



E-RATIONAL

VALUE FOR HEAT

Company / Product presentation

Joke Goethals

E-RATIONAL is a BEP Europe division



BURKE PORTER GROUP

Providing the World with
Intelligent Machines

About Burke Porter Group

A Family of Machine Manufacturers



Our Intelligent Machines



End of Line Testing

Roll Testing

Wheel Alignment

Headlights and ADAS

Automation Wheel & Tire



Automotive Powertrain

EOL NVH Testing

Suspension Assembly & Alignment

“Turnkey” Automation & Gaging



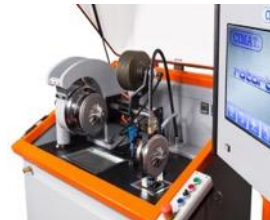
Laboratory Products

Emission Dynamometers

Mileage Dynamometers

NVH Dynamometers

Heavy Duty Dynamometers



Industrial Balancing

Prop-Shaft

Axles & Differentials

Vertical Spindle Balancers

Turbochargers

Aero-Turbines



Go To Market Services

Supercharger Machining

Engine Manifold Machining

Additive Manufacturing

Life Sciences Manufacturing



Steel & Energy

EDT Machines

Electrical Products & Equipment

Waste Energy Reclamation

Roll Grinding Machines



Automation & Integration

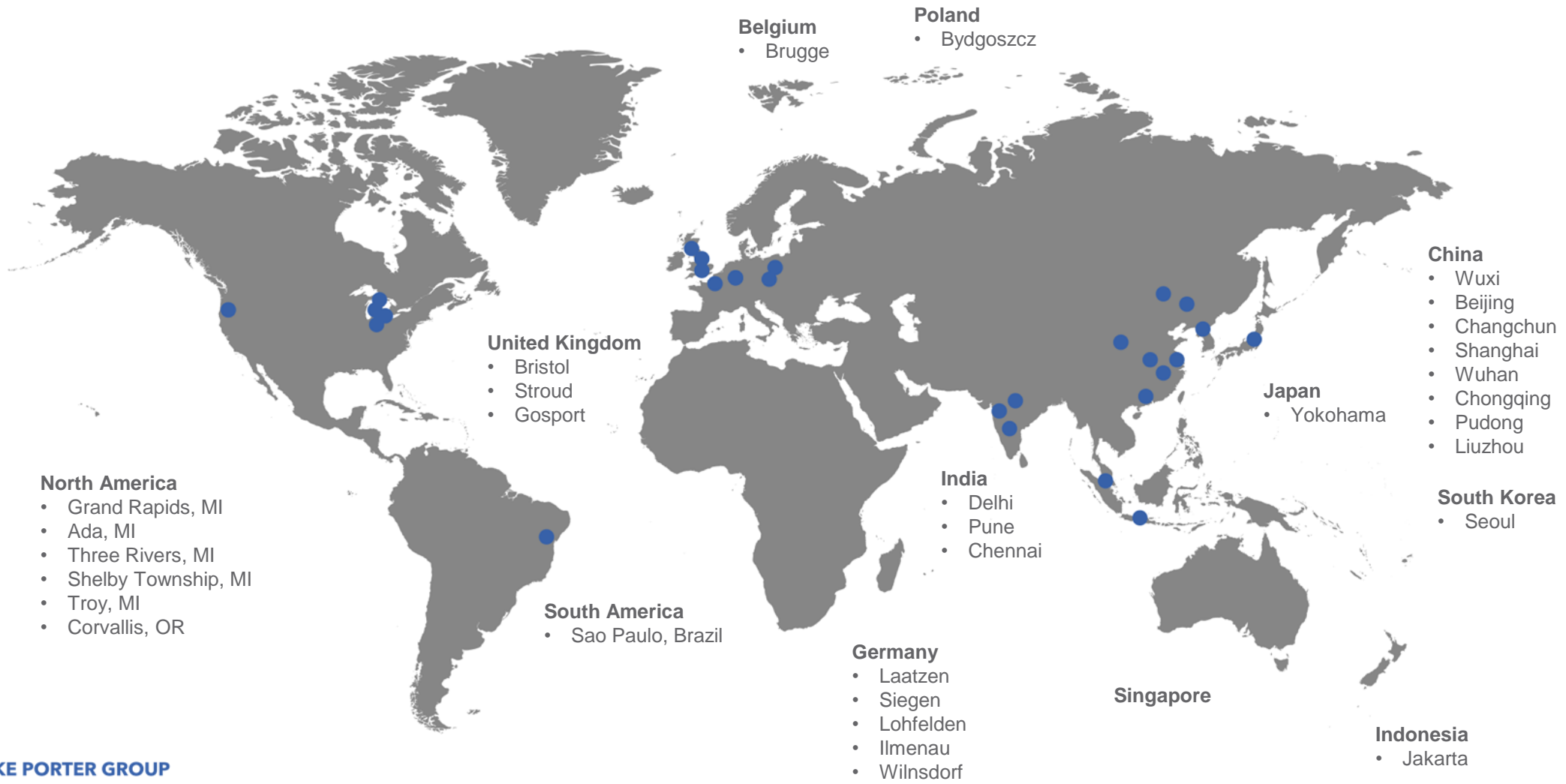
Assembly & Test Lines

Robotic Systems

Vision & Inspection Systems

Microfluidics Precision Motion Systems

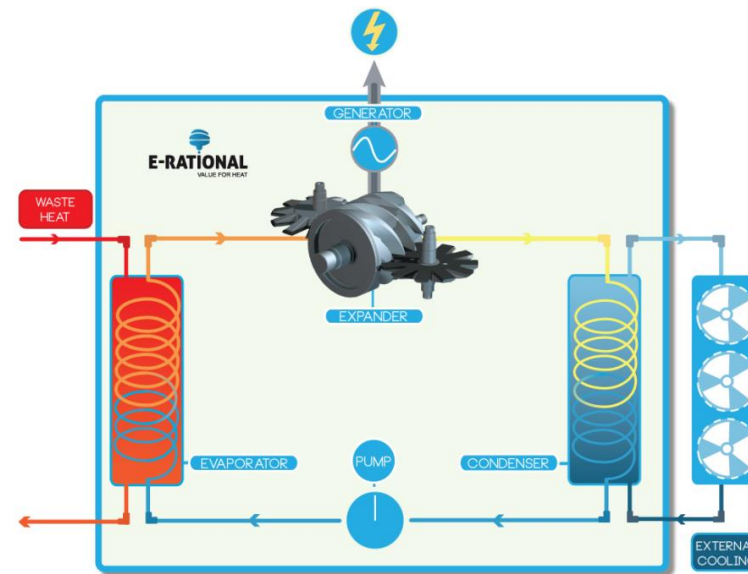
Covering the World – 31 Locations



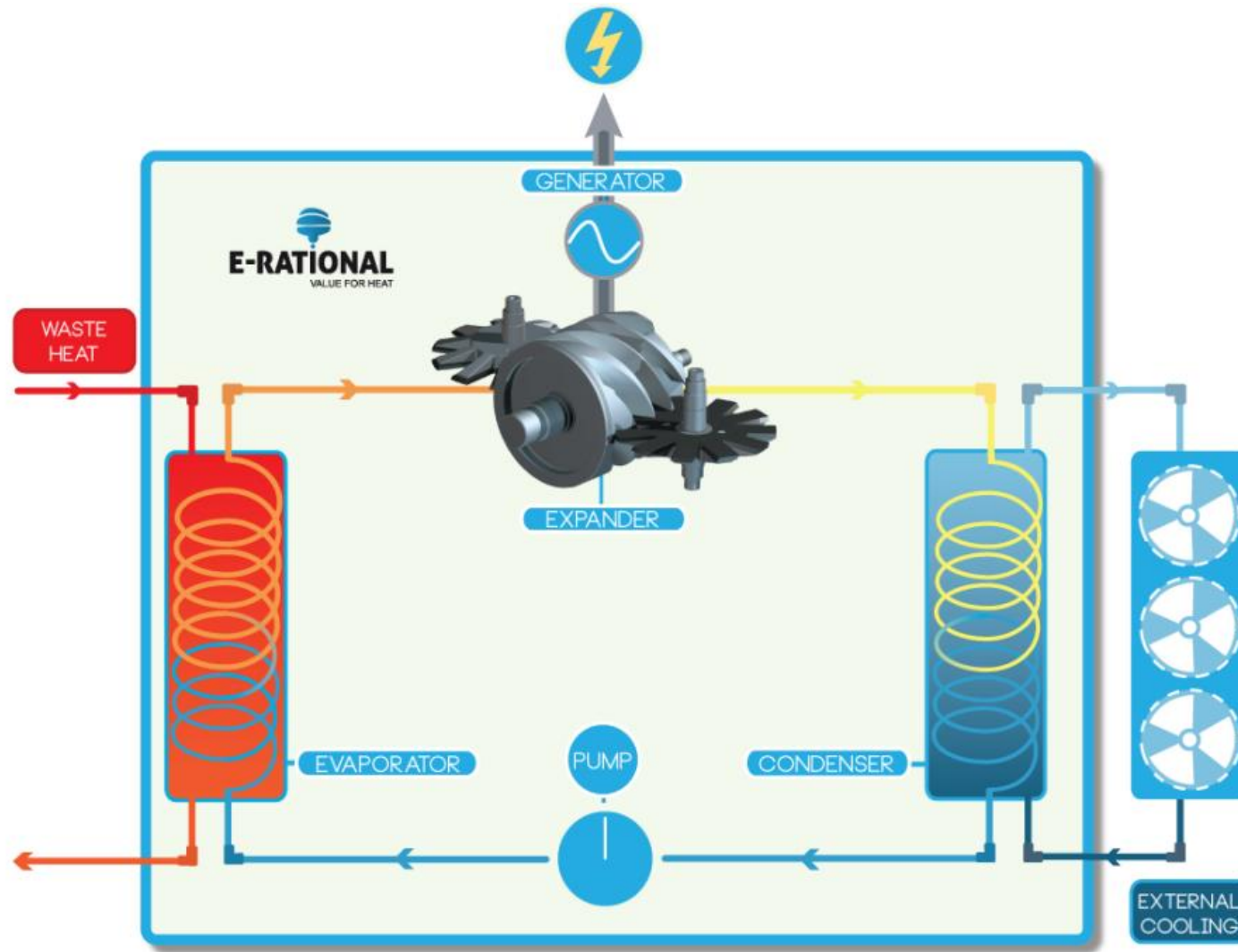
- E-RATIONAL ORC
- Reference installations
- E-RATIONAL market

ORC Technology

- Recover waste heat
between 85° C and 170° C
- Power range
from 55kWe up to 740kWe
- Optimized efficiency
full & part load
- Up to **7MWth** recovery in 1 unit
multiple units can be installed in parallel
- Principle based on Rankine Cycle
(cfr. Rankine cycle - classic steam cycle)



E-RATIONAL ORC_{Cycle}



E-RATIONAL ORC_{Types}



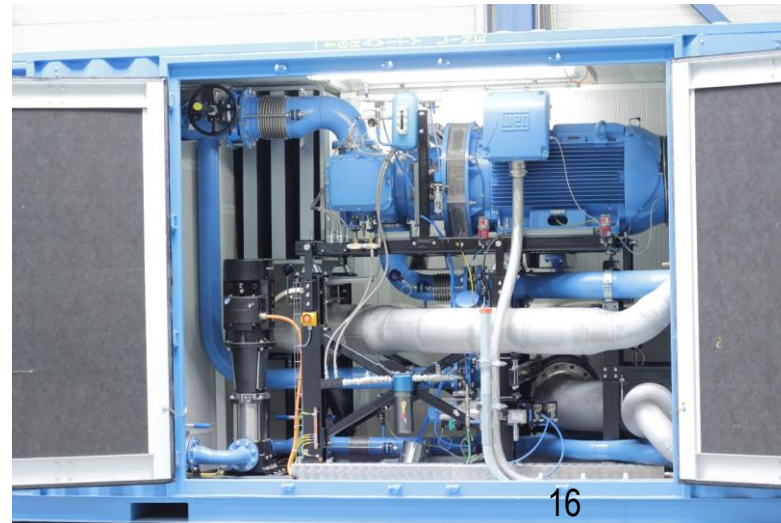
**Indoor – 10ft housing – noise protected skid
55 - 160 kWe installed**



