

Netzwerk für Zukunftstechnologien



Digitaler Treffpunkt Erneuerbare Energien Hamburg

Trigeneration mit der SunOyster – Strom, Wärme und Kälte von der Sonne

Hamburg | 7. Juli 2020

Agenda

14:00 Uhr: Begrüßung

Astrid Dose | EEHH

14:05 Uhr: Präsentation

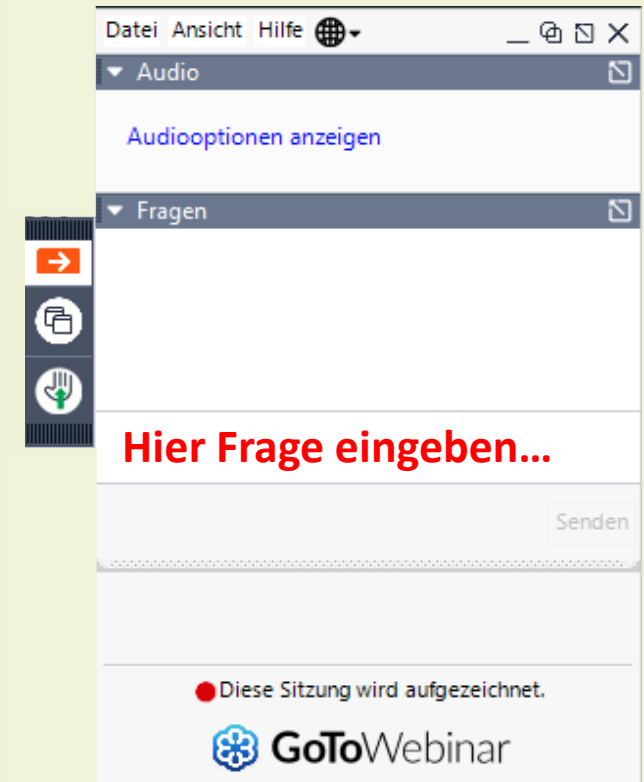
Dr. Carsten Corino | SunOyster Systems GmbH


14:30 Uhr: Publikumsfragen


14:45 Uhr: Ende

Cluster Erneuerbare Energien Hamburg


Netzwerk für Zukunftstechnologien






Datei Ansicht Hilfe 

▼ Audio 


Audiooptionen anzeigen


▼ Fragen 

Hier Frage eingeben...

Senden

 Diese Sitzung wird aufgezeichnet.

 GoToWebinar

Über uns

- **Gegründet 2010 auf Initiative der Hamburger Erneuerbare Energien Industrie und der Freien und Hansestadt Hamburg**
- **Netzwerkorganisation und Bindeglied zwischen Akteuren aus Wirtschaft, Forschung, Politik und Gesellschaft**
- **Aktuelle Angebote**
 - Web-Seminare zu aktuellen Themen
 - Arbeit in Foren zu Wärme, Finanzierung & Recht, Medien, Solar, etc.
 - Vermarktung von Themen der Mitglieder
- **Fokusthemen**
 - Offshore- und Onshore-Windenergie
 - Wärme
 - Sektorenkopplung
 - Speicherung

Möchten auch Sie Teil des Mitgliedernetzwerks des EEHH-Clusters werden? Weitere Informationen finden Sie [hier!](#)



10 JAHRE
RENEWABLE
ENERGY
HAMBURG
ENERGIESYSTEME
DER ZUKUNFT

Unsere weiteren Web-Seminare...



15. Juli 2020 14:00 Uhr

**Digitales Ideen- und Innovationsmanagement
bei Corona-Restart**

mit **Till Schomborg** | Lufthansa Industry Solutions

[Hier anmelden!](#)



22. Juli 2020 14:00 Uhr

**Digitalisierung in der Energiewirtschaft - der
Verbraucher im Mittelpunkt**

mit **Thorsten Meyer** | Stadtwerke Norderstedt

Hier anmelden!



Vielen Dank für Ihre Aufmerksamkeit!

Kontakt: info@eehh.de | www.eehh.de

SunOyster Systems GmbH, Halstenbek

Trigeneration mit der SunOyster: Strom, Wärme und Kälte von der Sonne

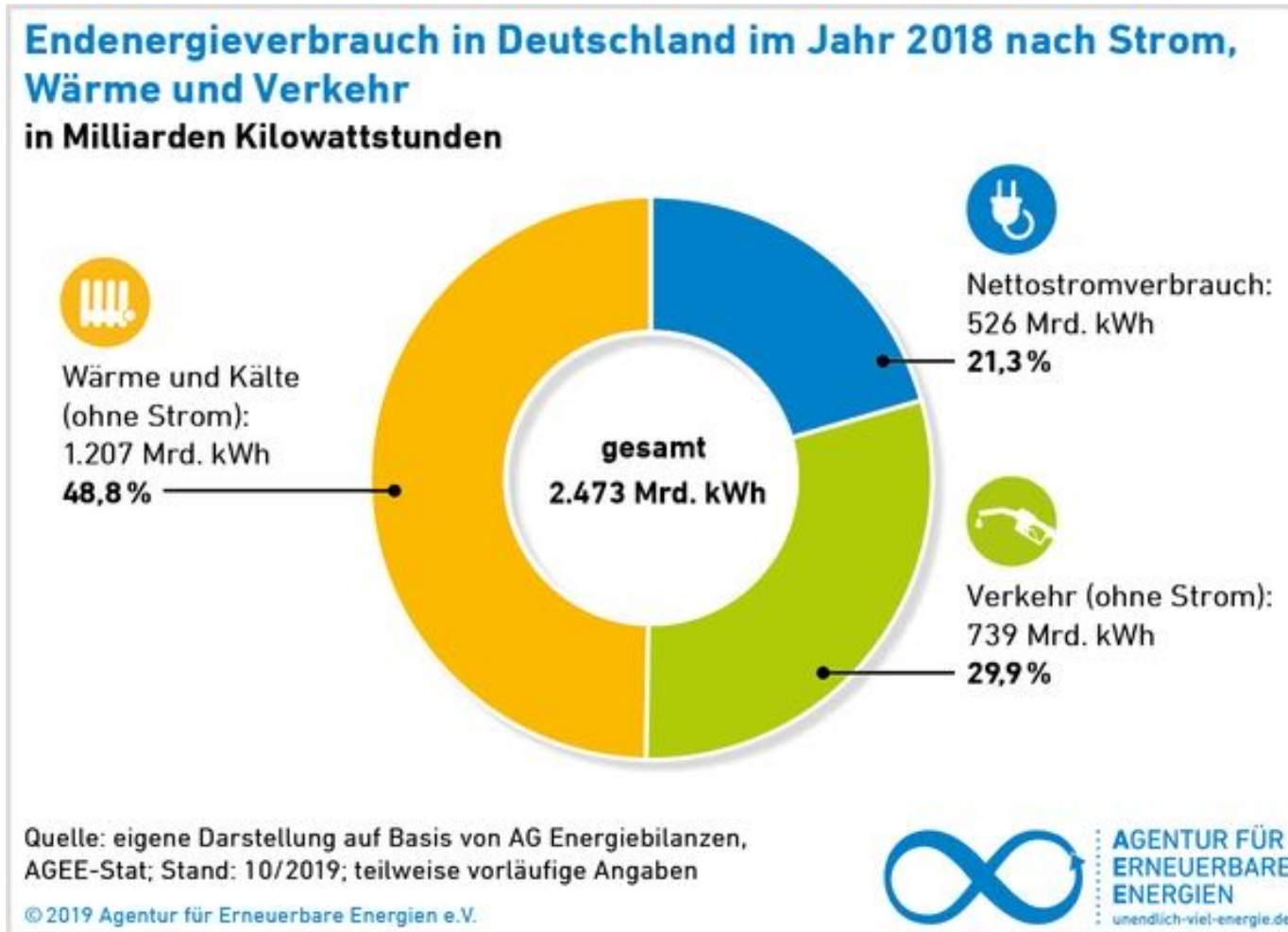
Dr. Carsten Corino, 7. Juli 2020



I. Ausgangslage



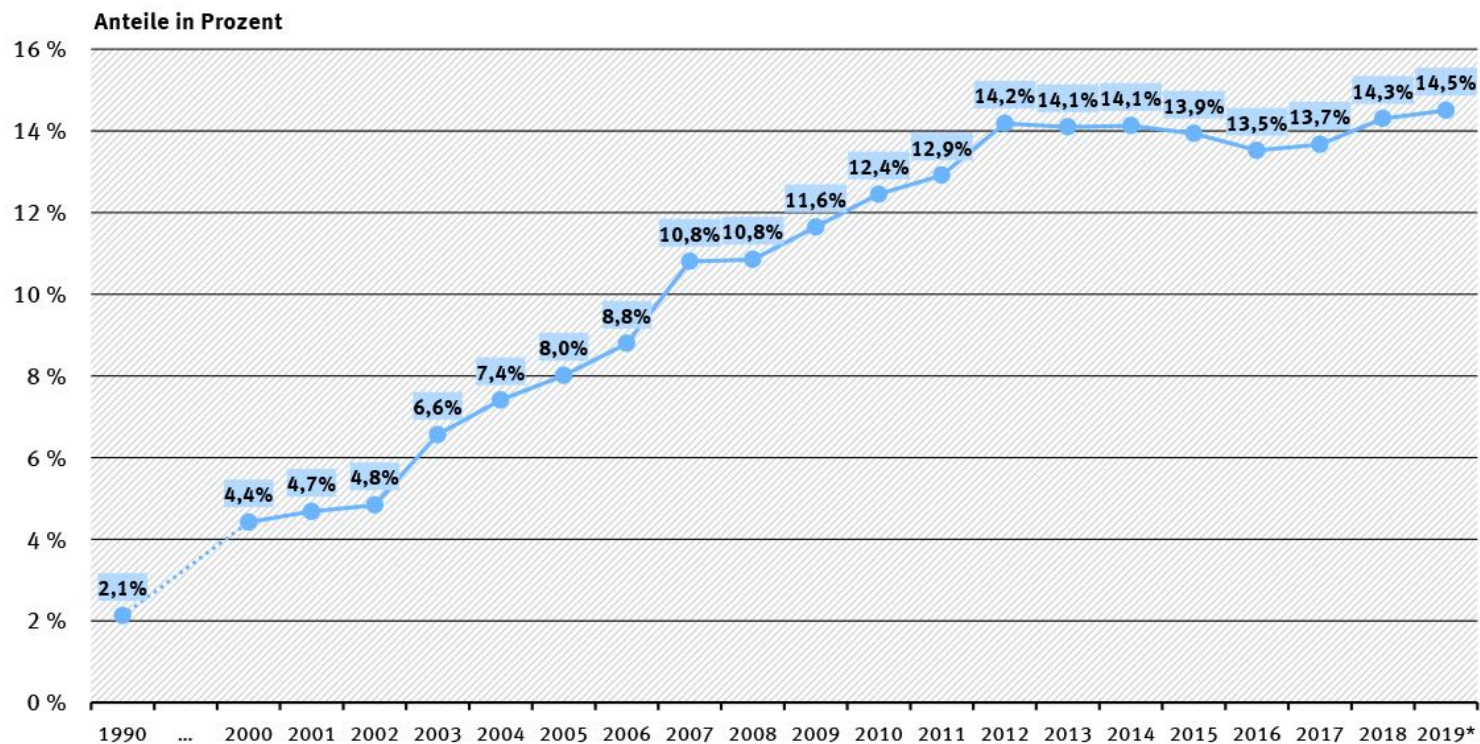
Endenergieverbrauch in Deutschland – Strom 21 %, Wärme 42 %, Kälte 7 %*



*Laut VDMA-Studie 2009

Anteil erneuerbarer an der Wärme- und Kälteversorgung stagniert unter 15 %

Anteil erneuerbarer Energien am Endenergieverbrauch für Wärme und Kälte



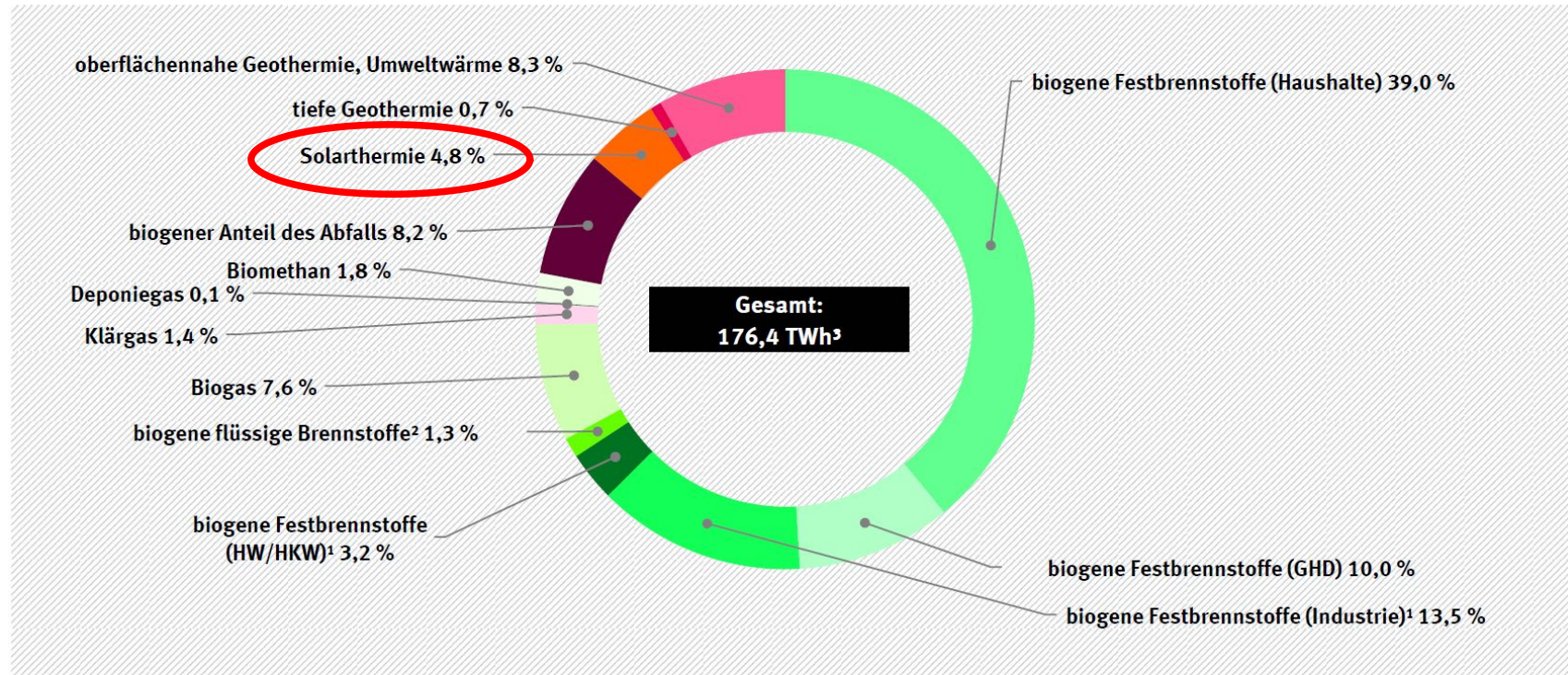
* vorläufige Angaben

Quelle: Umweltbundesamt (UBA) auf Basis AGEE-Stat, Stand 02/2020

Solarthermie hat noch großes Wachstumspotenzial

Wärmeverbrauch aus erneuerbaren Energien im Jahr 2019*

Anteile in Prozent



¹ inkl. Klärschlamm

Quelle: Umweltbundesamt (UBA) auf Basis AGEE-Stat, Stand 02/2020

II. Die SunOyster



Firmensitz Halstenbek, auf dem Dach der Scheune Vorbereitung für zwei SO 8, im EG Büros fürs Team



