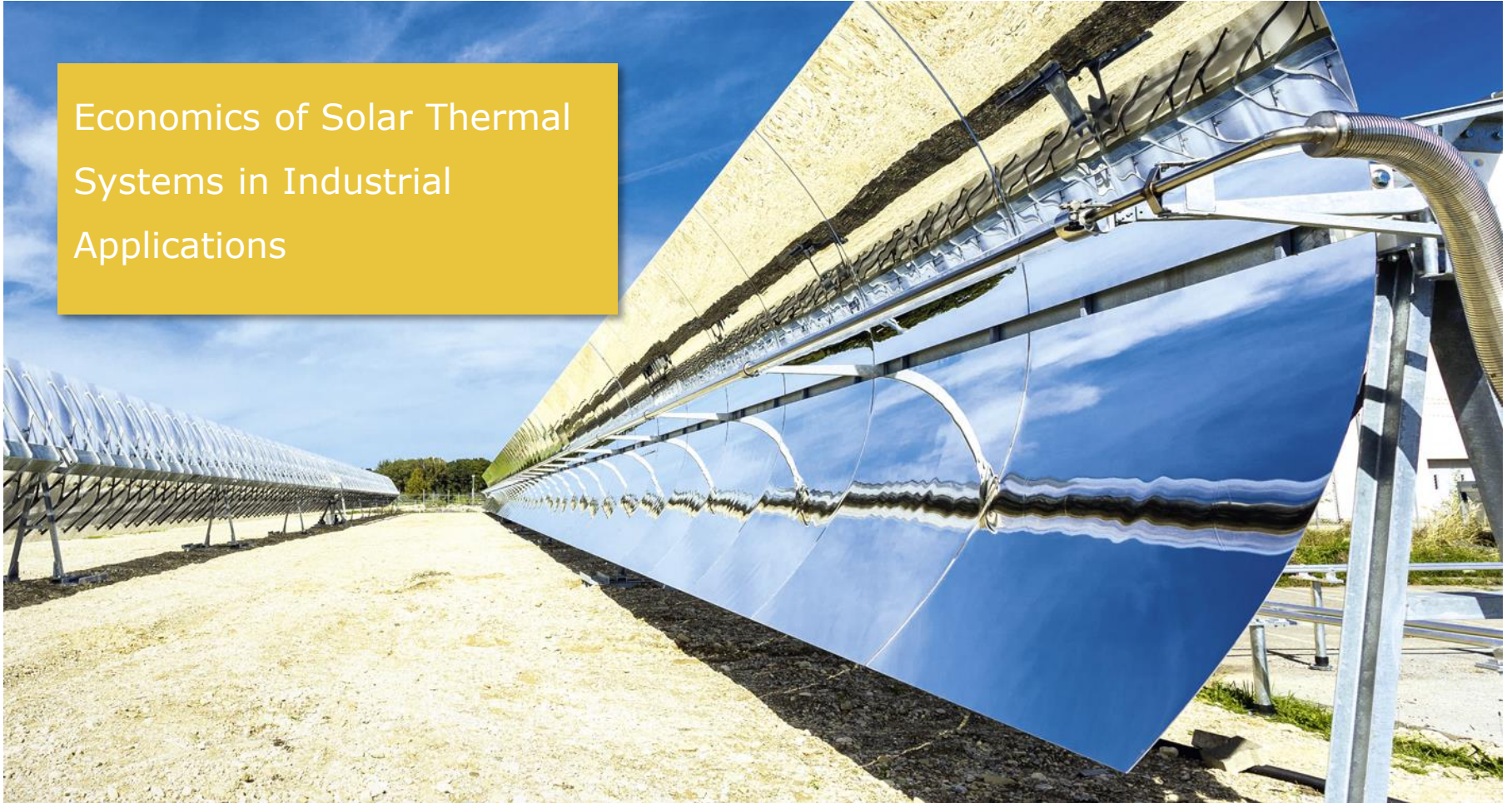


# protarget AG

## Solar Thermal Systems



Economics of Solar Thermal  
Systems in Industrial  
Applications



# protarget AG

## About the company

- Protarget AG Germany was founded in 2009 to develop, produce and sell turn-key concentrating solar thermal systems (CST)
- Our German engineering and design offices are located in Cologne and a manufacturing unit for vacuum receiver tubes in Chemnitz
- Local manufacturing resources in India and Chile for the production of CST components and construction of plants
- Protarget's Solar Technology is approved by DLR and TÜV Germany, in accordance to the European Pressure Equipment Directive PED as well as the Indian Boiler Regulation IBR, MNRE empaneled and eligible for Indian subsidies
- Commercial CST plants in Germany, Cyprus, India and Brazil successfully in operation. Further projects in Jordan, Chile, Cyprus and India at financing stage
- The key business objectives of Protarget are:
  - **Solar steam boiler systems to supply process heat for industrial applications**
  - **Solar power plant engineering and project management world-wide**