**Outdoor – 40ft container
220 - 740 kWe installed**



**Outdoor – 20ft container
90 - 250 kWe installed**

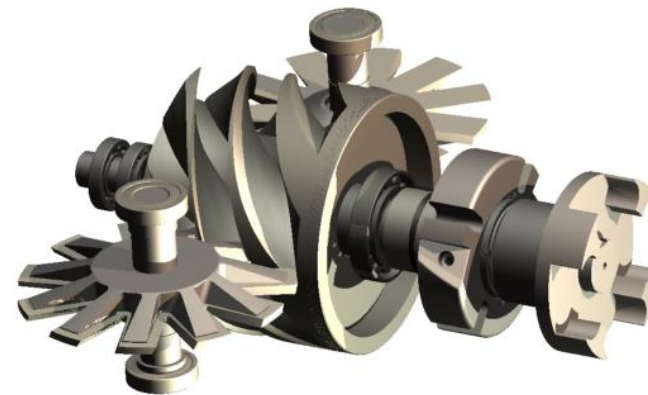


E-RATIONAL ORC_{Setup}

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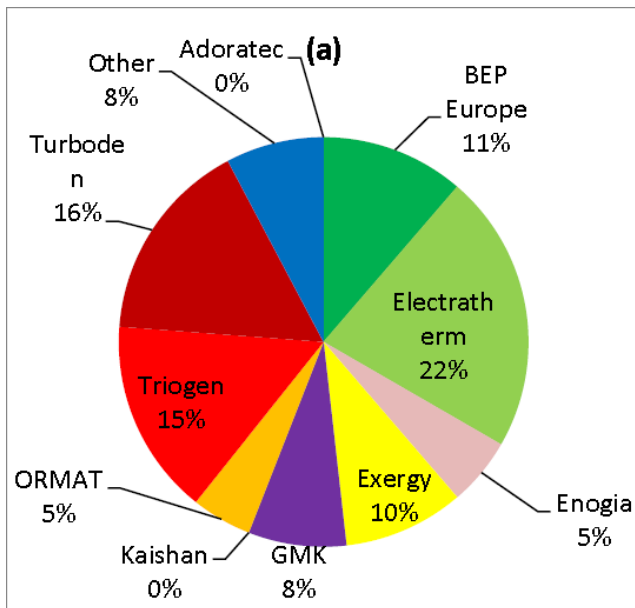
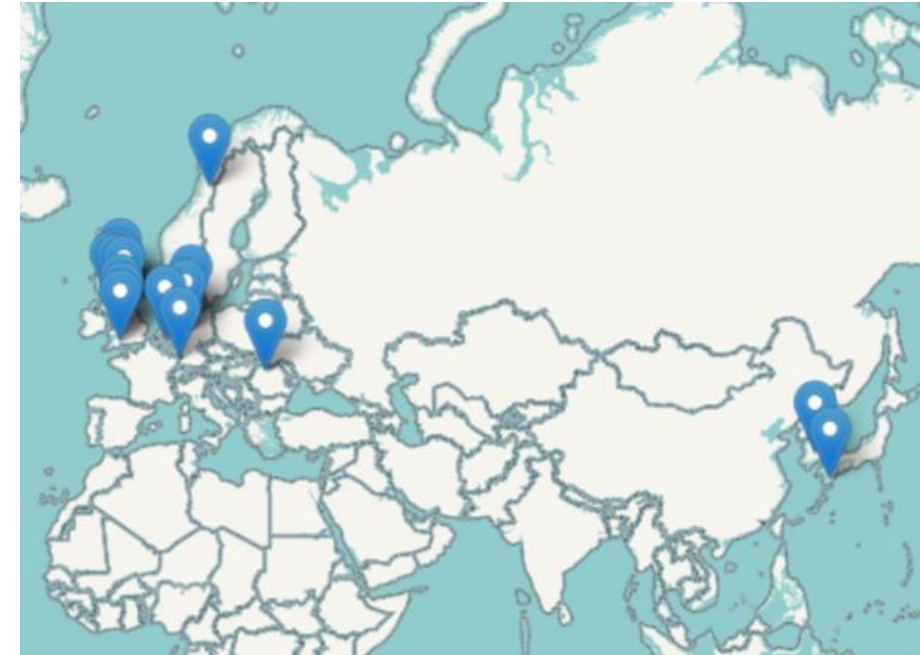
- Modular skid
- Easy installation, indoor or outdoor
- Asynchronous generator, easy synchronization to grid
- Full automatic operation with Siemens PLC
- Working medium is environment-friendly (0 ODP, low GWP)
- Standard components, widely available
- Robust Expander:
 - Single screw expander: no metal contact, no wear
 - Long life, low rotation speed (3000 / 3600 rpm)



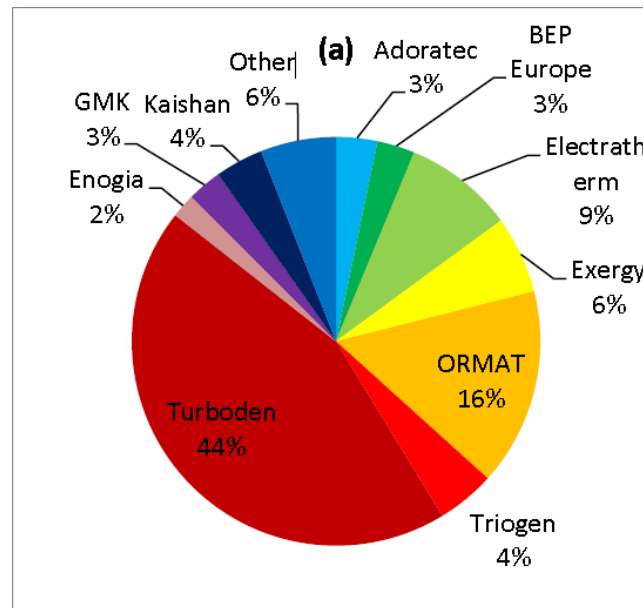
Reference installations



- Total = 29 machines
- Europe = 25 machines
- Asia = 4 machines
- Installed: 2011 – end of 2017
- Installed electric power > 4.9 MWe
- Recovered heat > 50 MWth



Europe (@Sanne Lemmens)



Worldwide (@Sanne Lemmens)



- Industrial Waste Heat
- Stationary Engines
- Geothermal Heat
- District Heating
- Combined Heat and Power (new)

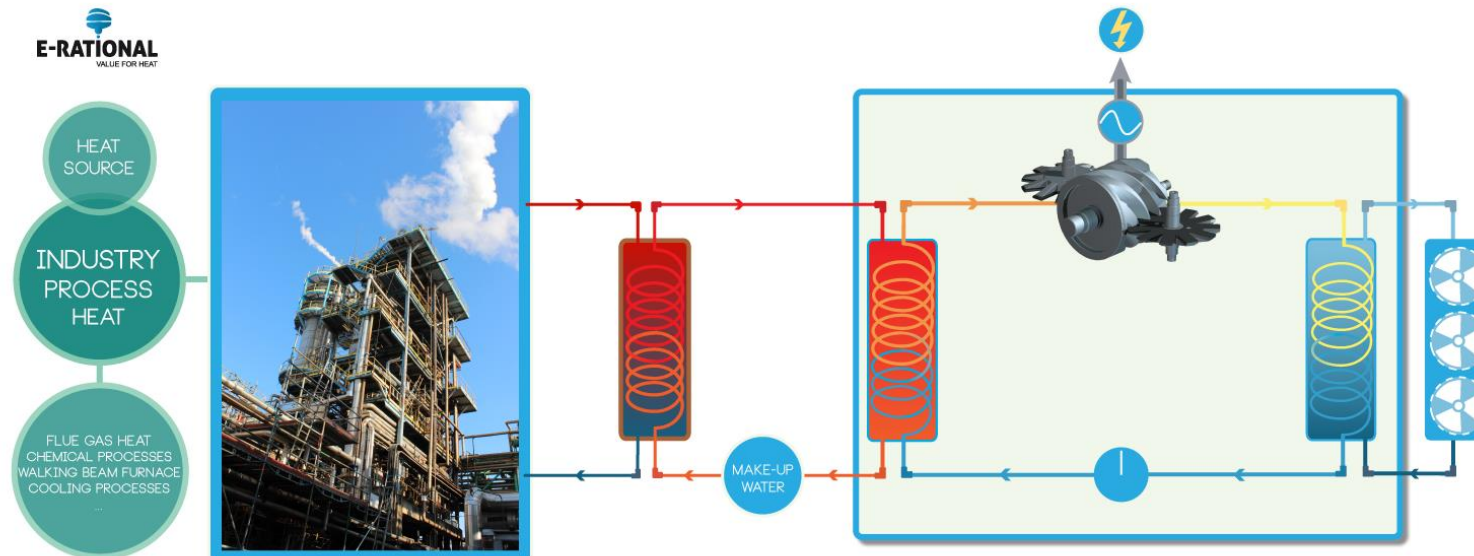




Industrial Waste Heat

Some examples:

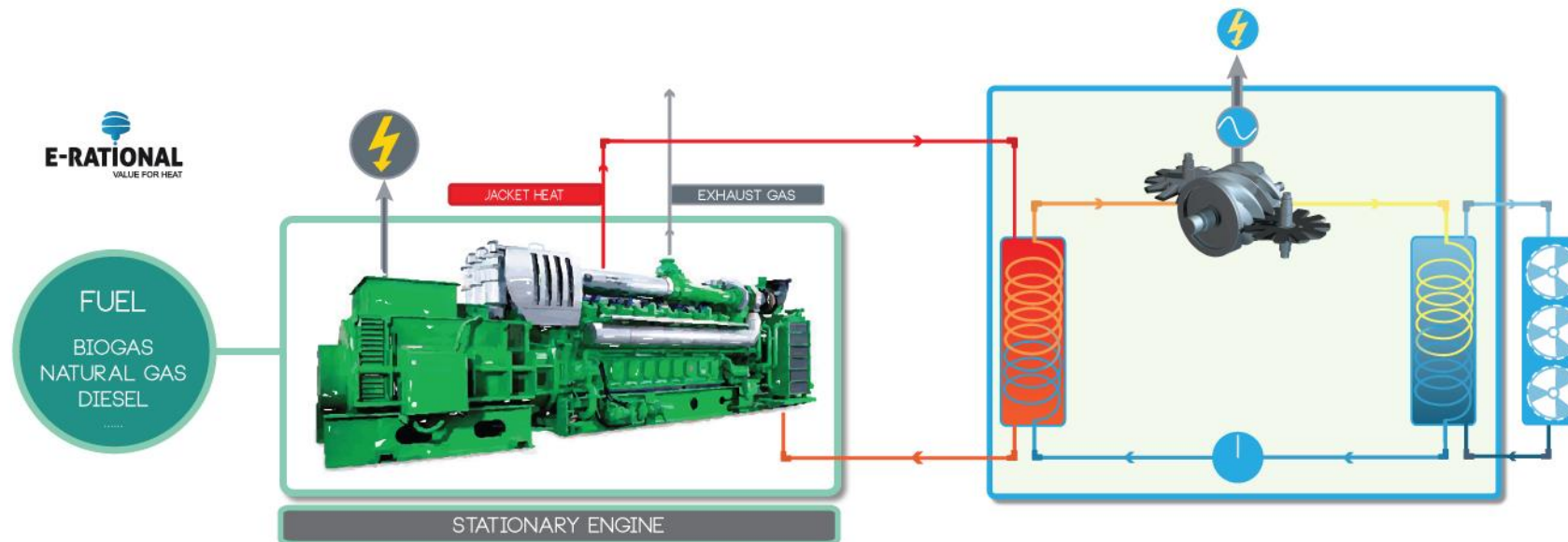
- Cooling processes
- Walking beam furnaces
83°C → 74°C
- Exothermal reactions
- ...





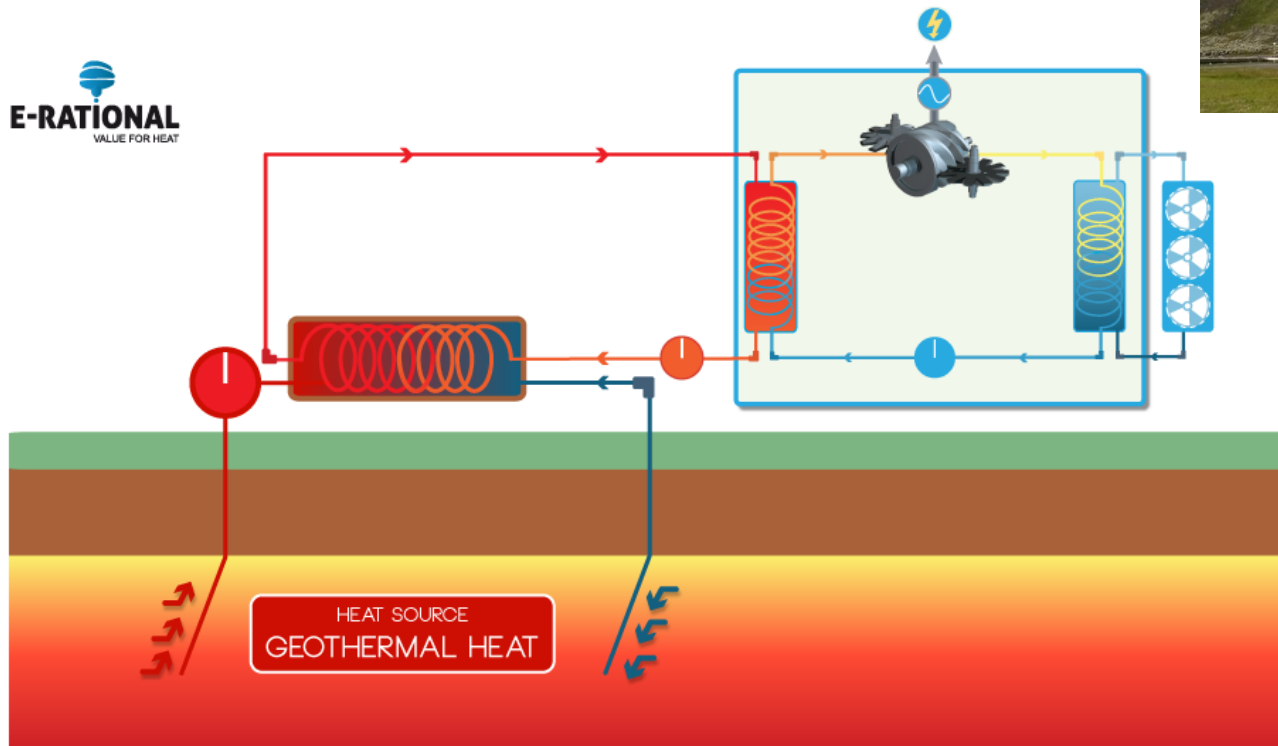
Stationary Engines

- Biogas, natural gas or diesel fuelled
- 38 – 42% conversion to electricity
- 62 – 58% heat
- ORC: 5 – 10% electricity gain
- Savings on fuel consumption



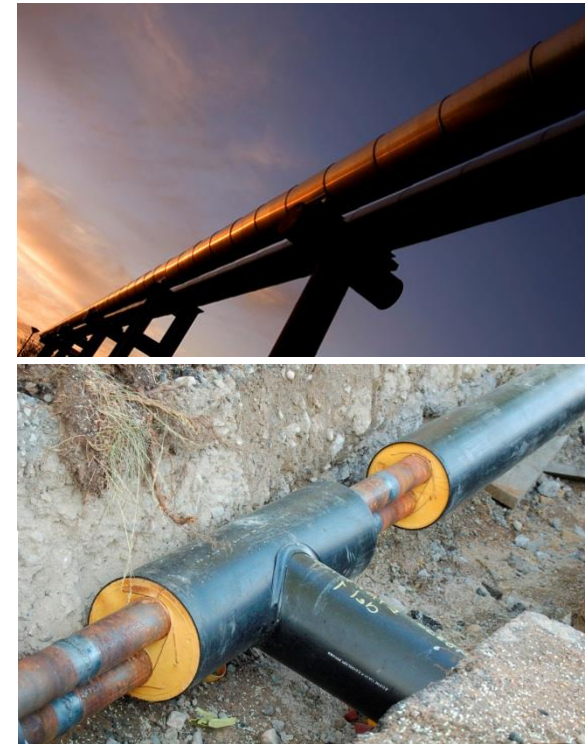
Geothermal Heat

- Low temperature heat sources
- Geothermal brine: salts & solids
- Secondary circuit necessary



