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Innovations in renewable gases

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Hydrogen transport in the natural gas network

The Fraunhofer Institute IKTS has developed a technology that allows hydrogen and natural gas to be separated cost-effectively and efficiently. The applied membrane technology makes it possible to transport the two gases together through the natural gas network and separate them at the destination. Carbon polymers are applied as an extremely thin layer on a porous ceramic carrier material and serves as a membrane that separates natural gas and hydrogen. The pores in the carbon have a diameter of less than one nanometer, making them well suited for gas separation. The separation behavior of the membrane can be further adjusted by physical and chemical processes. The smaller hydrogen molecules are forced through the pores of the membrane and escape to the outside, while the larger methane molecules are withheld. In this way, a hydrogen with a purity of 80 percent is produced. The remaining natural gas residues is separated in a second stage to achieve a purity of over 90 percent. Fraunhofer IKTS researchers are currently working on scaling up the technology so that larger volumes of natural gas and hydrogen can be separated.

More in German

48 plants jointly produce biomethane

In Bitburg (Rhineland-Palatinate), the longest biogas collection pipeline (45 km) has been built. It transports raw biogas to a joint processing plant. With a newly built biogas pipeline, the joint venture company "Biogaspartner Bitburg" will in future bundle the raw biogas deliveries of up to 48 biogas plants in the region. The 45-kilometer pipeline will transport the gas to a central processing plant at the commercial, service and leisure center at the service and leisure center at Bitburg airfield. There it is refined to natural gas level and fed into the gas network as biomethane. The shareholders are SWT Stadtwerke Trier, the private waste management company Luzia Francois and Landwerke Eifel AöR. The

plant network has a total potential of around 10,000 cubic meters of raw biogas per hour - which corresponds to an annual volume of around 64 million kilowatt hours. With this volume, a good third of the annual demand for natural gas can be met of the nearby district town of Bitburg (population 14,000). Since May 2020, initially seven plants have been feeding their biogas to the upgrading plant.
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Underground Sun Conversion: sustainable storage for the future renewable energy system
This project is based on the "Underground Sun Conversion" (USC) technology developed by RAG Austria AG in collaboration with BOKU, Vienna and represents the next step in implementing this new, innovative and unique storage technology. Underground Sun Conversion involves injecting CO_2 and H_2 into a porous underground gas storage facility (a depleted gas reservoir), where microbial methanation has been found to occur, meaning the biological conversion of CO_2 and H_2 to methane (CH_4), the main component of natural gas. This parallel conversion/storage technology, which is based on renewable gas, enables seasonal storage of large volumes of energy, which will not only enhance the stability of European energy networks and energy supply, but is also essential for ensuring that the continent's energy mix includes a higher proportion of (gaseous) renewables. The project will provide a first estimation of the potential for geological storage of energy in Switzerland using the "USC FlexStore" approach. In collaboration with Swiss energy supplier Energie 360° and research partners (Wiva, BOKU Vienna, Empa, University of Bern, OST) the project will tackle one of the biggest challenges facing the energy system of tomorrow: how to store fluctuating generation of renewables such as wind and solar power while at the same time maintaining high levels of security of supply, especially in winter, when the possibility of generating power is low and demand is high.
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Separation of Hydrogen from natural gas
The gas infrastructure is compatible with regenerative gases and also supports a range of applications for hydrogen. It can be proportionately blended and transported in the natural gas network for supply to the mobility sector, industry and heating market as demand dictates. But this hydrogen needs to be removed for applications that cannot tolerate a gas mixture. This issue is being tackled by a joint project between ONTRAS and five partner companies, which is investigating the use of membranes to separate natural gas and hydrogen. A pilot plant was erected in Prenzlau, Germany for this purpose. The plant allows to evaluate the best membranes for recovering hydrogen, the quantities that can be separated from the gas flow and the degree of purity that this hydrogen reaches. The hydrogen concentration is variable from 0 to 20%.
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Repsol produces renewable hydrogen using biomethane
Repsol has produced renewable hydrogen using biomethane as a raw material for the first time. The renewable hydrogen was used to manufacture fuels with a low carbon footprint, such as petrol, diesel, or kerosene for aviation. Ten tons of renewable hydrogen was produced at Repsol's Cartagena Industrial Complex from 500 MWh of biomethane, preventing emissions of approximately 90 tons of CO_2. The biomethane used as a raw material was obtained from urban solid waste. Through this process, Repsol replaces conventional natural gas with biomethane of sustainable origin to produce renewable hydrogen in its industrial complexes, therefore decarbonising its processes and products. The first industrial tests carried out by Repsol will also serve as an example for developing the system of guarantees of origin for renewable gases to be implemented in Spain.
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The Role of Sequential Cropping and "Biogas done right"
A recent article published by Ghent University in collaboration with the EBA and Consorzio Italiano Biogas shows that with appropriate innovations in crop management, sequential cropping could be applied as feedstock for biomethane production in different agroclimatic regions of Europe,

