

# Dates and events

## Next:

**London (UK), December 12-14, 2016**

The 2016 edition of the multidisciplinary World Congress on Sustainable Technologies (WCST). WCST-2016 conference theme is Sustainability and Policy.

## Past:

**Lisbon (Portugal), June 26-30, 2016**

INGRID project has been presented at the Energy 2016 Conference through the paper "Multi-objective Optimization of Energy Hubs at the Crossroad of Three Energy Distribution Networks"

**Bari (Italy), June 23-24, 2016**

INGRID project has been presented in the workshop "Smart Mediterraneo. Best practices, innovation and pilot projects in smart grid development in the Mediterranean region", organized by the European Commission Joint Research Centre Institute for Energy and Transport.

**Portoroz (Slovenia), June 7-9, 2016**

INGRID project has taken part at the first SEERC Conference through the paper "Simulation-based analysis of the potentiality of incentives for prosumer flexibility".



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# Newsletter

## Consortium

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| <b>Engineering Ingegneria Informatica</b><br>(coordinator) | <a href="http://www.eng.it">www.eng.it</a>   |   | Italy   |
| McPhy Energy S.A.  | <a href="http://www.mcphy.com">www.mcphy.com</a>   |  | France  |
| Hydrogenics  | <a href="http://www.hydrogenics.com">www.hydrogenics.com</a>   |  | Belgium |
| Tecnia   | <a href="http://www.tecnalia.com">www.tecnalia.com</a>   |  | Spain   |
| RSE  | <a href="http://www.rse-web.it">www.rse-web.it</a>   |  | Italy   |
| Enel Distribuzione   | <a href="http://www.enel.it/it-IT/reti/enel_distribuzione/">www.enel.it/it-IT/reti/enel_distribuzione/</a> |  | Italy   |
| ARTI   | <a href="http://www.arti.puglia.it">www.arti.puglia.it</a>   |  | Italy   |
| Studio Tecnico BFP   | <a href="http://www.studiobfp.com">www.studiobfp.com</a>   |  | Italy   |

## Imprint

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Project Web Site: <http://www.ingridproject.eu>



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## Editorial by ARTI

Welcome to the fourth issue of the newsletter of INGRID, the 7FP strategic project dealing with high-capacity hydrogen-based green-energy storage solutions for grid balancing. The newsletter will introduce you to main advances of the project, its consortium and some of the technologies used.

## A FOCUS ON THE INGRID DEMONSTRATOR BY ARTI and Studio Tecnico BFP

Civil works at the INGRID demonstrator started in April 2016 and they are almost concluded. The INGRID demonstrator has been installed in Troia Municipality, in Puglia. Puglia is a region located in the South-East of Italy, with about 4 million inhabitants, which can be considered an excellence in the green economy in the Mediterranean area, thanks to favorable climatic and market conditions and a long administrative and political work on these subjects. It is ranked in the first positions among the Italian regions in renewable energy production (except hydroelectric). Such leadership has been achieved in less than a decade: the ratio between electricity consumption and electricity production from renewable sources increased from 0.5% in 2000 to about 40%. Moreover, Puglia region is the second electricity producer (after Lombardia) in Italy and the first exporter

since nearly half of the electric energy produced in situ is exported (91.4% surplus). This has an important impact on the transmission and distribution grid. In the city of Brindisi where conventional plants are located and where electricity is sent to the north (Bari) and to the south (Salento region) several problems of congestion exist. Congestion problems are also common in the interconnection with Campania region. A different type of problem experienced in the region is the presence of large areas where reverse flows exist. Reverse flow indicate the fact that electricity is flowing from the distribution grid (lower voltage levels) to the transmission (higher voltage levels). The interested areas by these issues are those where a higher concentration of renewable sources is installed (Foggia and Salento areas). In Troia Municipality the electricity reverse flow

highest among the regional primary substations (62%). Troia is indeed a small municipality (7.000 inhabitants) characterized by the presence of several big wind farms and PV plants, connected to MV network. For this reason, Troia administration is very oriented to further development of storage and electric balancing systems and is supporting the INGRID project offering for free the land where the demonstrator is being realized. The regional administration, with the support of its Agency ARTI, has strongly supported INGRID and it is really interested in energy storage and smart grids. The world energy paradigm is changing and with it the Apulia region as well. Smart grids are indeed essential in this transformation, as a quote of president Barack Obama well summarized: "A nation that can't control its energy sources can't control its future".



