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TURBODEN

MOVE THE WORLD FORW>RD MITSUBISHI HEAVY INDUSTRIES GROUP


HEAT
ELECTRIFICATION

# High-Temperature Heat Pump and MVR Technologies

Turboden S.p.A.

A Group Company of MITSUBISHI HEAVY INDUSTRIES

# Over 45 Years of a Viable Sustainability


Since 1980, Turboden S.p.A. is a pioneer in the **energy transition**, offering technological solutions to industries and utilities for power generation and heat electrification.

The strength of being part of **Mitsubishi Heavy Industries group**, together with the **extensive experience** in engineering, supplying, and maintaining **low-carbon industrial solutions**, make Turboden a dependable partner for innovative systems.

Having established itself as a **world-leading company in sustainable power production**, with 470+ Organic Rankine Cycle (ORC) plants in more than 50 countries, Turboden further expands its expertise by developing **advanced Heat Pumps and Mechanical Vapor Recompression (MVR) solutions**, including the delivery of the world's largest steam-generating heat pump.

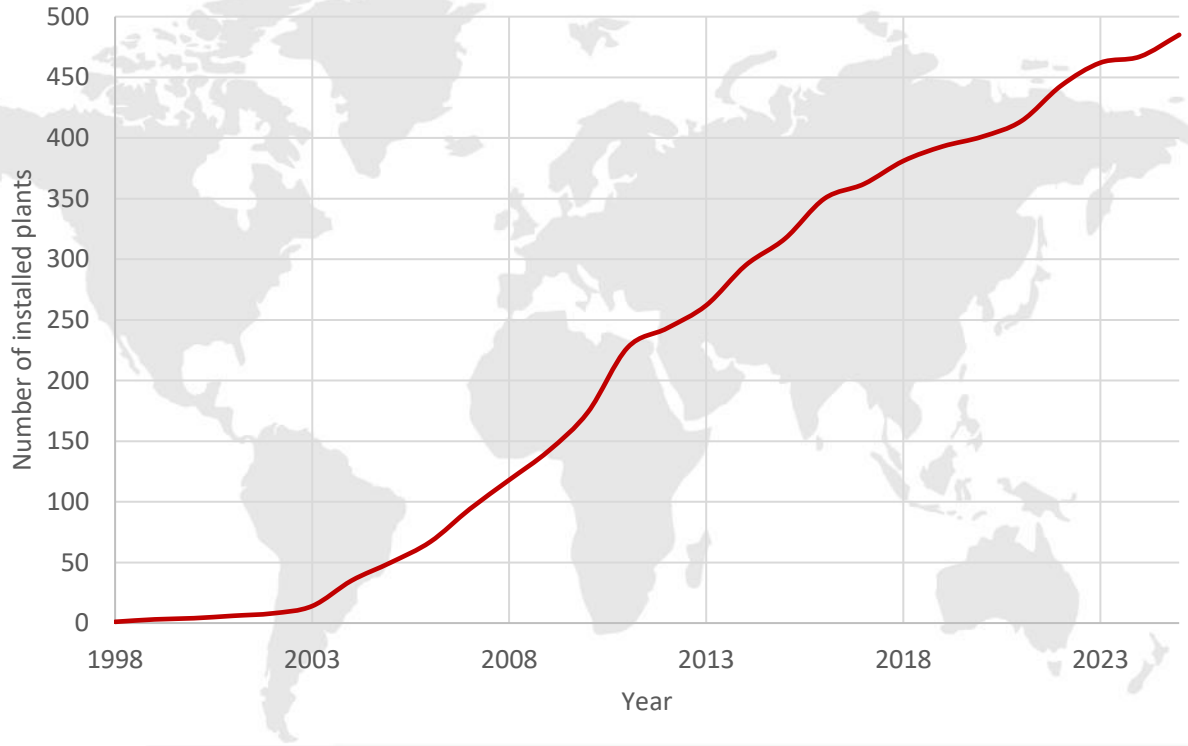
# Our Mission

*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.*

# Our Vision

*We accelerate the transition to a world powered by low-carbon technologies.*

# Global and Proven Experience




Overall capacity installed
**1+ GWe**

Largest plant under construction
**300 MWe**

Largest plant in operation
**29 MWe**

Worldwide presence in
**50+ countries**

Around
**470+ plants**

**HEAT ELECTRIFICATION**
3 units, 33 MWth

**HIGH TEMPERATURE POWER GENERATION* + COGEN**
450+ units, 840 MWe

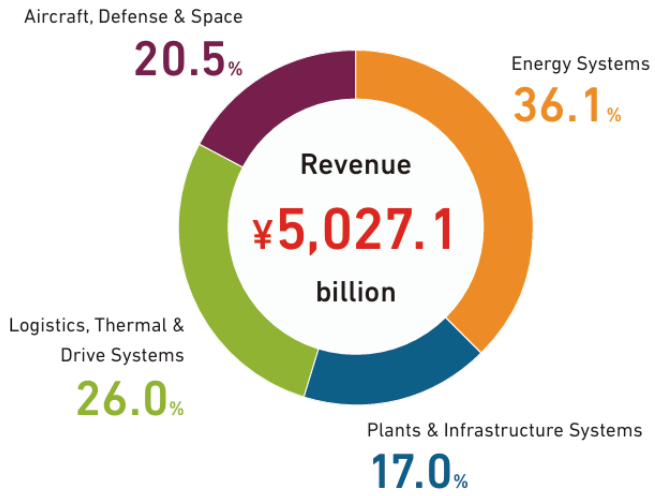
**GEOTHERMAL POWER GENERATION**
24 units, 457 MWe

Last update: July 2026
* ORC and gas expanders included.

# MHI at a Glance

MHI Group manages its operations through **three business domains and five segments**. We have grouped these business domains and segments based on the similarity of their respective customers and product characteristics into four reporting segments: **Energy Systems**; **Plants & Infrastructure Systems; Logistics, Thermal & Drive Systems**; and **Aircraft, Defense & Space**.

