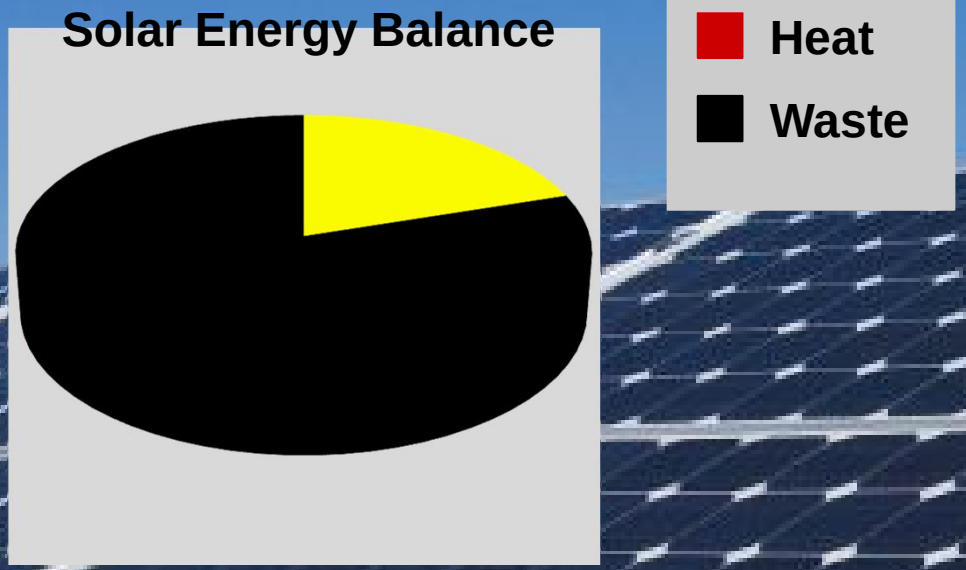
SunOyster Systems GmbH, Hamburg

The SunOyster – Solar CHP, in particular Solar Cooling

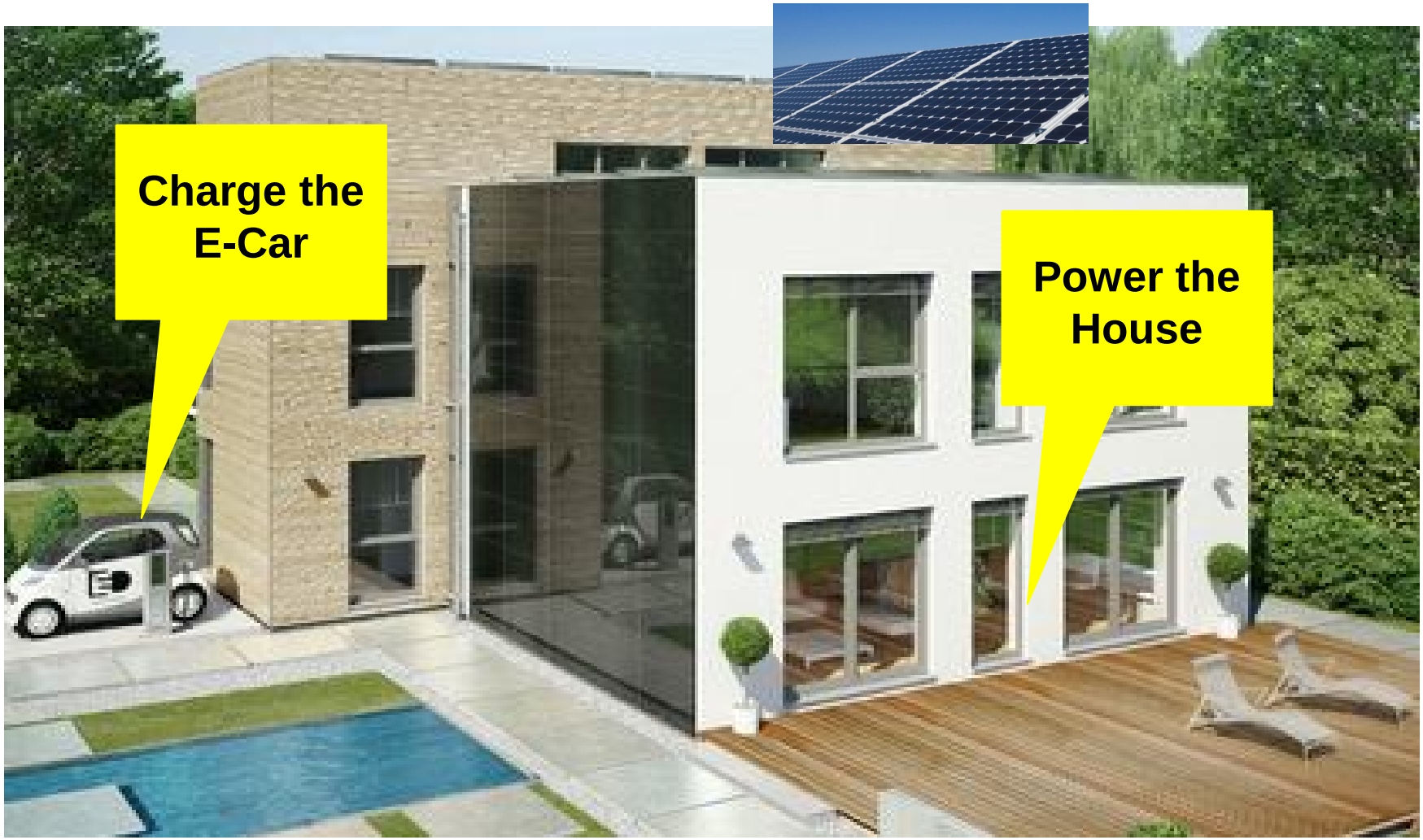
Carsten Corino, Ph.D., 5 April 2016

I. General Introduction

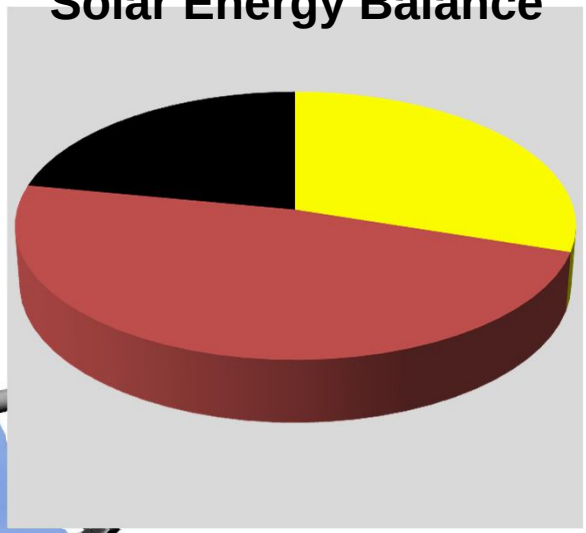
The problem: Photovoltaics wastes approx. 80% of the solar radiation



Generated PV electricity covers normally only a part of the total energy demand



The solution: Double the Power!
SunOyster converts almost 80% of the solar radiation into heat + power



