clean energy ahead

TURBODEN®

GEOTHERMAL

SMARTER BINARY SYSTEMS DELIVERED.

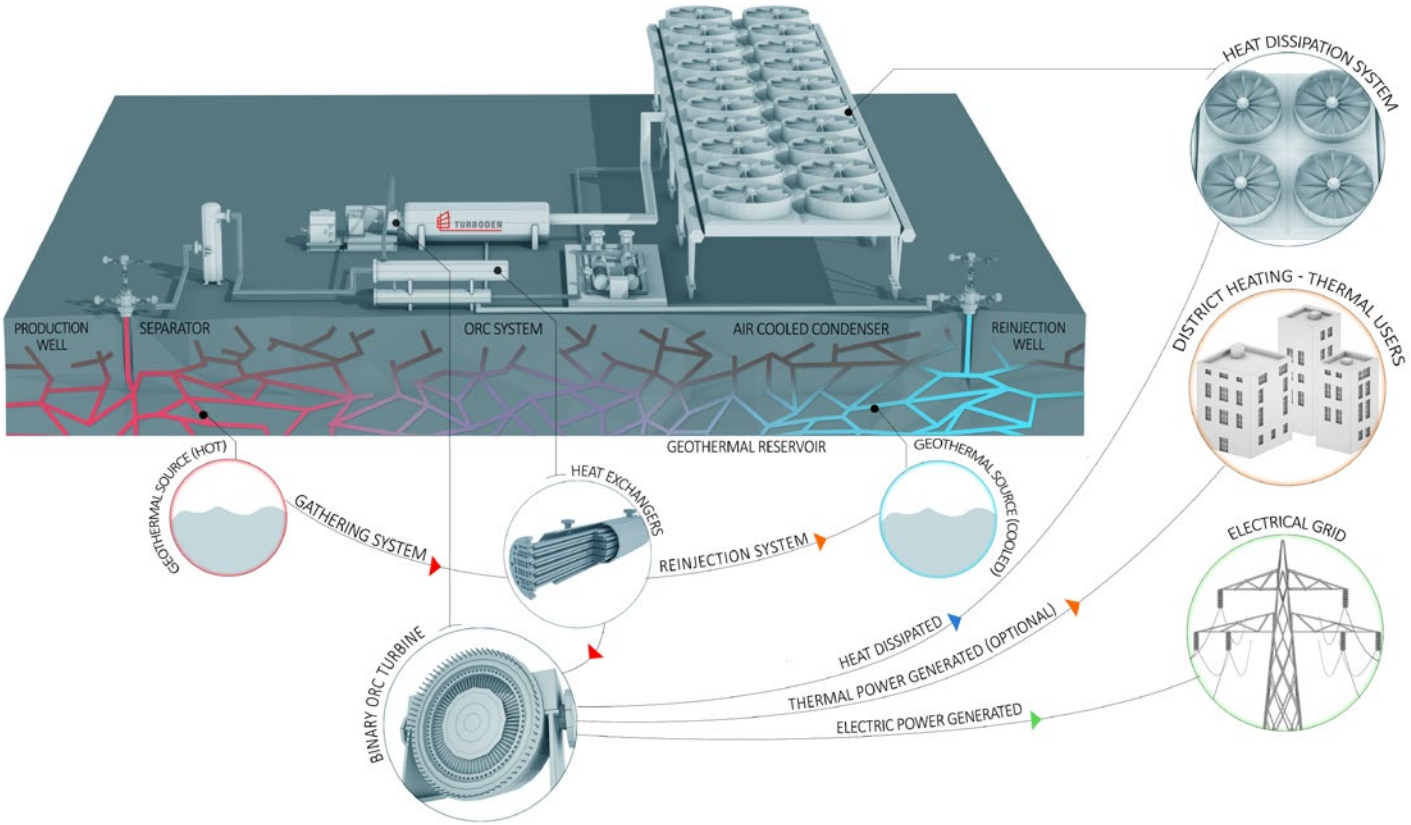
They believe in us

Turn geothermal source into useful power

Heat from the ground can be used as an energy source and it can be found in many regions of the world, especially at tectonic plate boundaries or at places where the crust is thin enough to let the heat through. The most common way of capturing energy from geothermal resources is to tap into naturally occurring hydrothermal convection systems, where cooler water seeps into earth's crust and is heated up within a reservoir.

Turboden is a global leader in the design, manufacture and maintenance of geothermal binary Organic Rankine Cycle (ORC) systems for power production, particularly suitable for the exploitation of low-to-high enthalpy sources. Turboden delivers cost-effective solutions with power outputs of up to 20 MWe per single turbine and geothermal fluid temperature at well-head between 100°C and 200°C.

