clean energy ahead
TURBODEN

MOVE THE WORLD FORWARD MITSUBISHI HEAVY INDUSTRIES GROUP

TURBODEN SOLUTIONS FOR INDUSTRIAL PROCESSES

Cod. 11-COM.P-18-rev.76

INCREASE YOUR ENERGY EFFICIENCY WITH OUR SOLUTIONS.

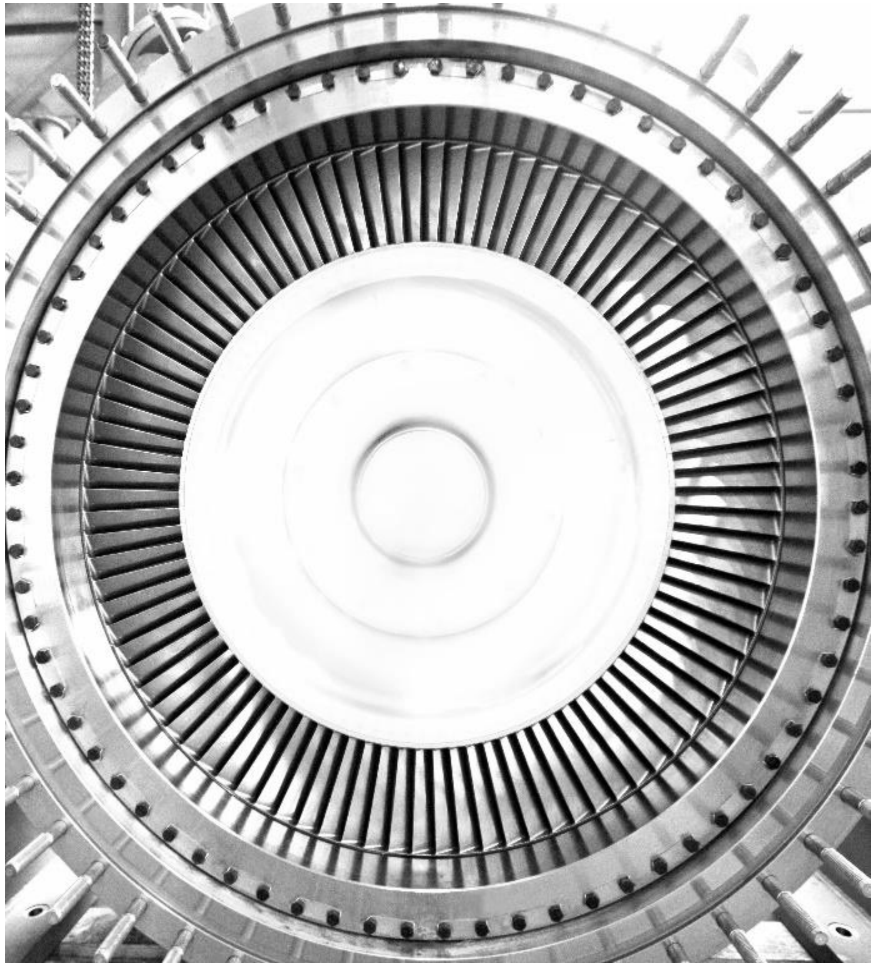
TURBODEN FOR INDUSTRIAL PROCESS

We provide energy efficiency solutions to increase the sustainability of your industrial process.

OUR PRODUCTS

Designed for decarbonisation.

ORC SYSTEM



Turboden Organic Rankine Cycle (ORC) units can produce electricity by recovering residual low-grade heat from **industrial processes** and from **internal combustion engines**, **gas turbines**, and fuel cells operating on open cycle. The generated power ranges up to **20 MW electric** per single shaft.

WHY CHOOSE ORC FOR ENERGY EFFICIENCY?

- Generate profit by valorising a waste heat source
- Reduce specific production cost by decreasing energy demand
- Improve company sustainability
- Contribute to lower carbonisation and combat climate change

ENERGY EFFICIENCY IN YOUR BUSINESS

PRODUCTION PROCESSES

Unexploited heat streams produced by industrial processes like **cement**, **glass**, **steel**, **ferroalloy**, **non-ferrous metals** (copper, aluminum, etc.), silicon metal, carbon black, etc.

OPEN CYCLES

Exhaust gases released by **gas turbines**, **internal combustion engines**, and **fuel cells** operating on open cycle.

OUTPUT

ELECTRIC POWER and/or MECHANICAL POWER

40+ plants

in heat recovery

Last update: April 2022

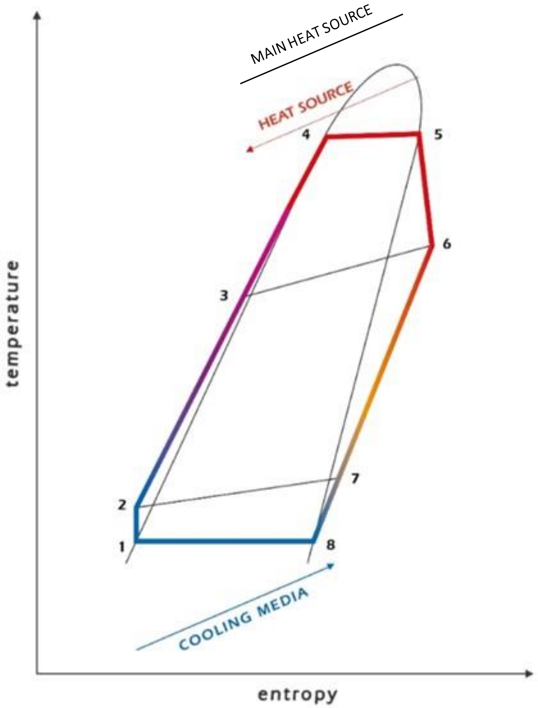
THE ORC CYCLE – HOW IT WORKS

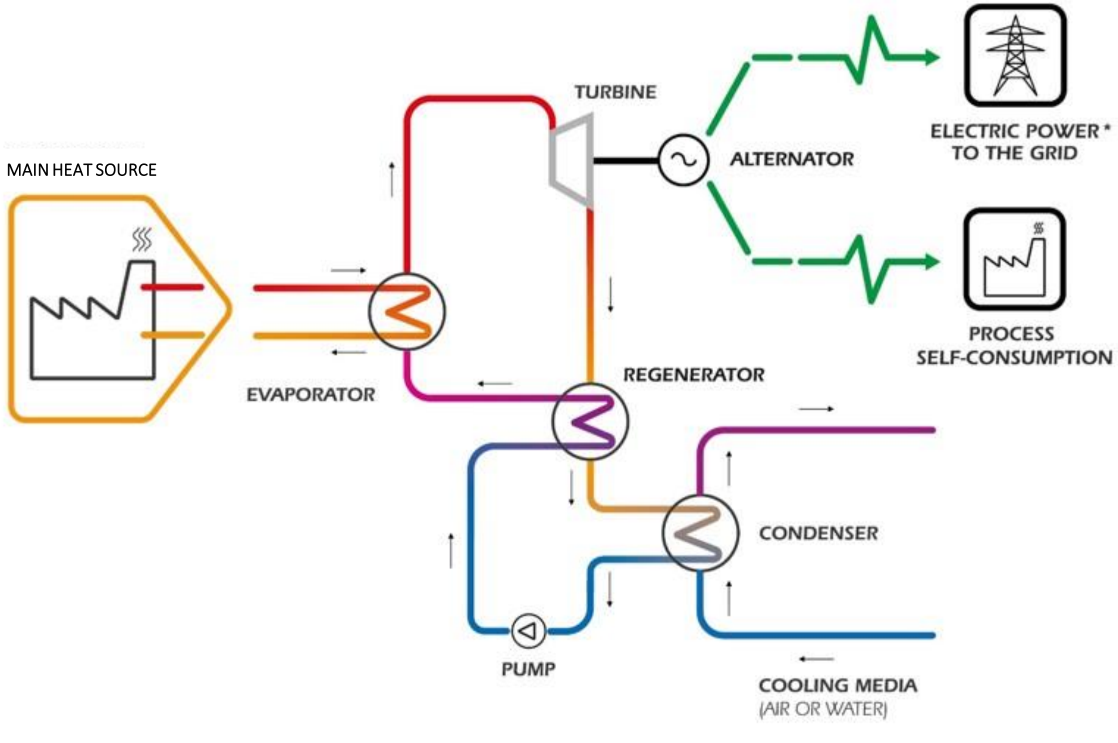
The ORC turbogenerator uses medium-to-high temperature thermal oil to preheat and vaporize a suitable organic working fluid in the evaporator (4>5).

The organic fluid vapor rotates the turbine (5>6), which is directly coupled to the electric generator, resulting in clean, reliable electric power.

The exhaust vapor flows through the regenerator (6>7), where it heats the organic liquid (2>3) and is then condensed in the condenser and cooled by the cooling circuit (7>8>1).

