



clean energy ahead
TURBODEN

BIOMASS

TURBODEN. ORC technology for distributed energy generation

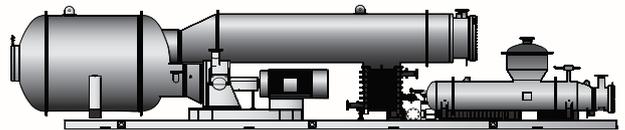
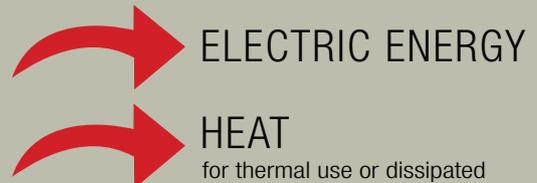
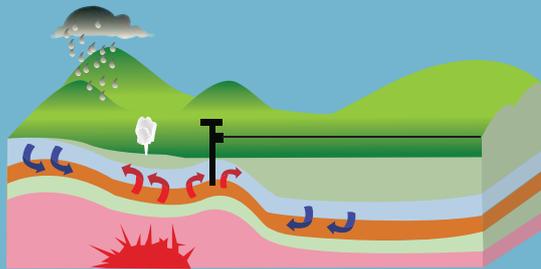
SOLAR ENERGY



WASTE HEAT



GEO THERMAL ENERGY



WOOD BIOMASS

To date most of Turboden's projects are **in the field of cogeneration from wood biomass**.

Turboden turbogenerators electric power output generally ranges between **500 kW and 2 MW**. Currently Turboden is specialized in this kind of applications with more than **90 plants in operation**.

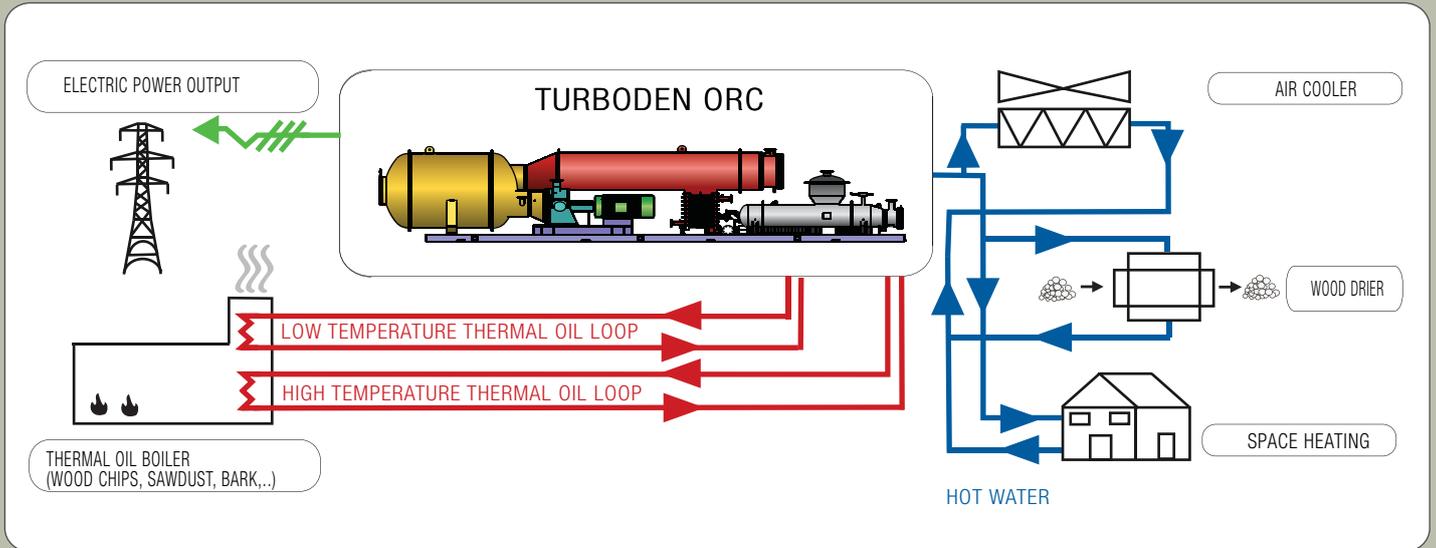
The present production capacity of Turboden is about **35 modules/year**.

