being in the frontline.

The Nordic H2 Energy Foresight suggests that the Nordic actors should take an active role in promoting the successful introduction of hydrogen energy and thereby exploit the anticipated business opportunities in this area. Coordinated actions are needed to ensure that the long-term investments in hydrogen energy technology will contribute to common welfare in the form of more sustainable energy systems and new profitable businesses.

Recommendations for a Nordic action strategy for the Nordic research and innovation area in hydrogen are:

² See http://ec.europa.eu/research/fch/pdf/hfp_ip06_final_20apr2007.pdf for the full document.

³ See http://ec.europa.eu/research/fch/index_en.cfm?pg=documents for the full documents.

⁴ See "Building the Nordic Research and Innovation Area in Hydrogen, Summary Report, January 2005", Nordic H2 Energy Foresight, P. Dannemand Andersen, B. Holst Jørgensen, et al, ISBN 87-550-3401-2, ISBN 87-550-3402-0 (Internet)

- Conduct coherent information and awareness campaigns on hydrogen economy and relevant innovation. The campaigns should be directed to decision-makers and the wider public.
- Closer Nordic co-operation on research and development in strategically defined key areas of hydrogen and fuel cell technologies where Nordic research and Nordic industry have the best opportunities. Publicly funded research should focus on areas where industry (of today or tomorrow) can utilise the results.
- Promote innovation in Nordic industry through demonstration projects, lighthouse projects and stimulation of niche markets – forming an early home market for Nordic industry.
- International co-operation. Improve the Nordic countries' impact on the international agenda setting.

Scandinavian Hydrogen Highway Partnership

Planning for the next phase of hydrogen transport development, the Scandinavian Hydrogen Highway Partnership (SHHP)⁵ is a collaborative initiative aiming to accelerate the introduction of hydrogen as a vehicle fuel in particular, and as an energy carrier in general. The formation of the partnership in June 2006 was intended to strengthen the ability of Scandinavian entrepreneurs and enterprises to take advantage of this emerging technology as well as provide a direct contribution to the progress towards a more sustainable society.

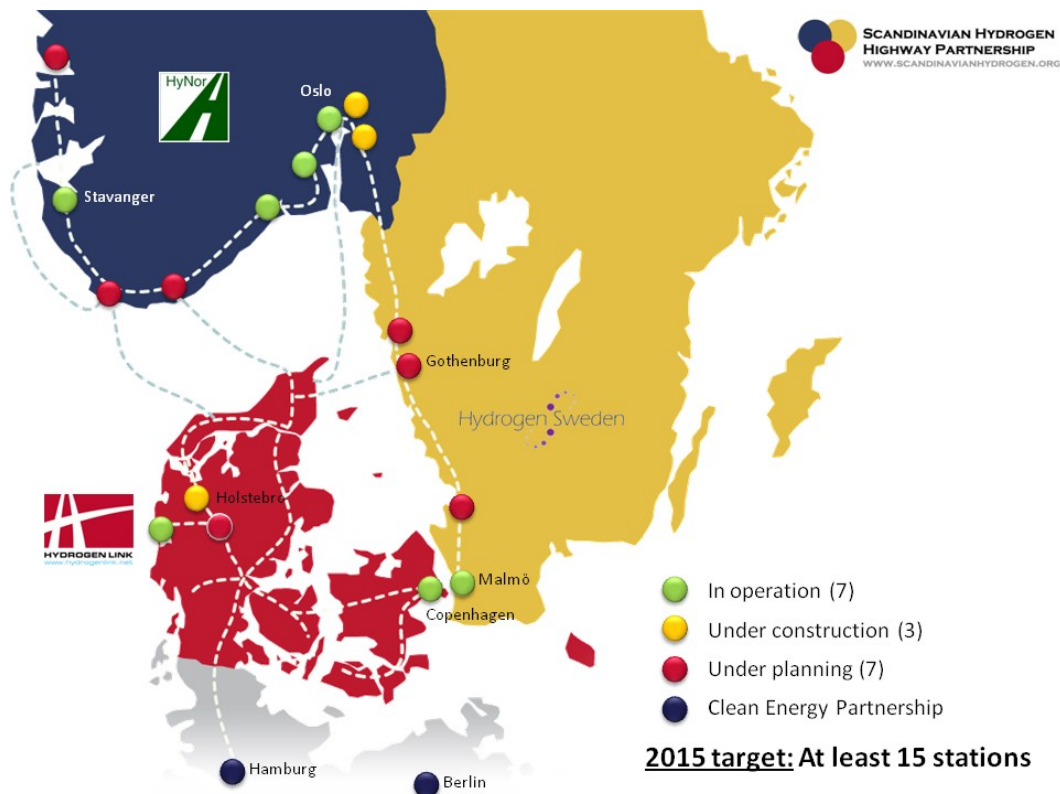
In the introduction of emerging technologies, uncertainties and the need for long-term commitment call for cooperation and risk sharing. Therefore, national networking bodies were established independently in Norway⁶, Denmark⁷ and Sweden⁸ already before the formation of the SHHP. Together these initiatives aim to avoid fragmentation and promote cohesion and cooperation, allowing a wider network of stakeholders to benefit from the learning and thus accelerate market penetration in each country.

⁵ See <http://www.scandinavianhydrogen.org/> for more detailed information on the SHHP.

⁶ See <http://www.hynor.no/> for more detailed information on the HyNor project.

⁷ See <http://www.hydrogenlink.net/> for more detailed information on the Hydrogen Link network.

⁸ See <http://www.vatgas.se/> for more detailed information on the Hydrogen Sweden (Vätgas Sverige) partnership.

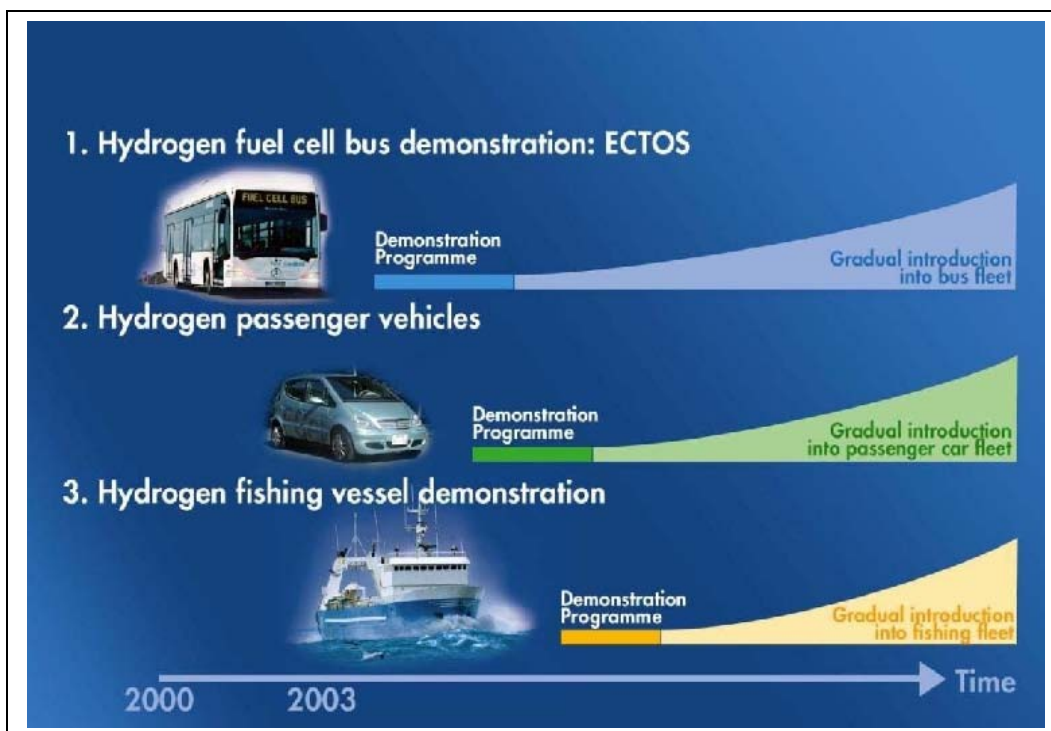


These three national networking bodies represent different experiences and competences, but are facing similar technical, social and economical challenges. Within SHHP those national networks cooperate intensively to accelerate the learning curve and anticipate actual introduction of hydrogen infrastructures and hydrogen-fuelled vehicles and applications. SHHP also has the ambition of demonstrating efficient fuel cell based auxiliary power units in vehicles. To supply these vehicles with hydrogen fuel, several supply routes are being followed. The focus is to explore pathways of sustainable hydrogen, based on local resources and competences in the three countries and regions.

The SHHP is well on schedule to realise a fuelling infrastructure of up to 15 nodes with hydrogen production and 30 satellite stations for the supply of smaller volumes and create more widespread distribution in rural areas. Currently seven stations (Malmö in south Sweden, Stavanger, Grenland, Drammen and Oslo in south Norway and Ringköping and Copenhagen in Denmark) are operational, and more stations are being planned.

SMART-H2

Iceland has been very visible in the hydrogen community since 1999 when large vehicle manufacturers and infrastructure companies joined with Icelandic partners to form Icelandic New Energy (INE). There have been ongoing demonstrations since the world's first commercial hydrogen refuelling station was built in 2003. There have been buses, stationary applications along with vehicles and recently a marine auxiliary demonstration project has been in operation.



Following the successful operation of fuel cell buses from 2003-2007 the next logical step was to test hydrogen passenger vehicles. During the last three years the fleet has grown from originally two fuel cell vehicles to 22 which actually will make Iceland the largest vehicle demonstrator in Europe and the 3rd largest in the world (only following LA and Tokyo area). This project has been running under the project name SMART-H2 (Sustainable Marine and Road Transport – Hydrogen in Iceland). The key elements is to test vehicles in normal conditions and perform similar research of the three pillars of sustainability, i.e. economic, social and environmental research, as was done during the hydrogen fuel cell bus demonstration.

