ORGANIC RANKINE CYCLE TECHNOLOGY
Turboden – The ORC Technology Made in Italy

Turboden is an Italian company and a global leader in the design, manufacture and service of Organic Rankine Cycle (ORC) turbogenerators, which harness heat to generate electric and thermal power from renewable sources, including biomass, solar, geothermal energy and waste heat from industrial processes, engines or gas turbines, suitable for distributed generation.

The company was founded in 1980 in Milan by Mario Gaia, Professor of Energy at the Politecnico di Milano and today Managing Director of Turboden. Prof. Mario Gaia implemented his vision for ORC technology by using organic fluids, instead of water, in a closed thermodynamic cycle. Moreover, his close connection with the university has always ensured the recruitment of highly qualified R&D personnel.

In the Eighties and Nineties, Turboden developed research projects in solar, geothermal and heat recovery applications and designed its first commercial units for the Swiss and Austrian markets.

At the end of the Nineties, Turboden started installing the first biomass ORC unit in Switzerland and after that the great diffusion of its ORC units began first in the German market and then all around Europe.

Turboden has always had a single mission: to design ORC turbogenerators for the generation of electric power and heat from renewable sources and from heat recovery, while constantly striving to implement ORC technical solutions.


Mitsubishi Heavy industries

Mitsubishi Heavy Industries is one of the world’s leading heavy machinery manufacturers, with consolidated sales of over $32 billion (in fiscal 2013). MHI’s products and services encompass shipbuilding, power plants, chemical plants, environmental equipment, steel structures, industrial and general machinery, aircraft, space systems and air-conditioning systems.

The company helps increasing general awareness of energy efficiency, therefore contributing to energy savings and efficiency as established by European guidelines and current international protocols.

In 2009, Turboden became part of UTC Corp., a worldwide leader in development, production and service for aero engines, aerospace drive systems and power generation gas turbines, to develop ORC solutions from renewable sources and waste heat worldwide.

In 2013 UTC exits the power market forming strategic alliance with Mitsubishi Heavy Industries.

In 2013 Mitsubishi Heavy Industries acquires from UTC Pratt & Whitney Power Systems (now PW Power Systems, Inc.) and the affiliate Turboden. Today Turboden s.r.l. and PW Power Systems, Inc. are MHI group companies to provide a wider range of products and services for thermal power generation systems.

Today Turboden keeps headquarters and production branch in Italy and the Italian quotaholders stay in charge of management.
ORC Technology

ORC technology is similar to a traditional steam turbine, but with a single, important difference. Instead of using water vapor, the ORC system vaporizes a high-molecular-mass organic fluid, resulting in excellent electric performance and several key advantages: slower turbine rotation, lower pressure and no erosion of metallic parts and blades.

The ORC unit is preassembled onto one or more skids and can be easily transported.

The ORC turbogenerator uses medium-to-high-temperature thermal oil to preheat and vaporize a suitable organic working fluid in the evaporator. The organic fluid vapor rotates the turbine, which is directly coupled to the electric generator, resulting in clean, reliable electric power.

The exhaust vapor flows through the regenerator, where it heats the organic liquid and is then condensed in the condenser and cooled by the cooling circuit. The organic working fluid is then pumped into the regenerator and evaporator, thus completing the closed-cycle operation.

Why a high-molecular-mass working fluid instead of water?

Advantages of Turboden ORC Turbogenerators

Technical Advantages
• High cycle efficiency
• Very high turbine efficiency
• Low turbine mechanical stress due to low peripheral speed
• Low turbine RPM, allowing the direct drive of the electric generator without gear reduction in many applications
• No erosion of blades, thanks to the absence of moisture in the vapor nozzles
• No water consumed

Operational Advantages
• Simple start-stop procedures
• Automatic and continuous operation
• No operator attendance needed
• Quiet operation
• High availability (typically 98%)
• Partial load operation down to 10% of nominal power
• High efficiency at partial load
• Lower maintenance cost
• Long life

ORC Applications

We design, produce, install and maintain Organic Rankine Cycle (ORC) turbogenerators, for the combined generation of electric power and heat, employing renewable resources and heat recovery from industrial processes, engines and gas turbines, particularly well-suited for distributed generation. The power of Turboden units generally ranges from 200 kW up to 20 MW per single unit.

Biomass
Turboden ORC units for cogenerative purposes allow the simple and highly efficient generation of electric power and heat from biomass.

