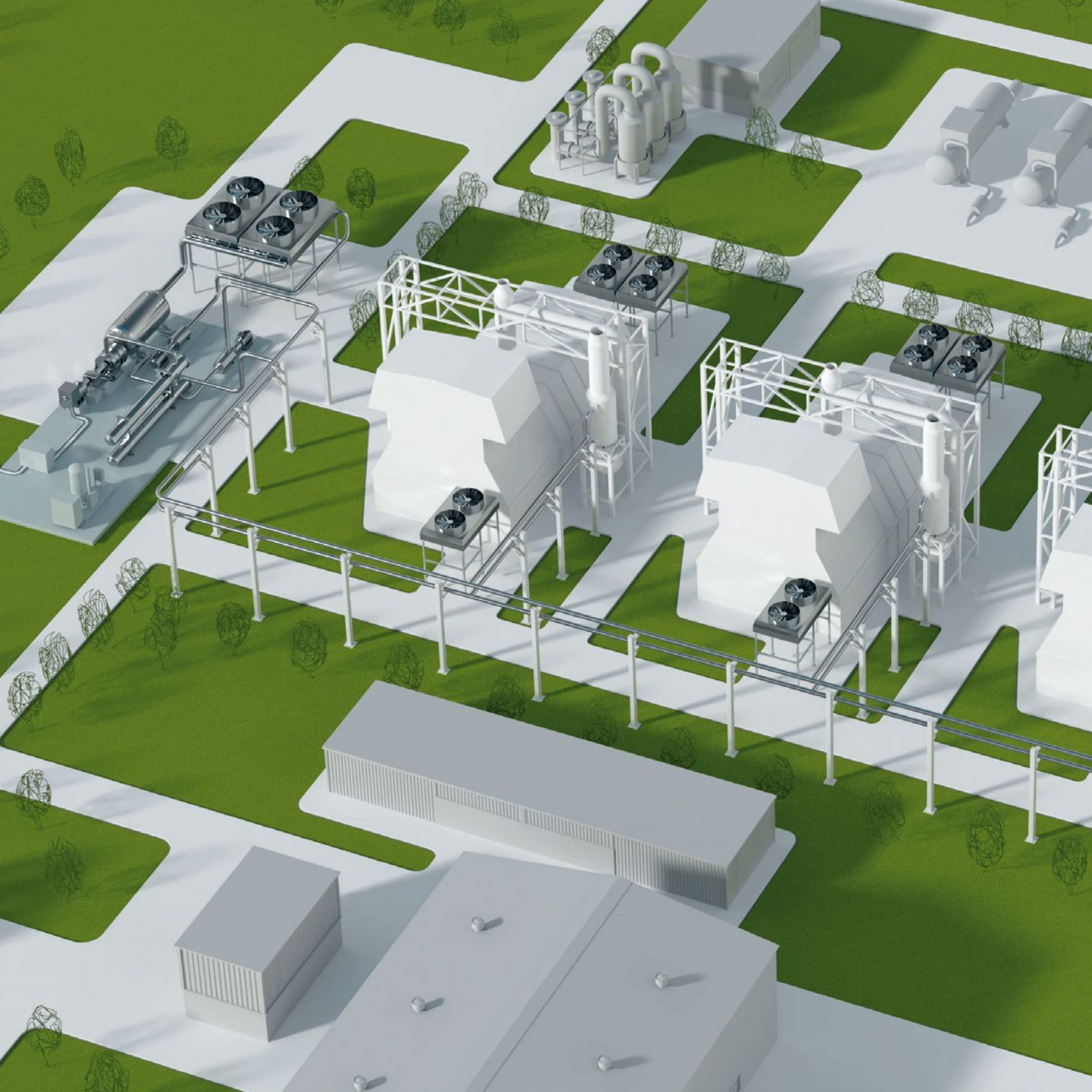
clean energy ahead

TURBODEN®

OIL & GAS

ENERGIZE YOUR FUTURE. DON'T WASTE YOUR POWER.