The project is mostly funded via INE and its partners, but part of the research work is now also funded via EU funds, i.e. through a new project called Prepar-H2. This EU-project is a spin-off from the Nordic cooperation described in this report, and has important partners from Norway and Denmark. In the SMART-H2 project there is also direct Scandinavian cooperation which has drastically been increased with this Nordic collaboration, specifically with regards to joint and open discussion with international vehicle manufacturers and also there is information exchange ongoing with Norway via a Memorandum of Understanding between Iceland and the HyNor project.

The current long term goal in Iceland is to get rid of the fossil fuel habit and replace with sustainable green fuel in the future. INE along with many partners are researching this path hoping to increase the share of renewable in the near future.

TEKES Fuel Cell Program and DEMO2013

In Finland, the Tekes Fuel Cell R&D programme - running in 2007-2013 - is creating a good ground for internationally visible demonstrations. The estimated budget of the seven-year programme is €150 million, with Tekes contributing €50 million of the total. The programme vision is that Finnish industry will - in cooperation with foreign technology partners, the research community and the Finnish government - develop for global markets new products and services based on fuel cell technology. The priority areas of the programme are speciality vehicles with fuel cell power modules (such as forklifts), stationary and portable fuel cell applications.

The intention is to start a major demonstration project in Vuosaari harbour area in Helsinki in 2013 (DEMO2013). International cooperation and visibility is strived for, meaning that the objectives are now significantly more ambitious than in the context of some earlier Finnish demonstrations (incl. the early demonstrations of Äetsä Hydrogen Village).⁹

In addition, a specific Fuel Cell Finland Industry Group was established in 2006 to intensify the co-operation between Finnish technology industry companies and stakeholders in the field of fuel cells, and to realize the new business opportunities based on this technology. The interest areas of the member companies include portable and micro applications, transportation applications, stationary applications, components and infrastructure, and research and education (VTT, Helsinki University of Technology and Tampere University of Technology).¹⁰

Purpose

The project's purpose was twofold; to increase the number of active organisations involved in the SHHP demonstration activities, and to pave the way for an extended collaboration between the Scandinavian countries and Finland and Iceland within this field.

Objectives

The project had four main objectives with underlying additional objectives, as described below

1. Identify and motivate triple helix actors on multiple levels

In each of the three national network bodies that SHHP consist of, the main objective was to identify and motivate various triple helix actors in order to create basis for up to 5 “hydrogen innovation HUB’s” in selected cities in each country. A HUB is defined as a geographical location around which demonstration activities occur. Triple helix actors may be the following on international, national, region and local levels:

- a. Authorities and politicians
- b. Universities and knowledge institutions
- c. Non-profit and non-governmental organisations
- d. Companies e.g. technology providers, sales channels & infrastructure operators

2. Identify and motive fourth helix actors in terms of end-users

In each national network body in the SHHP the objective was to identify and motivate various fourth helix actors in terms of end-users within various vehicle applications:

- a. City and regional busses
- b. City and regular cars
- c. Materials handling vehicles
- d. Specialty vehicles

⁹ See <http://akseli.tekes.fi/opencms/opencms/OhjelmaPortaali/ohjelmat/Polttokennot/en/etusivu.html> and <http://akseli.tekes.fi/opencms/opencms/OhjelmaPortaali/ohjelmat/Polttokennot/en/Demo2013.html> for more detailed information on the Tekes Fuel Cell Programme and the planned demonstration project (DEMO2013).

¹⁰ See <http://www.teknologiateollisuus.fi/en/branches/fuel-cell-finland-industry-group-414.html> for more information on the Fuel Cell Finland Industry Group and its member companies/organisations.

3. Align and gather actors in “hydrogen innovation HUB’s” in a cross-border EU supported Lighthouse project

On SHHP level the various triple helix actors and end-users were to be gathered on a cross-border level in a EU supported lighthouse project resulting in the establishment of up to 15 hydrogen filling stations and more than 700 hydrogen vehicles in operation throughout Scandinavian in 2012.

4. Identify collaboration possibilities and synergies with the present non-SHHP countries Iceland and Finland

It was to be through-fully analyzed how Iceland and Finland can interact and collaborate with the SHHP countries and join the triple and fourth helix innovation network and participate in projects and activities. This was expected to require stakeholder communication and analysis to ensure that all the relevant organizations are well informed and included in the future activities.

Methodology

Context

Enabling a future widespread use of sustainably produced hydrogen as fuel for transport requires a complex transformation of science and technologies into workable hydrogen vehicles and a far reaching hydrogen infrastructure of filling stations.

In Scandinavia most activities within hydrogen for transport is coordinated in the Scandinavian Hydrogen Highway Partnership (SHHP) which is constituted by national hydrogen transport network bodies in Norway (HyNor), Denmark (Hydrogen Link) and Sweden (Hydrogen Sweden). SHHP works towards establishing an early infrastructure of hydrogen filling stations by 2012 that enables driving hydrogen fuelled vehicles in Scandinavia.

In Iceland INE has been the key player functioning mostly as an enabler for the hydrogen technology, i.e. providing infrastructure with partners, demonstrating vehicles and coordinating most of RD & D activities connected to hydrogen.

In Finland, the key players in the field of hydrogen and fuel cells R&D are Tekes (coordination and funding of the Tekes Fuel Cell program), VTT (Technical Research Centre of Finland), and Fuel Cell Finland Industry Group (incl. Wärtsilä, Kalmar industries and a number of other companies). Important research is also conducted in Helsinki and Tampere Universities of Technology. The main focus in Finland has so far been in developing the fuel cell technology. The key players have, however, also participated in Nordic and European projects focusing on hydrogen technology in a broader sense (incl. hydrogen production, storage, transfer and infrastructure), as well as road mapping and societal embedding of the technology development.

Approach

It has been the main hypothesis of this project that the success of advancing hydrogen for transport and of realising the SHHP goals is mainly depending on securing an effective user-driven colorant triple helix innovation process between industry, academic and governments on multiple levels in terms of actors from local, regional, national and international level, thus demanding cross-border collaboration.

More specifically, the project design was built on the following methodology:

- Developing a Nordic triple helix innovation network on hydrogen must begin with a detailed mapping and identification of the various helix actors (industry, academia, authorities) on a cross-border setting at multiple levels - securing helix actors from local, regional, national and international level.
- The success of the triple helix will depend on the networks ability and success in involving and motivating the fourth actor group: general public and end-users of hydrogen cars (the fourth helix).
- Cooperation between the four actor groups (industry, academia, authorities and end-users) is needed. This can happen effectively by gathering the various actors around specific user-driven “hydrogen innovation HUB’s” in Nordic cities where the actors in collaboration are to develop, build and roll out hydrogen filling stations and vehicles through initiating joint cross border research, development, demonstration and early market deployment projects.

Communications and outreach

The communication activities within the project were documented in a communications plan, where the main points are described below.

Target groups

The selected target groups have been prioritised as follows.

1. Nordic and international value chain actors (research to end-users), both inside and outside the SHHP network, relevant for establishment of the Nordic hydrogen infrastructure.
2. National governments and decision makers within the Nordic countries including Nordic Council of Ministers
3. European authorities and decision makers
4. The general population in the Nordic countries

Communication activities for information to all target groups

- SHHP website and announcements of news on the website
www.scandinavianhydrogen.org
- Regular press announcements on news/progress in the SHHP, sent out to a broad spectrum of Nordic media
- Contributions to the debate on alternative fuels in media
- Using websites, newsletters and network meetings of the three national network bodies
www.hynor.no
www.hydrogenlink.net
www.vatgas.se
- Using websites, newsletters and network meetings of the project partners in Island and Finland
www.newenergy.is
www.newenergy.is/naha (North Atlantic Hydrogen Association)
www.iceh2.com
www.vtt.fi
- Information available at the physical demonstration sites

Communication activities for specific target groups

Some of these activities are performed by the regional and national networks.

Nordic and international value chain actors

- Participate as speaker in conferences/workshops
- Arrange SHHP conferences/workshops and meetings with end-users and suppliers
- Local and regional pre-studies and demonstration projects

- Newsletters from the three national networks

National governments and decision makers

- Personal communication with key stakeholders
- Arrange SHHP conferences/workshops for increased dialogue with decision makers
- Dissemination through co-operation with Nordic Energy Research and Nordic Council
- Offer advice, acting as a reference group

European authorities

- Active participant in European Commission events (e.g. workshops, exhibitions)
- Arrange SHHP conferences, inviting European authorities and decision makers
- Personal communication with key stakeholders
- Using national “ambassadors” on site

The general population

- Arrange study tours and visits at the demonstration sites showing refuelling stations and vehicles in operation
- Information about demonstrations available at tourist offices

Achievements

In a time where hydrogen and fuel cell technologies are on track for mass market introduction in the transport sector by 2015, the SHHP Innovation Networks project has played an important role to stimulate and support Nordic actors to take advantage of, and contribute to, this exciting and important development. Considering the results, as described in this report, it is clear **that the key achievement of the project is the combined Nordic springboard effect that has been generated** by advancing the Nordic hydrogen and fuel cell innovation system. A number of new projects have been initiated or supported. The number of active organisations and users involved in the SHHP demonstration activities has increased, and collaboration between the Scandinavian countries and Finland and Iceland within this field has been boosted. Thanks to this projects execution, hundreds of people have increased their knowledge of the concrete opportunities and obstacles within the field of hydrogen and fuel cells.

The project's achievements can be divided into three categories; *Increasing knowledge and awareness*, *Strengthening the network* and *Building the next steps*.

