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Turboden a servizio della sostenibilità: ORC e Pompe di Calore da fonti geotermiche

Innovazione e Sostenibilità per la Geotermia del Futuro

03 Marzo 2023

CNR, Auditorium dell'Area della Ricerca, Pisa

Via G. Moruzzi 1, Pisa

clean energy ahead
TURBODEN

OUR MISSION

We provide unique, reliable and advanced technologies founded on our core proprietary turbomachinery, with the aim of maximizing the value of renewable resources and energy efficiency.

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 electric and thermal power exploiting multiple sources.

SUMMARY

- TURBODEN COMPANY PROFILE
- TURBODEN ORC
- TURBODEN LHP
- REFERENCES

1. TURBODEN COMPANY PROFILE: MILESTONES

‘60-’70

Prof. Mario Gaia makes experience in the field of ORC within his research group at Politecnico di Milano.

1976

1st ORC prototype.

1980

Prof. Mario Gaia founds Turboden.

1988

1st ORC geothermal plant.

‘90-2000

Turboden enters geothermal, waste heat recovery and solar markets.

2000-2009

Turboden becomes leader in Europe with its biomass plants.

2013

MHI acquires the majority of Turboden.

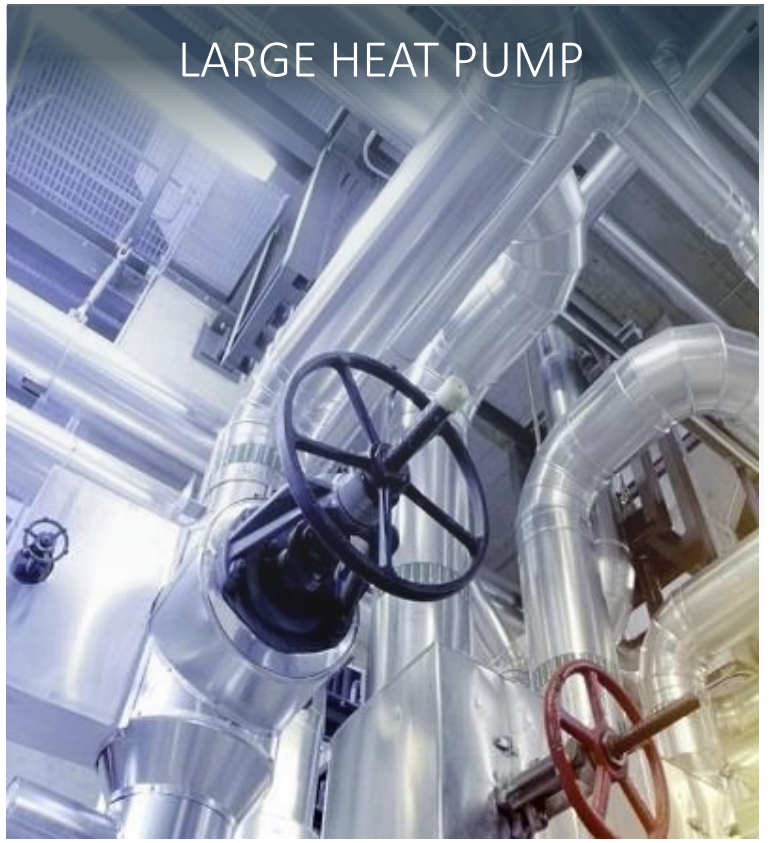
2019

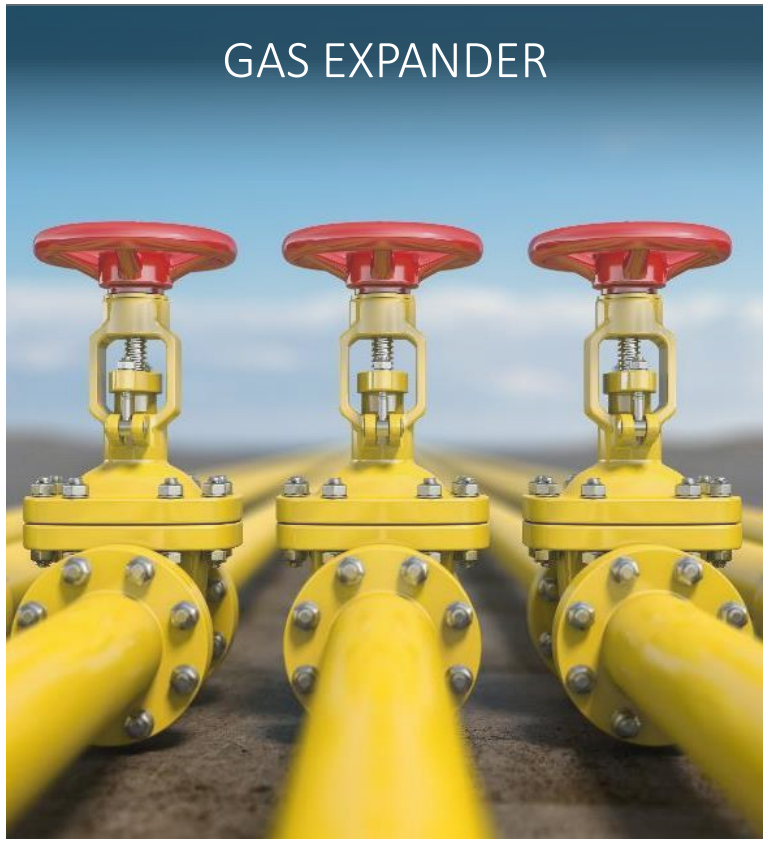
Turboden launches new products, LHP and EXP

