

February 26th 2020 Alberto Ghidoni

40 YEARS OF EXPERIENCE



SINCE 1980

Turboden is an Italian firm and a global leader in the design, manufacture, and maintenance of *Organic Rankine Cycle (ORC) systems*, highly suitable for distributed generation, which produce electrical and thermal power using multiple sources.

Today, thanks to its long experience in the energy efficiency sector, Turboden expands its solutions in offering gas expanders and large heat pumps.



TURBODEN IS A GROUP COMPANY OF MHI



One of the world's leading heavy machinery manufacturers, with

consolidated sales of around \$38

billion (in fiscal 2018). Foundation July 7, 1884

MHI BUSINESS DOMAINS













MITSUBISHI HEAVY INDUSTRIES, LTD.







INDUSTRY & INFRASTRUCTURE

AIRCRAFT,
DEFENSE & SPACE

\$12.9 B NET SALES

\$15.6 B NET SALES

\$6.3 B NET SALES

POWER

SYSTEMS

GLOBAL AND PROVEN EXPERIENCE



A worldwide presence in 45 countries with 400 plants

15 million hours

cumulative operation time

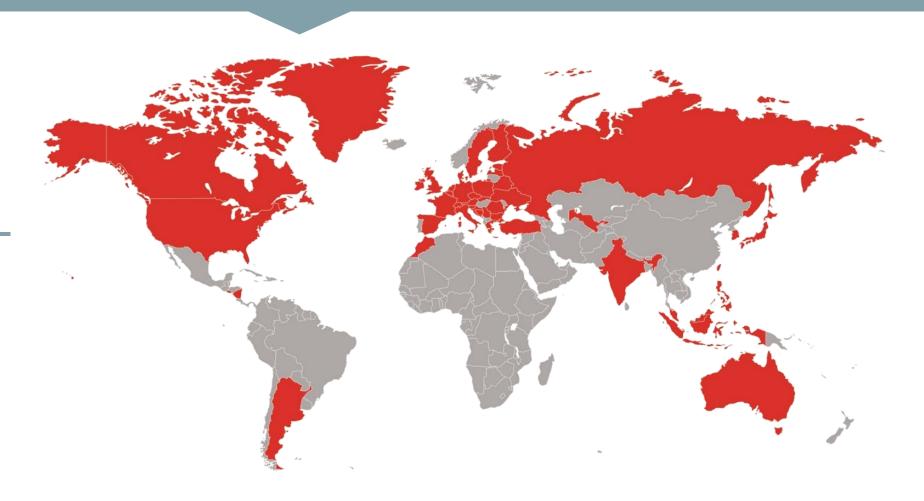
19 thousand GWh

electrical energy generated

98+%

average availability

Last update: November 2019

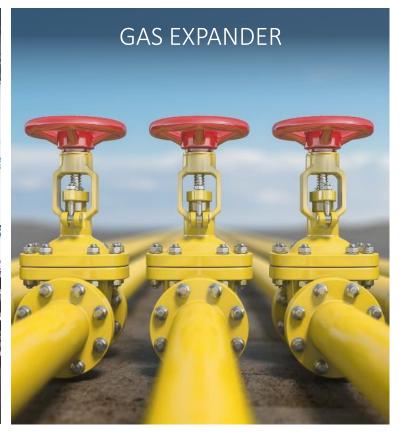


OUR PRODUCTS









MAIN FIELDS OF APPLICATION















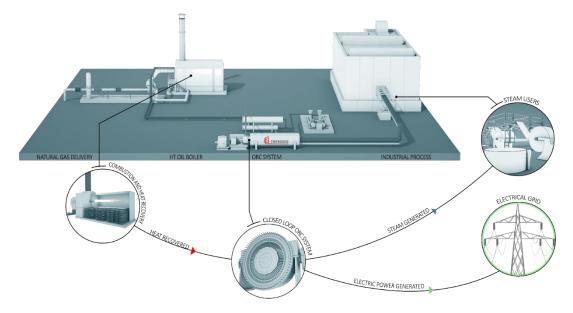


STEAM & POWER



STEAM & POWER SOLUTION

- Steam & Power ORC (ST&P®) is an innovative CHP solution
- ST&P ORC allows the generation of electricity and medium pressure steam
 (4 30 bar) for industrial use, with a high overall efficiency (> 90%).



