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

Gdańsk, March 23rd 2009

Solar thermal for dairies

A contribution from IEE "Engine" project

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Energy Efficiency in SME

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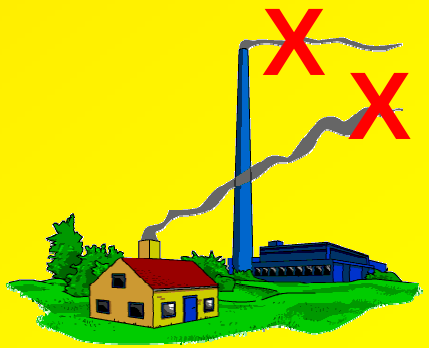

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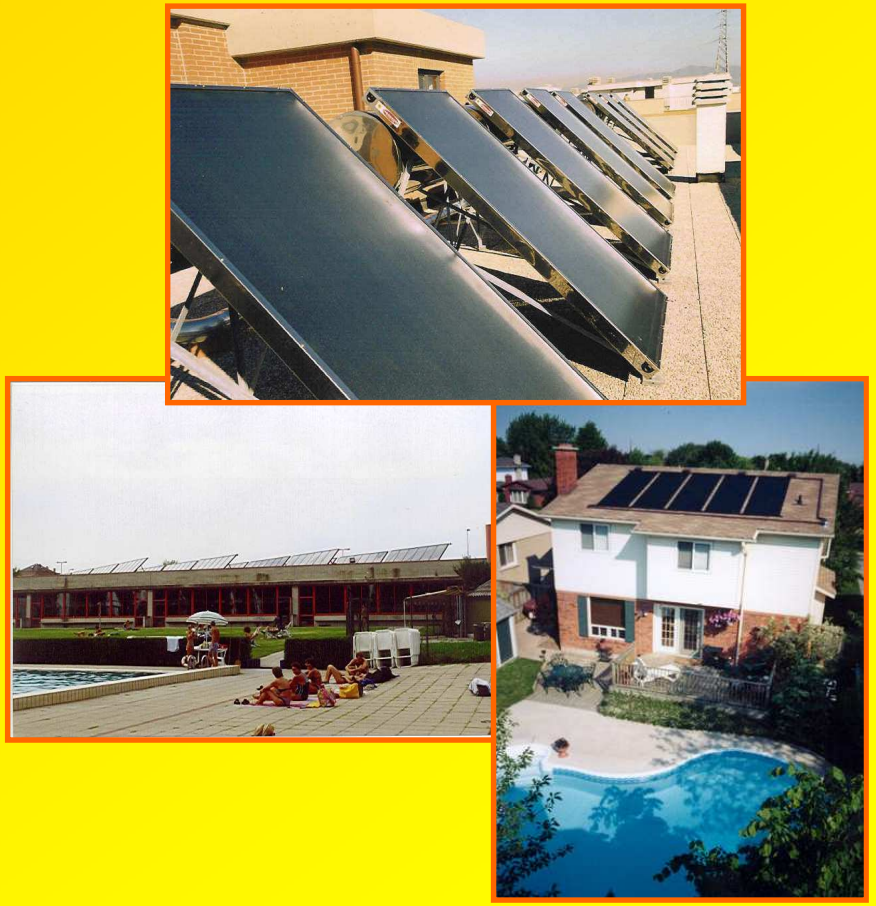
Solar thermal: not only hot water!

- Sanitary hot water production
- Heating covered and uncovered pools



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Solar thermal: not only hot water!

- Winter space heating
- Summer building cooling

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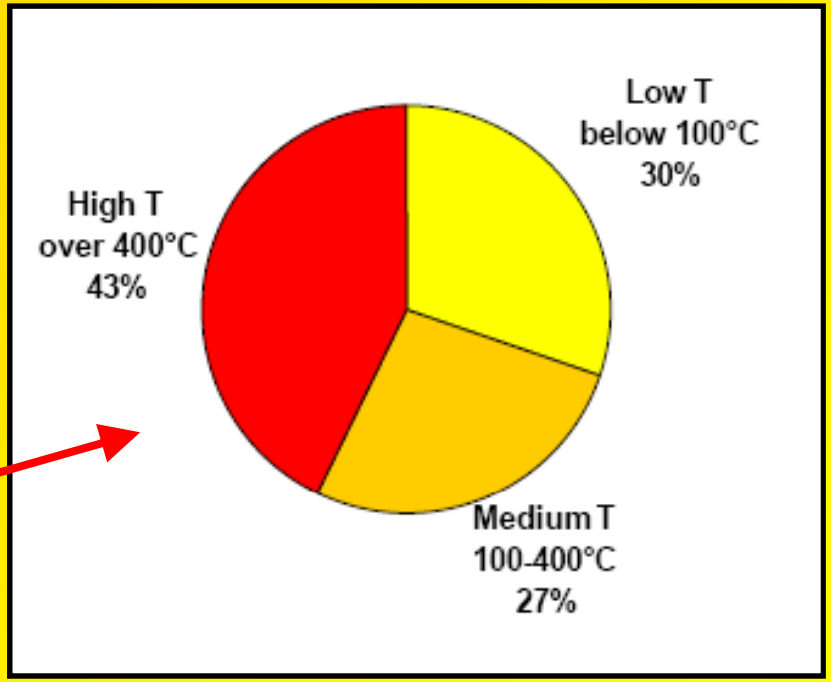
What about solar thermal for industrial use?