What is binary ORC technology?



Binary ORC plants exploit geothermal fluid to heat up and vaporize a secondary organic fluid that drives a turbine and produces electric power. In this way, the geothermal fluid remains within a closed loop of piping (from the reservoir to the reinjection) without passing through the turbine, with no harmful emissions into the atmosphere.

The heat that is not converted into electricity can be delivered to a thermal user or dissipated through a suitable cooling system. ORC is very effective for exploiting resources with high steam fractions at locations where it is not convenient to collect and deliver all the fluids to a centralized station, but preferable to employ modular well-head units.

Existing single-flash power plants can be improved by adding an ORC system on the separated brine stream, before reinjection. This makes it possible to produce more power from the same geothermal resource.

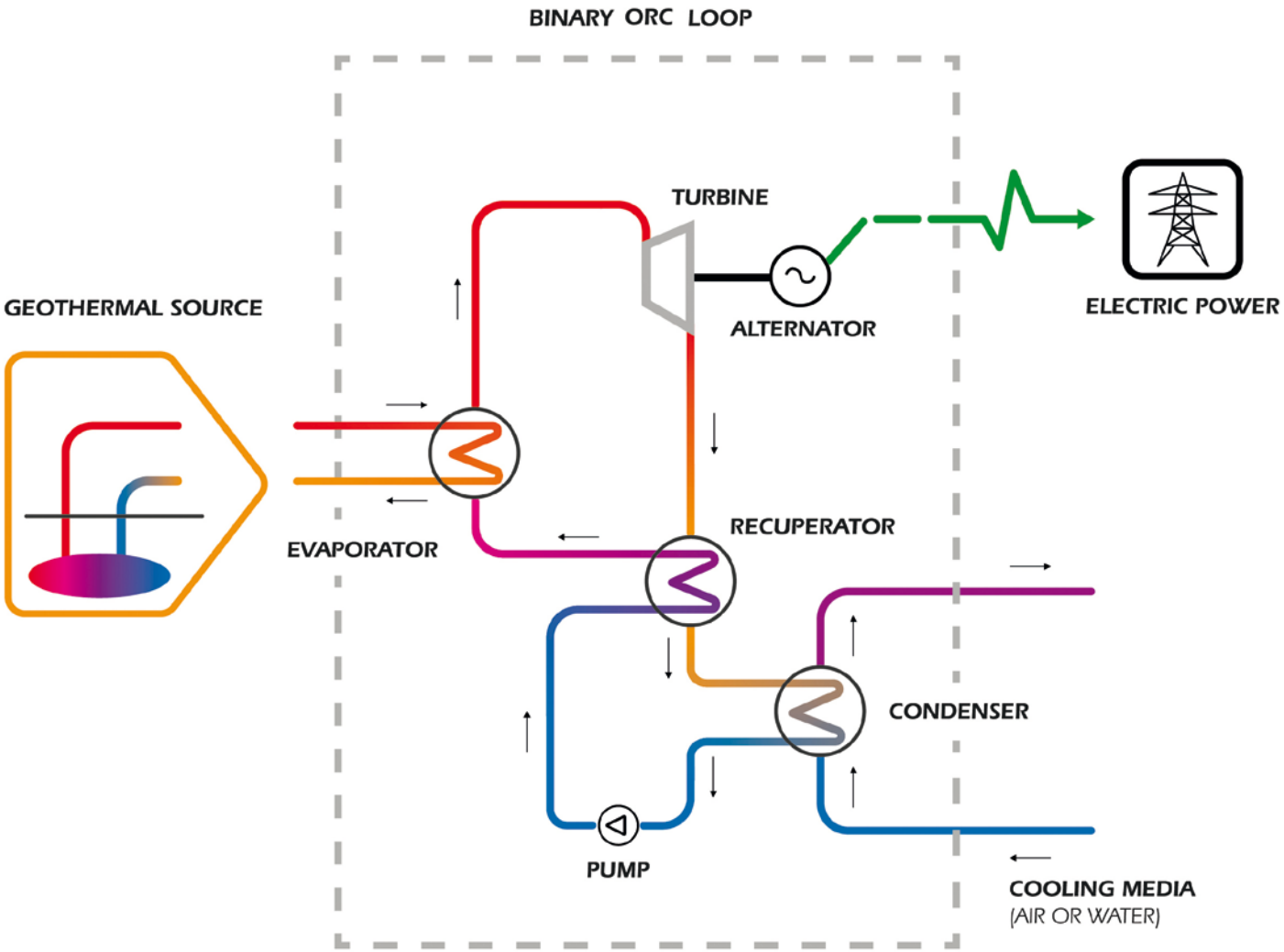
Why choose Turboden binary system?