SunOyster Team



Dr. Carsten Corino
Founder & GM



Dipl.-Des. Amelie Krahl
Marketing, PR



Dr.-Ing. Johannes Kneer
Head Thermal



Stephan Ulrich
Workshop



Dipl.-Ing. Martin Düsing
CAD Expert



Dipl.-Ing. Roy Ehlers
Head Electrical



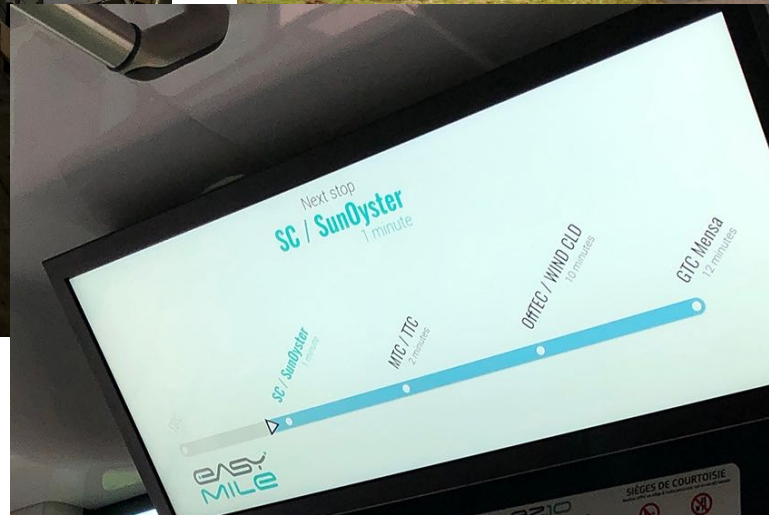
BA Lara Winkler
Team Assistant



Hauke Petersen
Installer

**+ freie
Mitarbeiter**

Produktionsstandort in Nordfriesland auf dem GreenTEC Campus, Enge-Sande

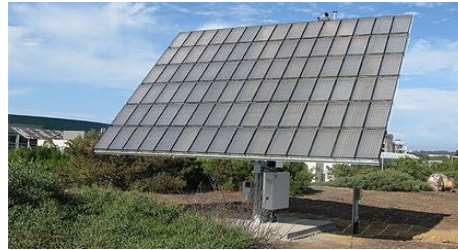


Die SunOyster kombiniert das beste von solarthermischen Kraftwerken (CSP), CPV und PV



CSP

Preiswerte
Parabolspiegel
Glashüllrohre
für Receiver



CPV

Zweiachsige
Nachführung
Konzentrator/ PV

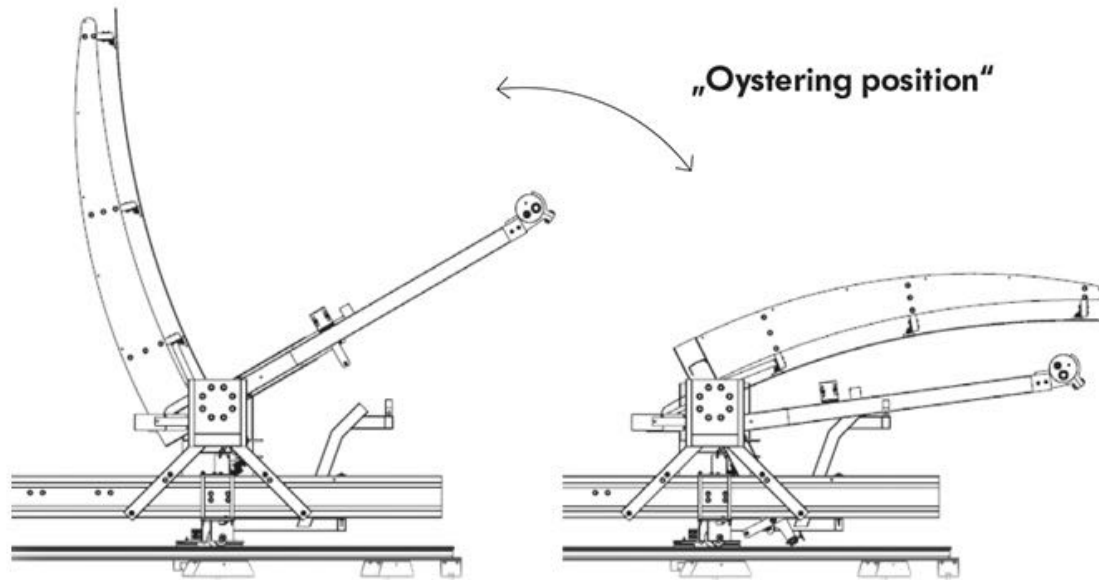


PV

Modular
Dachinstallation
Kosteneffizienz

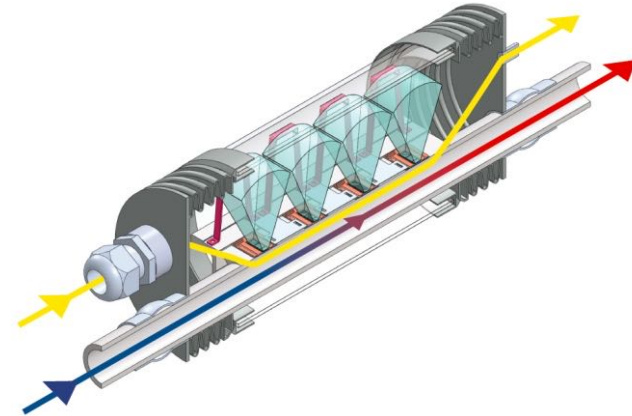
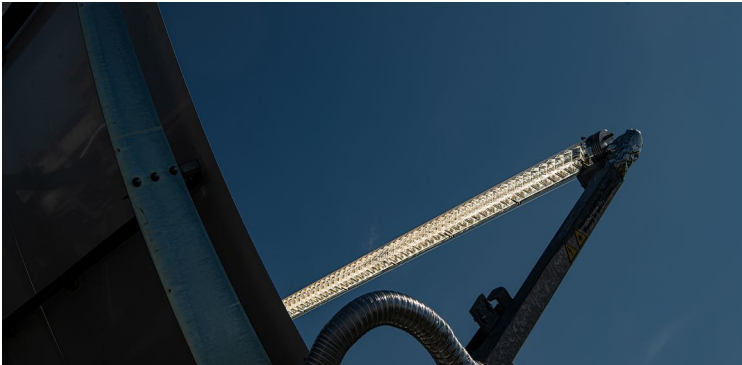


Die SunOyster schließt bei Sturm in die sichere „Oystering“-Position (->Dachinstallation OK!)



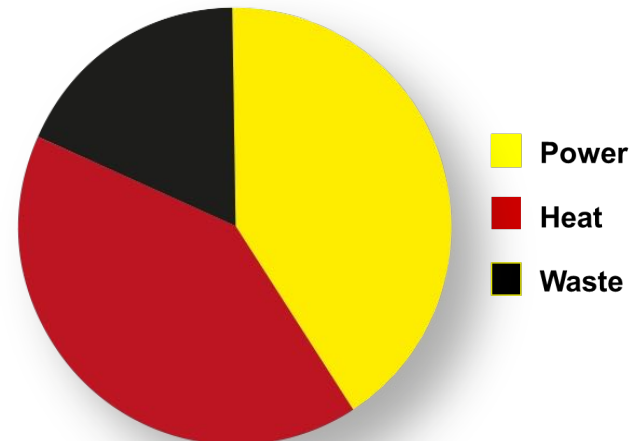
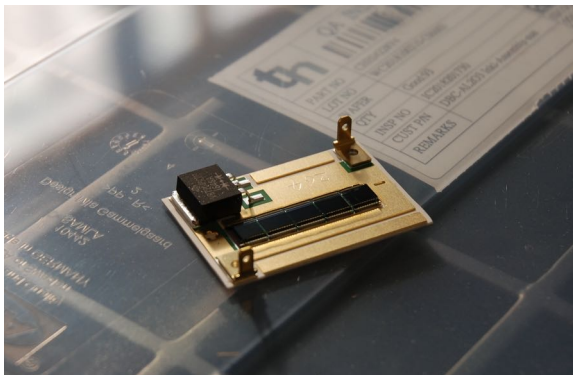
Hybrider Receiver (patentiert) für Strom und Wärme

Alurohr mit Glaslinsen und Konzentrator-Fotovoltaik.



Aus Serie 4,5 kW elektrische und
7,5 kW Wärmeleistung.

44 % el Wirkungsgrad



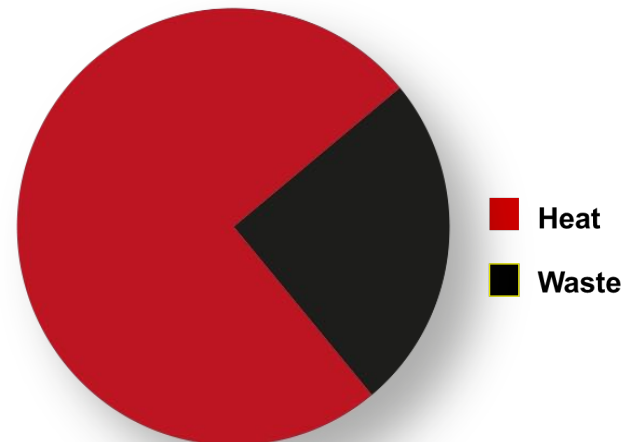
Solar Energy Balance

Thermischer Receiver für mehr Wärme

Stahlrohr mit selektivem Absorber.



12 kW Wärmeleistung aus SunOyster *heat*



Solar Energy Balance

Beim thermischen wie hybriden Receiver gilt:
 $16 \text{ m}^2 \text{ Spiegelfläche} = 16 \text{ PS}$

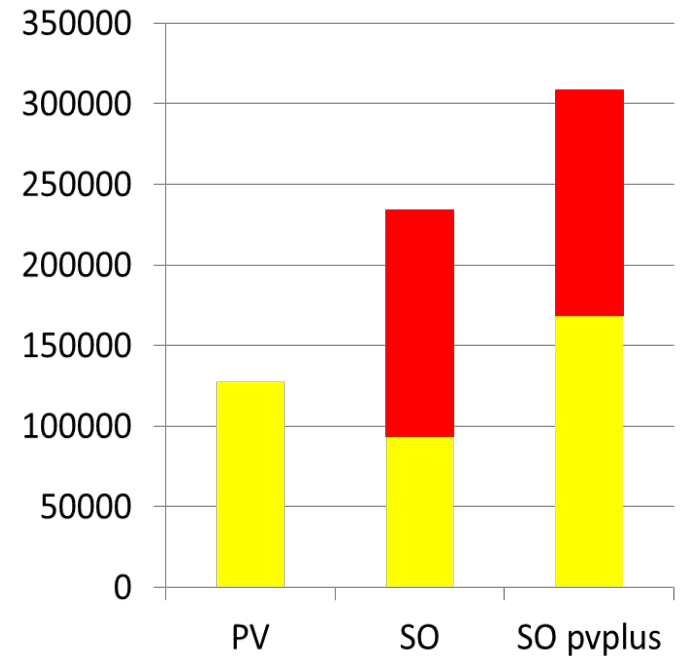


1

SunOyster *pvplus* mit 12 PV-Modulen erzeugt gegenüber normaler PV mindestens die doppelte Energie

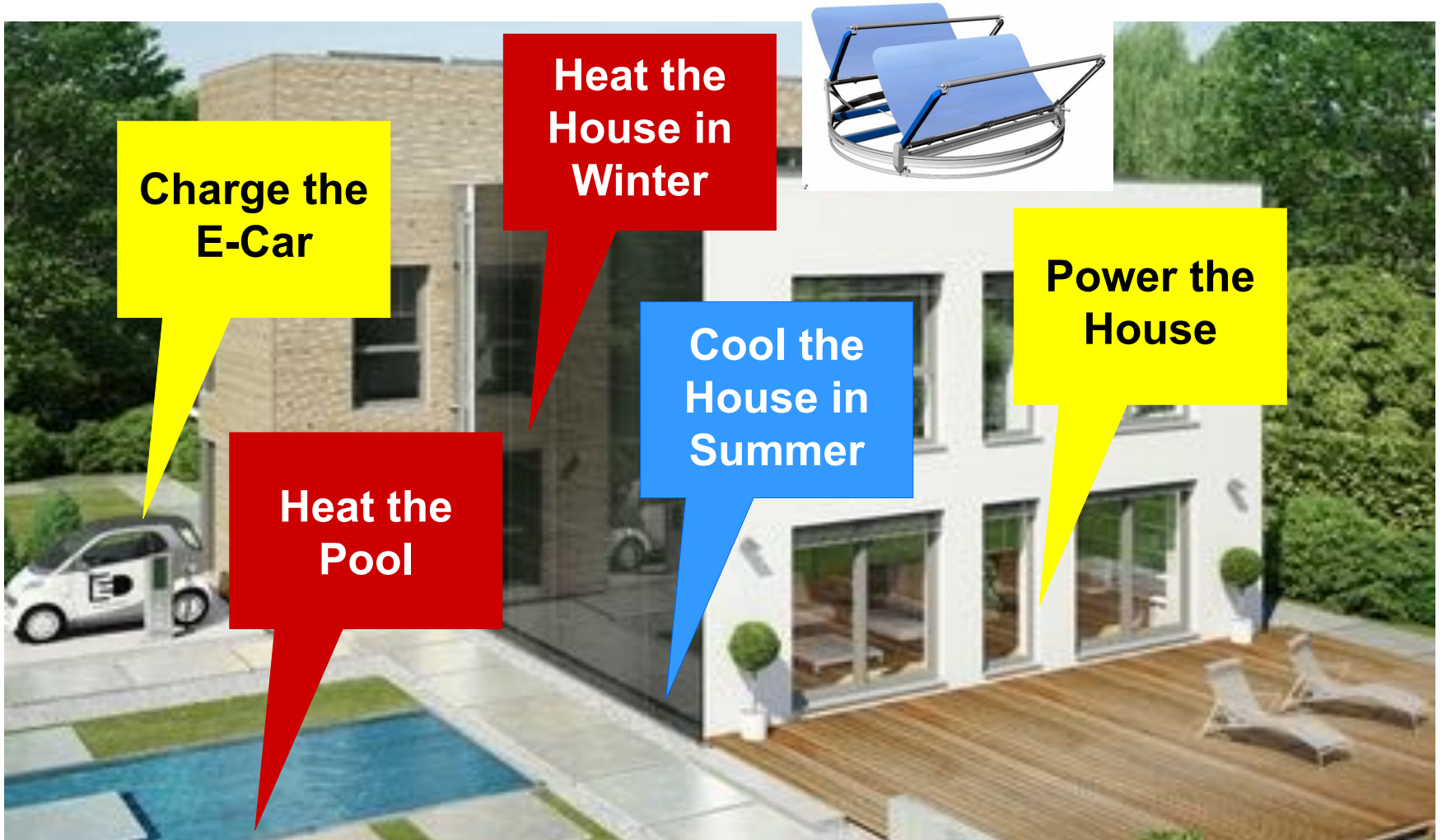


Rechenbeispiel Dach von 40 m x 20 m in Ahmedabad, Indien – ähnlich wie Südspanien