2020

	1990	2000	2010	2020
ORC SIZES AVAILABLE	300 kW	1 - 2 - 4 MW	5 - 8 - 10 MW	20 MW
ORC PLANTS INSTALLED	1	100	220	400+

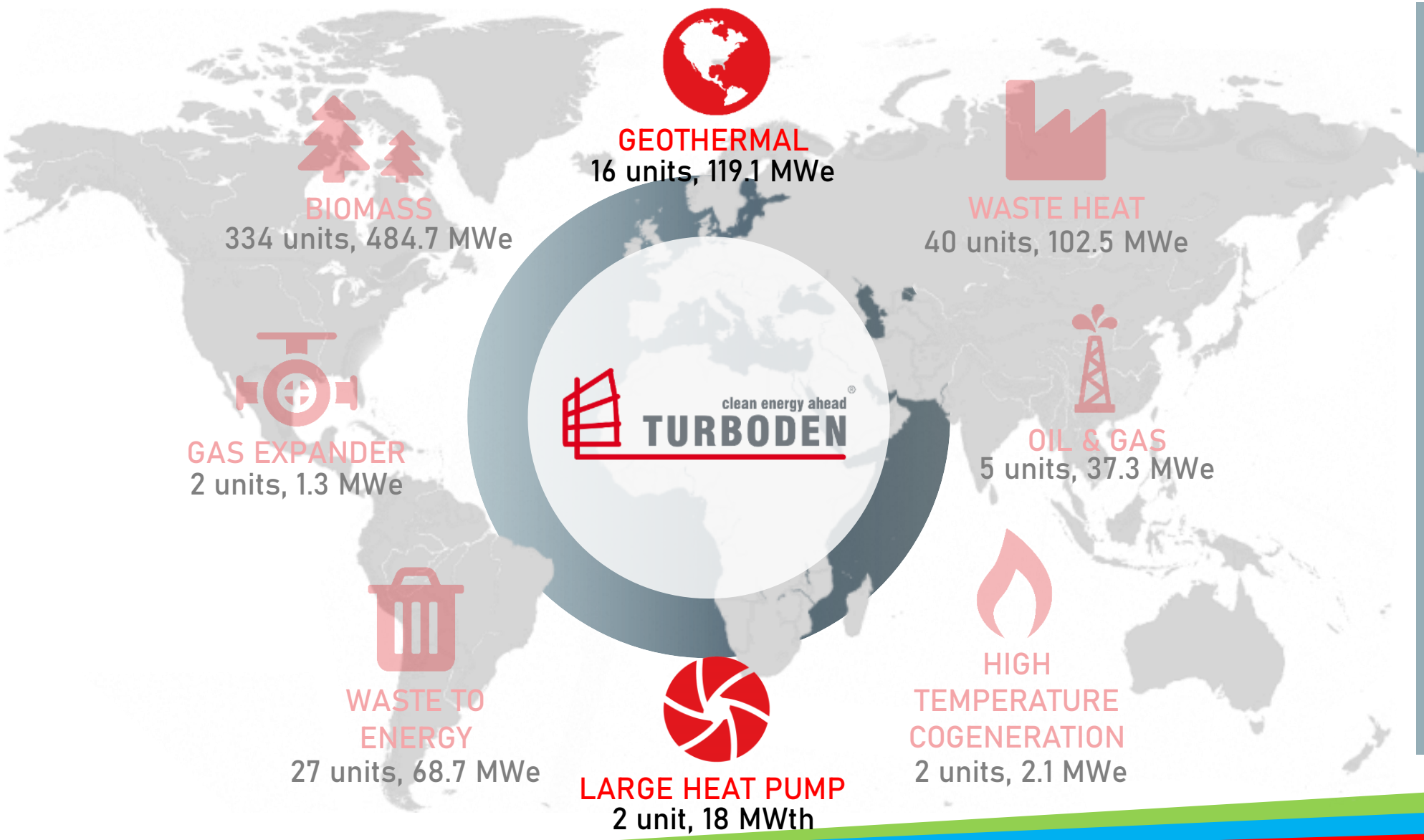
1. TURBODEN COMPANY PROFILE: PRODUCTS





Designed for decarbonisation.

