TURBODEN
LARGE HEAT PUMPS
MORE HEAT OUT OF HEAT.
OUR VISION

We contribute to the worldwide efforts to mitigate global warming by creating reliable and clean energy systems that are safe, cost-efficient and user-friendly.
Large Heat Pumps (LHPs) are at the forefront of the strategy for the electrification of heat in an increasingly decarbonised power grid. Through the supply of LHPs Turboden wishes to play a broader role in the decarbonisation of the District Heating sector and of some energy-intensive industrial processes.

Output from $3 \text{ MW}_{th}$ to $30 \text{ MW}_{th}$

High temperature lift ($\Delta T$ up to $80^\circ C$ and more)

High-temperature output (including steam generation)
### EASY TECHNOLOGY

- Easy and cost-effective operation & maintenance: automatic operation, no major overhaul, fast start-stop procedures
- Simple technical features: low pressures involved, low speed compressor, shell & tube heat exchangers

### FLEXIBILITY

- Fully tailored solutions with optimized performance
- Experience with a number of different working fluids (refrigerants and hydrocarbons) in ORC applications
- Compressor developed and assembled in-house
- Range size up to 30 MWth or more per unit
- Ease of integration

### DEPENDABILITY

- Several proven technical solutions shared with sister ORC technology
- Global after sales service with 24/7 remote assistance
- Long design life

### SUSTAINABILITY

- Core system for renewable energy and energy efficiency
- Clean generation of higher-grade heat
- Reduction of CO₂ emissions
APPLICATIONS – DISTRICT HEATING

DISTRICT HEATING | ENERGY EFFICIENCY IN INDUSTRIAL PROCESSES | HEATING & COOLING OF BUILDINGS | CHP PLANT PREHEATING

HEAT SOURCES

“FREE” HEAT:
- Waste water
- River water
- Sea water (as low as 2-3°C)
- Groundwater

“INCOME GENERATOR” HEAT:
- Power plants waste heat
- PP flue gas cleaning
- PP heat from CO₂ capture
- Data centers cooling
- Cooling in industrial processes
- District cooling
- Seasonal solar heat storage
EXAMPLE: STEELWORKS

FURNACE

Input: 10 MW\textsubscript{th}

70°C

75°C

LARGE HEAT PUMP

COP > 9

Input: 1.1 MW\textsubscript{e}

100°C

60°C

DISTRICT HEATING NETWORK

Output: 11 MW\textsubscript{th}
EXAMPLE: GROUND SOURCE PROJECTS

REINJECTION WELL & PRODUCTION WELL

LARGE HEAT PUMP

DISTRICT HEATING NETWORK

10°C 14°C

90°C 60°C
EXAMPLE: GEOTHERMAL WITH ORC

TURBOGENERATOR

140°C

28°C

40°C

80°C

60°C

REINJECTION WELL & PRODUCTION WELL

LARGE HEAT PUMP

DISTRICT HEATING NETWORK
EXAMPLE: GEOTHERMAL AND GREENHOUSES

Input: 5 MW\textsubscript{th} 

LARGE HEAT PUMP

Input: 1.5 MW\textsubscript{e} 

Output: 6.5 MW\textsubscript{th}

Output: 1 MW\textsubscript{th}

NATURAL GAS

CHP GAS ENGINE

GREEN HOUSE

HEAT USER

REINJECTION WELL & PRODUCTION WELL

DISTRICT HEATING NETWORK

120°C

10°C

90°C

60°C

90°C

60°C

90°C

60°C
APPLICATIONS – INDUSTRY

DISTRICT HEATING  |  ENERGY EFFICIENCY IN INDUSTRIAL PROCESSES  |  HEATING & COOLING OF BUILDINGS  |  CHP PLANT PREHEATING

HEAT SOURCES
- Cooling in industrial processes
- Power plants waste heat
- Other waste heat
- Waste water
- Ground source
EXAMPLE: CHEMICAL PLANT

- COP tends to be lower due to higher lift, hence more challenging
- May require special (more costly) materials
- Year-round (potentially >8,000 hrs_{eq}/y) waste heat valorisation thanks to internal re-use

**Input: 4 MW_{th}** → **Input: 1.5 MW_{e}** → **Output: 5.5 MW_{th}**
MHI BEHIND TURBODEN LHP

Beside their Supply Chain, Mitsubishi Heavy Industries (MHI) grants Turboden with access to specialist consultancy, particularly on important R&D aspects (e.g. the first 16 MW ORC turbine).

