Providing the World with Intelligent Machines
A Family of Machine Manufacturers
Our Intelligent Machines

About Burke Porter Group

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
- Roll Grinding Machines
- Waste Energy Reclamation

Automation & Integration
- Assembly & Test Lines
- Robotic Systems
- Vision & Inspection Systems
- Microfluidics
- Precision Motion Systems
Covering the World – 31 Locations

About Burke Porter Group

North America
- Grand Rapids, MI
- Ada, MI
- Three Rivers, MI
- Shelby Township, MI
- Troy, MI
- Corvallis, OR

South America
- Sao Paulo, Brazil

United Kingdom
- Bristol
- Stroud
- Gosport

Belgium
- Brugge

Poland
- Bydgoszcz

China
- Wuxi
- Beijing
- Changchun
- Shanghai
- Wuhan
- Chongqing
- Pudong
- Liuzhou

Japan
- Yokohama

South Korea
- Seoul

India
- Delhi
- Pune
- Chennai

Germany
- Laatzen
- Siegen
- Lohfelden
- Ilmenau
- Wilnsdorf

Singapore

Indonesia
- Jakarta

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

Reference installations
E-RATIONAL Market

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

Some examples:
- Cooling processes
- Walking beam furnaces
  $83^\circ C \rightarrow 74^\circ C$
- 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, ...)

Use remaining low temperature heat: Pre-heat air to the drying floor
Case study 1: Waste incineration

- Hamyang, South Korea
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

- 110kW_{av} \times 8000\text{h/year} \times 0.09\text{€/kWh}_{\text{elec. price + incentiv.}} = 79.200\text{€/year}
- Yearly maintenance cost = €12,000
- Simple payback < 5 years
- IRR_{7\text{years}} = 31.9\%
Hamyang, municipal waste incineration
• Penrith, UK
• Lochmaben, UK
• Gatehouse of Fleet, UK
Penrith, UK
• Customer: Crossfields Farm
• 2000kWth
• Hot water at 125°C – returning at 105°C
• 8% efficiency
• 220kWe 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, 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, UK
• Customer: Littleton Farm
• 2x 1000kWth boiler
• Hot water at 125°C – returning at 110°C
• 8% efficiency
• 185kWe 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

### Auto Controls

<table>
<thead>
<tr>
<th>No.</th>
<th>Auto Controls</th>
<th>Reset</th>
<th>Alarms</th>
</tr>
</thead>
<tbody>
<tr>
<td>560023-185-L</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>EG</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>CS</td>
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<td>CSO</td>
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<td></td>
</tr>
<tr>
<td>SG</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>BT1.1: Before Expander</td>
<td>123.0 °C</td>
<td></td>
<td></td>
</tr>
<tr>
<td>BT1.2: After Condenser</td>
<td>39.5 °C</td>
<td></td>
<td></td>
</tr>
<tr>
<td>BT0.1: Hot side IN</td>
<td>129.2 °C</td>
<td></td>
<td></td>
</tr>
<tr>
<td>BT0.2: Hot side OUT</td>
<td>115.0 °C</td>
<td></td>
<td></td>
</tr>
<tr>
<td>BT2.1: Cold side IN</td>
<td>36.3 °C</td>
<td></td>
<td></td>
</tr>
<tr>
<td>BT2.2: Cold side OUT</td>
<td>48.2 °C</td>
<td></td>
<td></td>
</tr>
<tr>
<td>BT3.1: Shaft Seal IN</td>
<td>61.7 °C</td>
<td></td>
<td></td>
</tr>
<tr>
<td>BT3.2: Shaft Seal OUT</td>
<td>71.0 °C</td>
<td></td>
<td></td>
</tr>
<tr>
<td>AT Shaft Seal</td>
<td>10.2 °C</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Temp Hot Water Buffer</td>
<td>44.5 °C</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>No.</th>
<th>Auto Controls</th>
<th>Reset</th>
<th>Alarms</th>
</tr>
</thead>
<tbody>
<tr>
<td>BP1.1: After Pump</td>
<td>10.53 bar</td>
<td></td>
<td></td>
</tr>
<tr>
<td>BP1.2: Vessel</td>
<td>1.59 bar</td>
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</tr>
<tr>
<td>BP3.1: Shaft Seal</td>
<td>4.34 bar</td>
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<td></td>
</tr>
<tr>
<td>Hot valve</td>
<td></td>
<td>100.0 %</td>
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</tr>
<tr>
<td>GP1.1: Pump Speed</td>
<td>GP1.1: Pump Power</td>
<td>43.8 Hz</td>
<td>7.4 kWe</td>
</tr>
</tbody>
</table>

**YESTERDAY**

Total: **+3495.031 kWh**

- [E-RATIONAL]

**VALUE FOR HEAT**
Gatehouse of Fleet, co-generation off-grid application

Power production

- **Infeed**: Off Grid / Diesel Off
- **Generator**: 171.3 kW
- **National Grid**
  - **Fan4**: 21.9 kW, 75.3%
  - **ORC**: 7.7 kW

Parameters power production:
- **Power jump External**: 10 kW
- **Power jump Internal**: 10 kW
- **Power jump Reserve**: 15 kW

Parameters generator:
- **Grease maintenance time**: 8000 h
- **No greasing running hours**: 2785.4 h

E-RATIONAL: VALUE FOR HEAT
Tack
Merci
Bedankt
Terima Kasih
谢谢
Спасибо
Kiitos
Teşekkür Ederiz
Gracias
Dziękujemy
Vielen Dank
Obrigado
Takk
感激
Thank You
Grazie
ขอบคุณ
Σας ευχαριστούμε
감사합니다