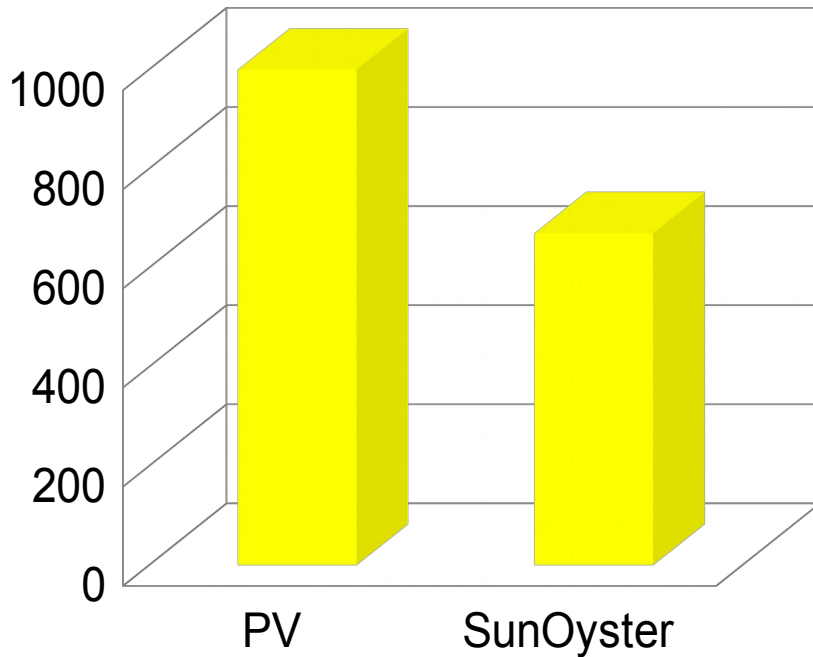
■ Heat Energy
■ Electric Energy

Die SunOyster kann den gesamten Gebäude-Energiebedarf an Strom, Wärme und Kälte decken

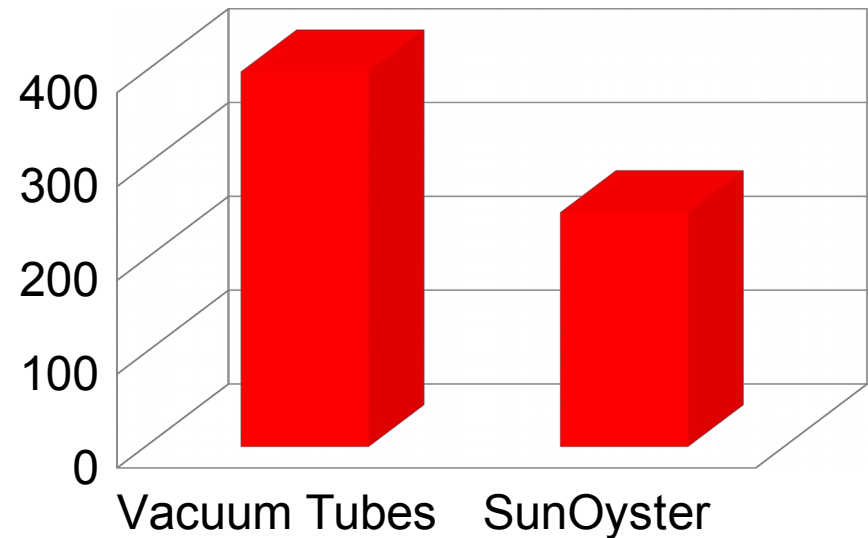


Günstige Energie, wenn auch Wärme oder Kälte gebraucht werden (Beispiel: SunOyster 16 *hybrid* in Deutschland für Serienpreis von 5.000 Euro)

Kosten der elektr. Leistung in € per kW für Anlagen bis 10 kW el



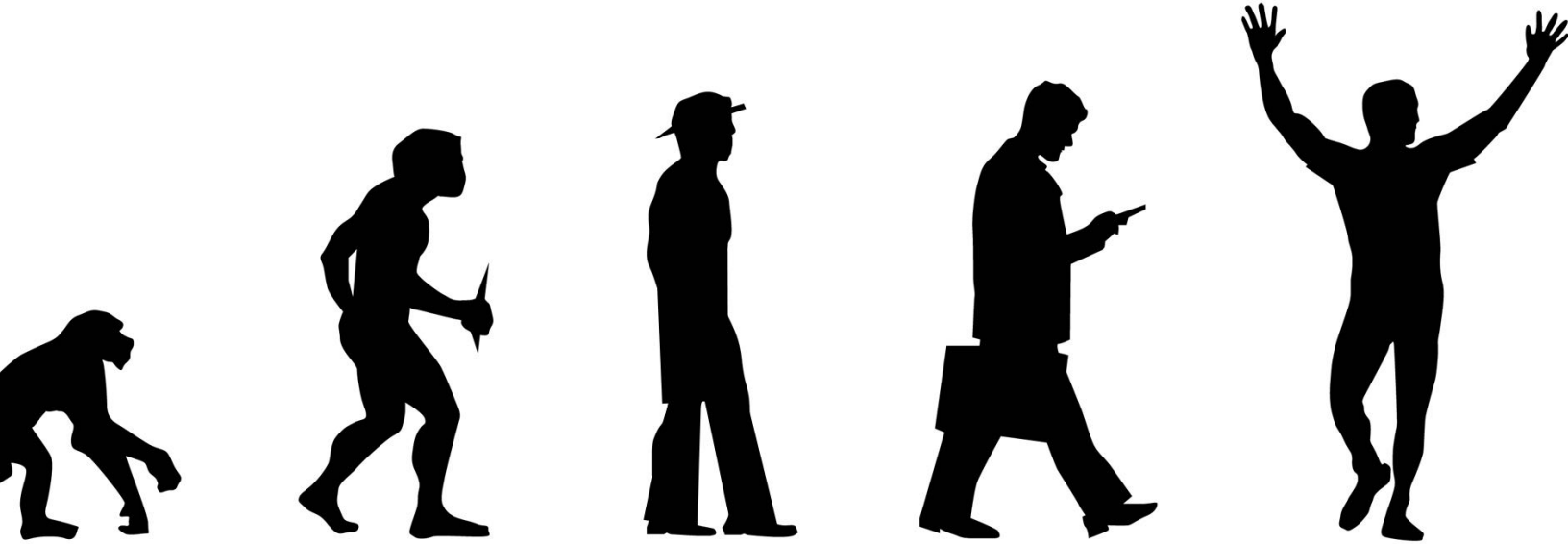
Kosten der therm. Leistung in € per kW th bei Anlagen bis 10 kW th



Online-Monitoring und App für smarte Gebäude



Evolution der Energieerzeugung



Neue SunOyster 8

Wir fördern Wirtschaft



Landesprogramm Wirtschaft: Gefördert durch die Europäische Union - Europäischer Fonds für regionale Entwicklung (EFRE), den Bund und das Land Schleswig-Holstein



Model Alu

Neue SunOyster 8

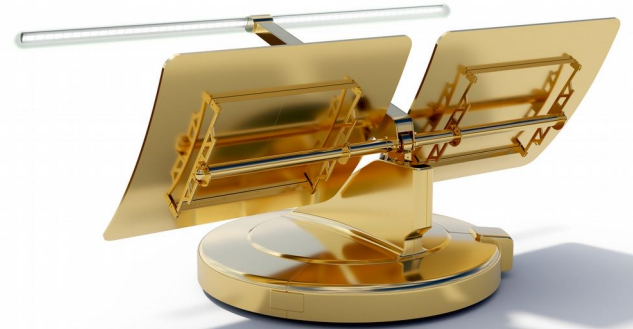
ist reservierbar!



Model Alu

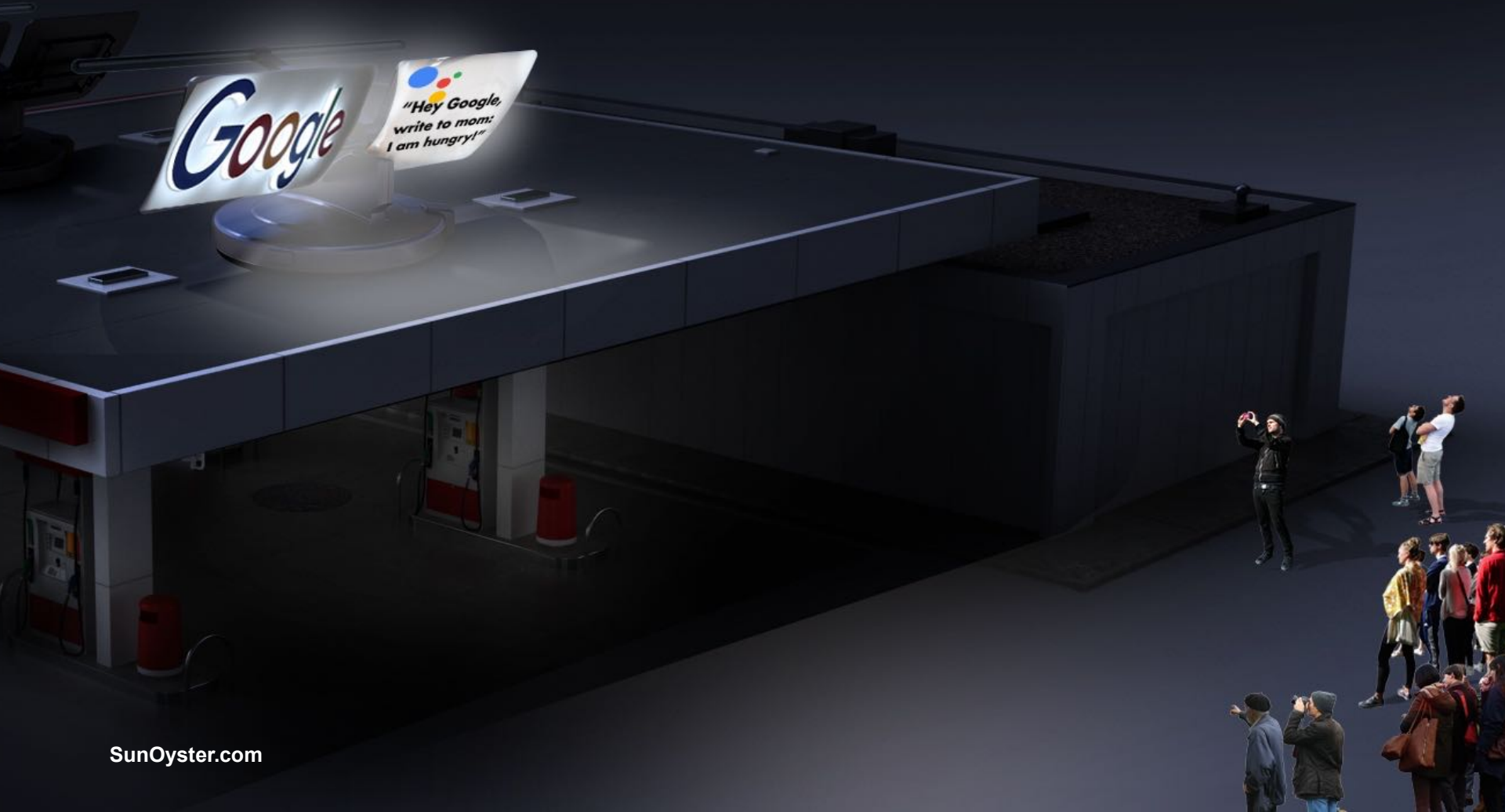
SunOyster 8

Model Gold (nicht nur für Dubai)



SunOyster screen.

**Die Rückseite der SunOyster kann als rundum
schwenkbare Projektionsfläche dienen**



III. Wärme



Vielfältige Wärmenutzungen



Warm Water

50°C – 70°C



Room Heating

25°C – 90°C



Desalination

25°C – 120°C



Process Heat

60°C – 170°C

85

0°C

110°C

170°C

up to 110°C SunOyster *hybrid*

up to 170°C SunOyster *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

In Zukunft Nahwärmenetze und Erdbeckenspeicher auch in Deutschland

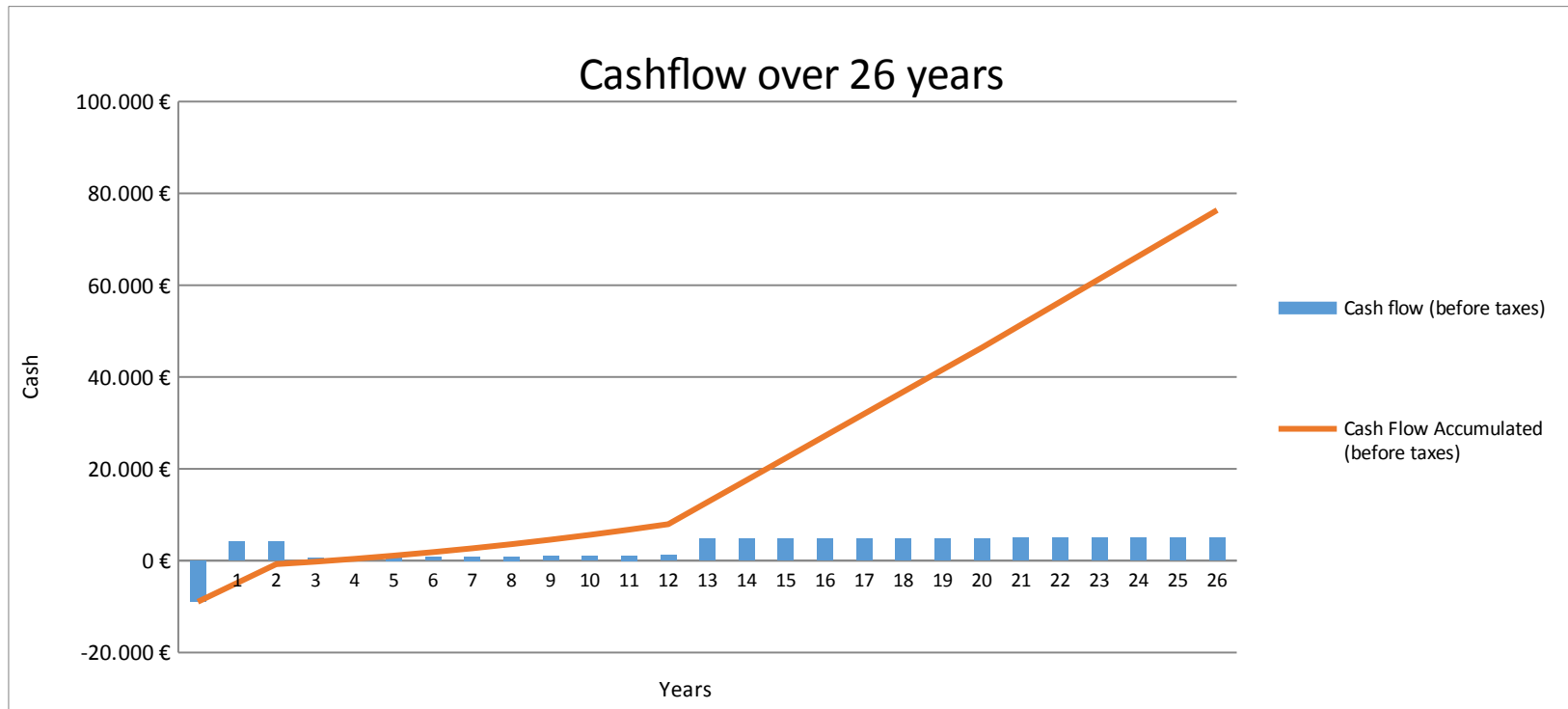


Förderung von Wärmeprojekten in Deutschland seit Anfang 2020

Bei Vorhandensein von Solar Keymark-Zeichen (geplant ab September):

- **30 bis 45 % Förderung auf Kosten von solarem Heizen;**
- <https://www.klima-sucht-schutz.de/foerdermittel/details/55575507/>
- **Bis zu 55 % der förderfähigen Investitionskosten von Prozesswärme-Anwendungen.**
- https://www.bafa.de/DE/Energie/Energieeffizienz/Energieeffizienz_und_Prozesswaerme/Modul2_Prozesswaerme/modul2_prozesswaerme_node.html