- 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)

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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?

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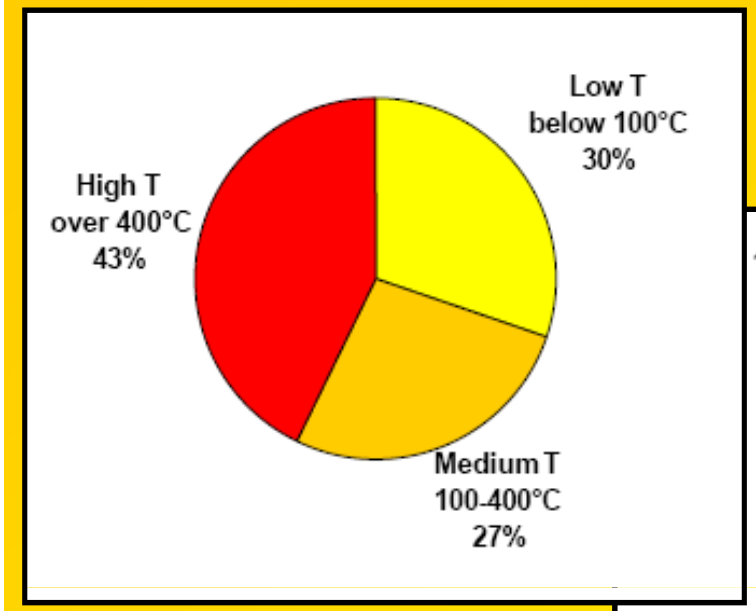
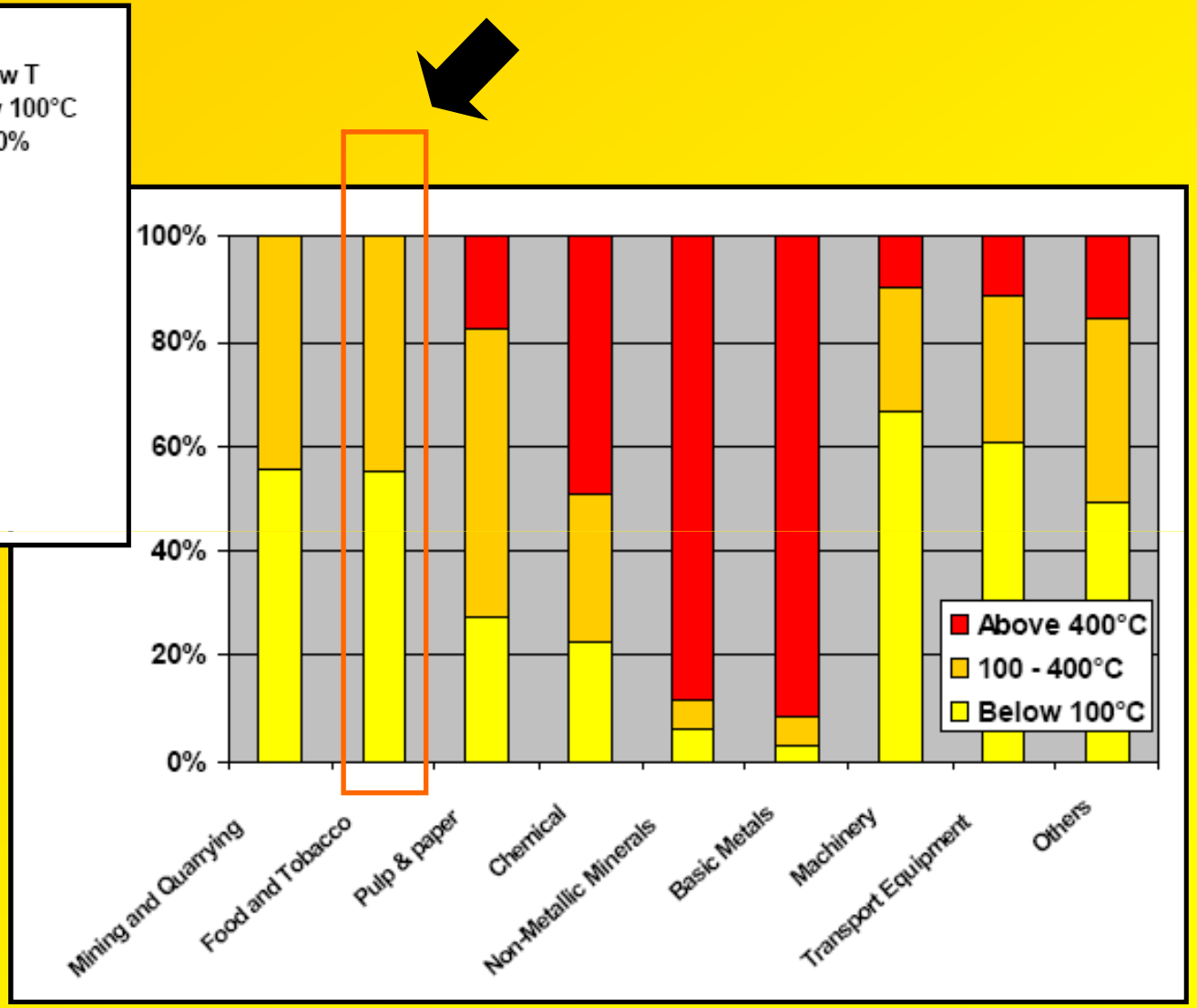
Which industrial sectors and which processes?