Geothermal
Turboden ORC units can produce electricity from geothermal resources with medium-to-low-temperatures, generally ranging between 100 °C and 200 °C (212 °F and 392 °F).

Heat Recovery
Turboden ORC units can produce electricity by recovering heat from industrial processes and combined cycles.

Waste to Energy
Turboden ORC units can produce electricity from waste to energy recovery processes.

Solar Thermal Power
Turboden ORC units allow the conversion of heat harnessed by solar collectors into electricity through an efficient thermodynamic cycle.
The power plant modules are preassembled and prequalified to facilitate ease of installation and startup. Each contains standardized components designed and integrated according to proven processes to ensure high quality.

Even with variable flow rates or slight fluctuations in temperature, the ORC continues to operate down to 10% of nominal power. This is a significant advantage over steam turbines.

ORC products are configured for either electricity-only applications where heat sources are captured to produce electric power or combined heat and power (CHP) applications that produce both electricity and hot water for use as space or industrial process heating.

ORC Main Components

Available ORC Models

Part load operation down to 10% of nominal load, Maintains 80% of the cycle efficiency down to 50% loading.

Cooling Water Temperature Effect on Cycle Efficiency (HRS Model)

HRS: Electric-Only, High-Efficiency Units
HR: Electric-Only, Standard-Efficiency Units
CHP: Combined Heat & Power Units

100% Thermal Power from Thermal Oil
**Geothermal Applications**

**ORC Turbogenerators for Geothermal Heat Sources**

Organic Rankine Cycle (ORC) turbogenerators are designed to generate electric power efficiently from medium-to-low-enthalpy geothermal sources with water temperatures typically ranging between 100 °C and 200 °C (212 °F and 392 °F). Turoden ORC units offer an excellent solution for newly discovered geothermal resources or bottoming of existing flash steam facilities.

**Key Features and Benefits**

- Hot water resource typically between 100 °C and 200 °C (212 °F and 392 °F)
- Sizes up to 20 MW
- Scalable for larger plants
- High cycle efficiency
- Enhanced cycle efficiency with two-level cycles
- Low O&M requirements
- Wide range of working fluids can be used
- Simple and unattended operation
- EPC capability*
- Brine and steam bottoming cycles to flash steam plants

* Depending on the country

**Thermodynamic Principle: The ORC Cycle**

The turbogenerator uses the geothermal water to preheat and vaporize a suitable organic working fluid in the evaporator (2→3→4). The organic fluid vapor powers the turbine (4→5) that is coupled to the electric generator through an elastic coupling. The vapor is then condensed in the condenser, cooled by water or air (5→1). The organic fluid liquid is finally pumped (1→2) to the preheater and evaporator, thus completing the sequence of operations in the closed-loop circuit.

**Example of ORC Plant in Geothermal Applications**

Due to the relatively low vapor point and noncorrosive properties of the organic working fluid, the turbine operates under lower pressures, lower peripheral speeds and no erosion of turbine blades.

No standard heat/cooling sources. Highly customized solutions.
Turboden ORC units can recover energy from relatively low- to moderate-temperature heat sources with excellent efficiency. HR units offer up to 20% efficiency and HRS units up to 26% efficiency. In gas turbine/engine heat recovery applications, the overall efficiency of the combined system can be significantly increased.

### Typical Applications

<table>
<thead>
<tr>
<th>Gas</th>
<th>Liquid</th>
<th>Steam/ Vapor</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cement</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Glass</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Oil&amp;Gas</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Chemicals</td>
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</tr>
<tr>
<td>Steel / Nonferrous</td>
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<td>-</td>
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<tr>
<td>Pulp &amp; Paper</td>
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<td>-</td>
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<tr>
<td>Food</td>
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<tr>
<td>Waste Treatment</td>
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<td>-</td>
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<td>Thermal Oxidizers</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Power Generation</td>
<td>-</td>
<td>-</td>
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</table>