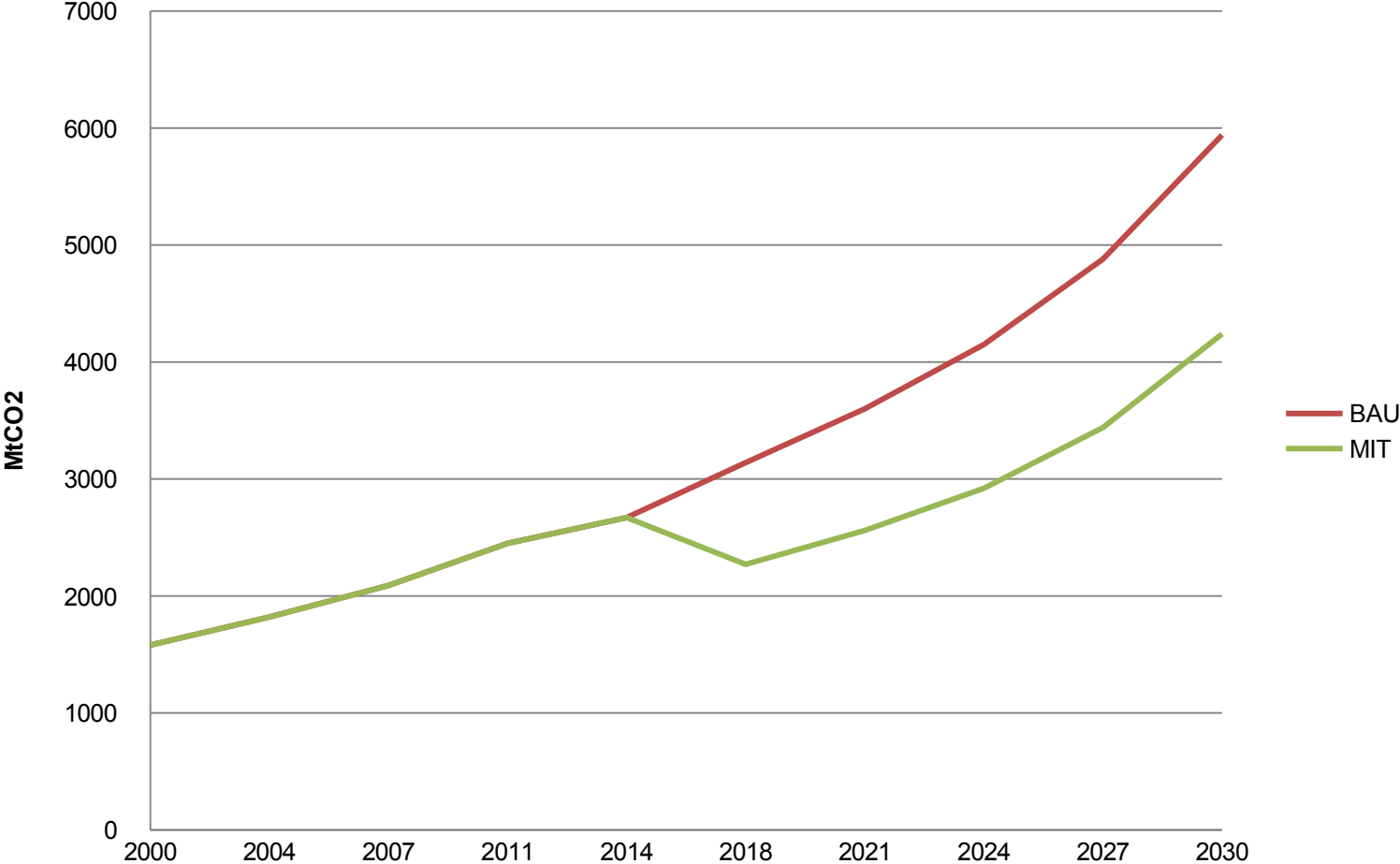
Vier SO 16 *heat* auf einem Apartmenthaus in Leipzig (1,5 Jahre Rückzahlzeit aufs EK, 25 % IRR)



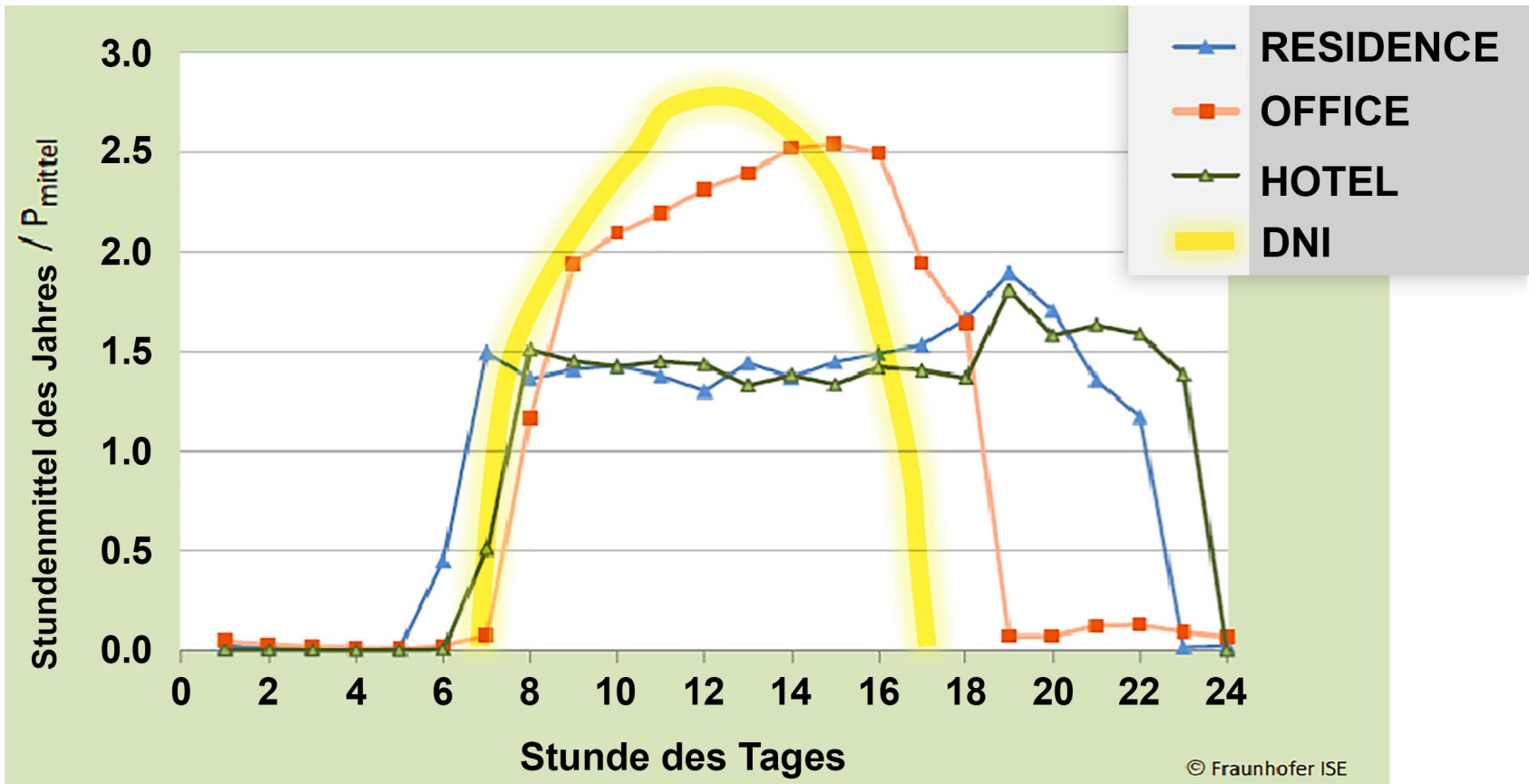
IV. Kälte



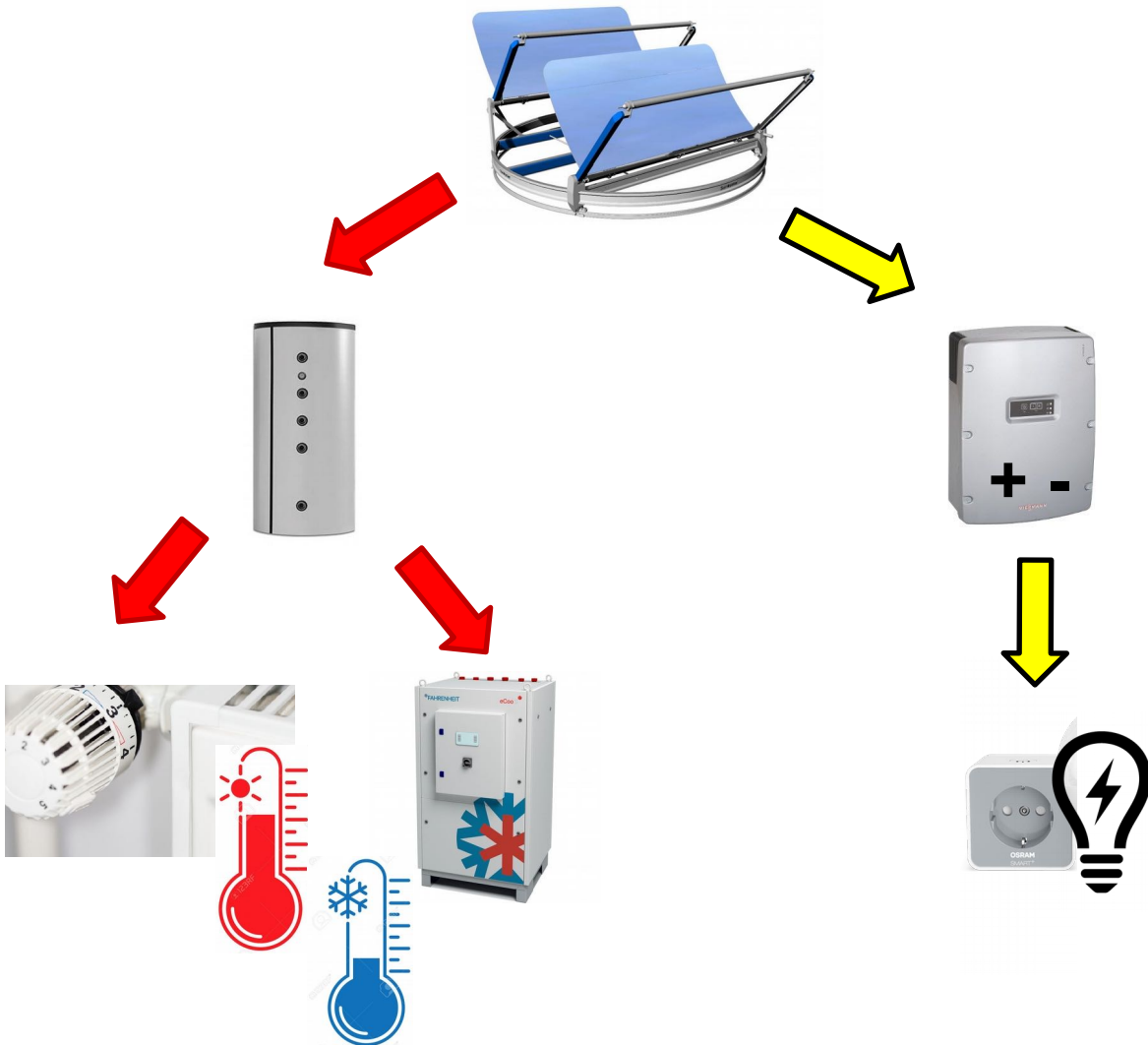
Weltweite Treibhausgasemissionen für Kühlung sollen nach Prognosen stark ansteigen



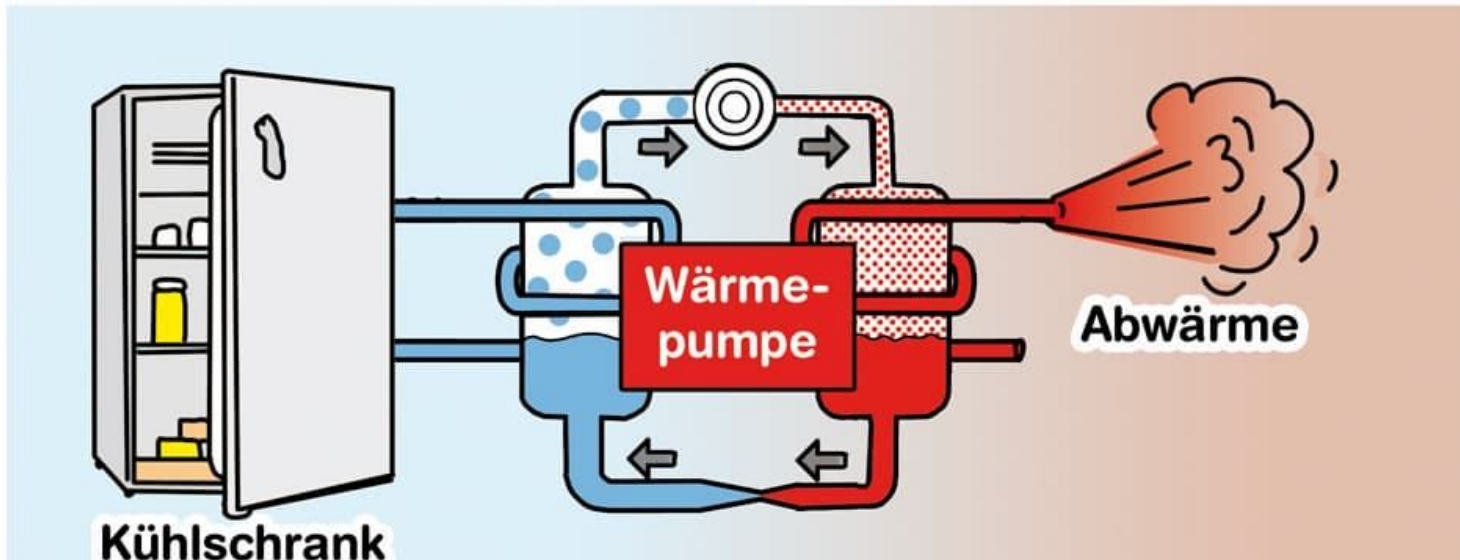
Gleichzeitigkeit von Solarstrahlung und Kühlbedarf



Mit der SunOyster können wir mit Strom und/oder Wärme kühlen – für ganzjährige Wärmenutzung besser mit Wärme



Thermische Kältemaschinen wandeln nach dem Wärmepumpenprinzip Wärme in Kälte um



www.energiesparen-im-haushalt.de

SOS bietet Komplettlösungen für Strom, Wärme und Kälte an (hier: unser Projekt SOcool Office)