Turn waste heat into useful power

Turboden Organic Rankine Cycle (ORC) units enable power production (up to 20 MW per single turbine) by recovering waste heat from the exhausts of gas turbines or internal combustion engines, or from the hot streams typically present in Oil & Gas industry. ORC turbogenerators provide a solution to improving the efficiency of typical Oil & Gas processes, by allowing users to reduce their environmental footprint through converting waste, high-to-low grade heat, into mechanical and/or electric power.

GAS TURBINES OR INTERNAL COMBUSTION ENGINES

- Gas compressor stations
- Gas storage
- Oil pumping stations
- Sea water injection systems

ASSOCIATED PETROLEUM GAS

- Boilers
- Gas turbines or internal combustion engines

PROCESS HOT STREAMS

- Refinery hot streams
- Thermal oil used in Oil & Gas process
- Geothermal and associated hot water

ELECTRIC POWER and/or MECHANICAL POWER



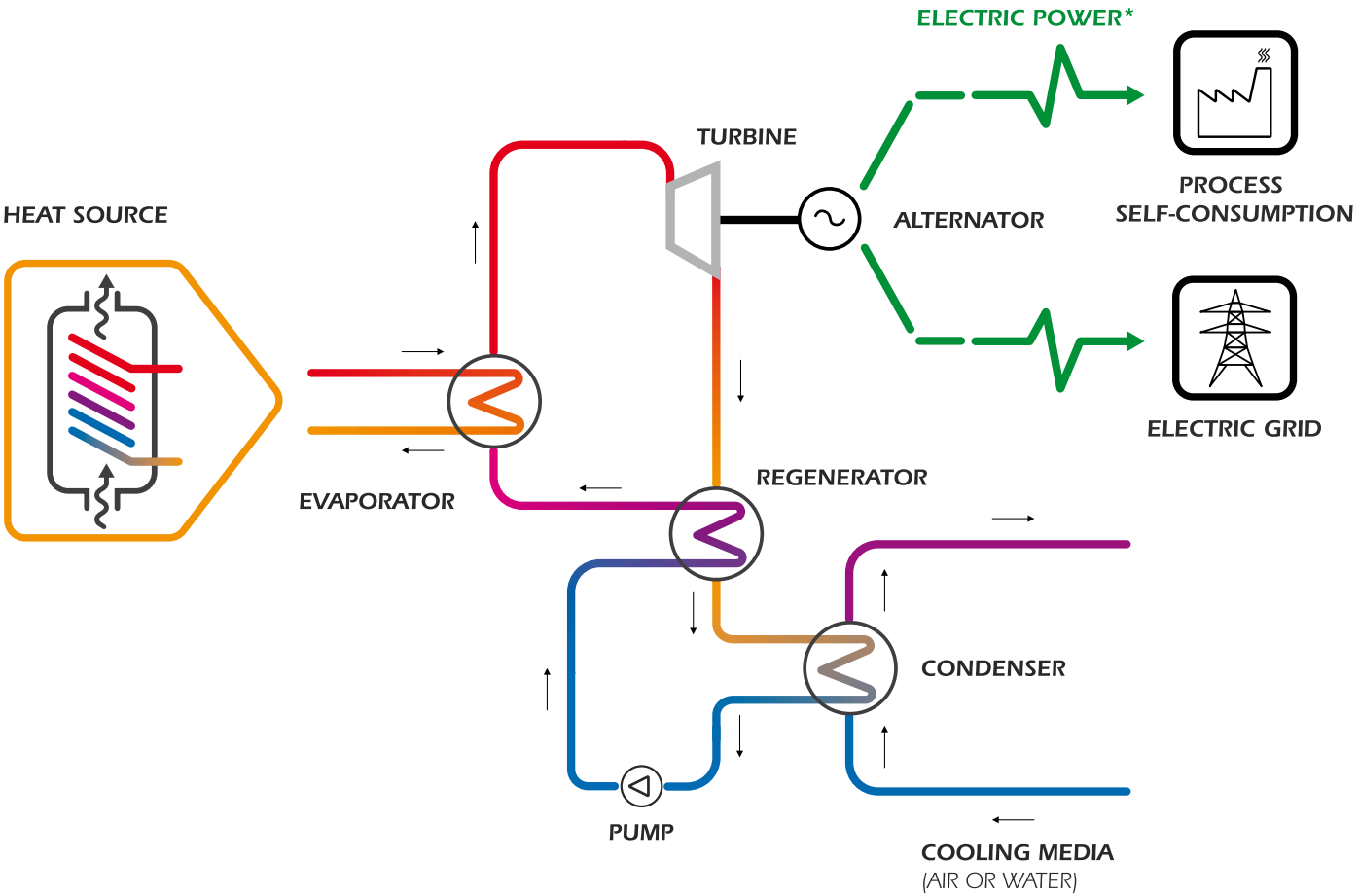



Why choose ORC for energy efficiency?