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Which industrial sectors and which processes?

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

≠ temperature of the heat supply medium (e.g. steam at 170°C)

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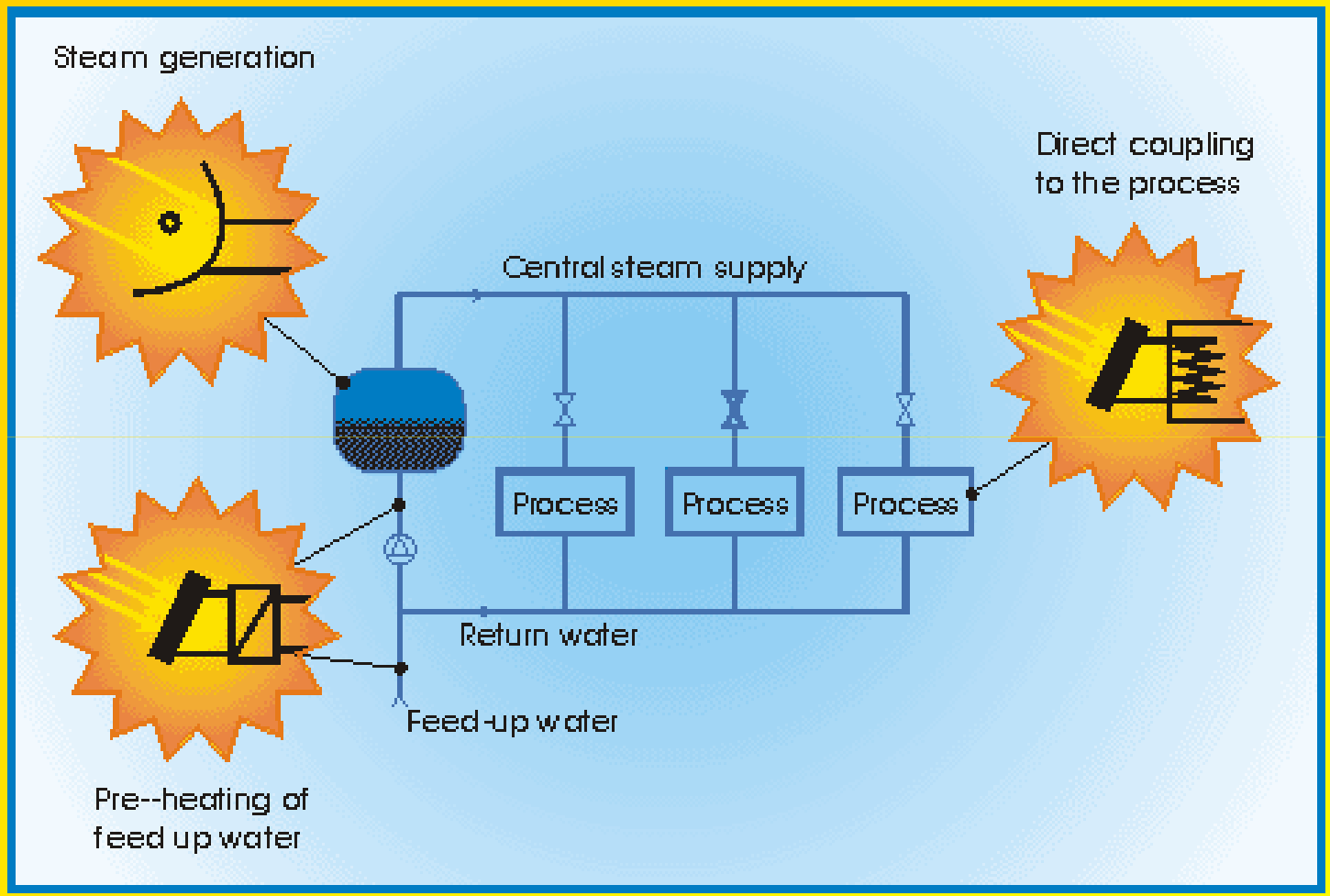
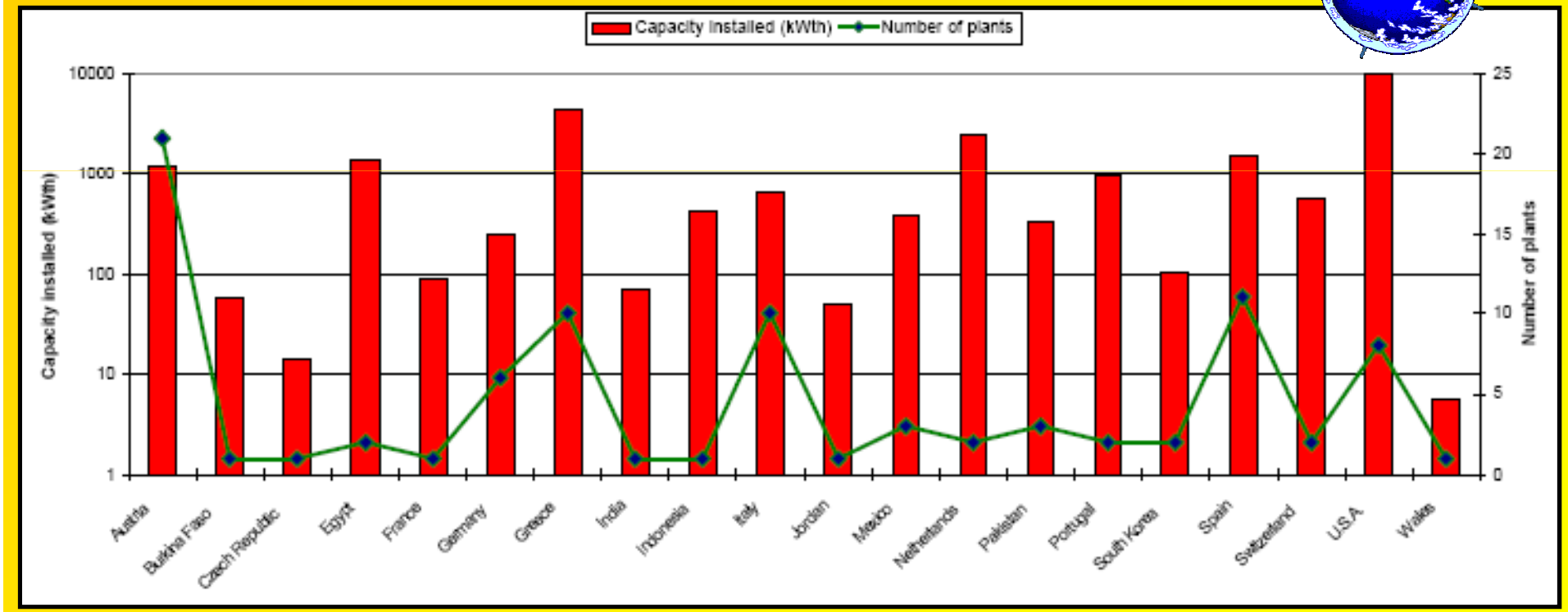
How to integrate solar in the processes



A few existing plants...

