Seminar on energy savings in building and agri sectors
Certification system in buildings

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Solar thermal for dairies
A contribution from IEE “Engine” project

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Solar thermal: not only hot water!

- Sanitary hot water production
- Heating covered and uncovered pools
Solar thermal: not only hot water!

☀ Winter space heating

☀ Summer building cooling
What about solar thermal for industrial use?

- Consumption in industry: **28%** of the total in EU25
- Of which about **70%** is heat
- What kind of heat?

- Solar thermal plant for **process heat production at low and medium temperature** (< 250°C)
SHIP: “Solar Heat for Industrial Processes”

Task 33/IV is a common research task of the International Energy Agency (IEA), which aimed at promoting the use of solar thermal for process heat production in industry.

From 2003 to 2007
Which industrial sectors and which processes?

- relevant heat demand…
- …and continuous
- at low or medium temperature
- is it feasible to integrate a solar thermal plant in the existing system for heat generation and supply?
Which industrial sectors and which processes?

- High T over 400°C: 43%
- Medium T 100-400°C: 27%
- Low T below 100°C: 30%

Bar chart showing the distribution of temperature categories across various industrial sectors.
Which industrial sectors and which processes?

<table>
<thead>
<tr>
<th>Branch</th>
<th>Unit Operation</th>
<th>Process Temperature (°C)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Milk and milk products</td>
<td>Pasteurisation</td>
<td>62 – 85</td>
</tr>
<tr>
<td></td>
<td>Cheese production</td>
<td>40 - 90</td>
</tr>
<tr>
<td></td>
<td>Sterilisation</td>
<td>130 – 150</td>
</tr>
<tr>
<td>Fruit and vegetable processing</td>
<td>Pasteurisation</td>
<td>&lt; 80</td>
</tr>
<tr>
<td></td>
<td>Sterilisation</td>
<td>110 – 125</td>
</tr>
<tr>
<td></td>
<td>Cooking</td>
<td>70 – 100</td>
</tr>
<tr>
<td>Meat processing</td>
<td>Washing, sterilization, cleaning</td>
<td>&lt; 90</td>
</tr>
<tr>
<td></td>
<td>Cooking</td>
<td>90 – 100</td>
</tr>
<tr>
<td>Beverages</td>
<td>Bottle washing</td>
<td>60 – 90</td>
</tr>
<tr>
<td>Brewing and Malting</td>
<td>Boiling</td>
<td>100</td>
</tr>
<tr>
<td></td>
<td>Bottle washing</td>
<td>60</td>
</tr>
</tbody>
</table>

≠ temperature of the heat supply medium (e.g. steam at 170°C)
How to integrate solar in the processes
A few existing plants...

90 plants: 25 MW (35,000 m²); 0.02% of the world solar thermal power
A few existing plants...
...but a huge potential!
Let’s focus on food sector and dairies...

Italian potential (energy) by sectors

- Textile: 25%
- Chemicals: 15%
- Transport: 14%
- Paper: 2%
- Food and beverage: 44%
## Heat demand in dairies

<table>
<thead>
<tr>
<th>Process</th>
<th>Heat demand (MJ/t milk)</th>
<th>Process temperature (°C)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pasteurization</td>
<td>42</td>
<td>65-85</td>
</tr>
<tr>
<td>Sterilization</td>
<td>330-500</td>
<td>120</td>
</tr>
<tr>
<td>Sterilization (in bottle)</td>
<td>480-515</td>
<td>140-150</td>
</tr>
<tr>
<td>Washing</td>
<td>100-420</td>
<td>&lt;60</td>
</tr>
<tr>
<td>CIP (Cleaning-In-Place)</td>
<td>200-600</td>
<td>70-80</td>
</tr>
<tr>
<td>Evaporation</td>
<td>25-600</td>
<td>95-116</td>
</tr>
<tr>
<td>Drying</td>
<td>440-640</td>
<td>&lt;180</td>
</tr>
</tbody>
</table>