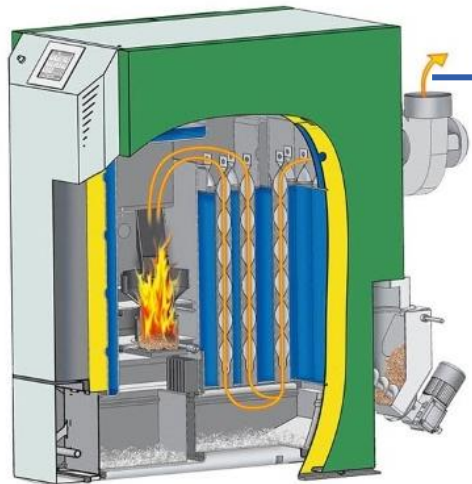
District Heating

- In combination with biomass/ waste incineration
- Excess Heat: summer - winter
- Input temperature: 90°C
- Return temperature: 70°C

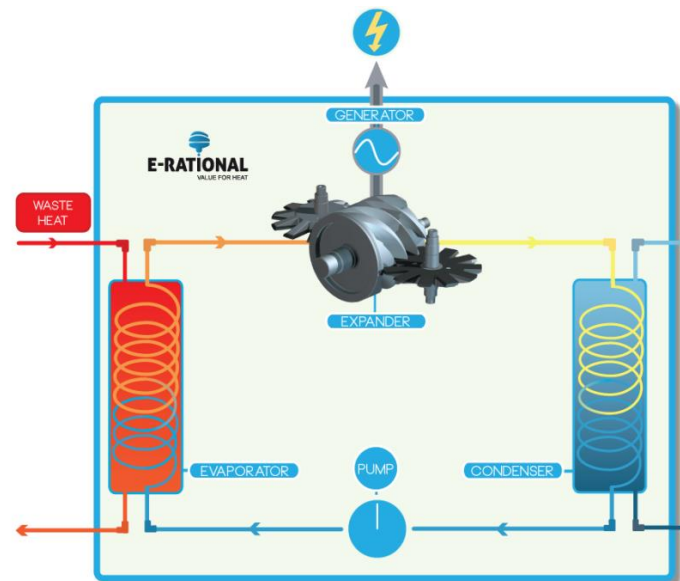


Combined Heat and Power

- Co-generation projects on biomass incineration
- Cooling used for heating purposes
- Typical UK-application
 - Heat coming from biomass boiler
 - Cooling used to pre-heat air
 - Air used for drying of biomass (wood chips, grass, ...)



Hot water from biomass boiler



Use remaining low temperature heat:
Pre-heat air to the drying floor



- Hamyang, South Korea

Case study 1: Waste incineration

Hamyang, municipal waste incineration

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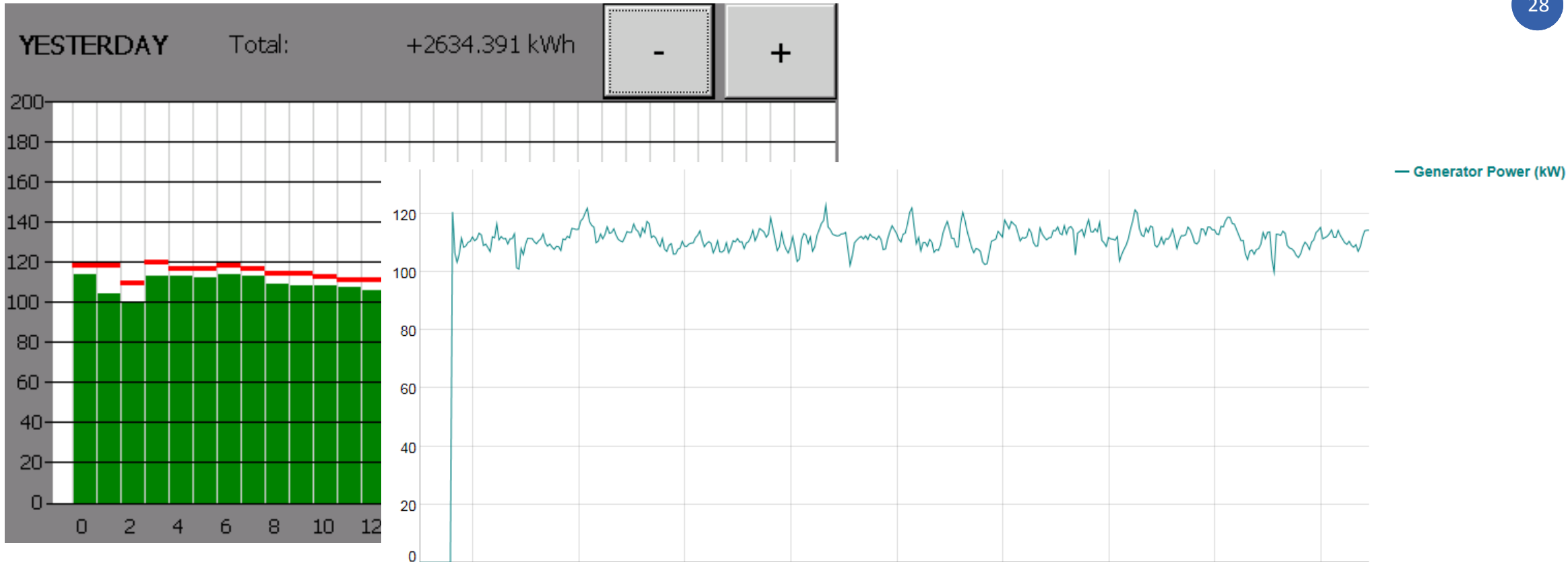
Hamyang, South Korea

- Customer: Hamyang Waste Recycle Center
 - 1500kWth
 - Steam at 160°C
 - 10% efficiency
 - 160kWe installed power
 - Equipped with regenerator for increased efficiency.
 - Commissioning 11/2016
-
- Heat recovered from process steam excess.
 - Steam condensed inside the ORC machine.