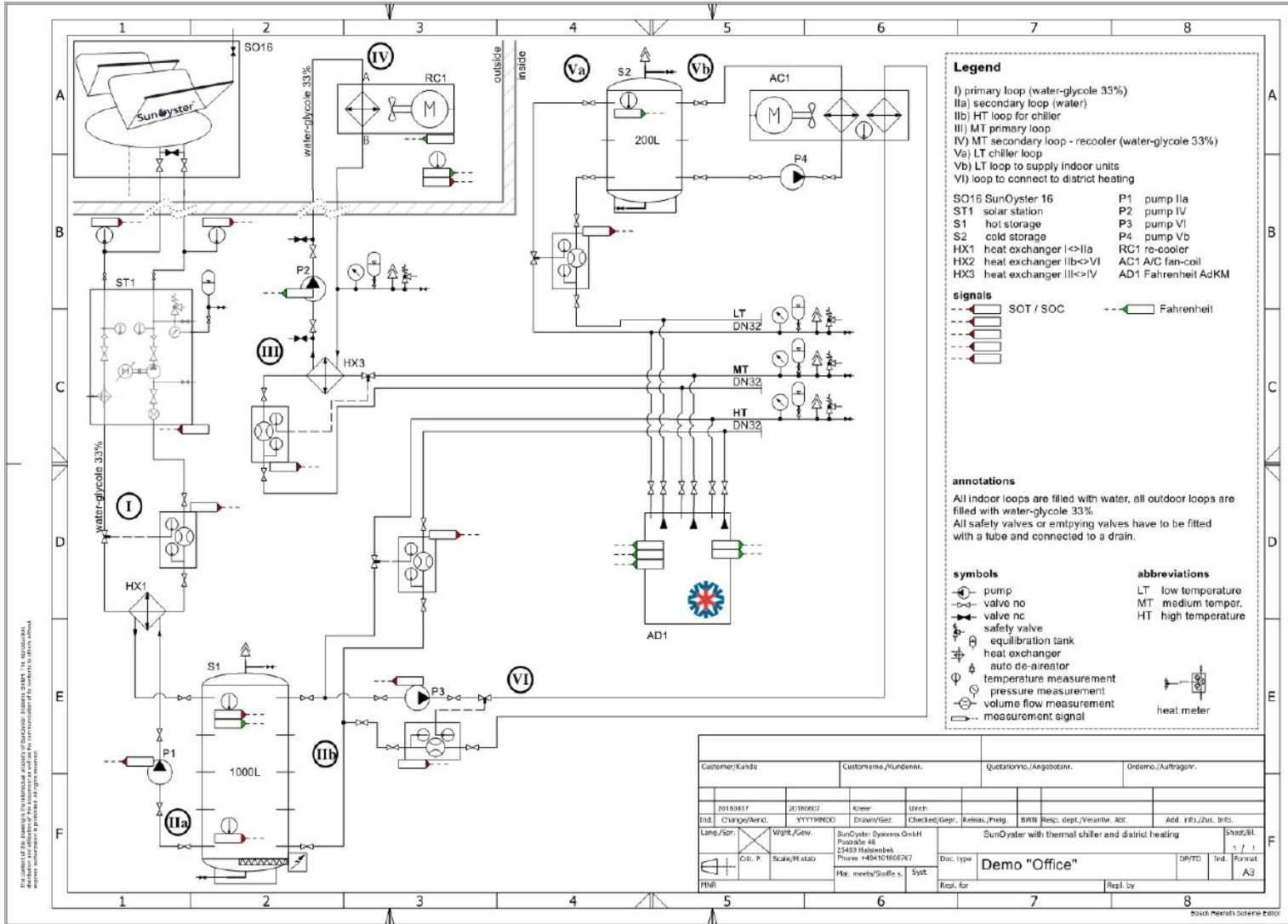
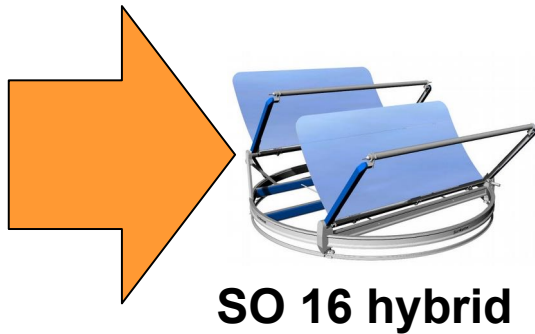


Bild von SOcool Office mit der deutschen Adsorptionskältemaschine von Fahrenheit im Zentrum

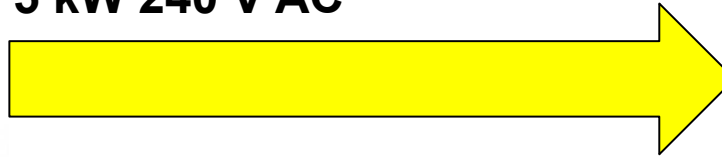


Kraft-Wärme-Kälte-Kopplung (KWKK/ Trigeneration) 150 % Nutzenergie bezogen auf 100 % Direktstrahlung!

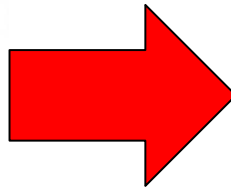
15 kW DNI



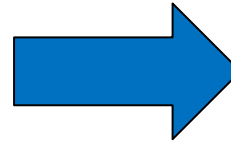
5 kW 240 V AC



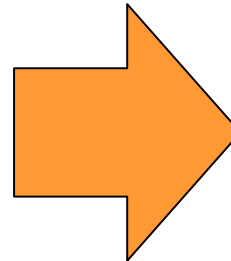
7.5 kW 90°C



5 kW 10°C



12.5 kW 37°C



= 22 kW Nutzenergie

Der Staat kühlt mit!

Typischerweise 40 % Förderung

Nach der [Richtlinie zur Förderung von Kälte- und Klimaanlageanlagen](#) (Kälte-Klima-Richtlinie) vom 19. Dezember 2018 werden u.a. stationäre Kälte- und Klimaanlageanlagen gefördert.

Von der Bafa gefördert werden solche stationären Kälte- und Klimaanlageanlagen, die mit nicht-halogenierten Kältemitteln betrieben werden. Hintergrund ist, dass diese üblicherweise in elektrischen Kältemaschinen genutzten Kältemittel mit Fluorverbindungen ein extrem hohes Treibhauspotential aufweisen und durch die F-Gase-Verordnung (EU) Nr. 517/2014 stark reduziert werden sollen.

Die Förderung ist auf 150.000 Euro pro Maßnahme sowie auf maximal 50 % der förderfähigen Ausgaben begrenzt.

Wirtschaftlich – Beispiel eines kleineren Hotel in Süditalien mit 8 SunOystern *hybrid*

| | |
|--|---|
| Electr., heat and cooling power, temp. | 40 kW el, 60 kW heat at max 95°C and 30-35 kW thermal chiller (COP 0.55-0.75) |
| Place and DNI | Catania, Sicily, 1,800 kWh/m ² a |
| Electricity value | 0.21 €/kWh |
| Heat value | 0.12 €/kWh (substituting oil) |
| Investment example | 40,000 € for 8 SunOysters hybrid (min. 400 m ² roof surface needed), e.g. 40,000 for chiller, total 124,600 € or 973 €/m ² |
| Total income/ saving p.a. | 23,710 € or 185 €/m² |
| Financing | 70% loan at 4 % interest |
| Payback of project/ equity | 5.26 years/ 1.58 years |
| IRR over 20 a | 38.64 % |

V. Weitere Projekte



SunOyster auf dem Dach einer Schule in Zhangjiakou, China: Heißwasser für Tee



SunOyster im Tiergarten Nürnberg – Strom und Wärme für das Tropenhaus

SunOyster [ostrea solaris]

Lieblingsbeschäftigung:
Energieerzeugung

| | |
|-----------------|--|
| Art | Ostrea solaris 16 hybrida pvplussa |
| Ordnung | Ostreida |
| Familie | Austern |
| Größe | Ø 5,24 m |
| Gewicht | 1 bis 1,3 t |
| Fortpflanzung | heiß! |
| Lebenserwartung | bis 30 Jahre |
| Verbreitung | weltweit |
| Lebensraum | Dächer, Carports, Garagen oder Freiland |
| Nahrung | direktes Sonnenlicht |
| Bestand | klein, aber stark wachsend |

Die SunOyster kann den kompletten Energiebedarf von Gebäuden decken; sie erzeugt zeitgleich Strom und Wärme.

Die gemeine SunOyster fühlt sich am wohlsten an sonnigen, klaren Tagen und führt sich bi-axial ganztägig der Sonne nach. Bei Sturm und in der Nacht klappt sie ihre Spiegel ein.

Optimale Raumausnutzung

Die SunOyster hat einen selektiven Vorteil gegenüber anderen Solarenergiewandlern wie etwa der Photovoltaik, weil sie auf derselben Grundfläche rund doppelt so viel Gesamtenergie (Strom und Wärme) erzeugen kann. So leistet sie einen wertvollen Beitrag zur Energieversorgung des Tropenhauses.

Zur Familie der Austern gehört daneben auch die SunOyster 8, die wegen ihres besonders hübschen Aussehens mit dem lateinischen Namen *Ostrea solaris venusta* bezeichnet wird. Zumeist lebt sie als Einzelgänger und erzeugt Energie am liebsten für Einfamilienhäuser. Sie kann aber auch in Rudeln auftreten, um größere Gebäude wie Hotels und Mehrfamilienhäuser zu versorgen.



BITTE NICHT FÜTTERN!



Schutzposition der SunOyster



SunOyster 8, Model Ala



N-ERGIE

Die SunOyster 16 *pvplus* wurde aus Geldern des Ökostrom-Produkts der N-ERGIE Aktiengesellschaft, STROM PURNATUR, finanziert. STROM PURNATUR Kunden erwerben somit Ökostrom aus Klimaweffulden in sinnvollerer Projekte. Die N-ERGIE präsentiert sich als Klimaschutz und die Region und macht sich



Projekt „SolarFreeze“ – Kühlung und Verarbeitung von Fisch auf den Kapverden, Test in Hamburg

Erzeugung von Slush Ice



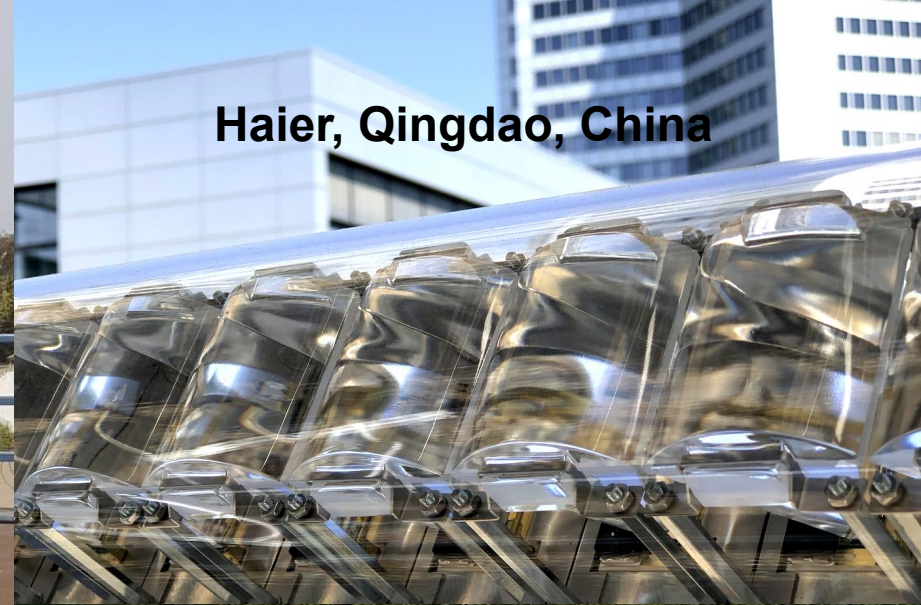
Yaobao Projekt für 100 SunOystern zur Dampferzeugung für Pharmaunternehmen in Taiyuan, China – aufgeschoben wegen Covid-19



Aufbau bei Swelect, Indien



Haier, Qingdao, China



engie, Belgien



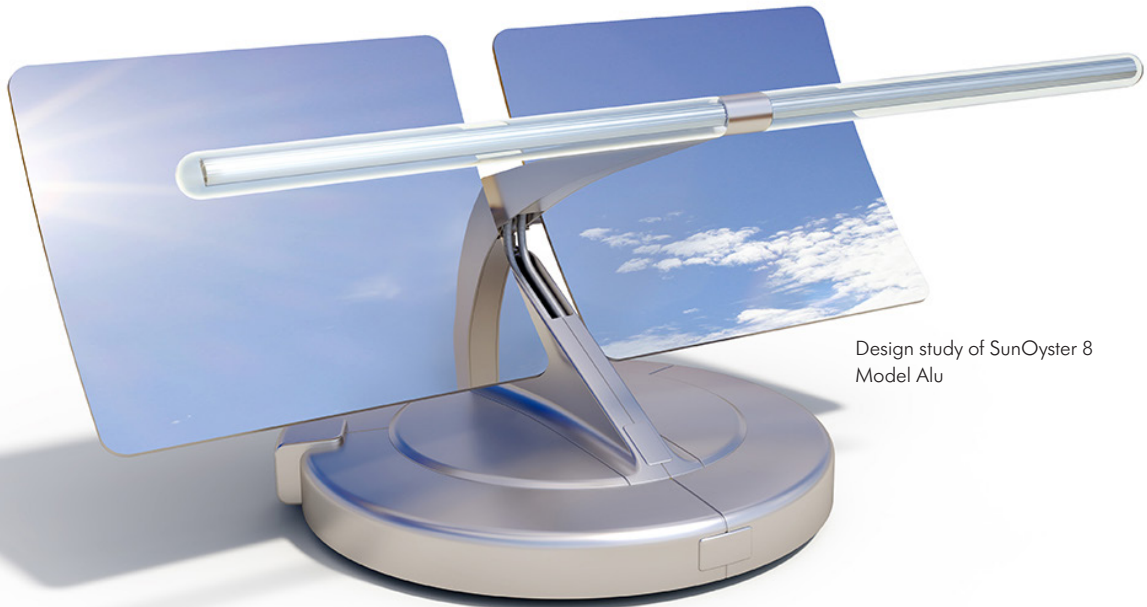
Wir freuen uns auf Ihr Projekt und danken für die Aufmerksamkeit!

SunOyster Systems GmbH
Poststr. 46, 25469 Halstenbek
Dr. Carsten Corino, cc@sunoyster.com
Tel. +49 4101 808767

The SunOyster logo features the word "SunOyster" in a bold, sans-serif font. The letter "o" is replaced by a stylized globe with blue and green segments. The logo is enclosed in a thin, grey, curved line that forms a partial circle around the text.

SunOyster®





Design study of SunOyster 8
Model Alu

Data Sheet

SunOyster 8

Note: Indicative data only. SunOyster Systems reserves the right to change specifications.



Introduction:

The **SunOyster 8** (SO 8) is a patented concentrating solar collector with roughly 7 m² gross mirror surface. It tracks the sun bi-axially to generate heat and potentially electricity. The SO 8 comes in **4 versions**:

- The purely thermal **SO 8 heat** generates up to 5.5 kW of thermal power.
- The **SO 8 hybrid** generates in its receiver both up to 2 kW of electricity and 3.5 kW of heat.
- Both versions of the SO 8 can in the **SO pvplus** be combined with 3 photovoltaic (PV) modules with an additional output of up to 1.2 kW of electric power.

Installation:

The SO 8 does not require a horizontal surface or platform for installation. It can be installed on any tilted surfaces including slanted roofs up to an angle of up to 45°C. The sub-structure of the SO 8 can be e.g. naked earth or gravel, a concrete or asphalt surface, concrete plates, ground anchors or steel beams, garages, pergolas, tile or metal roof.

Space demand, mechanics and weight:

- Space: The diameter of the swept area is 5.2 m, corresponding to a circular surface of 21.2 m². In a square, the surface is 27 m². The total height of the SunOyster mirrors is 2 m, of the mast 2.5 m.

- Ring profile: The ring profile on which the SO is turning has a diameter of 2.3 m (outer point to outer point.) It is made of alu. For special conditions, it can have a sub-structure for better spreading the load.
- Main frame: Triangular structure on three wheel groups.
- Other metal parts: Mainly anodized aluminum profiles. Exceptionally hot-dip-galvanized steel parts.
- Torque tube: 2 torque tubes attached to the elevation drive made out of 6082 alu and positioned in the center of the mirror at a height of 1.2 m above the bottom of the ring profile.
- Mirrors: The mirrors of the SO 8 have a height of 1.62 m and a width of 2 times 2 m, with a 25 cm gap in between. They consist of thin (1 mm) glass mirrors, glued on a sandwich structure. They reach more than 95 % reflectivity. Concentration factor ≥ 40 suns.

