Unique research project to investigate underground storage of wind and solar energy

Utl: Federal Minister of Transport, Innovation and Technology Alois Stöger, Managing Director of the Austrian Climate and Energy Fund Theresia Vogel and RAG Chief Executive Officer Markus Mitteregger open the Underground Sun Storage test facility in Pilsbach, Upper Austria

(Vienna and Pilsbach, 5 October 2015)

- **Growth in solar and wind power generation demands sustainable solutions for seasonal energy storage**
- **Large underground gas storage facilities already safe and reliable**
- **Power to gas technology enables conversion of surplus electricity into hydrogen or methane – Underground Sun Storage project to look into storability of hydrogen as an additive to natural gas and synthetic methane in pore reservoirs**

For the first time, a research project will investigate the possibility of storing wind and solar power at a former gas field. The storage project is based on power to gas technology, which converts electricity generated in this way into a mixture of methane and hydrogen.

The project was granted EUR 2.8 million by **the Austrian Climate and Energy Fund established by the Ministry for Transport, Innovation and Technology,** as part of its energy research programme. The research project should be completed in 2016, at a total cost of EUR 4.5 million.

Federal Minister **Alois Stöger** commented: “Research facilities like this one make a valuable contribution to implementing developments in renewable energy technology, one of our key focus areas. Energy research represents a vital investment for the future and strengthens Austria’s position as an industrial location. It also plays a part in ensuring safe, environmentally friendly and affordable energy supplies.”

Theresia Vogel, Managing Director of the Austrian Climate and Energy Fund, said: “The Climate and Energy Fund’s energy research programme supports essential technological breakthroughs and reductions in the cost of Austrian energy technologies. The power to gas facility in Pilsbach is a milestone that sends a clear signal beyond Austria’s borders, and will deliver key insights for the energy system of the future.”

RAG CEO **Markus Mitteregger** explained: “Gas can be transported in large quantities safely and out of sight via existing underground infrastructure, and held in environmentally friendly natural gas storage facilities that are also already in place. Austria’s geology is ideal for underground storage, so the country is able to make a major contribution to security of supply.”
Solar and wind power output is erratic because of changing weather conditions, meaning that generation cannot be adjusted in response to demand as is the case with conventional

power stations. In some parts of Europe, such as the north of Austria's Burgenland province, the amount of power generated by wind farms is already well in excess of demand on windy days. With wind and solar generating capacity growing fast, energy storage is becoming an increasingly pressing issue. And even Austria's pumped storage plants in the Alps are no longer sufficient to meet this need.

Power to gas has been widely discussed as a potential solution to the storage problem for some time. The technology uses surplus solar and wind power to split water into oxygen and hydrogen. The hydrogen can then either be directly injected into the gas grid, or converted into methane – the main constituent of natural gas – by means of a methanation process using carbon dioxide. At present direct hydrogen admixture is the more economic option, due to its higher efficiency and the shortage of suitable sources of carbon dioxide. However, up to now there has been no research into the effects of hydrogen on the storage capacity employed by natural gas infrastructure – the underground storage facilities.

An **Austrian consortium led by RAG** has addressed this issue, and is carrying out research into underground storage of a mixture of hydrogen and synthetic methane in the test facility that has now opened.

Markus Mitteregger added: "The results from laboratory tests conducted as part of the project have been very promising, and have fed into implementation of the test facility. We are even more excited about the data and insights that operating the new installation will generate."

RAG's project partners are the **University of Leoben**; the **University of Natural Resources and Applied Life Sciences, Vienna**; the **Energy Institute at Johannes Kepler University Linz**; **Verbund**; and **Axiom Angewandte Prozesstechnik**.
The project partners from outside Austria are **Nafta** (Slovakia), **Etogas** (Germany), the **German Technical and Scientific Association for Gas and Water**, or DVGW (Germany), and **Hychico** (Argentina).

Further information and a video about the project can be found at www.underground-sun-storage.at.

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Background information on the project partners

RAG

Rohöl-Aufsuchungs Aktiengesellschaft (RAG) is Austria's oldest oil and gas exploration and production company. One of its core business activities is energy storage. RAG has developed and operates its own storage facilities at Puchkirchen and Aigelsbrunn. A joint venture between RAG, Gazprom and Wingas operates the Haidach gas storage facility, and another, with E.ON Gas Storage, runs the 7Fields storage facility. Both facilities straddle the border between the provinces of Salzburg and Upper Austria.

Through its own storage capacity, which now totals about 5.8 billion cubic metres, and its activities as an operator, RAG makes a major contribution to security of supply in Austria and Central Europe as a whole. RAG is currently the fourth biggest gas storage operator in Europe.
The company sees itself as a partner for renewables and also develops geothermal energy projects.