### ➤ Germany



### ➤ India



### ➤ Cyprus



### ➤ Brazil

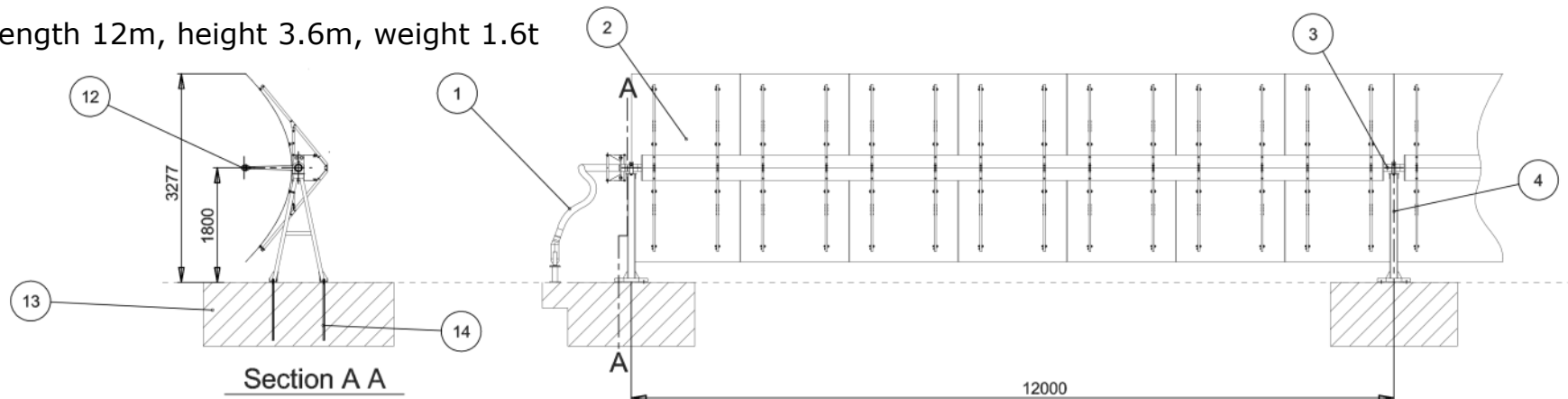




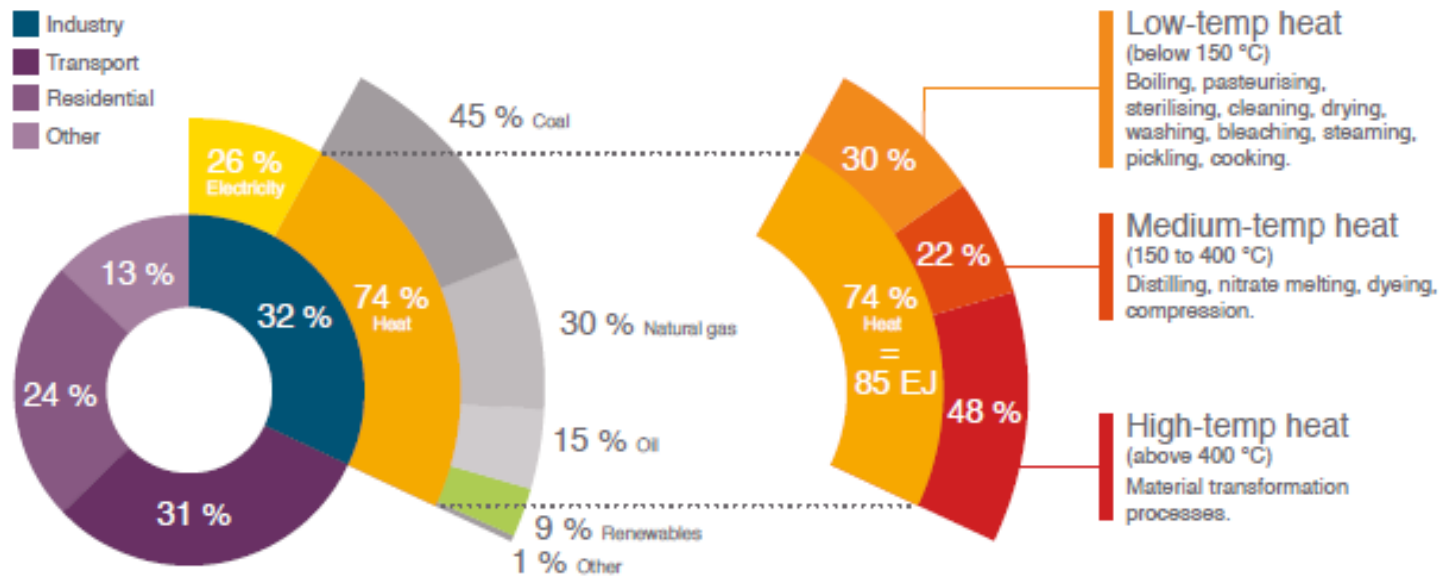
# Industrial Design

## Solar Module PT 950

- Special solar module, designed for process heat and steam supply of up to 420°C
- Robust design for industrial environments and harsh climatic conditions of deserts
- Developed in cooperation with the German Aerospace Centre DLR and industrial partners
- Collector technology DLR and TÜV approved, in accordance to the European Pressure Equipment Directive PED and Indian Boiler Regulation IBR
- Fully automated solar tracking system
- Modular torsion box design; easy to assemble
- Length 12m, height 3.6m, weight 1.6t