Warning – avoid concentrated radiation in eyes, on the skin or clothes!

- Weight: The total weight of the SO 8 Model White is below 400 kg.
- *pvplus*: In the front of the mirrors are 3 PV modules with a size of approx. 1.6 m height and 1 m width and +/- 5 cm flexible mounting positions. They are fixed at an angle of 10° to the ground and tracking the sun together with the SO from East to West. The weight of the support structure of the modules is up to 50 kg, the weight of typical modules is altogether 54 kg. For details of the modules see their data sheet.

sunoyster.com

Tracking: Two-axis in Azimuth and Elevation:

Azimuth tracking from East to West 450° rotation angle; planetary gear drive with tooth belt. Elevation drive with planetary and worm gears.

Warning – beware of moving parts!

Expected power output of SO 8:

| Type | Max. heat output | Max. electricity output ¹ | <i>pvplus</i> |
|--------------------|----------------------|--------------------------------------|-----------------------|
| SO 8 <i>heat</i> | 5.5 kW _{th} | - | + 1.2 kW _p |
| SO 8 <i>hybrid</i> | 3.5 kW _{th} | 2 kW _p | + 1.2 kW _p |

Please note that the power output of later serial products shall be even higher.

SO 8 *heat* - thermal receiver:

Insulated and protected by a 3 mm borosilicate glass tube with 150 mm outer diameter and anti-reflective coating, the thermal receiver features inside an extruded aluminum profile with absorber coating.

SO 8 *hybrid* - hybrid receiver:

Insulated and protected by a 3 mm borosilicate glass tube with anti-reflective coating, the thermal receiver features inside an extruded aluminum profile with absorber coating. On this, glass lenses – the so-called “SunOyster Crystal” – concentrates the light a second time onto the multi-junction concentrator PV (CPV) cells which have up to 44 % cell efficiency.

Temperature co-efficient for power: -0.1 %/K.

SO 8 *pvplus* – PV modules:

The SO 8 can carry 3 modules with a size of approx. 1 m x 1.6 m each. See separate data sheet of the PV modules.

Warning – both the hybrid receiver and the PV modules create electric hazards!

PV Inverter System:

- ABB UNO DM 3.3 TL PLUS SB with integrated DC Disconnect Switch.
- Max. efficiency: 97 %.
- Grid connection type: AC Single Phase (L / N / PE).
- Rated AC voltage: 230 V.
- Rated output frequency: 50 Hz or 60 Hz.
- Anti-islanding protection: According to local standards.

Electric Interconnection:

Junction box with clamp terminals for the grid connection cable (max. wire size 2.5 mm²). Recommended external AC overcurrent protection: 16 A.



Regional Economic Programme: Funded by the European Union - European Regional Development Fund (ERDF), the Federal Government and Land Schleswig-Holstein

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Control System:

- Customized and highly integrated control system with two independent motor controllers.
- Redundant safety system regarding wind speeds, fluid and receiver temperature and pressure.
- Integrated uninterrupted power supply system for closing the SunOyster during main grid failure.
- Local or central weather station equipped with at least the following sensors:
 - Anemometer and
 - Radiation sensor and
 - Ambient temperature sensor.
- Integrated inclination sensor and radiation sensors improve the tracking and allow an auto-commissioning of the SO.
- Optionally, a camera and additional weather sensors are available on request.

Data Interconnection:

- WLAN 802.11 b/g/n/ac (2.4 + 5.0 GHz)
- Bluetooth 4.2 (only for service)
- Optionally, LAN via RJ45 Connector with 10/100/1000 MBit

Thermal Properties:

- Heat transfer medium in areas without freezing temperatures: De-mineralized water. In other areas: solar fluid, i.e. water with corrosion protection additives. Standard version max. temperature of working fluid: 110°C.
- System pressure: min. 3 bar (2 bar gauge pressure) and max. 7 bar (6 bar gauge pressure).
- Flow Rate: Minimum flow of 200 l/h, at full radiation 550 l/h, maximum flow 1.500 l/h.
- Pressure loss: ≤ 0.3 bar at 550 l/h.

Warning – the high fluid temperature can cause burning hazards!

Thermal Interconnection:

Pipes for fluid should be installed to the ring profile. Pipes on the SunOyster are stainless steel pipes. Therefore, stainless steel is preferred for connecting pipes. The pipes should have a minimum inner diameter of 25 mm (1 inch) – preferably larger for long runs.

Environmental limits:

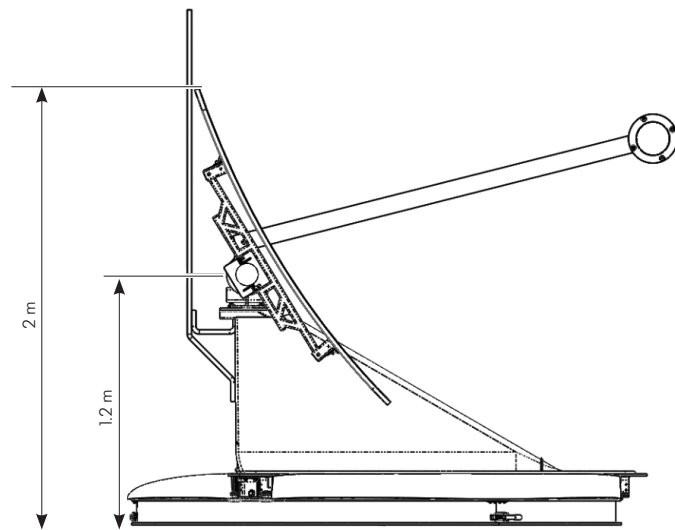
- Operational temperatures: - 30°C to + 45°C.
- Survival temperatures: -40°C to +60°C.
- Air humidity: 0-100 %, condensing.
- Wind: normal operation up to 55 km/h. Survival in safety position with normal turbulence up to 150 km/h.
- Snow: German load zone 2 up to 600 m (city of Freiburg).



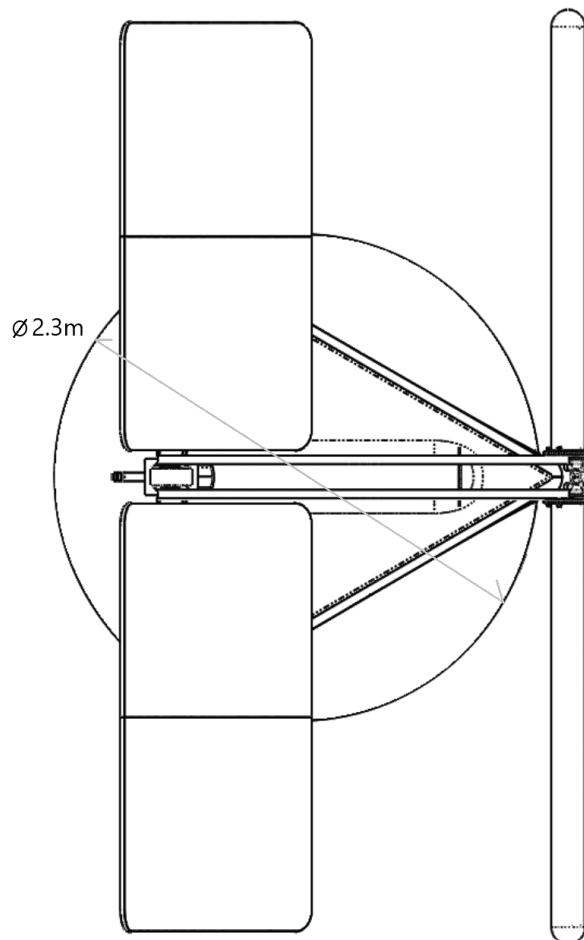
¹ Nominal power of generator under Concentrator Standard Test Conditions CSTC acc. IEC 62670-1:2013:1.000W/m², (25±2)°C, AM 1.5 acc. EN 60904-3

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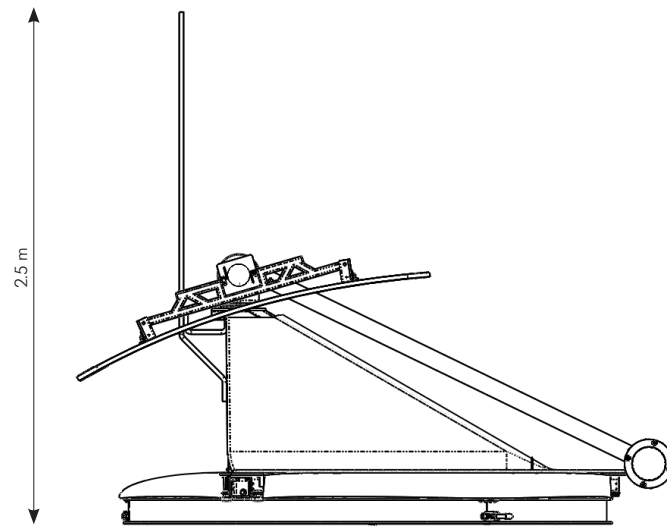
SunOyster 8 side view open:



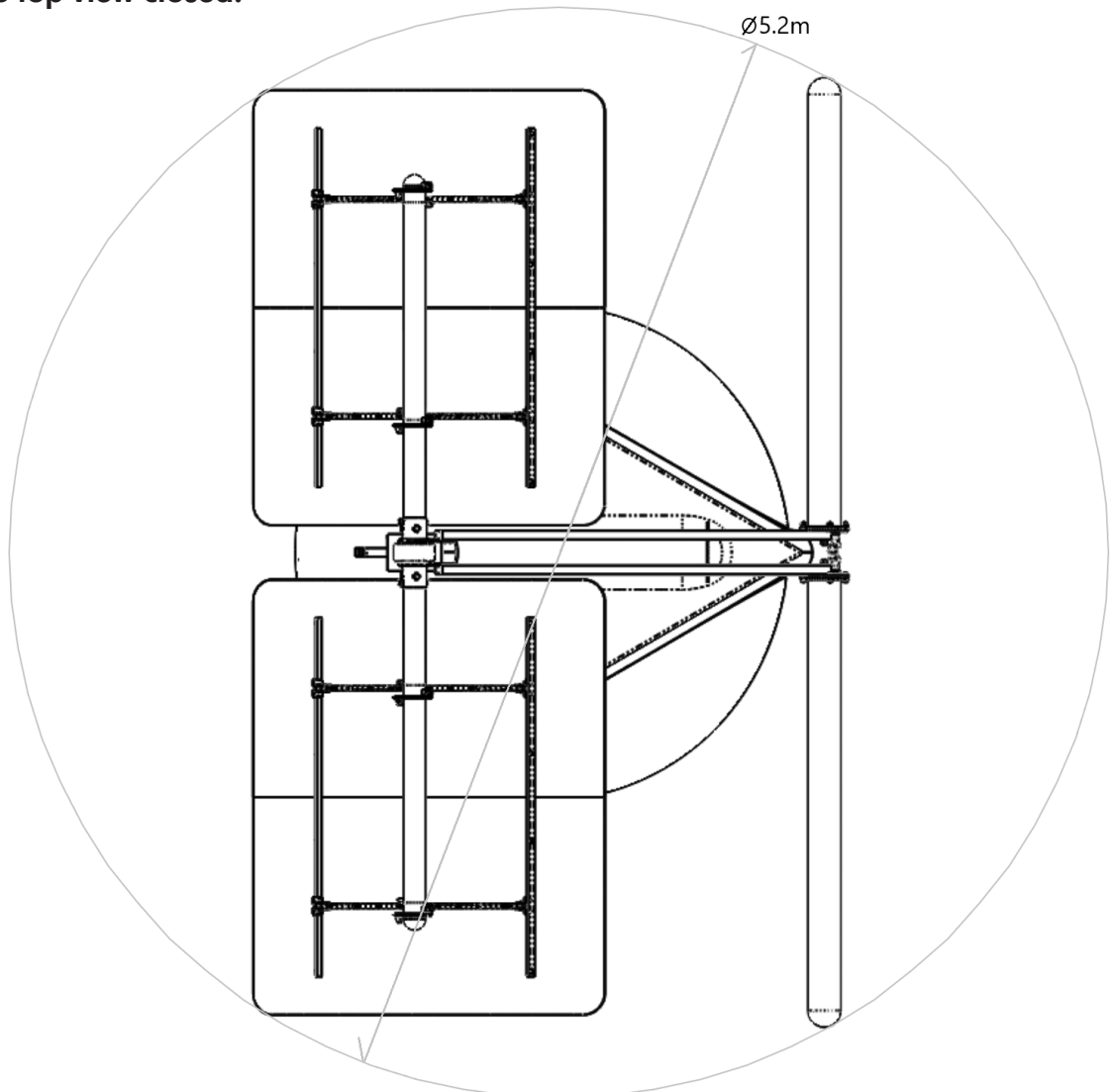
SunOyster 8 top view open:



SunOyster 8 side view closed:



SunOyster 8 top view closed:

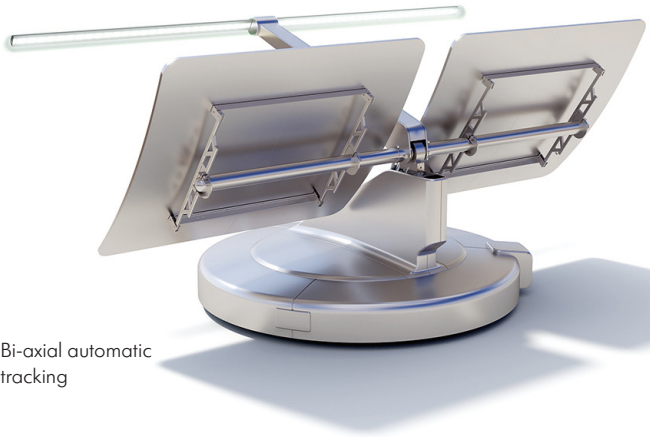




8

sun  **oyster**[®]

Double the Power.



Bi-axial automatic tracking

The new star of the SunOyster family: SunOyster 8

The SunOyster 8 offers the same benefits as its larger sister SO 16: Very high energy efficiency thanks to co-generation of electricity and heat. Therefore: Low cost of energy and best surface efficiency. We offer smart packages for heating and cooling to cover the complete energy demand of buildings.

Power output from serial production shall be 5.5 kW thermal power for the SO 8 *heat* – and 2 kW electric power and 3.5 kW of heat for the SO 8 *hybrid*. The *pvplus* version features 3 additional photovoltaic modules and provides an additional up to 1.2 kW of electricity.

SO 8 offers further advantages:

Compact. The rail base has a diameter of 2.25 m so that it can be installed e.g. on a single garage.

Light. The weight is below 400 kg.

Easy. All individual parts can be transported in a van, fit in a standard elevator or can be carried through the stairway. The installation can be done by just one person in one day.

Flexible. The SO 8 can be installed not only on flat roofs, but also on slanted roofs up to 30°. It searches for the sun automatically and commissions itself.

Robust. The unique flat Oystering position combined with a central torque tube resists high wind speeds and also decent snow loads. The coated aluminum profiles are highly corrosion resistant for a life time of at least 20 years.

Digital. Performance tracking by a mobile phone app.

Stylish. Sophisticated design with rounded mirror edges and smooth bodywork shapes the basic Model White which consist of powder coated metal parts. Model Alu will be very popular in California and Model Gold will rock Dubai. Many more designs are possible, allowing the customers to individualize their SunOyster.

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We foster the economy



Regional Economic Programme: Funded by the European Union - European Regional Development Fund (ERDF), the Federal Government and Land Schleswig-Holstein



This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 778106

Data Sheet

SunOyster 16 model 2.0

Note: Indicative data only. SunOyster Systems reserves the right to change specifications.



