Dynamic Simulations supporting the Design Process of a real Combined Heat and Power Application in Switzerland

ORC 2017 Milano

Adrian Rettig, Ulf Christian Müller, Lukas Gasser, Jonas Hurter
Heat Demand [MWh/a]

- Not connected & planned new districts
- Connected
- Lower limit for economical operation

Reference 2015-2025 2026-2035 2036-2045 2046-2055
Requirement to get granted special feed-in tariffs

No special feed-in tariffs for electrical plant efficiency below 30%.
Wood boiler & ORC (purely heat-driven)

No special feed-in
<table>
<thead>
<tr>
<th>Heat Utilization Rate [%]</th>
<th>Electrical Plant Efficiency [%]</th>
</tr>
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<tbody>
<tr>
<td>80</td>
<td>0</td>
</tr>
<tr>
<td>70</td>
<td>5</td>
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<tr>
<td>60</td>
<td>10</td>
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<td>50</td>
<td>15</td>
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<td>40</td>
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<td>10</td>
<td>35</td>
</tr>
<tr>
<td>0</td>
<td>40</td>
</tr>
</tbody>
</table>

**Compl. excess heat rejection (purely heat-driven)**

**Wood boiler & ORC (purely heat-driven)**

**No special feed-in**
Wood boiler & ORC (purely heat-driven)

Partial excess heat rejection

Compl. excess heat rejection (purely power-driven)

No special feed-in

Heat Utilization Rate [%]

Electrical Plant Efficiency [%]

Thermal Power [MWth]

Hour of the Year [h]
Simulation – Overall Plant Model (Modelica)
Simulation – Wood boiler, Thermal oil, ORC models
Simulation – Overall Plant Model (Modelica)
Control Concept & Verification

1. Storage fully charged
   - ORC power reduced
   - Cooler on

2. Low charge
   - ORC full power

3. Storage discharged
   - Gas boiler activated
   - Controls supply temp.
Simulation of the Year 2009

Zoom area

Thermal Power [MWth]

Day of the Year

Charge Level [-]
Coupling SCADA/Sim. – Communication

VM SCADA

KEPware OPC UA

OPC Client

OPC Server

Control box

Kontroller Lastregler mit E/A-Geräten

VM Simulation

KEPware LinkMaster

KEPware OPC UA

OPC Server

Dymola modell HSLU

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Conclusions

- For economical operation
  - Incentive exploitation necessary and
  - Possible to a large extend

- Dynamic simulations
  - Find suitable control concept
  - Deeper insight on interaction of subsystems
  - Support of commissioning
Outlook

- Model calibration
- (Performance) Monitoring of plant operation
- Evaluation of potential plant extensions
- Virtual commissioning on the next application
Very Important:
Clever control of your ORC plant, otherwise...
... the ORC works against you!!