Source: “Procesol II” project (data processed)
Heat demand in dairies

Shares of heat consumption for different temperatures ranges in an average dairy. Source: “Procesol II” project
<table>
<thead>
<tr>
<th></th>
<th>Tyras</th>
<th>Mevgal</th>
<th>Mandrekas</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Nazione</strong></td>
<td>Grecia</td>
<td>Grecia</td>
<td>Grecia</td>
</tr>
<tr>
<td><strong>Domanda di calore annua [MWh/anno]</strong></td>
<td>10550</td>
<td>22500</td>
<td>250</td>
</tr>
<tr>
<td><strong>Anno di realizzazione dell’impianto</strong></td>
<td>2001</td>
<td>1999</td>
<td>1993</td>
</tr>
<tr>
<td><strong>Tipo di processo/applicazione</strong></td>
<td>Acqua calda per lavaggio degli impianti</td>
<td>Acqua calda per lavaggio degli impianti e preriscaldamento dell'acqua di alimento del generatore di vapore</td>
<td>Acqua calda per lavaggio degli impianti</td>
</tr>
<tr>
<td><strong>Temperatura di processo [°C]</strong></td>
<td>35 -70</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td><strong>Area della superficie captante [m²]</strong></td>
<td>1009,56</td>
<td>727</td>
<td>170</td>
</tr>
<tr>
<td><strong>Tipo di collettori</strong></td>
<td>Piani vetrati selettivi (Chromagen CR-120)</td>
<td>Piani vetrati selettivi (403 m²), piani vetrati (216 m²); collettori a concentrazione parabolici lineari (108 m²)</td>
<td>Piani vetrati (THIA S.A.)</td>
</tr>
<tr>
<td><strong>Tipo di installazione e inclinazione</strong></td>
<td>Al suolo, tilt 45°</td>
<td>Su tetto piano</td>
<td>Su tetto piano</td>
</tr>
<tr>
<td><strong>Fattore V/S [lt/m²]</strong></td>
<td>50</td>
<td>14</td>
<td>12</td>
</tr>
<tr>
<td><strong>Sistema di produzione del calore convenzionale</strong></td>
<td>Generatore di vapore (GPL)</td>
<td>Generatore di vapore (Olio combustibile)</td>
<td>Generatore di vapore (GPL)</td>
</tr>
<tr>
<td><strong>Costo specifico dell’impianto solare [€/m²]</strong></td>
<td>173</td>
<td>248</td>
<td>152</td>
</tr>
<tr>
<td></td>
<td>Alpino</td>
<td>Centro Latte STASI</td>
<td>I.L.C. MANDARA S.p.a.</td>
</tr>
<tr>
<td>--------------------------</td>
<td>---------------</td>
<td>--------------------</td>
<td>------------------------</td>
</tr>
<tr>
<td><strong>Nazione</strong></td>
<td>Grecia</td>
<td>Italia</td>
<td>Italia</td>
</tr>
<tr>
<td><strong>Domanda di calore annua [MWh/anno]</strong></td>
<td>2150</td>
<td>166</td>
<td>-</td>
</tr>
<tr>
<td><strong>Anno di realizzazione dell'impianto</strong></td>
<td>1999</td>
<td>2005</td>
<td>2003</td>
</tr>
<tr>
<td><strong>Tipo di processo/applicazione</strong></td>
<td>Acqua calda per lavaggio degli impianti e preriscaldamento dell'acqua di alimentazione del generatore di vapore</td>
<td>Preriscaldamento acqua calda per produzione casearia, per lavaggio macchinari e pavimenti</td>
<td>Preriscaldamento acqua di alimento del generatore di vapore</td>
</tr>
<tr>
<td><strong>Temperatura di processo [°C]</strong></td>
<td>-</td>
<td>80</td>
<td>-</td>
</tr>
<tr>
<td><strong>Area della superficie captante [m²]</strong></td>
<td>740</td>
<td>57</td>
<td>112</td>
</tr>
<tr>
<td><strong>Tipo di collettori</strong></td>
<td>Piani vetrati (Sunny S.A.)</td>
<td>Piani vetrati (Costruzioni solari Panda 2 CU)</td>
<td>Piani vetrati selettivi</td>
</tr>
<tr>
<td><strong>Tipo di installazione e inclinazione</strong></td>
<td>Su tetto piano e pergola</td>
<td>Su tetto piano; tilt 30°</td>
<td>Su tetto piano; tilt 45°</td>
</tr>
<tr>
<td><strong>Fattore V/S [l/m²]</strong></td>
<td>27</td>
<td>70</td>
<td>54</td>
</tr>
<tr>
<td><strong>Sistema di produzione del calore convenzionale</strong></td>
<td>Generatore di vapore (Olio combustibile)</td>
<td>Generatore di vapore</td>
<td>Generatore di vapore (olio combustibile)</td>
</tr>
<tr>
<td><strong>Costo specifico dell'impianto solare [€/m²]</strong></td>
<td>178</td>
<td>667</td>
<td>626</td>
</tr>
</tbody>
</table>
Existing plants

Greece, 1999

Dairy

Process temperature: 20°C ÷ 70°C

Plant surface: 740 m² (flat plate collectors)
Existing plants

Austria, 2003
Washing and cooling wine bottles
Process temperature: 20–90 °C
Plant surface: 100 m² (flat plate collectors)
Existing plants

Italy

Dairy (pre-heating process and washing water)

Process temperature: 80 °C

Plant power: 39.9 kW (57 m²)

Flat plate collectors

Solar heat: 912 kWh/m² a

Solar fraction: 31%
Existing plants

Italy
Dairy
Hot water consumption: 30,000 liters/day
Natural gas consumption: 86% for hot water (not steam)
Process temperature: 80 °C
Evacuated tube collectors
Storage: 30,000 l
Existing plants

Italy
Dairy (pre-heating process heat)
Plant power: 78.4 kW (112 m²)
Flat plate collectors
Storage/surface: 54 l/m²
Existing plants

Italy
Washing plastic reusable boxes
Process temperature: 48 °C
Plant power: 47.6 kW (68 m²)
Evacuated tube collectors (with CPC)
Solar heat: 552 kWh/m² a
Solar fraction: 50%
Existing plants

Italy
Wine
Process temperature: 35-60 °C
Plant power: 42 kW (60 m²)
Evacuated tube collectors (with CPC)
Solar heat: 517 kWh/m² a
Solar fraction: 20% (heating)
Solar fraction: 70% (hot water)
Conclusions

Heat consumption at low and medium temperature is relevant in several industrial sectors.

Among them, the food (dairies in particular) sector is one of the most suitable.

Look at “horizontal” processes (washing, cleaning, cooking, etc.)

Several operating plants with commercial technology.

Plant design is more complex than “conventional” solar thermal:

- No standardisation and therefore no replication
- “Nobody should stop the industrial process”
- “Nobody should even touch the industrial process”
Conclusions: catch the opportunity

🌟 Subtract from the taxation income part of the investment for the purchase of the plant

🌟 Why a solar plant in my industry?

🌟 Not only economic pay back time…

🌟 Uncertainty on the evolution of the cost of conventional fuels

🌟 Economic reasons which are hardly quantifiable (e.g. improving environmental performance of the industry, since your customers are demanding for that)

🌟 Marketing image (e.g. “Solar beer” in Austria)
Potential and application
- “Special” solar collectors
- Solar plants for heating factory buildings
Thank you for your attention

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