**Composition of Revenue by Segment (FY2024)**




| | Main Businesses | Internal Organizations and Major Subsidiaries |
|---|---|---|
| Energy Systems | • Gas & steam power systems*<br>• Nuclear power systems<br>• Aero engines<br>• Compressors<br>• Marine machinery | Energy Systems<br>Nuclear Energy Systems<br>• Mitsubishi Heavy Industries Aero Engines, Ltd.<br>• Mitsubishi Heavy Industries Compressor Corporation<br>• Mitsubishi Heavy Industries Marine Machinery & Equipment Co., Ltd. |
| Plants & Infrastructure Systems | • Metals machinery<br>• Commercial ships<br>• Environmental systems<br>• $CO_2$ capture systems<br>• Engineering<br>• Machinery systems | Plants & Infrastructure Systems<br>→ GX Solutions<br>Machinery Systems<br>• Primetals Technologies, Limited<br>• Mitsubishi Shipbuilding Co., Ltd.<br>• Mitsubishi Heavy Industries Environmental & Chemical Engineering Co., Ltd.<br>• Mitsubishi Heavy Industries Machinery Systems, Ltd. |
| Logistics, Thermal & Drive Systems | • Material handling systems<br>• Engines<br>• Turbochargers<br>• HVAC systems<br>• Automotive air-conditioning system | Logistics, Thermal & Drive Systems<br>• Mitsubishi Logisnext Co., Ltd.<br>• Mitsubishi Heavy Industries Engine & Turbocharger, Ltd.<br>• Mitsubishi Heavy Industries Thermal Systems, Ltd. |
| Aircraft, Defense & Space | • Commercial aviation<br>• Defense aircraft<br>• Missile systems<br>• Naval ships<br>• Maritime systems (torpedoes)<br>• Special vehicles (tanks)<br>• Space systems | Commercial Aviation Systems<br>Integrated Defense & Space Systems<br>• MHI RJ Aviation Inc. |

* Includes GTCC, steam power, and air quality control system

**Turboden** is part of GX (Green Transformation) Solutions Division

HEAT ELECTRIFICATION HIGH-TEMPERATURE HEAT PUMP AND MVR TECHNOLOGIES

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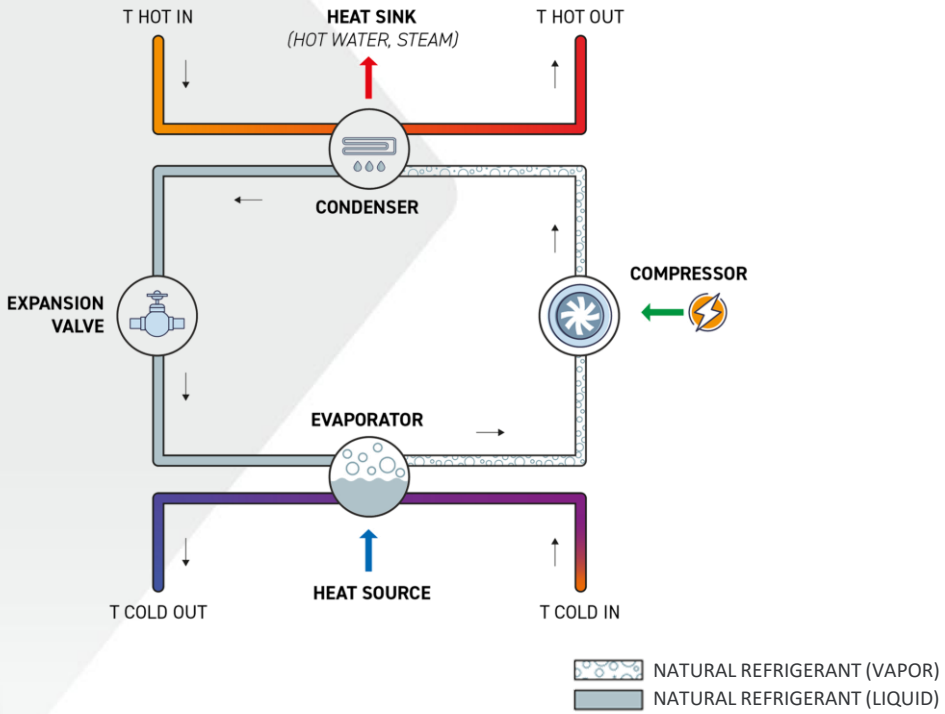
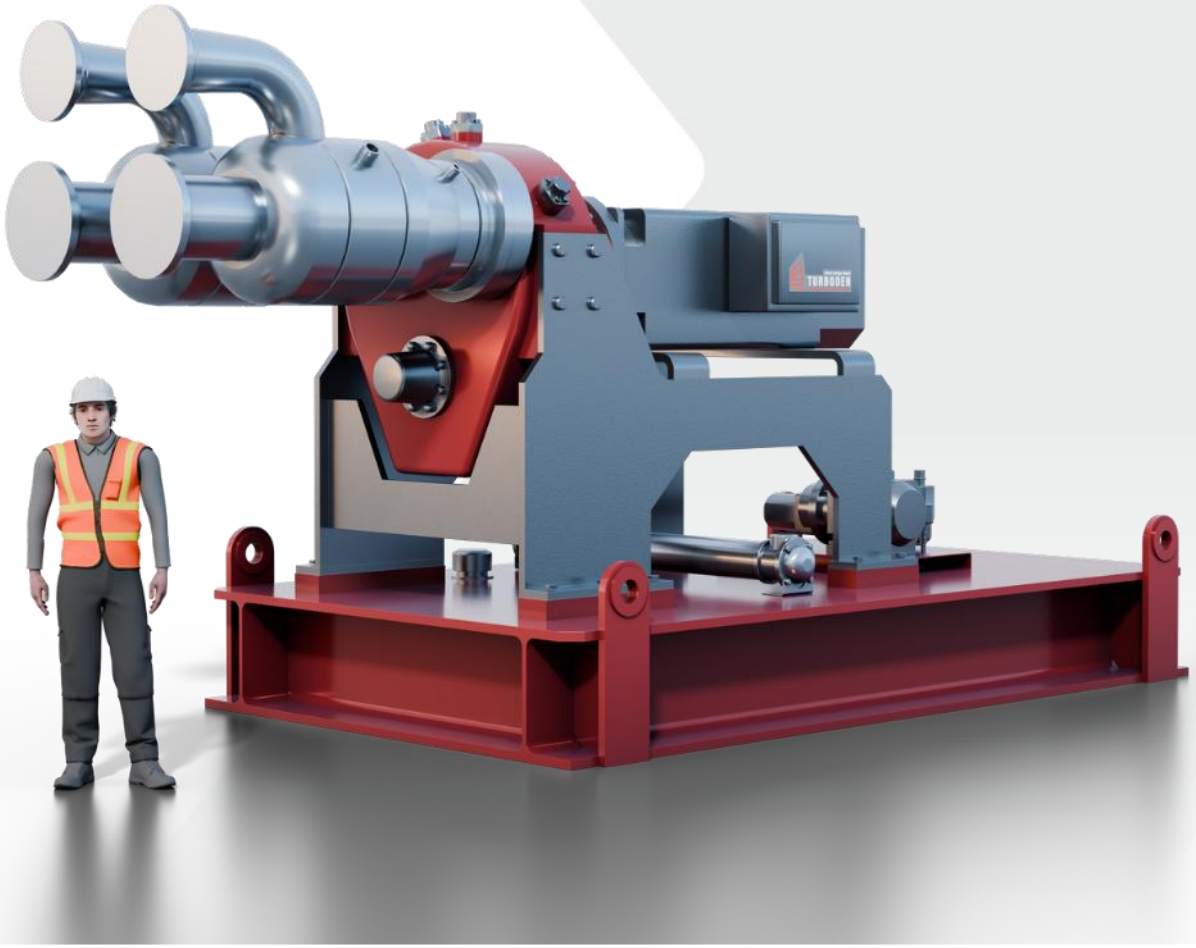
# A Portfolio to Cover Large Sizes and High Temperatures