The SunOyster covers the complete energy demand of power, heat and cold

SunOyster combines the best of solar thermal power plants (CSP), CPV and PV

CSP

Cheap mirrors
Glass tubes for receiver

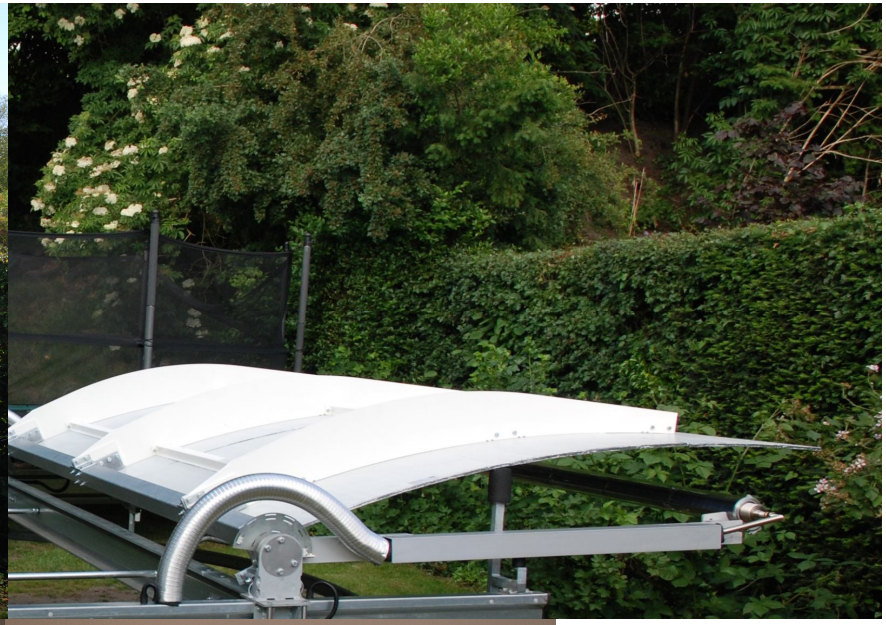
CPV

Bi-axial tracking
Concentrator cells