RAG's role in the Underground Sun Storage project
RAG is the lead company and biggest investor in the group that is undertaking this pioneering project. The experienced RAG staff on the Underground Sun Storage project team provide access to the company's extensive expertise in developing and commissioning underground storage facilities.
RAG will mainly be concerned with developing, building and operating an experimental facility for underground storage of renewable energy converted into a mixture of methane and hydrogen. Experts from RAG are also involved in all of the other work packages that make up the project. They are assisting with the provision of test materials, and verification of the relevance of the laboratory tests and simulations to real-life reservoir conditions.

Montanuniversität Leoben (University of Leoben)

As the leading academic project partner, the University of Leoben will contribute fundamental research and simulations. It will use laboratory experiments and proprietary simulation software to investigate the geochemistry and model the reactive transport processes concerned. Possibilities for de-mixing hydrogen and natural gas will be tested in long-term experiments on a set of three pressurised reactors filled with porous materials. The influence of the hydrogen-methane mixture on the properties of the materials used in pore storage facilities (cement and various grades of steel) will also be examined in laboratory experiments. In addition, a risk assessment will be performed to identify and evaluate the potential risks of underground hydrogen storage. Finally, a life cycle assessment will determine the environmental impacts of viable hydrogen storage scenarios.

University of Natural Resources and Applied Life Sciences, Vienna
Department for Agrobiotechnology, IFA Tulln
Institute of Environmental Biotechnology

The institute's Geobiotechnology and Chemodynamics working group under Prof. Andreas P. Loibner brings microbiology expertise to the project, offering extensive experience in the scientific description of microbial consortia and their metabolic capabilities. Research is carried out into microbial processes that take place underground, which are then evaluated in terms of their potential commercial use. As part of the Underground Sun Storage project, the group is examining microbial communities in natural gas storage facilities, and assessing microbial changes in the gas and in storage reservoirs following the addition of hydrogen. Insights gained from laboratory experiments (work package 3) will feed into implementation of the field trial (work package 8).

Energy Institute at the Johannes Kepler University (JKU) Linz
Role of the Energy Institute at the JKU Linz in the Underground Sun Storage project

The Energy Institute is responsible for the economic, systems analysis and legal research related to the Underground Sun Storage project. Legal analysis is required to establish how existing legislation may apply to storing hydrogen underground and, once the findings of the technical tests are available, to draw conclusions as to the need for any changes in the law. The economic and systems analysis is intimately connected with an examination of the technical aspects of the project. This project component will consist of detailed investigations of means of integrating the technology within the existing industrial and economic environment, and an assessment of these options, as well as the likely systemic effects of the technology, based on the outcomes of technical and commercial analyses. A range of alternative solutions will also be considered as part of the economic and systems analysis.

Verbund

Verbund is Austria's leading power company and one of Europe's largest producers of hydroelectricity. The company was established in 1947 in Vienna and has operations in power generation, transmission, trading and sales. Verbund has been a listed company since 1988, and is 51% government-owned.
Approximately 90 percent of its electricity comes from climate-friendly hydropower, making Verbund a reliable supplier of clean energy in Austria and Germany. The remainder of the generation mix comprises wind power and solar thermal installations generating heat and power.

Verbund's role in the Underground Sun Storage project

The energy sector is currently in the throes of a massive transition. Long established structures, based on central generators and decentralised consumers, are disintegrating. Decentralised power generation is gaining ground, at the expense of the traditional business model whereby energy is delivered to consumers. This is affecting the entire energy system, including the power generation mix, the networks that locally produced energy is increasingly being fed into, and the attitudes of consumers, who are becoming keen to produce and store their own energy. Larger-scale consumers, boasting increasingly mature technology, from heat pumps and photovoltaic arrays to local battery storage systems and electric vehicles, are also entering the picture. In collaboration with the Energy Institute at the Johannes Kepler University Linz, Verbund is examining the economic implications of power to gas as

part of the Underground Sun Storage project. A range of application scenarios will be explored and assessed.

Axiom

Axiom Angewandte Prozesstechnik was founded in 1992 as a specialist in industrial applications of membrane technology. Besides employing reverse osmosis technology in water purification projects, Axiom carries out intensive research into gas permeation technology, and has secured numerous patents.

In a joint research project with Vienna University of Technology's Institute of Chemical Engineering, Axiom developed new applications for membrane gas separation. These included the recovery of helium and hydrogen, the separation of carbon dioxide from natural gas, as well as biogas treatment. Axiom has steadily extended this area of its expertise, and has applied it with great commercial success, becoming a major supplier for the membrane gas separation process and a leading innovator in the field. Axiom sees membrane technology as one of tomorrow's key technologies.

Background information on the funding body

Austrian Climate and Energy Fund

The Climate and Energy Fund was set up by the Austrian Ministry for Transport, Innovation and Technology. The fund's energy research programme promotes research and technology development initiatives that bring together science and business. The focus is primarily on energy efficiency and conservation, renewables, innovative mobility and transport technologies, smart grids and storage. Since 2007 the fund has invested a total of EUR 322 million in some 800 energy and mobility research projects. An additional EUR 35 million will be invested as part of this year's energy research programme. Storage-related projects have received around 10% of the total research grants, or around EUR 33 million, which has been used to promote R&D into innovative storage technologies.