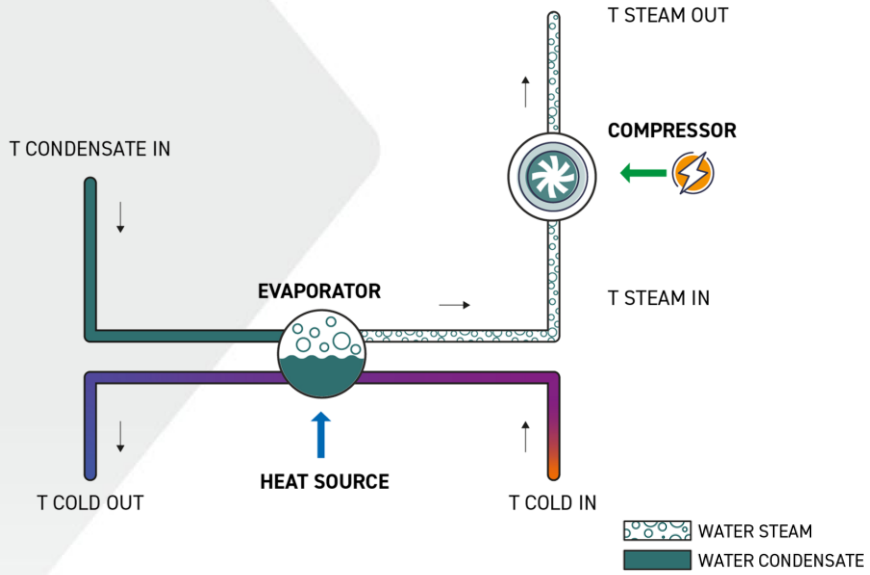




## LHP

Large Heat Pumps (LHP) are utility-scale heating plant, designed to transfer large quantities of heat from a lower temperature source to a higher temperature heat user, such as district heating grid or industrial process.

# A Portfolio to Cover Large Sizes and High Temperatures






## MVR

Mechanical Vapor Recompression (MVR) system, acting as an open cycle water heat pump, increases both the temperature and the pressure of a water stream, to generate steam at specific conditions needed.

# Turboden Compressor Technologies Portfolio

## TURBODEN HIT COMPRESSOR*

Integrally geared compressor double stage overhung

- Heavy duty machine designed for continuous operation with reduced maintenance
- Thermal power range: 5 MW to 30 MW
- Impeller diameter from 200 to 1,200 mm
- Enhanced flexibility for optimal part load operation and quick process adaptation
- Maximum safety with no harmful fugitive emissions

*Patent granted

## MITSUBISHI HEAVY INDUSTRIES COMPRESSOR

API617 beam type compressors

- Special Purpose API centrifugal compressor designed for critical process operation
- Thermal power up to 80 MW
- Impellers diameter up to 1,700 mm
- High reliability and availability
- DGS sealing system with leakage recovery system