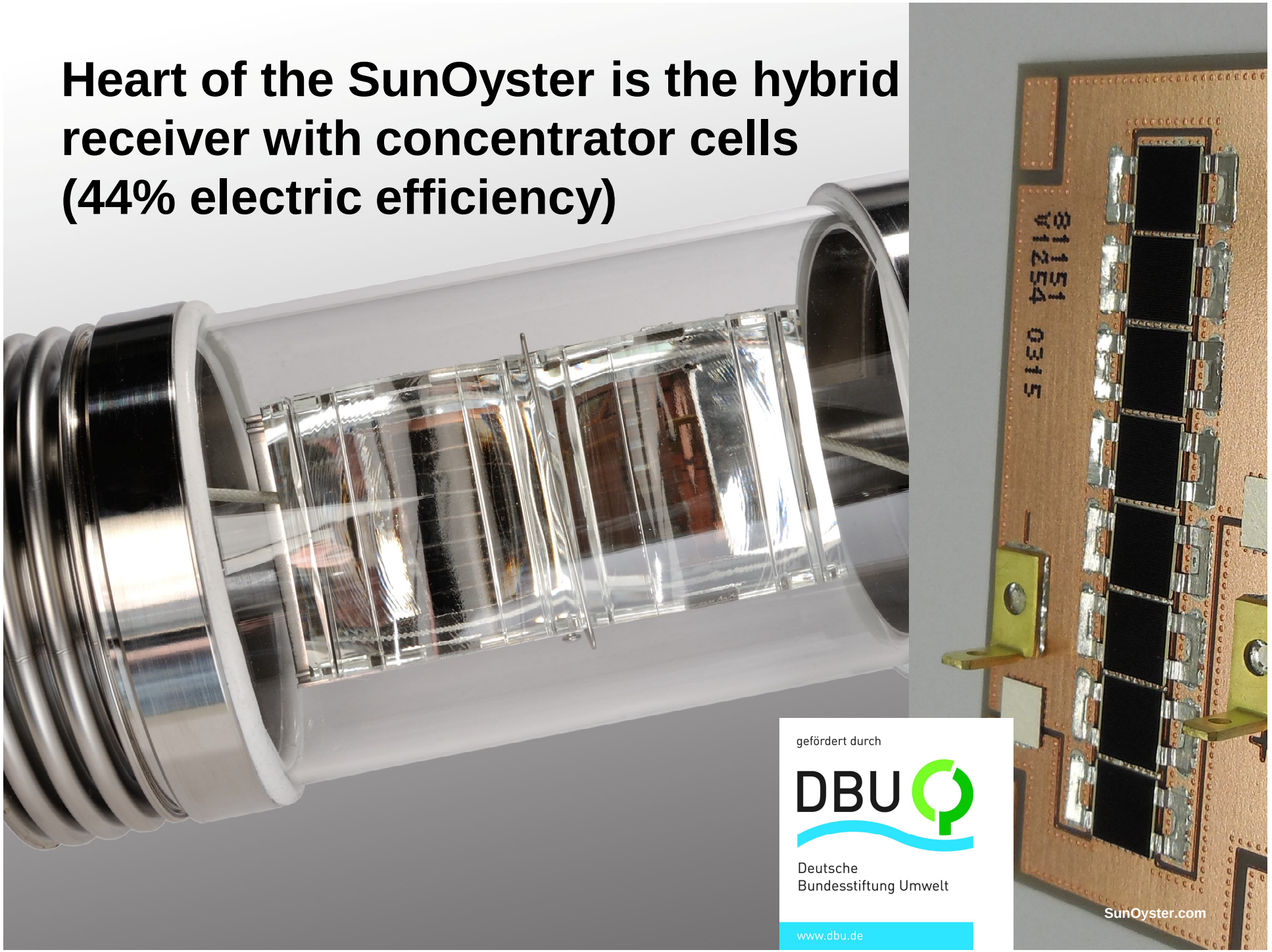
PV

Modular
Roof Installation
Cost-efficient

SunOyster closes in case of storm into the flat and safe „Oystering“ position



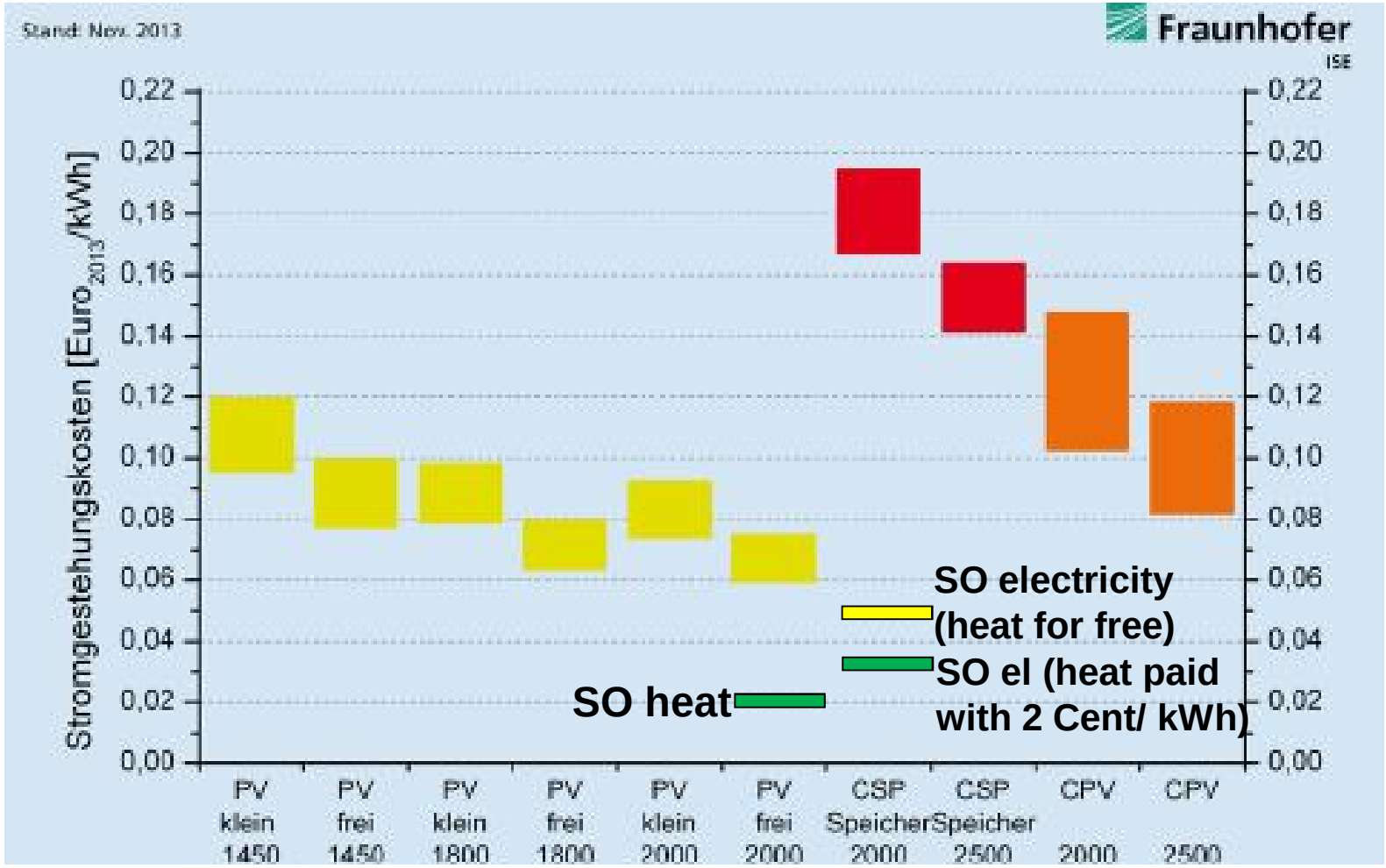
Heart of the SunOyster is the hybrid receiver with concentrator cells (44% electric efficiency)



