HyLAW

National Policy Paper - Sweden

Main Author(s): [Bjorn Aronsson]
Contributor(s): []

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1. Introduction and summary

1.1 HyLAW Summary and Methodology

HyLaw stands for Hydrogen Law and removal of legal barriers to the deployment of fuel cells and hydrogen applications. It is a flagship project aimed at boosting the market uptake of hydrogen and fuel cell technologies providing market developers with a clear view of the applicable regulations whilst calling the attention of policy makers on legal barriers to be removed.

The project brings together 23 partners from Austria, Belgium, Bulgaria, Denmark, Finland, France, Germany, Hungary, Italy, Latvia, Norway, Poland, Romania, Spain, Sweden, Portugal, the Netherlands and United Kingdom and is coordinated by Hydrogen Europe.

Through extensive research, interviews and legal analysis, the HyLaw partners have identified the legislation and regulations relevant to fuel cell and hydrogen applications and legal barriers to their commercialization.

This National Policy Paper provides public authorities with country specific benchmarks and recommendations on how to remove these barriers.

1.2 Policy Summary at National level

Looking for a sustainable and decarbonised future for Sweden, hydrogen may be an alternative which allows decreasing the pollution in both the transport and energy sector, at the same time that helps the industry improving their energy efficiency and incomes. However, nowadays hydrogen is the most used industrial gas but generally relatively unknown for the Swedish society.

Sweden had a research programme for hydrogen and fuel cells already in the 1960s, when ASEA (today ABB) had advanced research within the area. In the 1970s a first house hold application was made by a pioneer, Mr Tegstrom, whom used hydrogen for his house and he converted his car to run on hydrogen. Next research programme that took place was the Mistra's Fuel Cell Program that was running since 1997 and was closed June 30, 2010. The program was funded by Mistra (The Swedish Foundation for Strategic Environmental Research) with the amount of 124 million SEK (appr. 12,4 M€) and approximately the same amount was invested by companies participating in the program. 14 companies and 5 universities participated. The program goal was to implement Swedish research, with strong traditions in electrochemistry, into environmentally benign fuel cells for transport, mobile and stationary applications. A unique cooperation between the participants from academy and business was one of the results of the program. New and effective forms of cooperation was developed, where entrepreneurship, role identity, program design and timing was important elements. 25 PhDs graduated and 300 scientific articles was published. Two new fuel cell companies started partly due to the program. The research has supported the development of new products and product concepts such as bipolar plates, electrode materials, polymer membranes and stacks. A fuel cell stack with world class performance was designed and built. Ten inventions were patented.

Sweden has a national target to be the first fossil free nation in the world. Recently the climate law was decided, which stipulates that every national politician is personally responsible for the country's environmental and climate actions and that we as a country will fulfil the decided objectives. A coordinator appointed by the Government has been responsible for leading the different business sectors in their ambition and creation of action plans to reach fossil free processes and products. Totally 22 different action plans will be made and several of them will need hydrogen in order to reach the objectives. Some +100 demo projects have been executed during the last 15 years. The funding has been from FCH JU, CEF, Interreg-programs and national programs together with industry, local/regional public organizations and NGO's. Sweden has currently +100 entities with activity within the sector of hydrogen and fuel cells.

Currently, in Sweden, there are four Hydrogen Refuelling Stations (HRS) developed with private or state funds. There's financing secured for additional nine HRS during the coming two years. The Government has not yet decided on the plan for further deployment of HRS according to the requested plan in the directive for alternative fuels (DAFI; Directive 2014/94/EU) from the EU commission. Refuelling stations (HRS) are included in the scope of the Climate funding program, but the calculation model is designed so no HRS can get funding with current limits. The production of hydrogen via electrolysis processes is free from energy taxes according to a national law. Swedish actors within the hydrogen sector have together with the neighbor countries' actors an ambition to only use hydrogen made from renewable sources.