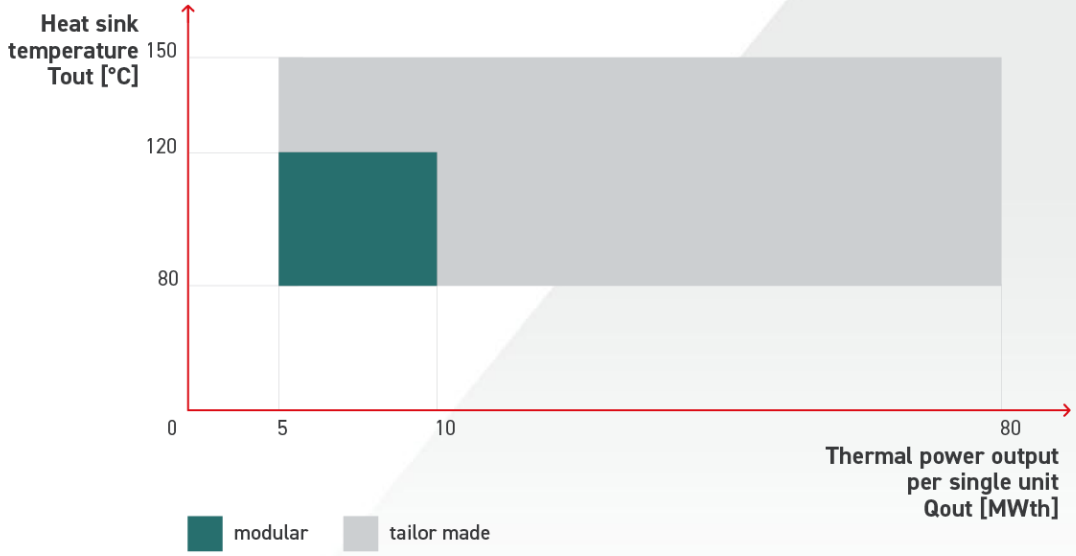
## TURBODEN STEAM COMPRESSOR

Integrally geared multistage centrifugal compressors

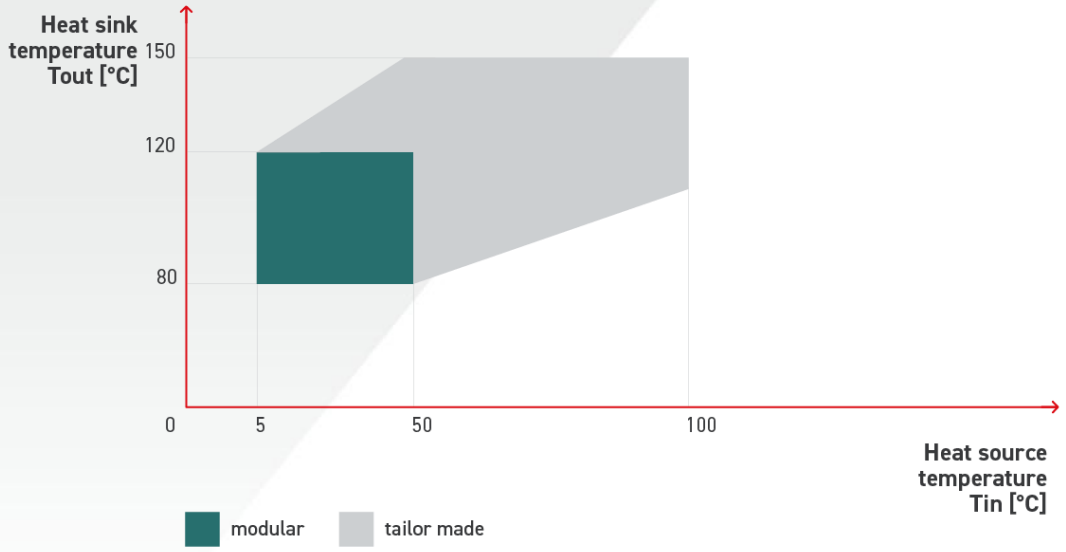
- Innovative product line designed for water steam compression
- Mechanical power range: from 100 kW to 10 MW
- Design conditions: up to 30 bar(a)/285°C (tailor-made configuration can be discussed on project specifics)
- Fluids: steam
- Suitable for MVR and direct steam recompression

# High-Temperature Heat Pumps for Hot Water Production

**THERMAL POWER OUTPUT VS HEAT SINK TEMPERATURE**

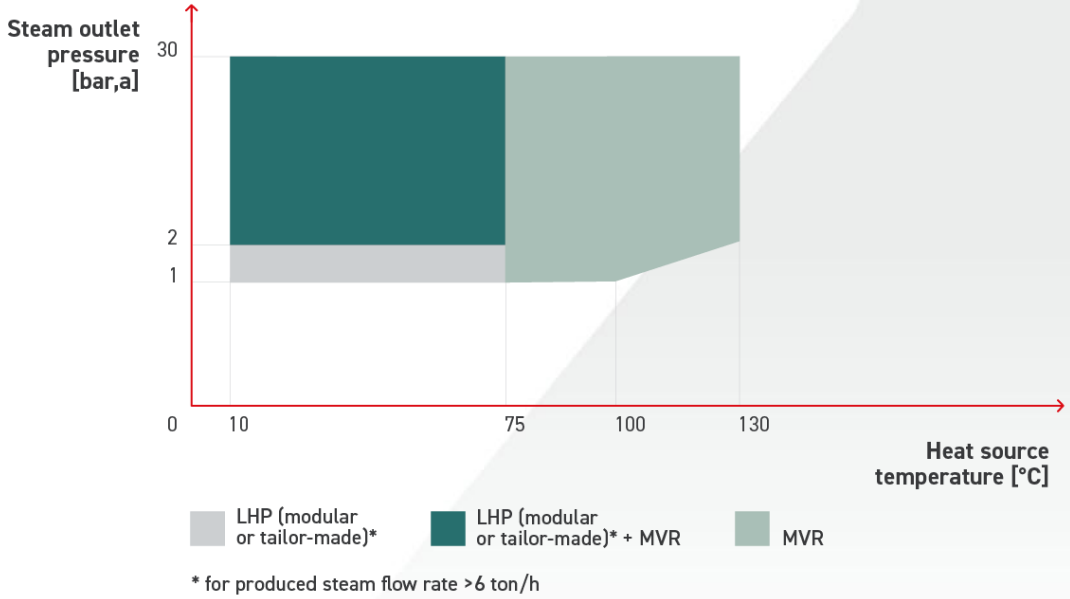



**HEAT SOURCE TEMPERATURE VS HEAT SINK TEMPERATURE**



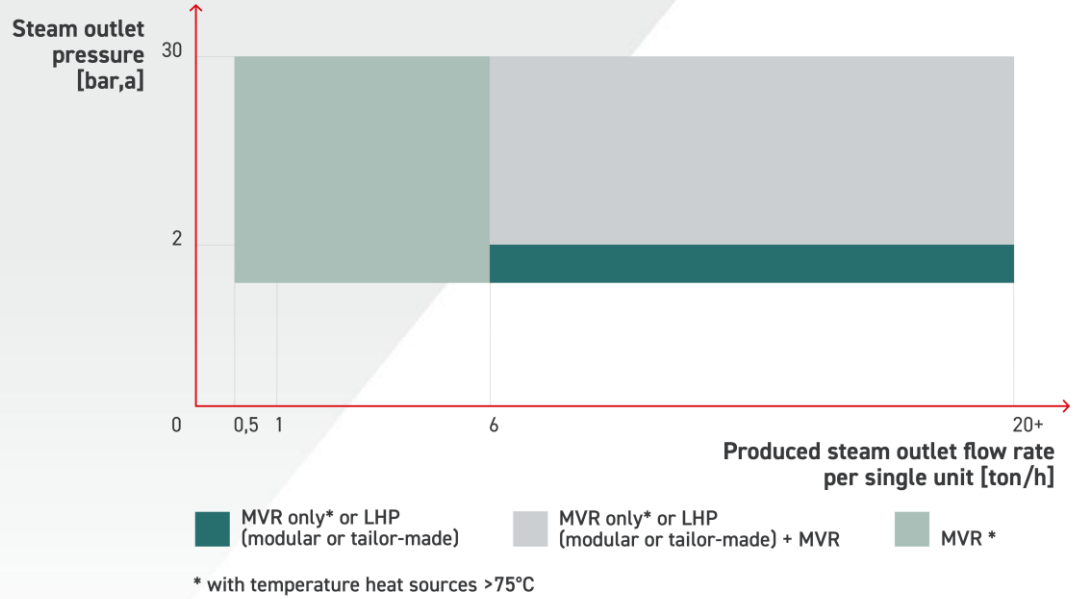
# High-Temperature Heat Pumps for Steam Generation