1. TURBODEN COMPANY PROFILE: GLOBAL AND PROVEN EXPERIENCE



Experience in over
50
countries

With
430+
installations

Installed power
830+ MWe

Electric power generated
25 thousand
GWh

Cumulative operation time
19 million
hours

Average availability
98.4%

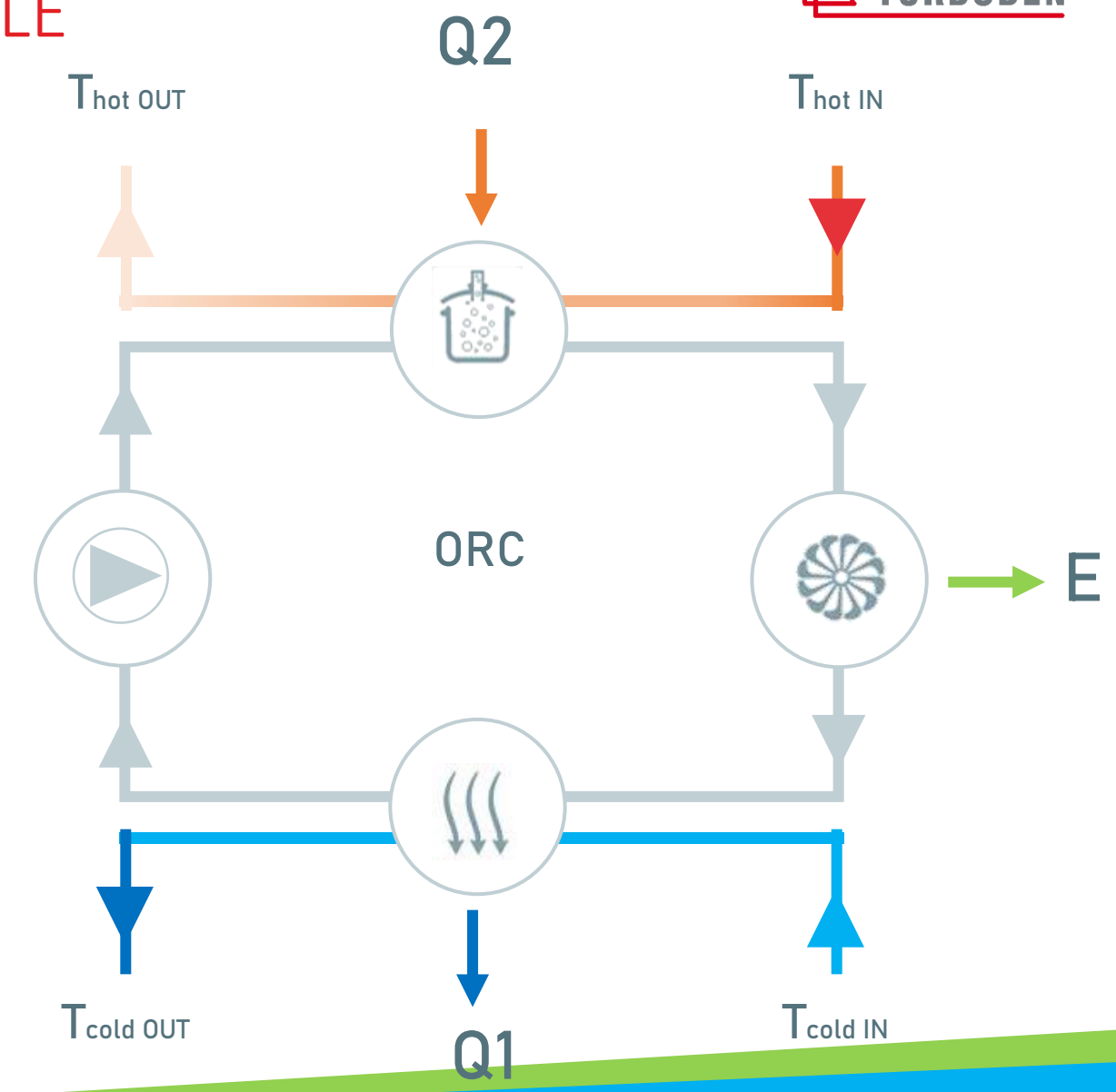
Last update: February 2023

2. TURBODEN ORC: THE ORC CYCLE

Differently from the conventional geothermal steam turbines, the ORC process uses low-to-high enthalpy geothermal fluid ($T_{hot,IN}$ → $T_{hot,OUT}$) to preheat and vaporize a suitable organic working fluid within a closed loop:

- The organic fluid vapor rotates the turbine, which is coupled to the electric generator (E).
- The exhaust vapor flows through the condenser, which is cooled by air or water ($T_{cold,IN}$ → $T_{cold,OUT}$) .
- The organic working fluid is then pumped again, thus completing the closed-cycle operation.

In such way the ORC turbine is not in contact with the geothermal fluid, which remains enclosed in the heat exchangers, allowing a full reinjection of all the brine and steam condensate with zero emissions to the ambient.