Sweden has from 1st of July 2018 introduced a bonus-malus system (ref. the French bonus-malus incentive) where zero and low emission vehicles get a bonus at purchase and high emitting vehicles get a malus (penalty) at purchase, in order to introduce more low emitting vehicles on the market. Electrical buses (including fuel cell buses) get at bonus up to 20 % of purchase prize.

By 2050, hydrogen will represent 18% of the total worldwide energy consumption. This would decrease the amount of CO_2 released in the atmosphere by 6 gigatonnes per year and, at the same time, create 30 million of jobs within an industry worth 2.5 trillion dollars annually[1]. [

These estimations, although ambitious, have already began to be implemented in different nations: 400 Hydrogen Refuelling Stations (HRS) are planned in Germany in 2023, in Japan, hydrogen is being seen as the main energy vector of the future with the Olympic games in Tokyo putting hydrogen to the main stage. In France, the national "Plan Hydrogène" proposes to use hydrogen as a key solution for the energy transition of the country, in the US major fleets of hydrogen trucks and a large infrastructure of refuelling stations is under development. These are some of the examples that show that that the world is starting to move towards the hydrogen economy.

[1] Hydrogen Council, 2017

2. Hydrogen Refuelling Infrastructure and Hydrogen as fuel

Hydrogen Fuel Cell Electric Vehicle (FCEV) passenger cars could represent almost 3% of new vehicle sales by 2030 (i.e. 4 million cars sold in 2030), ramping up to 35% by 2050[2]. Hydrogen refuelling infrastructure is essential to a transport sector which allows emission-free, FCEVs to operate. This infrastructure would not only service cars, buses or trucks on public roads as it is also necessary for the refuelling of captive fleets of forklifts and other special vehicles for material handling.

Once hydrogen has been produced and stored it can be used in mobile applications, generating zero emissions when driving. The deployment of Hydrogen Refuelling Stations (HRS), self-standing or integrated in existing refuelling infrastructure will be necessary to refuel these vehicles. Unlike other fuels, hydrogen can be produced on site in the HRS, requiring only electricity and water. This avoids the extraction, refining and distribution stages of fossil fuels and, in addition, retains value creation in the regional area of influence. In this way, by guaranteeing a supply of renewable energy, the whole cycle of hydrogen is zero emission.

2.1. Overview and assessment of current legal framework

Hydrogen mobility requires refuelling infrastructure

Sweden included hydrogen in the directive for alternative fuels (Directive 2014/94/EU) but so far avoided to set targets for an infrastructural roll out. This is now instead done from local and regional ambitions, in order to get to a fossil free transport sector.

In 2018 there are four public HRS in operation and one private HRS to be activated. During 2019-2020 additional nine public stations will be built. Approximately 40 FCEVs are in operation. Another 100 FCEVs will be added to the new nine HRS and five fuel cell buses will be in operation before end of 2020.

There are different pathways to producing hydrogen

Hydrogen as a fuel can be produced by the use of renewable sources when using an electrolyser by the only mean of electricity and water without any harmful emission. The hydrogen produced by electrolysis does not contains impurities as water and oxygen can be the only “pollutants”, therefore, a high degree of purity is easily achievable and its quality can easily conform the quality requirements for fuel cells.

Hydrogen can also be produced by reforming natural gas which has been the leading source of low-cost hydrogen gas for industrial use. The steam methane reformer uses the methane to produce H_2 and CO_2 and this hydrogen may require a purification process to conform further quality requirements for non-industrial use. This hydrogen is not emissions-free but can play a role in early stages before electrolysis becomes widely and economically available.

Renewable, low-carbon hydrogen requires a supporting regulatory environment and certification of origin

The certification and Guarantee of Origin of (renewable, low CO2) Hydrogen as fuel is not yet available. The CertifHy project works in this direction and it is foreseeable that the new European Renewable Energy Directive will define the character of renewable and low carbon Hydrogen at European level, paving the way for the establishment of the guarantee of origin scheme. Independently of the EU status, several countries (DE, DK, BE) have tried to define renewable hydrogen within their national frameworks. A Guarantee of Origin scheme will be needed to determine the carbon emissions of the fuel when it was produced and to promote low carbon hydrogen production at national and EU level.