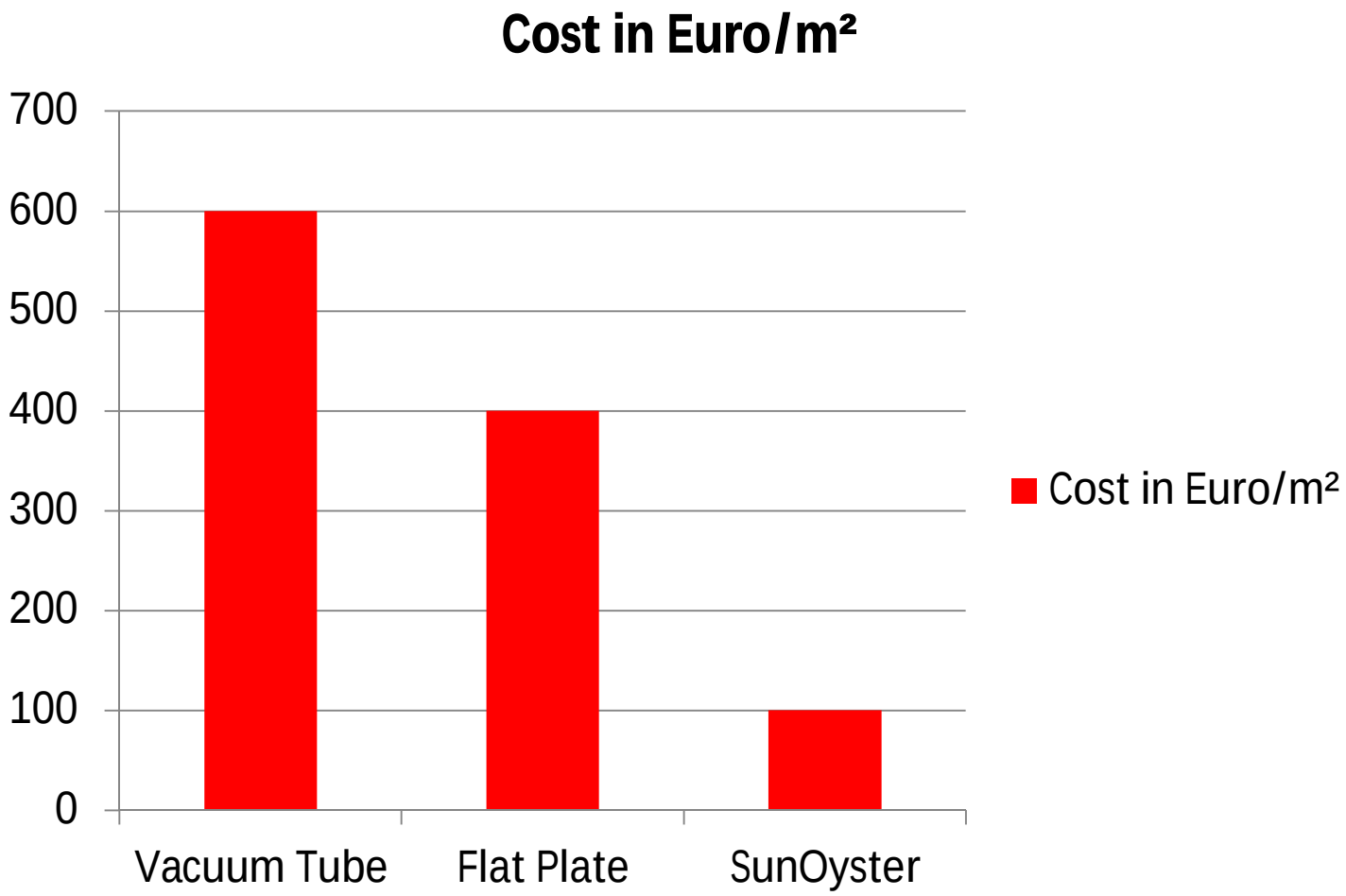
gefördert durch
DBU
Deutsche
Bundesstiftung Umwelt
www.dbu.de


16 m² of mirrors generate up to
5 kW electric and 7.5 kW thermal power,
at up to 170°C
Warnung vor optischer Strahlung
Warning for optical radiation
SunOyster.com

Electricity (and Heat) costs in Sunny Countries according to ISE, of SunOyster (SOS)