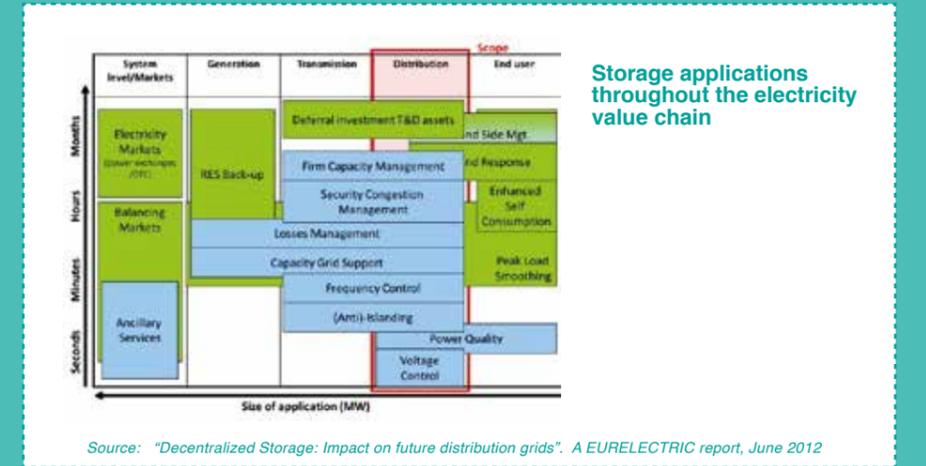
## A FOCUS ON TECHNOLOGIES DSO AND STORAGE TECHNOLOGIES BY E-DISTRIBUZIONE

Electric Storage Systems (ESS) are plants connected to the network able to absorb, accumulate and release electrical energy. The absorbed energy is converted into a form suitable to be easily stored and again, when necessary, converted into electricity and fed back into the network, given that electrical energy as such cannot be stored easily and must therefore be used in the same time when produced.

In the last decade the generation from renewable energy sources (RES) has acquired a primary role and ESS are currently used to address the issues in the modulation of power generation which are related to the specificity of RES, not always available and sufficiently predictable. A distinctive feature of the RES boom is that it has impacted heavily on distribution network by many micro and mini plants. Correspondingly ESS are adapting with installations of similar size, available for the prosumers to optimize the production of their facilities. Nevertheless, the dispersed generation paradigm involves a new role even for the DSO. The Distribution Operator must ensure full use of existing RES facilities and the hosting capacity for future ones, avoiding network congestion, unjustified curtailments in production and delays in the entry into service of new plants. ESS are an essential tool for carrying out these tasks, also able to improve efficiency of power transmission and voltage quality.

Hence the commitment of e-distribuzione (the new name recently taken by ENEL Distribuzione) to install and test experimental storage plants on its networks. Among the most recent ones, several 1 MVA Li-ion systems ranging up to 2 MWh. The INGRID multi-carrier hub installed in Troia is actually an asymmetric storage, consisting of an adjustable 1.3 MW passive load and a 100 kW generator. The storage technology is based on production, by water electrolysis, of hydrogen

stored (25 MWh gross) as solid state magnesium hydride. The generator is a hydrogen fuel cell. The demonstrator is characterized as a private installation connected to the public network, not directly operated by the DSO that can demand ancillary services to the storage operator. Trial objectives will be mainly the evaluation of system performance in the minimization of the power rise from MV to HV grid, the modulation of the load diagram of the HV/MV busbar, the LV regulation.



## RECENT DEVELOPMENTS THE INGRID PLANT: THE BEGINNING OF THE DEMONSTRATION PHASE BY ENGINEERING

The demonstration phase of the INGRID pilot is foreseen in the next period and it is aimed at validating the objectives of the Project. First of all, the operational phase will give an important feedback about the collaboration of the DSO with a multi carrier hub like the one INGRID implements. The DSO will daily or weekly provide the plant with a consumption profile, that the plant will try to follow by also taking into account the constraints of the hydrogen production and distribution processes. The Energy Management System (EMS) of the plant will manage the storage devices in order to make them available to receive the corresponding hydrogen in that period. Working as a variable load, the electrolyser is expected to significantly affect the grid, in terms of balancing service, since it will support the DSO for the overall stability of the grid. This impact will be registered and quantified by e-distribuzione. On the other hand, since most of the power consumed will be produced by the RES available in the zone, the operational phase will demonstrate the effectiveness of the use of the Hydrogen Solid-state Storage to stock "green energy", avoiding the RES curtailment, unavoidable otherwise. The cooperation with the DSO concerns also the generation capacity offered by the plant: during the demonstration phase, part of the hydrogen stored in the magnesium sponges will supply a fuel cell able to provide ancillary services to the LV grid and to support the EV recharging. Most of the activities regarding the plant construction, the health and safety policy, and device transportation have been finalized. Several system components have been already shipped to the plant in Troia and partially installed.