### Main Reference Installations

<table>
<thead>
<tr>
<th>Application Field</th>
<th>Reference Projects</th>
</tr>
</thead>
<tbody>
<tr>
<td>Reciprocating Engines</td>
<td>Many reference projects for heat recovery from gas and diesel engines with ORC power output from 0.5 MW up to 4.3 MW</td>
</tr>
<tr>
<td>Gas Turbines</td>
<td>Reference projects for heat recovery from gas turbine (e.g. in gas compressor stations)</td>
</tr>
<tr>
<td>Oil&amp;Gas</td>
<td>Reference projects for heat recovery from flue gas &amp; gas compressor stations</td>
</tr>
<tr>
<td>Steel &amp; Other Non-Ferrous Metals</td>
<td>Reference projects for heat recovery from EAF (3 MW in Germany and 2.2 MW in Italy), from rolling mill reheating furnace (0.7 MW in Singapore), from aluminum industry (1.7 MW in Germany) and from cast iron cupola furnace (0.7 MW in Italy)</td>
</tr>
<tr>
<td>Cement &amp; Refractory</td>
<td>Few reference projects: a 1 MW unit in Austria, a 2 MW unit in Morocco, a 4.3 MW and a 3.8 MW units in Romania and a 5.2 MW unit in Slovakia</td>
</tr>
<tr>
<td>Glass</td>
<td>Reference projects: a 1.3 MW and 0.5 MW units in Italy</td>
</tr>
<tr>
<td>Waste to Energy</td>
<td>Few reference projects: one in Belgium (3 MW), two in Italy (0.5 MW each), one in the USA (1 MW), two in Turkey (5.3 MW each), two in France (2.7 MW and 0.7 MW) and one in Finland (1.3 MW)</td>
</tr>
</tbody>
</table>

Turboden ORC units produce electricity by recovering heat from industrial processes, reciprocating engines and gas turbines. The electric power range in heat recovery applications is generally from 200 kW to 20 MW. Capable of utilizing a wide range of temperatures, an ORC power plant produces reliable electricity from a variety of heat sources.

Key advantages Turboden ORC units deliver are their ease of integration into the industrial process - even with inconstant heat sources - and complete automation, leaving the industrial user focused on its own production process.

### Example of Heat Recovery Plants

![Diagram of Heat Recovery Plants]
**Biomass Applications**

Biomass is an extremely important renewable energy source, available nearly everywhere. It can be stored for a long time and is often economically viable. Biomass is best utilized in combined heat and power plants, particularly when the power system is built near the heat consumer.

**CHP Units for Cogeneration from Biomass**

Cogeneration plants with Organic Rankine Cycle (ORC) products produce both heat and electric power from biomass efficiently and in a user-friendly manner. The generated power ranges between 200 kW and 20 MW. ORC split systems allow maximization of electric power production for a given biomass consumption due to a more efficient utilization of thermal power from the boiler, while nonsplit systems maximize electrical efficiency. ORC units can be fed by thermal oil, saturated vapor or superheated water.

**HRS Units for Electricity Generation from Biomass**

Turoden has developed new models of HRS ORC units capable of high electrical efficiency. HRS models can operate both in dissipative condition, maximizing the electrical output, and in cogeneration mode, with the ability to provide heat with a water temperature up to 60 °C (140 °F) while adjusting for seasonal thermal load and maximizing the utilization of the biomass. The ORC units can be fed by thermal oil or saturated vapor. Sizes range from 200 kW to 20 MW for a single unit.

**Applications**

- District heating networks
- Timber drying in sawmills
- Sawdust drying in wood pellet factories
- Air preheating in MDF factories
- Greenhouses, swimming pools, hot springs
- Refrigeration

**Fuels**

- Wood biomass: sawdust, wood chips, bark, treated wood
- Other biomass: dried sewage sludge, straw, green cuttings, rice husks, etc.
- Waste material

**Example of a CHP ORC in Biomass Applications**

Turoden ORC units can also be fed with saturated vapor or superheated water.
ORC power plants can produce electricity without any fossil-fuel consumption, hence, without the production of any greenhouse gas, NOx, SOx, carbon monoxide or any other undesirable pollutant.

Reference Plant
Hybrid Heat Recovery + Solar Power Plant
- Customer: Ciments du Maroc (Italcementi Group)
- Location: Ait Baha (Morocco)
- Plant type: Heat Recovery from cement production process + hybridization through CSP.
- Electric Power: 2 MWe
- Heat transfer fluid: Thermal oil at 280 °C
- Cooling device: air-cooler
- Gross electric efficiency: 20%

Example of ORC Solar Thermal Power Applications

The ORC power block uses an organic fluid to drive the turbine instead of traditional high-pressure steam. This results in a reliable, efficient and user-friendly solar thermal power plant.
Aftermarket Services

A Service Plan to Meet Your Needs

Turboden, a Mitsubishi Heavy Industries company, offers a complete portfolio of after-sale services that can be tailored to meet your needs, from simple planned maintenance to comprehensive service agreements.