- ZERO EMISSIONS AND FULL REINJECTION ACHIEVABLE
- NO CORROSION AND NO SCALING IN THE TURBINE
- HIGH STEAM AND BRINE HEAT CONVERSION – CYCLE EFFICIECY UP TO 25%

- multi-stage axial turbine
  - less sensitive than radial turbines to ambient temperature variations, showing nearly constant efficiency over a wide range of operating conditions
  - the most widely adopted in turbomachinery design, proven with billions of working hours worldwide
- more than 90% turbine isentropic efficiency achieved
- more than 60 different turbines developed on 4 standard frames
- 10 different working fluids (hydrocarbons, HFCs, HFOs)
- patented seal and bearing replacement system
- direct drive: rotation speed from 1,500 rpm to 3,000 rpm
- robust design, low vibration, and strict quality tests in collaboration with the Mitsubishi team


TURBODEN

Working Principle



The ORC turbogenerator makes use of a closed thermodynamic cycle to convert heat into electricity. The thermal power recovered from the geothermal source (single or dual-phase) vaporizes a suitable organic working fluid, which then expands in the turbine and produces clean and reliable electric power by means of the alternator. After passing through the recuperator for internal heat recovery, the vapour is cooled down, condensed and finally pumped back to start the cycle again.

Geo

From words to deeds

STADTWERKE MÜNCHEN - GERMANY

- SCOPE OF SUPPLY: EPC supply of three power plants and above-ground steam system
- SIZE: 5 MWe, 5.6 MWe, 5.6 MWe
- STATUS: in operation since 2013, 2012, 2013
- PRODUCTION: electric power and heat to district heating network
- HEAT SOURCE: geothermal water at about 140°C

GEOTHERMISCHE KRAFTWERKSGESELLSCHAFT TRAUNREUT - GERMANY

- SCOPE OF SUPPLY: EPC supply of the power plant and above-ground steam system
- SIZE: 4.1 MWe
- STATUS: in operation since 2016
- PRODUCTION: electric power and heat to district heating network
- HEAT SOURCE: geothermal water at 118°C

MITSUBISHI HEAVY INDUSTRIES - JAPAN

- SCOPE OF SUPPLY: ORC engineering, supply of the turbine and generator
- SIZE: 6 MWe
- STATUS: in operation since 2015
- PRODUCTION: electric power
- HEAT SOURCE: geothermal water and steam at 142°C

GEO POWER ENERGY DEVELOPMENT - CROATIA

- SCOPE OF SUPPLY: supply of the ORC power plant and design of above-ground steam system
- SIZE: 17.5 MWe
- STATUS: in operation since 2018
- PRODUCTION: electric power
- HEAT SOURCE: geothermal water and steam at 170°C

GEOTHERMIE HOLZKIRCHEN - GERMANY

- SCOPE OF SUPPLY: supply of the ORC power plant
- SIZE: 3.4 MWe
- STATUS: in operation since 2019
- PRODUCTION: electric power and heat to district heating network
- HEAT SOURCE: geothermal water at 152°C