- 90 plants: 25 MW (35,000 m^2); 0.02% of the world solar thermal power



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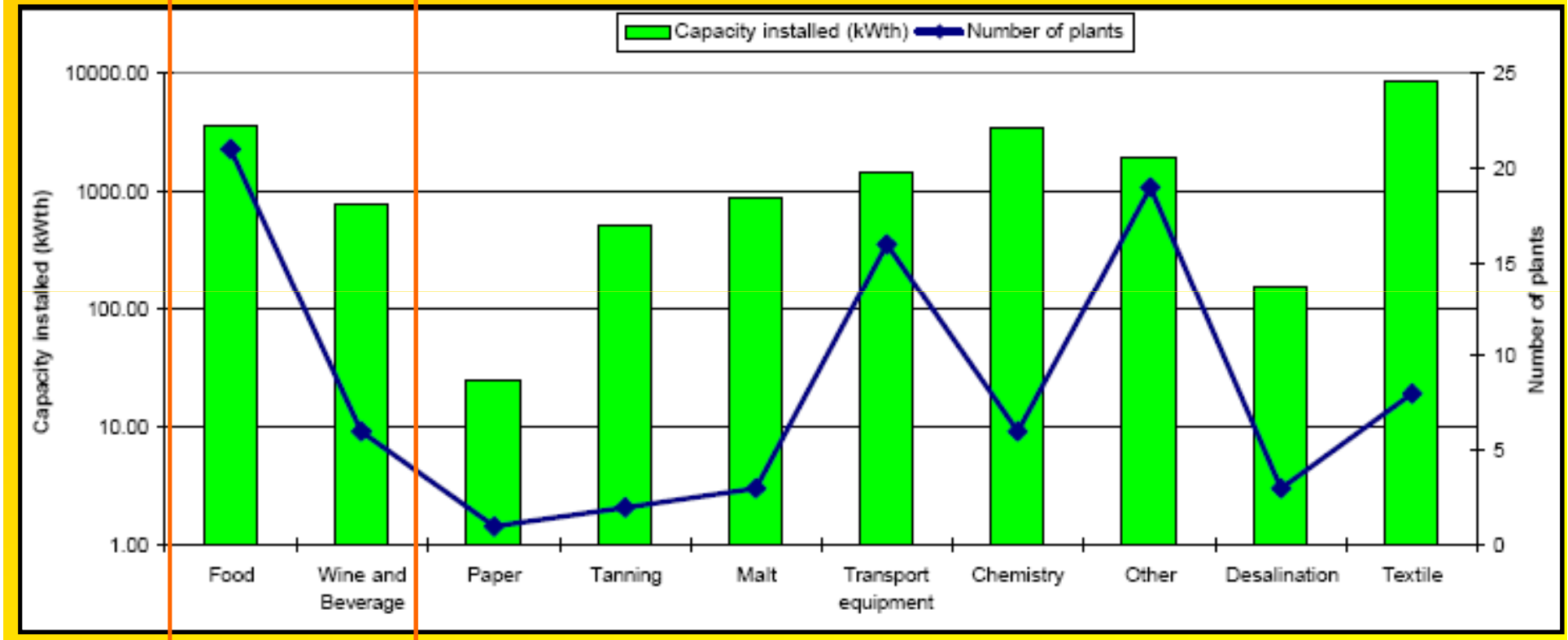