Investment for solar heat collectors (First figures acc. to solar cooling handbook ch. 7)



Manifold Heat Applications

Warm Water

50°C – 70°C

Room Heating

25°C – 90°C

Desalination

25°C – 120°C

Process Heat

60°C – 170°C

up to 170°C Heat

Cooling

55°C – 170°C

ORC Machine

90°C – 170°C

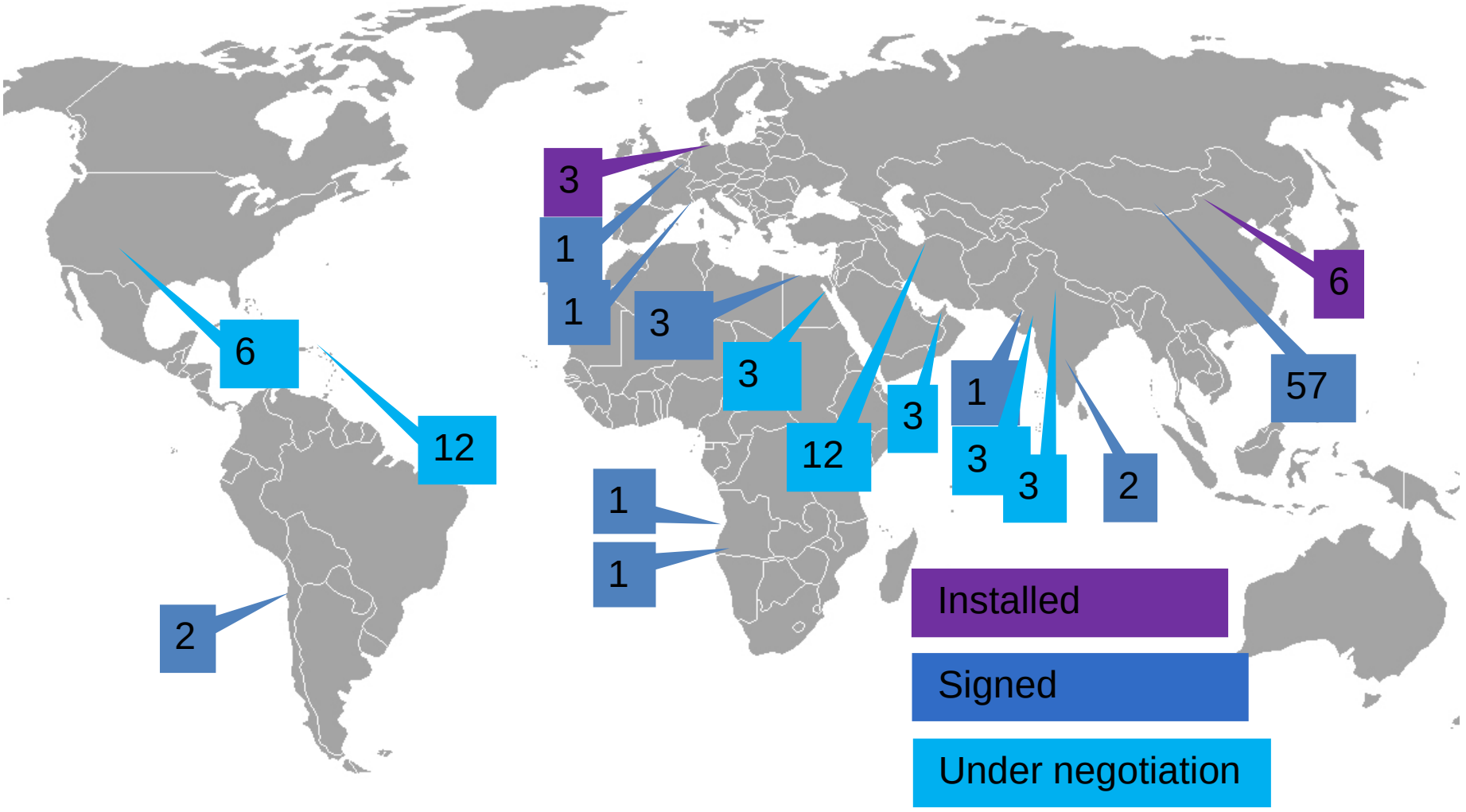
(Storage)

