Decentralized WTE based on ORC technology

TURN YOUR WASTE INTO USEFUL POWER.
Turboden Organic Rankine Cycle (ORC) technology generates electric and thermal power from many different heat sources.

In Waste to Energy plants, ORC is used to generate electricity from the heat available after thermal treatment of waste.

**ORC references:** 400+
**Working hours:** 10M+
**Waste to Energy ORC Plants:** 20
**Size:** 0.5-12 MWe
WHY DECENTRALIZED WTE?

ADVANTAGES

SMALL / MEDIUM WASTE TO ENERGY (<100,000 tpa)

- Low impact on road transport as waste is treated where generated
- Lower environmental footprint
- Easier authorization procedure
- Easier to secure waste and to reduce risk of waste shortage
- Higher public acceptance
- Small communities can be self sufficient in their power requirements
- New jobs opportunities in the local community
- Perfect alternative to landfill in rural or remote areas
- Reduction of greenhouse gas emissions
THE ORC – HOW IT WORKS

The ORC turbogenerator uses medium-to-high temperature thermal media to preheat and vaporize a suitable organic working fluid in the evaporator (4>5).

The organic fluid vapor rotates the turbine (5>6), which is directly coupled to the electric generator, resulting in clean, reliable electric power.

The exhaust vapor flows through the regenerator (6>7), where it heats the organic liquid (2>3) and is then condensed in the condenser and cooled by the cooling circuit (7>8>1).

The organic working fluid is then pumped (1>2) into the regenerator and evaporator, thus completing the closed-cycle operation.

The waste heat from production process is transferred to the ORC working fluid by means of an intermediate circuit or directly via the exhaust gases in direct exchange systems. The media used in the intermediate circuits are thermal oil, saturated steam or superheated water.
ORC VS STEAM COMPARISON

STEAM RANKINE CYCLE

- High enthalpy drop
- High pressures
- Superheating needed
- High speed, lots of stages
- Water treatment required
- Risk of blade erosion
- Periodic major overhaul
- Highly skilled personnel needed
- Low flexibility with significantly lower performances at partial load
- Good for large plants and high temperatures

ORGANIC RANKINE CYCLE

- Small enthalpy drop
- No supercritical pressure
- No need to superheat
- Low rpm, few stages
- No water treatment - water free system
- No risk of blade erosion
- Low mechanical stress, No major overhaul
- Completely automatic
- High flexibility - Wide operational range from 10% to 110%
- High availability (average >98%)

Technical features

Operation and maintenance

Other features
ORC FLEXIBILITY

NOTE: steam turbine suffers partial load operation due to high risk of blade erosion.
SMALL WTE APPLICATIONS

ORC technology helps to valorize waste of all kind

- Food waste
- Refuse-derived fuel (RDF)
- Solid recovered fuel (SRF)
- Plastic

- Municipal wastewater
- Industrial wastewater

- Hospital & Medical
- Chemical
- Pulp & Paper
- Tires
- Industrial by-products

- Chicken manure
- Other animal manure
- Dairy operation waste
- Animal by-products
### New Decentralized Energy from Waste Plants:
- Waste incineration (moving grate, fluidized bed, rotary kiln, ...)
- Waste gasification (partial oxidation process using air, pure oxygen, oxygen enriched air, hydrogen, or steam)
- Pyrolysis (thermal degradation of carbonaceous materials with absence or limited oxygen)

### Revamping of Existing Energy from Waste to Enhance EfW Overall Electrical Efficiency and Reduce Greenhouse Gas Emission.
WASTE TO ENERGY

AL EFFICIENCY

up to

30%

EFFICIENCY CHP

98%

* ORC system can produce hot water, steam or hot oil.
ENERGY FROM SEWAGE SLUDGE

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<tr>
<th>MUNICIPAL SOLID WASTE</th>
<th>SEWAGE SLUDGE</th>
<th>INDUSTRIAL AND HAZARDOUS WASTE</th>
<th>ANIMAL WASTE</th>
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The sewage sludge produced in WWTPs is growing as the percentage of people connected to the sewerage networks. In many countries, the disposal of sewage sludge and its agricultural use, must be replaced soon by thermal methods of sewage-sludge utilization. Hence the need of:

**SLUDGE MONO-INCINERATION** technologies to:
- Solve sludge disposal issues and costs
- Avoid sludge landfilling
- Recover phosphorous from incineration ashes

**ENERGY RECOVERY** to:
- Generate low carbon heat and green energy
- Increase WWTP sustainability
- Reduce energy bill and generate profit
POWER FROM SLUDGE INCINERATION