NEW
high-temperature
high-efficiency
CHP plant



STEAM & POWER: PROCESSES



Steam & Power ORC System was conceived to satisfy many manufacturing processes requiring electricity as well as relevant amount of medium pressure steam.



AGROFOOD & BEVERAGE



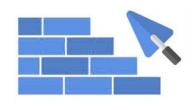
PAPER & WOOD INDUSTRY





RUBBER





OIL & GAS

BRICK

STEAM & POWER: ORGANIC RANKINE CYCLE



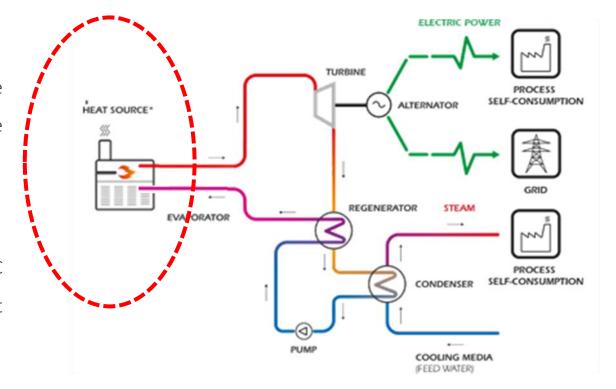
The Organic Rankine Cycle's principle is based on a turbogenerator that works with an organic fluid, characterized by high molecular mass which leads to a slower rotation of the turbine, lower pressures and no erosion of the metal parts and blades.

HEAT SOURCE

The fuel (natural gas, syngas, diesel, naphtha, pellets, process waste and other) is fed into the combustion chamber of the boiler, where it is mixed with preheated air and burned.

HEAT EXCHANGE

The combustion heat is transferred to the working fluid of the ORC module in the evaporating diathermic oil boiler, first in a radiant section and then in a convective section.



STEAM & POWER: ORGANIC RANKINE CYCLE

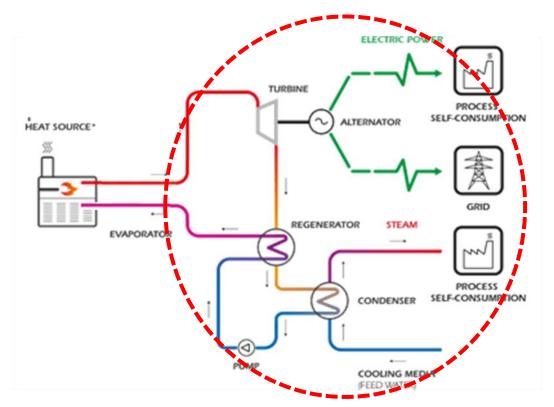


POWER PRODUCTION

The organic working fluid evaporates at 380°C and approx. 8 bar(g); it expands into the turbine, which drives the electric generator producing electricity.

STEAM PRODUCTION

Downstream the turbine, the organic vapour pre-heats the organic liquid in the regenerator and is then condensed at high temperature releasing its latent heat for steam generation, to feed the manufacturing process.