Hamyang, municipal waste incineration

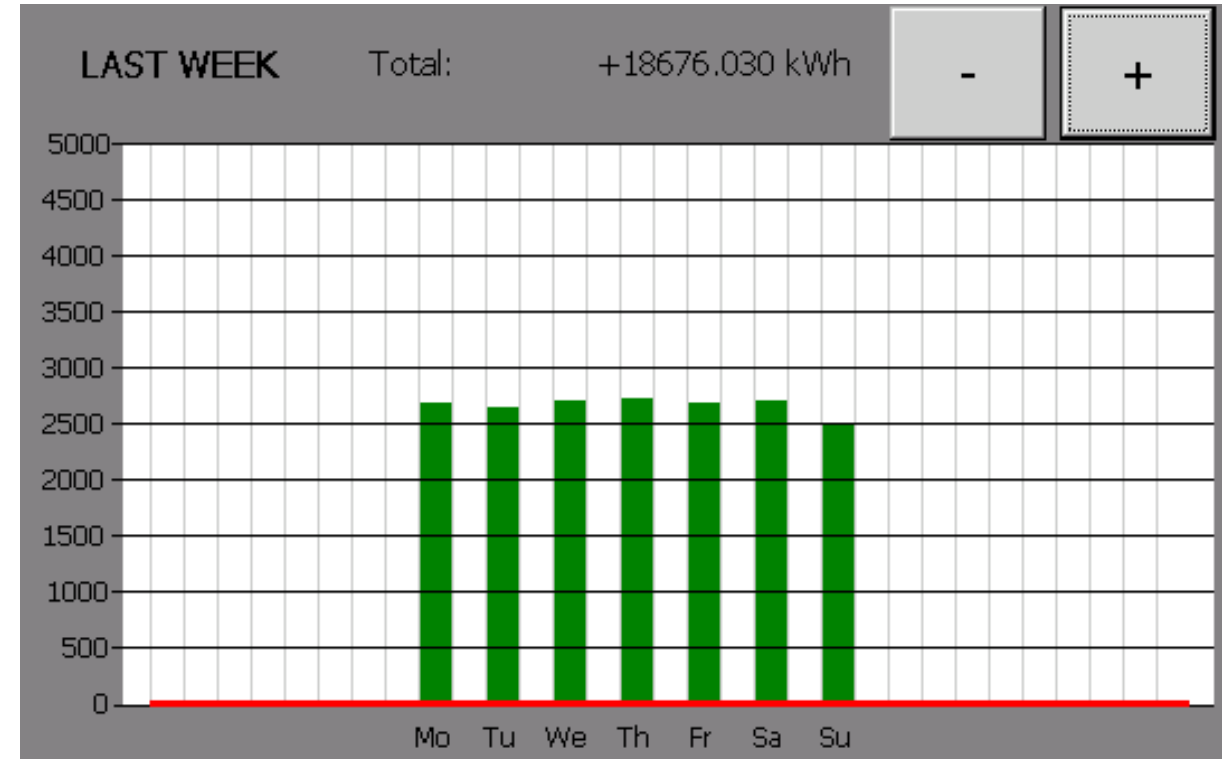
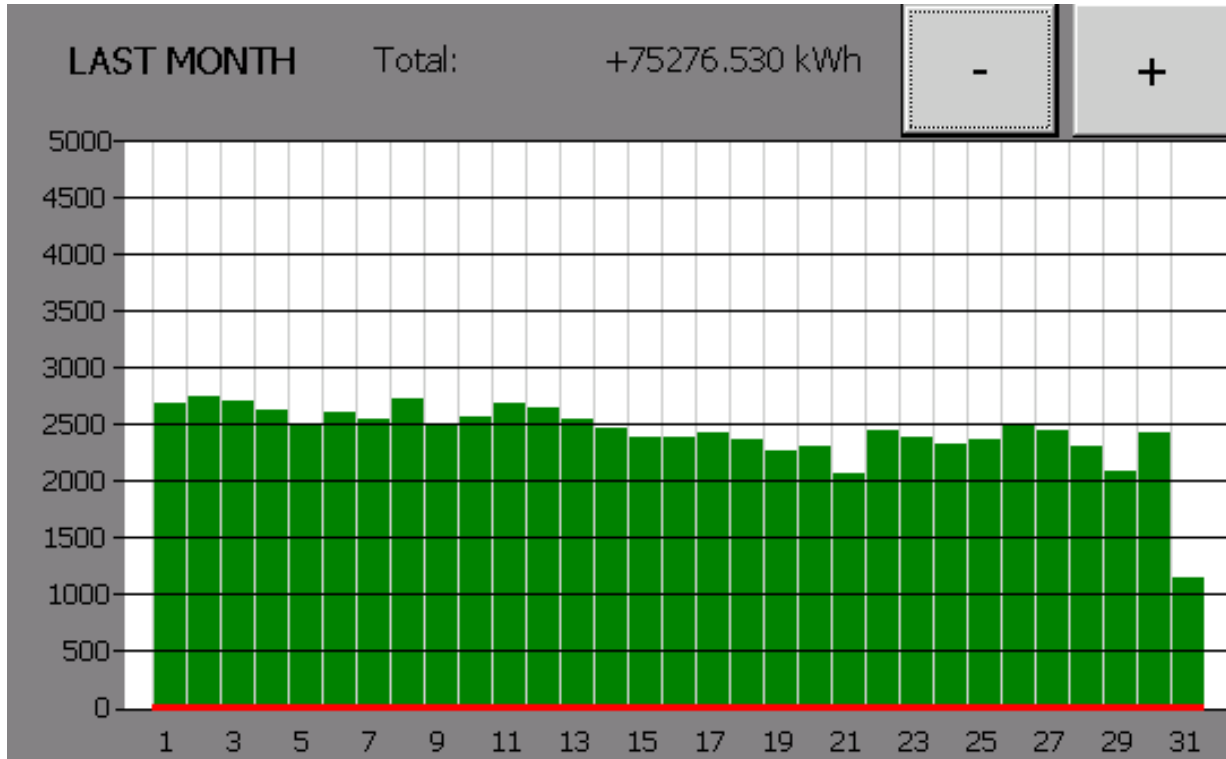
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- $110\text{kW}_{\text{av}} * 8000\text{h/year} * 0.09 \text{ €/kWh}_{\text{electr. price + incent.}} = 79.200 \text{ €/year}$
- Yearly maintenance cost = €12.000
- Simple payback < 5 years
- $\text{IRR}_{7 \text{ years}} = 31.9\%$

Hamyang, municipal waste incineration

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- Penrith, UK
- Lochmaben, UK
- Gatehouse of Fleet, UK

Case study 2: Biomass co-generation

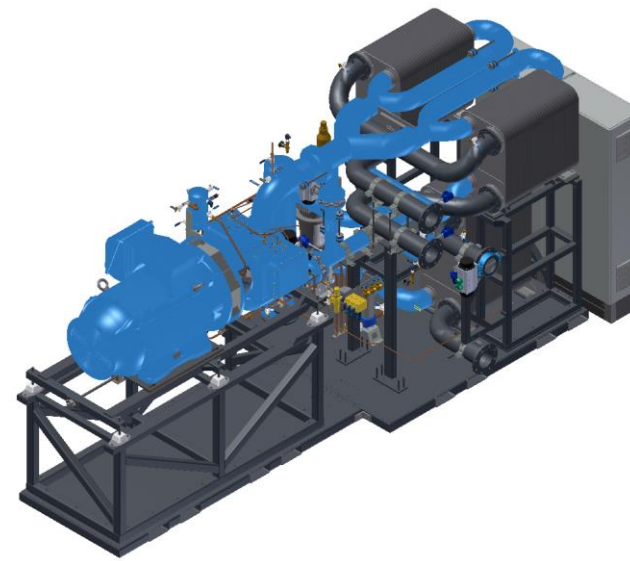
Penrith, co-generation drying application

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Penrith, UK

- Customer: Crossfields Farm
- 2000kWth
- Hot water at 125°C – returning at 105°C
- 8% efficiency
- 220kW_e installed power
- Commissioning 03/2016

- Heat recovered from biomass boiler.
- Cooling at 30 to 40°C
- Cooling applied for low temperature wood drying.
- OEE 2016: 86%
- Availability: 99,6%



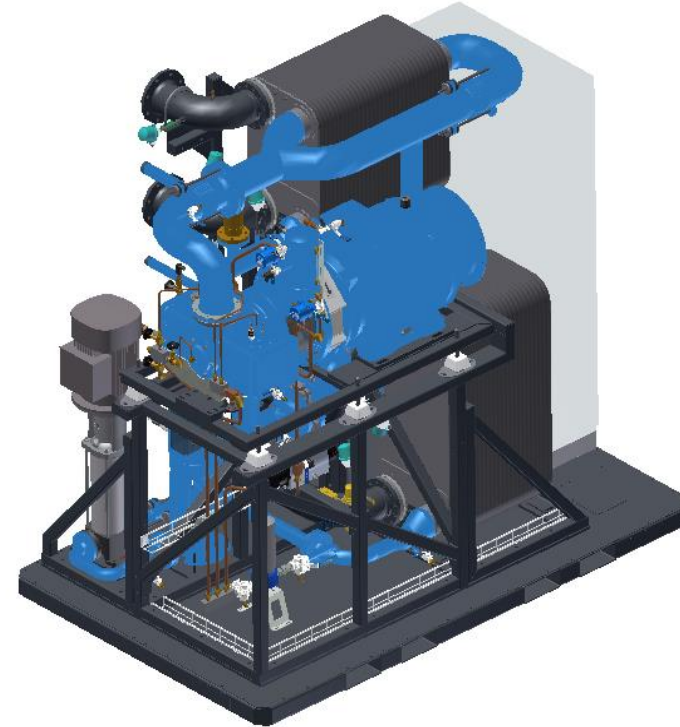
Lochmaben, co-generation off-grid application