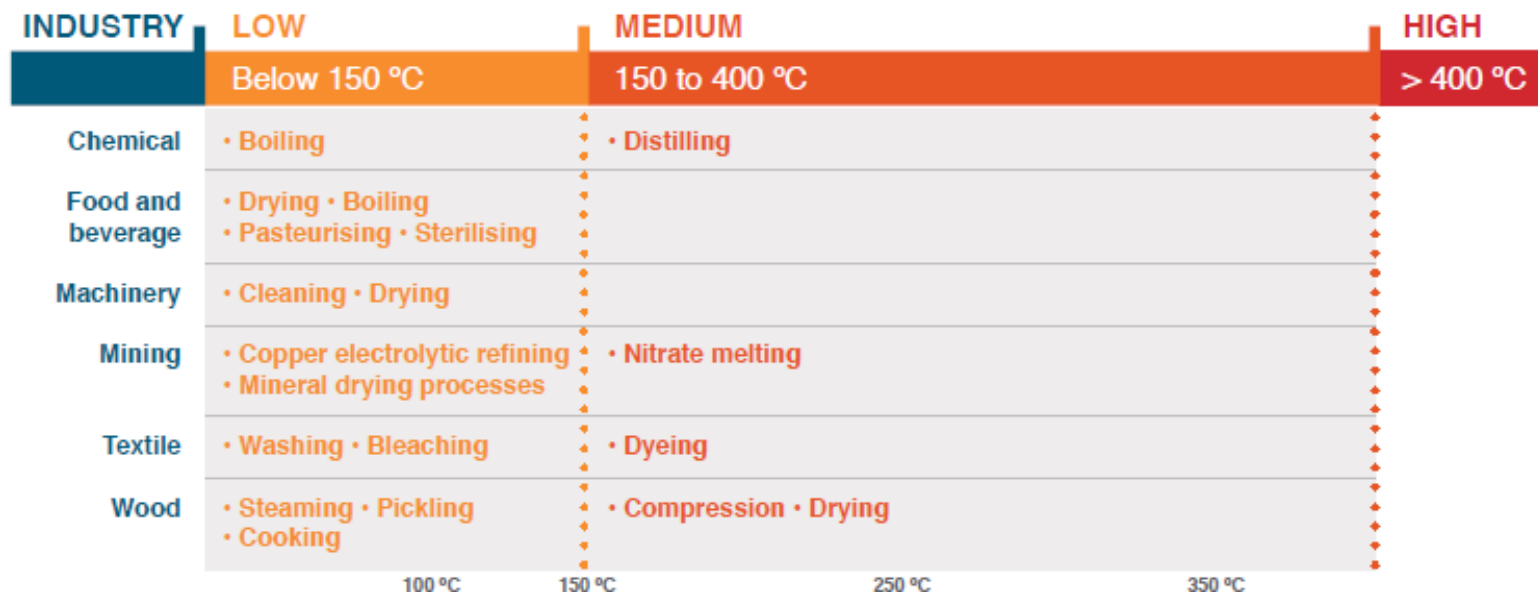
- 74% of the industrial energy is used for process heat and steam
- 90% of that is generated by burning coal, oil and gas
- 1,7% annual increase of industrial energy consumption



Source: Solar Payback 2017

Branches and applications in demand of thermal energy

- Most of the thermal processes in the industry requiring steam at 100-150°C
- To provide this temperature levels, conventional fuel boilers are typically operating at 150-200°C
- The food, beverage and textile industry are the main consumers of thermal energy