The After-Sale Team can respond with remote monitoring services, site maintenance services, part repair, spare-part sales and plant revision to reduce operating risk and maximize customer asset value through peak power plant reliability and availability.

Turboden scope is to maximize customer value through the achievement of the maximum reliability of Turboden ORC plants. Our customized systems provide capabilities for data trending and reporting, alerting the operator about power plant issues and performing advanced diagnostics and troubleshooting. With our Technical Team, this all leads to rapid identification and resolution of issues to keep the power plant running at its best.

An ORC power plant is automatically controlled and does not require continuous operator presence. Typically, three to five hours of weekly operation and maintenance are required, primarily to validate operational parameters. The plant can be remotely monitored and does not divert significant manpower away from the mission of the enterprise.
<table>
<thead>
<tr>
<th>Operation</th>
<th>TD 6 HR</th>
<th>TD 10 HR</th>
<th>TD 22 HR SPLIT</th>
<th>TD 40 HR SPLIT</th>
<th>TD 70 HR</th>
</tr>
</thead>
<tbody>
<tr>
<td>INPUT* - Thermal Oil</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Thermal Oil outlet temperature °C</td>
<td>170-120</td>
<td>140</td>
<td>170-120</td>
<td>145</td>
<td>170-120</td>
</tr>
<tr>
<td>Thermal power input MW</td>
<td>2.5-4.0</td>
<td>3.0</td>
<td>5.0-7.0</td>
<td>5.54</td>
<td>8.0-12.0</td>
</tr>
<tr>
<td>Thermal Oil inlet temperature °F</td>
<td>464-572</td>
<td>518</td>
<td>464-590</td>
<td>554</td>
<td>464-590</td>
</tr>
<tr>
<td>Thermal Oil outlet temperature °F</td>
<td>338-248</td>
<td>284</td>
<td>338-248</td>
<td>293</td>
<td>338-248</td>
</tr>
<tr>
<td>Thermal power input MMBtu/hr</td>
<td>8.53-13.65</td>
<td>10.24</td>
<td>17.06-23.88</td>
<td>18.90</td>
<td>27.30-40.95</td>
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<tr>
<td>OUTPUT** - Cooling Water</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Thermal power to condenser MW</td>
<td>2.0-3.5</td>
<td>2.4</td>
<td>4.0-5.0</td>
<td>4.4</td>
<td>6.0-9.5</td>
</tr>
<tr>
<td>Typical cooling water temperature (in/out)°C</td>
<td>25/35</td>
<td>25/35</td>
<td>25/35</td>
<td>26/38</td>
<td>25/40</td>
</tr>
<tr>
<td>Thermal power to the cooling water circuit MMBtu/hr</td>
<td>6.82-11.94</td>
<td>8.19</td>
<td>13.65-17.06</td>
<td>15.01</td>
<td>20.47-32.42</td>
</tr>
<tr>
<td>Gross electric power kW</td>
<td>500-800</td>
<td>600</td>
<td>900-1600</td>
<td>1108</td>
<td>1700-2500</td>
</tr>
<tr>
<td>Captive power consumption kW</td>
<td>18-36</td>
<td>25</td>
<td>36-70</td>
<td>46</td>
<td>60-100</td>
</tr>
<tr>
<td>Net active electric power output kW</td>
<td>480-760</td>
<td>575</td>
<td>850-1550</td>
<td>1062</td>
<td>1650-2400</td>
</tr>
</tbody>
</table>
| PERFORMANCES
| 50Hz, 400V | 60Hz, 480V |
| Electric generator**** | 50Hz, 400V | 60Hz, 480V |
| Cooling systems | closed loop water cooling | closed loop water cooling |
| Typical delivery time (EXW) Months | 9-11 | 9-11 | 9-11 | 11-13 | 12-14 |

* Turboden units up to TURBODEN 40 HR can be equipped with the “Split System”, a heat exchanger allowing additional low investment recovery from internal combustion engines exhaust gas. The “Split System” heat exchanger may use thermal oil / pressurized water as heat transfer fluid.