Increasing knowledge and awareness

Exhibitions, seminars and conferences

A large number of exhibitions, seminars and conferences have been organised or participated in by the project partners.

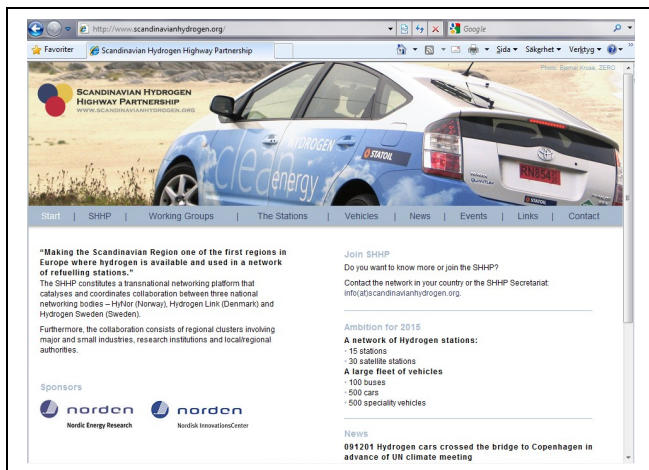
The ambitious engagement level in relation to events has been necessary to achieve the following benefits:

- Increased awareness and interest for hydrogen and fuel cells
- Improved understanding of activities and competencies throughout the Nordic region as well as overseas
- Strong positioning of SHHP and Nordic interests on the EU-level

For the full list of events, please see Appendix B. Raising awareness at exhibitions, seminars and conferences.

Web and print

A SHHP Innovation Networks invitation leaflet was designed and developed within the project in order to attract the interest of more organisations to participate in the emerging Nordic Hydrogen Innovation Network. During the time of the project, information on activities was continuously updated on the SHHP website, www.scandinavianhydrogen.org.



The invitation leaflet is found in Appendix A. Network invitation leaflet.

Strengthening the network

When the project was set up there were a number of national activities ongoing, some cooperating well, like the SHHP, but not as much in Iceland and Finland. One of the key objectives was to formulate a network between the actors to increase the cooperation, build relationships through continued dialogue, joint projects, etc.

This joint Nordic initiative has been very successful. As can be seen from this report there has been joint dissemination, cooperation in approaching vehicle manufacturers, joint applications for new projects etc. The increased cooperation set up in this project has helped the Icelandic and SHHP team for joint approach to vehicle/infrastructure providers. A small market region like the Nordic countries are much stronger united in a network-cooperation rather than individually approaching the vehicle manufacturers.

By bringing key players from the Nordic countries together, new opportunities opened and for Iceland and Finland this project was of high value to connect to the larger SHHP activity. It has opened gateways to information, projects, education and dialogue, drastically strengthening the foundations of hydrogen pillars, in Iceland specifically. The Finnish company partners of the SHHP Innovation Networks project - Gasum Oy, Fortum Oyj, Kabus Oy and Fuel Cell Finland Industry Group – had also an opportunity to discuss the SHHP developments and possible Finnish cooperation in the context of six Finnish partner meetings arranged in 2007-2009. Each partner also had an opportunity to present relevant projects of his/her organisation. VTT summarized the SHHP developments up to each meeting, giving also information on relevant meetings and other events (recent and forthcoming).

For the SHHP, the pan-Nordic discussions have provided important perspectives that will give guidance as the partnership evolves beyond 2010.

To further expand and develop the Nordic Hydrogen Innovation Network, the project has co-organised three Nordic networking conferences. In addition, a vast number of individual meetings have been carried out with a number of organisations and persons, especially with those interested in becoming early users of hydrogen vehicles.

Networking Conference in Reykjavik, Iceland

A networking conference was set up in Reykjavík in April 2008. It was a joint effort with the North Atlantic Hydrogen Association (NAHA) and Icelandic New Energy (INE), and coinciding with the launch of the first commercial H₂ auxiliary engine in marine environment. Most of the over 120 delegates came from the Nordic countries but were joined by actors from Canada, US, Japan and from other European nations. Presentations were made by vehicle manufacturers, infrastructure companies and also from the Nordic partners in this project. The SHHP representatives and also delegates from Finland could at the location see the outstanding pro-activeness of the pioneering Icelandic Hydrogen project and in what way demonstration activities can stimulate growth in the sector.

The networking activity provided an excellent platform for dialogue and information exchange and from that event many spin-offs have occurred. It also showed that connecting networking activities with new project launches strengthens the event and raises both public and media interest. It also provided a setting and atmosphere for the future networking conferences.

The program for the networking conference in Reykjavik can be found in Appendix D. Program, Iceland Conference.



The networking conference in Reykjavik coincided with the inauguration of Elding – the world's first whale watching ship equipped with hydrogen fuel cells for on board power production.

Networking Conference in Espoo, Finland

The second Nordic networking event within the framework of the project was the SHHP Networking Meeting and Seminar organised at VTT on 3-4 December 2008. The seminar was preceded by a Fuel Cell Workshop organised by Tekes (The Finnish Funding Agency for Technology and Innovation) and Fuel Cell Finland Industry Group in the afternoon of 3 December. A get-together meeting was arranged at VTT after the preceding workshop, in the evening before the Networking Seminar on December 4. There was also an opportunity to visit the VTT Fuel Cell and Vehicle Research Facilities (in the morning before the seminar), as well as an opportunity to discuss more specific business matching possibilities together with other Nordic actors after the seminar.



Nordic networking in the modern environment of the VTT Headquarters in Espoo, Finland.

In total, 39 participants attended the SHHP Networking Meeting and Seminar, including participants from each Nordic country and one participant from the Netherlands. 21 of the registered participants were from companies and industrial associations, 12 from universities and research institutes, and 5 from public funding organisations and ministries. The event received also significant media attention in Finland: the topic was taken up at least in 15 Finnish newspapers, in two relevant magazines and in two radio programs. The articles and radio programs were produced on the basis of the seminar materials, supported by a press release by VTT and interviews of VTT researchers. Altogether, the SHHP Networking Meeting and Seminar was

perceived as a successful event, paving the way for future collaboration between the Nordic countries in the area of hydrogen and fuel cell demonstrations and the required infrastructure.

The program and the speakers of the seminar are presented in Appendix E. Program, Finland Conference.

Networking Conference in Oslo, Norway

The third and final networking conference was arranged in Oslo on 25 November 2009, under the name Hydrogen and Fuel Cells in the Nordic Countries. The objective of the conference was to give a comprehensive overview of fuel cell and hydrogen activities in the Nordic countries and to strengthen the collaborative network within this field. The conference was combined with the annual HyNor conference and the Norwegian hydrogen and fuel cell seminar.



Presentations from leading Nordic and international experts were combined with networking, study tours and test drives in Oslo.

The first day of the event corresponded to the yearly HyNor conference and gathered close to 100 participants. Focus this year was on infrastructure as well as cars and buses in the HyNor project from a user and early market perspective. Representatives from the car and infrastructure industry were represented on the speaker list along with other hydrogen stakeholders. Ride and drive was offered as well as visit to the hydrogen fuelling station in Oslo.

The second and third day of the conference focused on ongoing research and demonstration projects within all fields of fuel cell and hydrogen R&D in the Nordic countries. This includes industrial products and product development, hydrogen production, hydrogen storage, fuel cells and hydrogen end-use as well as hydrogen system aspects.

During the conference the benefit of joint Nordic collaboration was clearly demonstrated. The successful conference offered valuable networking and was much appreciated among the Nordic researchers, engineers, public officials and business people attending.

The program for the networking conference in Oslo can be found in Appendix F. Program, Norway Conference.

Individual meetings

In order to inform and attract new organisations, the project partners have had individual meetings with a magnitude of companies, institutes and authorities throughout the project period. These meetings have been an important complement to the networking conferences, serving the purpose of collecting specific data, ideas and opinions from the actors in the network. A large portion of these meetings have also been to mobilise additional users of hydrogen vehicles among organisations and persons.

Building the next steps

Initiated and supported projects

A number of projects and initiatives have benefited from the execution of the SHHP Innovation Networks project. Some are a direct result of ideas or contacts arising from the project work, others are gaining benefits more indirectly. Most of the projects have already been started whilst others are still under preparation. Also worth noting is that the project besides ensuring collaboration between the Nordic countries, also has had participation from other European countries on selected strategic activities. See the list of projects in Appendix C. Nordic projects pushing the developments further.

Areas for collaboration possibilities between SHHP, Iceland and Finland

During the project period, the participating organisations have already benefited greatly from the Nordic collaboration, as outlined earlier in this report. However, looking forward, the following areas have been identified by the partners as most promising for continued collaboration between Scandinavia, Finland and Iceland, beyond this project.

Expanding the scope beyond land transport

There are numerous opportunities to increase this Nordic cooperation not only in land transport but also regarding marine hydrogen activities. The first steps were taken in Iceland in spring of 2008 with testing of hydrogen in marine context and now there are new initiatives being taken in Norway by powering a water-taxi in Bergen with hydrogen and fuel cells. In the near future there could be opportunities for the Nordic cooperation to take a lead in this field as ships (building, engines etc.) is very large in the Nordic countries – specifically in Finland.



Joint procurement of vehicles

The benefits of approaching the international vehicle manufacturers are well known within the Icelandic and Norwegian demonstration projects. The two projects have worked side-by-side when visiting for instance manufacturers in Japan. Looking forward, the potential for widening the collaboration to include also Denmark and Sweden is imminent, and when Finland is ready to kick-start demonstrations for road transport the relationships are already in place.

Joint projects and applications for funding on Nordic and EU level

A very concrete area for further collaboration is unmistakably within funding of projects and other relevant activities such as tradeshow and marketing events. In addition to road transport related demonstrations, the demonstration of fuel cell special vehicles was defined as the most promising area for Nordic cooperation from the Finnish company partners' point of view, possibly together with fuel cell buses in a longer term.