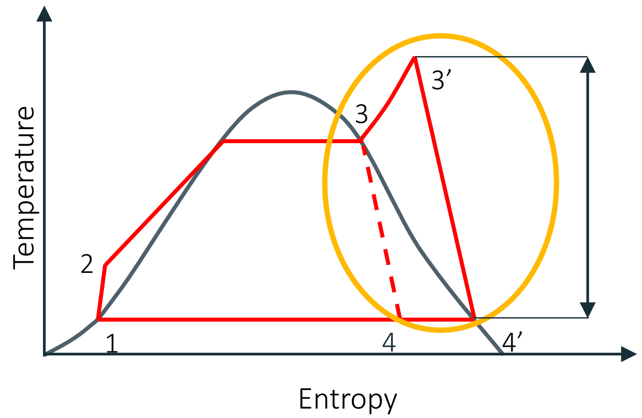
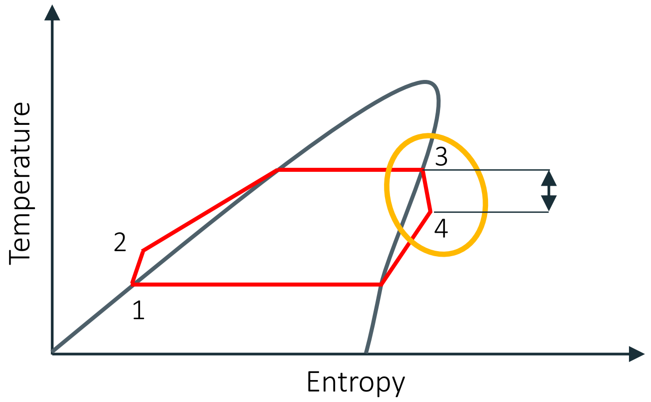
The organic working fluid is then pumped (1>2) into the regenerator and evaporator, thus completing the closed-cycle operation.



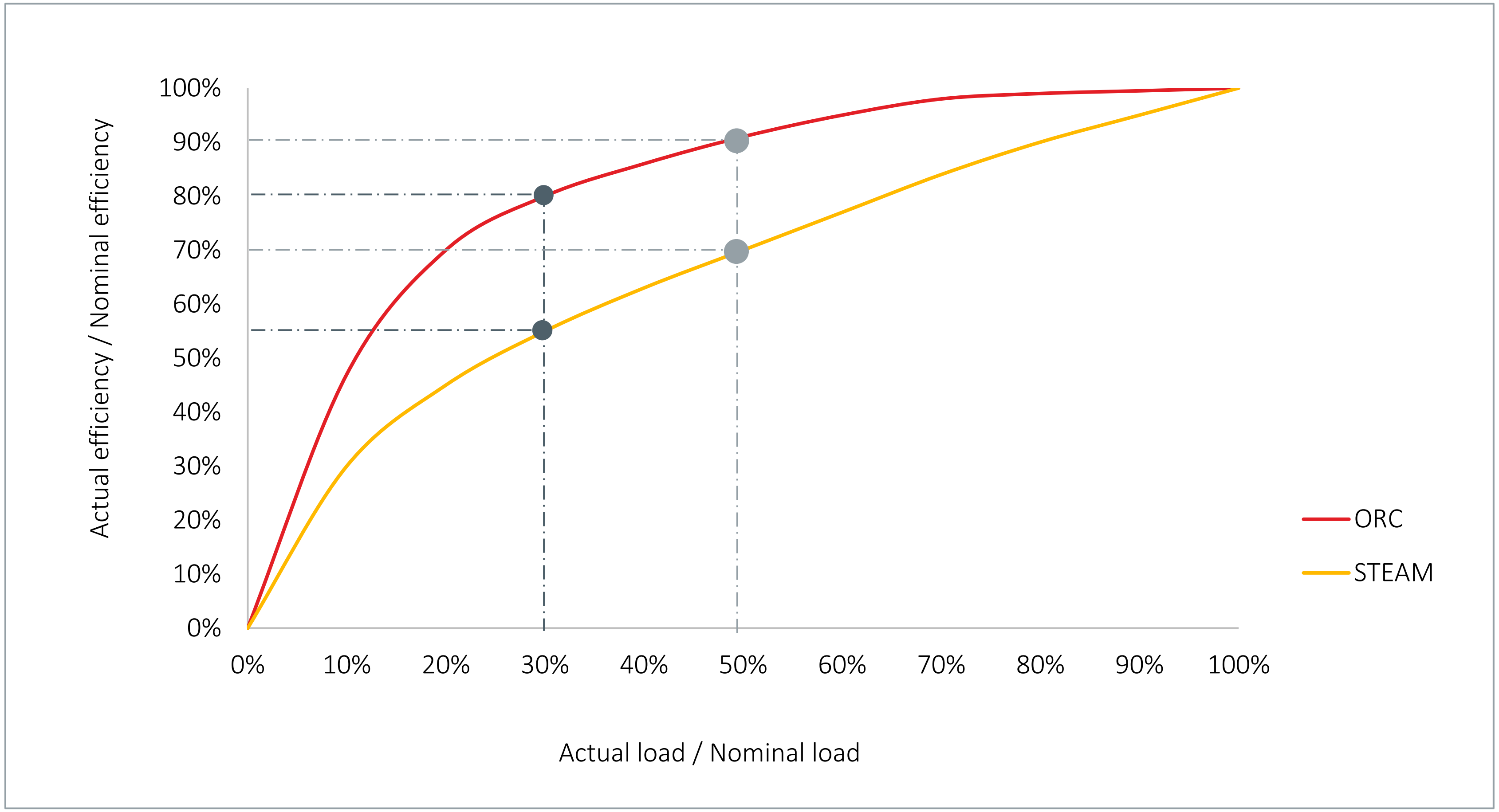


The waste heat from production process is transferred to the ORC working fluid by means of an intermediate circuit or directly via the exhaust gases in direct exchange systems. The media used in the intermediate circuits are thermal oil, saturated steam or superheated water.

THERMODYNAMIC CYCLE: ORC VS STEAM

	STEAM RANKINE CYCLE	ORGANIC RANKINE CYCLE
		
Thermodynamic features and consequences	▪ Superheating needed ▪ Risk of blade erosion due to possible liquid formation during the expansion ▪ High enthalpy drop – turbine with high stage number	▪ No need to superheat ▪ No risk of blade erosion thanks to dry expansion in the turbine ▪ Small enthalpy drop -turbine with low stage number
Operation and maintenance costs	▪ Water treatment required ▪ Highly skilled personnel needed ▪ Periodic major overhaul	▪ Water-free system ▪ Minimum Operation & Maintenance cost ▪ No major overhaul ▪ Completely automatic
Other features	▪ Low flexibility with significantly lower performances at partial load ▪ Convenience for large plants and high temperatures	▪ High flexibility - Wide operational range from 10% to 110% ▪ High availability (average >98%)

COMPARISON WITH STEAM TECHNOLOGY



50% PARTIAL LOAD

ORC 90%

STEAM 70%

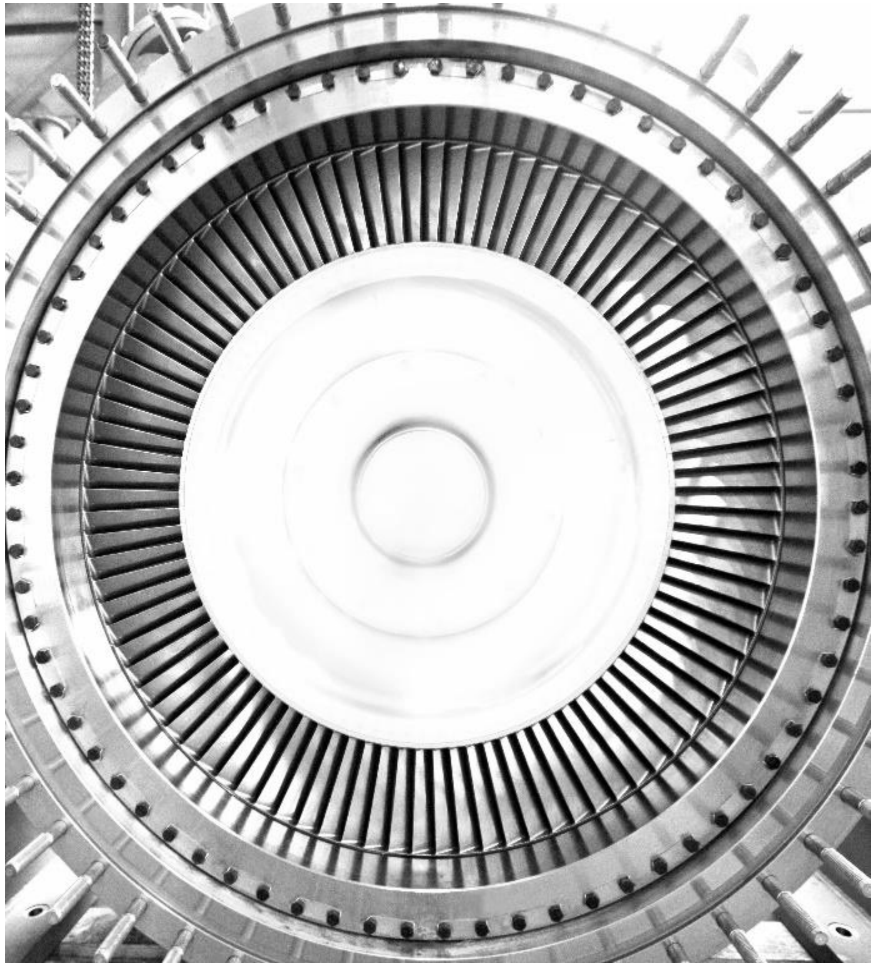
30% PARTIAL LOAD

ORC 80%

STEAM 55%

NOTE: steam turbine suffers partial load operation due to high risk of blade erosion.