-30°C – 170°C

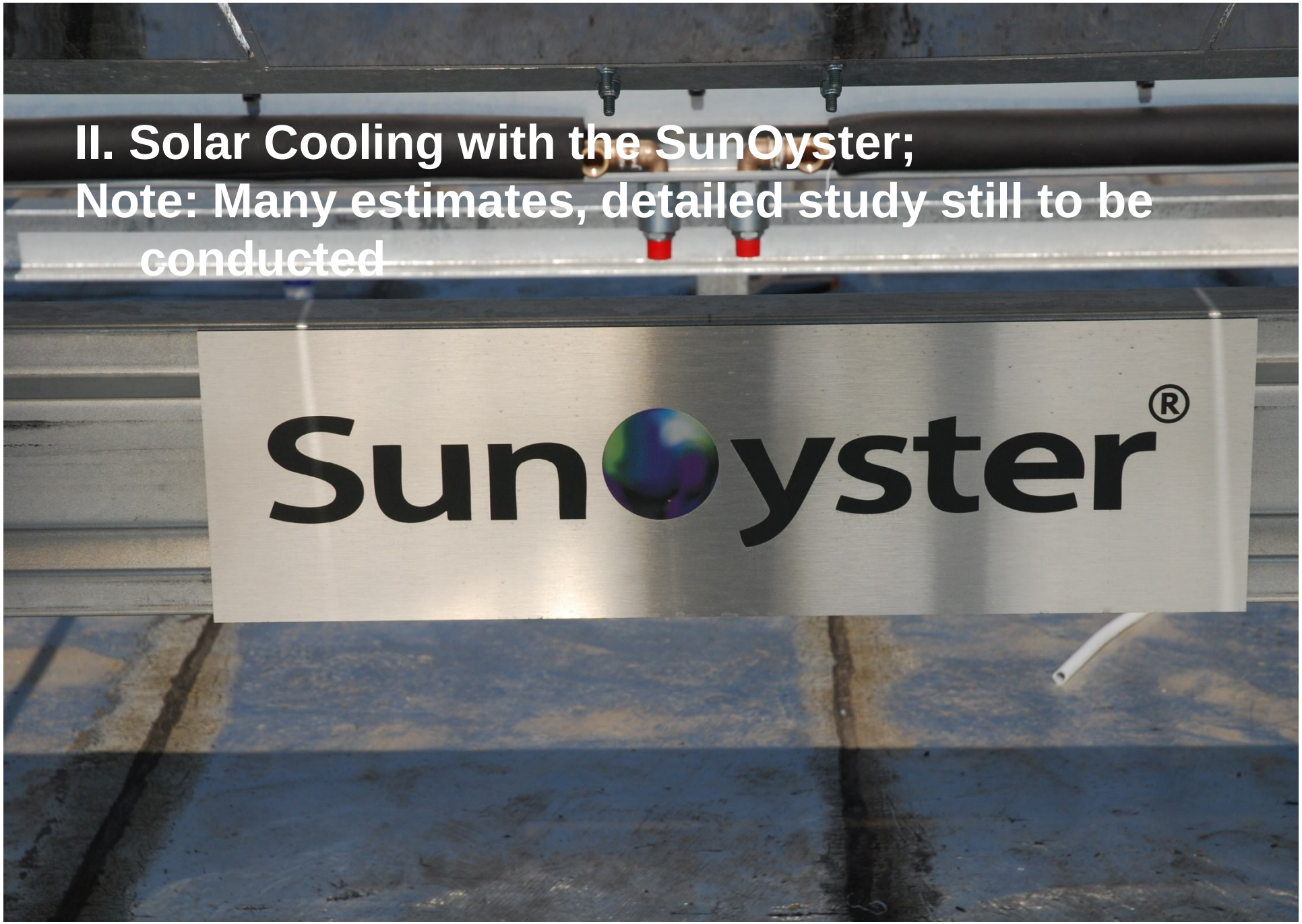
Pre-heating Steam Plants

100°C – 170°C

Projects of zero und pre-series SunOysters
Buyers e.g. GdF Suez, Tata Power, Chinacoal



SunOyster.com


II. Solar Cooling with the SunOyster;
Note: Many estimates, detailed study still to be conducted
SunOyster®

SOcool – Application for a future feasibility study under the EU SME Instrument

SunOyster Package	P1 Small size decentral electric, e.g. single family house	P2a Small size thermal, e.g. villa	P2b Small to medium thermal, e.g. villa or multi-family house	P3 Medium Size, e.g. hotel, office, apart-ment house
Target Building				
Number of SunOysters				
Chiller solution	Electric decentral	Thermal below 7.5 kW heat input, e.g. Purix	Thermal above 7.5 kW heat input, eg Sortech	Thermal above 75 kW heat input, eg Thermax
Thermal chiller solution				
Global Market	99 million units ~ 70 billion USD	1.3 million 3.7 billion USD		400.000 units 8.5 billion USD

Package 1 – Small Scale Electric Chiller

Equipment	e.g. 6x Daikin Emura FTXG 20L plus RXG20L	Specific cost in € per kW of cooling
Cooling Power	6x2.8=16.8 kW	
Power Input	6x0,8=4,8kW(1SO)	
EER	3.7	
Price of chiller with heat rejection	6x900=5,400 €	320
Av. cost tr+inst+comm	6x300=3,000?	180
Cold Distribution w inst	6x600+1,800?=5,400	320
SunOyster cost w cables+ inst. (electric)	4330	258
Total cost	18130	1080

Package 2a – Small Scale Thermal Chiller

Equipment	e.g. 2x Purix A25	Spec. Cost in € per kW cooling
Cooling Power	2x2.5=5 kW	
Heat Input	2x3=6 kW (3SO)	
EER	0.8 (1:4.5 to electric chiller)	
Price of chiller with heat rejection	2x2,400=4,800 €	960
Av. cost transport + inst. + commissioning	1,000?	200
Cold Distribution w inst	6x200+1,000?=2,200	440
SunOyster cost w pipes+ inst. (thermal)	2,300	460
Total cost	10,300	2,060

