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High-capacity hydrogen-based green-energy storage solutions for grid balancing

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Energy storage is becoming a critical issue to balance and integrate larger shares of fluctuating renewable energy and improve power grid reliability and efficiency.
Hydrogen energy storage represents a viable option to increase carbon-neutral energy supply due to its high energy density and reversibility, however its widespread adoption is yet to come until the actual concerns on safety and transformation costs will be solved.

Objectives

The four year INGRID R&D European project aims at researching and demonstrating how and to a what extent the combination of solid-state high-density hydrogen energy storage and advanced ICT technologies for real time monitoring and control of smart distribution grids will be able to balance highly variable power supply and demand, in a scenario of large penetration of intermittent distributed renewable energy sources.

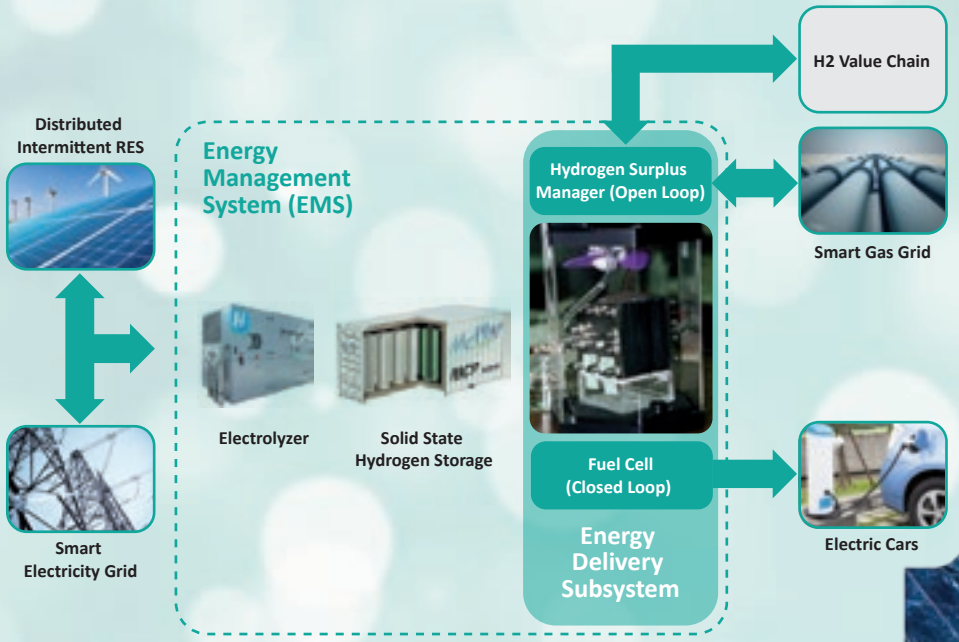
INGRID is positioned at the forefront of the research on **hybrid multi-carrier energy systems**, which are emerging as an effective option to successfully integrate larger shares of electricity from distributed RESs and optimize at higher system level the efficiency of the energy distribution, through the supply of carbon-neutral energy, either electricity or gas.

Vision and concept

The INGRID concept is for a cyber-physical system node which will optimally manage real-time damping of power fluctuations through a solid state hydrogen-based energy storage system. The **Energy Management System (EMS)** is the software stack which manages the INGRID node, and is in charge of decoupling intermittent RESs from power and gas distribution networks.

EMS main roles are to supervise and control power production from nearby RESs, manage power surplus stored as hydrogen and optimize energy delivery as hydrogen surplus through either a fuel cell serving local electric cars charging (Closed Loop operation), either injecting hydrogen into a close gas network, biomass plant, or in a gas turbine (Open Loop operation).

The INGRID Green Hydrogen Energy Storage system (GES) includes: i) **a Water Electrolyzer (WE)** connected to the RES generator working as a controllable load while producing hydrogen to alleviate the power network congestion ii) the **Hydrogen Solid Storage (HSS)** subsystem which will store the hydrogen flowing out from the WE as solid state metal hydrides. **Magnesium Metal hydrides**, which provide higher volumetric density than compressed or liquid gas, will be used for the hydrogen storage with clear advantages in terms of safety, stability, modularity, higher density, reversibility, ramp up time iii) an **Energy Delivery Subsystem** which will be in charge for the optimal supply of the energy discharged as hydrogen surplus by the HSS among the electrical or hydrogen value chains.



The INGRID project will be demonstrated through the design, deployment and the operation of a 39 MWh energy storage real life demonstrator located in Puglia, the Italian region with the largest RES portfolio. Such facility includes an hydrogen energy storage installation with more than 1 ton of safely stored hydrogen and a novel fast responding 1.2 MW electrolysis hydrogen generator and will provide smart balancing support for the local distribution power grid.

Thanks to the INGRID expected outcomes, intermittent renewable energy sources will be operated continuously, without the need of shutting down them when upward power distribution networks become too much congested.