ORC SYSTEM FEATURES



Simplicity

- ✓ Remote monitoring and automatic operation
- ✓ No water use and treatment required
- ✓ Minimal maintenance activities

Flexibility

- ✓ Ease of integration
- ✓ Excellent part load capability down to 10% load
- ✓ Different primary energy sources

Dependability

- ✓ High availability
- ✓ Long life (> 25 years)
- ✓ 40+ years in the design and production of turbomachinery

Sustainability

- ✓ Core system for renewable energy and energy efficiency
- ✓ Clean generation of power and heat
- ✓ Reduction of CO_2 emissions

LARGE HEAT PUMP

Large Heat Pumps are utility-scale heating plants that supply large quantities of high-temperature heat exploiting a colder energy source that would otherwise be wasted, e.g. through cooling towers. Hence, industrial processes or district heating networks can benefit from this new higher-grade heat source.

KEY POINTS

- Large-scale: output from 3 MWth to 30 MWth per unit
- High-temperature lift (ΔT up to 80°C and more)
- High-temperature output: above 100°C, including steam generation
- Various industrial applications: steel, chemicals, food & beverages, glass, refractories, pulp & paper, etc.

LARGE HEAT PUMP SCHEMATIC

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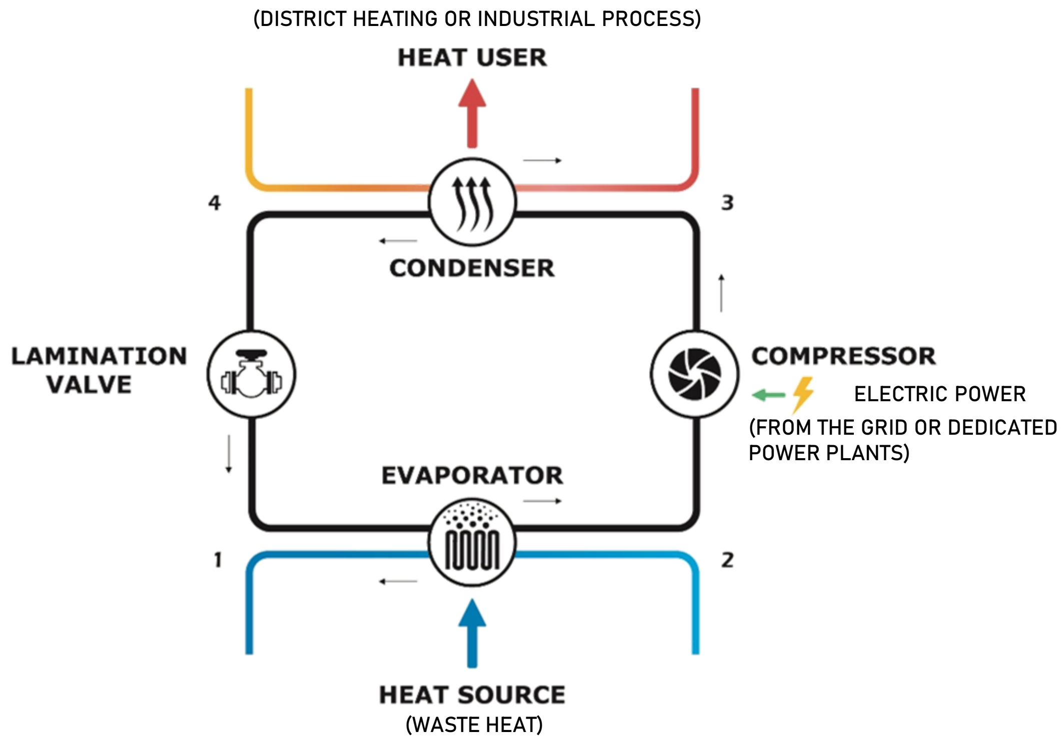
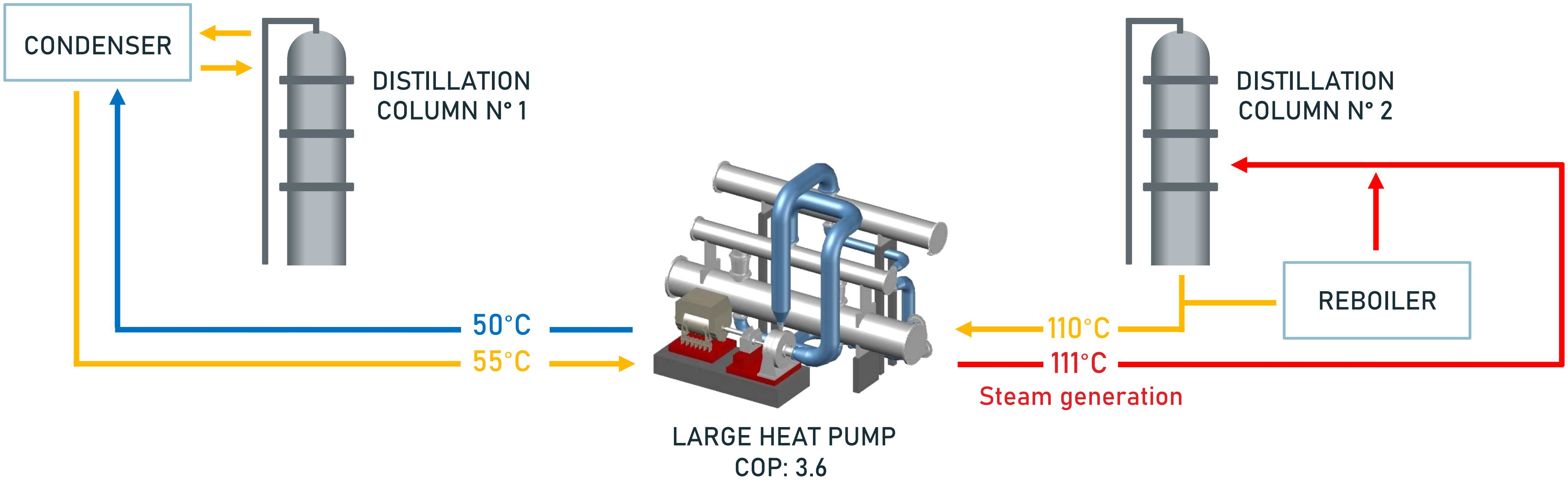


WASTE HEAT SOURCES

- Cooling in industrial processes
- Power plants waste heat
- Other waste heat
- Waste water
- Ground source
- River water

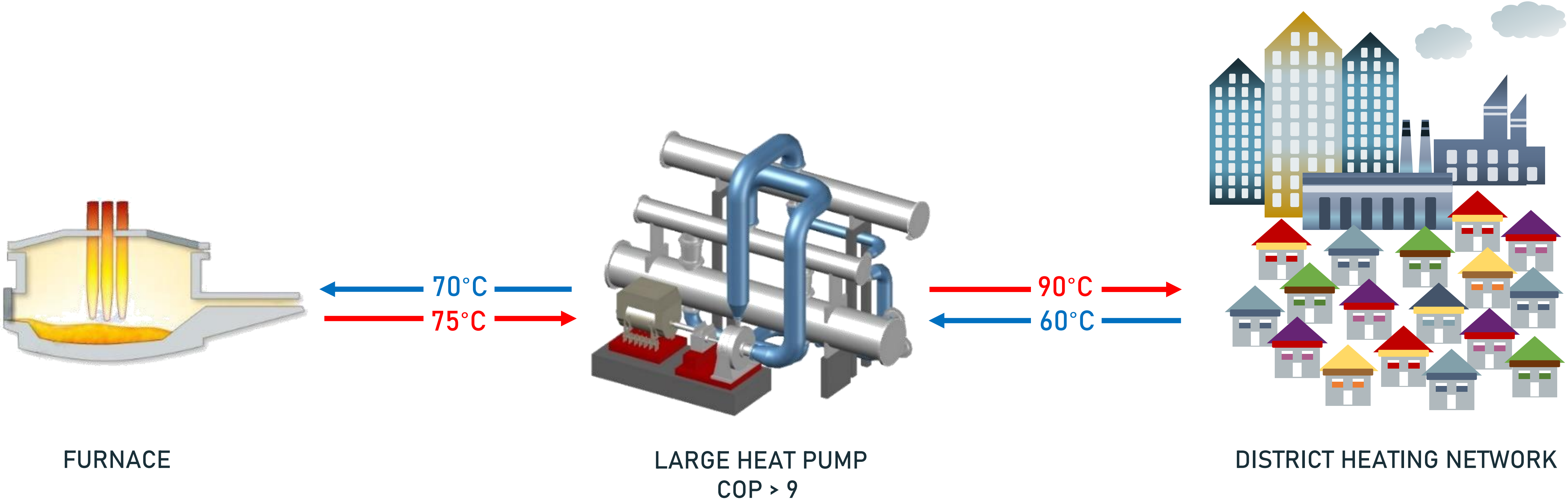
LHP IN A CHEMICAL PLANT

The low-grade heat that needs to be dissipated to cool a distillation column (n.1) can feed a LHP and therefore be used to displace other sources of higher-temperature heat in another distillation column (n.2).



