Having Sustainability in Mind: Lithium from the Upper Rhine Graben for Batteries

Research Project on the Use of Deep Geothermal Energy to Extract the Raw Material – Funding Is Granted by the Federal Ministry for Economic Affairs and Energy

View into the interior of the geothermal plant in Bruchsal. (Photo: EnBW/Uli Deck)

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Worldwide demand for lithium is increasing. The raw material is much sought-after in particular for e-mobility. To meet this increasing demand, production of lithium by deep geothermal energy plants has been discussed for some years now. Some pilot projects are being carried out at the moment, among others in the Upper Rhine valley. The Federal Ministry for Economic Affairs and Energy has now decided to fund the UnLimited project for the setup of a pilot facility at the geothermal power plant in Bruchsal by EnBW Energie Baden-Württemberg AG as consortium leader in cooperation with Karlsruhe Institute of Technology (KIT), BESTEC, HYDROSION, and the University of Göttingen.

Current demand for lithium in Germany is met completely by imports. However, consumption is increasing, as lithium-ion batteries are also needed for mobile and portable applications. Geothermal plants all over the world sometimes pump up deep waters with high lithium concentrations. This gives rise to the question of how lithium could be extracted. The project UnLimited (German acronym of studies for lithium production from hot deep waters in Germany) is aimed at

developing the technical and economic basis required for lithium production from hot deep waters in Germany.

Domestic Production Opens up Alternatives for Supply Chains

“The water tapped in Bruchsal is relatively rich in lithium, the concentration being about 150 mg/liter water,” says Professor Jochen Kolb, Head of the Geochemistry and Economic Geology Group of KIT’s Institute of Applied Geosciences. Although it will not cover total German consumption, this domestic production will open up alternatives for supply chains and reduce the environmental impact. “Short transport paths, flexibility in supplies, supply security, and expanded supply chains: We will use geothermal waters much more efficiently,” says Kolb, “with the side effect of giving geothermal energy an economic boost.”

At the Bruchsal geothermal plant that has been jointly operated by EnBW and the Bruchsal municipal utility company since 2010, deep water is used to produce heat and power and returned into the reservoir after thermal use. Together with the water pumped, about 800 tons of lithium chloride per year are extracted and returned unused. Within the framework of a previous project, EnBW together with KIT developed a sustainable lab-scale process to extract the lithium dissolved in the deep water.

“These laboratory studies make us feel optimistic. We have proved that lithium extraction is technically feasible. Now, the next step is technical implementation under real conditions and determination of economic efficiency on a larger scale,” says Dr. Thomas Kölbel, geothermal energy expert of EnBW. “Our plant in Bruchsal is operated in a closed loop. This means that neither gases nor liquids are released into the environment. Now, we want to demonstrate sustainable and environmentally compatible production on the industrial scale.”

Efficient Use of Lithium Contained in Thermal Waters

Previous studies revealed that thermal waters have increased lithium concentrations in the Northern German Basin and in the Upper Rhine Graben. Deep water with a temperature ranging between 160 and 180°C is pumped from layers between 3,000 and 5,000 meters depth. Then, this water is passed through a heat exchanger. This exactly is the point of intervention of the scientists. They install an ion sieve that is run parallel to geothermal plant operation. “An economically reasonable extraction process may improve the profitability of such plants,” Kolb says. At the laboratory, such processes reach an

efficiency of about 85 to 95%. Under real conditions, an efficiency of about 70% is envisaged.

Lithium for 20,000 Batteries Might Be Extracted in Bruchsal

The project is aimed at extracting lithium from geothermal water on a pilot scale parallel to plant operation. Every geothermal plant located in the Upper Rhine Graben pumps about 30 to70 liters of water per second to the surface. “Within about 40 minutes, the amount of lithium needed for a battery could be extracted,” Kolb says. “The amount of lithium extracted within about two minutes would be sufficient for an e-bike.” Based on about 8,000 operation hours per year, the amount of lithium extracted by the geothermal plant in Bruchsal would be sufficient for the production of about 20,000 batteries.

“By means of an extensive reservoir analysis, we want to prove sustainability and economic efficiency of lithium extraction from the deep water together with our project partners,” says Dr. Jochen Schneider, Managing Director of HYDROSION GmbH. “Another important aspect is the quality of lithium and the fact that no harmful wastes are released into the environment.” Lithium extraction from a renewable energy source must meet highest environmental standards and it is absolutely necessary to transparently inform the public about the process, he emphasizes.

To estimate the lithium amounts in the geological underground, knowledge of the release processes of lithium in the geothermal reservoir and the dimension of the reservoir (circulation volume) is required. To quantify the lithium load, geoscientists of Göttingen University apply methods to study hydrogeochemical processes at the interface of solid rock and circulating fluid. For this purpose, the distribution of stable lithium isotopes is used.

Project costs amount to about EUR 3.4 million. The Federal Ministry for Economic Affairs and Energy funds the UnLimited project with EUR 2.7 million.

Being “The Research University in the Helmholtz Association,“ KIT creates and imparts knowledge for the society and the environment. It is the objective to make significant contributions to the global challenges in the fields of energy, mobility and information. For this, about 9,300 employees cooperate in a broad range of disciplines in natural sciences, engineering sciences, economics, and the humanities and social sciences. KIT prepares its 24,400 students for responsible tasks in society, industry, and science by offering research-based study programs.

Innovation efforts at KIT build a bridge between important scientific findings and their application for the benefit of society, economic prosperity, and the preservation of our natural basis of life. KIT is one of the German universities of excellence.

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