Harmonisation of standards

In the ambition to accelerate the commercial introduction of electric vehicles with fuel cells and the required refuelling infrastructure, the harmonisation of standards is very pertinent. This also ties in with the interplay between the fuel cell and the battery in the vehicles, and correspondingly, between the hydrogen and the electricity on the infrastructure side. If the Nordic actors engaged in the national and international standardisation efforts would join forces, the ability to influence the outcome of international negotiations would increase.

Structured process for continued knowledge exchange

The value of a continued exchange of knowledge and experiences within the Nordic context that goes beyond the end of this project is recommended. It should be divided into thematic areas such as demonstration projects, scenario analysis and foresights, and possibly lobbying. It was also considered useful to link the regional and national demonstration projects to other corresponding efforts in the Nordic countries, so that the lessons-learned could be utilized in forthcoming efforts.

Application to become European Lighthouse Project

During 2008, various Scandinavian actors within hydrogen and fuel cells joined forces with other actors from Europe in preparing a proposal for large scale demonstration of fuel cell vehicles and hydrogen station in Oslo. A proposal was submitted for the European Fuel Cells and Hydrogen Joint Undertaking program in January 2009 and the proposal was selected for funding negotiations in May 2009. Final agreement was successfully found in December 2009 and the project will commence January 2010.

The project goes under the name "H2MOVES Scandinavia" and will be the first major demonstration project within the FCH-JU program. For the SHHP partnership this means that a major milestone has been achieved namely of securing the Scandinavian region as one of the regions in Europe to achieve the demonstration region status, and ensured European support.

Also the H2MOVES project will mark the beginning of active demonstration activities from major car manufacturers in Scandinavia. Such activities by the car manufacturers are crucial in enabling a future market introduction of hydrogen for transport.

There is no doubt that the valuable support received from Nordic Energy Research and the Nordic Innovation Centre has been absolutely crucial for the SHHP in securing the H2MOVES Scandinavia project.

Evaluation

Assessing the results

According to the project plan, the project will be a success if:

- A. Sufficient triple helix actors are identified at multiple levels throughout the Nordic countries making it possible to set in motion many subsequent research, development, demonstration and early market deployment projects in Nordic countries within hydrogen for transport
- B. Sufficient fourth helix actors in terms of vehicle end-users are identified and motivated to join demonstration and deployment projects enabling bringing more than 700 hydrogen vehicles on roads throughout Scandinavia by 2012
- C. The composition and competences of the identified triple and fourth helix actors stand a strong chance of attracting massive EU support for setting up “hydrogen innovation HUB’s” in selected cities in Scandinavia resulting in 15 hydrogen filling stations by 2012
- D. Sufficient collaboration possibilities are identified in Iceland and Finland making it possible for actors in these countries to join SHHP projects and activities

The fulfilment of these criteria:

- A. The project has managed to compile the most comprehensive list ever, of Nordic actors within hydrogen and fuel cells. The actors on the list have been invited to the network conferences arranged by the project and a majority of them has also been in individual meetings with the project partners. As documented in this report, a significant number of projects involving these actors have been initiated or supported by our project.
- B. The user oriented approach and strategy of the Icelandic and Scandinavian region, has so far proven successful, although it is expected that the big benefit of this approach is yet to come. By mobilising the vehicle end-users, the demand side of the emerging commercial market can grow much faster. This process is well underway and the approach is being fine tuned and complemented as we proceed. However, the speed of development is also very contingent on many other factors, such as vehicle availability and price, infrastructure roll-out as well as supporting policy measures. With 26 vehicles on Scandinavian roads today, the goal of 700 hydrogen vehicles is expected to be reached by 2015 or soon thereafter.
- C. As described in this report, the work of this project has provided valuable, and sometimes even crucial, support to Nordic actors applying for EU-funding within the area of hydrogen and fuel cells. The two outstanding examples are H2moves Scandinavia and Prepare-H2. Together with other projects with Nordic participation, it is estimated that already by 2009 more than 10 million Euros in EU-support has been secured through the FCH-JU. In terms of hydrogen refuelling stations, the current status is seven in operation and another three under construction. The joint efforts are on track for reaching a total amount of 15 by 2012 or shortly thereafter.
- D. Strong collaboration opportunities has not only been identified, but also in some areas initiated between actors in Iceland, Finland and the Scandinavian countries. These opportunities now have an even better chance of being successfully realised, leveraging the network and findings of this project.

In summary, the evaluation of the project confirms that the Nordic network within hydrogen and fuel cells is advancing steadily and with good pace. The four success criteria defined in the project plan have been fulfilled, although the forecast of deployed vehicles should be re-calibrated in accordance to the new 2015-timeline presented by the international car manufacturers¹¹.

Assessing the process

Considering the working process of the project, there are some important learnings to be made.

Given the type of project, with a focus on building and strengthening the professional network, it differs quite dramatically from a standard project with measurable goals and dedicated resources. The rapidly evolving innovation system calls for flexibility and creativity in this kind of projects, allowing the partners to seize the opportunities for progress as they arise. Much of this cannot be planned in advance, and is only made possible by working closely with the key people within the network. It was found that in order to master such a networking project, an open and frequent communication between the partners is crucial, especially in terms of expectations and procedures.

The partners have during the execution of the project seen that it has provided structure to otherwise diverse information from miscellaneous sources. Compressing and outlining the relevant developments was facilitated by the partners' expertise in the field, including innovation system theory. It was, however, noted that in addition to networking and updates on industry news, the company partners (especially those with engineering background) would have appreciated more concrete facts on the new technology and its development. To achieve this, it was suggested to involve fuel cell companies more intensively also in the core project team.

It was noted in Finland in particular, that keeping the hydrogen and fuel cell subject on the agenda is valuable in itself as there is a danger that short-term developments are prioritised over the long-term potential. The SHHP and Icelandic demonstrations makes the issue more concrete in the Nordic region and may provide a relevant reference and learning platform for ongoing and forthcoming regional/national demonstration projects.

¹¹ See <http://www.greencarcongress.com/2009/09/automakers-fcv-20090909.html> for more information on the statement.

Conclusions

The overall conclusion of the project is that there is a compelling case for moving forward in the Nordic countries concerning large scale deployment activities of fuel cell vehicles and hydrogen stations onwards a possible market introduction beyond 2015. Building on the outstanding progress already made regarding demonstration activities, in particular in Iceland and within the SHHP, the project partners recognise the following supporting conclusions as important.

Please note that these conclusions are based on the practical experience and industry know-how of the project's participating partners, and as such are not the outcome of a scientific process.

European competitiveness through Nordic complementarities

The hydrogen and fuel cell industries and activities are at very different state-of-play in each of the Nordic countries. There are some clear complementary competencies and we see this opening exciting opportunities for the Nordic Region to become an even stronger player in Europe. To achieve this, a well established communication pathway has been set in action between the key Nordic players in hydrogen. Already this has led to new projects which have started or will start in the near future, some with significant support from the EU through the FCH JU.

The importance of a selling story

The Nordic market for vehicles is fairly small and does not automatically become a priority for the international vehicle manufacturers. However, combining the Nordic efforts creates a compelling case, and by cooperating the Nordic actors have a strong voice on the international scene. The work of profiling and promoting the Nordic option is seen as crucial as future activities must expand and strengthen the collaboration with international companies, in particular car manufacturers and oil and energy companies.

Political support accelerate developments

Now that the Nordic approach has been proven on the industry and EU-level, it should be followed on the national political level – i.e. in relation to regulations, policies and strategies. If the Nordic countries could better harmonise their frameworks, the development and commitment towards a more sustainable future would benefit greatly. A joint Nordic plan covering key areas for commercialisation, e.g. detailed strategies for the hydrogen infrastructure roll-out, would accelerate developments tremendously and ensure a more cost-effective route towards the future.

Exceptional challenges call for exceptional innovation

For the human civilisation, turning away from fossil fuels is an exceptional challenge that we must succeed in. It will not be easy, cheap or fast. This is not business-as-usual and it is not evident how we should address this challenge. It will however, without a doubt, require some exceptional innovations. In light of this, the project foresees the need to be creative around two critical areas relating to the introduction of hydrogen as a vehicle fuel; a) Identification and motivation of vehicle end-users and pooling of these in joint vehicle purchasing or leasing, and 2) Development of innovative and supportive deployment mechanisms to bridge the gap between ongoing demonstration projects and market introduction.

Batteries and fuel cells make strong partners

During the project period hydrogen has not been considered always as the ultimate solution – like it had been introduced a few years earlier. During the latter part of the period there have been a lot of discussions regarding battery vehicles. The interest and commitment of research, industry and other actors in relation to hydrogen and fuel cells is in general firm and rising, however the perception when looking in the media coverage might be giving a different view. There is a clear hype of battery technologies right now and the misperception is that this is making the fuel cell less interesting. It is in fact the other way around. Battery and fuel cell technologies make perfect partners. This is the only known combination of technologies that may provide zero emission vehicles that deliver the same features and functionality as what we are used to today. Worth noting is also that the unfortunate battery hype underlines the importance of managing expectations. To responsibly educate the public and the media will avoid building expectations that cannot be met by the technology. This fact also calls for new initiatives focusing on education and professional dissemination of information.

Recommendations

Overall the Nordic countries are well underway towards becoming one among the first regions worldwide where hydrogen for transport is introduced in the market beyond 2015. The number of hydrogen stations and vehicles put in operation especially in the SHHP network and Iceland has increased significantly over the past few years. Also, more stations and vehicles are planned with European support and participation from international car manufacturers. These concrete steps are combined with a strong and active network of various organisations from across the entire value chain behind hydrogen for transport, which through this project has been further matured and strengthened.