A few existing plants...



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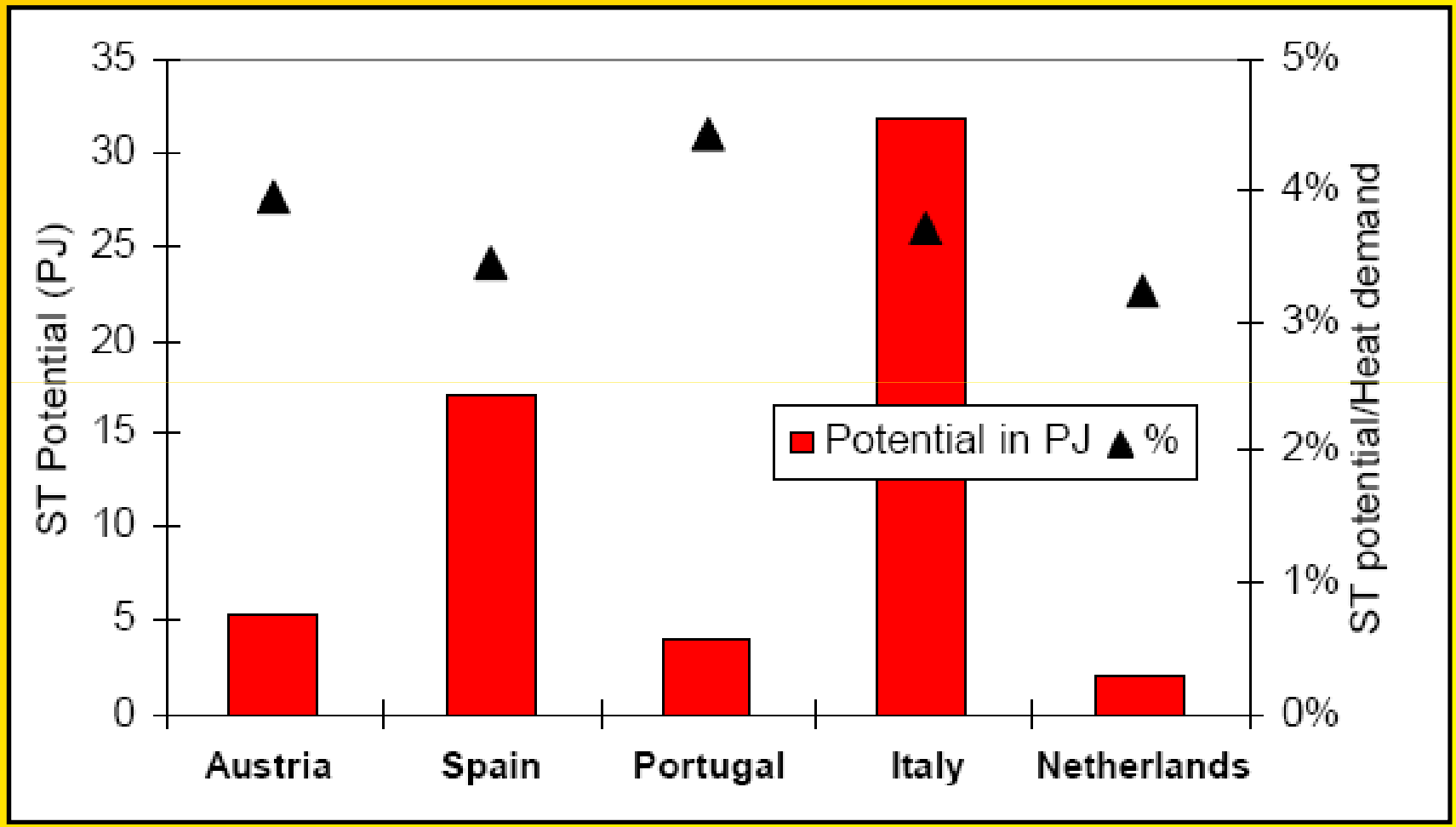
...but a huge potential!