## HEAT SOURCE TEMPERATURE VS STEAM OUTLET PRESSURE




* for produced steam flow rate >6 ton/h

## PRODUCED STEAM OUTLET FLOW RATE VS STEAM OUTLET PRESSURE




* with temperature heat sources >75°C

# Dependable Partner to Reduce Carbon Footprints

Turboden delivers reliable heat-upgrade systems designed to decarbonize the following sectors:

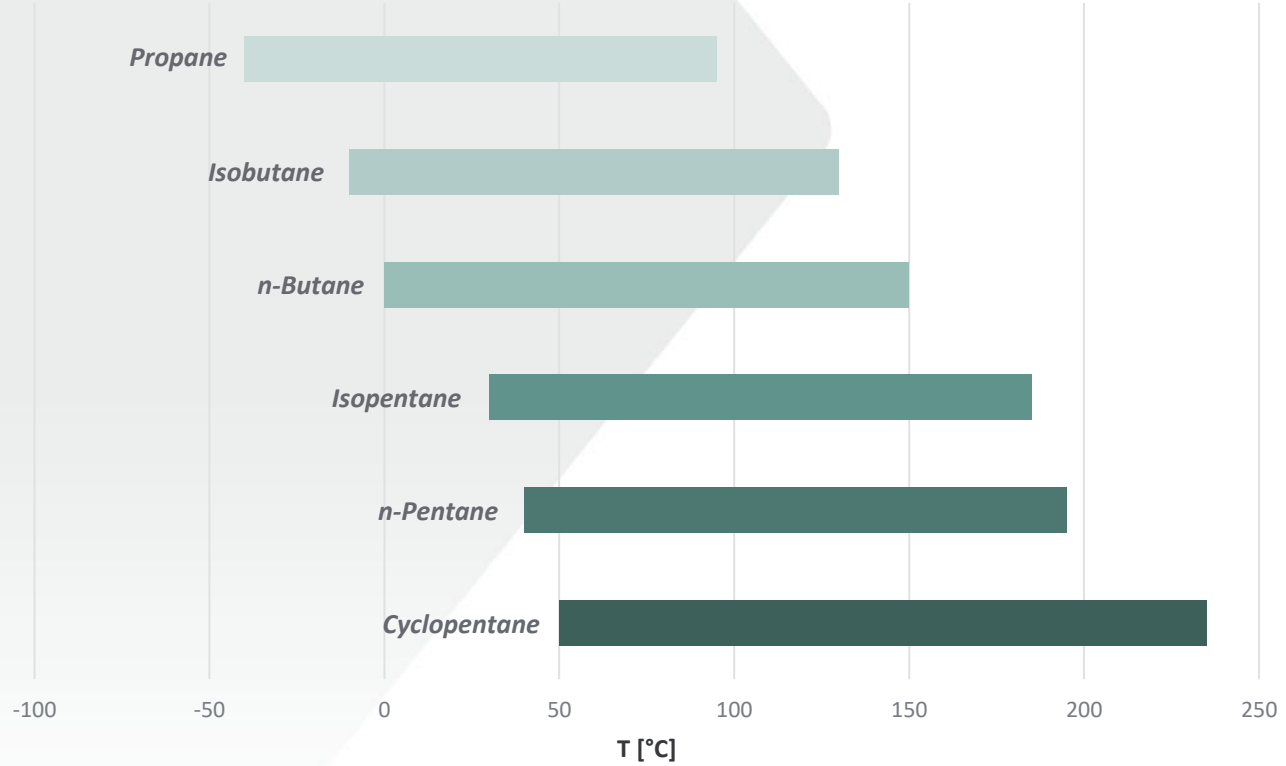
**district heating networks** exploiting multiple heat sources including cooling water from industries

**industrial applications**, such as pulp & paper, refinery & petrochemical, chemical & pharmaceutical, food & beverage

**Carbon Capture and Storage** (CCS) improving sequestration efficiency by up to 20% compared to conventional systems

# Flexibility to Manage Different Fluids

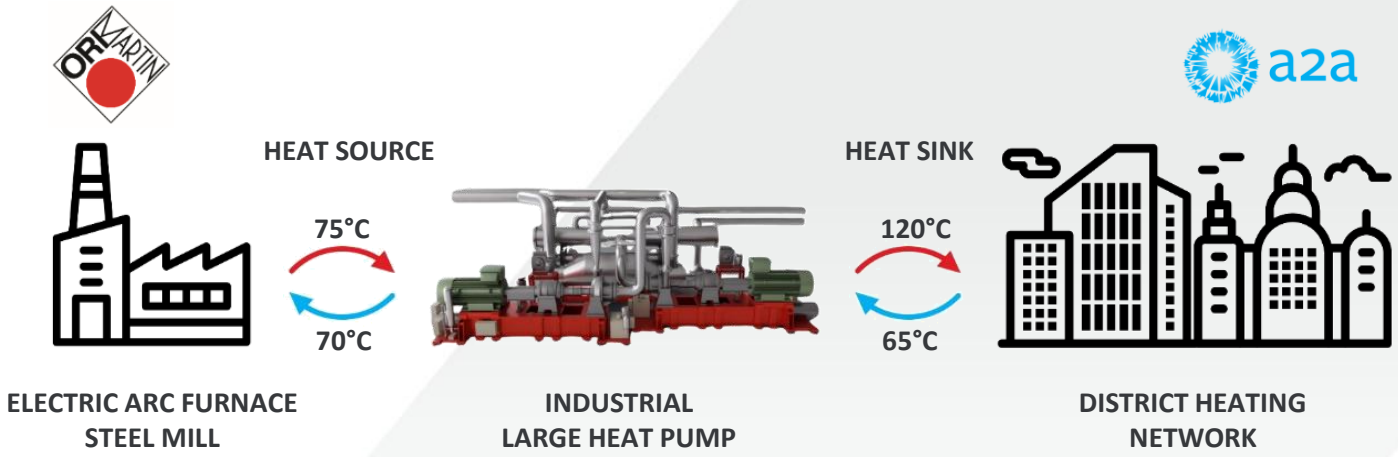
- Natural refrigerants with low ODP and GWP[1]
- Cost effectiveness (hydrocarbons up to 10 - 15 times lower than equal performances HFOs)
- HFOs within possible PFAS ban[2]
- High temperature suitable
- Flammability handled as usual best practice in industrial plants[3]




[1] *GWP: Global Warming Potential. ODP: Ozone Depletion Potential.*
[2] *Council of the EU and the European Council, https://www.consilium.europa.eu/en/press/press-releases/2023/10/05/fluorinated-gases-and-ozone-depleting-substances-council-and-parliament-reach-agreement/.*
[3] *HEX construction according to ASME and international standard. ATEX requirements: IEAC 600079-10 as ZONE 2. Ventilation according to EN378. Turboden experience with 40+ reference plants in operations adopting hydrocarbons.*

# Case History: ORI Martin Steelworks

Instead of wasting the heat generated during the steelmaking process and dissipated through cooling towers, the customer enhanced its value by installing a LHP to upgrade the heat for district heating, taking advantage of a more efficient and sustainable solution.