During the progress of the project, the partners have identified a number of interesting and important areas where further work should be done to accelerate the developments in the Nordic region. The activities are concentrated around ensuring a transformation from the present demonstration projects to large scale deployment of vehicles and roll out of stations onwards a later market introduction.

The recommendations outlined below are addressed to Nordic stakeholders within industry, research and government.

Expand and strengthen collaboration with car manufacturers and energy companies

When commencing on deployment activities, strong collaboration and active involvement of car manufactures and energy companies are important as these respectively are to provide vehicles and stations. Targeted networking activities should be initiated to attract more car companies to conduct testing of electric vehicles with both batteries and fuel cells and later roll-out in the Nordic countries. Also energy companies should be motivated to commence station build-up expanding the infrastructure network, ensuring optimal synergies between hydrogen and electricity for recharging. This should not only account to international based energy companies, but also local or regional ones. Hydrogen offers strong drivers such as job creation and renewable energy storage that may be of particular interest for local and regional based energy companies.

Define a detailed roadmap for infrastructure and vehicle roll-out

Significant investments in especially stations are necessary during the deployment phase to ensure a widespread network, enabling a market introduction. Decisions on such investments require a detailed and through-full planning of and strategy for efficient infrastructure roll-out combined with vehicle allocation. Also such planning can draw a path for a transition towards renewable based hydrogen supply and thus ensuring synergy with renewable energy production. A specific next step could be a joint Nordic research and analysis project with the intent of formulating a roadmap for hydrogen infrastructure and vehicle onwards 2025 potentially with scenarios onwards 2050.

Mobilise vehicle end-users and secure deployment mechanisms

Existing demonstration projects have included only small vehicle fleets and few early-adopter end-users that have accepted very high price levels for the vehicles. Future deployment projects will require handling of several dozens of vehicles at many and potentially scattered end-users. Also the higher number of vehicles requires that costs for these are lower in order to gather enough end-users. To reduce costs, mobilising of end-users and joint purchasing is necessary to increase volume as well as deployment mechanisms to cover the extra cost that still will be associated with fuel cell

vehicles in the deployment phase. This requires an active identification and motivation of end-users and effort to join these in joint projects (network task). Also efforts need to be done on ensuring support from deployment programs (applications) or formulation of tax or other market incentives.

Harmonise early market policies in the Nordic countries

The range of technologies that are competing to make us independent from fossil fuels is huge, and much time and effort is spent on predicting the winners and losers. What we do know is that technological break-throughs will happen, but in which areas we do not know. It is, however, the view of many scientists, engineers, politicians and business people, that hydrogen is very likely to play an important role in the more sustainable energy systems that must evolve. But where geographically will these systems evolve first? Also here there is competition, and the Nordic region is among the leaders. To keep and to strengthen this position, the Nordic countries would benefit greatly from harmonising the early market policies and incentives for zero-emission vehicles powered by renewable energy.

Appendices

Appendix A. Network invitation leaflet

The network invitation leaflet shown below has been useful when informing of the project and attracting new participants.

Do you also want to see vehicles with only water coming out of the tail pipe?



Photo: Icelandic New Energy

Join a Nordic network of hydrogen and fuel cell professionals and users taking on the challenge of introducing hydrogen as a vehicle fuel.

Ensuring a future widespread use of hydrogen—as fuel for transport and produced through sustainable methods—requires a complex transformation of science and technologies into workable hydrogen vehicles, along with a far reaching hydrogen infrastructure of filling stations.

The Scandinavian Hydrogen Highway Partnership (SHHP) works towards establishing an early infrastructure of hydrogen filling stations enabling driving hydrogen fuelled vehicles in Scandinavia by 2012. Reaching this goal is important in paving the way for a major commercial roll out of hydrogen vehicles and infrastructure post 2012.

This leaflet invites you and your organisation to participate in an initiative aiming to involve a greater number of actors from industry, academia and governments on local, regional, national and international level. Through a wider cross-border collaboration, not only within Scandinavia, but also with the Nordic neighbours of Finland and Iceland, we can benefit from each others' experiences and knowledge. The project will be applying a user driven approach, ensuring that commercial and technical requirements are taken into account.

Join the network to:

- get involved to hydrogen conferences and events throughout the Nordic countries
- find ways into demonstration projects and potentially large scale EU-funding
- share your experiences with colleagues in the industry

Are you a hydrogen professional?

You specifically get:

- to influence on the direction of hydrogen for transport in the Nordic region
- to join the working groups within the SHHP
- to expand your Nordic business development arena

Are you new to the hydrogen industry?

You specifically get:

- increased understanding of opportunities in the field
- contact with some of the leading organisations within the industry



OPPORTUNITIES FOR BUSINESS...

Great global business opportunities lay in the development of technologies that enable the use of a sustainable production of fuels for the transport sector, such as hydrogen and fuel cell technology. According to a study conducted by PricewaterhouseCoopers, the market for hydrogen and fuel cell technology for transport will grow by 84 % annually, from \$123 million in 2003 to \$10,8 billion in 2011.

The Nordic H2 Energy Foresight research project pointed out the favourable conditions for a development of a Nordic market for hydrogen and fuel cells. For example, the five Nordic countries are ranked in the top ten of the Growth Competitiveness Ranking. The Nordic countries with more than 24 million inhabitants are wealthy and have large research and development resources.

In the SHHP network, as well as in Finland and Iceland, hundreds of actors, in terms of knowledge institutions and companies, are already active in research and development of hydrogen and fuel cell technologies. The technology is fast entering a phase with large scale demonstration and early market deployment. This thanks to increasing public R&D support and the creation of market incentives, such as freeing of hydrogen cars of all taxes which has happened in Denmark and Norway.

...AND HOPE FOR THE PLANET

One of the challenges in fuelling the world's increasing need for transportation, is to lower the dependency on fossil fuels – a limited resource that often comes from politically unstable regions. Hydrogen fuel can be produced from renewable and locally produced energy sources e.g. sun, wind or biogas, thus reducing dependency of fossil fuels. Further, the chemical process in the fuel cell is twice as efficient as gasoline combustion engines, and, with the only emission being pure water – this allows for zero emission locally.

"Collaborating with business partners, sharing a long time perspective on hydrogen and fuel cells, will speed up the market introduction."

Sven Wolf,
Project leader,
SHHP Innovation Networks



CONTACT

Contact the SHHP Innovation Networks project to find out more about this initiative.

Denmark
H2logit, Mikael Sloth
ms@h2logit.com,
+45 96 27 96 02

Finland
VTT Technical Research Centre of Finland,
Annele Sevola
annele.sevola@vtt.fi
+358 20 7224297

Iceland
My O-ras, Jón-Björn Skúlason
skulason@myenergy.is
+354 598 03 10

Norway
StatcollHydro, Ulf Hørsed
uhf@statcollhydro.com
+47 22 97 20 00

Sweden
Hydrogen Sweden, Sven Wolf
sven.wolf@vapo.se
+46 31 334 37 72



Appendix B. Raising awareness at exhibitions, seminars and conferences

The list below documents the significant number of events attended or organised by the project.

Exhibitions, seminars and conferences 2007

- | | |
|-----------|--|
| 26 Sep | Meeting with DG TREN and DG Research, Brussels
A dedicated meeting to position the SHHP with the key officials from the EU Commission DG Transport and Energy as well as DG Research. |
| 9 Oct | Roads2HyCom Regional Workshop, Brussels
Per Hörberg of Region Västra Götaland participates and presents the SHHP at the regional workshop arranged by the EU-project Roads2HyCom. |
| 10-11 Oct | EU HFP Review Days, Brussels
A number of representatives from the SHHP participates at the Review Days. Ulf Hafselde presents SHHP at the JTI Regional Grouping workshop. |
| 17-18 Oct | Gasdagarna, Båstad
Participation in the exhibition and presentation at the Swedish Gas Association's annual seminar. |
| 23 Oct | Fuel Cells, October 2007: "Can the fuel cells cope with the Atlantic Ocean".
Presentation by Icelandic New Energy at the NHA conference held in San Antonio, October 2007. Publication in proceedings. |
| 25-26 Oct | ETTAR Workshop, Gothenburg
Participation and presentation by Sven Wolf, Hydrogen Sweden, at the EU project ETTAR's workshop. |
| 6 Nov | Zero Regio Workshop, Montecatini Terme
SHHP presentation at the conference by Hilde Ström, HyNor. |
| 7-9 Nov | Clean Vehicles and Fuels, Stockholm
Participation at the national and international convention and exhibition with a SHHP-stand. Sven Wolf; Hydrogen Sweden, presents SHHP at the international conference. |
| 29 Nov | CleanTech, Copenhagen
SHHP presentation by Ulf Hafselde. HyNor |
| 11 Dec | Annual conference of HyNor, Oslo
Update on SHHP progress is presented at the conference. |

Exhibitions, seminars and conferences 2008

- | | |
|-----------|---|
| 6-7 Feb | Energisession 2008, Göteborg
A seminar arranged by SHHP and Hydrogen Sweden. SHHP is presented to representatives of the industry and decision makers from the western Sweden. |
| 27 Feb | 4th International Hydrogen and Fuel Cell Expo 2008, Tokyo
SHHP presentation by Ulf Hafselde. HyNor |
| 12-13 Mar | Sveriges Energiting, Stockholm
SHHP presentation both at the exhibition as well as at the conference. Speaker at the conference is Einar Håndlykken, ZERO. |

