DON'T WASTE THE POWER OF GAS PRESSURE REDUCTION
WHY EXPANDERS?

Confident in our know-how, we aim to provide cutting-edge technologies to enhance the adoption of decarbonisation initiatives in the natural gas sector.
INTRODUCTION

Turboden gas expander is a solution to enhance the energy efficiency of a natural gas network infrastructure, producing electricity by taking advantage of the reduction of gas pressure from the delivery level to the one required by users, be they residential or industrial.

KEY POINTS

- Design based on 40+ years of experience, leveraging Mitsubishi Heavy Industries support
- Long experience in the energy efficiency sector
- Profit generation while reducing the gas pressure
- Solution for natural gas network decarbonisation
- Unmanned installations, thanks to specific technology features
- Turn-key equipment capabilities
- Over 60 Turboden turbine models within the 400 power plants fleet
THE CONFIGURATION

Gas expanders
THE SOLUTION

Natural gas turboexpanders reduce gas pressure from the delivery level to the one required by users, be they residential or industrial.

Unlike common pressure regulators (still present in bypass to the turboexpander, for safety reasons, as a redundant system), the turboexpanders exploit the pressure drop to produce electricity, improving the energy efficiency of the entire gas distribution system.
FEATURES

**Simplicity**
- ✓ Skidded solution of the complete expansion system
- ✓ Simple and robust power set with proven track record
- ✓ No major overhaul

**Flexibility**
- ✓ Wide range of solutions, starting from 100 kWe
- ✓ Ease of integration into existing gas network facilities
- ✓ Simple and automatic handling of partial loads

**Experience**
- ✓ Over 60 Turboden turbine models within the 400 power plants fleet
- ✓ 40+ years in the design and production of turbomachinery
- ✓ Long experience in the energy efficiency sector

**Operation & Service**
- ✓ High availability
- ✓ Designed to last over time (> 20 years)
- ✓ Structured after sales team, prompt assistance, personalized services
## TURBODEN RATING

### EXPANDERS SIZES

<table>
<thead>
<tr>
<th>Feature</th>
<th>EXP 300</th>
<th>EXP 600</th>
<th>EXP 900</th>
<th>EXP &gt; 1 MW</th>
</tr>
</thead>
<tbody>
<tr>
<td>Turbine stages/admission</td>
<td>Single stage radial turbine</td>
<td>Multi stages axial turbine</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Flow rate</td>
<td>&gt;5000 Sm³/h</td>
<td>20,000 – 100,000+ Sm³/h</td>
<td></td>
<td></td>
</tr>
<tr>
<td>In - out gas pressure range</td>
<td></td>
<td>50 - 1 bar(g)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Bearings</td>
<td>Self-lubricated rolling bearings</td>
<td>Rolling bearings</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Seals</td>
<td>Single tight casing for impeller and generator</td>
<td>Double mechanical</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Generator</td>
<td>Permanent Magnet Generator</td>
<td>A/Synchronous LV - Eff. 97%</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Containerization</td>
<td>Sandwich panel REI 120 if 10m gate distance possible; or concrete if 2m gate distance possible. Necessary to segregate electrical panel and hot water boiler.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Gas pre-heating</td>
<td>Custom based on project specific features (e.g. gas fired boilers, waste heat, heat pump...)</td>
<td></td>
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<td></td>
</tr>
</tbody>
</table>
CORE COMPONENTS

HIGH-PRESSURE GAS

HEAT TO AVOID GAS FREEZING AFTER EXPANSION

GAS AT REQUIRED PRESSURE (5-10°C)

EXPANDER (TURBINE)

CONTROL CABINET

ELECTRIC GENERATOR
REFERENCES

CUSTOMER: Italgas, Italy
CONFIGURATION: power generation from gas pressure reduction in the natural gas network infrastructure of Rome
EXP POWER: 1.3 MWe (2 gas expanders, 650 kWe each)
KEY FEATURE: 2 x 80,000 Sm3/h @ 50 - 24 barg
HIGHLIGHTS: high efficiency project, electrified by two turboexpanders and two cogenerative gas engines

CUSTOMER: A2A, Italy
CONFIGURATION: power generation from gas pressure reduction within Brescia’s natural gas network infrastructure
EXP POWER: 0.3 MWe
KEY FEATURE: 25,000 Sm3/h @ 12 - 6 barg
HIGHLIGHTS: smart city project – expansion of the natural gas entering the Brescia’s gas distribution network, exploiting the district heating for the natural gas pre-heating
REFERENCES

CUSTOMER: Pietro Fiorentini/Italgas, Italy
CONFIGURATION: power generation from gas pressure reduction in the natural gas network infrastructure of Turin
ORC POWER: 0.3 MWe
KEY FEATURE: 9,000 Sm3/h @ 24 - 6 barg
HIGHLIGHTS: power generation from gas pressure reduction implemented in one of the reduction and measurement station of Turin natural gas distribution network

CUSTOMER: HERAtech, Italy
CONFIGURATION: power generation from gas pressure reduction in the Ravenna natural gas network infrastructure
ORC POWER: 0.7 MWe
KEY FEATURE: 25,000 Sm3/h @ 45 - 5 barg
HIGHLIGHTS: high efficiency expansion system to exploit the natural gas expansion at one of the main gate of Ravenna natural gas distribution network
TURBODEN MILESTONES

- **‘60-’70**: 1st ORC prototype.
- **1976**: Prof. Mario Gaia makes experience in the field of ORC within his research group at Politecnico di Milano.
- **1980**: Prof. Mario Gaia founds Turboden.
- **1998**: 1st ORC biomass 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.
- **2020**: Turboden enters geothermal, waste heat recovery and solar markets.

**ORC SIZES AVAILABLE**
- **1990**: 300 kW
- **2000**: 1 - 2 - 4 MW
- **2010**: 5 - 8 - 10 MW
- **2020**: 20 MW

**ORC PLANTS INSTALLED**
- **1990**: 1
- **2000**: 100
- **2010**: 220
- **2020**: 400+
WHY TURBODEN

MITSUBISHI HEAVY INDUSTRIES GROUP
- Turboden fully embraces the values, philosophy and vision of its parent company MHI
- 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 turbine design
- Total capacity of 750+ MWe, 400+ plants, 50 countries
- Global presence

CUSTOMER ORIENTATION
- Always dedicated to the success projects of the customers
- Prompt assistance and customized after-sales service
- Ready to provide optimized solutions for the clients
- High availability
- High customer satisfaction
DEDICATED 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.

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

**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
OUR EXPERIENCE. YOUR POWER.