

## DER Test Facility (DER-TF)

It consists of a LV microgrid, connected to the MV grid by means of a 800 kVA transformer. It is constituted by several generators with different technologies (renewable and conventional), controllable loads and storage systems. DER-TF can provide electricity to the main grid with a maximum power of 350 kW.

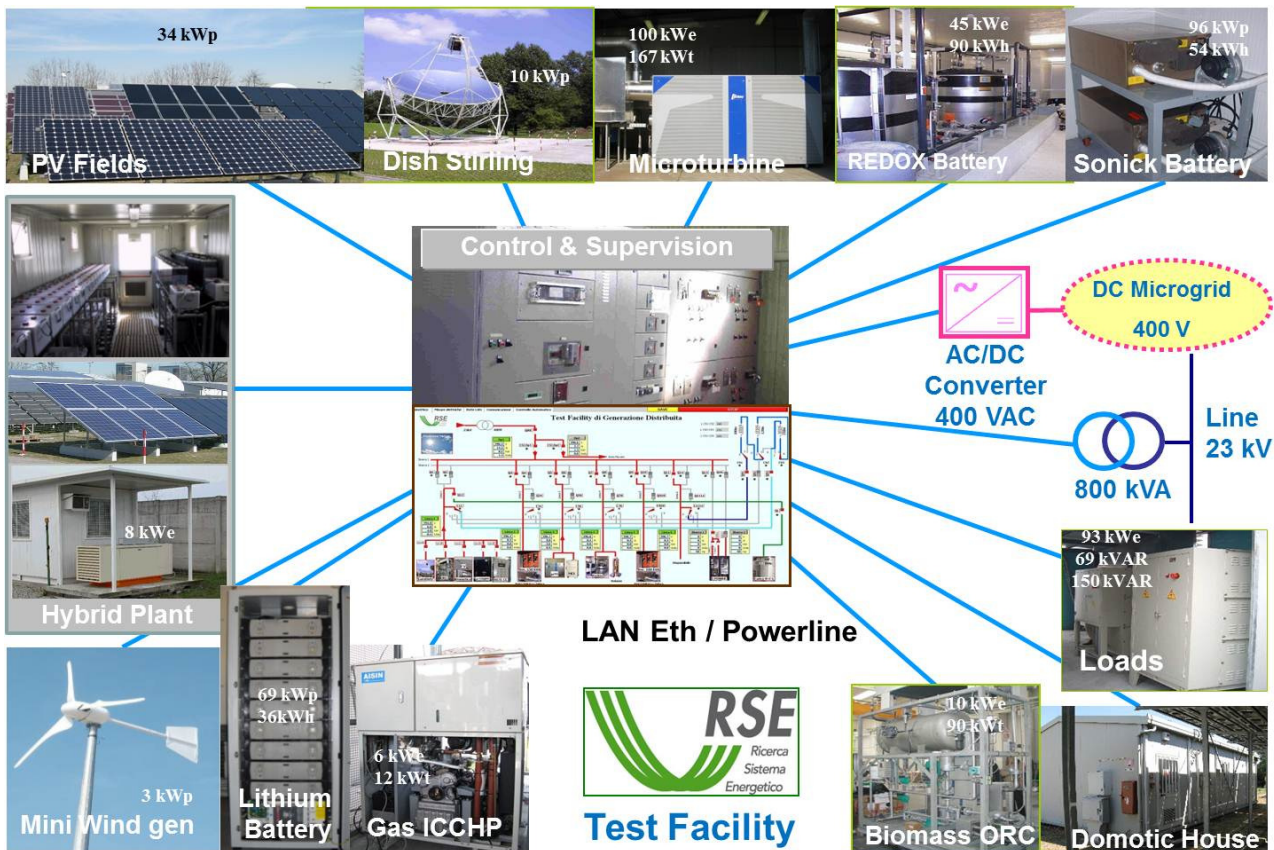
The following distributed energy resources are available at the present time:

- a hybrid renewable energy system consisting of:
  - a photovoltaic plant (10 kWp);
  - a lead acid storage system;
  - a diesel engine coupled with an asynchronous generator (7 kVA);
  - a simulated asynchronous wind generator (8 kVA)
- five PV fields of different technologies for a total nominal power of 14 kW;
- a solar thermal plant with a parabolic dish and a Stirling engine (10 kW);
- a CCHP plant with a gas micro-turbine (105 kWe, 170 kWth, 100 kWre);
- a Vanadium Redox Battery (42 kW, 2 hours);
- two high temperature Zebra batteries (64 kW, 30 minutes);
- a controllable three-phase resistive-inductive load (100 kW + 70 kVAR);
- a capacitive load and several R/L loads with local control (150 kVAR);
- a CHP plant with a gas internal combustion engine (6 kWe, 13 kWth)
- a Lithium battery system (60kW, 30 minutes)
- a DC net (400V, including Zebra batteries, superC banks, PV emulator, Resistive Load) connected to DER Test Facility by a bi-directional inverter (100 kWe).

All these DERs are connected to the microgrid by means of a configuration and interconnection board that allows the microgrid operator to change the interconnections of DERs manually or by means of remote commands from a computer. This way it's possible obtaining different grid topologies: radial grids and also meshed configurations. There's also the opportunity to extend feeders till one kilometre.

The interconnection board and all the DERs are provided with electrical measure equipments, constituting a high-speed Data Acquisition System (DAS), that has been set up to collect and analyse the experimental data derived from the field test.

In the below picture a schematic representation of the DER-TF is shown.



A Communication system is available with different technologies: LAN Ethernet, Wireless and Power Line. A supervision and control infrastructure has been also implemented, providing several services:

- Interface with distributed resources (equipped with their local control systems): the
- control system gets measurement and sends commands and set-points
- Archive functions: data storage and retrieval, in order to permit further analysis
- Standard TCP/IP interface towards optimization applications.

The RSE DER Test Facility is a complete and well-structured system with different generators, storage systems and loads that well reproduces a real microgrid, allowing researchers to develop studies and experimentations on DERs. Through RSE DER Test facility researchers may perform their experiments, demonstrations and validations simulating the operation of an actual microgrid in interconnected and islanding mode and its behaviour during disturbances such as voltage and frequency variations.