- 29 Mar-2 Apr NHA 2008, Sacramento
SHHP presentation at the Exhibition through the h2moves.eu projects participation.
- 14 Apr The Annual Meeting of Fuel Cell Finland Industry Group, Helsinki
Presentation made by Annele Eerola, VTT.
- 21-25 Apr Exhibit Hydrogen + Fuel Cells, Hannover
SHHP presentation at the Exhibition through the h2moves.eu projects participation.
- 23-24 Apr Role of hydrogen in the North Atlantic, Iceland
The first of two Networking Conferences during 2008 organised in collaboration with the SHHP Innovation Networks project. Presentations made by Jon Björn Skulason, Mikael Sloth and Ulf Hafselld.
- 15-19 Jun 17th World Hydrogen Energy Conference, Brisbane
Presentations made by both Ulf Hafselld and Sven Wolf
- 17 Jun Skånes Energiting
Participation in the exhibition with the SHHP stand.
- 13-15 Oct HFP General Assembly 2008
Joint Scandinavian/Nordic stand and presentations.
- 20 Oct Nordic H2 seminar at the Norwegian Embassy in Japan
Presentations by Anne-Marit Hansen, Steffen Möller Holst and Jón Björn Skúlason.
All key Japanese car manufacturers and government agency present.
- 20-24 Oct Joint Icelandic/Norwegian H2 team visits Toyota, Honda, Nissan and Mazda for joint discussion on H2 cooperation and RD & D projects. Presentation to the car manufacturers on all visits.
- 28-29 Oct Expomark Energy Fair, Tampere
Presentation made by Annele Eerola, VTT.
- 5-6 Nov Gasdagarna, Falkenberg
Participation in the exhibition and presentation at the Swedish Gas Association's annual seminar.
- 20 Nov Annual Meeting of the Hydrogen and Fuel Cell Network in NRW, Dusseldorf
Presentation made by Sven Wolf.
- 21 Nov Breakfast seminar, Kristianstad
Presentation made by Sven Wolf.
- 1 Dec Hydrogen for Transport Conference, Copenhagen
Presentation made by Mikael Sloth.
- 3-4 Dec Nordic Networking Seminar, Espoo
The second of two Networking Conferences during 2008 organised in collaboration with the SHHP Innovation Networks project. Presentations made by all project participants.
- 16 Dec Annual conference of HyNor, Oslo
Update on SHHP progress is presented at the conference.

Exhibitions, seminars and conferences 2009

- 5-6 Feb Energisession 2008, Skövde
SHHP is presented to representatives of the industry and decision makers from western Sweden. Participation in the exhibition with the SHHP stand.
- 11-12 Mar Sveriges Energiting, Stockholm
SHHP presentation both at the exhibition as well as at the conference.
- 30 Mar Meeting with HyRaMP and JTI, Brussels
SHHP presentation to the EC-officials and regional stakeholders.
- 15 Apr Meeting with The Royal Academy of Science, Stockholm
SHHP presentation made by Sven Wolf.
- 13 May Electric Vehicle Symposium, Stavanger
Participation in the exhibition with the SHHP stand.
- 14 May Electric Vehicle Symposium, Stavanger
Presentation on Icelandic and joint Nordic activities regarding H2 transport, by INE.
- 29 Apr-2 May Hydrogen and FuelCells, Vancouver
SHHP participation and presentations by a number of SHHP representatives.
- 3 June Meeting with Innovasjon Norge, Gothenburg
SHHP presentation made by Sven Wolf.
- 9 June Skånes Energiting, Malmö
SHHP presentation by Sven Wolf and participation in the exhibition with the SHHP stand.
- 17 June European Hydrogen Associations Annual Meeting, Brussels
SHHP presentation made by Sven Wolf.
- 8-9 Sep Nordic Climate Solutions 2009, Copenhagen
Participation in the Nordic lounge with the SHHP stand.
- 14-18 Sep Int. Conf. World Bioenergy – Clean Energy & Fuels, Stockholm
SHHP participation and presentations by Hilde Ström and Sven Wolf.
- 15 Sep Annual Seminar of the Tekes Fuel Cell Program, Espoo.
SHHP poster included in the poster exhibition.
- 26-27 Oct HFP General Assembly 2009, Brussels
Participation by Mikael Sloth, Hilde Ström and Sven Wolf
- 11-12 Nov Gasdagarna, Lund
Participation in the exhibition with the SHHP stand and presentation at the Swedish Gas Association's annual seminar.
- 25-26 Nov Nordic Hydrogen and Fuel Cell Conference, Oslo
The third and last Networking Conferences organised in collaboration with the SHHP Innovation Networks project.
- 30 Nov Hydrogen Vehicle Parade and Industry Update, Copenhagen
A major VIP-event in the lead up to the UN Climate Change Conference in December.

Appendix C. Nordic projects pushing the developments further

The list below documents a significant number of projects that range from directly initiated to indirectly supported by the project. Please note that this is not a complete list of all hydrogen and fuel cell related projects in the Nordic countries.

H2moves Scandinavia

Status: Commences 1 January 2010

European Lighthouse demonstration project on fuel cells and hydrogen for transport. Several vehicles from car manufacturers will be demonstrated in Oslo together with the establishment of a hydrogen refueling station. Further a European showcase tour of the vehicles will be conducted together with a mobile hydrogen refueling station. The total project budget is around €20 million. Project applied for funding from the European Fuel Cells & Hydrogen Joint Undertaking program in January 2009. In May 2009 the project was selected for negotiation and the project start will be in January 2010. Project consortium includes partners from Norway, Denmark, Sweden and Germany.

ScanWays

Status: Planned

R&D analysis project on developing hydrogen transport roadmaps for supply and provision of hydrogen for transport purposes onwards 2025. The project applied for funding from the Nordic N-INNER program in April 2009, however without luck. Application may be resubmitted for future calls from suitable programs. Total eight companies and universities are participating from Norway, Sweden, Germany and Denmark.

PreparH2

Status: Commences early 2010

R&D analysis project on preparing socio and economic evaluations of future H2 lighthouse projects. Project applied for funding from the European Fuel Cells & Hydrogen Joint Undertaking program in January 2009. In May 2009 the project was selected for negotiation which was positively concluded in end of October. The project kick-off is expected project start in early 2010. Six companies and universities are participating from Norway, Iceland, Germany, Italy and Denmark.

Interreg ÖKS application

Status: Ongoing

Pre-project aimed at preparing a full Interreg application with the purpose of facilitating a Scandinavian program under which regions and municipalities may procure hydrogen vehicles to a reduced cost. Funding was secured in end 2009 and is ongoing. Hydrogen Link Denmark and Hydrogen Sweden are conducting the project.

Nordic Supply Network Model for Hydrogen Refuelling Stations

Status: Planned

The project would develop an integrated approach and flexible computer tool to support decision making on sustainable and fluently functioning hydrogen supply networks on national and Nordic

level. DTU, SINTEF and VTT are responsible for conducting the main research tasks, supported by relevant industrial partners (incl. H2Logic, DGC, possibly also Hydrogen Sweden; DTU would coordinate). EoI proposal for NordForsk Call “Sustainable Freight and logistics”, submitted in October 2009. Was not selected for implementation in this call (other funding opportunities are searched for).

VIP-event 30 Nov 2009

Status: Completed

Before and during the United Nations Climate Change Conference in Copenhagen (COP15) a number of hydrogen and fuel cell showcase and communication activities were carried out, to ensure visibility of the technology. On Nov 30, 14 fuel cell vehicles from Honda, Daimler, GM, Fiat and Think drove across the Oresund Bridge from Malmö to Copenhagen. The event was organised in collaboration with the European Hydrogen Association, the European Regions’ and Municipalities’ Partnership on Hydrogen and Fuel Cells, the FCH JU Program Office and the associated Industry Grouping. Pictures can be downloaded from <http://www.hydrogenlink.net/eng/news-copenhagen-hydrogen-parade-30-11-09.asp>

Working PEM

Status: Completed

In the Finnish Working PEM project, a highly instrumented 10 kW PEM fuel cell power plant is developed for the use of working machine operating environment. The focus is in balance of plant (BoP) and control system development for the power plant. International progress in the fuel cell technology is followed by producing technology and market update reports on project specific topics. Contractor: VTT. Funding: TEKES Fuel Cell Programme. Ended in 2009, a continuation is planned.

REFORMH2

Status: Ongoing

In this project the production of hydrogen from bioethanol by reforming in a catalytic membrane reactor will be studied. The produced hydrogen will be separated and purified as an energy source for fuel cell applications. Contractor: University of Oulu, Åbo Akademi et.al. Funding: TEKES Fuel Cell Programme, Finland.

DEMO 2013 Feasibility Study

Status: Ongoing

Tekes plans to demonstrate the Finnish fuel cell program results in 2013 in Vuosaari harbour area in Helsinki. The Feasibility Study/planning of the project is in the initiation stage and will be completed by the end of 2011. The broad demonstration project is intended to include also international cooperation. Planning project runs 2009-2011 (a wide range of demonstrations planned for year 2013).

FCH city buses for Finnish demonstration use

Status: Planned

Some preliminary discussions have been undergone about the possibility of Finnish partner to join a FCH JU bus demonstration. Possible start 2011.

Regional/national H2roadmap

Status: Ongoing

Initiative by PrizzTech/Äetsä Hydrogen Village, Finland. The project is funded by regional EU funds. Task is to find local applications for fuel cells also including a hydrogen technology and introduction road map for Finland. Project funded 2009-2011.

Wärtsilä SOFC

Status: Ongoing

Wärtsilä is developing 20 and 50 kW SOFC power units for ships APU and DG. Started 2001. Wärtsilä also plans to participate in the Finnish DEMO2013 project.

Cargotec

Status: Ongoing

At present a fork lift demonstration based on Kalmar fork lift as a part of Working PEM project has been completed. Cargotec plans to participate in the Finnish DEMO2013 project with a new fuel cell application.