** Calorific value of biomass is a variable factor. The data provided herein are valid for a calorific value of 20MJ/kg (low heating value). The data provided herein are valid for a calorific value of 17MJ/kg (high heating value).

*** Electric efficiency depends on several factors, primarily Heat and Cooling Source Temperatures and thermal media.

**** Induction or synchronous, medium voltage available upon request. If reduction gear is required, electric power is reduced of about 1.5%.

DISCLAIMER: NTEP. Data provided herein are not binding and might change without prior notice.
### Turboden High Efficiency (HRS) Units - Typical Sizes and Performances

<table>
<thead>
<tr>
<th>Model</th>
<th>Thermal Oil inlet temperature °C</th>
<th>Thermal Oil outlet temperature °C</th>
<th>Overall thermal power input kW</th>
<th>Thermal Oil inlet temperature °F</th>
<th>Thermal Oil outlet temperature °F</th>
<th>Overall thermal power input MMBtu/hr</th>
</tr>
</thead>
<tbody>
<tr>
<td>HRS 50</td>
<td>300-320</td>
<td>170-200</td>
<td>18000-40000</td>
<td>572-608</td>
<td>356-392</td>
<td>61.4-136.5</td>
</tr>
<tr>
<td>HRS 55</td>
<td>315</td>
<td>190</td>
<td>20000</td>
<td>599</td>
<td>374</td>
<td>68.3</td>
</tr>
<tr>
<td>HRS 65</td>
<td>315</td>
<td>200</td>
<td>25380</td>
<td>599</td>
<td>374</td>
<td>86.6</td>
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<tr>
<td>HRS 110</td>
<td>315</td>
<td>250</td>
<td>40023</td>
<td>599</td>
<td>374</td>
<td>134.9</td>
</tr>
</tbody>
</table>

**Cooling System (1)**

- **Design cooling system temperature (2)** °C 0 - 40
- **Thermal power to the cooling system kW** 13000 - 30000
- **Design cooling system temperature (2)** °F 32 - 104
- **Thermal power to the cooling system MMBtu/hr** 44.4 - 102.4

**Performances**

- **Gross electric power kW** 4500 - 11000
- **Gross electric efficiency 23 - 27%**
- **Captive power consumption (3) kW** 180 - 500
- **Net active electric power output kW** 4500 - 10000
- **Net electric efficiency (4) 22 - 26%**

**Electric generator**

- 50Hz, 6kV
- 60Hz, 4160V

**Biomass consumption (5) kg/h**

- 9000 - 20000

**Typical delivery time (EXW) Months**

- 10 - 15

**DISCLAIMER**

- Note: Data provided herein are not binding and might change without prior notice.

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### Turboden Combined Heat & Power (CHP) Units - Typical Sizes and Performances

<table>
<thead>
<tr>
<th>Model</th>
<th>Thermal Oil inlet temperature °C</th>
<th>Thermal Oil outlet temperature °C</th>
<th>Overall thermal power input kW</th>
<th>Thermal Oil inlet temperature °F</th>
<th>Thermal Oil outlet temperature °F</th>
<th>Overall thermal power input MMBtu/hr</th>
</tr>
</thead>
<tbody>
<tr>
<td>CHP 20</td>
<td>300-320</td>
<td>170-200</td>
<td>18000-40000</td>
<td>572-608</td>
<td>356-392</td>
<td>61.4-136.5</td>
</tr>
<tr>
<td>CHP 21</td>
<td>315</td>
<td>190</td>
<td>20000</td>
<td>599</td>
<td>374</td>
<td>68.3</td>
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<tr>
<td>CHP 22</td>
<td>320</td>
<td>200</td>
<td>25380</td>
<td>599</td>
<td>374</td>
<td>86.6</td>
</tr>
<tr>
<td>CHP 30</td>
<td>315</td>
<td>250</td>
<td>40023</td>
<td>599</td>
<td>374</td>
<td>134.9</td>
</tr>
</tbody>
</table>

**Hot Water**

- **Hot water temperature (in/out) °C** 60/80
- **Thermal power to hot water circuit kW** 2664
- **Hot water temperature (in/out) °F** 140/176
- **Thermal power to hot water circuit MMBtu/hr** 9.09

**Performances**

- **Gross active electric power kW** 643
- **Gross electric efficiency 19.3%**
- **Captive power consumption kW** 32
- **Net active electric power kW** 611
- **Net electric efficiency 18.3%**

