

Research News

August 3, 2026

Page 1 | 3

Decarbonization in industry

Energy-Efficient Electric Drying With Superheated Steam

Industrial drying processes consume large amounts of energy and negatively impact the climate since they burn fossil fuels to heat air. Researchers at the Fraunhofer Institute for Interfacial Engineering and Biotechnology IGB are working with industry partners on a new approach to decarbonize this process: Instead of hot air, they are using superheated steam. Combined with a heat pump and smart controls, their superheated steam drying process saves significant amounts of energy and eliminates the need for natural gas.

Drying is a key process widely used across many sectors, including the paper, cement and chemical industries. It is a key step in the production, processing and treatment of minerals, food or detergents, for example. Countless materials, products and raw materials are dried to preserve them, allow further processing or maintain their quality. Current drying processes rely on hot air. Researchers at Fraunhofer IGB are now taking a different approach: In the LowCarbDry project, they are replacing hot air with superheated steam at atmospheric pressure while electrifying the drying process using a heat pump. The team is working closely with Evonik Operations GmbH and Pergande Group on this development. The aim of the project is to significantly lower energy consumption and support energy systems integration by shifting from fossil fuels such as natural gas to renewable electricity. By using electricity-generated superheated steam, the partners aim to reduce drying energy demand by a factor of 2 to 4, depending on the drying method and temperature level.

Superheated steam lowers energy consumption

“Industrial drying uses a significant amount of energy. During hot-air drying, the air must be heated for the moisture to evaporate. This usually involves burning natural gas, which dramatically increases carbon emissions. But most importantly, some of the energy is lost to the atmosphere through the warm exhaust air,” says Antoine Dalibard, a research scientist at Fraunhofer IGB. “Instead of drying moist products with hot air, we use superheated, dry steam in a closed-loop system. Closing the process gas circuit minimizes heat loss to the outside, making the process more energy efficient than traditional hot-air drying methods,” Dalibard explains. The excess steam released from product drying can then be condensed. This produces condensation heat at a temperature of about 90 to 100 °C, which can be re-used for many other processes or fed into a local heating network.

Increasing the share of green electricity while further reducing operating costs

August 3, 2026

Page 2 | 3

Using a heat pump, the process can be further electrified, saving energy, increasing energy efficiency and reducing operating costs. “The heat pump increases the temperature of the low-temperature steam from the drying process so the heat can be reused in the further drying process,” Dalibard explains. Recovering heat in this way can further boost the energy efficiency of an industrial plant. Using superheated steam as a drying medium also allows for the integration of a special type of open heat pump: a system based on mechanical vapor recompression. Compressors raise the pressure of excess steam generated during the drying process. The compressed steam is then condensed and reused to provide the heat required for drying, resulting in significantly improved energy efficiency.

When combined with an innovative control system, the plant can operate the drying process more flexibly: Model predictive control allows the system to run only when electricity is cheap thanks to high renewable energy availability. This increases the share of renewable electricity while further lowering operating costs. Together, these three innovative approaches—steam drying, heat pumps and greater flexibility—reduce energy consumption by up to 80 percent, significantly decarbonizing industrial drying processes.

Superheated steam technology can be used in a variety of dryers, including belt, drum and spray dryers. “We have already tested our drying process in a wide range of applications. The process enabled us to dry mineral raw materials, construction materials, organic residues, along with food and animal feed, while preserving product quality and maintaining high energy efficiency,” says Dalibard. The project partners have already put pilot systems for superheated-steam spray drying into operation.



Fig. 1 Using electricity-generated superheated steam instead of hot air for industrial drying processes can drastically lower energy consumption. © Fraunhofer IGB



Fig. 2 Superheated steam enables energy-efficient and gentle drying of a wide variety of products such as lime, straw, couscous or insect larvae. © Fraunhofer IGB

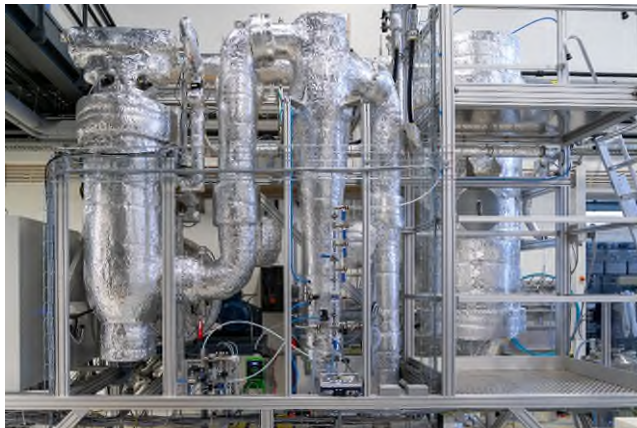


Fig. 3 The project partners have already commissioned a pilot system for superheated-steam spray drying as part of the LowCarbDry project. © Fraunhofer IGB

The Fraunhofer-Gesellschaft, headquartered in Germany, is one of the world's leading organizations for applied research. It plays a major role in innovation by prioritizing research on cutting-edge technologies and the transfer of results to industry to strengthen Germany's industrial base and for the benefit of society as a whole. Founded in 1949, the Fraunhofer-Gesellschaft currently operates 74 institutes and research units throughout Germany. Its roughly 30,000 employees, predominantly scientists and engineers, work with an annual business volume of 3.6 billion euros; 3.2 billion euros of this stems from contract research.

Contact

Contacts

Monika Landgraf

Fraunhofer-Gesellschaft, Munich
Director of Corporate Communications
Phone: +49 89 1205-1333
presse@zv.fraunhofer.de

Claudia Vorbeck

Fraunhofer Institute for Interfacial Engineering and Biotechnology IGB
Head of Marketing and Communications
Phone +49 711 970-4031

claudia.vorbeck@igb.fraunhofer.de

www.fraunhofer.de

