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Press release

Use of green methane in transport and power generation – researchers and industry present interim results of the MethanQuest project

- New technologies for producing gas from renewable sources -– from PEM to direct seawater electrolysis
- Testing of hydrogen, methanol and methane for use in ships, cars and power generation
- Sector coupling concept with LNG hub and microgrid in Rhine port of Karlsruhe

The flagship project MethanQuest was launched in September 2018, and on it a total of 29 partners from research, industry and the energy sector have come together to work on processes for producing hydrogen and methane from renewables and for using them to achieve climate-neutral mobility and power generation. The project participants have now submitted their interim results. These relate to electrolysis systems for producing hydrogen, both on land and in offshore wind parks, equipment for producing methane, the use of gas engines in cars, ships and CHP plants, and concepts for energy systems that efficiently couple the transport, electrical power, gas and heating sectors. Common to all plant and processes is the integration of renewables.

“One of the demands of the energy revolution is that we find innovative solutions for using renewables to make new fuels for mobility and power generation. So it’s essential to identify future trends in technology at an early stage and promote their development. We recognized such an upcoming innovative technology back in 2018 and began to provide funds for it. We have been supporting the MethanQuest research project for over two years now and the interim results it has reported show valuable findings that will strongly contribute to the progress of the energy transition,” said Norbert Brackmann, Member of the German Bundestag and Federal Government Coordinator for the maritime industry. Over the period 2018 to 2021, the German Federal Ministry for Economic Affairs and Energy (BMWi) is providing19 million euros in funds to the MethanQuest project.

“Hydrogen and methane manufactured using renewable energy resources (e-methane) are set to play an important role. The energy revolution will see, for example, the electrical power supply becoming increasingly dependent on flexible gas-fired power plants in order to compensate for the fluctuations that the use of renewables involves. Furthermore, LNG is beginning to gain a foothold as a new marine fuel,” reported project coordinator Dr Frank Graf from the DVGW-Research Center, part of the Engler Bunte Institute at the Karlsruhe Institute of Technology.

New technologies for producing gas from renewable sources -
From PEM to direct seawater electrolysis

Six subprojects are working on the numerous research projects of the MethanQuest project, which is being led by DVGW and the Rolls-Royce business unit Power Systems. The MethanFuel group is researching into new processes for manufacturing methane out of renewables. All the technologies involved – from water electrolysis to CO_2 extraction and methanation – have been examined and enhanced.

AREVA H2Gen, in collaboration with its project partners Fraunhofer ISE und iGas energy, has developed an innovative PEM electrolysis system which is being tested over a period of nine months in the Höchst industrial park. PEM electrolysis, in which hydrogen is produced using electrical power generated from renewables, is the first step in the Power-to-Gas process. Flexibility is required in terms of the system's power requirement – hence it is operable with up to 2.3 MW as well as with a low partial load without running the risk of premature wear and tear or damage. That means that draw-off of electrical power for hydrogen production can be selected according to the current demand and related prices. In this way, the PEM electrolysis system can be deployed economically and to support power grid stability.

Meanwhile, the TU Berlin (Technical University of Berlin) is looking to the more distant future. To enable hydrogen to be produced in offshore wind parks in very high quantities, it would be highly advantageous if the seawater could be electrolyzed directly. The TU Berlin has now successfully developed and tested an efficient concept which makes the process feasible without the need to desalinate the seawater in advance.

Plant produces 10 m^3 of methane per hour

The steps involved in converting hydrogen into methane have been successfully demonstrated by MethanQuest partner DVGW and the Engler-Bunte-Institut, Teilinstitut Chemische Energieträger - Brennstofftechnologie (EBI ceb) of the Karlsruhe Institute of Technology. Firstly, a long-term experiment in capturing CO_2 from the air has been conducted. Furthermore, a new catalytic methanation plant produces some 10 m^3 of pure methane per hour and also displays excellent dynamic load behavior. That is a significant advantage when it comes to dealing with the supply fluctuations involved in using electricity produced from renewables.

Testing of hydrogen, methanol and methane for use in ships, cars and in power generation

In the three sub-projects MethanCar, MethanPower and MethanMare, the partners are working on engines capable of combusting renewable gas highly efficiently without producing harmful by-products. A car engine powered by methane which was built under the leadership of Ford is currently being put through its paces. The primary focus lies on achieving high efficiency and on developing exhaust aftertreatment strategies for the Otto engine.

Coordinated by Rolls-Royce Power Systems, the MethanPower group are currently investigating a concept involving a large-sized innovative Otto engine fueled by hydrogen. Used in power generation, the aim is for this engine to achieve the power density of a natural

gas engine with minimum emissions. The researchers are delighted by the results so far – hydrogen combustion produces few noxious emissions and achieves high power densities. That opens up possibilities for using previously unharnessed surpluses from renewable energies to stabilize the power grid in a decentralized setting.

The sub-project MethanMare is concerned with the energy revolution in the maritime sector and shows how fuels manufactured from renewables can be used to support it. Research has found that with the use of catalyzers and an extremely complex technique for high-pressure gas injection, emissions from a methane-powered ship engine can be lowered by up to 80% compared with those of a conventional gas engine. The systems are being tested for their resistance to aging, and catalyzer regeneration measures examined. Furthermore, CO_2 emissions could be further reduced by optimizing piston and injector nozzle geometry.

Tests have also shown that methanol combustion in large high-speed engines gives rise to low contaminant emissions (nitrogen oxides and particulates) and zero methane emissions.

LNG hub concept for Rhine port

The MethanGrid group has conceptualized an LNG hub for the Karlsruhe inland port which takes the form of a multi-functional system of e-methane storage and distribution. Firstly, the hub secures at regional level the supply of LNG to ships navigating the Rhine. Furthermore, the hub can also be used to supply trucks and larger distribution points with LNG, and also support the high-pressure gas network in Baden-Württemberg for peak load coverage.

Microgrid simulates sector-coupling in Karlsruhe inland port

In collaboration with Rolls-Royce Power Systems and other partners, the DVGW Research Center has also developed a complete locally coupled energy supply system for the Karlsruhe inland port facility. Electricity, gas, heating, industry and transport – in other words, all the current sectors – are coupled by means of this microgrid so that the available energy, including renewables, can be optimally exploited. The microgrid is currently being tested in simulated scenarios using real data from the port facility and other components. This will enable the final development of a concept that is practical to implement.

The interim results provided by the MethanSys sub-project show how possible developments in e-methane across the whole of Germany's energy system can be comprehensively modeled and evaluated along with the gas infrastructure.

"The partners of the MethanQuest lead project are very satisfied with the results so far. The additional findings expected by the end of the project in fall 2021 will shed light on the topic of renewable methane in a holistic manner - from costs and feasibility to environmental and climate impact," explains project coordinator Dr. Manuel Boog, who works in technology development at Rolls-Royce Power Systems.

Info-box e-methane/ Power-to-Gas

E-methane can be produced using electricity made from renewable sources – otherwise known as the 'Power-to-Gas' process. E-methane is simple to store and use at a later date, thereby facilitating a CO_2-neutral energy cycle. The basic principle is as follows: Renewable energy sources such as wind or solar are used to generate electrical power. In the

electrolysis process, this electrical power is used to break down water into its components (hydrogen and oxygen). Using the hydrogen, and carbon-dioxide from the air (CO_2 capturing) or from biomass, plus further energy input, synthetic fuels such as e-methane, e-diesel and e-methanol can be manufactured.

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