**Electric generator**

- 60Hz, 480V
- 60Hz, 4160V

**Plant size**

- Single Skid
- Multiple Skid

**Biomass consumption**

- 1606

**Typical delivery time (EXW) Months**

- 9-11

**DISCLAIMER**

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### Turboden Combined Heat & Power (CHP) Units WITH SPLIT*

**TURBODEN 6 CHP**
- **TURBODEN 7 CHP**
- **TURBODEN 10 CHP**
- **TURBODEN 14 CHP**
- **TURBODEN 18 CHP**
- **TURBODEN 22 CHP**
- **TURBODEN 26 CHP**
- **TURBODEN 28 CHP**

#### THERMAL INPUT

<table>
<thead>
<tr>
<th>Thermal Oil</th>
<th>Nominal temperature (HT) loop (in/out) °C</th>
<th>Thermal power input (HT) loop kW</th>
<th>Nominal temperature (LT) loop (in/out) °C</th>
<th>Thermal power input (LT) loop kW</th>
<th>Overall thermal power input kW</th>
</tr>
</thead>
<tbody>
<tr>
<td>312/252</td>
<td>2956</td>
<td>283</td>
<td>252/132</td>
<td>293</td>
<td>3339</td>
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<td>3572</td>
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<td>338</td>
<td>252/132</td>
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<td>4685</td>
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<td>450</td>
<td>250/130</td>
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<td>6130</td>
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<td>8935</td>
<td>8935</td>
<td>855</td>
<td>249/130</td>
<td>855</td>
<td>9790</td>
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<td>10975</td>
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<td>1045</td>
<td>250/135</td>
<td>1045</td>
<td>12020</td>
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#### THERMAL OUTPUT - Hot Water

<table>
<thead>
<tr>
<th>Hot water</th>
<th>Nominal temperature (HT) loop (in/out) °C</th>
<th>Thermal power input (HT) loop kW</th>
<th>Hot water</th>
<th>Nominal temperature (HT) loop (in/out) °C</th>
<th>Thermal power input (HT) loop MMBtu/hr</th>
<th>Overall thermal power input MMBtu/hr</th>
</tr>
</thead>
<tbody>
<tr>
<td>60/80</td>
<td>1244</td>
<td>784</td>
<td>60/80</td>
<td>1244</td>
<td>26.79</td>
<td>33.41</td>
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<td>60/80</td>
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<td>784</td>
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<td>60/80</td>
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<td>784</td>
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#### PERFORMANCES

<table>
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<tr>
<th>Gross active electric power kW</th>
<th>619</th>
<th>729</th>
<th>1000</th>
<th>1317</th>
<th>1862</th>
<th>2319</th>
<th>2632</th>
<th>2833</th>
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</thead>
<tbody>
<tr>
<td>Gross electric efficiency</td>
<td>18.5%</td>
<td>18.6%</td>
<td>19.5%</td>
<td>19.6%</td>
<td>19.0%</td>
<td>19.3%</td>
<td>18.6%</td>
<td>18.1%</td>
</tr>
<tr>
<td>Captive power consumption kW</td>
<td>32</td>
<td>40</td>
<td>51</td>
<td>62</td>
<td>87</td>
<td>98</td>
<td>155</td>
<td>166</td>
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<tr>
<td>Net active electric power kW</td>
<td>587</td>
<td>689</td>
<td>949</td>
<td>1255</td>
<td>1775</td>
<td>2221</td>
<td>2476</td>
<td>2667</td>
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<tr>
<td>Net electric efficiency</td>
<td>17.6%</td>
<td>17.6%</td>
<td>18.5%</td>
<td>18.7%</td>
<td>18.1%</td>
<td>18.5%</td>
<td>17.5%</td>
<td>17.0%</td>
</tr>
</tbody>
</table>

#### DISCLAIMER NOTE:
- Data provided herein are not binding and might change without prior notice.
- Biomass consumption*** Kg/h 1459 1709 2244 2935 4279 5253 6194 6857

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* The Turboden split system allows maximisation of electric power production for a given biomass consumption.
** Induction or synchronous, medium voltage available upon request. If reduction gear is required, electric power is reduced of about 1.5%.
*** Assuming a low heating value of biomass = 2.6 kWh/kg and boiler efficiency = 0.88.

The thermal oil boiler is not included in the Turboden scope of supply.