SMART POLYGENERATION GRID: A NEW EXPERIMENTAL FACILITY

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ABSTRACT

This paper presents the development of a new experimental facility for analysis and optimization activities on smart polygeneration grids. The test rig is being designed and built in the framework of the European project “Energy-Hub for residential and commercial districts and transport” (E-HUB), which targets optimal energy management of residential and commercial districts.

The experimental rig, named “Energy aNd Efficiency Research Demonstration District” (E-NERDD), is located inside the University campus in Savona, and is based on four different prime movers able to produce both electrical and thermal energy: a 100 kWe micro gas turbine, a 20 kWe internal combustion engine, a 3 kWe stirling engine, and a450 kWe fuel cell/gas turbine hybrid system emulator based on the coupling of a micro gas turbine with a modular vessel. While the electrical side is based on the connection with the campus grid (further developments are planned for a local electrical grid including storage units), thermal energy is managed through a dual ring-based water distribution system. The facility is also equipped with thermal storage tanks and fan cooler units to study and optimize different thermal management algorithms generating different thermal load demands. The facility also includes an absorption chiller for cold water generation. As a result, trigeneration operation is possible in a physically simulated urban district. Moreover, the rig is equipped with six photovoltaic panels (significant for the electrical aspects) and 10 kWp of thermal solar panels to be integrated in the grid.

Further technologies to be considered for the E-NERDD are power plants based on other renewable resource (e.g. with biomass fuel). These systems are planned to be analyzed through real plants (remote connection with the field) or through virtual models based on real-time dynamic approaches.

Experimental tests related to the performance of the micro gas turbine are reported and discussed in this paper. The focus here is on machine correction curves essential to evaluate factors for quantifying ambient temperature influence on machine performance. This analysis is essential for setting the thermal distribution grid and for future optimization tests