2. TURBODEN ORC: BENEFITS

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

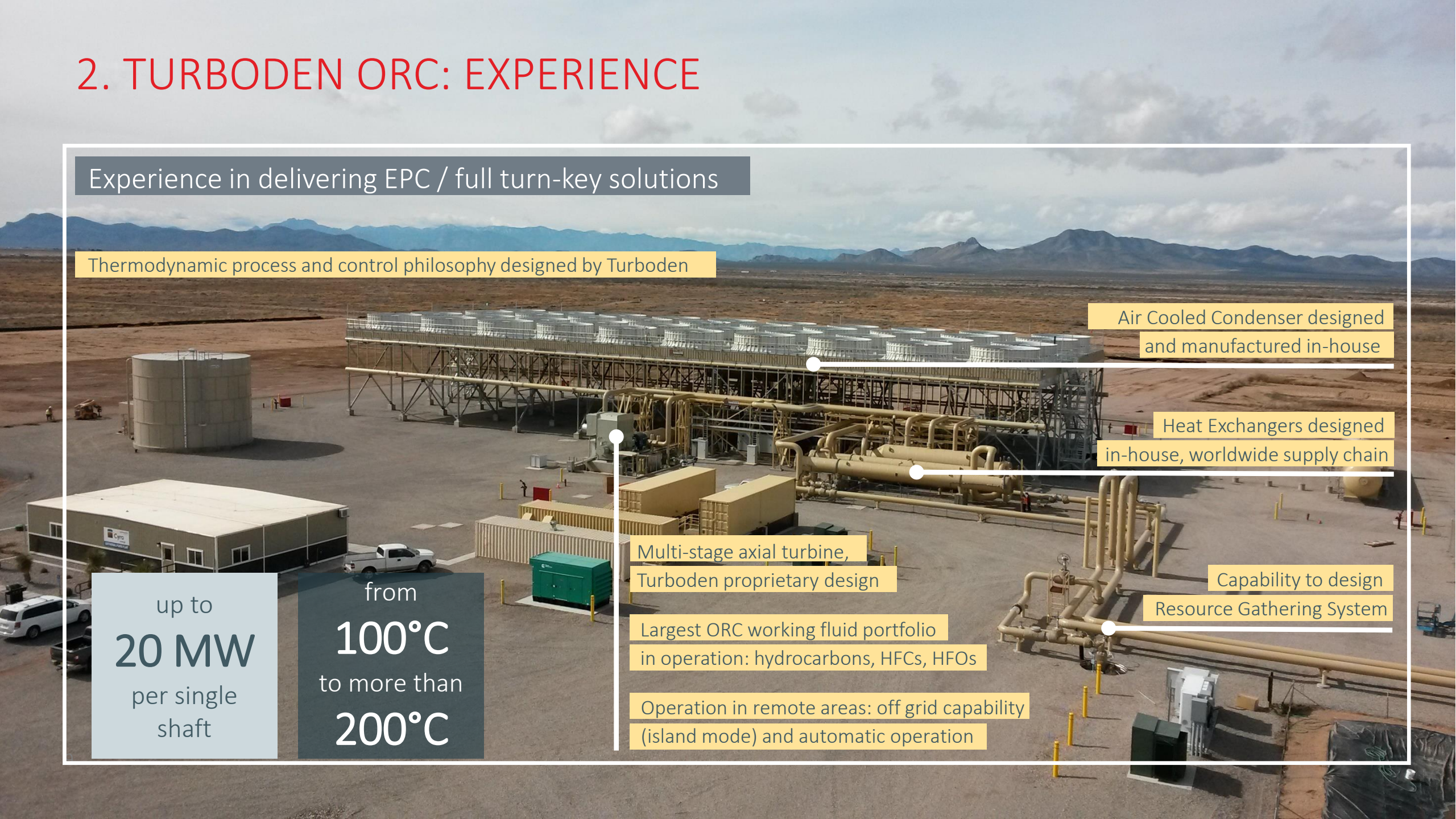
Dependability

- ✓ 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

2. TURBODEN ORC: EXPERIENCE



Experience in delivering EPC / full turn-key solutions

Thermodynamic process and control philosophy designed by Turboden

Air Cooled Condenser designed and manufactured in-house

Heat Exchangers designed in-house, worldwide supply chain

Multi-stage axial turbine, Turboden proprietary design

Capability to design Resource Gathering System

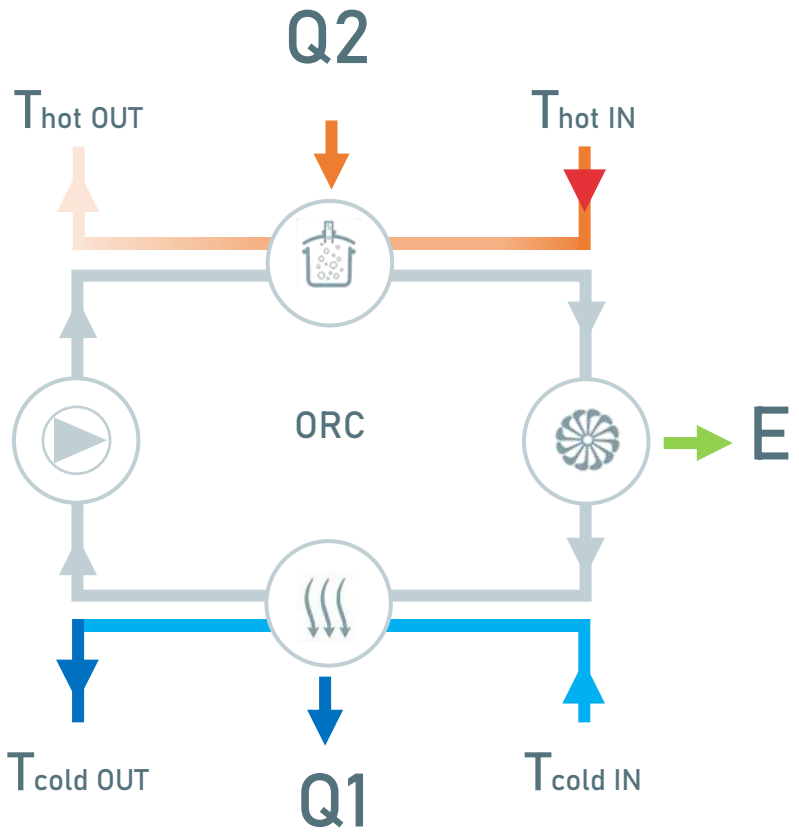
Largest ORC working fluid portfolio in operation: hydrocarbons, HFCs, HFOs

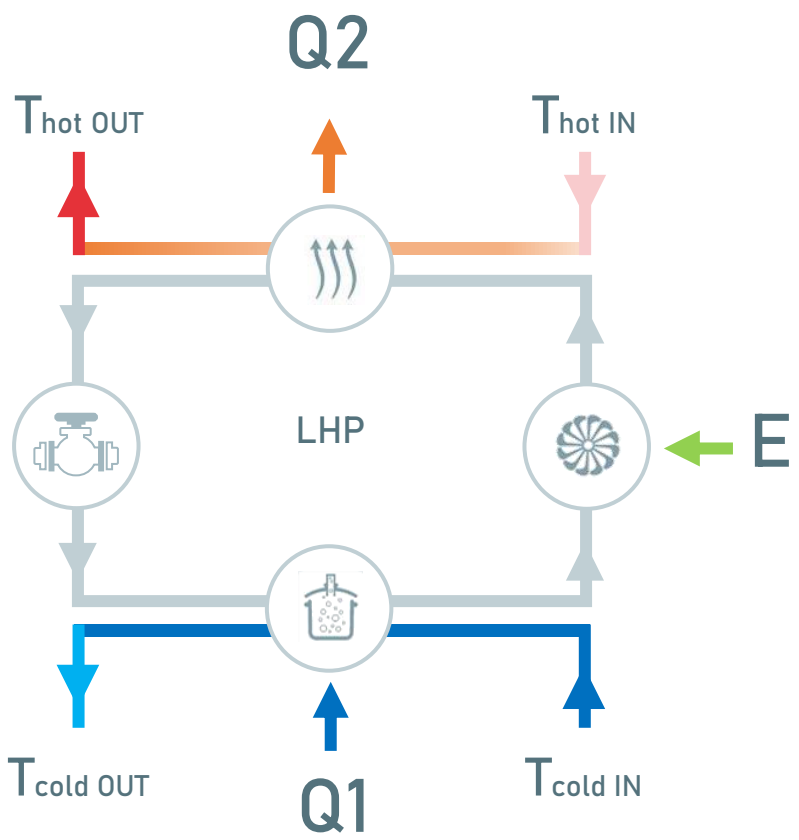
Operation in remote areas: off grid capability (island mode) and automatic operation

