Technical Workshop – UNECE Task Force on Hydrogen
Sustainable Hydrogen Production Pathways in CIS countries

Wednesday 23 March 2022
10.00 – 13.00 CEST

On Wednesday 23 March, the United Nations Economic Commission for Europe (UNECE) Task Force on Hydrogen organised a Technical Workshop as part of the project: "Sustainable hydrogen production in the UNECE region and its role in the development of a hydrogen ecosystem and export potential", to discuss opportunities for countries in Eastern Europe and Central Asia to sustainable hydrogen production, trade and development of a regional hydrogen ecosystem.

The technical workshop i) reviewed methods to produce sustainable hydrogen (from renewable energy through electrolysis, from nuclear power, from gas with CCS and from coal with CCS); ii) discussed cost and technical performance of various hydrogen production pathways in CIS countries; and iii) identified economic, technical, policy and investment barriers to hydrogen projects.

UNECE Work on Hydrogen

- Hydrogen could account for up to 12% of global energy use by 2050. UNECE data from the Carbon Neutrality project shows that hydrogen will play an important part in energy transition and that all sustainable hydrogen productions technologies will play a role.
- Now it is important to define the right priorities to kick-start a hydrogen ecosystem and start developing required hydrogen infrastructure.
- UNECE Task Force on Hydrogen was initiated by the UNECE Group of Experts on Gas, the Group of Experts on Renewable Energy and the Group of Experts on Cleaner Electricity Systems. This community of experts developed a technology brief on hydrogen that assessed the whole hydrogen value chain and assessed various technology production pathways.
- Subregional project on sustainable hydrogen production pathways of which implementation this workshop is a part. The project aims to assess national potential to contribute to development of a hydrogen ecosystem and to explore what are the opportunities for hydrogen export potential as well as domestic applications. More subregional activities will follow this spring/ summer.
- UNECE Task Force on Hydrogen also started exploring the regulations around GOH (Guarantee of Origin for Hydrogen) and more work will be done later this year.

Technology lead presentations. All presentations are available here

Hydrogen from renewable energy: Constantine Levoyannis, Head of EU Affairs, NEL Hydrogen

- Hydrogen technology is catching up on the maturity curve with solar and wind power.

- Growth in renewable hydrogen is expected to accelerate decrease in capex for electrolysers and planned investments in the hydrogen sector by 2030. Electrolysers market by 2050 is expected to be $50-60bn.
- Drivers of cost reduction for renewable hydrogen include: electricity c.70%, capex c.15%, project financing c.9% and O&M c.5%
- Two main issues remain an obstacle to its development: the manufacturing cost of electrolysers and unclear regulatory framework.
- 21 countries have published a hydrogen national strategy. There is a gap in Eastern Europe and Central Asia.
- There is a global commitment to increase the electrolysers capacity to achieve targeted production goals. The total commitments announced are equal to an increase of electrolyser capacity to 38.5 GW by 2030.
- There is a challenge in pushing for a standardization of electrolysers to reduce system cost and enable $1.5/kg Hydrogen since the cost is already affected by the electricity price.
- European Union aims to increase the production of hydrogen by 10 million tons by 2030 and imports 10 million more tons of hydrogen. This will lead to the creation of 80 GW of electrolysers capacity (doubled the size of original 50 GW target).
- Electrolysis needs development of sustainable energy sources and to have a clear certification as such for primary energy sources such as biomass.

Hydrogen from nuclear power: Dr Philip Rogers, Technology Leader of the National Nuclear Laboratory of the United Kingdom

- Nuclear power can be complementary to renewable energy technologies
- For countries that decided to deploy nuclear power there are wide properties of nuclear power to produce hydrogen
- Nuclear power can be used to produce hydrogen through electrolysis
- Nuclear power could be used with steam electrolysis; this production pathway could be ready in 2030 since the commercial technologies are in development and is expected to improve efficiencies by 40 %
- Heat and electricity produced by nuclear power can also be used in SMR (Steam Methane Reforming), this would significantly reduce carbon intensity compared to SMR pathway from fossil fuels
- The heat from nuclear power could be used to produce hydrogen through elevated temperature thermochemical reaction; this technology is still in R&D (Research & Development) and is planned for 2040
- Nuclear power produces flexible electricity to grid provided by electrolyser coupling.
- Cost is highly dependent on financing arrangement; it represents 60 % of nuclear power plants' cost
- A project in Saudi Arabia has been successful in achieving a 99% conversion efficiency through solid oxide electrolysis.
- Safety and waste remain a challenge for a scaled nuclear power deployment

Hydrogen from natural gas: Dr Yuriy Melnikov, Hydrogen Expert, Skolkovo School of Management

- Steam methane reforming (SMR) from natural gas is currently the most commercially developed technology for large-scale hydrogen production, but it requires CCS to become zero-carbon
- Oxygen can be used as an input instead of air for combustion through *Autothermal methane reforming* which leads to more concentrated CO2 emissions and an easier and more efficient CCUS deployment.
- Scaled hydrogen from natural gas with CCS will require long-term storage of captured CO2; 20% of the 40 million tons of CO2 captured today is sent to long-term storage - the rest is used for enhanced oil recovery (EOR)
- One CCUS pathway is the production of solid carbon through elevated temperatures, but it does imply long term storage issues: the production of 5 million tons of hydrogen led to 60 million tons of solid carbon.
- Pyrolysis is a promising technology, but there are issues with technological readiness, scaling, cost and carbon utilization. The process requires high temperatures (more than 800 °C; the optimum level for a non-catalytic process is 1100-1300 °C)
- Hydrogen from natural gas can be low-carbon under certain conditions and its certification
- An LCA (lifecycle analysis) implies that electrolysis should only be used if powered by low carbon energy sources otherwise it produces more CO2 emissions than SMR with CCUS.
- There is a consensus on the fact that renewable hydrogen will start to be as competitive as CCUS hydrogen cost wise in 10 to 40 years.