- GENERATE PROFIT FROM LEVERAGING A WASTE RESOURCE
- REDUCE CO_2 EMISSIONS, IMPROVING O&G COMPANY SUSTAINABILITY
- LOW OPERATIONAL COSTS AND NO WATER NEEDED
- IMPROVE O&G COMPANY SUSTAINABILITY
- ADD A RELIABLE SOURCE OF POWER, EVEN IN REMOTE LOCATIONS

- automatic operation with no operator attendance required
- minimum maintenance requirements
- closed loop, no water used and negligible fluid replacement required
- high-efficiency and full flexibility operation from 10% to 110% of the nominal load
- efficient use of high-to-low grade and variable heat sources, not exploitable by alternative technologies (e.g. steam)
- ease of integration with no impact on prime process

Working Principle

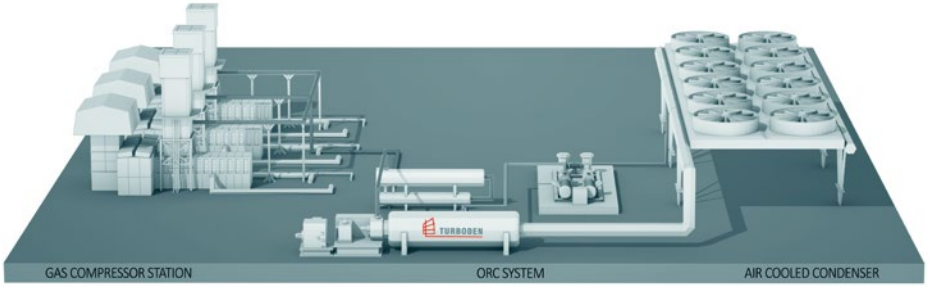


* ORC units can produce electric and/or mechanical power

The ORC turbogenerator makes use of a closed thermodynamic cycle to convert heat into electricity. The thermal power recovered from the waste heat vaporizes a suitable organic working fluid, which then expands through the turbine and produces clean and reliable electric power through the alternator. After passing through the regenerator for internal heat recovery, the vapor is cooled down, condensed and finally pumped back to start the cycle again. The heat from the hot source is transferred to the ORC working fluid by means of an intermediate circuit or directly via the combustion gases in direct exchange systems. The media used in the intermediate circuits are thermal oil, saturated steam or pressurized water.

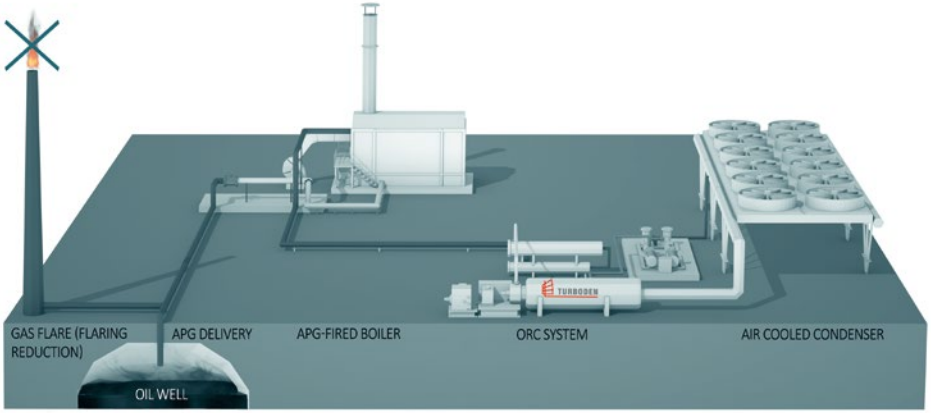
Make your process more sustainable

ORC technology is the perfect solution for natural gas compressor stations, but also in the exploitation of flare gas, hot water from exhausted oil wells, and refinery hot streams.