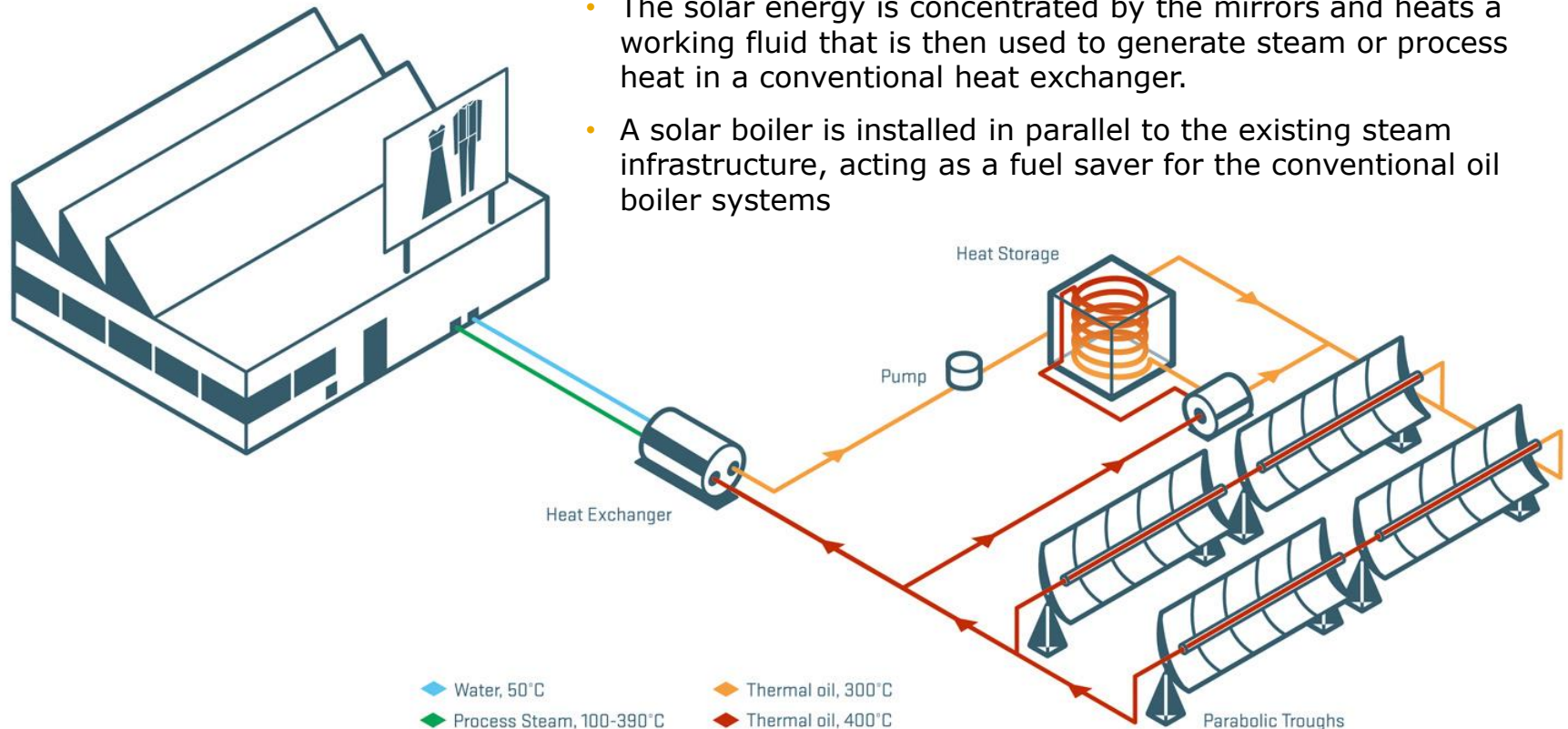


Source: IEA TASK 49

# Steam Technology

## Solar Boiler for Process Steam Generation

- A solar steam boiler system employs rows of large mirrors called parabolic troughs that move about one axis in order to track the sun throughout the day.
- The solar energy is concentrated by the mirrors and heats a working fluid that is then used to generate steam or process heat in a conventional heat exchanger.
- A solar boiler is installed in parallel to the existing steam infrastructure, acting as a fuel saver for the conventional oil boiler systems



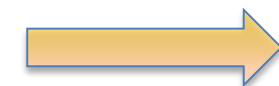
## Comparison conventional vs. solar boiler

### Conventional steam boiler systems

- + Low investment cost
- + Operated with oil or gas
- + Standardised sizes
- + Proven and reliable
- Operating cost (fuel)
- CO<sub>2</sub> emissions

### Fuel boiler example

- Capacity: 5 ton oil boiler
- Output: Steam@170, 10 bar
- Load profile: 10 hours/day, 5 days/week  
2.200 hours/p.a.
- Fuel cost: 700 EUR/ton (Oil)
- **Annual cost: 550.000 EUR**



**Annual cost savings  
500.000 EUR**

### Protarget Solar Boiler System

- + Integrated in parallel to the exiting boiler
- + Operating as a fuel saver
- + Providing process steam of up to 400° C
- + With thermal storage system 24/7 supply
- + Lifetime 20 years and more
- + Zero emissions

### Solar Boiler example

- Capacity: 5 ton solar steam boiler
- Output: Steam@170, 10 bar
- Load profile: 10 hours/day, 5 days/week  
2.200 hours/p.a.
- Fuel cost: 0 EUR
- **Annual cost: 50.000 EUR**



