

PRODUCT SHEET

ENERGY PRODUCTION



ORC MODULE

ZE - 150 - LT

PLANT TECHNOLOGY

The structure of the proposed plant is based on the so-called low-temperature organic Rankine cycle (LT-ORC), and may be summed up by the diagram in **Figure 1**.

A heat source **[1]** generates heat, which is conveyed through a **vector fluid** circulating into a closed loop to one or more primary heat exchangers, usually a **preheater** and an **evaporator [2]**, where said heat is transferred from the vector fluid to the **working fluid**.

The working fluid - a low-boiling, biodegradable, non toxic liquid when at room temperature - **boils** in the evaporator at a temperature far lower than that of water, becoming a high-pressure dry gas which spins through its expansion the impeller of a specifically designed and sized **turbine [3]**.

The high-speed rotation (12.000÷18.000 Rpm) of the turbine shaft spins the rotor of a **generator** which is directly connected to it, thus producing **electric power [4]** which, after being synchronized in frequency, phase and voltage by a **power converter**, may be injected into the national power grid or self-consumed, according to local needs and policies.

Downstream the turbine, the working fluid - still in gas phase - is conveyed to another heat exchanger, called a **condenser [5]**, where it is cooled, releasing its excess heat and condensing back into a liquid which is collected in a **condensation tank**, ready to be sent back to the primary heat exchanger by a **recirculation pump**, thus closing the loop.

Excess heat released in the condenser is a low-temperature thermal energy source itself, which may be **used for other purposes** such as preheating or desiccating biomass fuel (thus increasing its heating value), building heating, hot water production and so on.

In case that is not possible, residual heat may be dissipated by using an **external cooling system [6]** such as an evaporative cooling tower or a dry cooler.

The ZE-105-CHP module is a highly versatile **combined heat and power generation system**, which operates in combined heat & power (CHP) mode producing more than **1 MWT thermal output** at 80°C for heating or sanitary use as well as **105 kW of electric power**.

This makes this system the ideal choice for large residential plants or any other application where the need for thermal power takes a precedence over that for electric power.

Moreover, as a purely cogenerative plant, this system has access to the **regional and state incentives** reserved for those systems.

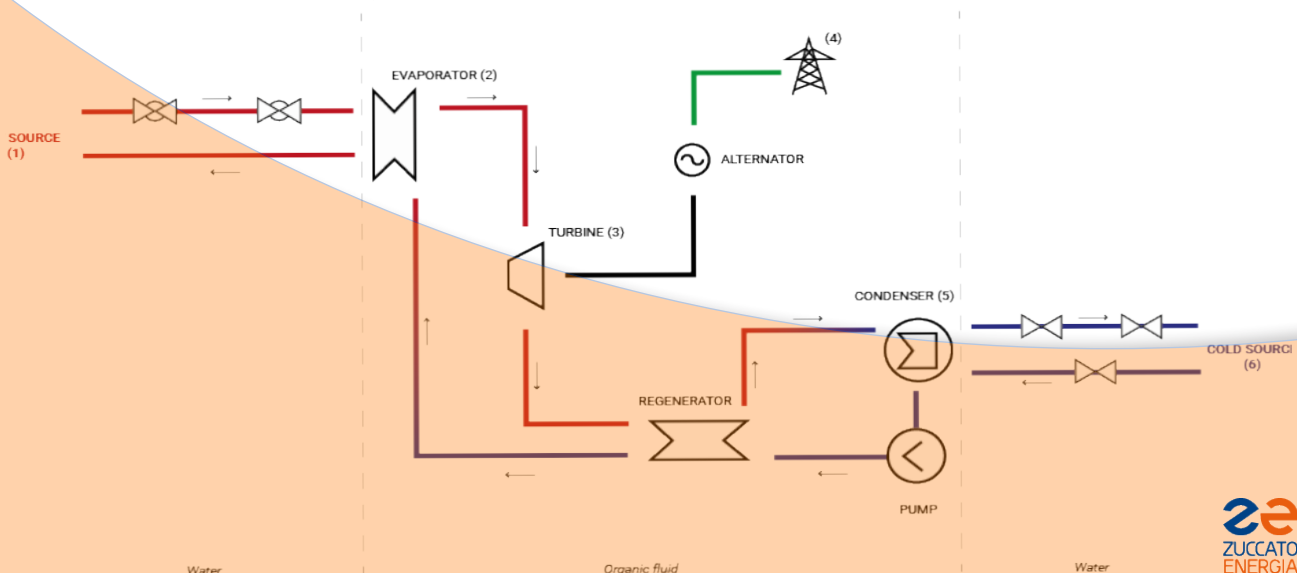


Figure 1 - Plan Diagram

INNOVATION

Independently designed and manufactured using the most advanced technologies in finite elements and fluid-dynamics analysis (CFD/CFX), the ZE turbogenerators are designed from scratch to operate in a low-temperature organic Rankine cycle which uses a special working fluid that offers better performances and several advances over traditional steam turbines:

