SWEDEN

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INTRODUCTION AND BACKGROUND

Sweden has set ambitious energy goals to combat climate change, increase energy security and strengthen the competitiveness of Swedish industry. Today, the production of electricity and heat is free from fossil fuels and greenhouse gas (GHG) emissions to a major extent. Therefore, the greatest potential for reduction in Sweden's GHG emissions is in the transport sector. A target has been set for a fossil fuel-independent vehicle fleet by 2030, as a step towards zero net GHG emissions by 2050. To reach these goals, research and development in clean energy technologies must be prioritised.

Fuel cells using hydrogen as fuel have the potential to contribute to a vehicle fleet independent of fossil fuels. Sweden has well-established automotive companies that have started a technology switch from conventional drive system with combustion engines towards electrification of the drivetrain. In Sweden, the vehicle manufacturers have programs for R&D and demonstration for fuel cells in the area of auxiliary power units (APU) in heavy trucks and range extenders for battery electric vehicles. There are also a number of government-funded research and demonstration programmes wherein research is conducted on hydrogen and fuel cells. The government spends about €2 million ($2.2 million USD) annually on fuel cell and hydrogen projects in Sweden.

UPDATE ON MEMBER'S ENERGY FRAMEWORK

UPDATE ON RELEVANT POLICIES

In 2009, Sweden adopted new energy goals under the "integrated climate and energy policy" framework. The overall energy goals aim to combat climate change, increase the energy security and strengthen the competitiveness of industry. Using 2008 as a base year, Sweden aims for the following energy market improvements by 2020:

- A share of at least 50% renewable energy in gross final consumption and 10% renewable energy in the transport sector
- A reduction of the energy intensity by 20%
- A reduction of GHG emissions by 40%

Sweden has set a target for a fossil fuel-independent vehicle fleet by 2030 as a step of the way towards zero net GHG emissions by 2050.

VITAL STATISTICS

Sweden is a member of the EU but not EMU.

Population

Sweden has a population of 9,753,627 (March 2015) (SCB, Swedish official statistics)

Territory

449,964 km²

Capital

Stockholm

GDP/capita

403,000 SEK or 41,170 EUR

Average Annual GDP Growth

2% average from 2000–2013 (SCB)

Production

Swedish electricity production is almost fossil free where the backbones is made up by hydro-, nuclear and CHP from biomass. Sweden imports almost all liquid energy for transport (electricity for trains and some biofuel production for road transport excluded). The transport sector uses roughly 100 TWh/year.

See data charts at the end of this report for primary energy structure details.

UPDATE OVERVIEW ON RELEVANT PROGRAMS AND PROJECTS

Funding

The Swedish Energy Agency is governed through the Ministry of Enterprise and is responsible for all R&D funding related to energy technology. This mandate encompasses all parts of the energy value chain including horizontal aspects (sustainability and policy measures). The yearly budget for year 2014 was 1400 million SEK ($164 million USD). Most of the budget is intended for financing of basic and applied research in the energy field.

HYDROGEN R,D&D SPECIFICS

PROGRAMS, PROJECTS, INITIATIVES IN BRIEF

Sweden has a number of government-funded research and demonstration programmes that support its national energy goals. An example for hydrogen production is a programme called **Energy gas technology**. This programme includes research and demonstration of production, distribution and storage of energy gases like methane, hydrogen and dimethyl ether (DME). In another programme called **Material technology for thermal energy processes**, research is performed in the area of material technology which enables the efficient use of renewable fuels (biogas, liquid biofuels and hydrogen) for heat and electricity production. Research is also undertaken in **hydrogen production from photosynthezing bacteria and artificial photosynthesis.**

Regarding fuel cells, here is one principal research programme called FFI (Fordonstrategisk Forskning och Innovation - Strategic Vehicle Research and Innovation). FFI is a major partnership between the Swedish government and automotive industry, which includes joint funding of research, innovation and development concentrating on climate & environment and safety in the automotive industry. The FFI roadmap for 2025 includes electric vehicles with longer drive distances, and some fuel cell equipped vehicles. In a competence centre (a collaboration between national industry and universities), research in the field of high temperature corrosion is performed. In this centre, the research aim is development of new materials and processes for more efficient energy conversion technologies, such as fuel cells.

Funding

Overall, the government in Sweden spent around €2 million ($2.2 million USD) on fuel cell and hydrogen projects in Sweden.

STATUS OF MARKET INTRODUCTION OF HYDROGEN AND FUEL CELLS

Sweden currently has two hydrogen filling stations in operation, one in the City of Malmö serving four Hyundai fuel cells vehicles and one in Arjeplog in Northern Sweden at a winter test center for cars. The Arjeplog HRS is used by several car manufactures from different countries all over the world.

