DON’T WASTE THE POWER OF GAS PRESSURE REDUCTION. EXPLOIT IT.
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
**THE SOLUTION**

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

Unlike the reduction stations (still present in by-pass 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.
<table>
<thead>
<tr>
<th>FEATURES</th>
<th>Simplicity</th>
<th>Flexibility</th>
<th>Experience</th>
<th>Operation &amp; Service</th>
</tr>
</thead>
<tbody>
<tr>
<td>✓</td>
<td>✓ Skidded solution of the complete expansion system</td>
<td>✓ Wide range of solutions, starting from 100 kWe</td>
<td>✓ Over 60 Turboden turbine models within the 400 power plants fleet</td>
<td>✓ High availability</td>
</tr>
<tr>
<td>✓ Simple and robust power set with proven track record</td>
<td>✓ Ease of integration into existing gas network facilities</td>
<td>✓ 40+ years in the design and production of turbomachinery</td>
<td>✓ Designed to last over time (&gt; 20 years)</td>
<td></td>
</tr>
<tr>
<td>✓ No major overhaul</td>
<td>✓ Simple and automatic handling of partial loads</td>
<td>✓ Long experience in the energy efficiency sector</td>
<td>✓ Structured after sales team, prompt assistance, personalized services</td>
<td></td>
</tr>
</tbody>
</table>
## TURBODEN RATING

<table>
<thead>
<tr>
<th>EXPANDERS SIZES</th>
<th>EXP 400</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>70 – 1 bar(g)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>✓ Bearings</td>
<td>Rolling bearings</td>
<td>Self-lubricated rolling bearings</td>
<td></td>
<td></td>
</tr>
<tr>
<td>✓ Seals</td>
<td>Single tight casing for impeller and generator</td>
<td>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>Hot water boiler fed by natural gas and shell&amp;tube heat exchangers + possible combination with electrical heaters and heat pumps – custom based on project specific.</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
SYSTEM LAYOUT

HIGH-PRESSURE GAS

HEAT TO AVOID GAS FREEZING AFTER EXPANSION

GAS AT REQUIRED PRESSURE (5-10°C)

AXIAL TURBINE EXPANDER

CONTROL CABINET

ELECTRIC GENERATOR

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

Prof. Mario Gaia founds Turboden.

Turboden enters geothermal, waste heat recovery and solar markets.

Turboden becomes leader in Europe with its biomass plants.

MHI acquires the majority of Turboden.

Turboden develops natural gas expansion technology. In 2019 first turboexpander.
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

Gas expanders
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.

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
TWO GAS EXPANDERS FOR ITALGAS GENERATORS 650 kWe EACH
ELECTRIFICATION OF ITALGAS GAS NETWORK

CUSTOMER:
Italgas

COUNTRY:
Italy

STATUS:
under construction

GAS EXPANDER SIZE:
1.3 MWe (2 gas expanders, 650 kWe each)

DESCRIPTION:
power generation from gas pressure reduction in a natural gas network infrastructure

OVERALL SOLUTION:
comprehensive project of a greenfield high efficient natural gas pressure reduction station, electrified by means of two turboexpanders and two cogenerative gas engines

HIGH EFFICIENCY of the pressure reduction station

COMBINATION of gas expander and gas engines
THE SITE

OUR EXPANDER
## PROJECT DETAILS

### GAS REDUCTION STATION

<table>
<thead>
<tr>
<th>Feature</th>
<th>Specification</th>
</tr>
</thead>
<tbody>
<tr>
<td>Station size</td>
<td>280,000 Sm3/h</td>
</tr>
<tr>
<td>In - out gas pressure</td>
<td>~ 50 (max design 75) - 24 bar(g)</td>
</tr>
<tr>
<td>In - out gas temperature</td>
<td>5° ± 15 - 5 °C</td>
</tr>
</tbody>
</table>

### SINGLE EXPANDER

<table>
<thead>
<tr>
<th>Feature</th>
<th>Specification</th>
</tr>
</thead>
<tbody>
<tr>
<td>Flow rate</td>
<td>80,000 Sm3/h</td>
</tr>
<tr>
<td>In - out gas pressure</td>
<td>50 - 24 bar(g)</td>
</tr>
<tr>
<td>Expander power output</td>
<td>650 kWe</td>
</tr>
<tr>
<td>In - out gas temperature</td>
<td>40 - 5 °C</td>
</tr>
<tr>
<td></td>
<td>heated up with a hot water/natural gas heat exchanger</td>
</tr>
</tbody>
</table>