- **Low operational temperature** which allow our systems to tap even low-grade heat sources;
- **High condensation temperature** which may allow the use of simple air-cooled condensers;
- **Totally dry working fluid**, which means no turbine blade erosion, giving the system **high reliability** and **reduced maintenance costs** as well as fewer controls;
- **Lower operational pressures** (20 bar max), which mean safer operation, less bureaucratic problems and reduced plant costs;
- **No atmospheric emissions** (closed circuit operation);

From an environmental standpoint, ZE systems are reproachless:

- They **recover otherwise wasted resources** such as waste heat and byproducts or help tapping renewable sources such as solar and geothermal heat;
- They use **plain tap water for thermal energy transfer** instead of environmentally dangerous diathermal oil;
- Their **working fluid is ozone-friendly, non-toxic, non flammable** in liquid form, and 100% biodegradable;
- They are made of recyclable, **environmental friendly materials**, use a minimum of plastic parts and employ no toxic substances in their construction.

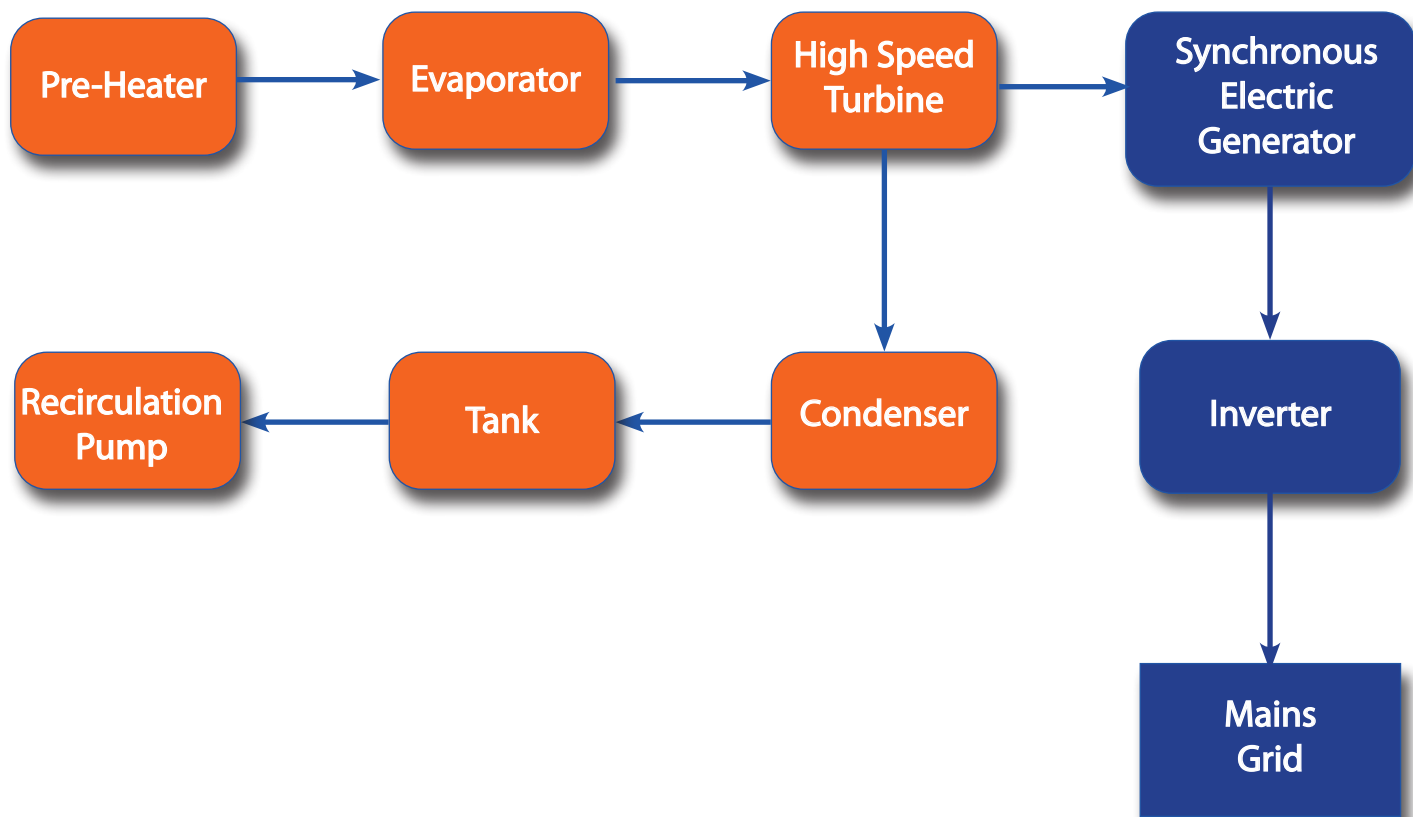
The ZE turbogenerators have been **custom designed from scratch** for the purpose of being installed in small plants (<1MWe). So, several engineering solutions have been incorporated in their design to enhance their performance:

- **Direct turbine-to-alternator coupling**, to eliminate the attrition losses inherent in gearboxes;
- **Use of ceramic bearings** to prolong operational life and allow very high-rpm operation;
- **Custom-designed and sized turbines and power converters** for every plant size to obtain optimal mechanical-to electric energy conversion and performance in energy grid output.

Our innovative technology has already been widely **field-tested** with success in dozens of plants throughout Europe, Asia, Africa and America, from biomass and biogas fueled plants in Italy to solar-assisted plants in Africa, from large farms in the USA to Korean power stations..

All systems by Zuccato Energia are equipped with telecontrol and telediagnostic systems that allow constant monitoring and real-time intervention in case of malfunction through the 3G / GPRS / EDGE cellphone network and any Web-savvy device (PC or tablet).

ORC CIRCUIT COMPONENTS



PROCESS DATA

WORKING FLUID	
Type	Mixture of non-toxic, non-flammable, environmental-friendly HFCs
Operational range	60-165°C
Condensation temperature	~ 33°C (@1 bar)
Working pressure	max. 20 bar
Organic vapor mass flow	~ 5,26 kg/s

HEAT EXCHANGER	
Type	Brazed plate
Working pressures	30 bar (Nominal) / 39 bar (Test) / 225 bar (Burst)
Construction materials	AISI316 S/S & 99,9% copper
Max working temperature	195°C

PREHEATER + EVAPORATOR

Total thermal power input	1100 kWt
Vector fluid	Pressurized water
Vector fluid temperature (input/output)	$\geq 160^{\circ}\text{C}$ / 140°C
Vector fluid flow rate	13.14 kg/s
Electric power output from turbine	150 kWe

CONDENSER

Thermal power dissipation	940 kWt
Condenser cooling water temperature (in/out)	26°C / 36°C
Condenser circuit flow	22.46 kg/s

TURBINE

Type	Single-stage radial inflow turbine w/fixed nozzles, directly coupled to generator shaft
Operating Temperature (Input/Output)	140°C in/ $\sim 100^{\circ}\text{C}$ out
Stage pressure	PS 16 (tested to 24 bar)
Materials	Machined steel (body) / Aluminium alloy (impeller)
Speed control	Feedback loop on the generator current output
Seals and gaskets	Sealed labyrinth on impeller back and optionally at generator interface. Env. seal : Gaskets / O-rings

GENERATOR

Type	Synchronous, permanent magnet
Power Output	160 kWe
Cooling Fluid	Water + glycol (antifreeze) mix @ $T_{IN} < 40^{\circ}\text{C}$
Rotational Speed	13.000 Rpm (12...18 kRpm)
Rectifier /synchronizer	Built-in / Included
Cooling System	Water jacket

