Biomass-driven technology allows for enhanced energy conversion

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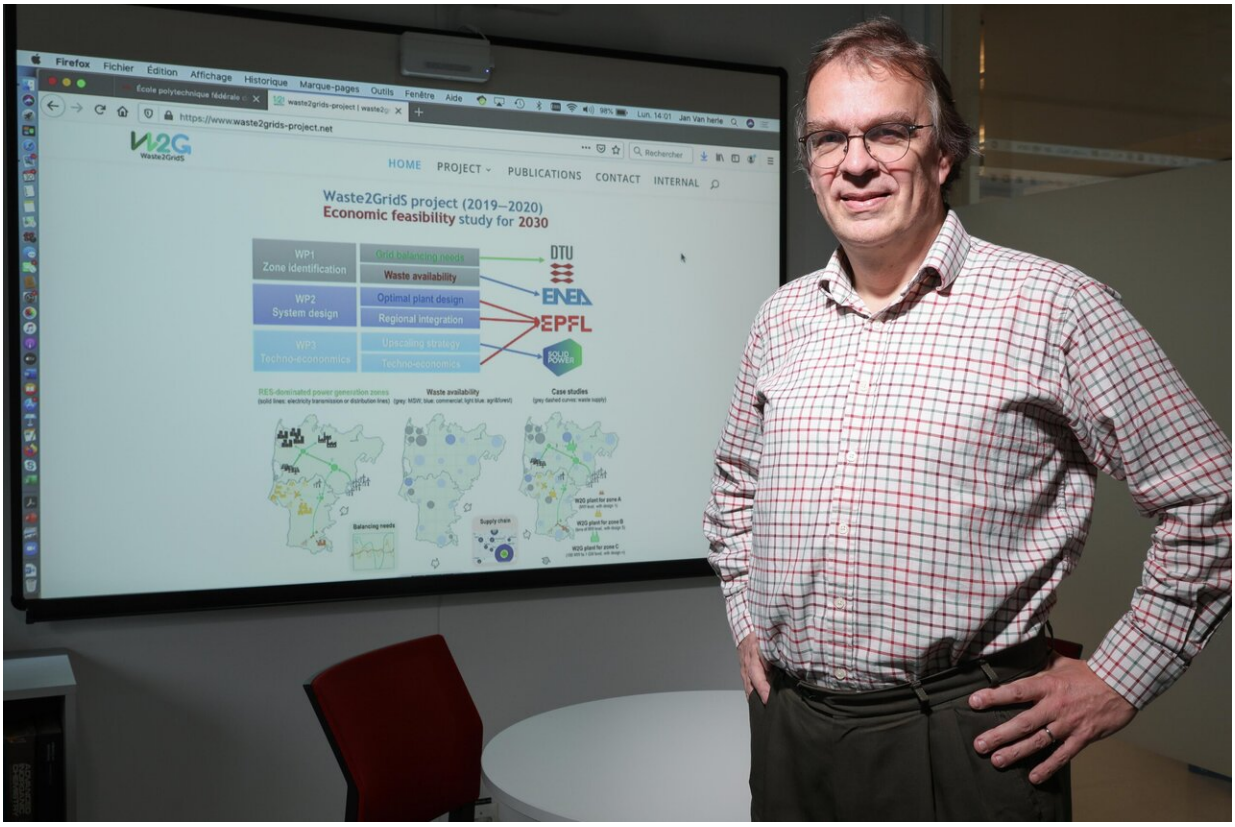

This study was coordinated by EPFL's Group of Energy Materials (GEM), based in Sion and directed by Jan Van Herle. Credit: EPFL

Organic waste—whether from households, agriculture or agroforestry—can be used as energy resource, but is often

underexploited. A team of EPFL scientists has developed a methodology to better incorporate this resource into existing power grids and gas distribution systems, depending on local availability and demand.

Many energy resources are available locally, like biomass from households, farms and agroforestry operations, but how can we make the best use of them? Scientists at EPFL's Group of Energy Materials (GEM), based in Sion, set out to answer this question with an energy-optimization approach that can feed both power grids and gas pipelines. Their system uses a gasification process to turn biomasses into hydrogen, and further into methane, with the help of reversible solid-oxide cell technology (rSOCs). GEM scientists are specialized in this technology, which can both store electricity as methane (Power2Gas) and convert the methane back into electricity—with high yields in both directions.

Biomass refers to all matter that is organic: wood, agricultural waste, food waste, manure, etc. It served as the main energy source for mankind before the industrial revolution led to the widespread adoption of fossil fuels (carbon and then oil/gas), and still accounts for 10% of global primary energy supply. Biomass is considered a renewable energy source as long it is produced in at least the same quantity as it is consumed, without net deforestation nor competition with food production. It is used in the form of biofuels, for generating heat, electricity, gas and various chemicals and cosmetics.

Completely reversible technology

The GEM scientists' idea was to identify the optimal configurations for biomass plants operating at a scale between 1 MW and 100 MW, in a multi-purpose mode: to generate power fed into the electrical grid in case of electricity demand; when there is no demand for electricity, to produce hydrogen and/or methane (the main component of natural gas) and inject it into the natural gas grid.

"Our study aims to come up with the optimal design for a biomass plant and its organic-matter supply chain," says Maria Perez Fortes, a GEM scientist. "We applied our approach for the conditions in two countries: one in Denmark, representative of northern Europe, and one in Italy, representative of southern Europe. In both cases, we assessed the needs of the local power grid, how much and what kind of biomass streams are locally available, what the associated transportation costs are, and a number of other factors. Our goal was to develop an effective grid-balancing approach that relies more heavily on renewable energy, consuming power when the supply is high (to store it as gas) and generating it when the supply is low. That's why we decided to use reversible solid-oxide cells –the only technology that can switch seamlessly between electricity and gas production."

The advantages of the proposed system configuration are its flexibility and continuous operation, in either of the production modes, thereby eliminating plant shutdowns. It can be used to generate or store electricity or natural gas, and can adjust supply to meet demand. The system can be particularly useful in conjunction with other local renewable-energy systems (like solar panels and wind farms) that are dependent on weather conditions, to cover any gaps in power production. By providing a method for adding local biomass streams to power grids and gas pipelines, GEM's methodology can optimize power and gas distribution networks and and their coupling, secure a steady supply of electricity that is adjusted to demand in real time, and enable utilities to manage their assets more efficiently.

More information: EPFL's Group of Energy Materials (GEM): www.epfl.ch/labs/gem/

Waste2GridS project's page: www.waste2grids-project.net/