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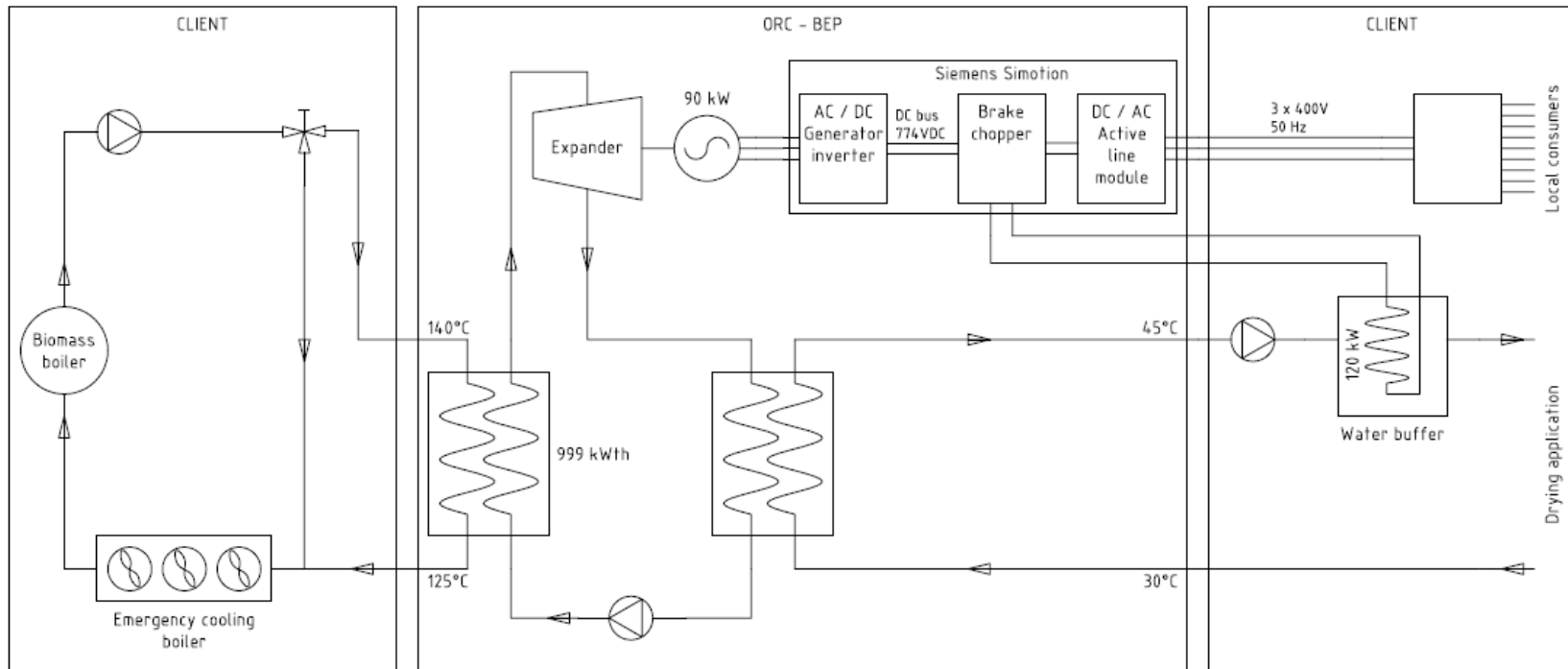
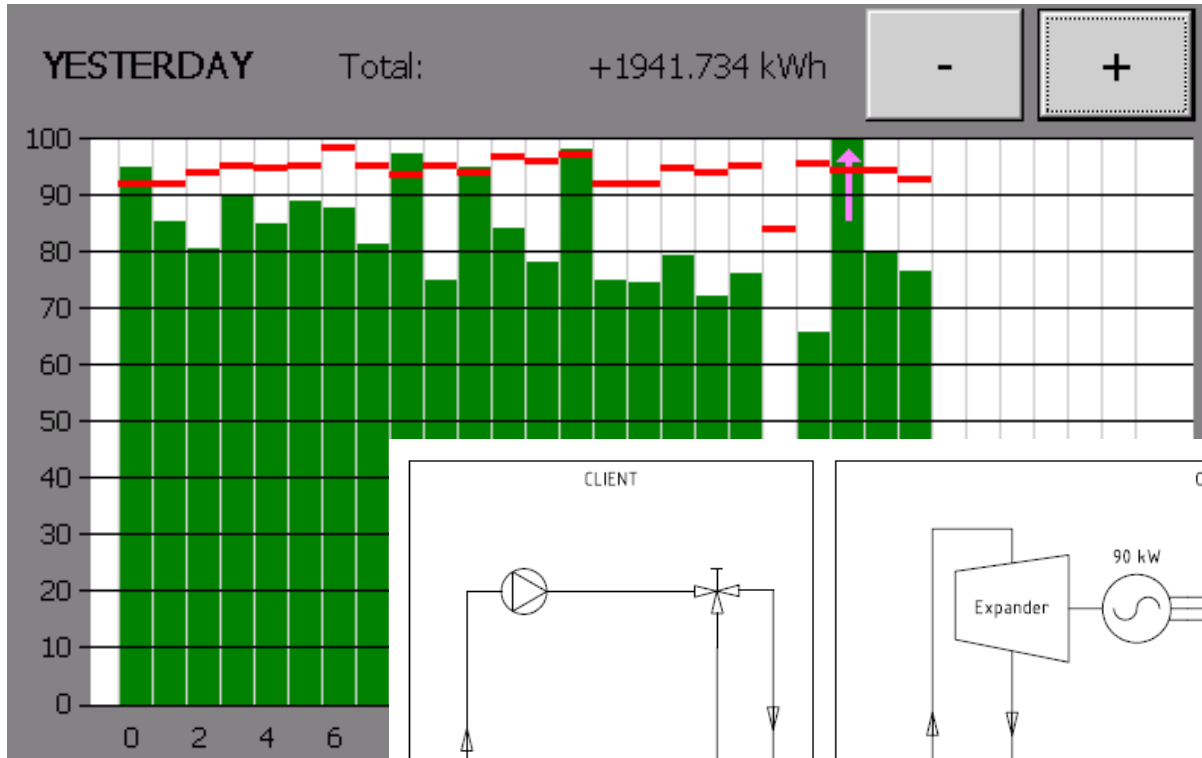
Lochmaben, UK

- Customer: Slacks Farm
- 2x 1000kWth
- Hot water at 125°C – returning at 110°C
- 8% efficiency
- 2x 90kWe installed power
- Commissioning 12/2016

- Heat recovered from biomass boiler.
- Cooling at 30 to 40°C
- Cooling applied for low temperature wood drying.
- 1 machine installed off-grid, providing power to ventilators at the drying floor.