GAS COMPRESSOR STATION

Designed according to specific site features, the ORC-based heat recovery system exploits the gas turbines' exhausts to produce up to 30% ÷ 40% of additional useful power. Without impacting on gas compressor station operation, the ORC system produces additional power for the station itself, especially electrical motor-driven compressors, or for external users.



ASSOCIATED PETROLEUM GAS

When the chemical composition of Associated Petroleum Gas is poor and it cannot be exploited by traditional technologies, ORC represents a feasible solution to produce electric power by using it. The heat recovery configuration involves a boiler fueled by flare gas that feeds the ORC unit, which in turn produces electricity and thermal power at low temperature (in case of a cogeneration unit).

Add free power to your cycle

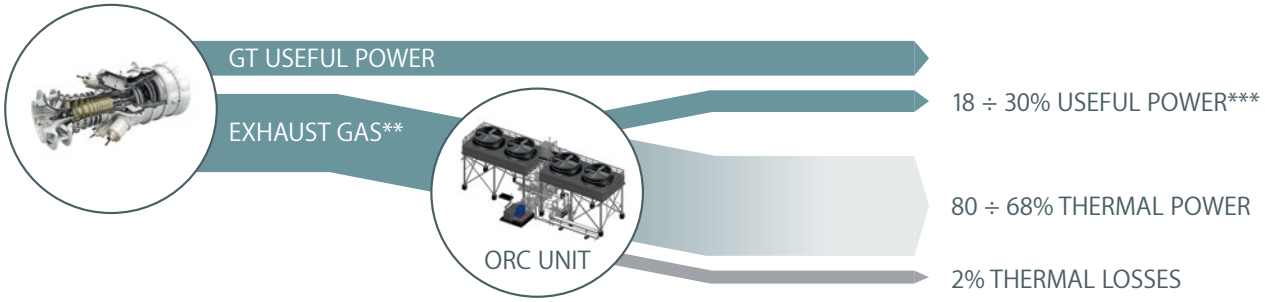
In combined cycles, Turboden ORC units can be installed downstream of:

- Gas turbines (GT), with up to 40% of additional power
- Internal combustion engines (ICE), with up to 10% of additional power

In both cases the combined cycle achieves an efficiency greater than 50%.