Hydrogen from coal: Dr Andrew Minchener, General Manager for International Centre for Sustainable Carbon

- Coal currently accounts for 27 % of the hydrogen demand.
- According to IEA, the demand for hydrogen, including hydrogen from coal, will follow an exponential curve by 2050
- Hydrogen can be produced through coal gasification where coal is heated at high temperatures with oxygen to produce syngas, which is then upgraded through water gas shift reaction which allows to separate CO2 from hydrogen.
- Costs vary due to local factors, fuel price, renewable energy, load factor, learning rates and carbon taxes. Hydrogen from coal gasification with CCUS as low as US$1.6/kg to US$2.4/kg
- Carbon intensity of Hydrogen from coal with CCUS (90 % capture rate) can be limited to 3kgCO2/kg H2
- Examples from Asia Pacific show that there is no prejudice of hydrogen type and all low-carbon hydrogen technologies are encouraged
- Examples from North America illustrate high technology readiness facilitate market creation in specific sectors (transport and industry)
- Near term actions are required to overcome barriers and reduce costs
- Role of hydrogen valleys and industrial clusters to establish longer term signals to promote investor confidence and stimulate commercial demand
- Examples: Humber project UK, Porthos NL, Northern Lights NO, NyNet UK

Dialogue with project beneficiary countries

Kazakhstan

- In Kazakhstan, all types of hydrogen will play a role thank to its infrastructure and abundant natural resources.
- Kazakhstan is committed to achieve carbon neutrality by 2050 through its Roadmap Transition towards Green Economy by 2050. This also includes the development and the deployment of a hydrogen development strategy. The government aims to increase share of renewables from 3% in 2020 to 30% in 2030 and 50% in 2050
- Short-term: pilot projects focusing on mobility with the deployment of hydrogen powered vehicles and hydrogen fueling stations. (Cooperation with Airliquide) and creation of hydrogen competence centers and laboratories to support national R&D activities
- Mid- to long-term: enhancing domestic hydrogen applications in heating and industry
- These projects need a different policies framework than the one in the European Union due to different technology levels and needs as well as level of the institutional capacity.

Uzbekistan

- Uzbekistan is at the stage of reforming its energy sector
- The country has vast potential in solar and wind resources, gas, coal and nuclear. As a major global uranium exporter, Uzbekistan started developing a nuclear power plant with 2.4GW capacity
- Natural gas is widely deployed in Uzbekistan. 15% of transportation in Uzbekistan is already using natural gas station. This provides a solid base to launch hydrogen application in transport sector
- Uzbekistan could become a hydrogen exporting country through the use of its already existing natural gas infrastructure.

Tajikistan:

- Mountainous country with vast hydro potential which currently accounts for about 98% of country's electricity generation.
- Still, the power supply is vulnerable to supply shocks and seasonal shortages that provide strong drivers for the development and deployment of alternatives
- The government is currently trying to exploit domestic coal reserves to diversify the national energy mix and is also recognizing the potential of hydrogen (incl synthetic fuels) from coal
- Development of hydrogen in Tajikistan could be impacted by electricity costs variations. There is a need for a more resilient energy system and energy connectivity and an integrated energy system could enable it.

Turkmenistan:

- In May 2021, the government published the presidential strategy for low carbon energy and hydrogen on a global scale, an export-oriented strategy.
- The first step toward this strategy is developing international cooperation in innovative technologies of which hydrogen was identified as one of the key priorities.

- Turkmenistan started drafting of a national Roadmap for the development of international cooperation in the field of hydrogen

Armenia:

- Armenia is currently vastly dependent on imports of fossil fuels, but country has a vast hydropower and solar potential; the basis of the *Scaling up renewable energy program for Armenia*
- Armenia reaffirms its interest in hydrogen as a solution to decarbonize its energy system as the government is currently developing the solar power infrastructure
- Need for a clear policy framework to allow full development of the renewable energy and hydrogen potential

Azerbaijan:

- Azerbaijan has played a historically important role as an oil producer. Most of its hydrocarbon production comes from offshore fields in the Caspian Sea. The country's largest hydrocarbon basins are located offshore in the Caspian Sea.
- Azerbaijan has been a net exporter of natural gas since 2007. Most of Azerbaijan's natural gas exports are shipped through Georgia to Turkey through the South Caucasus Pipeline (SCP)
- In October 2021, the Energy Ministry presented a green legislative package which includes the use of wind energy potential of the Caspian sea. The significant potential of offshore wind energy can enable hydrogen production in Azerbaijan. However, the country yet has to develop its national strategy.
- Azerbaijan can benefit from its large pipeline infrastructure to export hydrogen; via the Trans Adriatic Pipeline (TAP).

Belarus:

- Belarus sees hydrogen as economically viable energy that could provide cleaner electricity and fuel.
- It also affirms its willingness to build on its natural gas infrastructures and pipelines network to support hydrogen export
- Potential of production green ammonia through hydrogen has been recognized and could be scaled based on current infrastructure
- Developing Thermochemical Hydrogen production technology by 2050 is one of Belarus' current objectives

Next steps

- Policy dialogue, April 2022 at Annual Resource Management Week, information to follow
- Analysis on hydrogen potential in Eastern Europe & Central Asia, April – June 2022, analytical work launched
- Subregional technical workshop, June 2022, to review preliminary findings from the analytical work