SEWAGE SLUDGE
1.5 dry ton/hour

Belt press sludge dewatering  70°C  FBC  Thermal oil heat exchanger

950 kW for internal plant consumption

90°C
Waste to energy

POWER FROM INDUSTRIAL WASTE

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Industrial waste disposal, often risky and expensive for many companies, can be exploited locally to generate profit and

- Solve the issues to dispose residues of production
- Avoid gate fee for waste disposal
- Reduce transport costs
- Generate power for self-consumption or export to grid
- Generate low carbon heat for own production processes
- Reduce energy bill and production costs
- Reduce CO₂ emissions and Increase business sustainability
Proper animal manure disposal is always a concern. The exploitation of wet biomass such as animal manure for landfill or agricultural use is not always a feasible solution (smells, dirt, contamination of soil, etc.). Hence the possibility (becoming a must) to employ:

DIRECT COMBUSTION OR GASIFICATION technologies to:
- Solve manure storage and odor issues
- Reduce manure volume and disposal costs

and ENERGY RECOVERY to:
- Generate low carbon heat for local thermal usage
- Generate green energy and reduce energy bill
Wet biomass cannot reach combustion temperatures (above 850°C) without the use of auxiliary fuel (i.e. natural gas, dry biomass), which is a big operational cost and thus is to be avoided.

That is why it is necessary to lower the humidity level before incineration, using a drying system. The heat used in the drying system could be sourced in different part of the process:

1. Exhaust gases after thermal oil or steam heat exchanger (between 200°C to 300°C)
2. High Enthalpy thermal oil or steam before the turbo expander.
3. Low enthalpy heat at turbine condenser (hot water 70°C to LP steam).
### ORC ADVANTAGES IN SMALL-MEDIUM WTE

<table>
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<tr>
<th>Advantage</th>
<th>Details</th>
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<tr>
<td>Flexibility to deal with different and variable thermal sources and waste</td>
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<td>High-efficiency power generation (up to 30%)</td>
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<td>Possibility to cogenerate heat (hot water or LP steam)</td>
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<td>Small footprint in modular skids</td>
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<td>NO water consumption</td>
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<td>Automatic and unmanned operation</td>
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<td>Low maintenance and OPEX</td>
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<td>High availability (98%) and dependability</td>
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<td>Easy integration with traditional and advanced thermal treatment technologies</td>
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THANKS FOR YOUR ATTENTION

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POWER FROM RDF COMBUSTION

CUSTOMER: Evra Enerji, Turkey
ORC SIZE: 13 MWe
DESCRIPTION: power generation from gasification of RDF and thermal oil heat exchanger
WASTE: 2/3 RDF, 1/3 biomass
HEAT CARRIER: thermal oil
COOLING SYSTEM: air cooled condensers

CUSTOMER: Terraverde, Italy
ORC SIZE: 1.2 MWe
DESCRIPTION: power generation from gasification of RDF with syngas burner and thermal oil heat exchanger
WASTE: RDF (refuse-derived fuel)
HEAT CARRIER: thermal oil
COOLING SYSTEM: air coolers
POWER FROM SLUDGE INCINERATION

CUSTOMER: Albany County Sewer District
COUNTRY: United States of America
ORC SIZE: 1 MWe
DESCRIPTION: power generation from sludge incineration with multiple hearth incinerator in a waste water treatment plant
WASTE: 1.5 dry tons of sewage sludge per hour
HEAT CARRIER: thermal oil
COOLING SYSTEM: water cooled condenser + air coolers (closed water loop)

CUSTOMER: Suez International
COUNTRY: Romania
ORC SIZE: 2 x 0.6 MWe
DESCRIPTION: power generation from sludge incinerator with fluidized bed in a waste water treatment plant
WASTE: dewatered sewage sludge
HEAT CARRIER: thermal oil
COOLING SYSTEM: Water cooled condenser / once-through
INDUSTRIAL WASTE COMBUSTION

CUSTOMER: SABA
COUNTRY: Poland
STATUS: in operation since 2018
ORC SIZE: 1 MWe
DESCRIPTION: power generation from a waste incineration plant
WASTE: plastic and hospital waste
HEAT CARRIER: thermal oil
COOLING SYSTEM: air coolers
AGENDA

- WHY DECENTRALIZED WTE?
- WHAT'S AN ORC AND HOW IT WORKS?
- ORC ADVANTAGES IN SMALL / MEDIUM WTE PLANTS
- DECENTRALIZED WTE APPLICATIONS
- REFERENCES