MHI to support Turboden in the development of the new Turboden Large-scale Heat Pump (LHP), through their two divisions:
- MHI Thermal Systems
- MHI R&D
and potentially also through MHI Compressor Corporation.

Mitsubishi Heavy Industries produce centrifugal heat pumps and chillers of smaller size:
- MHI Heat Pumps: up to 600 kW thermal
- MHI Centrifugal chillers: up to 9.5 MW cooling

(*) larger size under development
WHY TURBODEN

PART OF MITSUBISHI HEAVY INDUSTRIES GROUP

- Turboden fully embraces MHI values, pillars of its philosophy and vision
- Turboden leverages the financial stability of its parent company and the technical support to satisfy customer needs

CAPABILITIES & EXPERIENCE

- With 40 years of experience, Turboden holds the know-how of the ORC technology
- Excellence in R&D and turbomachinery design
- Total capacity of 630 MWe and 1,340 MWth with 384 plants in 45 countries
- Global presence

CUSTOMER ORIENTATION

- Always dedicated to the success projects of the customers
- Customers are followed also in the after-sales, thanks to the service department
- Ready to provide optimized solutions for the clients
- High availability
- High customer satisfaction
ABOUT US

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.

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.

Today Turboden develops also large-scale heat pumps to satisfy the growing demand of higher-grade heat starting from lower-temperature renewable or otherwise wasted sources of heat.
TURBODEN IS A GROUP COMPANY OF MHI

MHI GROUP AT A GLANCE

POWER SYSTEMS
- Thermal Power Systems
- Nuclear Energy Systems
- Offshore Wind Power Systems
- Pumps
- Marine Machinery
- Compressors
- Aero Engines

$12.9 B NET SALES

INDUSTRY & INFRASTRUCTURE
- Engine & Energy
- Turbochargers
- Air-Conditioning & Refrigeration
- Automotive Thermal Systems
- Industry Instruments
- Machinery/Equipment
- Mechatronics Systems/ITS
- Metals Machinery
- Environmental Systems
- Chemical Plants
- Shipbuilding & Ocean Develop.
- Land Transportation Systems

$15.6 B NET SALES

AIRCRAFT, DEFENSE & SPACE
- Commercial Aircraft
- Mitsubishi Regional Jet (MRJ)
- Defense Aircraft
- Missile Systems
- Space Systems
- Special Vehicles
- Naval Ships
- Maritime & Space Systems

$6.3 B NET SALES

One of the world’s leading heavy machinery manufacturers, with consolidated sales of around $38 billion (in fiscal 2018).
Foundation July 7, 1884

MHI GROUP AT A GLANCE

- 83,000 EMPLOYEES WORLDWIDE
- $38B ANNUAL REVENUE
- 300 COMPANIES WORLDWIDE
- 31,783 PATENTS GLOBALLY

$1.3B OPERATING INCOME

54% SALES OUTSIDE JAPAN
GLOBAL AND PROVEN EXPERIENCE

COUNTRIES: 45

PLANTS (ORC): 384

TOTAL CAPACITY (ORC): 630 MWe – 1,344 MW<sub>th</sub>

CUMULATIVE OPERATION TIME (ORC): 15 million hours

AVERAGE AVAILABILITY (ORC): 98+%
Over 60 different axial turbines, from 2 to 6 stages reaching up to 20 MW of power and in some cases exceeding isentropic efficiency 90%. The new compressor shares a number of technical features and solutions with Turboden turbine.

Some of the working fluids are used with temperatures > 300°C in ORC systems.

A deep understanding of fluid properties, thermal stability and flammability allows Turboden to use over 10 different working fluids in its systems.

Pioneer in the development of innovative solutions in the ORC space, now extending its reach to related technologies like Large Heat Pumps and Gas Expanders.
AFTER-SALES SERVICE

Qualified staff is exclusively dedicated to the customer assistance, both from remote and on-site, with the aim of optimizing the management of the plants. The customer can choose the most suitable service package thanks to the wide range of services offered.

COVERAGE

2 service subsidiaries and 5 international service partner companies

ASSISTANCE

Turboden 24/7, the call center service h24, 7 days per week

CUSTOMISED 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 (TOS – Turboden Online Service)
- dedicated spare parts warehouse
AN EXTENSIVE NETWORK OF INSTITUTIONAL RELATIONS