## PROJECT FEATURES

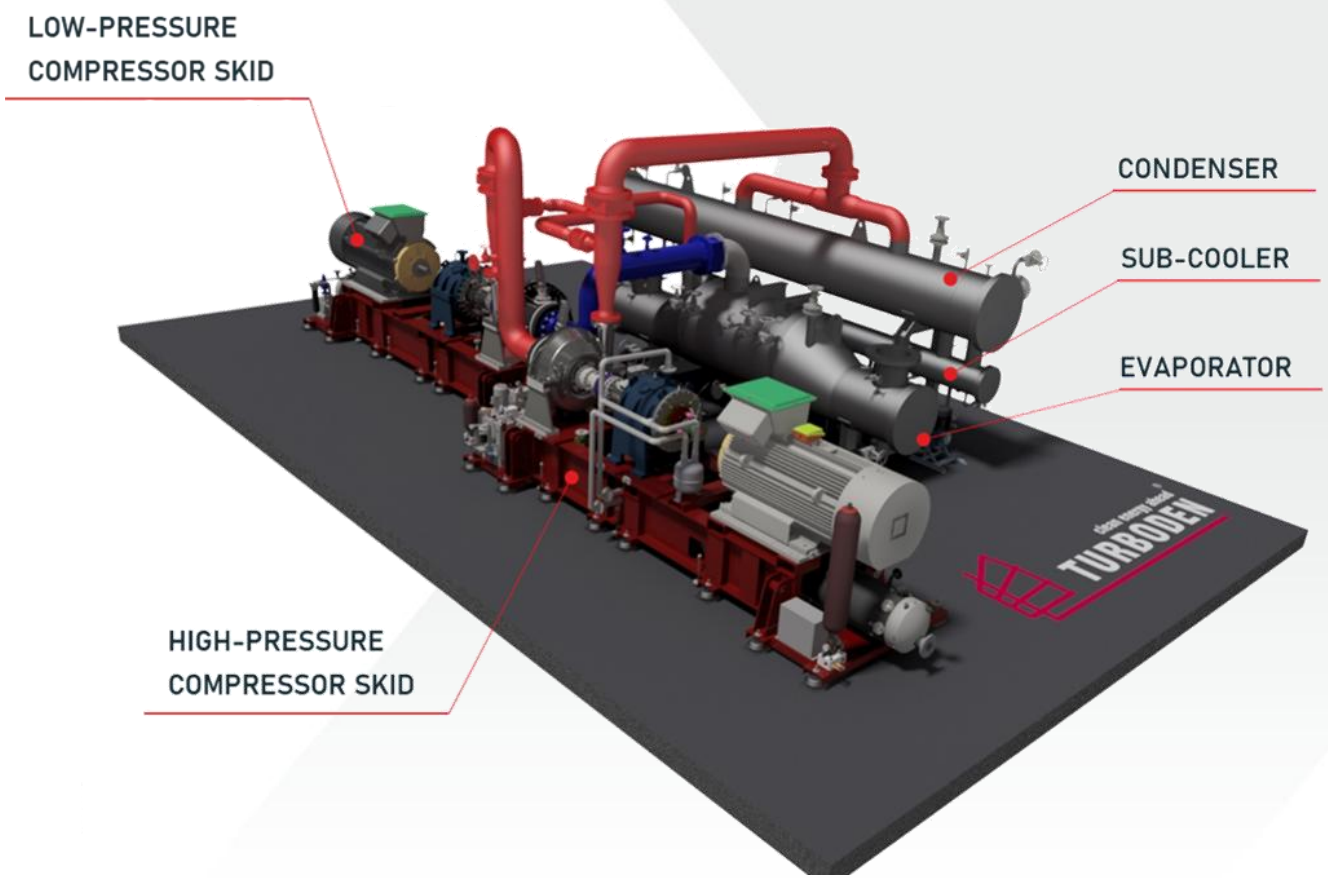
- Country: Italy, in operation since 2023
- Size: 6 MWth (equivalent to 3,500 houses)
- Exploitation of steel mill waste heat to serve local district heating network
- Output: pressurized water at 120°C delivered to the district heating network

## TECHNICAL FEATURES

- Centrifugal innovative compressor designed by Turboden
- LHP working fluid: synthetic refrigerant

WATCH THE VIDEO

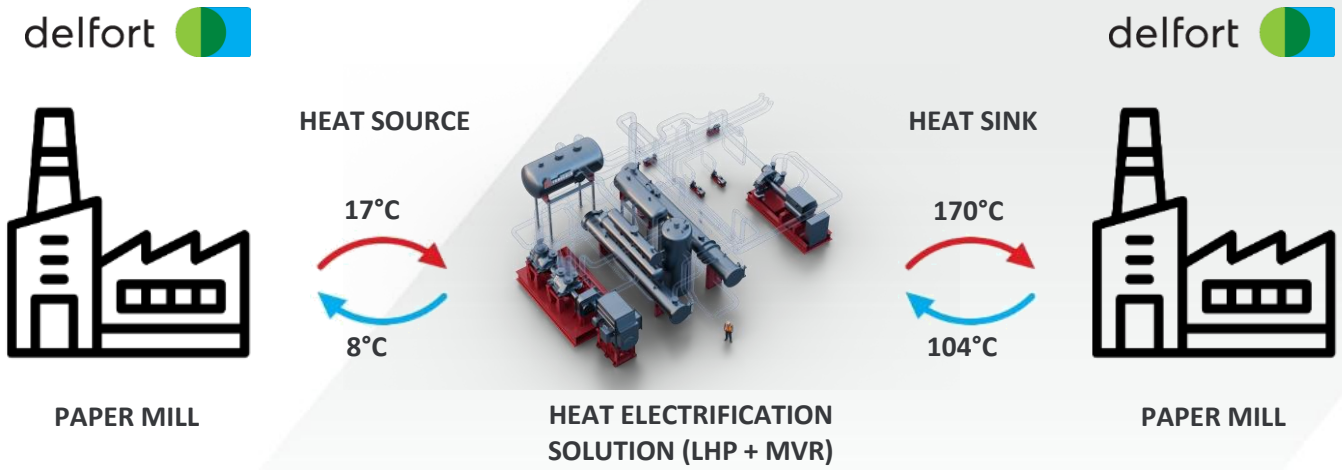
# Case History: ORI Martin Steelworks




# Case History: ORI Martin Steelworks

# Case History: Delfort Paper Mill

The customer valorized the low-temperature wastewater from the paper mill by installing an innovative heat-upgrade solution, a LHP together with an MVR, to produce valuable steam for the paper mill itself.