up to **20 MW** per single shaft

from **100°C** to more than **200°C**

3. TURBODEN LHP: ORC VS LARGE HEAT PUMP PROCESS





EFFICIENCY = E / Q2

COP = Q2 / E

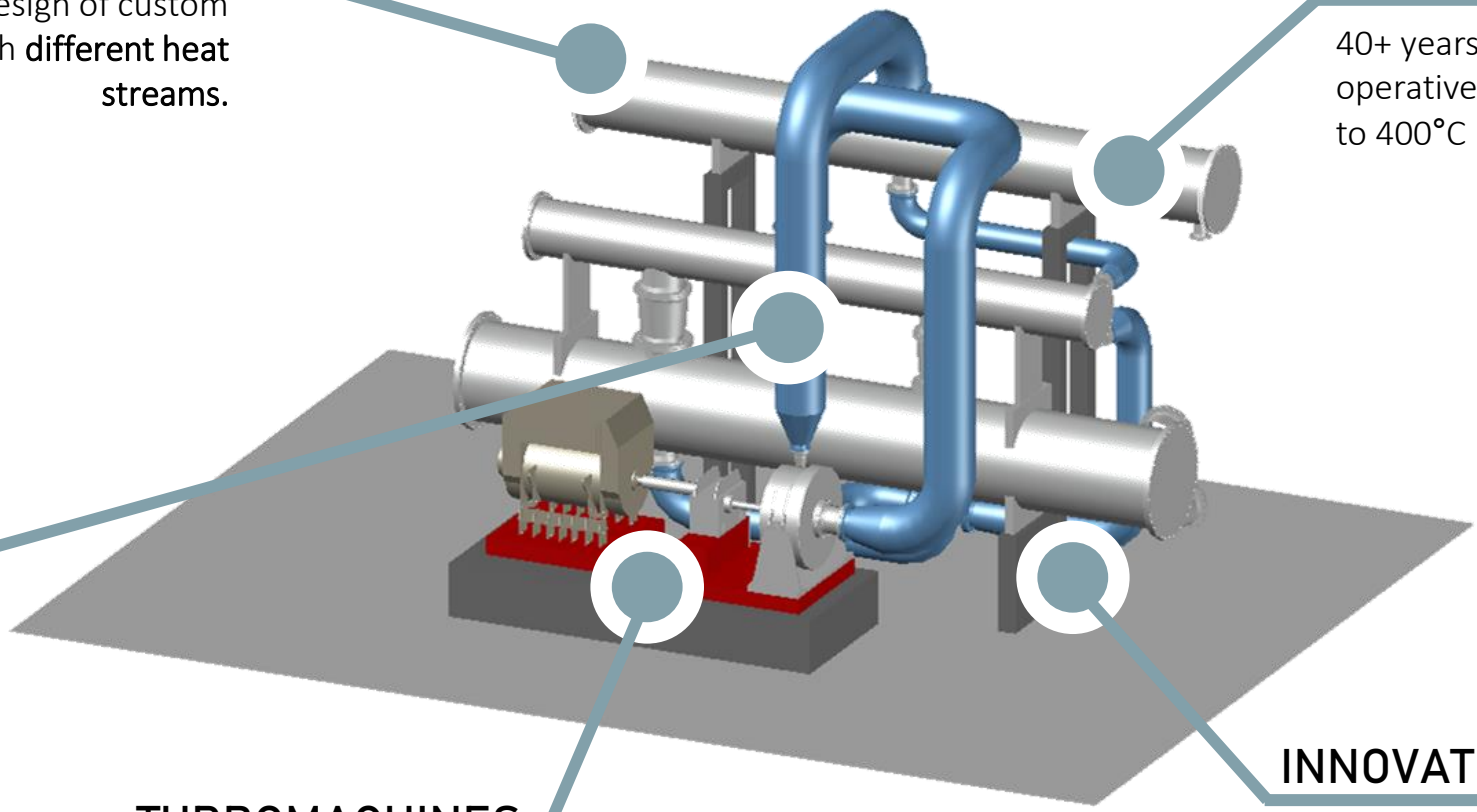
3. TURBODEN LHP: THE EXPERTISE APPLIED

HEAT TRANSFER

Expertise in design of custom equipment with **different heat streams.**

HIGH TEMPERATURE

40+ years experience with operative temperatures up to 400°C



WORKING FLUIDS

Selection of most suitable fluid case by case. Use of **low GWP**, **low ODP** and **not harmful fluids.**

TURBOMACHINES

Own design for more than 60 different turbines. Compressor shares **common technical features** and solutions with Turboden turbine.

INNOVATIVE DESIGN

Custom-made design with multiple possibilities of optimization.

3. TURBODEN LHP: BENEFITS

Large Heat Pumps (LHP) are utility-scale heating plants that allow to transfer large quantities of heat from a colder source to a higher temperature heat user, like a district heating network or an industrial process.