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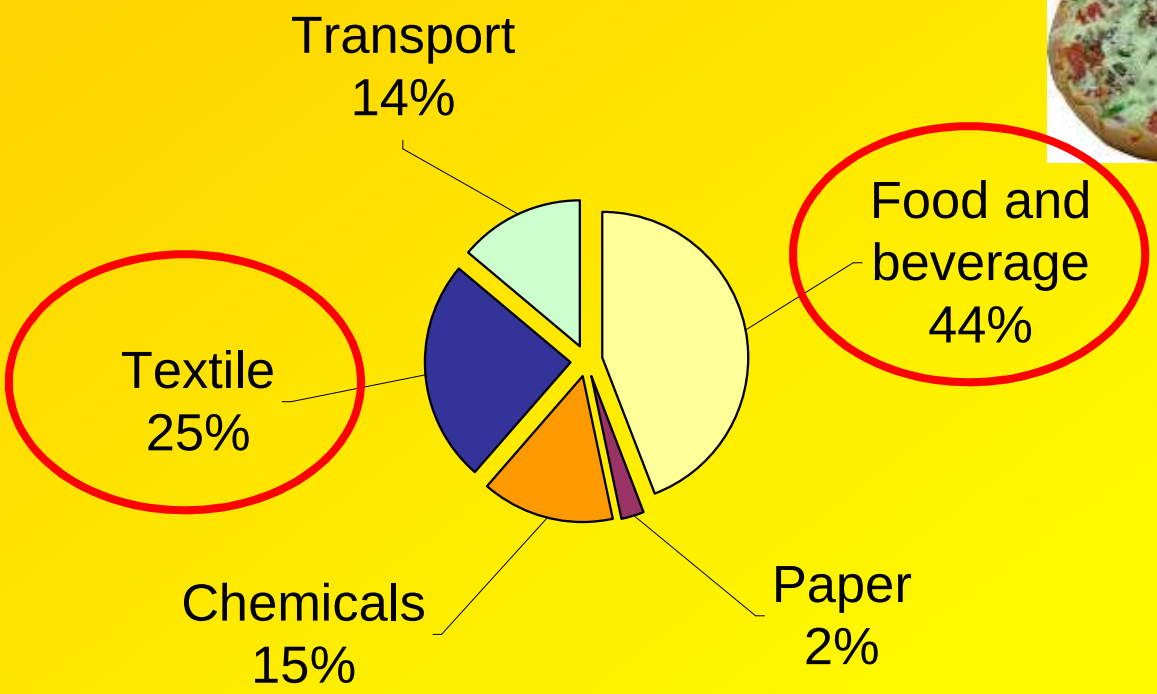
Let’s focus on food sector and dairies...