**PROJECT FEATURES**

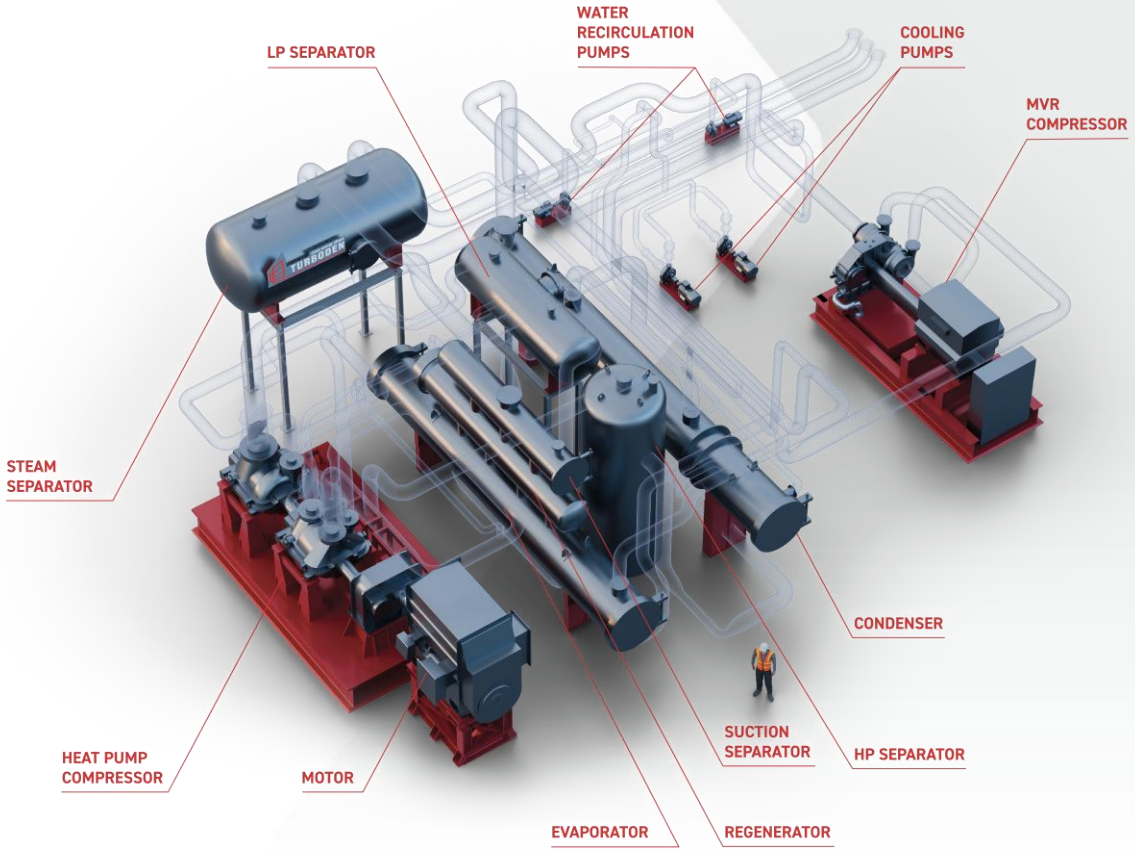
- Country: Finland, in operation since 2026
- Size: 12 MWth
- Exploitation of paper mill waste heat to generate steam at 3.4 bar(a) for the process
- Output: superheated steam at 170°C delivered to the paper mill

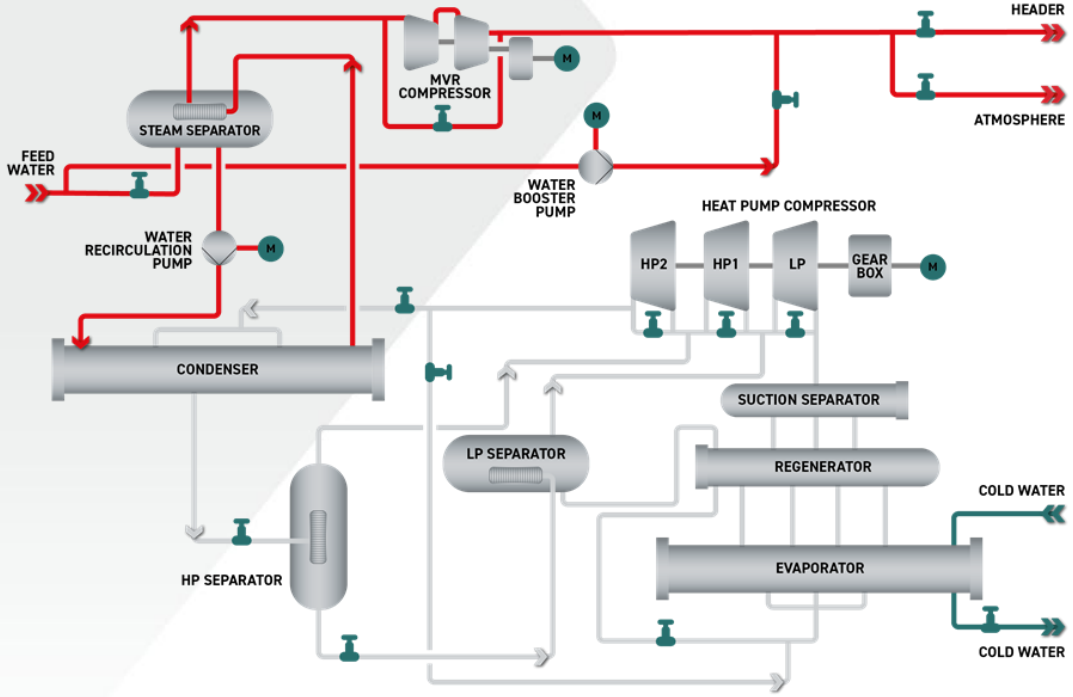
**TECHNICAL FEATURES**

- Integration of LHP with MVR to provide high-temperature steam at high efficiency (COP 2)
- Centrifugal MCO compressor
- LHP working fluid: natural refrigerant