Lochmaben, co-generation off-grid application

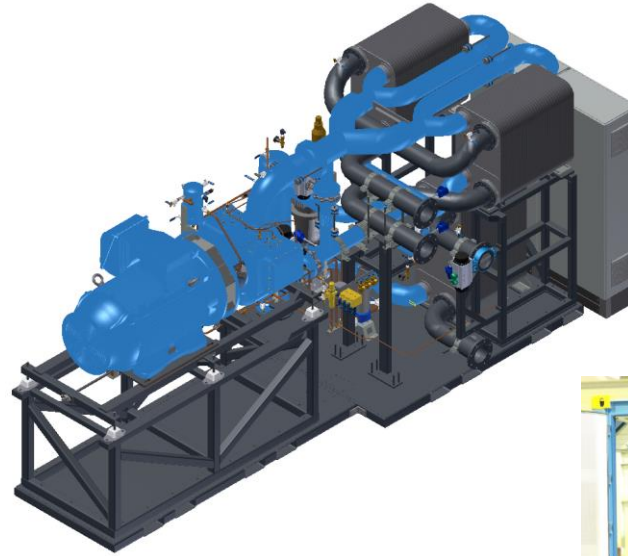


Gatehouse of Fleet, co-generation off-grid application

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Gatehouse of Fleet, UK

- Customer: Littleton Farm
 - 2x 1000kWth boiler
 - Hot water at 125°C – returning at 110°C
 - 8% efficiency
 - 185kW_e installed power
 - Commissioning 03/2017
-
- Heat recovered from biomass boiler.
 - Cooling at 35 to 45°C
 - Cooling applied for low temperature wood drying.
 - 1 machine installed off-grid, providing power to ventilators at the drying floor.



Gatehouse of Fleet, co-generation off-grid application

560028-185-1

PLC
EG
CS
CS0
SG

Auto Controls

Reset Alarms

9/13/2017
15:11:37

BT1.1: Before Expander	123.0 °C	BP1.1: After Pump	10.53 bar	Hot valve	100.0 %
BT1.2: After Condensor	39.5 °C	BP1.2: Vessel	1.59 bar	GP1.1: Pump Speed	43.8 Hz
BT0.1: Hot side IN	129.2 °C	BP3.1: Shaft Sealing	4.34 bar	GP1.1: Pump Power	7.4 kW
BT0.2: Hot side OUT	115.0 °C				
BT2.1: Cold side IN	36.3 °C				
BT2.2: Cold side OUT	48.2 °C				
BT3.1: Shaft Seal IN	61.7 °C				
BT3.2: Shaft Seal OUT	71.9 °C				
ΔT ShaftSeal	10.2 °C				
Temp Hot Water Buffer	44.5 °C				

YESTERDAY

Total: **+3495.031 kWh**

-

+

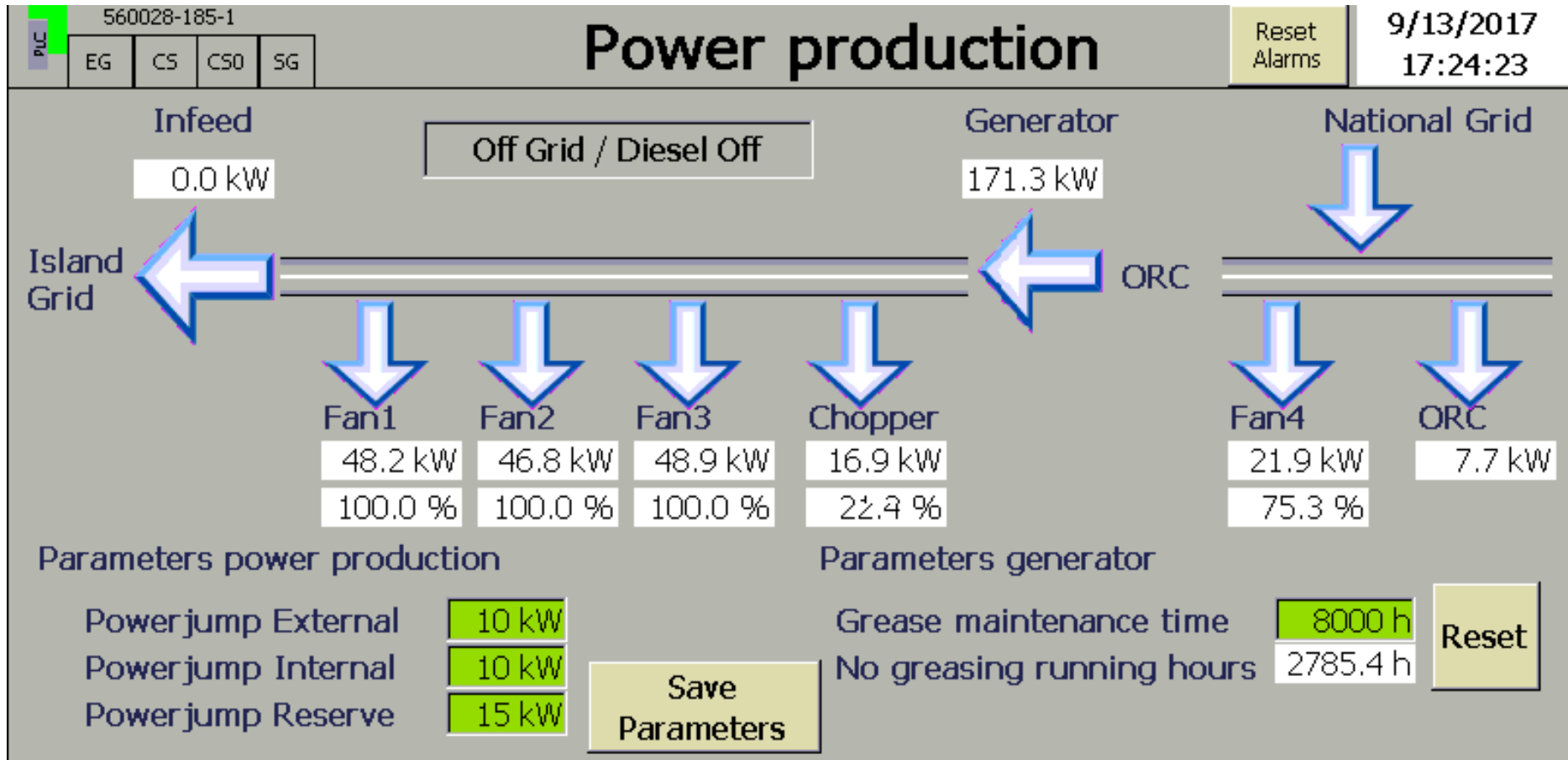
● Emergency Stop	● Lvl ShaftSeal BL3.1
● Authorisation Plant	● Lvl buffer HIGH BL1.
● Exp. valve: Open	● Lvl buffer LOW BL1.
● Bypass valve: Closed	● Cooling on
● Off Grid	● Hot valve on

Previous Screen

System

Manual Operations

Gatehouse of Fleet, co-generation off-grid application





Tack	Obrigado	Vielen Dank
Merci	ありがとうございます	
Bedankt	Takk	感謝您
谢谢	Terima Kasih	Grazie
	ขอบคุน	
Киitos	Спасибо	Thank You
	Tak	
Teşekkür Ederiz	감사합니다	
Gracias		
Dziękujemy	Σας ευχαριστούμε	