LHP IN A STEELWORK

Heat from the cooling of the steelmaking process can be upgraded through a LHP and used for district heating instead of being wasted, i.e. dissipated through cooling towers.



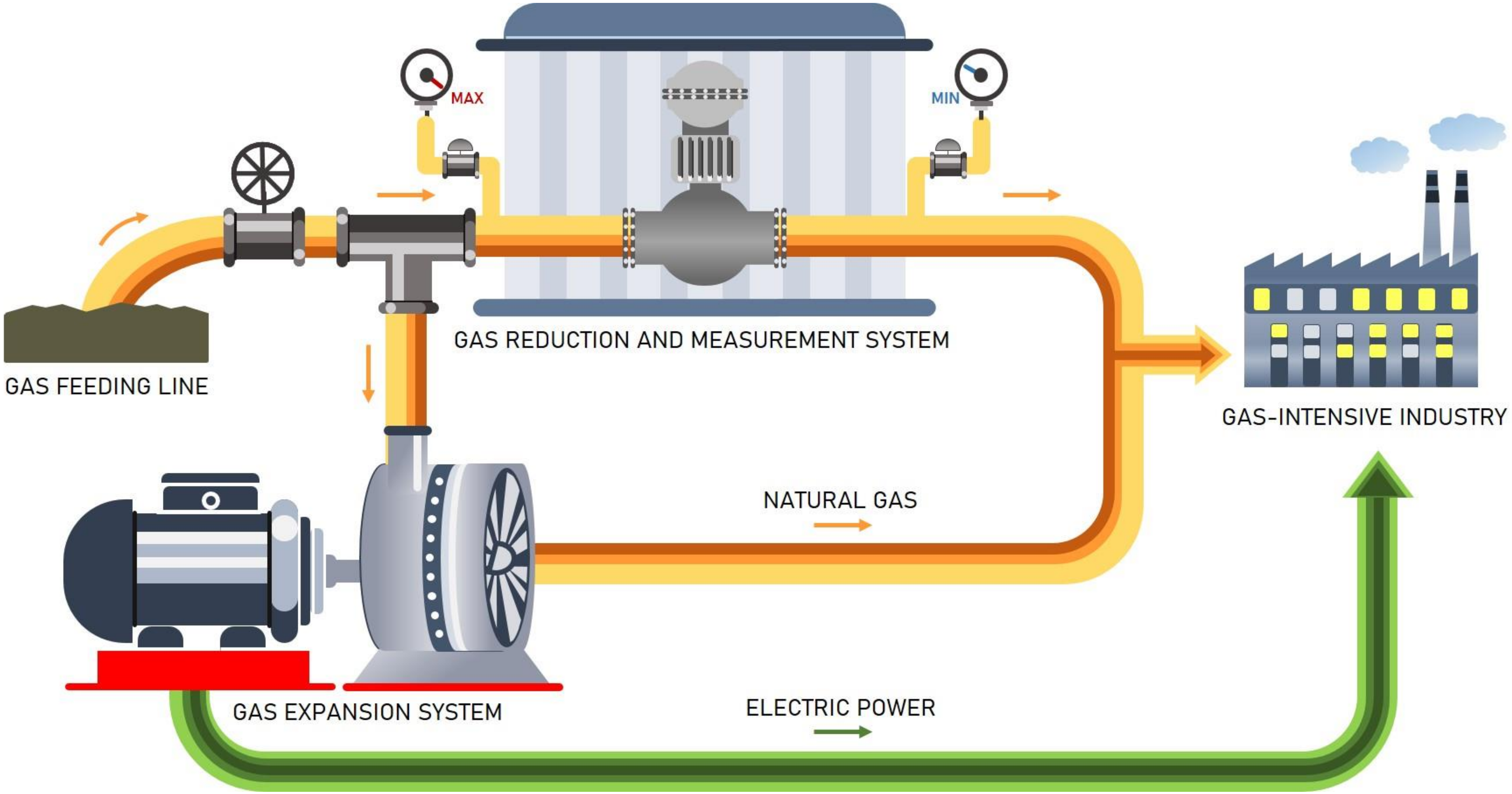
GAS EXPANDER

Turboden gas expander is an alternative solution to standard lamination valves, aimed at enhancing the energy efficiency of gas-intensive industries (or industrial parks). It produces clean electricity by exploiting gas pressure drop, otherwise wasted, from the delivery level to the one required by the industrial process. The decarbonised electricity is then delivered to the factory, reducing the associated costs.

KEY POINTS

- Design based on 40+ years of experience, leveraging Mitsubishi Heavy Industries support
- Profit generation while reducing the gas pressure
- Improvement of industry green footprint
- Unmanned installations, thanks to specific technology features
- Over 60 Turboden turbine models within the 400+ power plants fleet

GAS EXPANDER CONFIGURATION



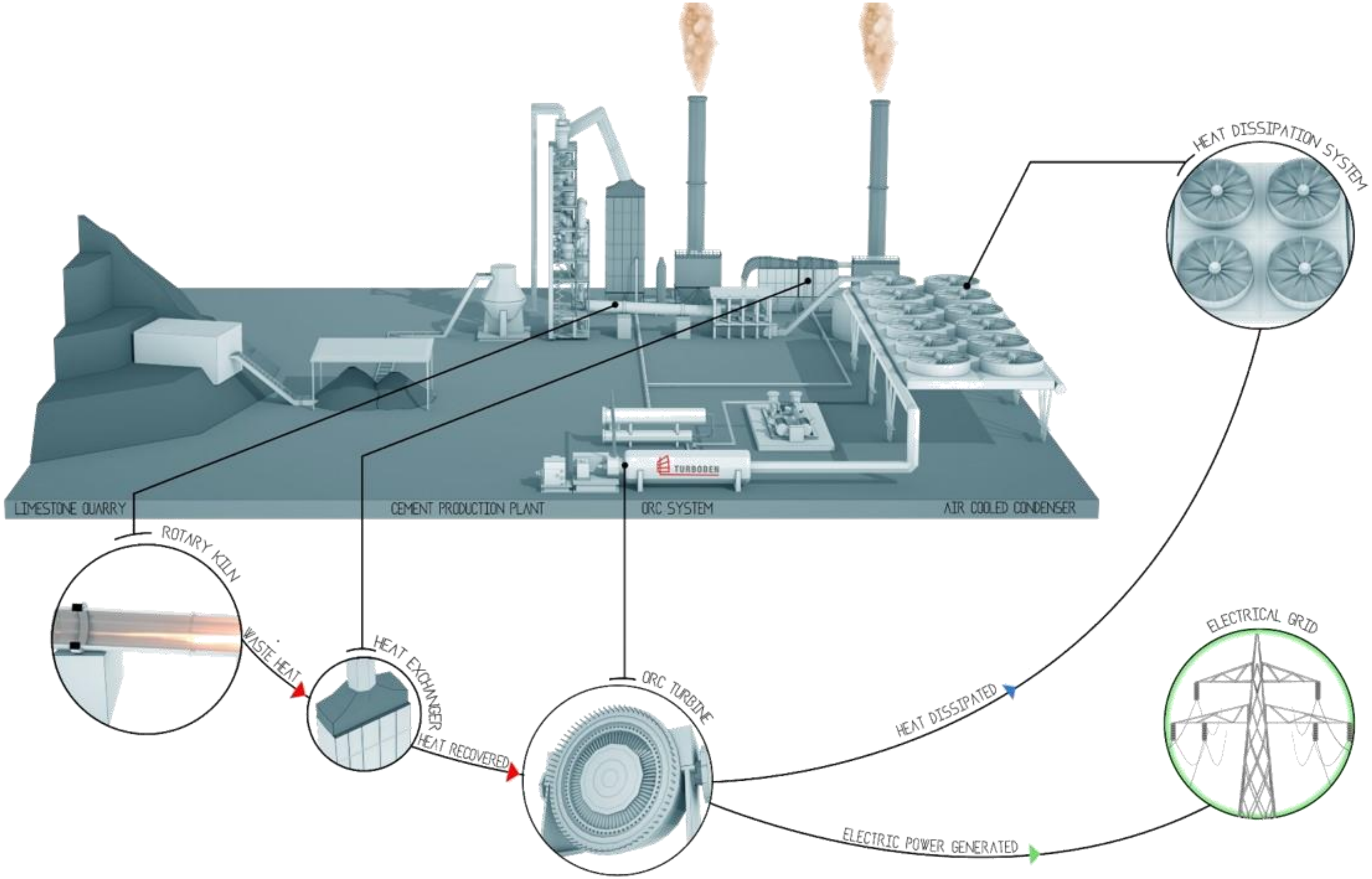
GAS EXPANDER RATING

It is a technology developed to properly fit the natural gas pressure and flow rate distinctive of gas-intensive industries.