**WATCH THE VIDEO**

# Case History: Delfort Paper Mill



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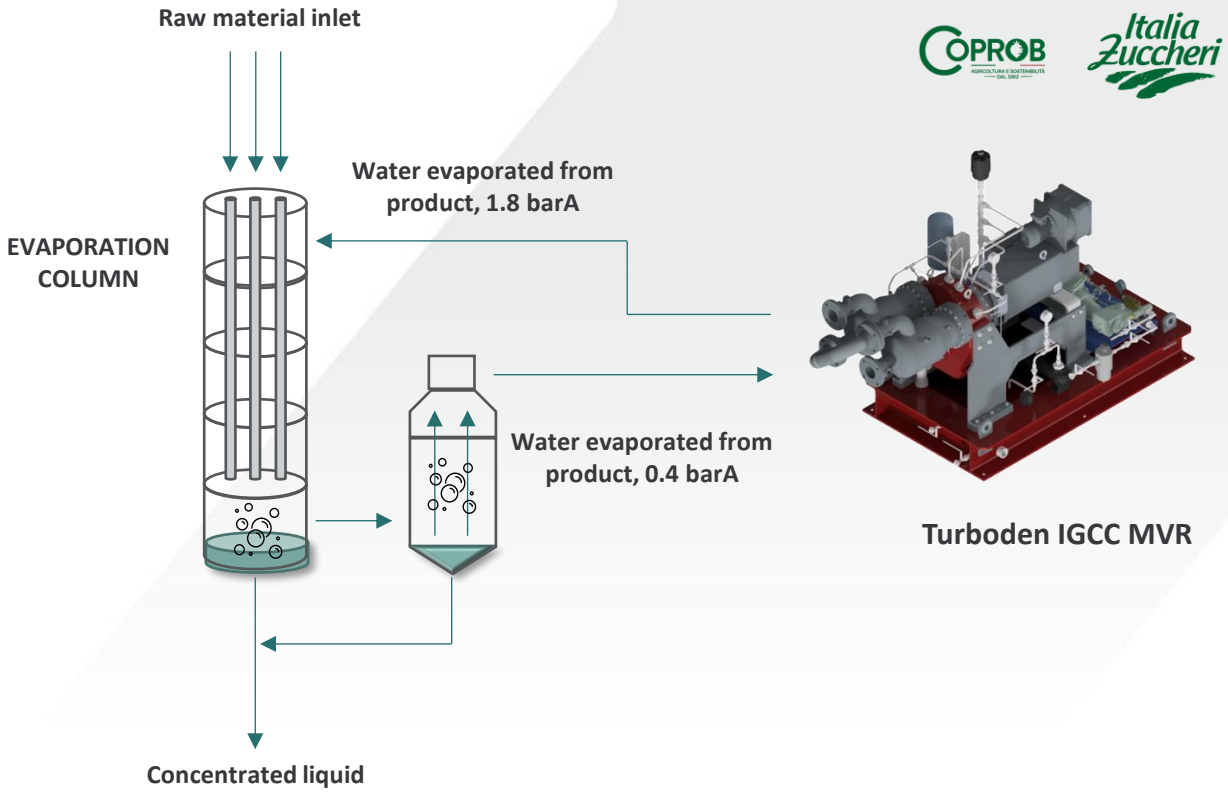
# Case History: Delfort Paper Mill

# Case History: Co.Pro.B. Italia Zuccheri

In the process, heat dries the final product. The resulting water vapor is compressed with a Turboden IGCC compressor and condensed releasing its latent heat, which is efficiently reused to further enhance the evaporation process. A single Turboden MVR is installed in a multi-effect evaporator ensuring easy installation, high reliability and small footprint.






Turboden IGCC MVR

## PROJECT FEATURES

- Country: Italy, under construction
- Size: 22 ton/h of steam
- Single MVR installed in a multi-effect evaporator
- Output: saturated steam at 1.8 bar(a) delivered to the sugar process

## TECHNICAL FEATURES

- Capability to handle process steam
- Three-stage integrally geared centrifugal compressor

The plant is one of the selected industrial heat pumps co-funded by the European Union under the project HP4INDUSTRY

# Case History: Co.Pro.B. Italia Zuccheri

# Service & After Sales Support at a Glance

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.


1. Customer request or Turboden planned checks
2. Trend analysis with local operator support
3. Focused teamwork and technical decisions
4. Reaction plan: remote or on-site
5. Satisfied customer

## COVERAGE

1 main office in Brescia, 4 service subsidiaries and 4 international service partner companies.

## ASSISTANCE

- Turboden 24/7 for troubleshooting and remote consultancy
- Turboden software for performance monitoring and operation parameters control

## CUSTOMISED SERVICES

- dedicated staff for remote technical support
- dedicated staff of fields technicians for on-site planned maintenance, predictive maintenance, unplanned and extraordinary maintenance
- dedicated spare parts warehouse
- availability guarantee

# Service & After Sales Support at a Glance

**REMOTE TECHNICAL SUPPORT**
Real-time remote technical support through our **Turboden Online Service (TOS 4.0)** platform, enhanced by our proprietary Turboanalytics AI and backed by **24/7 expert assistance** to rapidly detect, prevent, and resolve issues while maximizing performance.

**SCHEDULED MAINTENANCE**
Planned maintenance **aligned with customer's production schedules**, offering customized services to **minimize downtime** and **optimize performance**, from basic tasks to full equipment overhauls.

**PREDICTIVE MAINTENANCE**
Data-driven monitoring to anticipate issues, with **customized wear-part management** ensuring reliability and continuous coverage.

**AVAILABILITY GUARANTEE**
Service programs backed by an **availability guarantee**, with financial compensation if plant availability does not meet expectations.

**EXTENDED WARRANTY**
Seamless **coverage beyond expiry**, scalable from main components to a full package, with all repair and fault resolution **costs fully covered.**

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