In Sweden we see potential in the production of low-carbon hydrogen from reforming of biogas, gasification of biomass and from the chemical industrys’ excess hydrogen from different processes.

Regulatory and technical issues for the deployment of hydogen as a fuel

There is currently no separate laws or regulations for the implementation of hydrogen as a fuel and the build out of the refuelling infrastructure. We follow the regulations for the CNG-infrastructure that is up running since 1995 and we use a checklist for the risks where hydrogen differs from methane gas, which is approved as an accepted process for the permission process at the local fire brigades.

In addition, due to the very high purity requirements for hydrogen, standard ISO 14687–2:2012 is costly to implement, measure and enforce. Importantly, purity requirements should be verifiable, which is not the case in Spain. The reason for this is that there are just a few independent laboratories (in the world) who can verify the purity required by ISO 14687–

[2] Hydrogen Council, Scaling up study, November 2017

2:2012. In other words, the purity of hydrogen for FCEV cannot be guaranteed because the required measurements to show compliance with the standard are expensive/not available.

The purity requirements for hydrogen, standard ISO 14687–2:2012 should be followed and we have one institute (RISE) that can verify the purity.

Quality of fuel is an obvious matter of importance, but it should be taken in account in a reasonable way, not detracting the maketing of hydrogen due to extremely technical measures that cannot be satisfied in an economical way today.

The Swedish Government has decided that the origin of fuels should be labled at the refuelling stations and this will be implemented during 2018.

Looking at the whole picture, in absence of a national network of HRS, the manufacturers of fuel cell vehicles do not yet see Sweden as a prioritized market where they can invest, develop and sell their technology in big scale.

2.2. Conclusions

The effective deep decarbonisation of transport involves electrifying all means of transport, either directly using electricity (catenary), storing this energy in electrochemical devices (batteries) or in fuels that act as an energy vector (hydrogen) that subsequently generates electricity on board the vehicles.

In the case of hydrogen, the energy used to produce the fuel must come from local renewable energies, favouring management of the intermittency of these sources, while at the same time retaining the value generation in the regional area of influence and avoiding the external energy dependence based in fossil fuels.

For any of these solutions to work, an appropriate legislation is needed to facilitate the deployment of the necessary infrastructure. To promote the installation of HRS, it is necessary that the concept of hydrogen as an energy carrier is known by the administration and the authorities and furthermore, that the legal and administrative processes to develop such infrastructures are clear and do not produce uncertainty in its development.

Clear legislation in this regard can pave the way to establish our nation as suitable for the development of hydrogen trucks, or for facilitating the logistic warehouses to easily incorporate hydrogen fuel cell forklifts within its fleets. A clear and ambitious legislation will finally promote that the national companies that develop this technology will increase their sales with the result of further cost reductions and increased market share.

2.3. Recommendations

- Make a national plan for the HRS-infrastructure, which is required according to the directive for alternative fuels (Directive 2014/94/EU)
- Secure funding both nationally and within EU for this plan and execute
- Develop the implemented bonus-malus system and make it even more benefitable to use hydrogen as a fuel
- Connect the HRS-infrastructure plan (Directive 2014/94/EU) with the industrial production of hydrogen and the electrical grid system's need of energy storage
- Promote the "green" hydrogen in order to always offer hydrogen produced from renewable energy sources with definitions from the EU level a Guarantee of Origin system
- Investigate the potential in also offering hydrogen for trucks, buses, aircrafts and ships
- Synchronize the potential national HRS-plan with the neighbour countries' similar plans
- Address the authority responsible for verifying the quality of hydrogen as fuel.
  Appoint an authority responsible for hydrogen within the transport sector and the energy sector