March 2017

Institute for Sustainable Process Technology

Power to Ammonia: From renewable energy to CO_2-free ammonia as chemical feedstock and fuel

ISPT and its partners in the Power to Ammonia (P2A) project have recently successfully concluded a feasibility study into the storage of renewable energy in ammonia (NH_3) for three business cases.

Driven by ambitious CO_2 reduction targets and increasing production of renewable energy (e.g., wind and solar), parties in the energy sector, together with chemical industries, are looking for innovative ways to produce CO_2-free ammonia and use this ammonia to balance supply and demand without having to revert to fossil-fuel-based generation of electricity. The study shows that the electrochemical production of ammonia from renewable energy is a likely option and also offers a very promising solution for large-scale seasonal storage and import of renewable energy.

The benefits of ammonia

The idea is simple: at times when or at locations where there is a surplus of renewable energy, it can be converted via electrolysis into hydrogen and finally into ammonia. Ammonia can be stored and transported as a liquid. Thanks to its high energy density, transportation and storage of ammonia in large volumes is more feasible than, say, hydrogen. What's more, the chemical industry can use this ammonia as a renewable feedstock for the production of fertilizers and other products. Applications could even include wind turbines that provide electricity solely for the sustainable local production of ammonia. Such facilities do not need to be linked to the electrical grid, which would eliminate the need for expensive power cables.

Collaboration

"The great thing about this project is that it brings together all relevant parties in the value chain," says Hans Wiltink of ISPT, leader of the P2A project, which ran for a year. "Innovations like this cannot be brought about by just one or two players. Agreements need to made on the technology, the business case, financing, and the way in which parties collaborate in the chain. Who is going to play which role? The renewable energy generated needs to be transported, converted into ammonia, stored, and finally used again as chemical feedstock or fuel for a power plant – it's a long chain, involving many different companies and new types of collaboration."

Sustainable super battery

The feasibility study included a business case in an industrial setting at the new high-efficient gas-fired Magnum power plant operated by energy provider Nuon in Eemshaven, in the north of the Netherlands. The aim of this case study was to find out whether ammonia from renewable energy could be used as an alternative fuel to natural gas to generate electricity in the plant. "As an energy company, Nuon is very interested in carbon-free fuels for our plants, as well as new ways of storing electricity," says Geert Laagland, Head of Engineering at Nuon. "By storing local surpluses of renewable energy in ammonia, we can turn our power plant into a sustainable super battery. In addition, we're interested in the option of importing sustainably produced ammonia from renewable electricity sources in remote locations. Another option is to produce CO_2-neutral ammonia from natural gas near remote gas fields and inject the CO2 back into the subsurface nearby these fields."

ISPT
Institute for Sustainable Process Technology

Ammonia as a chemical feedstock
Ammonia produced from renewable energy can also help the energy-intensive chemical industry to move towards more sustainable ways of working. "If we can use 'renewable' ammonia as the primary feedstock for our fertilizer and melamine production, we can significantly reduce our CO_2 footprint," says Ruud Swarts, Technology Manager at OCI Nitrogen. "Electrolysis can currently not compete with conventional ammonia production. However, the P2A study has shown that the technology could be competitive in 10 to 15 years' time, particularly if current trends such as increasing renewable electricity production and rising CO_2 prices can be combined with innovative business models. Of course, there are still many hurdles to be overcome. By setting up pilots for this new technology, we can identify these and find ways to solve them."

Alleviating the grid
For grid owners a major advantage of producing ammonia from wind and solar power will be that investments in the grid can be reduced. If the share of wind and solar power increases without energy storage, the investment required to increase grid capacity will be substantial. "P2A enables energy to be stored for periods of days, weeks or even months," says Guy Konings, Market Manager at Joulz. "Substantial amounts of electricity can be converted into ammonia when needed, providing enormous flexibility in the grid."

Getting ready for the future
Just increasing the generation of wind and solar energy will not be enough to achieve our national CO_2 reduction targets in the coming decades. The P2A feasibility study shows that ammonia can play an essential role in achieving these targets, by offering opportunities for the production of CO_2-neutral ammonia and using this ammonia for storage of renewable energy. Gas-fired power plants could soon be made more sustainable by importing CO_2-neutral ammonia from abroad for immediate use. Local storage of surplus renewable energy in ammonia will probably be technologically feasible by 2030, when the supply (and surplus) of renewable energy is likely to be much higher than today. By giving power to ammonia, we're getting ready for a sustainable future.

You can read the full report here.

About ISPT
The Institute for Sustainable Process Technology unites industry, universities, research organizations and SMEs in order to accelerate innovation and ultimately transform process technology into a green, clean, efficient endeavour. In addition to developing knowledge, the Institute fosters the demonstration and application of new technologies. More information: www.ispt.eu.

About Power to Ammonia
Power to Ammonia is a partnership between ISPT, Stedin Infrastructure Services, Nuon, ECN, Delft University of Technology, University of Twente, Proton Ventures, OCI Nitrogen, CE Delft and Akzo Nobel. The Power to Ammonia project is unique in bringing the energy sector, industrial companies and knowledge institutes together to enable the transition to a sustainable energy supply. The project received a Top Sector Energy subsidy from the Dutch Ministry of Economic Affairs.