Solar Cooling Simulation for Planning and Optimization

Polysun Simulation Software

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Objective

- Introduction
- Planning Methodology:
  - System dimensioning → Power levels
  - Efficiency & Financials → Energy consumption
- Examples:
  - Solar Cooling with PV-System
  - Solar Cooling with Heat Assisted Chillers
- Building model
- Conclusion
Vela Solaris
- Founded in December 2006 as a Spin-Off from the Technical University Rapperswil
- 10 People in Winterthur, Switzerland. World-wide Online-Marketing activities and partner network
- Activities in innovation and research projects

NERCRE
- Chinese National Engineering Research Center for Renewable Energy, Beijing (Founded in 1992)
- Alliance to Sunpu (China/World) and Sunda (EU)
- Solar thermal and PV expertise
- Research and commercial
- Polysun distribution partner since 2007
Planning Tool Polysun

- Draw your system with Components from Database
- World-wide Weather data included (Meteonorm®)
- Simulate with a variable time step (Δt ~ seconds, if necessary)
- Software license 3300 EUR
- Runs on Win & Mac
- Simplified version on www.polysunonline.com
Polysun user friendliness

- 15 languages including Chinese
- Wizard
- Templates
- Stable numerics
Planning Methodology

- System dimensioning
  - Traditional dimensioning methodology: make the system big enough for the hardest time in the year
  - Make sure the Power levels match

- Further optimization
  - Efficiency: Minimize energy consumption over the year
  - Self-consumption: Production and consumption have to match during the day
  - Financial: Consider variable energy prices
Solar Cooling with Sorption Chiller

- Server room cooling application
- Storage Tank on the hot side and on the cool side
Alternative System design:
Storage tank only on the hot side…
Server Room Cooling: Validation

Sortech
ACS 08
Solar Cooling with Sorption Chiller

Database with Chiller Components from Companies (Sortech, Climeatewell, Yazaki, …)
Cooling and heating with PV & Compression Chiller

Example:
- Building 9m × 11.2m, 3 floors, low energy building. Location: Rome, Italy
- Cooling in summer ($T_{sp}=21^\circ$C) and heating in winter ($T_{sp}=26^\circ$C)
- PV field assumed to cover the entire roof ($82m^2$)
Results: PV for heating and cooling

Note:
- Excess PV power expected
  (size of the PV field was chosen to cover the entire roof)
Results for heating in winter

PV Self-consumption in January 46%, in February 31%

Outside temperature
Photovoltaic electric production
Electric power to from grid
Heatpump electric consumption
Other electric consumption
Results for cooling in summer

PV Self-consumption in August 46%, in September 48%

- Outside temperature
- Photovoltaic electric production
- Electric power to/from grid
- Heatpump electric consumption
- Other electric consumption
Building model

- Important to model passive solar gain properly
- Help for users who do not know the building in early planning stage
- Living area relevant for heating and air-conditioning
- Database of building types + user can edit parameters

<table>
<thead>
<tr>
<th>Building type (examples)</th>
<th>Overall heat transmission coeff.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Passive house</td>
<td>0.17 W/K/m²</td>
</tr>
<tr>
<td>New building, well insulated</td>
<td>0.24 W/K/m²</td>
</tr>
<tr>
<td>Average residential building 2010</td>
<td>0.34 W/K/m²</td>
</tr>
<tr>
<td>Average residential building 2000</td>
<td>0.50 W/K/m²</td>
</tr>
<tr>
<td>Building not modernized (&lt;1995)</td>
<td>0.80 W/K/m²</td>
</tr>
</tbody>
</table>

- Building type
- Windw to wall ratio (WWR)
- Solar transmittance of glass
- Air change and infiltration
- Internal loads
- Heat capacity
Building model

**Simple building model**
- Passive solar gain with simplified model

**Polysun building model**
- Solar irradiation on walls and into windows calculated in every time step
Summary / Conclusion

- Easy to use planning tool for renewable energy systems
  - Solar thermal
  - Photovoltaic
  - Heat pump
  - Absorption + Adsorption
  - Storage (thermal and el. Batteries)

- Programmable Controllers

- Solar Cooling is available

- Opportunity for disseminating good solar cooling systems (via automatic update to existing users or online version)

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