Highly efficient
Electrically driven based on turbo compressor technology

Large-scale
Output from 3 MWth to 30 MWth per single unit

High lift
Up to more than 100°C, possible thanks to custom design

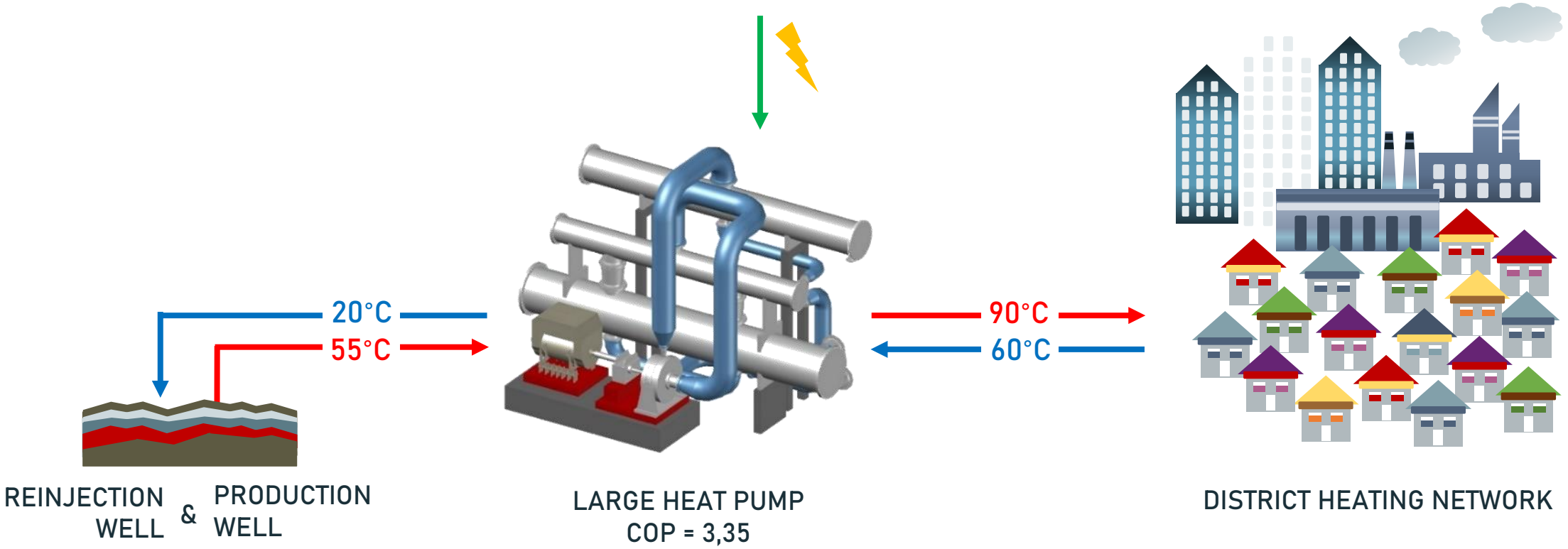
High temperature
Output up to 200°C with the possibility to generate steam

Environment-friendly
Experience with 10+ different working fluids with low GWP and low ODP