EXPANDERS SIZES	EXP 400	EXP 600	EXP 900	EXP > 1 MW
✓ Turbine stages/admission	Single stage radial turbine	Multi stages axial turbine		
✓ Flow rate	>5000 Sm3/h	20,000 - 100,000+ Sm3/h		
✓ In - out gas pressure range	70 - 1 bar(g)			
✓ Bearings	Rolling bearings	Self-lubricated rolling bearings		
✓ Seals	Single tight casing for impeller and generator	Mechanical		
✓ Generator	Permanent Magnet generator	A/Synchronous LV - Eff. 97%		
✓ Containerization	Sandwich panel REI 120 if 10m gate distance possible; or concrete if 2m gate distance possible. Necessary to segregate electrical panel and hot water boiler.			
✓ Gas pre-heating	Hot water boiler fed by natural gas and shell&tube heat exchangers + possible combination with electrical heaters and heat pumps – custom based on project specific.			

CEMENT

WASTE HEAT RECOVERY IN CEMENT INDUSTRY



In cement production process, Turboden ORC systems can produce electric power by recovering waste heat from two hot gas streams:

- kiln pre-heater (PH) gas
- clinker cooler (CC) gas

Turboden ORC systems are easy to integrate, with no impact on industrial process or prime equipment (engine, gas turbine) operation.

TURBODEN REFERENCES IN CEMENT

PLANT	COUNTRY	START UP	KILN CAPACITY (ton/day)	HEAT SOURCE	HEAT CARRIER	ORC GROSS EL. POWER (kW)
CIMENTS DU MAROC (HeidelbergCement Group, former Italcementi)	Morocco	2010	5,000	PH	thermal oil	2,000
HOLCIM ROMANIA (LafargeHolcim Group)	Romania	2012	4,000	PH + CC	thermal oil + superheated water	4,000
CRH SLOVAKIA (former Holcim Group)	Slovakia	2014	3,600	PH + CC	thermal oil	5,000
CARPATCEMENT (HeidelbergCement Group)	Romania	2015	3,500	PH + CC	thermal oil	3,800
JURA-CEMENT-FABRIKEN (CRH Group)	Switzerland	2016	3,000	PH	superheated water	2,300
CEMENTI ROSSI	Italy	2018	3,500	PH + CC	none – direct exchange	2,000
ÇİMKO (Sanko Group) - EPC: CTP Team	Turkey	2019	9,500	CC	thermal oil	7,000
HOLCIM SUISSE ECLÉPENS (LafargeHolcim Group)	Switzerland	2020	2,300	PH + CC	thermal oil	1,300
SÖNMEZ ÇIMENTO EPC: CTP Team	Turkey	2020	6,000	PH + CC	thermal oil	7,300
SECIL EPC: CTP Team	Portugal	Under construction	3,800	PH + CC	thermal oil	7,200

HOLCIM ROMANIA

CUSTOMER:
Holcim Romania (LafargeHolcim Group)

COUNTRY:
Romania

ORC ELECTRIC POWER:
4 MW

STATUS:
in operation since 2012

CLINKER PRODUCTION CAPACITY:
≈ 4,000 ton/day

HEAT SOURCE:
pre-heater exhaust gas + clinker cooler air

HEAT CARRIER:
thermal oil + superheated water

COOLING SYSTEM:
water cooled condenser + cooling towers (open loop)

CRH

CUSTOMER:
CRH (former Holcim Group)

COUNTRY:
Slovakia

ORC ELECTRIC POWER:
5 MW

STATUS:
in operation since 2014

CLINKER PRODUCTION CAPACITY:
≈ 3,600 ton/day

HEAT SOURCE:
pre-heater exhaust gas + clinker cooler air

HEAT CARRIER:
thermal oil

COOLING SYSTEM:
water cooled condenser + cooling towers (open loop)

CARPATCEMENT

CUSTOMER:
Carpatcement (HeidelbergCement Group)

COUNTRY:
Romania

ORC ELECTRIC POWER:
3.8 MW

STATUS:
in operation since 2015

CLINKER PRODUCTION CAPACITY:
≈ 3,500 ton/day

HEAT SOURCE:
pre-heater exhaust gas + clinker cooler air

HEAT CARRIER:
thermal oil

COOLING SYSTEM:
air cooled condenser (no water consumption)

ÇIMKO

CUSTOMER:
CTP Team / Çimko (Sanko Holding)

COUNTRY:
Turkey

ORC ELECTRIC POWER:
7 MW

STATUS:
in operation since 2019

CLINKER PRODUCTION CAPACITY:
≈ 9,500 ton/day

HEAT SOURCE:
clinker cooler air

HEAT CARRIER:
thermal oil

COOLING SYSTEM:
air cooled condenser (no water consumption)

SÖNMEZ ÇIMENTO

CUSTOMER:
CTP Team / Sönmez Çimento

COUNTRY:
Turkey

ORC ELECTRIC POWER:
7.3 MW

STATUS:
in operation since 2020

CLINKER PRODUCTION CAPACITY:
≈ 6,000 ton/day

HEAT SOURCE:
pre-heater exhaust gas + clinker cooler air

HEAT CARRIER:
thermal oil

COOLING SYSTEM:
air cooled condenser (no water consumption)

STEEL & METALS


INTEGRATED STEEL PLANTS
(SINTER COOLER, ETC.)
medium temperature, high flow rate
ELECTRIC ARC FURNACE
(EAF)
high flow rate at high temperatures, high dust content, large variations in operating cycle
SUBMERGED ARC FURNACE
(SAF)
high flow rate at medium temperatures, medium dust content, stable flow rate
PROCESS FURNACE
(RE-HEATING, ETC.)
low temperature power available, small WHR plants
MAIN HEAT SOURCES

TURBODEN REFERENCES IN STEEL & METAL

PLANT	START UP	MAIN PROCESS EQUIPMENT			HEAT CARRIER	ORC
		type	charge	capacity		gross electric power (kW)
NATSTEEL Singapore	2013	steel rolling mill billet reheating furnace	billet	125 ton/h	none – direct exchange	700
ELBE STAHLWERKE FERALPI Germany	2013	steel electric arc furnace	scrap	100 ton	saturated steam	2,700
ORI MARTIN Italy	2016	steel electric arc furnace	scrap - consteel	85 ton	saturated steam	2,200
FONDERIA DI TORBOLE Italy	2016	iron cupola furnace	scrap, pigs	30 ton/h	thermal oil	700
ARVEDI Italy	2018	steel electric arc furnace	scrap	250 ton	saturated steam	10,000
SAFRAN EPC: INVEST ENERGY Malaysia	2019	chemical vapor infilatration furnace	n.a.	n.a.	thermal oil	1,900
POSCO ICT South Korea	2019	Fe-Mn submerged arc furnace	raw materials	150 ton/d	thermal oil	1,200
SACAL Italy	2019	aluminum rotative furnaces	scrap	n.a.	thermal oil	2,100

ESF ELBE-STAHLWERKE FERALPI

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CUSTOMER:
ESF Elbe-Stahlwerke Feralpi GmbH

COUNTRY:
Germany

ORC ELECTRIC POWER:
2.7 MW

STATUS:
in operation since 2013

TYPE OF PROCESS FOR WHR:
steel - electric arc furnace

HEAT SOURCE:
EAF exhaust gas

HEAT CARRIER:
saturated steam

COOLING SYSTEM:
water cooled condenser + cooling towers (open loop)

FONDERIA DI TORBOLE

CUSTOMER:
Fonderia di Torbole

COUNTRY:
Italy

ORC ELECTRIC POWER:
0.7 MW

STATUS:
in operation since 2016

TYPE OF PROCESS FOR WHR:
iron cupola furnace

HEAT SOURCE:
cupola furnace exhaust gas

HEAT CARRIER:
thermal oil

COOLING SYSTEM:
water cooled condenser + air coolers (no water consumption)

ARVEDI

CUSTOMER:
Arvedi S.p.A.

