PRESS RELEASE

THE POTENTIAL OF THE ZERO-EMISSION GEOTHERMAL SOURCE: THE POINT OF VIEW OF TURBODEN

Rome, April 3, 2019, Marco Baresi - Institutional Affairs & Marketing Director for Turboden S.p.A., as well as Vice President of EGEC, the European association representing more than 120 operators from industry, academia and utilities, presents the point of view of the company, at the press conference on "Zero Emission Geothermal: Italy, world leader in the production of track-cycle and total recirculation plants". The focus is on the domestic market where, to date, no binary geothermal plants with ORC technology have yet been built, despite the high potential and the announcements made several times by government bodies on the subject of a long-term policy development. The expected decree "RES2" is going to be the strategic tool to enable the development of domestic geothermal source with zero emissions and its industrial chain. In accordance with what has been promoted by Rete Geotermica, the network of national operators active in total reinjection geothermal energy, it is mandatory to reserve a contingent for innovative geothermal energy and total reinjection in the range of 100-150 MW. This is in order to allow the development of this source also on the Italian territory, until now reserved for conventional geothermal energy only, where Italy boasts world leadership in this field thanks to the national top player Enel Green Power.

Turboden S.p.A., an Italian company of the Mitsubishi Heavy Industries group, is a leader in the design, production and maintenance of Organic Rankine Cycle (ORC) turbogenerators for the production of electricity and heat from various renewable sources such as biomass, geothermal, concentrated solar and excess heat from various industrial processes, engines and gas turbines.

Almost 40 years of experience in the construction of turbogenerators based on organic Rankine cycle (ORC) technology have allowed Turboden to design, produce and distribute more than 370 plants in 42 countries and to exceed 15,000,000 operating hours with an average availability exceeding 98%, generating clean and distributed energy for more than 19,000 GigaWatt hours of electricity.

Today Turboden employs more than 250 people in Italy, a facility in Turkey and a few operational offices in other countries around the world.

The world power installed by geothermal source is estimated as 14,600 MegaWatt (source Thinkgeoenergy updated Jan.2019) with the most virtuous nations such as the United States, Indonesia, Philippines, Turkey and New Zealand, each with an installed base of more than 1000 MW. Italy follows with 944 MW installed. China is investing heavily in the decarbonisation of its cities, converting traditional heating systems to geothermal plants.

In Europe, installed capacity is around 2500 MW in 7 countries with 102 plants producing electricity, while more than 280 district heating plants from geothermal sources are active in 24 countries; the geothermal potential that can be installed in Europe is in

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the order of several TWh of electricity that can be produced (source EGEC market report 2017). In this sense, the opportunity for European and domestic technology suppliers is significant if properly supported.

Analyzing the geothermal plants installed in the world, it is evident the strong imbalance with other renewable sources, think for example that the total power of photovoltaic power stations installed in Italy today exceeds 18,000 MegaWatts against the 14,600 MegaWatts installed worldwide in geothermal energy, despite the huge intrinsic advantages of this source.

- Geothermal energy has a capacity factor higher than other renewable sources (> 90%), i.e. the ratio (availability) between the production of electricity actually supplied by the plant over a period of time and the theoretical supply of energy that could have been produced if it had operated at full rated power continuously over time. For this reason, geothermal energy is a base-load energy source, not dependent on the presence of the sun, wind or other external factors.
- Geothermal energy has a lower production cost (LCOE - Levelized cost of energy) than other traditional energy sources including fossil fuels. It is the ratio between the discounted value of the sum of cash outflows and the discounted value of electricity production over the operational life of the plant. This value is low for geothermal energy because the plants have very long operational lives (more than 30 years), so with initially high investments, a source of base-load as a decarbonisation tool remains available in the long term.
- The geothermal sources are renewable sources of clean energy that can be exploited without emissions into the atmosphere

So why is geothermal energy so scarce?

An ESMAP-World Bank report of 2016 indicates the average construction time of a geothermal plant as between 5 to 10 years. This is mainly due to:

- The need for competency in carrying out work underground for the cultivation of geothermal resources;
- Intrinsic risk with exploration, which can sometimes find a source with lower than expected characteristics such as temperatures or fluid flows;
- High initial investments required;
- Skills in power generation to optimize production, given the existing resource;
- Absence of a stable regulatory framework and support tools for mitigating prospecting risk and for project financing.

These factors have, in fact slowed down the development of geothermal exploitation compared to that of other renewable sources that are relatively "easier" to install.

Turboden has been present in the geothermal field for years; the first pilot plant dates back to 1988 in Zambia as part of a development cooperation programme and financed with international funds. Only in the last decade, however, has Turboden

focused on this area by developing innovative technological solutions for world markets. In 2018, for example, it is important to highlight the start-up of two important plants:

- In December, Turboden successfully started up the largest single ORC turbine in Europe with a power of 17.5 MWe for the geothermal plant at Velika Ciglena in Croatia for the customer Geoen - MB Holding.

The plant uses steam and hot water at 170°C to produce electricity and power the local electricity grid. In 2016, the project won the Best Innovation Award, promoted by Mitsubishi Heavy Industries, for its innovative design (5-stage turbine, low speed, patented project). This award confirms Turboden's role as one of the leading manufacturers of large ORC systems.

- Also in December 2018, a 15 MW plant was started up in New Mexico - USA for Cyrq Energy, carrying out the reconstruction of an obsolete plant.

The two plants mentioned are in addition to the existing ones in Bavaria - Germany, where in the Munich area there are 9 binary plants with total reinjection, 5 of which were built by Turboden. Some of them are directly connected to the District Heating network, contributing to the generation of heat in addition to the production of clean electricity.

Other Turboden projects include geothermal plants in Japan (5 MW on the island of Kyushu), in France for Electricitè de Strasbourg EDF group and for another operator of the size of 11 MW, the largest plant of its kind in France. Other examples include the Afyon plant in Turkey and others in Kenya and El Salvador, with the recent award of two major geothermal projects.

Turboden's activities in the geothermal sector have been possible thanks to the constant development of efficient solutions and with a constant focus on innovation in the field of turbines, working fluids used and more integrated plant solutions.

The relevance of the R&D issues has led Turboden to be one of the promoters of the European Technology Innovation Platform ETIP for deep geothermal, recognized by the European Commission, currently engaged in defining the Strategic Research Agenda to 2030 in accordance with the Vision document promoted in 2018.

Turboden is active in European and global associations and networks, as well as has active relationships with development banks and funds operating in the geothermal field in order to promote its full development.

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