CYRQ ENERGY - USA

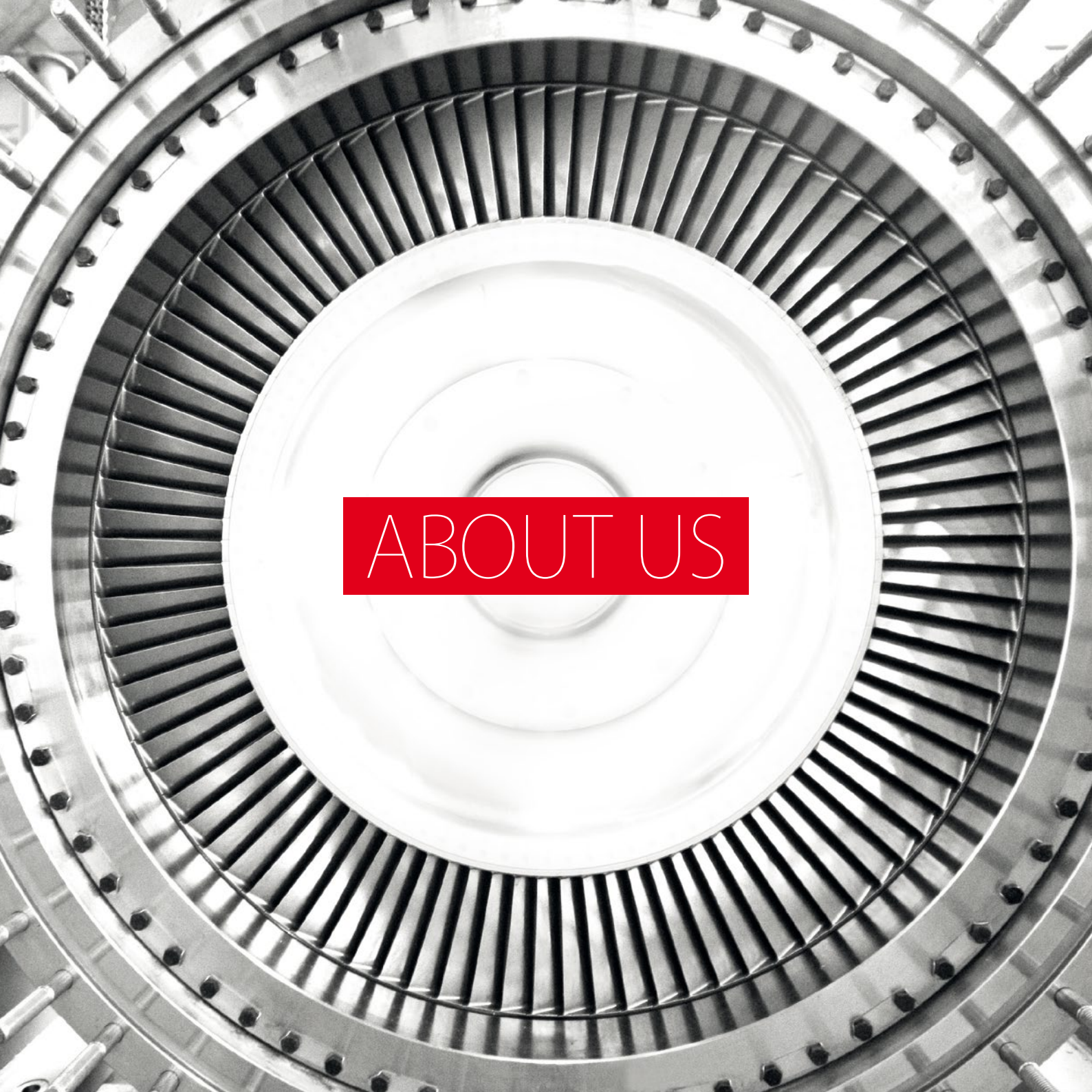
- SCOPE OF SUPPLY: supply of the ORC power plant
- SIZE: 14 MWe
- STATUS: in operation since 2018
- PRODUCTION: electric power
- HEAT SOURCE: geothermal water at 154°C

E.ON BUSINESS SOLUTIONS - GERMANY

- SCOPE OF SUPPLY: EPC supply of the power plant and above-ground steam system
- SIZE: 3.7 MWe
- STATUS: under construction
- PRODUCTION: electric power
- HEAT SOURCE: geothermal water at 122.5°C

ENERGY DEVELOPMENT CORPORATION - THE PHILIPPINES

- SCOPE OF SUPPLY: supply of the ORC power plant and acid dosing system
- SIZE: 29 MWe
- STATUS: under construction
- PRODUCTION: electric power
- HEAT SOURCE: geothermal water at 170°C


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 2018). 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.