INVERTER

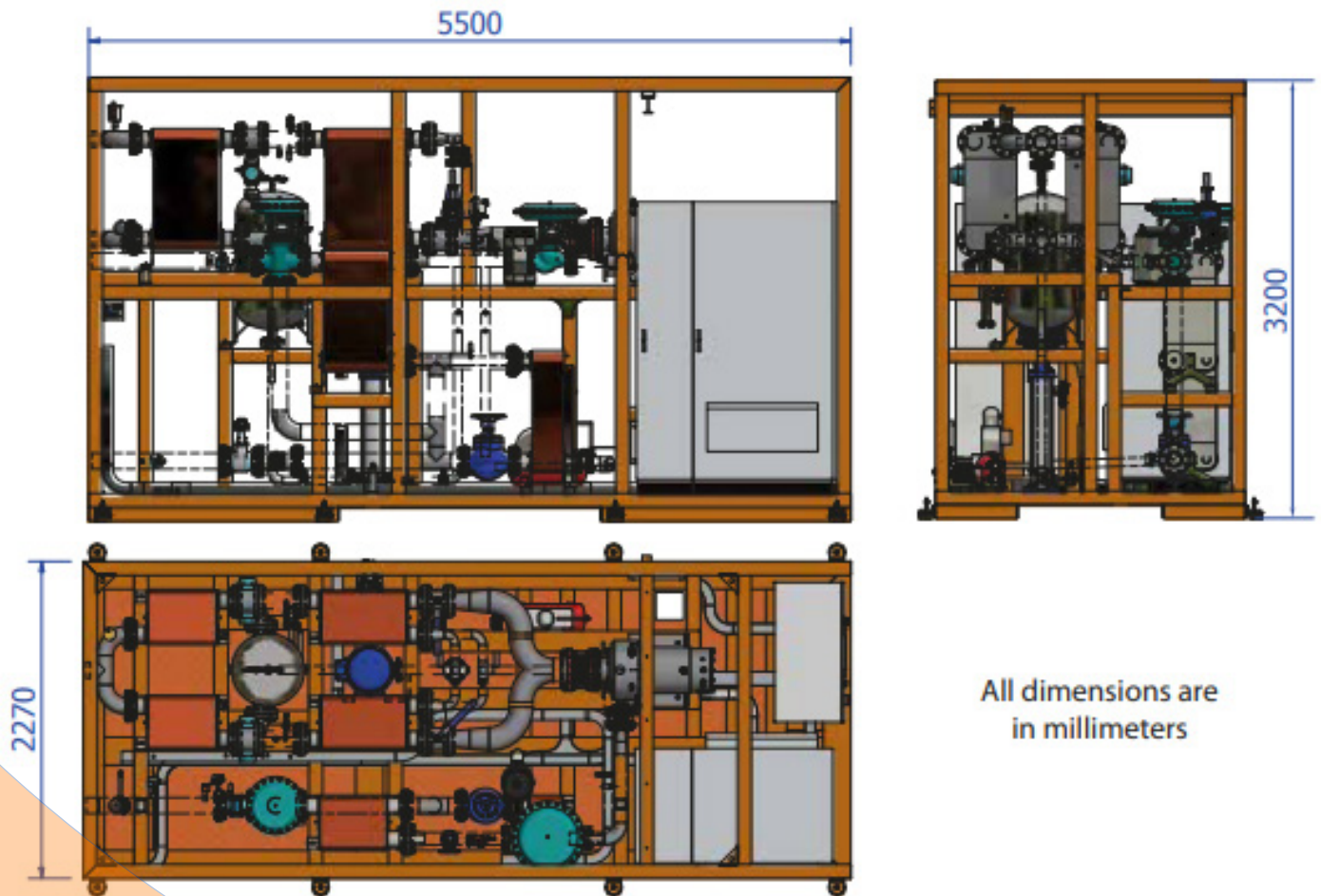
Type	IGBT- mains synchronized, air-cooled
Output power	150 kWe
Output voltage / frequency	from 380 to 480 V 3-phase, 50/60Hz
Max operational environmental temperature	40°C
Braking chopper	Included, 150kW

ZE-105-CHP SKID DIMENSIONS

The power generation module is supplied mounted on a self-supporting compact frame ("skid") which houses all the principal components.

Dimensions and weights given here are for the **standard version** of the ZE-105-CHP ORC module, designed for **indoor** installation, which fits on a low-bed trailer truck for shipping.

Zuccato Energia, as system developer and manufacturer, can also build the skid in custom dimensions, add soundproofing or weatherproofing enclosures, and modify the system's working point, to tailor the system on the client's needs.



When programming installation spaces, it is advisable to leave some free space ideally at least **1.5 meters** all around the skid - for easy maintenance access.

Zuccato Energia, as system developer and manufacturer, may also upon request design and build the module with custom dimensions and working points, to tailor the system to the client's needs.