SolabCool
and
Thermo Chemical Energy Storage

De Beijer RTB B.V.
Introduction De Beijer RTB:

Profile:
• Engineering company with 30 years of experience in renewable energy solutions and products.
• Many international cooperation’s with institutes and universities.
• Various renewable energy products successfully launched to the market in the past.

Main activity:
De Beijer RTB is mainly active in the field of Solar, thermo-chemical-energy storage and thermo-chemical conversion technology.

Main projects:
Development and the pre-production SunRidge and Thermo-chemical energy storage
De Beijer RTB Development Projects

**NL:**
- TKI - Tessel
- TKI - Compas
- TKI - C.C.O.

**EIT:KIC**
- Sun-ridge
- Energo

**EU**
- FP 7 (MERITS)
- H 2020
  - SpinES
  - SCS4Flex
Nominal energy flows Solabcool

- Nominal performance at nominal conditions
- Seasonal performance in actual building/actual climate

\[ \text{COP} = \frac{P_{\text{cool}}}{\frac{P_{\text{heat}}}{\eta_{\text{heat}}} + \frac{P_{\text{aux}}}{\eta_{\text{aux}}}} \]
Heat-driven cooling
Solab Module

Ø 31 cm

90 cm
Maximum cooling power range
CHP /water /cooling application
INT LOAD: Boilers, MDS, Solab, Fans

EXT LOAD

AIR OUT

GENSET

FAN + RADIATOR

BOILER 1

15 kW

MDS-40

15 kW

BOILER 2

30 kW

SOLABCOOL

15 kW

FAN + RADIATOR

AIR OUT

Option: Ext. cooling (15 kW)
Key players and market drivers

- Consumer Building manager
- Heat generating company
- Property developer Housing company
- District heating company
- New construction
- Existing buildings
- EPC requirements
- Growing demand for houses equipped with cooling
- GIW: Compulsory guaranteee energy installation
- Requirements local authorities district heating

Growing demand for cooling driven by improved insulation
Demand for improved living comfort
Legislation reduction F-gases

Excess heat in the summer

Declining demand for heat
Less heat sales in the summer
Growing demand for cooling

Legislation Europe:
EPBD, EED
National government
System demonstration residential

<table>
<thead>
<tr>
<th>14-aug</th>
<th>15-8-2014</th>
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<tbody>
<tr>
<td>IX start</td>
<td>multiple starts</td>
</tr>
<tr>
<td>68,8</td>
<td>SWin</td>
</tr>
<tr>
<td>62,8</td>
<td>SWout</td>
</tr>
<tr>
<td>14,2</td>
<td>TresIn</td>
</tr>
<tr>
<td>17,3</td>
<td>TresOut</td>
</tr>
<tr>
<td>22,3</td>
<td>MTin</td>
</tr>
<tr>
<td>26,7</td>
<td>MTout</td>
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<tr>
<td>5719</td>
<td>P_SW</td>
</tr>
<tr>
<td>3310</td>
<td>P_Cooling</td>
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<tr>
<td>313</td>
<td>P_electric</td>
</tr>
<tr>
<td>0,58</td>
<td>COP_thermal</td>
</tr>
<tr>
<td>10,55</td>
<td>COP_electrical</td>
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</table>

![Graph showing temperature and on/off states]
Cooling office building incineration plant AVR
Solab Cascade monitoring
System demonstration small office

- System operational
  - HVAC unit not capable to handle cooling output
  - Lower temperature to SolabPumps
  - System performance as expected for these temperatures

<table>
<thead>
<tr>
<th>Data</th>
<th>Cooling time (sec)</th>
<th>Avg Pcool (Watt)</th>
<th>Avg Pheat (Watt)</th>
<th>COP</th>
<th>Start stops</th>
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<tbody>
<tr>
<td>24 June</td>
<td>4257</td>
<td>2945</td>
<td>5652</td>
<td>0.52</td>
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<td>25 June</td>
<td>7448</td>
<td>3221</td>
<td>6290</td>
<td>0.54</td>
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<tr>
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<td>3197</td>
<td>6130</td>
<td>0.51</td>
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<td>27 June</td>
<td>17250</td>
<td>3130</td>
<td>5990</td>
<td>0.55</td>
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<td>18288</td>
<td>3526</td>
<td>5735</td>
<td>0.61</td>
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<td>2 July</td>
<td>2624</td>
<td>3588</td>
<td>7244</td>
<td>0.49</td>
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<td>21564</td>
<td>3203</td>
<td>5332</td>
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<td>4 July</td>
<td>8936</td>
<td>3031</td>
<td>5083</td>
<td>0.59</td>
<td>1</td>
</tr>
</tbody>
</table>

Duiven - 28 November 2014
Energy conversion by TCM

\[ \text{Reactor} \]

Diagram showing the process of energy conversion in a TCM reactor, with diagrams illustrating the flow of NaS and H₂O and the conversion reactions:

- \( \text{NaS} + n\text{H}_2\text{O} \rightarrow \text{NaS} + n\text{H}_2\text{O}(g) + Q_{\text{charge}} \)
- \( \text{NaS} + n\text{H}_2\text{O}(g) \rightarrow \text{NaS} + n\text{H}_2\text{O} + Q_{\text{condensation}} \)
# Energy density of the materials

<table>
<thead>
<tr>
<th>Storage options</th>
<th>Storage density</th>
<th>Storage duration</th>
<th>Storage</th>
<th>Cycling efficiency</th>
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</thead>
<tbody>
<tr>
<td>Hot water</td>
<td>&lt; 0.2 GJ/m³ (dT= 50°C)</td>
<td>Day</td>
<td>Thermal</td>
<td>~ 70%</td>
</tr>
<tr>
<td>Phase change materials</td>
<td>&lt; 0.3 GJ/m³</td>
<td>day-year</td>
<td>Thermal</td>
<td>~ 90%</td>
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<tr>
<td>Thermochemical</td>
<td>~ 1 GJ/m³</td>
<td>day-year</td>
<td>Thermal</td>
<td>~ 90%</td>
</tr>
<tr>
<td>Electrical Batteries</td>
<td>~ 1 GJ/m³</td>
<td>minutes-months</td>
<td>Electrical</td>
<td>75%</td>
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<tr>
<td>Chemical Looping</td>
<td>~ 3 GJ/m³</td>
<td>day-year</td>
<td>Electrical &gt; thermal</td>
<td>70%</td>
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</table>
Thermochemical Storage

Module Capacity 8 kWh
Power 5 kW
Dimensions 850x300
Solar/Heat/Cold storage distribution system
Thermodynamics
Product development
Innovation
Solar island District heating ‘Almere’

Flat Plate Collectors 7000 m² Production 10,000 GJ/y at 75°C
Integration

Ridge Collector
Electrical Heat Pumps

Geotherm

Energion®
SWEAT®

District heating

Automotive airco
District Heating Units
Heatpipe for refurbishing electrical boilers → Solarboiler
Company ‘Principles’

- Flexibility
- Reliability
- Innovation
- Spirit

FUN

It’s our Competence that makes the difference