GWP: Global Warming Potential
ODP: Ozone Depletion Potential

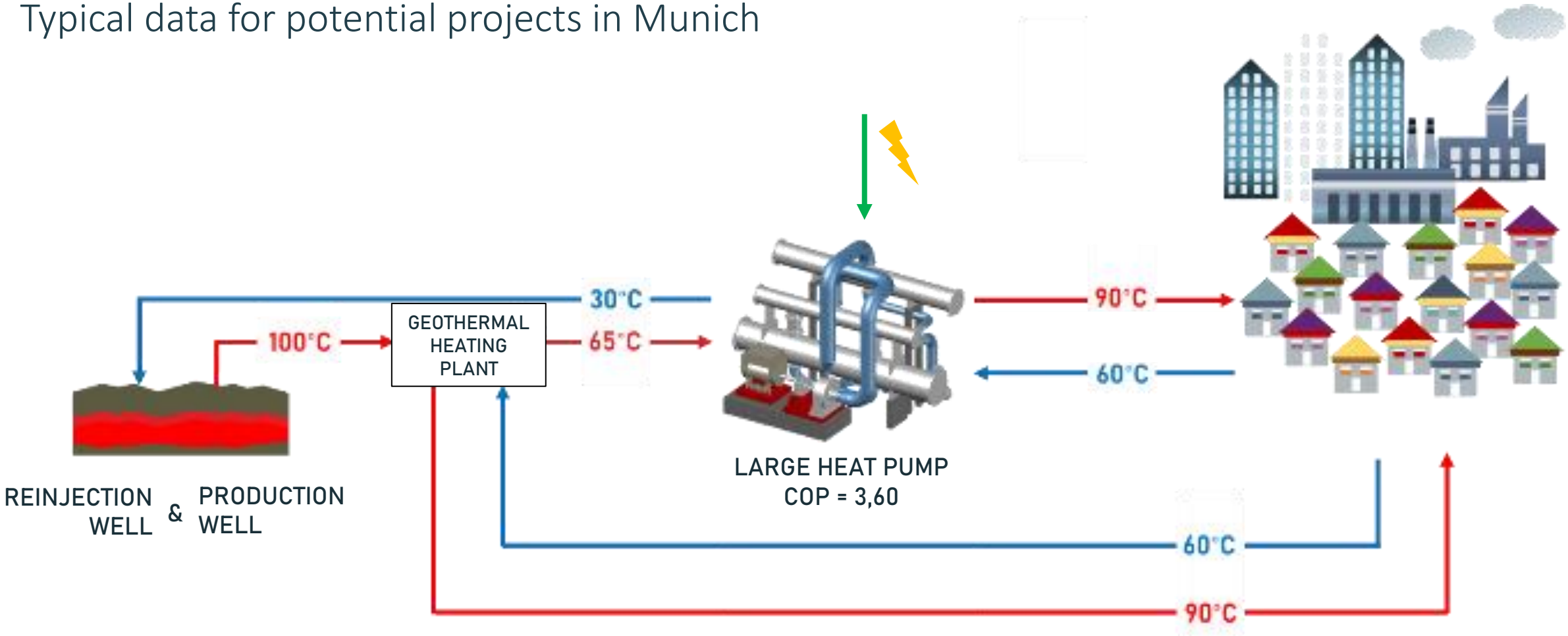
3. TURBODEN LHP: CASE STUDY 1

Typical data for potential projects north of Munich



3. TURBODEN LHP: CASE STUDY 2

Typical data for potential projects in Munich



4. REFERENCES: ORC GEOTHERMAL

2012

Site: Dürrnhaar, Germany

Customer: SWM - StadtWerke München

Configuration: power only

ORC power: 5.6 MWe

Liquid brine: 138 °C

CLICK FOR YOUTUBE VIDEO

2013

Site: Kirchstockach, Germany

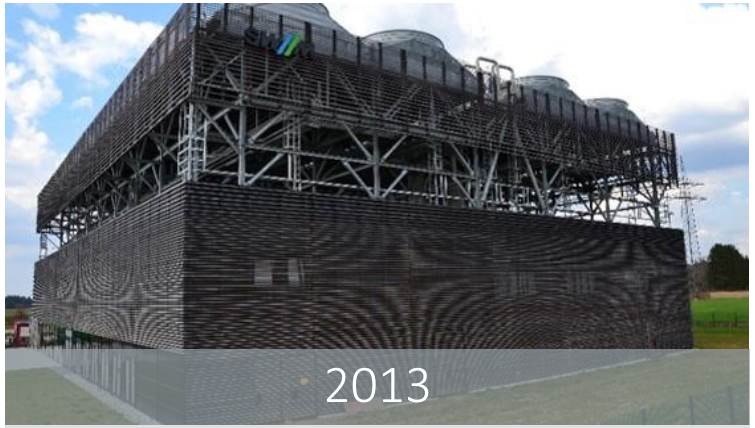
Customer: SWM - StadtWerke München

Configuration: power only

ORC power: 5.6 MWe

Liquid brine: 138 °C

CLICK FOR YOUTUBE VIDEO



2013

Site: Sauerlach, Germany

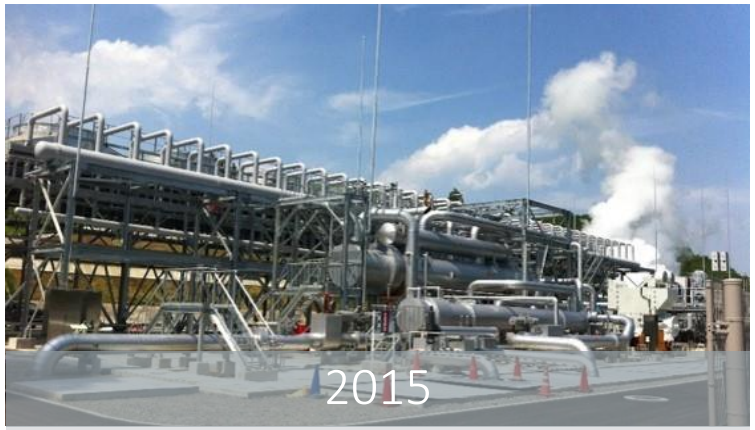
Customer: SWM - StadtWerke München

Configuration: power & heat

ORC power: 5 MWe + 4MWth

Liquid brine: 140 °C

4. REFERENCES: ORC GEOTHERMAL



Site: Sugawara, Japan

Customer: Kyushu Electric

Configuration: power only

ORC power: 5 MWe

Liquid brine + steam: 140 °C

Site: Traunreut, Germany

Customer: GKT Traunreut

Configuration: heat & power

ORC power: 4.1 MWe + 12 MWth

Liquid brine: 118 °C

Site: Soultz-sous-Forêts, France

Customer: GEIE

Configuration: power only

ORC power: 1.7 MWe

Liquid brine: 170 °C

4. REFERENCES: ORC GEOTHERMAL

2018

Site: Velika Ciglena, Croatia

Customer: Geo Power Energy development d.o.o.