Fields of application

- Utilities that supply heat to district housing, public users or industrial users
- Mid-large sawmills that utilize the heat for wood drying
- Pellet producers that utilize the heat for sawdust drying
- MDF panel producers (Medium Density Fiber panel)



ORC plant in biomass based cogeneration system



Thanks to the Turboden ORC it is possible to **cover the own consumption** required by the process and to access incentives schemes for Renewable Energy.

Combined Heat & Power (CHP) with split - Standard Sizes and typical performances*

	TURBODEN 4 CHP - split	TURBODEN 6 CHP - split	TURBODEN 7 CHP - split	TURBODEN 10 CHP - split	TURBODEN 14 CHP - split	TURBODEN 18 CHP - split	TURBODEN 22 CHP - split
INPUT - thermal oil							
nominal temperature "HT" loop (in/out)	°C 310/250	310/250	310/250	310/250	310/250	312/252	312/252
thermal power input "HT" loop	kW 2100	2965	3485	4690	6130	8935	10975
nominal temperature "LT" loop (in/out)	°C 250/130	250/130	250/130	250/130	250/130	252/132	252/132
thermal power input "LT" loop	kW 200	275	330	450	585	855	1045
overall thermal input	kW 2300	3240	3815	5140	6715	9790	12020
OUTPUT - hot water							
hot water temperature (in/out)	°C 60/80	60/80	60/80	60/80	60/80	60/90	60/90
thermal power to the cooling water circuit	kW 1844	2600	3060	4100	5350	7850	9630
PERFORMANCES							
gross active electric power	kW 424	617	727	1001	1317	1862	2282
gross electric efficiency	0.184	0.19	0.191	0.194	0.196	0.19	0.189
captive power consumption	kW 24	30	38	51	62	87	107
net active electric power	kW 400	587	689	950	1255	1775	2175
net electric efficiency	0.174	0.181	0.181	0.184	0.186	0.181	0.181
electrical generator	asynchronous triphase L.V. 400V	asynchronous triphase L.V. 660V	asynchronous triphase L.V. 660				
plant size	single skid	single skid	single skid	single skid	multiple skid	multiple skid	multiple skid
biomass consumption**	kg/h 1005	1416	1667	2247	2935	4279	5254

* The Turboden split system allows maximising electric power production for a given biomass consumption.

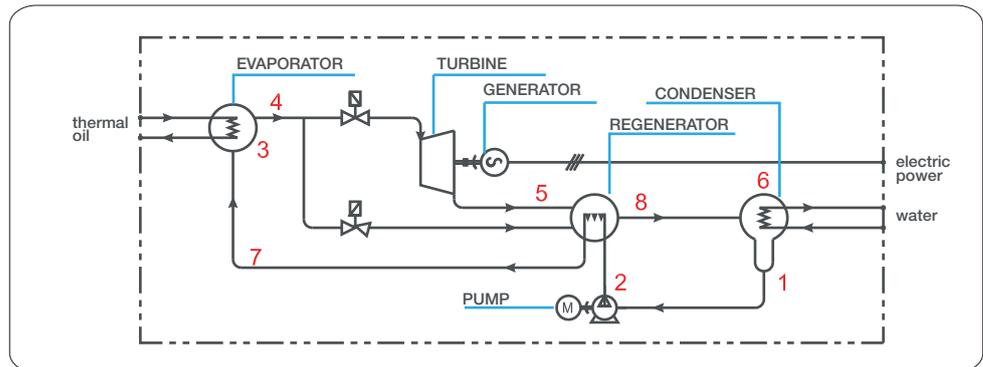
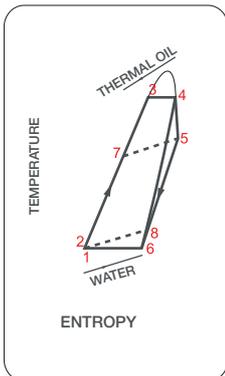
** Assuming a low heat value of biomass = 2,6 kWh/kg and boiler efficiency = 0,88 . The thermal oil boiler is not included in the Turboden scope of supply.

