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HyNor – The Norwegian Hydrogen Highway

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1 Introduction

Hydrogen is one of the most promising energy carriers which can make the transport sector emission-free. The challenges related to hydrogen as an energy carrier are however not only technical. Due to the nature and purpose of transport, a number of refueling points or hydrogen stations are needed for it to be attractive as a fuel. The cliché “chicken and egg”-situation is often used to describe the dilemma of implementing new fuels such as hydrogen. Without hydrogen stations where people can refuel the cars, it is not profitable to produce the few cars that will be needed. Without many customers asking for hydrogen fuel and very few customers actually using the existing stations, the operators of the station will not want to build more stations due to the economical loss it presents.

Hydrogen has many years been looked upon as an alternative to conventional fuels, either because of energy security and/or environmental reasons. Norway has a long history of hydrogen technology, and especially on the production side, with big actors such as *Norsk Hydro*, making hydrogen from electrolysis for their fertilizer production. The interest for hydrogen has steadily been growing in Norway, already being considered an “energy nation”.

2 The HYNOR Project

In 2003 the interest parties from industry, government, environmental organizations and academia joined forces and initiated the HyNor project. Hydrogen was identified as one, or the one energy carrier which could give clean transport for the future, and a potential for Norway as an energy nation to also play an important part in the future “hydrogen society”. In order to demonstrate that the technology for the hydrogen infrastructure exists and to demonstrate that it is a viable alternative to the already existing fossil-based infrastructure, it was decided to build a “Hydrogen highway” from Stavanger in the west of Norway, along the southern coast, ending in the capital of Norway, Oslo, in the east. This road stretch is 580 kilometers long, and a certain number of sites, or nodes along the way were identified as important for having a hydrogen highway, and being able to drive a hydrogen car comfortably along the route without running out of hydrogen. Separate private-public project groups were established for all the nodes and a steering committee for the project leaders of each node was established to coordinate the efforts.

Figure 1: The HyNor-road with its six nodes. The Agder nodes still remain to be built. (HyNor)

The cities along the road account for more than half than half the population of Norway. The phase I (2003 -2009) project goal was to enable hydrogen driving on this road. On May 11th 2009 the two easternmost stations along the route in Drammen and Oslo were opened. A hydrogen and electrical vehicle rally was held at the opening, the participant cars driving the hydrogen road from Oslo to Stavanger. The rally illustrated the potential of the hydrogen vehicles and hydrogen refueling stations, all of which are publicly available. Three of the stations are multifuel stations with petrol, diesel, LPG and CNG in addition to hydrogen. Although a modern hydrogen vehicle can drive the entire hydrogen road without refueling along the way, in the south of Norway however, two stations still remain to be built to ensure hydrogen availability for a stretch of about 400 kilometers between Porsgrunn and Stavanger.

3 Hydrogen Refuelling in Public Environment

From the construction of the first station and throughout the project, all the hydrogen refueling stations has been designed as public fuelling stations. Three of them are integrated into commercial stations in retail environment, and for two of them they can be operated with a regular credit card. In order to achieve the level of high availability for the public from the start of the project, there has been a very strong focus on safety and commercial interface. Comprehensive training on emergency response and on hydrogen properties and safety has been done for personnel at station.

Another important factor for the HyNor project is demonstrating the various sources of hydrogen that exist, from industrial by-product to reforming of natural gas and biogas, to electrolysis from renewable energy sources. The first station which opened in Stavanger in 2006 has trucked-in reformed natural gas as its source of hydrogen, while the second station which opened at Herøya, Grenland gets hydrogen piped directly from a nearby chlorine-production plant, where hydrogen is one of the bi-products. The stations in Oslo and

Drammen currently get trucked in hydrogen from Grenland, but in 2010 the Drammen station will be provided with locally produced hydrogen which has its origin in biogas. The stations in Drammen and Oslo are also prepared for installing electrolysers locally when the demand gets high enough. As of 2010 all four hydrogen stations in Norway are still available and in normal operation, and are as such permanent stations.

4 Hydrogen- and Battery-electric Vehicle Rally

The rally that was held at the official opening of HyNor in May 2009, the “EVS Viking Rally”, was a three day rally going from Oslo to Stavanger, with many different tests along the way, from eco driving to regularity tests and hill climbs. There were public events at all the stations along the way, and the rally sparked international attention. The finish-line of the rally was right outside the conference hall for the 24th Electrical Vehicle Symposium which was held in Stavanger from 11th to 13th of May 2009. Fifteen hydrogen vehicles participated in the rally. Celebrities such as His Royal Highness Crown Prince Håkon Magnus and Prince Albert of Monaco attended parts of the rally and the event. A new zero emission rally will be held in August 2010.

Figure 2: The opening of HyNor on May 11th. (Statoil)

5 HYNOR Phase II and International Collaboration

The HyNor project continues in a second phase, from 2010 to 2015. During Phase II four additional stations will be included in the project, increasing the density of stations in the Stavanger and Oslo area. There will be a strong focus on acquiring more vehicles, both cars and buses. International cooperation and collaboration will also be intensified, and in November 2009 a memorandum of understanding (MoU) was signed between HyNor and the Californian Fuel Cell Partnership (CaFCP). The collaboration with CaFCP will include

market issues, safety and training of first line responders. HyNor is also part of the Scandinavian Hydrogen Highway Partnership (SHHP), which is a Nordic hydrogen infrastructure project which will enable driving a hydrogen vehicle all the way through Norway, Sweden and Denmark. In addition there will be a focus on adapting the technology used at the stations to what will become the market standards for hydrogen refueling stations.

The HyNor project has laid a solid foundation for further hydrogen projects, and in 2010 the EU-project H2-moves Scandinavia will commence in Oslo. It will lead to the introduction of 17 new hydrogen fuel cell vehicles and one new hydrogen station in Oslo within 2011. In addition there is progress on a bus project which also will be located in Oslo. The realization of the bus project will bring 5 hydrogen fuel cell buses to Oslo, and the final decision of the project will be in June 2010. As such, the increased activity and projects related to HyNor, makes it still more attractive as a project for early introduction of hydrogen as fuel for vehicles.