Configuration: power only

ORC power: 17.5 MWe

Liquid brine + steam: 171 °C

CLICK FOR YOUTUBE VIDEO

2018

Site: Lightning Dock, USA

Customer: Cyrq

Configuration: power only

ORC power: 14 MWe

Liquid brine: 155 °C

CLICK FOR YOUTUBE VIDEO

2019

Site: Holzkirchen, Germany

Customer: Holzkirchen GmbH

Configuration: power & heat

ORC power: 3.4 MWe + 10 MWth

Liquid brine: 152 °C

4. REFERENCES: ORC GEOTHERMAL

UNDER CONSTRUCTION

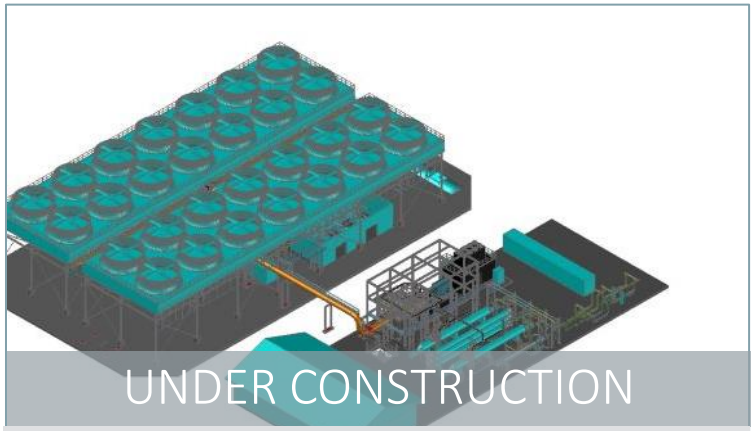
Site: Berlin, El Salvador

Customer: LaGeo

Configuration: bottoming plant

ORC power: 8 MWe

Liquid brine: 172 °C



UNDER CONSTRUCTION

Site: Kirchweidach, Germany

Customer: EON

Configuration: power & heat

ORC power: 3.7 MWe

Liquid brine: 122 °C

UNDER CONSTRUCTION

Site: Palayan, Bac-Man, the Philippines

Customer: Energy Development Corp.

Configuration: bottoming plant

ORC power: 29 MWe

Liquid brine: 171 °C

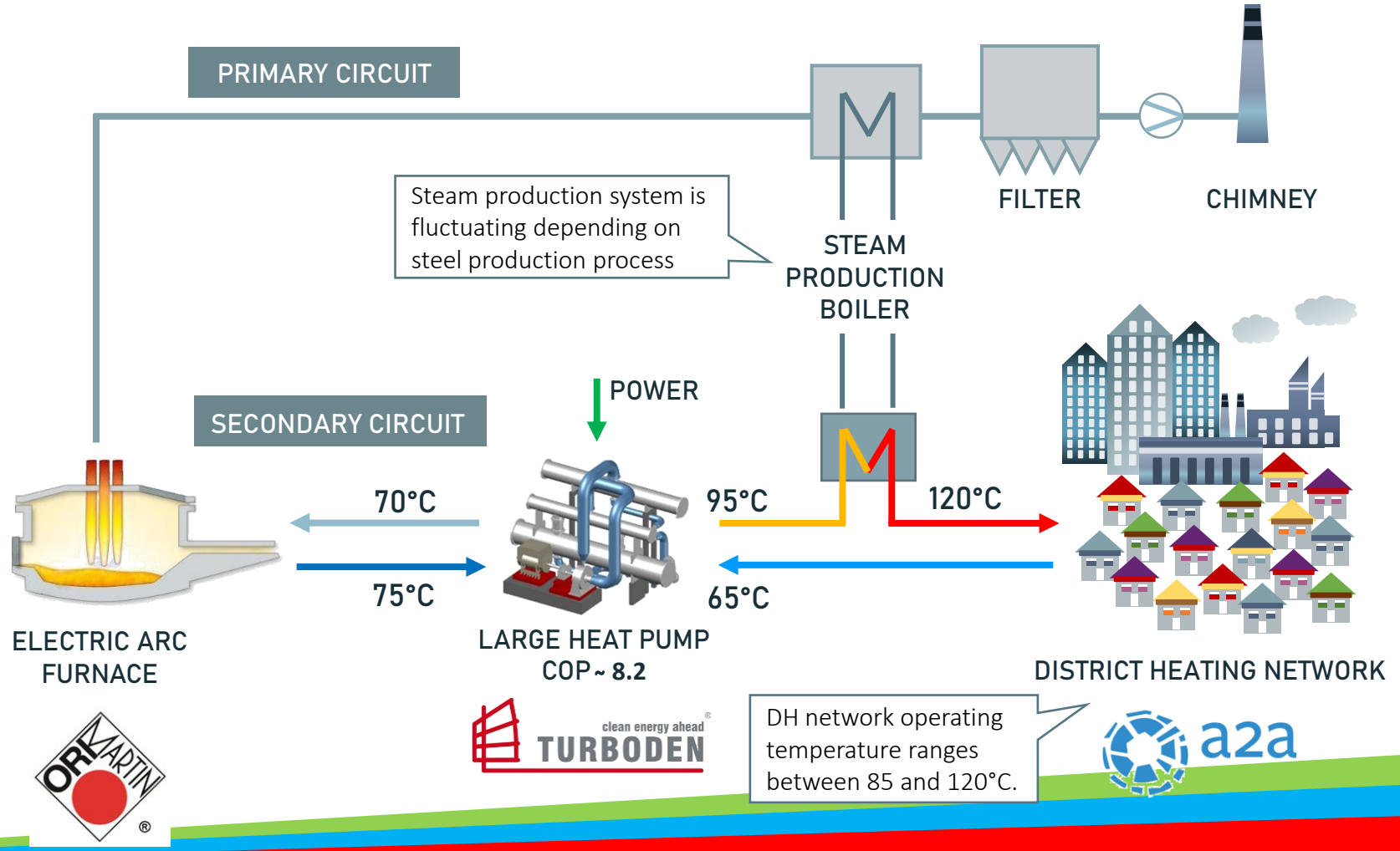
4. REFERENCES: LHP FOR DISTRICT HEATING

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.

LHP TECHNICAL FEATURES

Main technical features of LHP:

- **6 MWth** design heat delivered with output temperature up to **120°C**
- Full **integration** with DH network. Control system designed to be highly flexible depending on:
  - DH network operating temperature
  - Steam production boiler heat production
- **High flexibility** with 2 compression stages and variable frequency driver (due to a very variable process)
- Working fluid: Low GWP HFO, R1233ZD
- **Start-up February 2023**



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MOVE THE WORLD FORWARD MITSUBISHI HEAVY INDUSTRIES GROUP

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