Italian potential (energy) by sectors



Heat demand in dairies

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

Source: “Procesol II” project (data processed)

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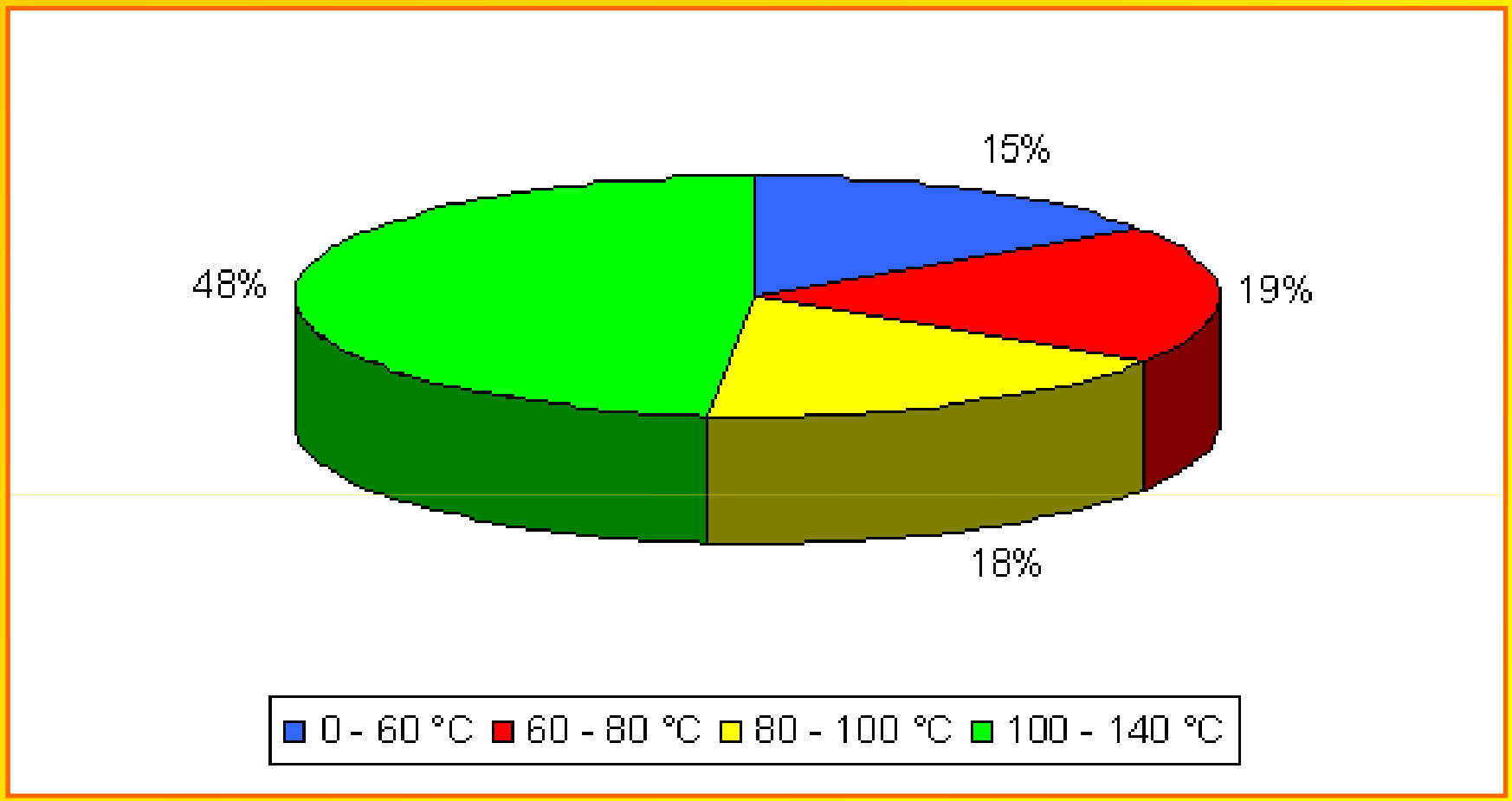
Heat demand in dairies



Shares of heat consumption for different temperatures ranges in an average dairy. Source: “Procesol II” project