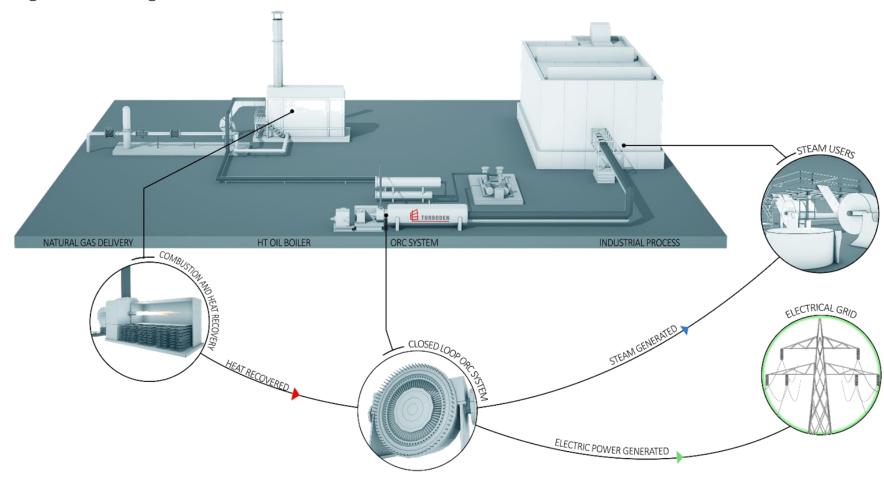


ST&P ORC produces electricity and steam, without wasting condenser hot water.

STEAM & POWER



Example of natural gas fired configuration.



STEAM & POWER: MULTI-FEED TECHOLOGY



01 HEAT SOURCE

02

ORC UNIT

03 HEAT MEDIA

O4 PROCESS

FUELS

- Natural gas
- Wood biomass
- Pellets
- Poor gases (from landfill, coke oven gas, APG, syngas, etc.)
- Waste (sludge, residues, etc.)
- HFO, LFO, Diesel
- Coal
- ...

HEAT RECOVERY

- Heat recovery from gas turbines
- Heat recovery from industrial processes
- ...



- Steam
- Pressurized water
- Thermal oil
- Air
- ...

- Pulp & Paper
- Food & Beverage
- Chemicals
- Rubbers
- Plastics
- Textiles
- ...

STEAM & POWER ORC: FEATURES







THE FEATURES

- > Electric power rating from 400 kWe to 10 MWe (multiple units)
- > CHP steam output pressure range from 5 to 30 bar
- > CHP steam capacity range from 4 to 80 t/h (multiple units)

^{*} Steam output at 10 bar(g)

TECHNOLOGIES BENCHMARK & COMPARISON





Legend:

ICE = Internal Combustion Engine

GT = Gas Turbine

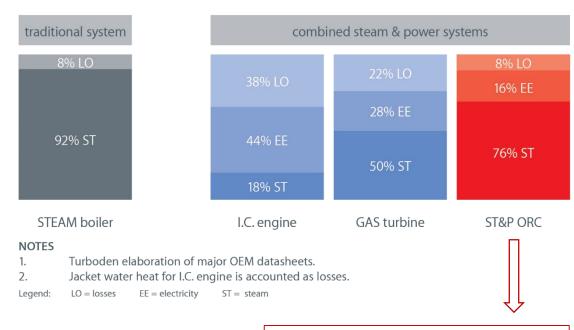
MGT = Micro Gas Turbine

ST&P = Steam & Power ORC

ELECTRICAL ENERGY / HEAT RATE:

1 kWe - 4/5 kWt

TURBODEN STEAM & POWER: A NEW COGENERATION TECHNOLOGY



ST&P numbers

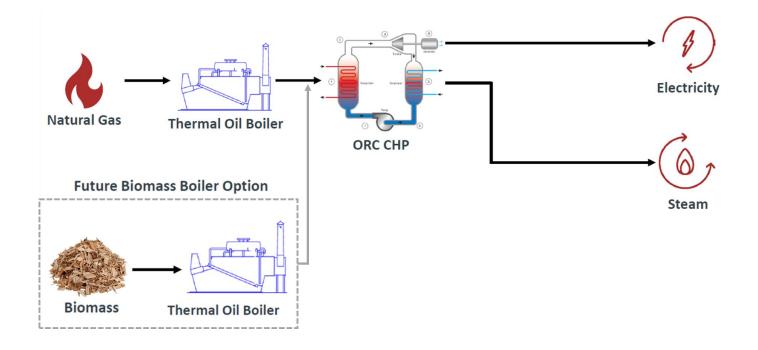
76% steam output16% electricity outputOverall efficiency > 90%