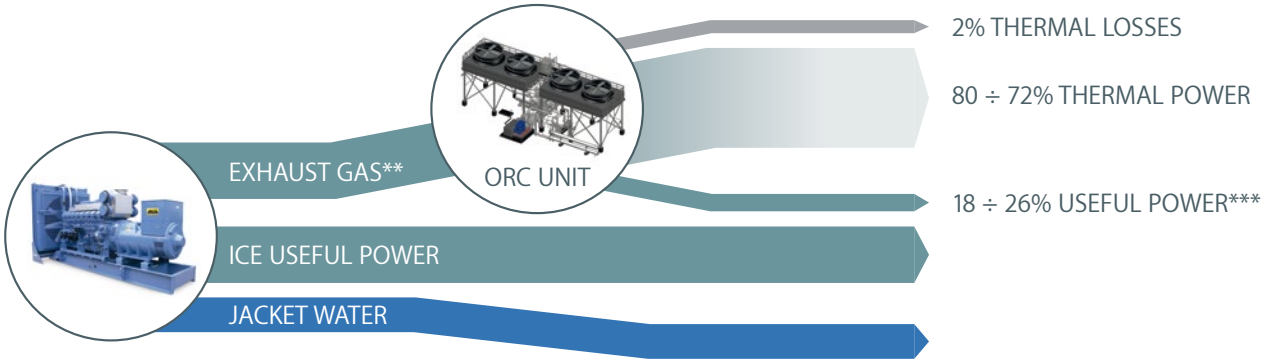
GAS TURBINES

30÷40% ORC additional power*

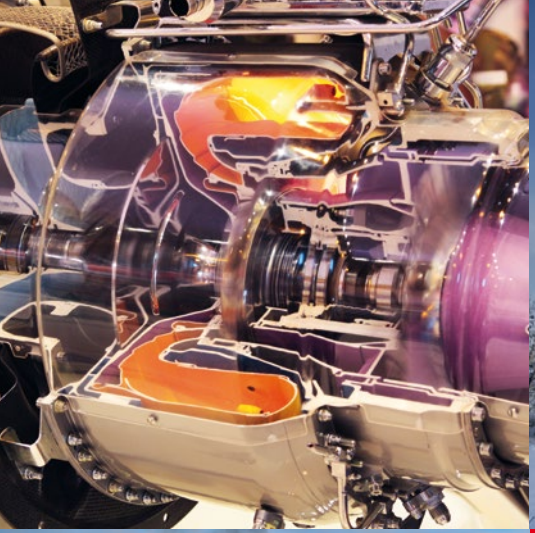


INTERNAL COMBUSTION ENGINES

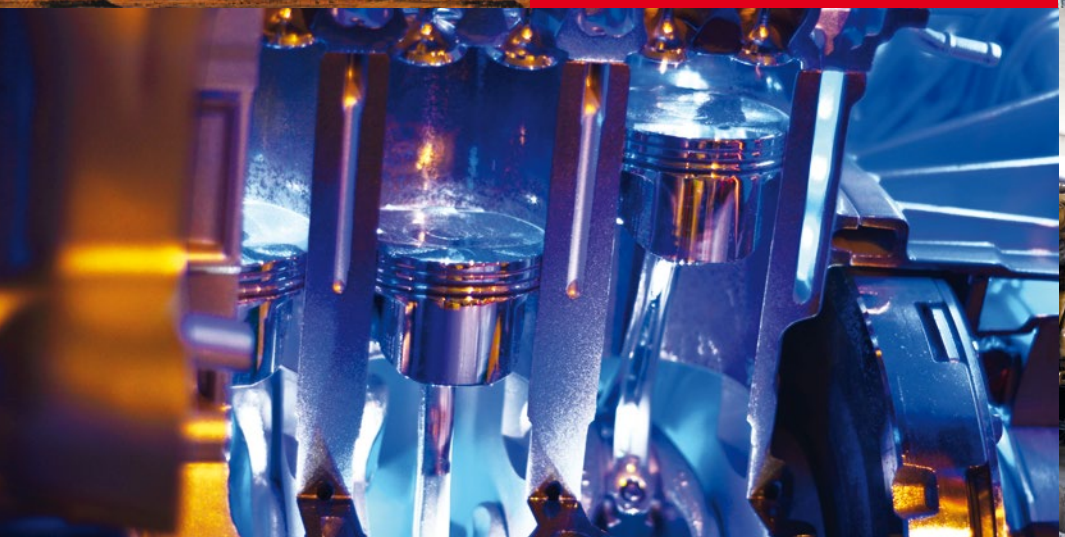
10% ORC additional power*



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



O&G



From words to deeds

TRANSGAS - CANADA

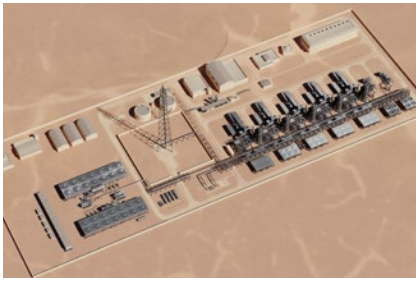
- STATUS: in operation since November 2011
- DESCRIPTION: bottoming of a 3.5 MW Solar gas turbine in a gas compressor station along TransGas pipeline
- FEATURES: power produced (1 MWe) delivered to the national grid

LUKOIL - RUSSIA

- STATUS: in operation since October 2015
- DESCRIPTION: flare gas exploitation for power and heat production to serve LUKoil refinery in Perm
- FEATURES: cogeneration system, electricity (1.8 MWe) and hot water (to heat up the crude oil) produced