Based on the previous technologies, one SunOyster can cool 870 m² of surface

7.5 kW
heat

5 kW
power

2x Purix A25
chiller with 2x2.5
kW cooling

6x Dakin Emura
20 with 6x2,8 kW
cooling

~ 200 m²
cooled surface

~ 670 m²
cooled surface

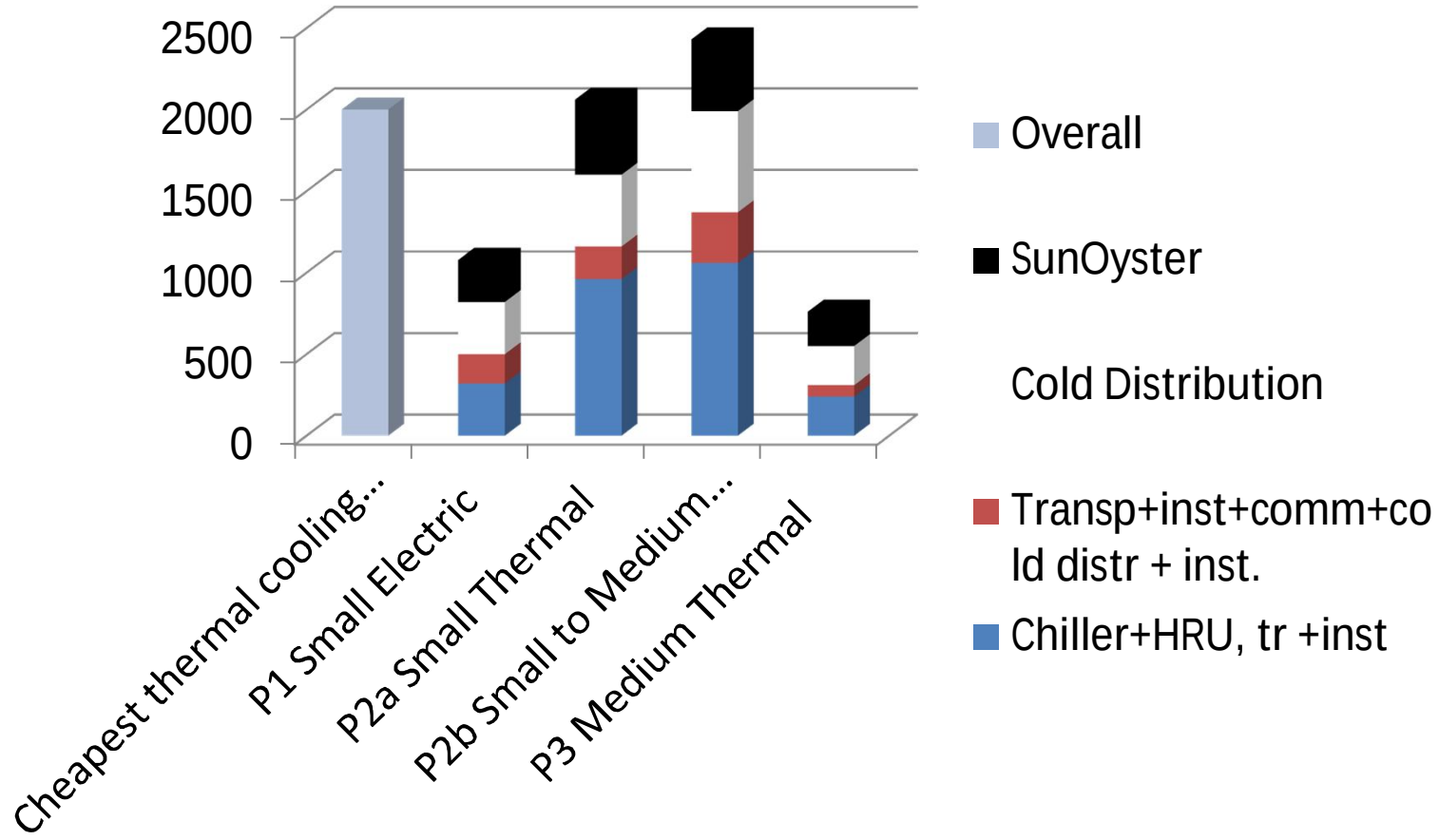
Package 2b – Small to medium scale thermal chiller

Equipment	e.g. Sortech Ecoo 2.0	Spec. Cost in € per kW
Cooling Power	16 kW	
Heat Input	25 kW (3 SO)	
EER	0.65 (1:6 to electric chiller)	
Price of chiller with heat rejection	17,000 €	1,060
Av. cost transport + inst. + commissioning	5,000	310
Cold Distribution w inst	10,000?	620
SunOyster cost w pipes+ inst. (thermal)	7,000	440
Total cost	39,000	2,450

Package 3 – Medium scale thermal chiller

Equipment	e.g. Thermax HD 10B 60 TR	
Cooling Power	210 kW	
Heat Input	160 kW (22 SO)	
EER	1.3 (1:3 with electric chiller)	
Price of chiller with heat rejection	50,000 €	240
Av. cost transport + inst. + commissioning	15,000?	70
Cold Distribution w inst	50,000?	240
SunOyster cost w pipes + inst. (thermal share)	45,000	210
Total cost	160,000	760

Comparison of Cost (Estimates)



Preliminary Conclusions

- The **SunOyster** can from serial production provide cheap electricity and heat of up to 170°.

- The combination of SunOysters with **medium scale double effects absorption chillers** (e.g 200 kW) can lead to total specific costs below 1000 €/kW of cooling and can be attractive. Relation of its thermal EER to electric EER is roughly 1 to 3.

- The combination of SunOysters with a small **Purix A25 chiller** (5 kW) can with total specific costs in the range of 2,000 €/kW still be affordable, in particular with a low total investment of 10,000 Euro for a six-room villa cooling. EER relation is roughly 1:4.

- In comparison, a small to thermal chiller like the **Sortech Ecoo 2.0** is despite the larger size with 2,500 €/kW less attractive, and the total cost of almost 40,000 Euro is already quite a big block. EER relation is roughly 1:6 and the weakest.

- Competitor is **electric cooling** with total specific costs of approx. 1,000 €/kW. However, with heat costs of only 2 Eurocents the medium scale chiller can be competitive from electricity costs of ~5 Cents, the Purix chiller from ~10 Cents.

We are looking forward to many interesting solar cooling projects!

cc@sunoyster.com
+49 4101 808767