COUNTRY:
Italy

ORC ELECTRIC POWER:
10 MW

STATUS:
in operation since 2018

TYPE OF PROCESS FOR WHR:
steel - electric arc furnace

HEAT SOURCE:
EAF exhaust gas

HEAT CARRIER:
saturated steam

COOLING SYSTEM:
water cooled condenser + cooling towers (open loop)

ORI MARTIN

CUSTOMER:
ORI Martin

COUNTRY:
Italy

ORC ELECTRIC POWER:
2.2 MW

STATUS:
in operation since 2016

TYPE OF PROCESS FOR WHR:
steel - electric arc furnace

HEAT SOURCE:
EAF exhaust gas

HEAT CARRIER:
saturated steam

COOLING SYSTEM:
water cooled condenser + cooling towers (open loop)

GLASS

Waste heat can be recovered from the production process of:

- Float glass
- Container glass

NEW SOLUTIONS

TYPICAL SCHEME	NEW SCHEME	HYBRID SCHEME
ELECTRIC POWER	**COMPRESSED AIR**	**POWER & AIR**
ORC TURBINE + ELECTRIC GENERATOR	ORC TURBINE + AIR COMPRESSOR	ORC TURBINE + ELECTRIC GENERATOR + AIR COMPRESSOR

- Up to 800 kW
- Modular design
- Direct exchange configuration

FOR CONTAINER GLASS

TURBODEN REFERENCES IN GLASS INDUSTRY

PLANT	COUNTRY	START UP	MAIN PROCESS EQUIPMENT type	MAIN PROCESS EQUIPMENT capacity	HEAT CARRIER	ORC gross electric power (kW)
AGC (GEA Bishoff)	Italy	2012	float glass	600 ton/d	thermal oil	1,300
undisclosed	Italy	2015	container glass	500 ton/d	thermal oil	500
DÜZCE CAM (Çalbıyık Grup)	Turkey	2018	float glass	2 x 600 ton/d	thermal oil	6,200
SAINT-GOBAIN (GEA Bishoff)	India	2019	float glass	600 ton/d	thermal oil	1,200
SAINT-GOBAIN (GEA Process Engineering)	Italy	2019	float glass	600 ton/d	thermal oil	1,200 (mechanical power used to produce compressed air)
VETRERIE DEL NORD	Italy	Under construction	container glass		thermal oil	1,000
VETRERIA COOPERATIVA PIEGARESE SOC. COOP. A R.L.	Italy	Under construction	container glass		thermal oil	2,000
AFT FLOAT GLASS THAILAND	Thailand	Under construction	float glass	600 ton/d	thermal oil	1,800

AGC

EPC / FINAL USER:
GEA Bischoff / AGC Flat Glass Italia

COUNTRY:
Italy

STATUS:
in operation since 2012

ORC ELECTRIC POWER:
1.3 MW

GLASS PRODUCTION CAPACITY:
600 ton/day

HEAT SOURCE:
float glass furnace exhaust gas

HEAT CARRIER:
thermal oil

COOLING SYSTEM:
water cooled condenser + cooling towers

GLASS PRODUCER

EPC / FINAL USER:
undisclosed

COUNTRY:
Italy

STATUS:
in operation since 2015

ORC ELECTRIC POWER:
0.5 MW

GLASS PRODUCTION CAPACITY:
500 ton/day

HEAT SOURCE:
container glass furnace exhaust gas

HEAT CARRIER:
thermal oil

COOLING SYSTEM:
water cooled condenser + closed loop cooling towers

DÜZCE CAM

EPC / FINAL USER:
Calbıyık Grup / Düzce Cam

COUNTRY:
Turkey

STATUS:
in operation since 2018

ORC ELECTRIC POWER:
6.2 MW

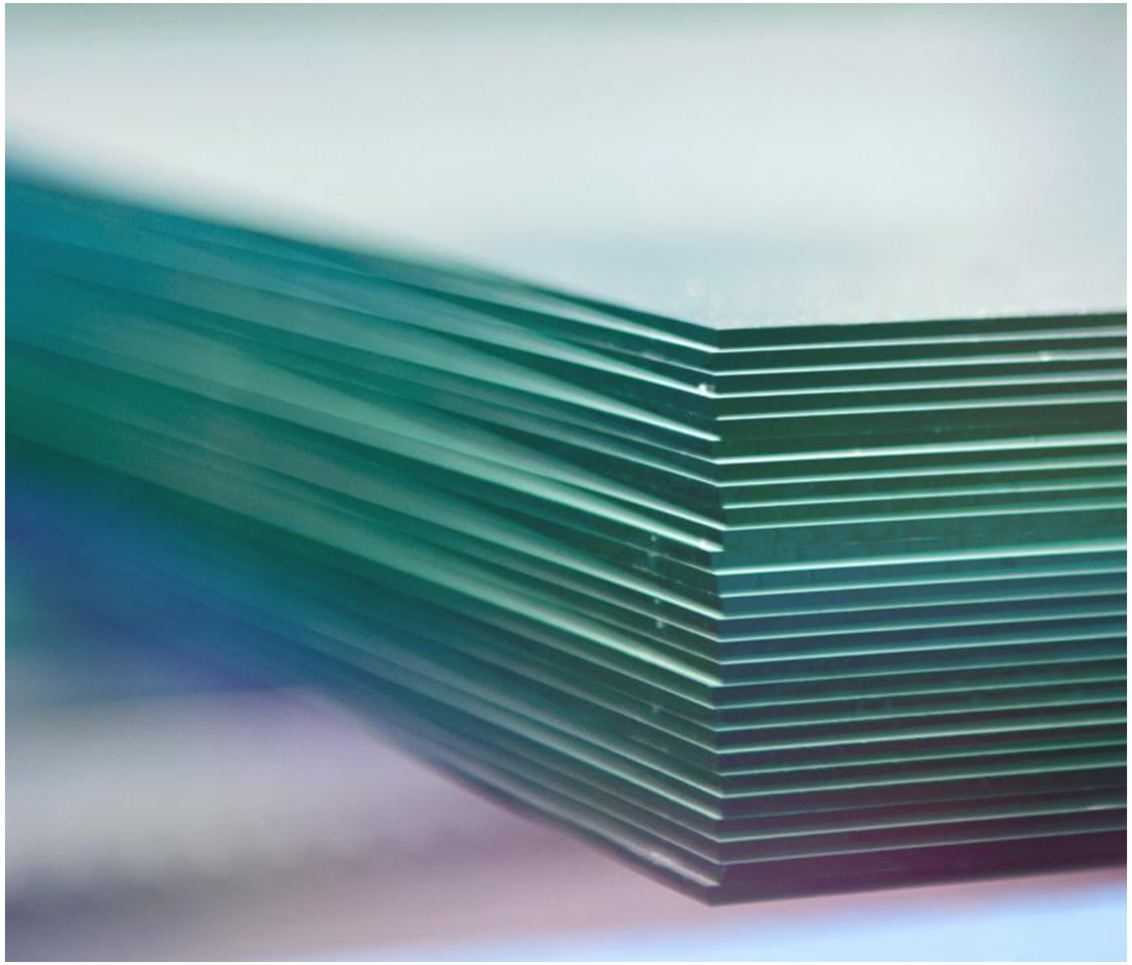
GLASS PRODUCTION CAPACITY:
2 x 600 ton/day

HEAT SOURCE:
two float glass furnaces exhaust gas

HEAT CARRIER:
thermal oil

COOLING SYSTEM:
air cooled condenser (no water consumption)