STEAM & POWER ORC: FEATURES



Technical Advantages

- Well established and proven technology by Turboden (MHI)
- 10/15 % more efficient than other CHP technologies (gas fired turbine/HRSG system, Engines)
- Solution offers highest market availability due to low operating pressures and low turbine axis RPM (>98%)
- · No overhauls required
- Allows for future fuel flexibility: dual-fuel operation with natural gas, biogas and biomass
- Long term, fixed O&M contracts
- Multiple sizing options available depending on final size requirements
- Outdoor installation
- Island operation
- Up to 80% Carbon reduction



STEAM & POWER ORC: 0.5MWE - 6MWE



Current Avg. Electrical Usage (MW)		1	2	3	4	5
Current Avg. Thermal Usage (MW)		5	10	15	20	25
Current Avg. Site Utility Costs (inclusive of EU ETS where applicable)		€2,662,164	€5,324,328	€7,986,492	€12,635,491	€15,794,363
Fuel – Natural Gas	New Site Utility Costs	€1,883,438	€3,766,875	€5,650,313	€9,568,765	€11,960,957
	Net Savings	€778,726	€1,557,453	€2,336,179	€3,066,725	€3,833,406
	Carbon Reduction	17%	17%	17%	17%	17%
Fuel - Biomass	New Site Utility Costs	€2,012,402	€4,086,840	€6,215,820	€8,963,353	€11,189,192
	Net Savings	€649,762	€1,237,488	€1,770,672	€3,672,137	€4,605,172
	Carbon Reduction	79%	79%	79%	79%	79%
Fuel – 50:50 Gas/Biomass	New Site Utility Costs	€1,976,890	€3,966,001	€5,976,782	€9,252,046	€11,550,058
	Net Savings	€685,274	€1,358,327	€2,009,710	€3,383,444	€4,244,305
	Carbon Reduction	51%	51%	51%	51%	51%

CENTRALE DEL LATTE DI BRESCIA



CUSTOMER:

Centrale del Latte di Brescia

COUNTRY:

Italy

STATUS:

under construction

EL. POWER PRODUCED:

0.7 MWe

STEAM PRODUCED:

5 ton/hour at 15 bar(a)

DESCRIPTION:

electric power and steam production for milk pasteurization

FUEL:

natural gas

HEAT CARRIER:

thermal oil



CENTRALE DEL LATTE DI BRESCIA



THE CUSTOMER

Centrale del Latte di Brescia established in 1930 with the objective of ensuring hygiene checks on milk and daily distribution to all citizens. Centrale del Latte di Brescia was the first municipal dairy in Italy to have a UHT plant for production of long-life milk. The company was the first in the world to pack UHT milk in fully recyclable PET bottles.

THE NEED

Centrale del Latte di Brescia used to produce steam by means of a traditional boiler buying electric power from the local grid. The customer decided to look at a cogeneration solution to increase the overall efficiency of the system and reduce related costs.

OUR SOLUTION

Turboden provides a turnkey solution, supplying the complete system, from the natural gas-fired boiler to the high-temperature ORC turbogenerator. The Turboden solution perfectly fits the energy needs of Centrale del Latte di Brescia, which uses an ST&P ORC System to cogenerate about 700 kW electric power and 5 ton/hour of steam at 15 bar(a) needed to pasteurize long-life milk.

CHP IN WOOD INDUSTRY



CUSTOMER:

Cork Green Energy

COUNTRY:

Ireland

STATUS:

in operation since 2019

ORC SIZE:

1,3 MWe

DESCRIPTION:

CHP for Pellet plant production

FUEL:

wood residues

HEAT CARRIER:

thermal oil

WATER TEMPERATURE (IN/OUT):

70 - 90 °C