- The Water Electrolyser and the Fuel Cell have been delivered by Hydrogenics, installed and placed inside the plant.



- The filling stations for the Hydrogen Solid-state Storage have been delivered by McPhy Energy, along with their gas panel and electrical cabinet. The gas distribution panel has been delivered to



be connected with the Water Electrolyser. The magnesium blocks have been delivered too and installed in their respective stations. The magnesium-based storage devices are now being tested and certified by the designated figures.

- BFP has concluded all the civil works: the control room, the transformer cabin and the repository for the hydrogen blocks have been built up. The electrical connections to the MV and LV grid have been performed.



The contracts for telecommunications services will be activated in the next days. Once completed the last remaining activities, concerning the gas piping and the electrical connection, the EMS will be deployed, and the operational phase will start.

## INGRID PARTNERSHIP: AN INTRODUCTION TO HYDROGENICS

Incorporated in 1995, Hydrogenics Corporation is a publicly listed company on the NASDAQ and the TSX since 2001. Initially the three Canadian founders wanted to build a fuel cell company, but were unable to find any component suppliers back in the early 90's. Hence, they refocused on FC test equipment instead. After the successful IPO the company invested in FC capability, later divested the equipment activity and acquired the electrolyser business of Stewards and Vandendorpe in Belgium. Hydrogenics is a worldwide leader designing, manufacturing, and installing hydrogen systems around the globe. It offers world leading expertise for a wide range of products and applications, including:

### PEM (proton exchange membrane) and alkaline electrolyser hydrogen generators for

- hydrogen generation for industrial processes;
- hydrogen generation for fueling stations;
- hydrogen energy storage and transportation.

Hydrogenics is pioneering "Power-to-Gas", the world's most innovative way to store and transport energy;



### hydrogen fuel cell power generators for

- transportation such as urban transit buses, commercial fleets and utility vehicles;
- large and small stationary applications such as backup power for hospitals, emergency services, data centers, corporate and production facilities, telecommunication and small commercial buildings;
- free standing electrical power plants and UPS (uninterruptible power supply) systems.

The INGRID project offered Hydrogenics the opportunity to upscale its pressurized alkaline technology by a factor of 2.5, getting this technology ready for grid-scale energy storage applications. Additionally the integration into multiple renewable hydrogen applications is a very valuable learning process. And lastly it gave Hydrogenics the exposure to the Italian renewable energy landscape and stakeholders.

Within the INGRID project Hydrogenics is responsible for the hydrogen generation technology as well as the re-electrification or fuel-cell technology. Next to the solid hydrogen storage technology from McPhy, Hydrogenics technology takes up a central role in the INGRID project.

## NEWS

### Ingrid paper awarded as Best Paper in IARIA ENERGY 2016

The paper "Multi-objective Optimization of Energy Hubs at the Crossroad of Three Energy Distribution Networks" has been awarded as the best paper in IARIA ENERGY 2016 conference, held in Lisbon (Portugal) on June 26-30, 2016.

The paper has been presented by Engineering to explain some INGRID optimized tools. The paper provides a multi-objective optimization framework aimed at the management of a multi-carrier energy system involving both electricity and hydrogen. Using the concept of the multi-carrier hub, the proposed system has been modelled in order to define completely every energy flow inside the INGRID plant.

### Online the INGRID plant virtual tour

It's now available online the virtual tour of the 3D rendering of the INGRID plant. It includes an aerial view, an automatic tour and some hotspots with the descriptions of the different parts of the INGRID plant located in Troia (FG) in Puglia (Italy). Discover the INGRID demosite at the link (it is available using Firefox browser): <http://www.virtualereale.com/vr.html>

### Online the INGRID project video

How to face the challenge of the increasing incidence of renewable energy production, often intermittent and insufficiently aligned in space and time with energy consumers? Watch the project infographic video on the project website and discover how the INGRID Consortium is trying to answer this question. Enjoy the INGRID video!

<https://www.youtube.com/watch?v=1K0ImQR4BqY>