Two other hydrogen filling stations are planned and under construction on the west coast of Sweden in the city of Göteborg and one at the Arlanda Airport, the major airport in Stockholm.

PRIVATE INITIATIVES

Three Swedish fuel cells companies are published on the stock market in Sweden: PowerCell, myFC and Impact Coatings.

PowerCell AB

PowerCell is a developer and manufacturer of PEFC fuel cells, diesel reformers and fuel cells systems. They deliver single stacks and complete power packs for transport and stationary applications fuelled with hydrogen or other fuels.

myFC

myFC is a manufacturer and developer of commercial portable fuel cells. The main product today is Powertrekk, which is suitable for mobile phones and laptops and is available on the market in all major electronic stores. A new smaller and more and ergonomic product, JAQ, will be released for sales toward the end of 2015. These products are running on hydrogen produced from a salt (sodium silicide, NaSi), which dissolves on contact with water to produce hydrogen.

Impact Coatings

Impact coating supplies PVD equipment for industrial surface treatment to the component manufacturing industry. They have developed a special surface protection suitable for metallic bipolar plates used in PEFC using hydrogen as fuel. Impact Coating has received a substantial contract from the fuel cell vehicles industry.

- ***Sandvik,*** Sandvik Materials Technology is a developer and producer of special metals and one of their products suitable for fuel cells is a pre-coated strip steel for the production of bipolar plates and interconnectors for different types of fuel cells, such as PEFC and SOFC.
- ***Catator,*** Catator is a specialist in customized catalytic process design including fuel cells systems. Catator has developed a fuel cells system for a small unmanned aircraft.
- ***Cellkraft AB*** is a small company in Sweden that produces robust hydrogen fuelled PEFC. They developed fuel cells for special purposes like APU in harsh climate.

REFERENCES

Swedish Energy Agency – http://www.energimyndigheten.se/en/

Other important websites:

1] Powercell - http://www.powercell.se/
2] myFC AB - http://www.myfuelcell.se/
3] Impact Coatings - www.impactcoatings.com/
4] Gobigas project - http://www.goteborgenergi.se/English/Projects/GoBiGas__Gothenburg_Biomass_Gasification_Project
5] Cellkraft AB - http://www.cellkraft.se/index_en.html
6] Catator – http://www.catator.se/
7] Hydrogen Sweden branch organisation- http://www.vatgas.se/in-english

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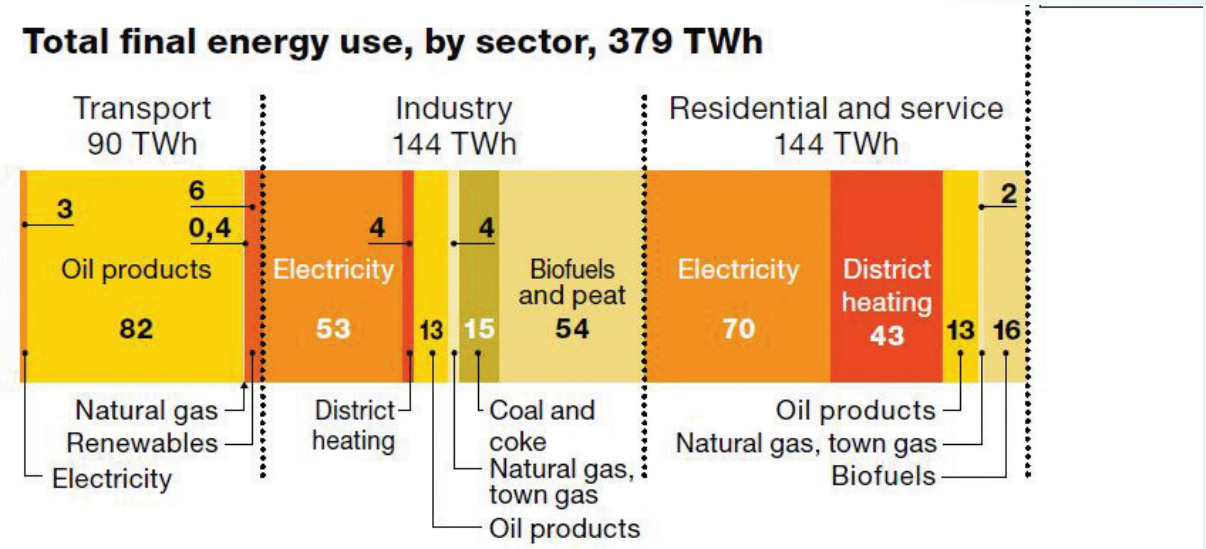
Figure 1 Total energy supply and final use in Sweden in 2011, TWh



Source: Annual energy balance sheets. EN20. Swedish Energy Agency.