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	Tyras	Mevgal	Mandrekas
Nazione	Grecia	Grecia	Grecia
Domanda di calore annua [MWh/anno]	10550	22500	250
Anno di realizzazione dell'impianto	2001	1999	1993
Tipo di processo/applicazione	Acqua calda per lavaggio degli impianti	Acqua calda per lavaggio degli impianti e preriscaldamento dell'acqua di alimento del generatore di vapore	Acqua calda per lavaggio degli impianti
Temperatura di processo [°C]	35 -70	-	-
Area della superficie captante [m^2]	1009,56	727	170
Tipo di collettori	Piani vetrati selettivi (Chromagen CR-120)	Piani vetrati selettivi (403 m^2), piani vetrati (216 m^2); collettori a concentrazione parabolici lineari (108 m^2)	Piani vetrati (THIA S.A.)
Tipo di installazione e inclinazione	Al suolo; tilt 45°	Su tetto piano	Su tetto piano
Fattore V/S [l/m^2]	50	14	12
Sistema di produzione del calore convenzionale	Generatore di vapore (GPL)	Generatore di vapore (Olio combustibile)	Generatore di vapore (GPL)
Costo specifico dell'impianto solare [€/m^2]	173	248	152

	Alpino	Centro Latte STASI	I.L.C. MANDARA S.p.a.
Nazione	Grecia	Italia	Italia
Domanda di calore annua [MWh/anno]	2150	166	-
Anno di realizzazione dell'impianto	1999	2005	2003
Tipo di processo/applicazione	Acqua calda per lavaggio degli impianti e preriscaldamento dell'acqua di alimento del generatore di vapore	Preriscaldamento acqua calda per produzione casearia, per lavaggio macchinari e pavimenti	Preriscaldamento acqua di alimento del generatore di vapore
Temperatura di processo [°C]	-	80	-
Area della superficie captante [m²]	740	57	112
Tipo di collettori	Piani vetrati (Sunny S.A.)	Piani vetrati (Costruzioni solari Panda 2 CU)	Piani vetrati selettivi
Tipo di installazione e inclinazione	Su tetto piano e pergola	Su tetto piano; tilt 30°	Su tetto piano; tilt 45°
Fattore V/S [l/m²]	27	70	54
Sistema di produzione del calore convenzionale	Generatore di vapore (Olio combustibile)	Generatore di vapore	Generatore di vapore (olio combustibile)
Costo specifico dell'impianto solare [€/m²]	178	667	626

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Existing plants

Greece, 1999

Dairy

Process temperature: 20÷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 m^2)

Flat plate collectors

Solar heat: 912 kWh/m^2 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

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Existing plants

Italy

Dairy (pre-heating process heat)

Plant power: 78.4 kW (112 m^2)

Flat plate collectors

Storage/surface: 54 l/m^2

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Existing plants

Italy

Washing plastic reusable boxes

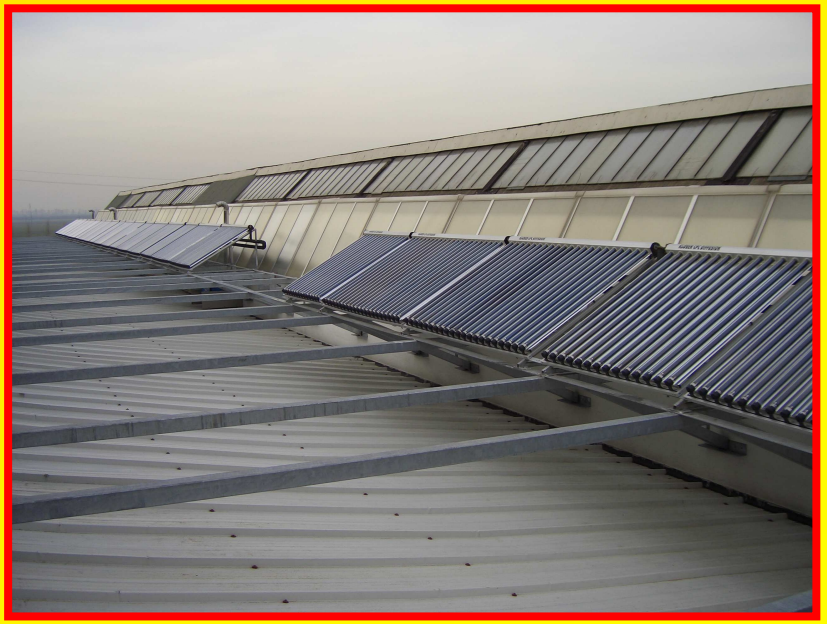
Process temperature: 48 °C

Plant power: 47.6 kW (68 m^2)

Evacuated tube collectors (with CPC)

Solar heat: 552 kWh/m^2 a

Solar fraction: 50%



Existing plants

Italy

Wine

Process temperature: 35-60 °C

Plant power: 42 kW (60 m^2)

Evacuated tube collectors (with CPC)

Solar heat: 517 kWh/m^2 a

Solar fraction: 20% (heating)

Solar fraction: 70% (hot water)

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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 shoud even touch the industrial process”

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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)

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www.iea-shc.org/task33/index.html

-Potential and application

- “Special” solar collectors

- Solar plants for heating factory buildings

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Thank you for your attention

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