SOFCPower

Status: Ongoing

The Finnish national SOFC development project that was started with the name FINSOFC is now continuing with the new name. The project, coordinated by VTT, is focused on system development, but also cell and stack testing is included. Started 2002.

TopDrive (Optimising topologies of fuel cell hybrid drive trains for working machines)

Status: Starting

In this new Finnish project fuel cell hybrid drive trains as well as fuel cell hybrid APU systems for working machines are studied. Fuel quality as well as safety and reliability aspects are included. Project is continuation to WorkingPEM. Contractor: VTT & Alto. Funding: TEKES Fuel Cell Programme. EoI, Oct. 15, 2009

Evaluation of alternative fuels

Status: Ongoing

Many projects are in Iceland involving different alternative fuels. This project is comparing fuel efficiency and impact on the domestic fuel portfolio. It includes methane vehicles, hydrogen, plug-in and BEV. Information and execution of the project is mostly done via a MS student thesis. The project was funded by the Icelandic Energy Fund in late 2008 and all data collection is done in 2009. The goal is to finish the project 31/12/09.

New research and energy

Status: Completed

Evaluation of the grid network in Reykjavik for production of Hydrogen. The project consortium involved energy companies from Iceland, Greenland, Norway, Canada and the Faroe Islands.

Applied and funded by NORA in early 2008. Project finished with conclusions available at INEs web site: www.newenergy.is

Regional collaboration project in Skåne

Status: Ongoing

With the aim of facilitating the regional introduction of hydrogen as an energy carrier, this project plays an important role to support the actors and initiatives in the region of Skåne. The exciting collaboration opportunities with the City of Copenhagen will be a core part of the project. In the regional network there is already today close to 150 individuals and the organisations involved span private and public sectors as well as academia. Supported by EU Regional Development Funds.

Refuelling station & vehicles for demonstration and testing in Gothenburg

Status: Ongoing

The purpose of the project is to establish a refuelling station for renewable hydrogen, hythane and electric quick charging, in the city of Gothenburg. The project will also sign up vehicles and users and perform a testing program to evaluate the station, vehicles and the user behaviour. The project partners represent Swedish and Norwegian energy companies, local and regional authorities and companies.

CanDan2

Status: Ongoing

R&D and demonstration project 2nd generation fuel cell systems for backup power and materials handling and supporting hydrogen dispensers and infrastructure in Denmark and Canada. Project successfully applied for 1st and 2nd phase funding from the Danish EUDP program in 2007 and 2008. Project is ongoing with five companies from Denmark and a university participating. Various organisations from Canada are also involved.

LINK2009

Status: Ongoing

R&D and demonstration project 2nd generation fuel cell systems road vehicles and supporting hydrogen dispensers and infrastructure. Several fuel cell vehicles are to be demonstrated in Denmark together with establishment of hydrogen refuelling stations in a number of cities. Project successfully applied for 1st phase funding from the Danish EUDP program in 2008. Phase 1 is ongoing. Funding for phase 2 was secured at the EUDP program in July 2009. Phase 2 is ongoing with around 10 organisations (companies and universities) from Denmark are participating in the project.

CanDan1.5

Status: Completed

R&D Analysis of power balancing with fuel cells and hydrogen production plants in Denmark. Project successfully applied for funding from the Danish FORSKEL program in 2007. Project was finished in May 2009. Five companies from Denmark and a university participated. Project report can be found at: <http://www.hydrogenlink.net/download-reports.asp>

HyLIFT-C3

Status: Ongoing

R&D of 3rd generation fuel cell systems for material handling vehicles. Project successfully applied for funding from the Danish DANATF program in 2008. Project is ongoing with participation of a Danish company and university.

How2use

Status: Ongoing

R&D analysis project on vehicle end-users demands for fuel cell vehicles and hydrogen infrastructure. Project was granted funding from the Danish program for User-driven Innovation in June 2009 and is ongoing. Ten organisations from Denmark and Norway are participating.

Appendix D. Program, Iceland Conference

Conference Agenda April 23-24th 2008

Hydrogen in the North Atlantic Area, research and demonstration.

April 23rd Agenda, Location is at Reykjavik Energy, Bæjarhálsi 1, 110 Reykjavik

09:45 Chairman of NAHA, *Hjálmar Árnason* – Opening – key topics for hydrogen in the North

09:55 **Government policy in Iceland, renewable energy and environmentally friendly fuels**

Hon. Össur Skarphéðinsson, Minister of Industry

10:15 **The European Industry Grouping for a Fuel Cell and H₂ Joint Technology Initiative**

Gijs van Breda Vriesman, Chairman JTI Industry Grouping

10:35 **The Icelandic story, status and accomplishment, vehicles and boat activities.**

Jón Björn Skúlason, General Manager, Icelandic New Energy Ltd. (INE)

10:55 **Development of fuel cell buses and vehicles and future outlook**

Monika Kentzler, Coordinator HyFLEET:CUTE, Daimler AG

11:15 **FORD hydrogen and fuel cell vehicle development.**

Scott Staley, Chief Engineer Hybrid & Fuel Cell Technology Development, FORD

~ 12:00 Lunch, test drive of vehicles will be available

13:10 **HyNOR (Scandinavian Hydrogen Highway) – Build up and status of vehicles and infrastructure.**

Ulf Hafselid, Head of Business Development Hydrogen, StatoilHydro

13:30 **The Three Pillars of Sustainability, socio, economic and environmental research within SMART-H2 in Iceland.**

Brynhildur Davidsdottir, University of Iceland – *Maria Maack*, INE.

13:50 **Optimisation of hydrogen infrastructure build-up – case of Reykjavik, Thorshavn and Nuuk.**

Lilja Guðmundsdóttir, INE and University of Iceland.

14:10 **Opportunities regarding small scale hydrogen infrastructure.**

Hallmar Halldórsson, Icelandic Hydrogen

14:30 **Hydrogen production utilising existing hydro power plants**

Peter Kjeldmann, Nuukissiorfit (Greenland)

14:50 **Ramea - Wind-Diesel-Hydrogen Project**

Jim Keating, Business Development, Newfoundland and Labrador Hydro

15:10 Coffee

15:30 Experience of retrofitting hydrogen vehicles and hydrogen storage

Wally Dubno, Quantum, LA, California

15:50 Intergration of an auxiliary boat engine into a whale watching ship.

Hjalti Pall Ingolfsson, Varmaraf.

16:10 Hydrogen ferry between Thorshavn and Nolsoy (Faroe Island).

Terji Durhuus, Jarðfeingi.

16:30 Hydrogen Link Denmark

Mikael Sloth, H₂-Logic

16:50 The Pure Project

Daniel Aklil, Pure Energy Centre

~17:30 Conference closing

Wrap-up and discussion coordinated by the chairman of NAHA

April 24th 10:00-12:00

Launch of the first demonstration of hydrogen and fuel cell on board a commercial vessel. The Minister of Industry will launch the project. Conference guests are all invited to the harbour area for the launch, and a first test-trip. Please note that the event will be outdoors so dress according to cool weather conditions; rain or snow or frost. Usually temperatures are around 0-5°C. Bring at least windbrake, scarf and gloves also for the energy excursion. Umbrellas are useless -and remember to bring bathing-gear for the excursion!!!!

Press event

On-site at the harbour there will be a collection of environmentally benign vehicles: one of the largest hydrogen fleet in Europe, methane cars, hybrids, plug-in hybrid, ethanol, etc.

Renewable Energy Excursion, afternoon April 24th 2008, (for interested conference guests):

13:10 Leave Reykjavik; visit at the Hydrogen station

(14:30) Visit to the Nesjavellir power plant (geothermal) – Orkuveita Reykjavíkur

(15:45) Visit to the Ísafoss power plant (Hydro) – Landsvirkjun

(18:00) Visit and dip into the Blue Lagoon

(20:00) Visit with light dinner to the new Energy Campus at Keflavik Airport (former NATO base)

Appendix E. Program, Finland Conference



SHHP Innovation Networks Nordic Network Meeting and Seminar Programme

Site: VTT, Valimo, Metallimiehenkuja 2, Espoo, Finland

Time: Thursday December 4, 2008, at 10:00 – 16:15

Get together evening on December 3, 19:00 – 21:00

Excursion to VTT Fuel Cell & Vehicle Research Facilities
in Thursday morning, December 4, 8:30 – 10:00

Chair Sven Wolf, Managing Director, Hydrogen Sweden

10:00 Opening and Welcoming

Annele Eerola, Deputy Technology Manager, VTT Organisations, Networks and Innovation Systems

10:10 Long-term climate and energy strategies - Recent Finnish perspectives

Jatta Jussila, Senior Adviser, Ministry of Employment and the Economy

10:20 Nordic H₂ & FC cooperation from the European perspective

Rolf Rosenberg, Board Member in the EU FCH Joint Undertaking Research Grouping and Chief Research Scientist, VTT

10:35 Challenges in the H₂/FC area seen from the Nordic perspective

Lise Jørstad, Senior Adviser, Nordic Energy Research

10:50 Nordic cooperation: possibilities to exploit Nordic potential

Natalia Grebennik, Innovation Advisor, Nordic Innovation Center

11:05 Scandinavian Hydrogen Highway Partnership; building on experience from the HyNor project

Hilde Strøm, Business Development Manager Hydrogen, New Energy Dpt, StatoilHydro

11:35 Existing and future hydrogen demonstrations in Sweden

Sven Wolf, Managing Director, Hydrogen Sweden

11:55 - 12:55 Lunch

12:55 H₂ Logic fuel cell hybrids for transportation

Steven Westenholz, Sales Manager, H₂ Logic

13:15 Iceland, striving towards the hydrogen society

Jón Björn Skúlason, General Manager, Icelandic New Energy Ltd.