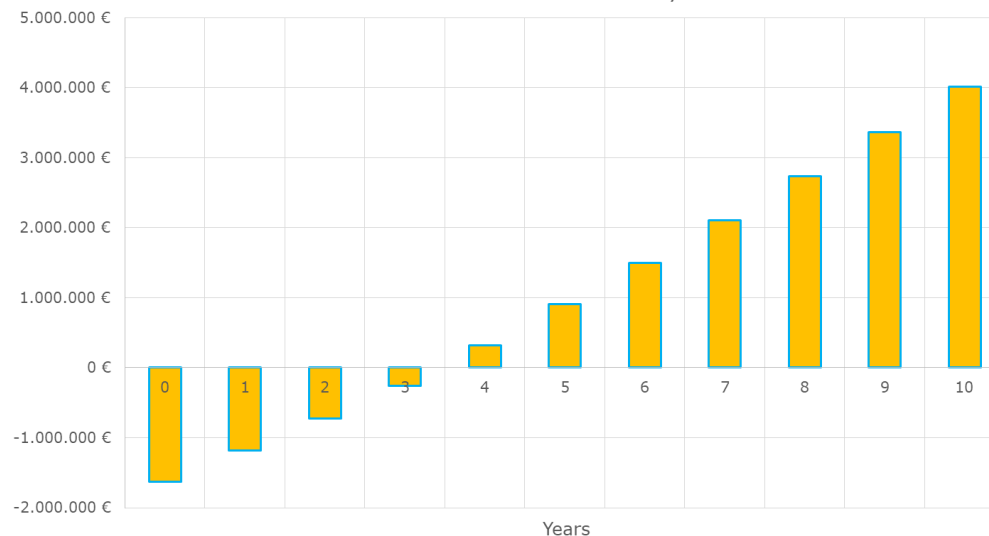
### Economics of a solar steam boiler system:

- System capacity: 5 tons/h
- Investment cost: 1.912.000 EUR
  - Financing cost: 5% p.a.