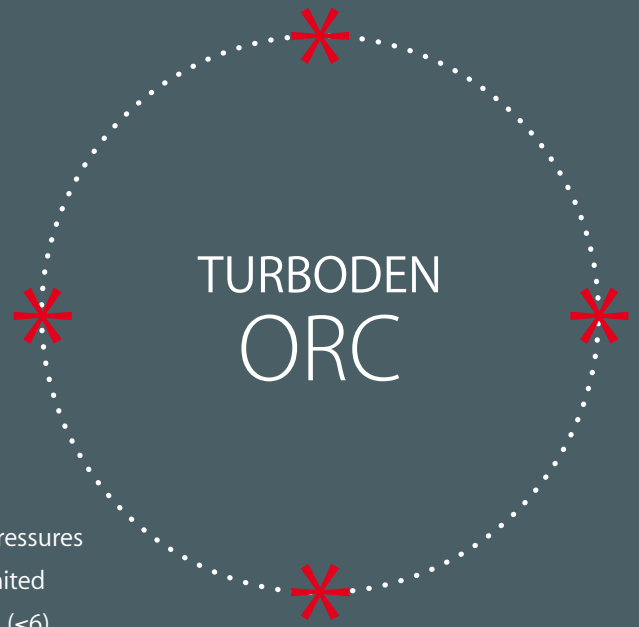
CAPABILITIES & EXPERIENCE

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

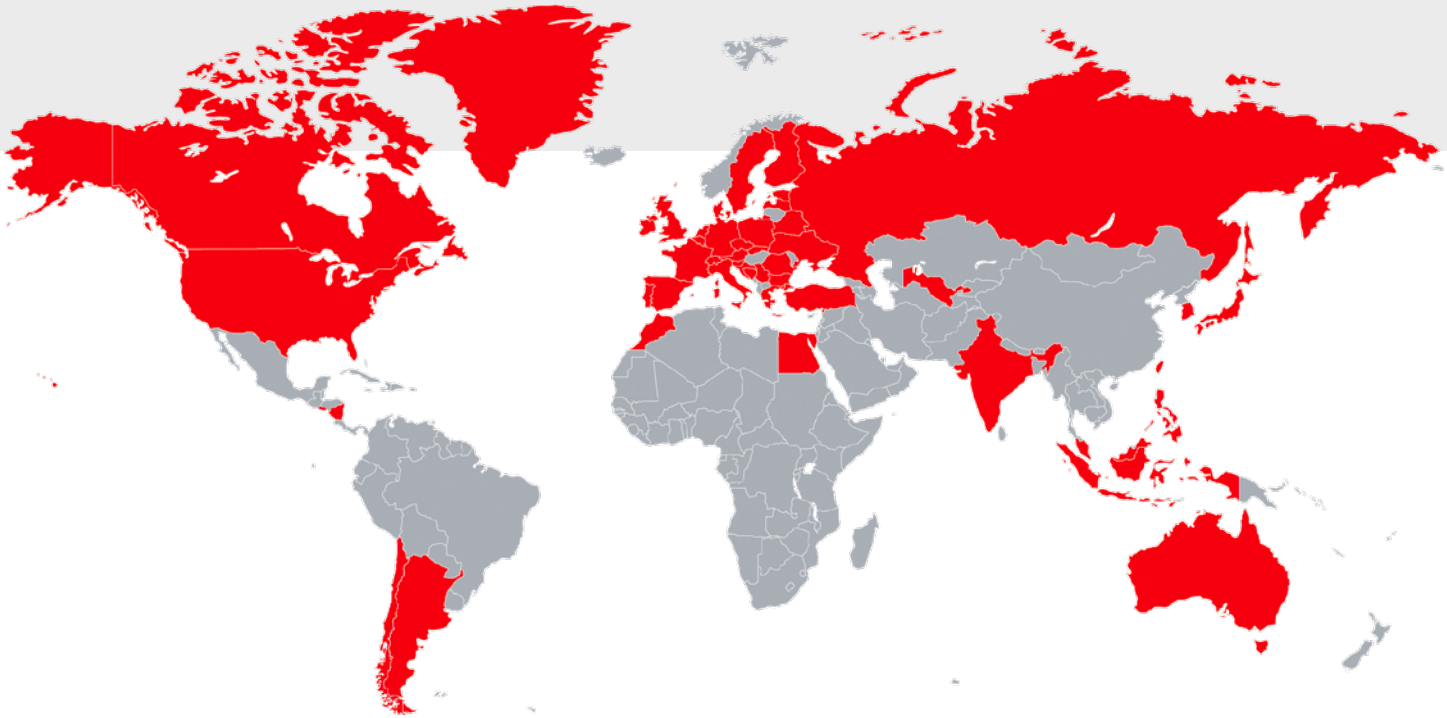
TREND ANALYSIS WITH LOCAL OPERATOR SUPPORT

FOCUSED TEAMWORK AND TECHNICAL DECISIONS

REACTION PLAN: REMOTE OR ON-SITE

SATISFIED CUSTOMER

Meet our global and proven experience



Geo

PLANTS: 16
TOTAL CAPACITY: 119 MWe

PLANTS: 409
COUNTRIES: 50
TOTAL CAPACITY: 760 MWe
CUMULATIVE OPERATION TIME: 19 million hours
AVERAGE AVAILABILITY: 98+%

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MOVE THE WORLD FORW>RD

MITSUBISHI HEAVY INDUSTRIES GROUP

GEOTHERMAL

clean energy ahead®

TURBODEN

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