contributing to climate and renewable energy targets. In Italy, sequential cropping has been applied in more than 600 farms through a new model for sustainable food, feed and biogas production, called Biogas done right™. However, little is known on the potential to expand the practice in other regions of Europe. The study confirms a minimum realistic biomethane potential of 46 billion m^3 per year that could be unlocked by the anaerobic digestion of sequential crops, and a maximum potential of 185 bcm/year when using 60% of the arable land in Europe.
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Ductor's first commercial fertilizer product certified organic
Ductor's High Nitrogen Liquid Fertilizer is now available and approved for organic production by the California Department of Food and Agriculture (CDFA). The new fertilizer of the Finish/Swiss company offers a directly plant available form of Nitrogen. The production has started in Ductor's first plant in Juanita, Mexico and the product is now available in the US with a plan to soon start marketing around the world. Ductor's unique two-step biogas process allows to produce renewable energy, high-nitrogen liquid fertilizers and organic NPK fertilizers that support farmers improving soil health and soil fertility.
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Getting hydrogen out of banana peels
There are currently three main methods for converting biomass into gaseous energy: anaerobic digestion, gasification and pyrolysis. Anaerobic digestion is a microbial process producing methane, carbon dioxide and a fertilizer, gasification converts solid or liquid biomass into gas and solid compounds at temperatures around 1000°C. The gas is called "syngas" while the solid is "biochar". Biomass pyrolysis, is similar to gasification except that biomass is heated at lower temperatures, between 400-800°C, and at pressures up to 5 bar in an inert atmosphere. Recently, scientists at EPFL have developed a new method for biomass photo-pyrolysis that produces not only valuable syngas, but also a biochar of solid carbon that can be repurposed in other applications. The method performs flash light pyrolysis using a Xenon lamp, commonly used for curing metallic inks for printed electronics. The lamp's white flash light provides a high-power energy source as well as short pulses that promote photo-thermal chemical reactions. This flashing technique was used on different sources of biomass: banana peels, corn cobs, orange peels, coffee beans and coconut shells, all of which were initially dried at 105°C for 24 hours and then ground and sieved to a thin powder
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High-purity hydrogen produced from biogas
Graz University of Technology (TU Graz) in Austria and start-up Rouge H2 Engineering have produced high-purity hydrogen from biogas directly at a biogas plant. It is a sustainable process for decentralized hydrogen production, the so-called 'chemical-looping hydrogen method'. The research results led to a compact on-site on-demand plant that can produce hydrogen from biogas, biomass, or natural gas. Rouge H2 Engineering and TU Graz built a first demonstration plant on the company's premises in Mureck. The 10kW plant diverts around 1% of the biogas flow (approximately 30 liters per minute) of the Styrian company Ökostrom Mureck and mixes it with steam. The mixture flows into the plant's reactor. There, the biogas is reformed and syngas produced. This gas subsequently reduces iron oxide to iron. Then steam enters the reactor, which deoxidizes the iron back to iron oxide – releasing hydrogen with a purity level of 99.998%.
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First plant in Switzerland will produce liquid CO_2 from biogas
The regional energy distributor (RWB) and Recycling Energy are building a CO2 liquefaction plant in Nesselnbach, Switzerland. The turn-key plant is delivered by Hitachi Zosen Innova. The carbon dioxide produced during the purification of raw biogas will then no longer be blown into the atmosphere, but upgraded and liquefied. The CO2 will then be bottled and sold for industrial use, such as for the production of dry ice, in medical technology or as carbon dioxide for beverages. Construction of the

plant will start in in spring 2022. Production is scheduled to begin in fall. This is the first project that has been implemented in Switzerland to date in which CO2 is the focus and sold as a product. The new plant will be integrated into the existing biogas production plant, where gas is extracted from food waste. Recycling Energy produces raw gas there, which is refined by RWB and fed into the gas grid as biogas. The new plant is large, in the the size of a shipping container and two twelve-meter-high washing towers and two twelve-meter-high tank containers. The CO2 extracted from the purification process will be collected by the industrial gas company Messer Schweiz and sold on the national CO2 market. The new plant captures around 90 percent of the CO2 produced. That is up to 3,000 tons of CO2 per year.
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BioCarbonics seeks AD operators to explore green CO2 opportunities
Anaerobic digestion (AD) plant operators are being offered a new opportunity to benefit from an 'innovative' carbon capture and utilisation (CCU) model, proposed by BioCarbonics. The UK-based green CO_2 company has created a new channel to market for the biogas industry to enable CO_2 captured from biogas facilities to be taken to market. Green CO_2 produced from biogas has a higher reliability of supply and is a more sustainable product than traditional CO_2 derived from fossil fuels. In addition, capturing and utilising this CO_2 contributes to the Renewable Heat Incentive sustainability criteria for AD plants and can boost the bottom line with long-term offtake agreements. Biogas owners capture and process their CO_2 stream to produce a food and beverage quality liquid CO_2, for use by local businesses. Hereford works with UK cider-maker Westons Cider, which supplies its biogas plant with apple pomace – a by-product from apple pressing. The company uses BioCarbonics' CO_2 to carbonate its drinks.
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How CNG engines react to H_2
Biogas and synthetic methane can already be fed into the existing gas infrastructure without any problems. However, incorporating hydrogen into the existing gas network has its limitations. An increase will require a gradual adaptation of both the infrastructure and end users. In particular, underground gas storage facilities, CNG vehicles, gas turbines, stationary gas engines and industrial or domestic gas appliances need to be adapted. Today, CNG vehicles must have a hydrogen tolerance of two percent by volume, which is ensured by the H_2 tolerance of the tank system and the fuel specifications, meaning that no higher an H_2 value is offered at filling stations. Various studies have shown that an admixture of up to 10 percent by volume of H_2 would be feasible for large parts of the gas network. Experts have now analysed five transition scenarios with different H_2-methane mixtures in order to identify the most cost-efficient transformation method possible. In the case of vehicles, it became clear that the use of flexifuel is feasible in principle for all defossilisation scenarios. However, the expected additional costs increase where the maximum H_2 content is used and are largely determined by the tank system. A higher proportion of hydrogen in the grid leads to a significant reduction in the costs of producing renewable gas. However, they shift the majority of the subsequent costs from the infrastructure to the manufacturers of vehicles and engines. Methanation and membrane separation could offer an economical alternative to vehicle and gas station adaptation.
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