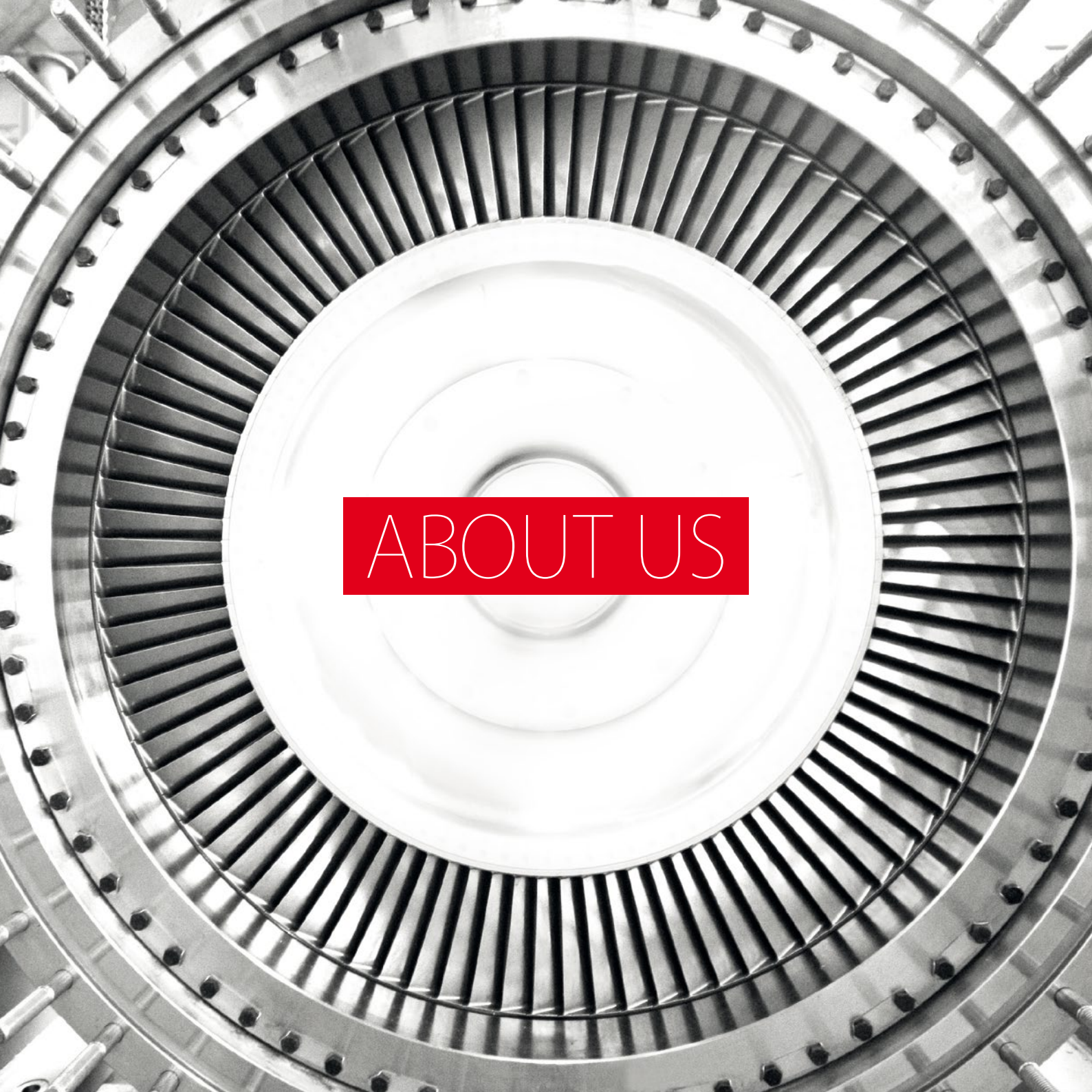
UZTRANSGAZ - UZBEKISTAN

- STATUS: in operation since 2021
- DESCRIPTION: bottoming of 3x15 MW GE gas turbines in the gas compressor station serving the Hodzhaabad underground storage system
- FEATURES: island mode operation to sustain compressor station power demand (1 MWe)



GASCO - EGYPT

- SIZE: 28 MWe
- STATUS: under construction
- HEAT SOURCE: exhaust gas of 5X30 MW GT (4 in operation, 1 in stand-by) in the gas compressor station of Dahshour
- COOLING SYSTEM: air cooled condenser (no water consumption)
- HEAT CARRIER: thermal oil



ABOUT US

clean energy ahead®
TURBODEN

Turboden, a group company of Mitsubishi Heavy Industries, is an Italian firm and a global leader in the design, manufacture and maintenance of Organic Rankine Cycle (ORC) systems, highly suitable for distributed power generation. ORC systems can generate electric and thermal power exploiting multiple sources, such as renewables (biomass, geothermal energy, solar energy), traditional fuels and waste heat from industrial processes, waste incinerators, engines or gas turbines.