AFT FLOAT GLASS THAILAND



EPC / FINAL USER:
AFT Float Glass Thailand

COUNTRY:
Thailand

STATUS:
under construction

ORC ELECTRIC POWER:
1.8 MW

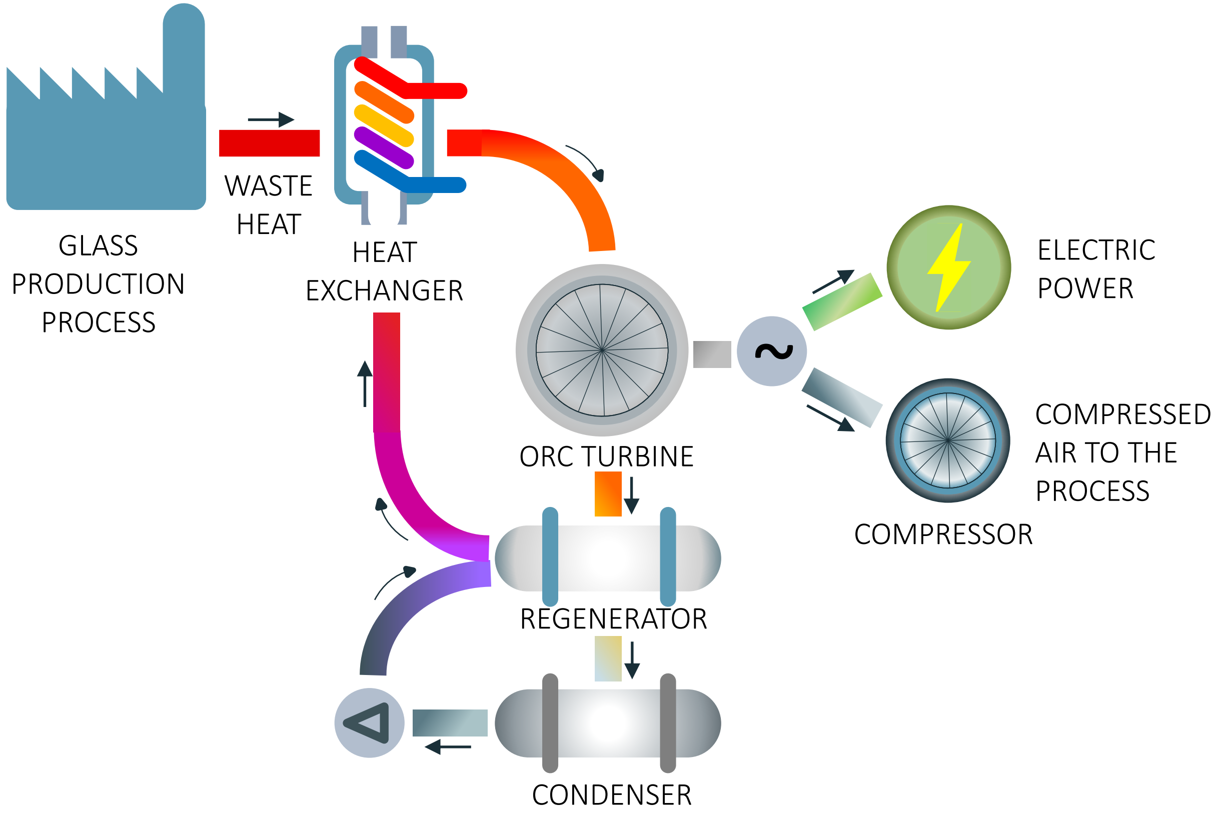
GLASS PRODUCTION CAPACITY:
600 ton/day

HEAT SOURCE:
float glass furnace exhaust gas

HEAT CARRIER:
thermal oil

COOLING SYSTEM:
water cooled condenser + cooling towers

SAINT GOBAIN ITALY



EPC / FINAL USER:
GEA Process engineering / Saint Gobain Italy

COUNTRY:
Italy

STATUS:
in operation since 2019

SOLUTION:
ORC turbine connected to double-shaft generator and air compressor

ORC ELECTRIC POWER:
1 MW

COMPRESSED AIR PRODUCTION:
84 Nm3/min at 7 bar(g)

GLASS PRODUCTION CAPACITY:
600 ton/day

HEAT SOURCE:
float glass furnace exhaust gas

HEAT CARRIER:
thermal oil

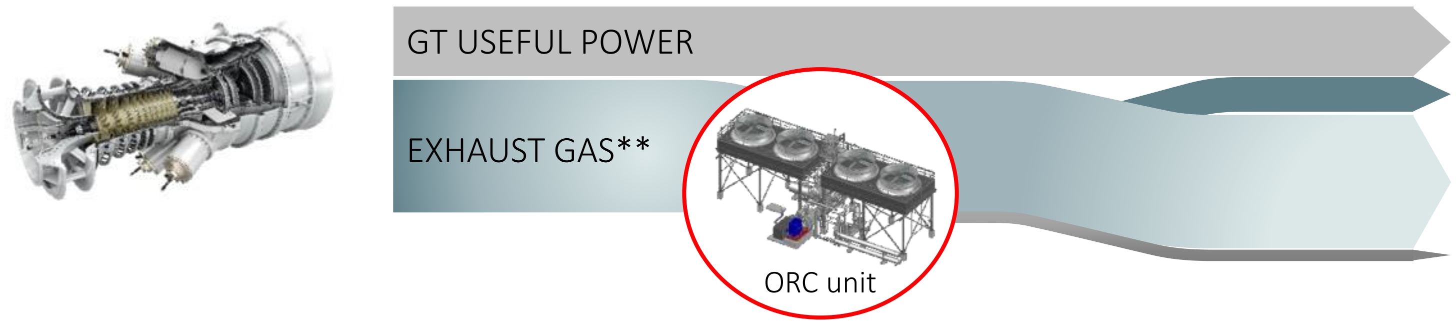
COOLING SYSTEM:
water cooled condenser + closed loop cooling towers

COMBINED CYCLES

OVERALL PLANT PERFORMANCES

GAS TURBINES

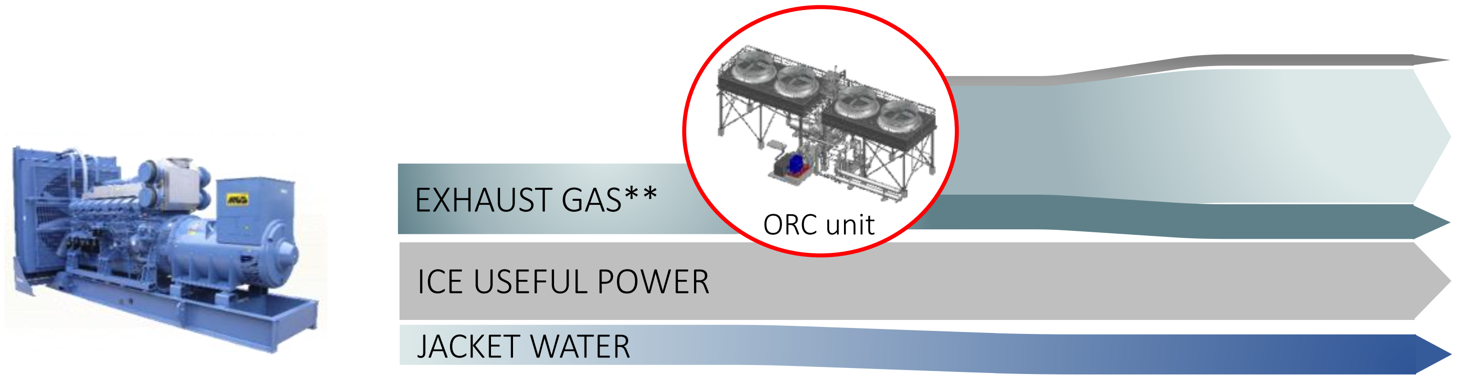
30÷40% ORC additional power*



18 ÷ 30%	Useful power ***
80 ÷ 68%	Thermal power
2%	Thermal losses

INTERNAL COMBUSTION ENGINES

10% ORC additional power*

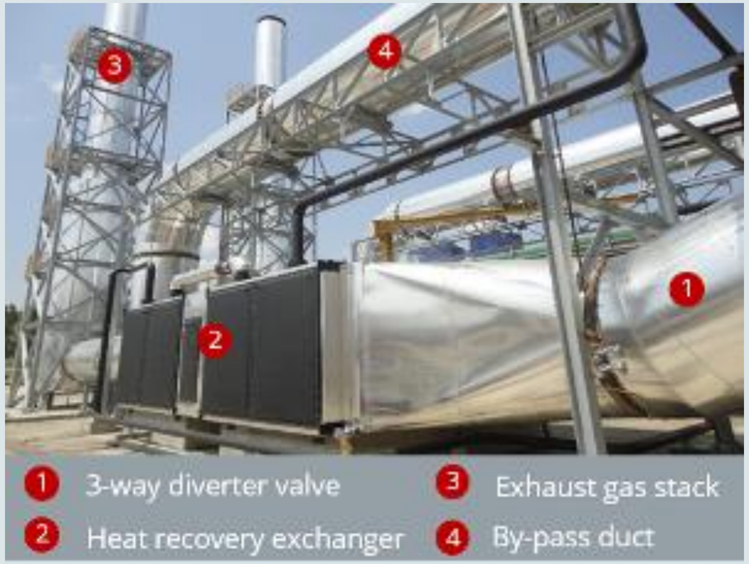


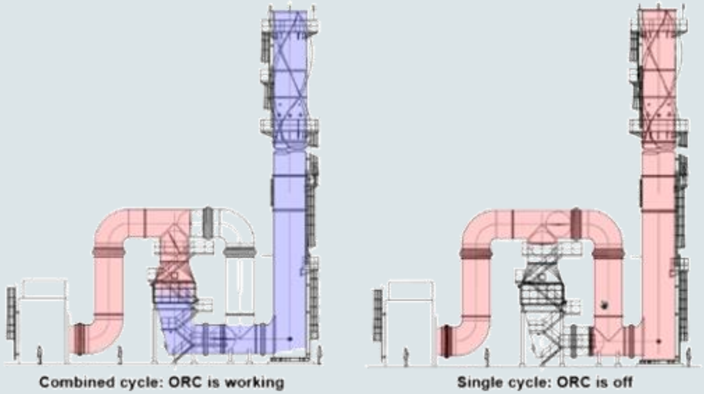
2%	Thermal losses
80 ÷ 72%	Thermal power
18 ÷ 26%	Useful power ***

* ORC power output compared to GT or ICE shaft capacity (e.g. 10 MW GT → 3÷4 MWe ORC; 10 MW ICE → approx. 1 MWe ORC).
** Min. flow to ORC: from GT 10-15 kg/s; from ICE 30-40 kg/s.
*** Mechanical and/or electric, calculated on thermal power input to ORC.