13:35 Finnish Fuel Cell Forklift Demonstration

Jorma Nurmi, Development Manager, Kalmar Industries & Jari Ihonen, Senior Research Scientist VTT

VTT Fuel Cell Research in Finland

Rolf Rosenberg, Chief Research Scientist, VTT

13:55 - 14:15 Coffee

14:15 - 16:00 Business matching

- Directions by Sven Wolf (Swedish, Danish, Norwegian, Icelandic and Finnish contact points)
- Discussions in lecture hall Valimo and meeting room no. 203, opportunities for more private discussions

16:00 - 16:15 Closing



Supported by



Appendix F. Program, Norway Conference

Tuesday 24 November: HyNor conference

09:00 Hydrogen fuels in Norway

HyNor - status 2009, Anne Marit Hansen, Statoil/HyNor leader 2009

Status on hydrogen and fuel cells, Steffen Møller-Holst, SINTEF

What can we expect from battery technologies?, Ann Mari Svensson, SINTEF

A skeptic's view on hydrogen in the transport sector, Trond Andresen, IKT NTNU

Questions and discussion

11:00 Break

11:20 Hydrogen cars and buses

Mercedes program on hydrogen cars and buses, Johnny Danielsen, Mercedes-Benz

Developing Legal Requirements: Allowable Hydrogen Permeation Rate From Road Vehicles, Paul Adams, Volvo

Leasing zero-emission cars, Thomas Andersen, Leaseplan

12:20 Lunch

13:20 Hydrogen suppliers and producers

Statoil Hydrogen Activity, Per Øyvind Hjerpaasen, Statoil

Linde Hydrogen Concepts, Robert Adler, Linde

H2Logic Hydrogen Activity, Michael Sloht, H2Logic

Hydrogen quality from decarbonised fossil fuels, Maria Barrio, SINTEF

14:30 Experiences from hydrogen car drivers in Viking Rally 2009

Veronica og Marlene Engan, winners of Viking Rally 2009

Ole Martin Lundefaret, reporter in Autofil and TV2, participant in Viking Rally

Truls Wickholm, Member of Parliament, participant Viking Rally

Bjørnar Kruse, advisor ZERO, organizer Viking Rally 2009

15:15 HyNor 2010-2015

HyNor's new leader will summarize and present HyNor phase 2

15:30 Hydrogen in practice

Guided tour to the hydrogen fuelling station at Statoil Økern, 5 min from conference hotel by Bjørn Gregert Halvorsen, Statoil

Hydrogen vehicle test drive. Due to limited capacity, the first to sign up for the test drive during the registration will be given priority.

16:30 End of day 1

Wednesday 25 November

08:45 Coffee and registration

09:15 Welcome by the conference organising committee

09:20 Session 1 - Chair: Bjørn Hauback

09:20 Elizabeth Anne Unger

Icelandic New Energy

The Current Status of Hydrogen and Fuel Cell Development in Iceland

09:40 Jon Björn Skulason

Icelandic New Energy

Social Dimensions in Context with Hydrogen Demonstrations

10:00 Steffen Møller-Holst

SINTEF / Norwegian Hydrogen Council

The Action Plan 2007-2010 from the Norwegian Hydrogen Council- Mid-Term Assessment. Are we on track?

10:20 Sven Wolf

Hydrogen Sweden

The European Regions' and Municipalities' partnership on Hydrogen and Fuel Cells (HYRAMP)

10:40 Short Break

11:00 Session 2 - Chair: Torgeir Nakken

11:00 Andreas Bodén

Powercell

Powercell - An Environmental Friendly Power Generator for the Future

11:20 Hans Jörg Fell

Hydrogen Technologies

On-Site Hydrogen Production by Water Electrolysis – Status and Trends

11:40 Claus Torbensen

Dantherm

Commercial Production of Fuel Cell Power Supply Solutions

12:00 Lunch and poster session

13:30 Session 3 - Chair: Steffen Møller-Holst

13:30 Frank de Bruijn

Hydrogen and Clean Fossil Fuels Energy research Centre of the Netherlands

[*Keynote lecture: PEM Fuel Cells: Durability & Cost*](#)

14:00 Bjørn Hauback

IFE

[*The Challenge – Hydrogen Storage*](#)

14:20 Dag Bjerketvedt

Høgskolen i Telemark

Hydrogen Safety Research at Telemark University College

14:40 Short Break

14:50	Session 4a - Chair: Frank de Bruijn	Session 4b - Chair: Stein Trygve Briskeby	Session 4c - Chair: Helge Weydahl
14:50	Arne Lind	Svein Sunde	Lars Hildebrandt
	IFE	NTNU	KTH
	Modelling of Distributed Renewable Energy Hydrogen Systems	<i>Characterisation of Catalysts for the Oxygen Evolution Reaction in PEM Water Electrolysis</i>	<i>Ion Conduction In Gadolinium-doped Ceria Mixed with Alkali Carbonates</i>
15:10	Björn Wickman	Mikhail Tsypkin	Yngve Larring
	Chalmers	NTNU	SINTEF
	<i>Corrosion Induced Degradation of Carbon Supported Platinum Model Electrodes Measured with Electrochemical Quartz Crystal Microbalance</i>	<i>Nanocrystalline IrxMn1-xO2 as Anode Electrocatalyst For Pem Water Electrolysers</i>	<i>PC-SOFC Technology: Materials, Cells And Stacks Development</i>
15:30	Alejandro Oyarce Barnett	Anu Lokkila	David Berstad
	KTH	Helsinki University of Technology	SINTEF
	<i>In-Situ Durability Studies of Carbon Nanotube- and Carbon Nanofiber-Supported Pt as PEMFC Cathodes</i>	<i>Study of SO2-Depolarized Water Electrolysis</i>	<i>A Future Energy Chain Based on Liquefied Hydrogen</i>
15:50	Maria Wesselmark	Edel Sheridan	Marit Stange
	KTH	SINTEF	SINTEF
	<i>The Activity and Stability of Platinum on Metal Oxides in Thin</i>	<i>Electrochemical Separation of Hydrogen using</i>	<i>Properties and Application of Supported</i>

Film Electrodes in PEFC

Polybenzimidazole (PBI) Fuel
Cell Technology

*Pd-23%Ag Membranes
for H₂ Production and
Separation*

16:10 Coffee Break

16:30 Session 5a - Chair: Pertti Kauranen Session 5b - Chair: Svein Sunde

16:30 Piotr Ochal Preben Vie
NTNU IFE

*CO Stripping as an
Electrochemical Tool for Coreshell
Catalysts Characterization* *A Calorimetric Analysis of a
PEMFC and the Production
of H₂O₂ at the Cathode*

16:50 Katrin Iris Kortsdottir Sebastian Skoog
KTH Chalmers

*The Influence of Organic Impurities
in the Hydrogen Feed of the
Activity of a PEMFC* *Diffusion Barriers to Prevent
Degradation of PEM-Fuel
Cell Membranes*

17:10 Mahdi Darab

NTNU

Synthesis and Characterization of
Platinum/Carbon Electrocatalysts
with Different Techniques

17:30 End of day 2

19:00 Conference dinner and social gathering at Thon Hotel Opera

Thursday November 26

09:00 Session 6 - Chair: Reidar Tunold

09:00 Tor Svendsen Bjørheim
University of Oslo

Prize lecture by the Norwegian Hydrogen Forum's prize winner 2009: *A combined
conductivity and DFT study of protons in PbZrO₃ and alkaline earth zirconate perovskites*

09:30 Anders Ødegård
SINTEF

*Development and Demonstration of an Efficient and Cost Competitive PEMFC System for
Cold Nordic Climate - NORPEM*

09:50 Helge Weydahl
Prototech

A HTPEM Fuel Cell Propulsion System For a Small Passenger Ferry

10:10 Short break

10:30 Session 7 - Chair: Jón Björn Skulason

10:30 Mikael Näslund

Dansk Gasteknisk Center

Danish Fuel Cell Micro Cogeneration Development and Field Tests

10:50 Anneli Ojapalo

Tekes fuel cell

TEKES Fuel Cell Programme Demo2013 – A Broad Demonstration Project in Finland

11:10 Jari Ihonen

VTT

8 kW And 16 kW PEMFC Triple Hybrid System Development and Testing

11:30 Summary - Truls Nordby

11:45 End of conference

Presentation of keynote speakers

Frank de Bruijn, ECN

Frank de Bruijn, born in 1966, studied chemistry at the University of Utrecht, specialising in electrochemistry at the lab of Professor J.H. Sluyters. In 1996, he received his PhD at the University of Technology Eindhoven, at the Laboratory of Chemical Technology of Prof. G.B. Marin. In 1996, he joined ECN, the Energy research Centre of the Netherlands in Petten, working on the development of materials and components for the PEMFC, the Proton Exchange Membrane Fuel Cell. At present, he leads the Unit Hydrogen and Clean Fossil Fuels at ECN, where around 60 people are working on the research and development of materials and components for fuel cell systems, hydrogen production, CO₂ capture and on system integration. In the electrocatalysis group of the SKA group, he is Associate Professor for 1 day in the week, setting up fuel cell related R&D in cooperation with ECN.



norden

Nordic Innovation Centre

Nordic Innovation Centre

Nordic Innovation Centre (NICE) is an institution under the Nordic Council of Ministers facilitating sustainable growth in the Nordic economies.

Our mission is to stimulate innovation, remove barriers and build relations through Nordic cooperation. We encourage innovation in all sectors, build transnational relationships, and contribute to a borderless Nordic business region.

We work with private and public stakeholders to create and coordinate initiatives which help Nordic businesses become more innovative and competitive.

Nordic Innovation Centre is located in Oslo, but has projects and partners in all the Nordic countries.

For more information: www.nordicinnovation.net