MITSUBISHI
HEAVY INDUSTRIES

Mitsubishi Heavy Industries, Ltd. (MHI), headquartered in Tokyo, is one of the world's leading industrial firms with 80,000 group employees and annual consolidated revenues of around 38 billion U.S. dollars (year 2016). For more than 130 years, the company has channeled big thinking into innovative and integrated solutions that move the world forward. MHI owns a unique business portfolio covering land, sea, sky and even space. MHI delivers innovative and integrated solutions across a wide range of industries from commercial aviation and transportation to power plants and gas turbines, and from machinery and infrastructure to integrated defense and space systems.

Why Turboden?

PART OF MITSUBISHI HEAVY INDUSTRIES GROUP

Turboden benefits from the Mitsubishi Heavy Industries global network in a number of ways, including: financial stability, sharing of business practices (including customer warranties) and technology development.

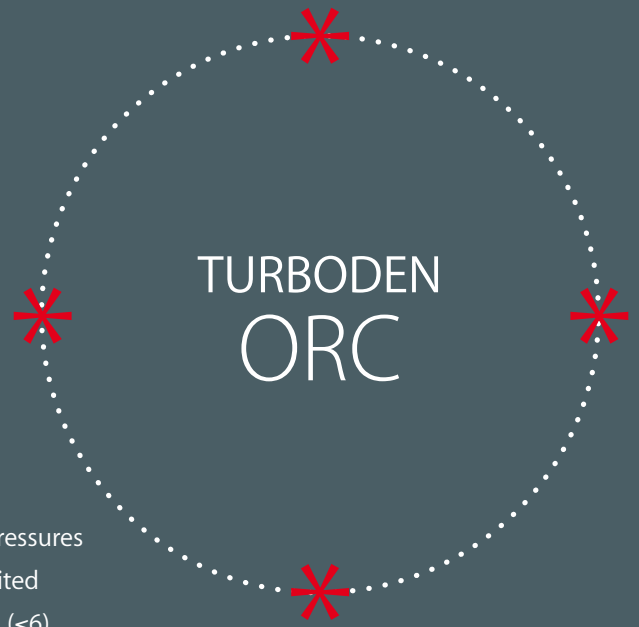
CAPABILITIES & EXPERIENCE

With 40+ years of experience, a global presence, 750+ MWe installations, and 400+ plants in 50 countries, Turboden is a market leader in the proprietary design and manufacturing of ORC optimized turbines.

CUSTOMER ORIENTATION

Optimized solutions for each customer and a qualified service department exclusively dedicated to customer assistance.

Feel our strengths



FLEXIBILITY

- Range size up to 20 MW per single shaft
- Different primary energy sources
- Large rangeability
- Cogeneration or power-only mode
- Ease of integration
- Island mode

RELIABILITY

- High availability (98%+)
- Long life

SUSTAINABILITY

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

EASY TECHNOLOGY

- Simple technical features: low pressures involved, low speed turbine, limited number of stages of the turbine (≤6), self-lubricating fluids, no water required
- Easy and cost-effective operation & maintenance: automatic operation (no qualified operator required), minimal maintenance activities, no major overhaul (turbine not subject to erosion or corrosion), fast start-stop procedures, no chemical and water treatments, low refilling of fluid required

Always by your side

24/7
SUPPORT*

<2h
REACTION TIME

97%
PLANTS WITH AFTER-SALES CONTRACTS

*up to

GLOBAL COVERAGE

- 2 service subsidiaries and 5 international service partner companies

CUSTOMIZED SERVICES

- single contact for requests for support
- staff dedicated to on-site and remote technical support
- assistance of an international network of companies able to provide technical support
- wide range of services provided
- prompt assistance and customized after-sales services
- remote technical support using innovative tools
- dedicated spare parts warehouse