EXHAUST GAS HEAT RECOVERY EXCHANGER CONFIGURATION

- EGHEs installed in **by-pass** to the main exhaust gas ducting in order to **avoid any impact on the gas turbines operation** in any circumstance.
- **EGHEs completely isolable** with a diverter prior to the EGHEs and an insulation valve right after it. Diverter equipped with air sealing to ensure 100% insulation. This permits to **insulate the EGHEs, ensuring gas turbines operation** even in case of major issues on the EGHEs.
- Pneumatic **safety-closed diverter** to avoid any impact on gas turbines operation even during emergency situation.
- EGHE equipped with sparking detector, flame detector and thermocouples in different bundle position to **ensure the maximum safety of the system.**
- **False air** fan installed in order to keep the EGHE temperature at acceptable level even in case of gas turbines particular operation cases.





TURBODEN REFERENCES IN COMBINED CYCLES

PLANT	COUNTRY	START UP	ORC SIZE (MWe)	HEAT SOURCE
TRANSGAS	Canada	2011	**1**	Solar Centaur 40 gas turbine in gas compressor station
UZTRANSGAZ	Uzbekistan	2021	**1**	3 GE LM 1600 gas turbines in gas compressor station
GASCO	Egypt	under construction	**24**	5 X 30 MWe gas turbines (4 in operation, 1 in stand-by) in gas compressor station
PISTICCI I	Italy	2010	**1.8**	3 x 8 MWe Wärtsilä diesel engines
TERMOINDUSTRIALE	Italy	2008	**0.5**	1 x 8 MWe MAN diesel engine
PISTICCI II	Italy	2012	**4**	2 x 17 MWe Wärtsilä diesel engines
CEREAL DOCKS	Italy	2012	**0.5** (direct exchange)	1 x 7 MWe Wärtsilä diesel engine
E&S ENERGY	Italy	2010	**0.6**	2 x 1 MWe Jenbacher gas engines + 3 x 0.8 MWe Jenbacher gas engines + 1 x 0.6 MWe Jenbacher gas engine – landfill gas
ULM	Germany	2012	**0.7**	2 x 2 MW Jenbacher gas engines (+ additional heat from process)
KEMPEN	Germany	2012	**0.6**	Gas engines
MONDO POWER	Italy	2012	**1**	1 x 17 MWe Wärtsilä diesel engine
HSY	Finland	2011	**1.3**	4 x 4 MWe MWM gas engines – landfill gas
FATER	Italy	2013	**0.7** (direct exchange)	1 x 8 MWe Wärtsilä diesel engine
ORTADOGU I	Turkey	under construction	**2 x 2.3**	28 x 1.4 MWe Jenbacher engines + 4 x 1.2 MWe MWM engines – landfill gas
ORTADOGU II	Turkey	2020	**2.3**	12 x 1.4 MWe Jenbacher engines – landfill gas
BIOGASTECH	Belgium	2019	**0.7**	4 x 3.3 MWe Jenbacher gas engines

TRANSGAS

CUSTOMER:
TransGas

COUNTRY:
Canada

STATUS:
in operation since 2011

DESCRIPTION:
power generation from waste heat from Solar Centaur 40 gas turbine in a gas compressor station

ORC ELECTRIC POWER:
1 MW (more than 28% of gas turbine shaft power)

GAS TURBINE PRIME POWER:
3.5 MWm

GAS TURBINE EFFICIENCY:
28%

UZTRANSGAZ

CUSTOMER:
Uztransgaz

COUNTRY:
Uzbekistan

STATUS:
in operation since 2021

DESCRIPTION:
power generation from waste heat from 3 GE LM 1600 gas turbines in Hodzhaabad gas compressor station operated by Uztransgaz

ORC ELECTRIC POWER:
1 MW - island mode operation. The ORC unit covers the compressor station captive consumption

FEATURES:
solution with air-cooled condenser, no water needed, containerized solution

DAHSHOUR

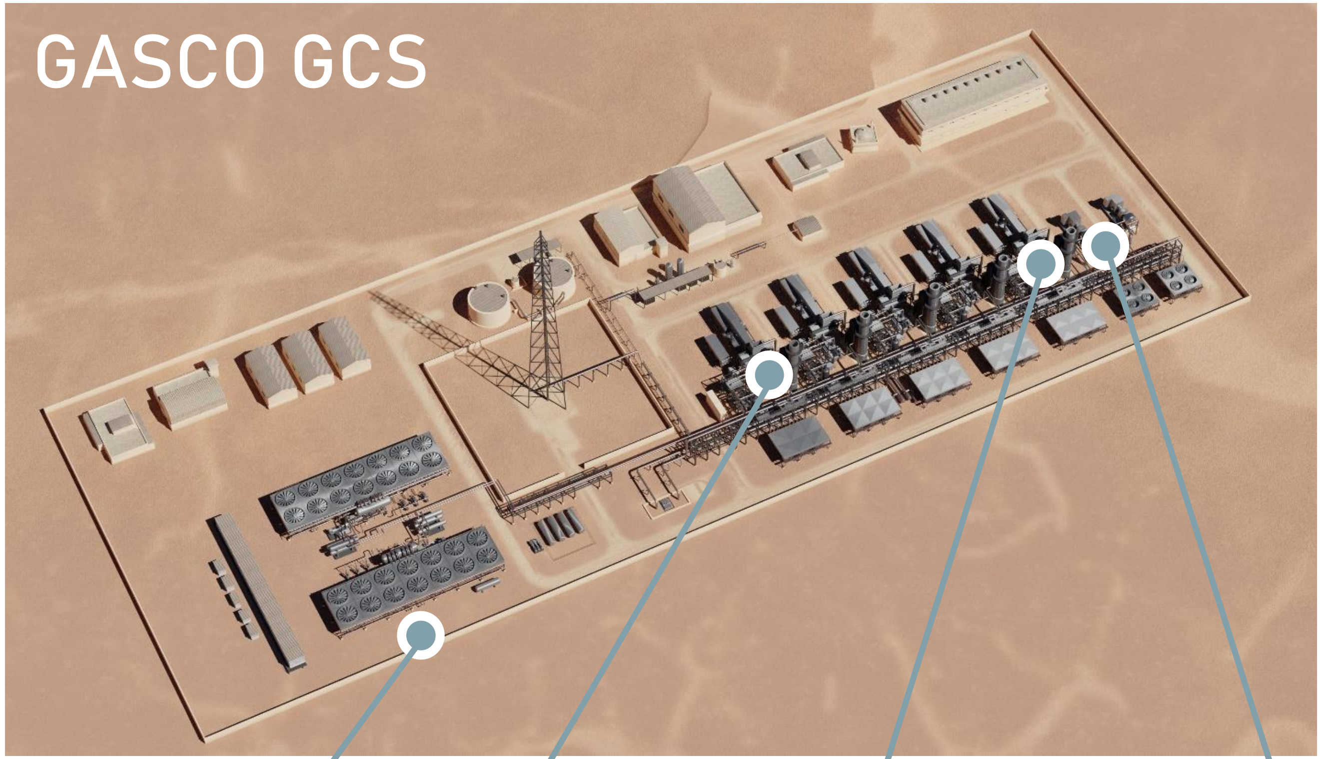
CUSTOMER:
GASCO

COUNTRY:
Egypt

STATUS:
under construction

DESCRIPTION:
power generation from waste heat from 5 simple cycle GTs (4 in operation 1 in standby) in gas compressor station.

ORC ELECTRIC POWER:
24+ MWe to feed 2 electrical motor driven compressors of 10 MW each that will empower compressor station pumping capacity.



24 MWe ORC SYSTEM
(two ORCs of 12 MWe net each)

NEW GAS TURBINE COMPRESSION TRAIN
50 MW GT driven train

ELECTRICAL MOTOR DRIVEN TRAINS
(two trains of 10 MW each)

WASTE HEAT RECOVERY SYSTEM
one WHR exchanger for each GT
(4 existing GTs + 1 new GT)

CEREAL DOCKS

CUSTOMER:
Cereal Docks

COUNTRY:
Italy

STATUS:
in operation since 2012

DESCRIPTION:
power generation from exhaust gas of 1 x 7 MWe Wärtsilä diesel engine

ORC ELECTRIC POWER:
0.5 MW

HEAT CARRIER:
none – direct exchange

COOLING SYSTEM:
water cooled condenser + air coolers (closed water loop)

HSY

CUSTOMER:
Helsinki Region Environmental Services Authority HSY

COUNTRY:
Finland

STATUS:
in operation since 2011

DESCRIPTION:
power generation from exhaust gas of 4 x 4 MWe MWM gas engines – landfill gas

ORC ELECTRIC POWER:
1.3 MW

HEAT CARRIER:
thermal oil

COOLING SYSTEM:
water cooled condenser + air coolers (closed water loop)

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