- O&M cost: 50.000 EUR p.a.
  - Cost increase O&M: 2 % p.a.
- Fuel cost: 700 EUR/ton
  - Fuel cost increase: 2% p.a.

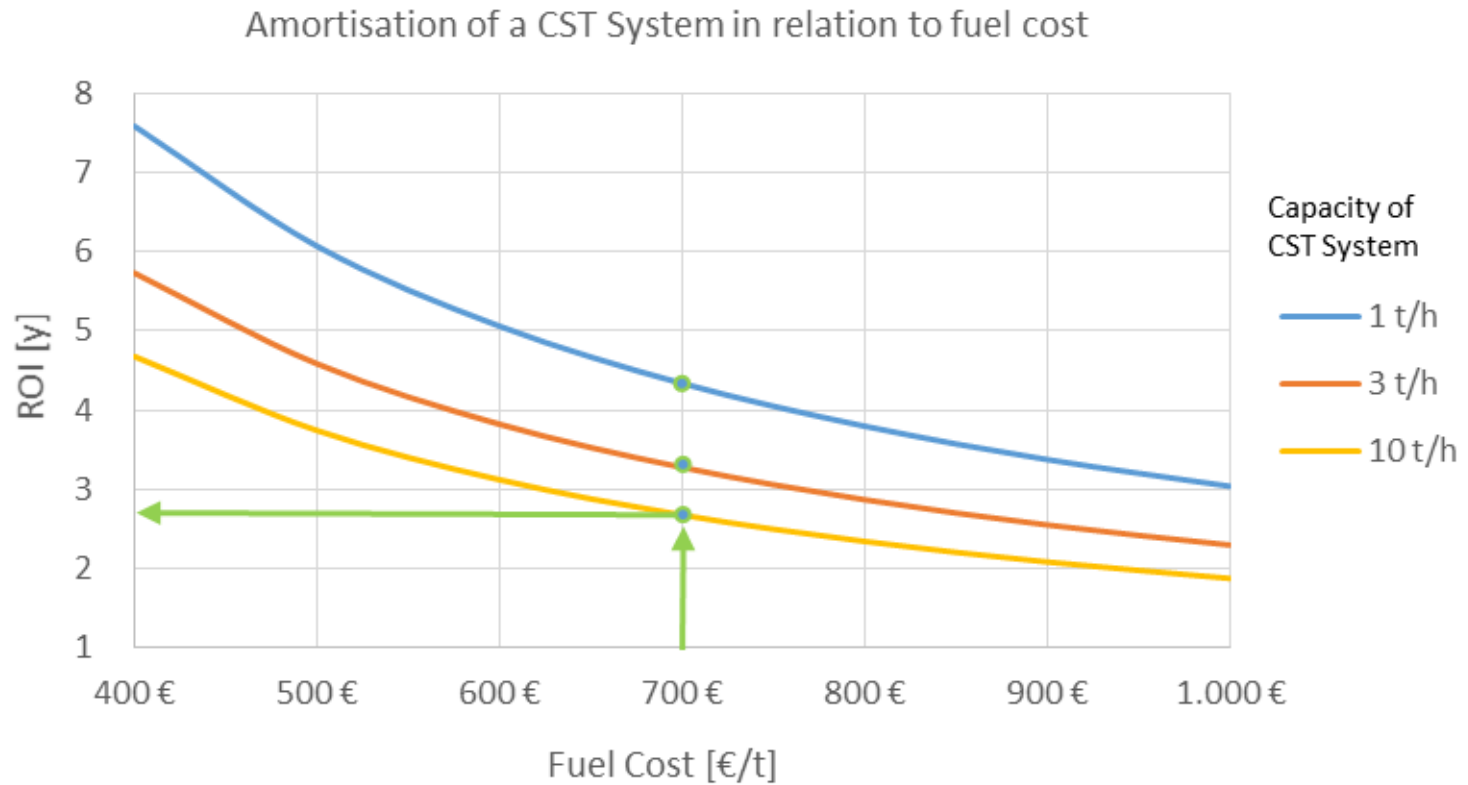
### Economic results:

- **Fuel saving: 550.000 EUR p.a.**
- **CO<sub>2</sub> reduction: 3.200 tons p.a.**
- **Amortisation: 3-4 years**

Amortisation of the Solar Boiler System







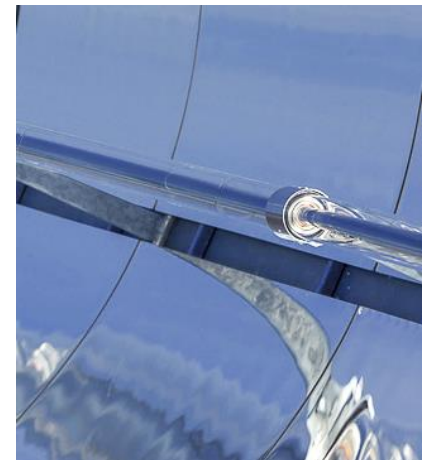
\* Cost of financing are not considered in the amortisation graph above

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## Summary

- Where steam is produced in conventional boilers, using diesel or fuel oil at for example 700 EUR/ton, this results in steam costs of 50 EUR/ton
- With Protarget's CST technology, steam is generated at 10 EUR/ton of steam, which is 80% cheaper compared to conventional fuels
- Protarget is also offering an energy contracting model (PPA), to reduce the financial burden for the customer to a minimum
- Our solar boiler systems are designed to last 20 years and more, protecting companies from the inevitable price increase of fossil fuels and other externalities such as carbon tax

**Where sunshine and land is available and fuel has a value, CST is the best technology for thermal energy generation**



# Contact:

**protarget AG**  
zeissstrasse 5  
50859 köln - Germany  
[www.protarget-ag.com](http://www.protarget-ag.com)



**technical director:**  
john mitchell  
[mitchell@protarget-ag.com](mailto:mitchell@protarget-ag.com)

**commercial director:**  
martin scheuerer  
[scheuerer@protarget-ag.com](mailto:scheuerer@protarget-ag.com)