Turboden is an Italian company, with nearly 30 years experience in **designing, manufacturing, installing and maintaining turbogenerators based on the Organic Rankine Cycle (ORC)**, a technology for the combined generation of heat and electric power from **various renewable sources**, particularly suitable for **distributed generation**.

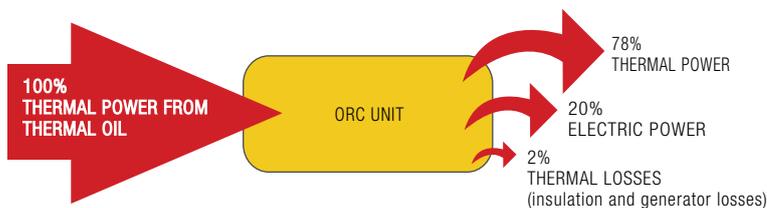
ORC Technology

The principle of Turboden ORC technology is similar to that of traditional plants with a steam turbine with a major difference: instead of water, the ORC system vaporizes an **organic fluid with high molecular mass**. Such a fluid allows to **obtain optimal performance even from low temperature** sources to produce electricity up to approximately 10 MW.

Thermodynamic principle: the ORC Cycle



The turbogenerator uses the thermal oil to pre-heat and vaporize a suitable organic working fluid in the evaporator (7 3 4). The organic fluid vapour powers the turbine (4 5), which is directly coupled to the electric generator through an elastic coupling. The exhaust vapour flows through the regenerator (5 8) where it heats the organic liquid (2 8). The vapour is then condensed in the condenser (cooled by the water flow) (8 6 1). The organic fluid liquid is finally pumped (1 2) to the regenerator and then to the evaporator, thus completing the sequence of operations in the closed-loop circuit.



Turboden ORC units have **high overall energy efficiency** in cogenerative applications: 20% of the thermal power coming from the thermal oil is transformed into electric power, while 78% remains available at a temperature high enough for thermal use.

Turboden ORC technical advantages

- High cycle efficiency
- Very high turbine efficiency (up to 90%)
- Low mechanical stress of the turbine, due to low peripheral speed
- High availability/reliability
- Simple start-stop procedures
- Automatic continuous operation and low noise
- Low operation and maintenance requirements
- Low specific technical skill requirements
- Long life

Map of Turboden ORC units

GERMANY ORC units **62**

application	in operation	ordered
biomass	49	13

AUSTRIA ORC units **32**

application	in operation	ordered
biomass	28	2
HR	1	
geothermal	1	

ITALY ORC units **23**

application	in operation	ordered
biomass	11	7
HR	2	3

POLAND ORC units **3**

application	in operation	ordered
biomass	2	1

SWITZERLAND ORC units **2**

application	in operation	ordered
biomass	2	

FRANCE ORC units **2**

application	in operation	ordered
biomass		1
geothermal	1	

BELGIUM ORC units **3**

application	in operation	ordered
biomass		2
HR	1	

THE NETHERLANDS ORC units **1**

application	in operation	ordered
biomass	1	

UNITED KINGDOM ORC units **1**

application	in operation	ordered
biomass		1

SPAIN ORC units **1**

application	in operation	ordered
biomass		1

CZECH REP. ORC units **2**

application	in operation	ordered
biomass	1	1

MOROCCO ORC units **1**

application	in operation	ordered
HR		1

Total ORC units

in operation	ordered	total
100	33	133

TURBODEN ORC UNITS

	in operation	ordered	total
STANDARD			
T200	0	4	4
TURBODEN 4	0	0	0
TURBODEN 6 (T500)	16	2	18
TURBODEN 7 (T600)	15	4	19
TURBODEN 10 (T800)	20	3	23
TURBODEN 14 (T1100)	17	6	23
TURBODEN 18 (T1500)	26	7	33
TURBODEN 22 (T2000)	3	6	9
TURBODEN 12 HRS	0	1	1
SPECIAL			
Geothermal or similar source	2	0	2
Prototype	1	0	1
	100	33	133

Last updated May 2009