CUSTOMER REQUEST OR TURBODEN PLANNED CHECKS

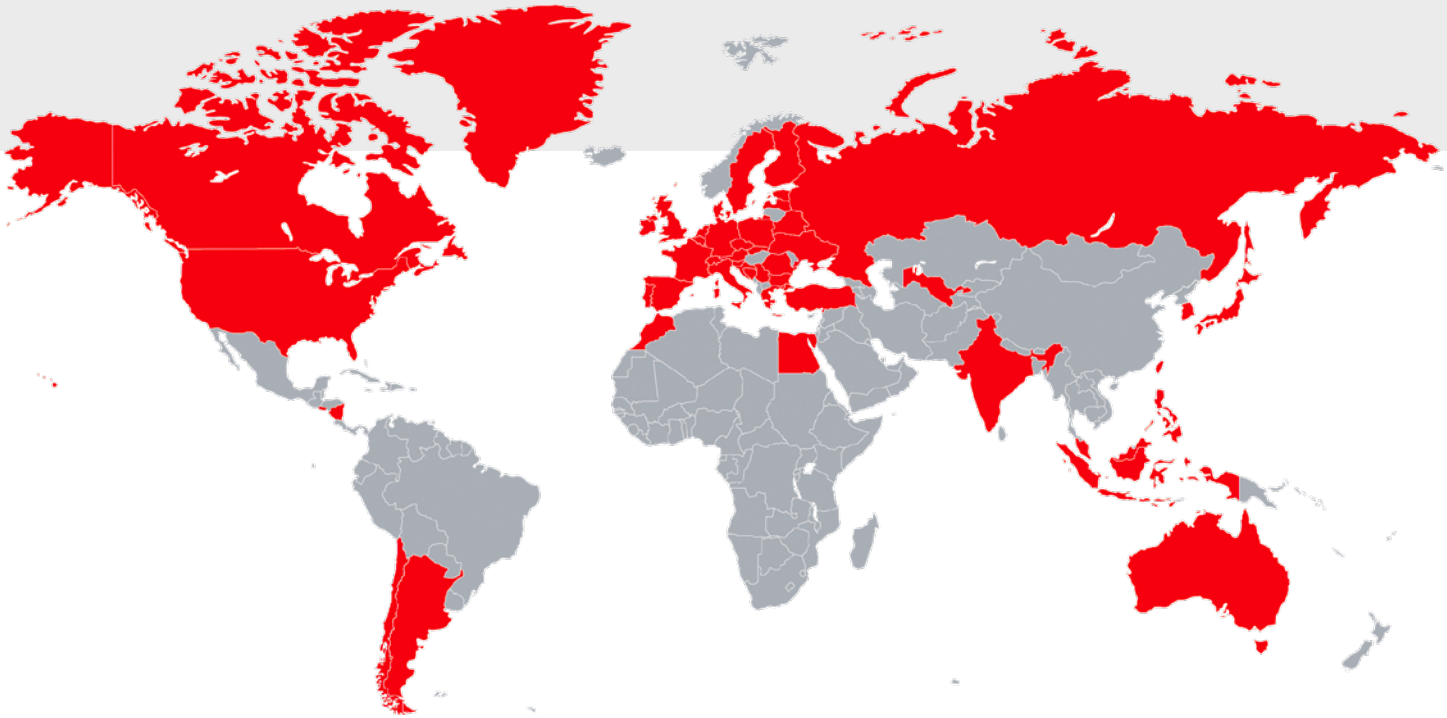
TREND ANALYSIS WITH LOCAL OPERATOR SUPPORT

FOCUSED TEAMWORK AND TECHNICAL DECISIONS

REACTION PLAN: REMOTE OR ON-SITE

SATISFIED CUSTOMER

Meet our global and proven experience



PLANTS: 409

COUNTRIES: 50

TOTAL CAPACITY: 750 MWe

CUMULATIVE OPERATION TIME: 19 million hours

AVERAGE AVAILABILITY: 98+%

Update November 2021

MOVE THE WORLD FORW>RD

MITSUBISHI HEAVY INDUSTRIES GROUP

OIL & GAS

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TURBODEN

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