Introduction:

The **SunOyster 16** (SO 16) is a patented concentrating solar collector with roughly 16 m² gross mirror surface. It tracks the sun bi-axially to generate heat and potentially electricity. The SO 16 comes in **4 versions**:

- The purely thermal **SO 16 heat** generates up to 12 kW of thermal power.
- The **SO 16 hybrid** generates in its receiver both electricity and heat, at present up to 3.2 kW of electricity and 6.0 kW of heat.
- **SO 16 heat** as well as **hybrid** can in the version **pvplus** be combined with 12 photovoltaic (PV) modules with an additional output of up to 3.8 kW of electric power.

The SO 16 model 2.0 features some improvements over the pre-series (model 1.0) and is available from the end of 2019.

Installation:

The SO 16 requires a horizontal surface or platform for installation. It can be installed on roofs, carports or on the ground. The sub-structure of the SO 16 can be e.g. a concrete or asphalt surface, concrete plates, ground anchors or steel beams. On this, twelve base profiles support the ring profile of the SO 16. Each support point for the base profiles has to carry a static weight load of 100 to 150 kg, plus varying dynamic loads.

Mechanics:

- The SO 16 has – including *pvplus* – a swept diameter of 8.30 m, corresponding to a circular surface of approx. 54 m².
- Ring profile:
Rail profile S7 in corten steel, 5.24 m in diameter.
- Main frame:
Rolled steel profiles with zinc-aluminum-magnesium (ZAM) coating. Main frame rolling on steel or polymer wheels on the ring profile.
- Other profiles:
Hot-dip-galvanized steel profiles.
- Torque tube: 2 torque tubes at a horizontal distance of 3 m from each other, with the back torque tube elevated to minimize shading.
- Mirrors:
On the torque tubes, the two semi-parabolic mirror troughs have a width of 3,870 mm and a height of approx. 1,900 mm and consist of three mirror segments each. 4 mm of toughened glass, reaching approx. 95% reflectivity, with ceramic pads on the back side for installation. Concentration factor ≥ 30 .

Warning – avoid concentrated radiation in eyes, on the skin or clothes!

- *pvplus*: In the front and on both sides of the SO 16 each 4 PV modules, fixed at approx. 17° to the ground and tracking the sun together with the SO 16 from East to West.

Tracking: Two-axis in Azimuth and Elevation:

Azimuth tracking from East to West $\geq 350^\circ$ rotation angle; gear motor. Elevation tracking working angle 160° ; two individual drive systems with worm gears.

Warning – beware of moving parts!

Expected power output of model 2.0:

| Type | Max. heat output | Max. electricity output ¹ | <i>pvplus</i> |
|---------------------|----------------------|--------------------------------------|-----------------------|
| SO 16 <i>heat</i> | 12 kW _{th} | - | + 3.8 kW _p |
| SO 16 <i>hybrid</i> | 6.0 kW _{th} | 3.2 kW _p | + 3.8 kW _p |

Please note that the power output of later serial products shall be even higher.

SO 16 *heat* - thermal receiver:

Insulated and protected by a 3 mm borosilicate glass tube with anti-reflective coating. The thermal receiver features inside a steel tube with selective coating.

SO 16 *hybrid* - hybrid receiver:

Insulated and protected by a 3 mm borosilicate glass tube with anti-reflective coating, the hybrid receiver features inside an extruded aluminum profile. On this, glass lenses – the so-called “SunOyster Crystals” – concentrate the light a second time onto the multi-junction concentrator PV (CPV) cells which have up to 44 % cell efficiency. Temperature co-efficient for power: $-0.1\%/K$.

SO 16 *pvplus* – PV modules:

The SO 16 can carry 12 modules with a size of approx. 1 m x 1.6 m each. See separate data sheet of the PV modules.

Warning – both the hybrid receiver and the PV modules create electric hazards!

PV Inverter System:

- SO 16 *hybrid*: 1x ABB UNO-DM- 3.3-TL-PLUS
- SO 16 *hybrid pvplus*: 2x ABB UNO-DM- 3.3-TL-PLUS
 - Integrated DC disconnect switch.
 - Max. efficiency: 97,0%.
 - Grid connection type: AC Single Phase (L / N / PE).
 - Rated AC voltage: 230 V.
 - Rated output frequency: 50 Hz or 60 Hz.
 - Recommended external AC overcurrent protection: 16 A.
 - Anti-islanding protection: According to local standards.

Electric Interconnection:

Junction box with clamp terminals for the cable (max. wire size 2.5 mm²). The cable shall be positioned at the center of the SO plus 1 m cable length.

Control System:

- Customized and highly integrated control system with 3 independent motor controllers.
- Redundant safety system with integrated temperature switches in each receiver.
- Integrated UPS system for closing the SunOyster during main grid failure.
- Local or central weather station equipped with the following sensors:
 - Anemometer and
 - Radiation sensor.
- Power consumption: 10-20 W average (max. 300 W).

Data Interconnection:

Junction box with RJ45 ethernet port. The ethernet cable shall be positioned at the center of the SO plus 1 m cable length.

Thermal Properties:

- Heat transfer medium in areas without freezing temperatures: De-mineralized water. In other areas: solar fluid, i.e. water glycole with corrosion protection additives. Standard version max. temperature of working fluid: 105°C. High temperature version up to 170°C, with thermal oil more.
- System pressure: min. 3 bar (2 bar gauge pressure) and max. 7 bar (6 bar gauge pressure) for standard version, for high temperature version up to 16 bar.
- Flow Rate: Minimum flow of 250 l/h, at full radiation 750 l/h, maximum flow 1,500 l/h.
- Pressure loss: ≤ 0.5 bar at 1,500 l/h.

Warning – the high fluid temperature can cause burning hazards!

Thermal Interconnection:

Pipes for the hot fluid should be installed to within a distance of 1 m from the center of the SunOyster. Stainless steel pipes are preferred. The pipes should have a minimum inner diameter of 25 mm (1 inch) – preferably larger for long runs. The two ends have a 1 inch external pipe thread.

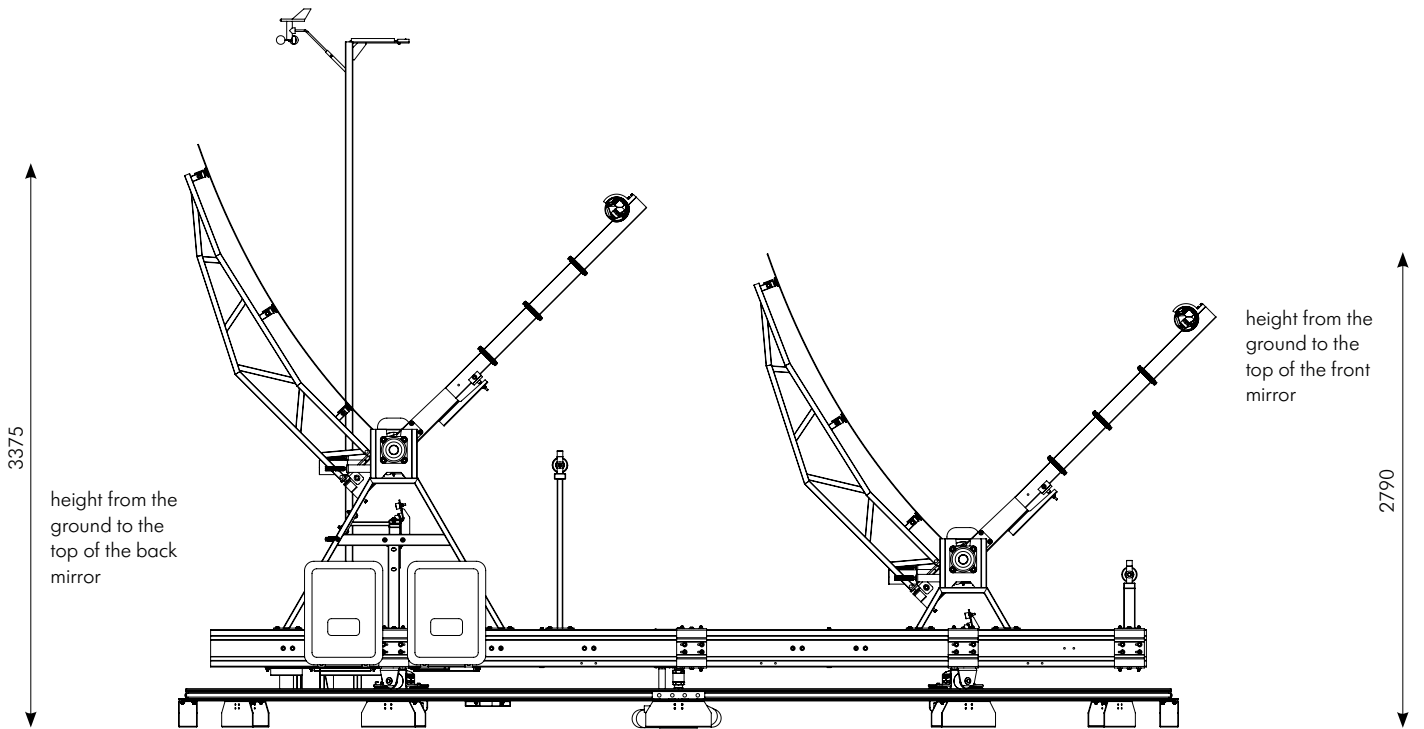
Environmental limits:

- Operational temperatures: $-30^\circ C$ to $+45^\circ C$.
- Survival temperatures: $-40^\circ C$ to $+70^\circ C$.
- Air humidity: 0-100%, condensing.
- Wind: normal operation up to 55 km/h. Survival in safety position with normal turbulence up to 150 km/h.
- Remove snow on SunOyster.

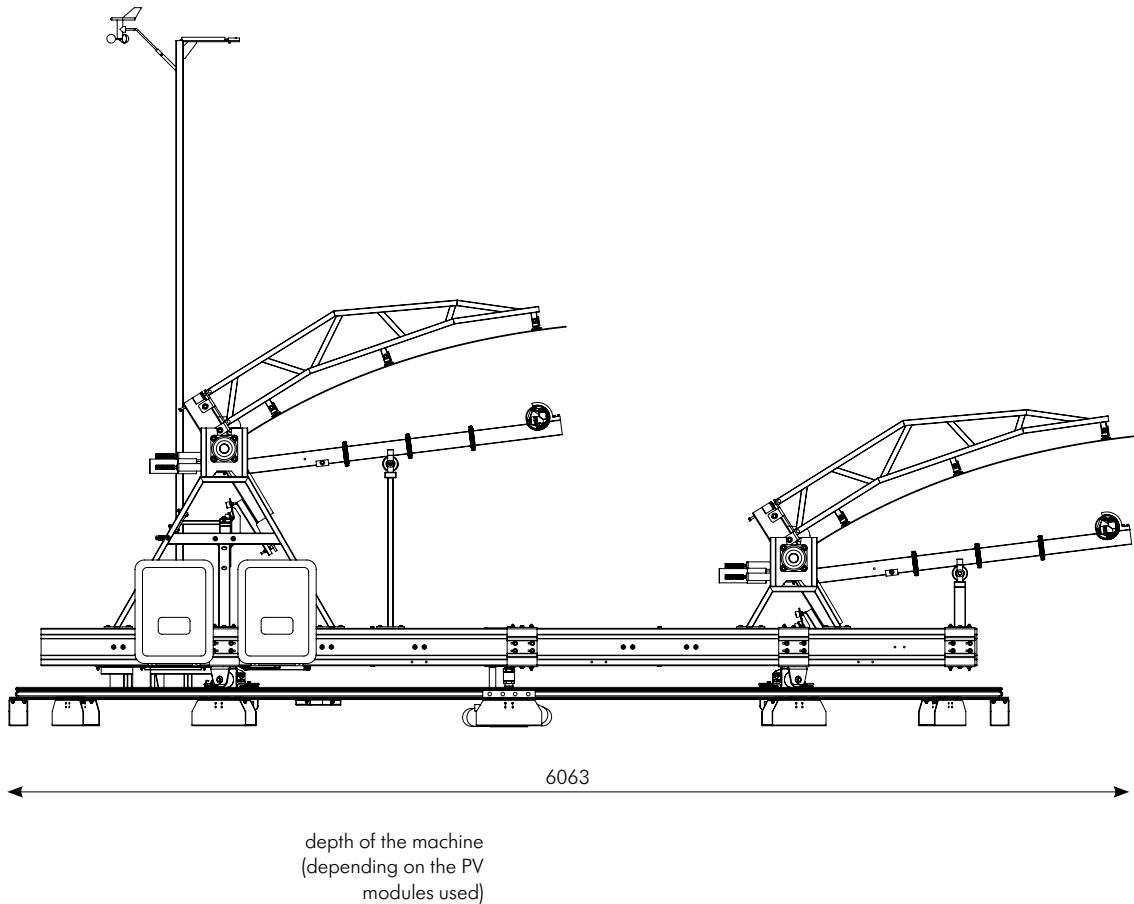


¹ Nominal power of generator under Concentrator Standard Test Conditions CSTC acc. IEC 62670-1:2013:1.000W/m², (25±2)°C, AM 1.5 acc. EN 60904-3

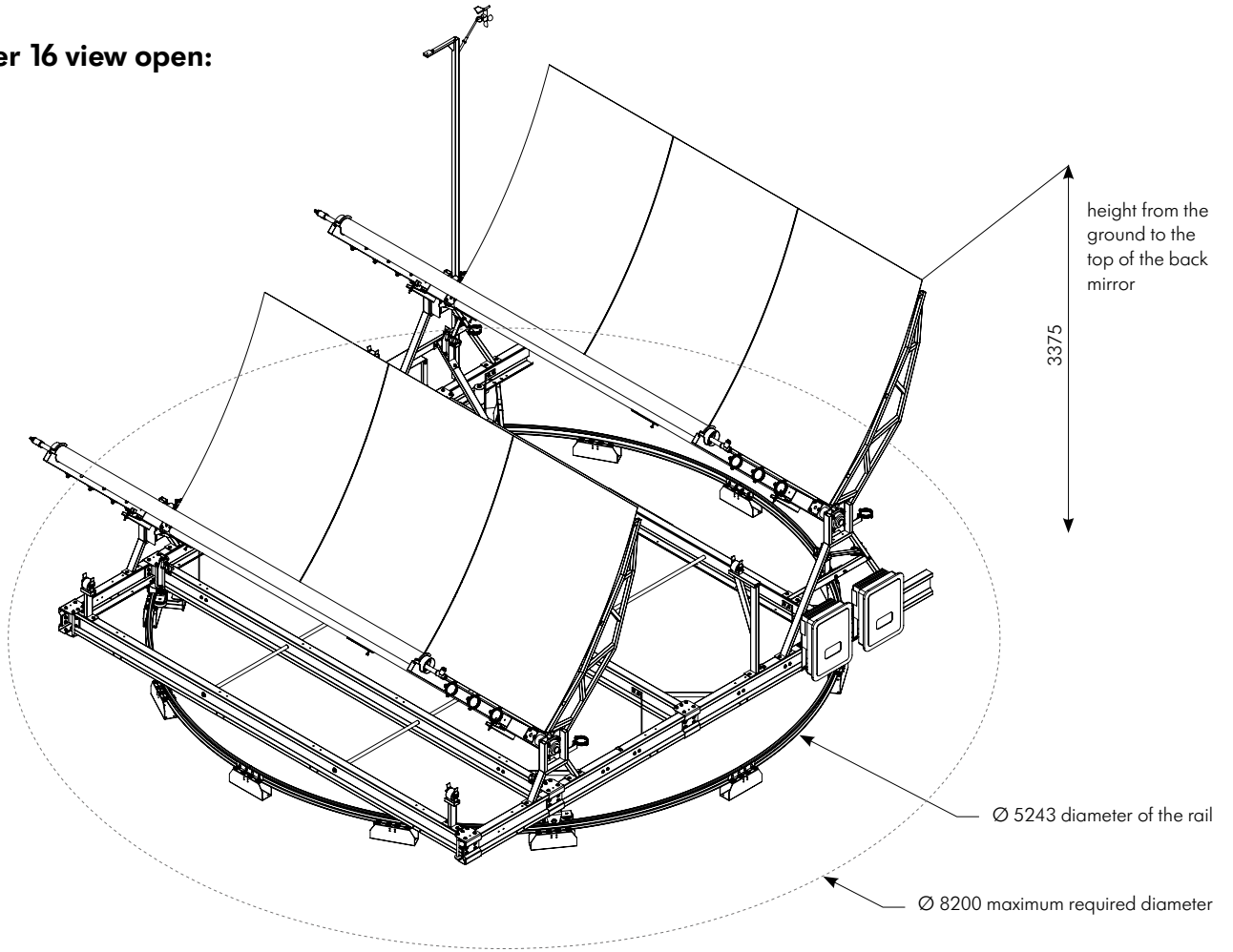
SunOyster 16 side view open:



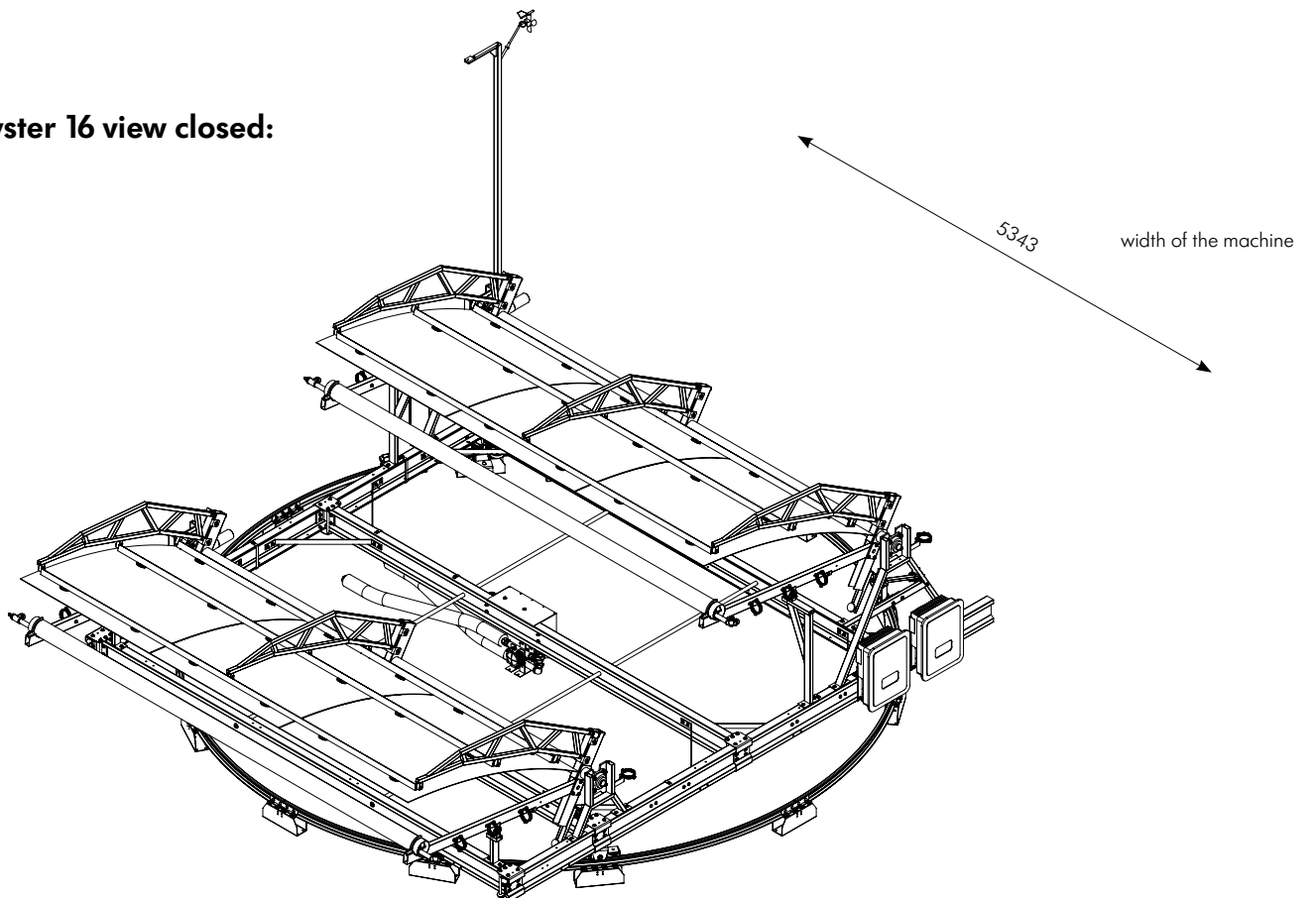
SunOyster 16 side view closed:



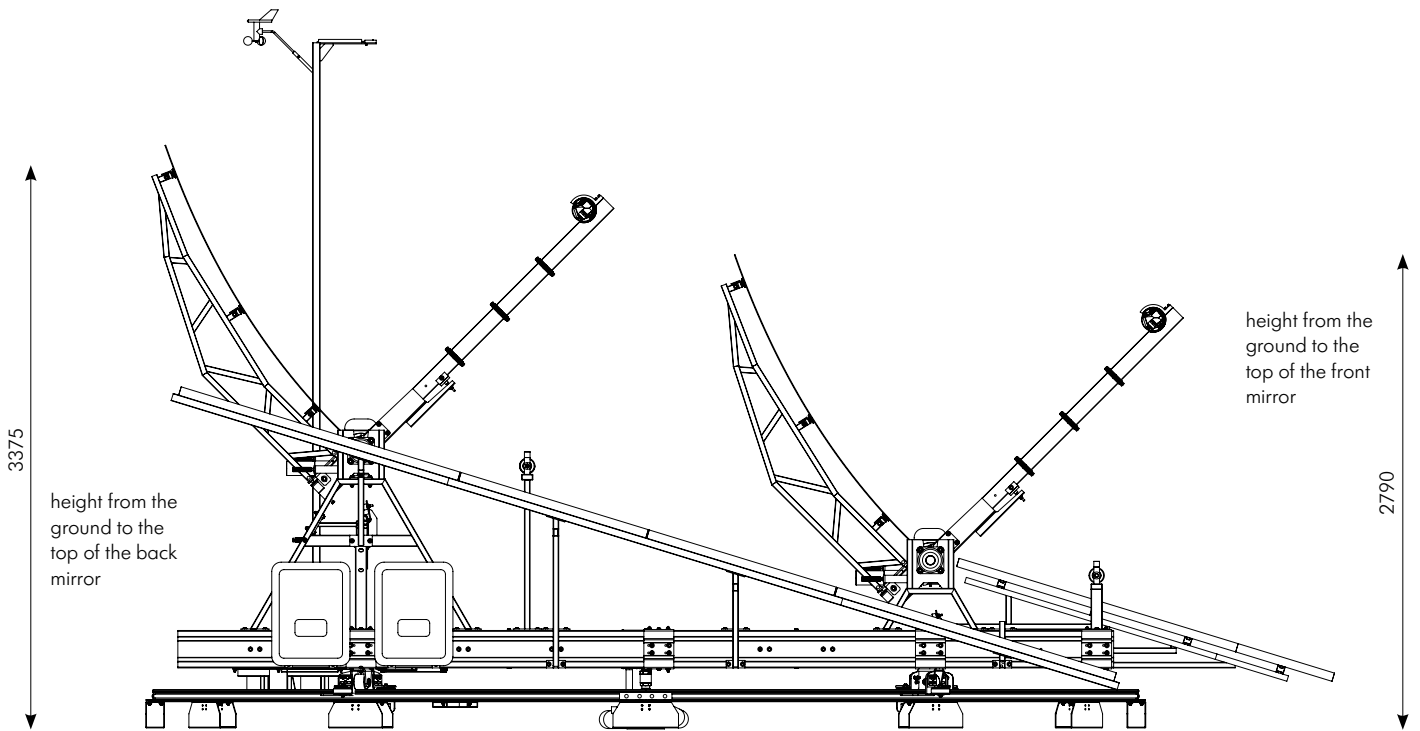
SunOyster 16 view open:



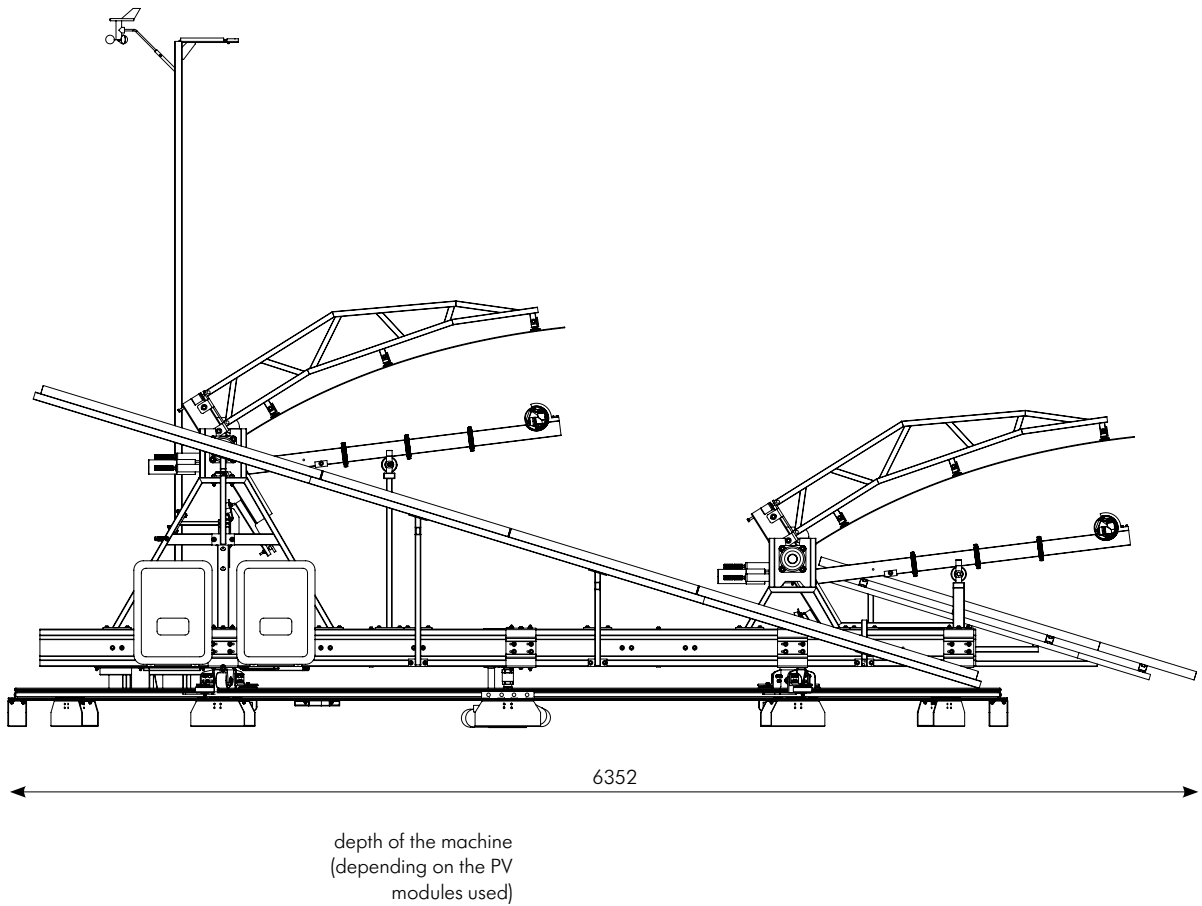
SunOyster 16 view closed:



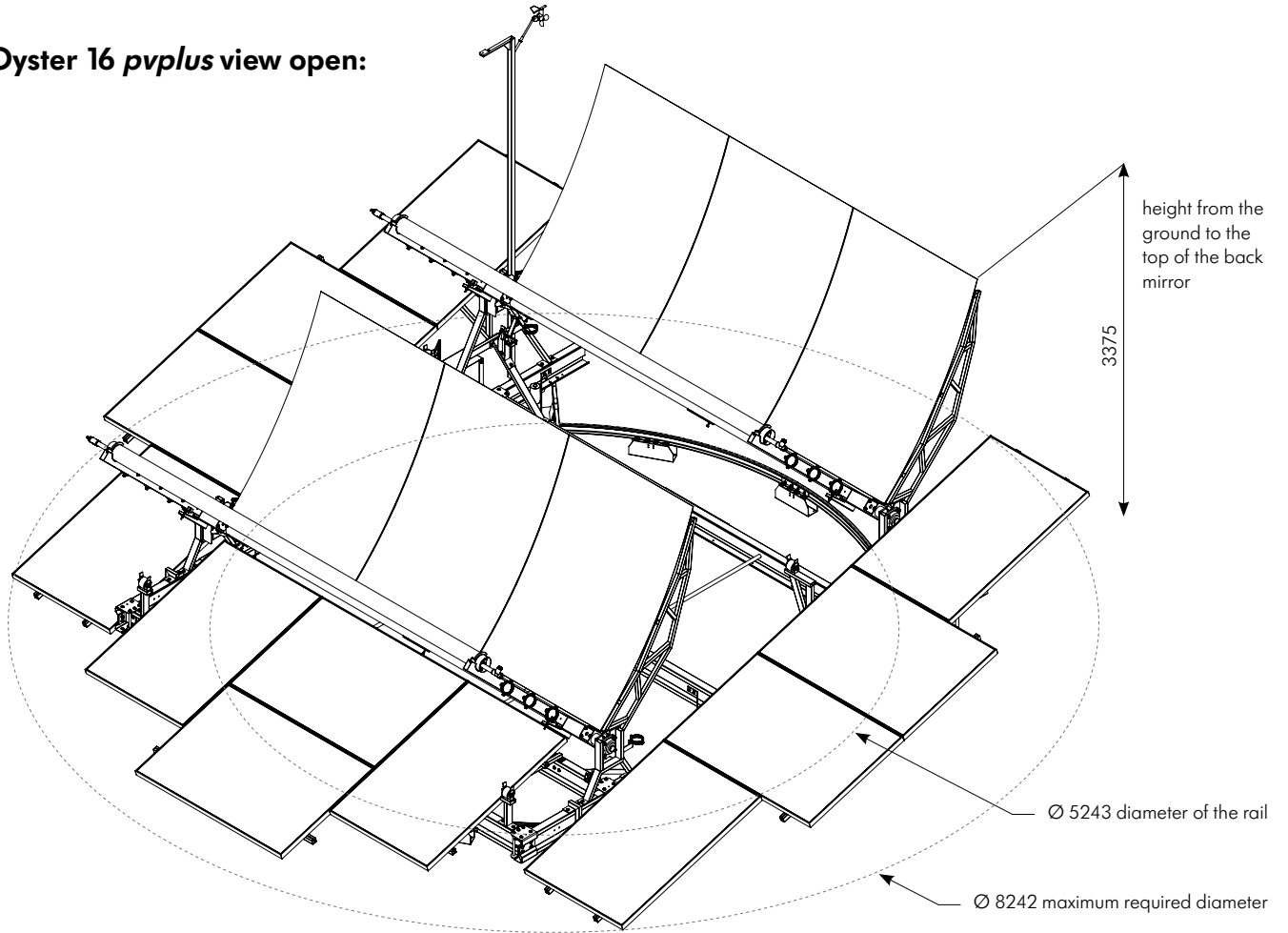
SunOyster 16 *pvplus* side view open:



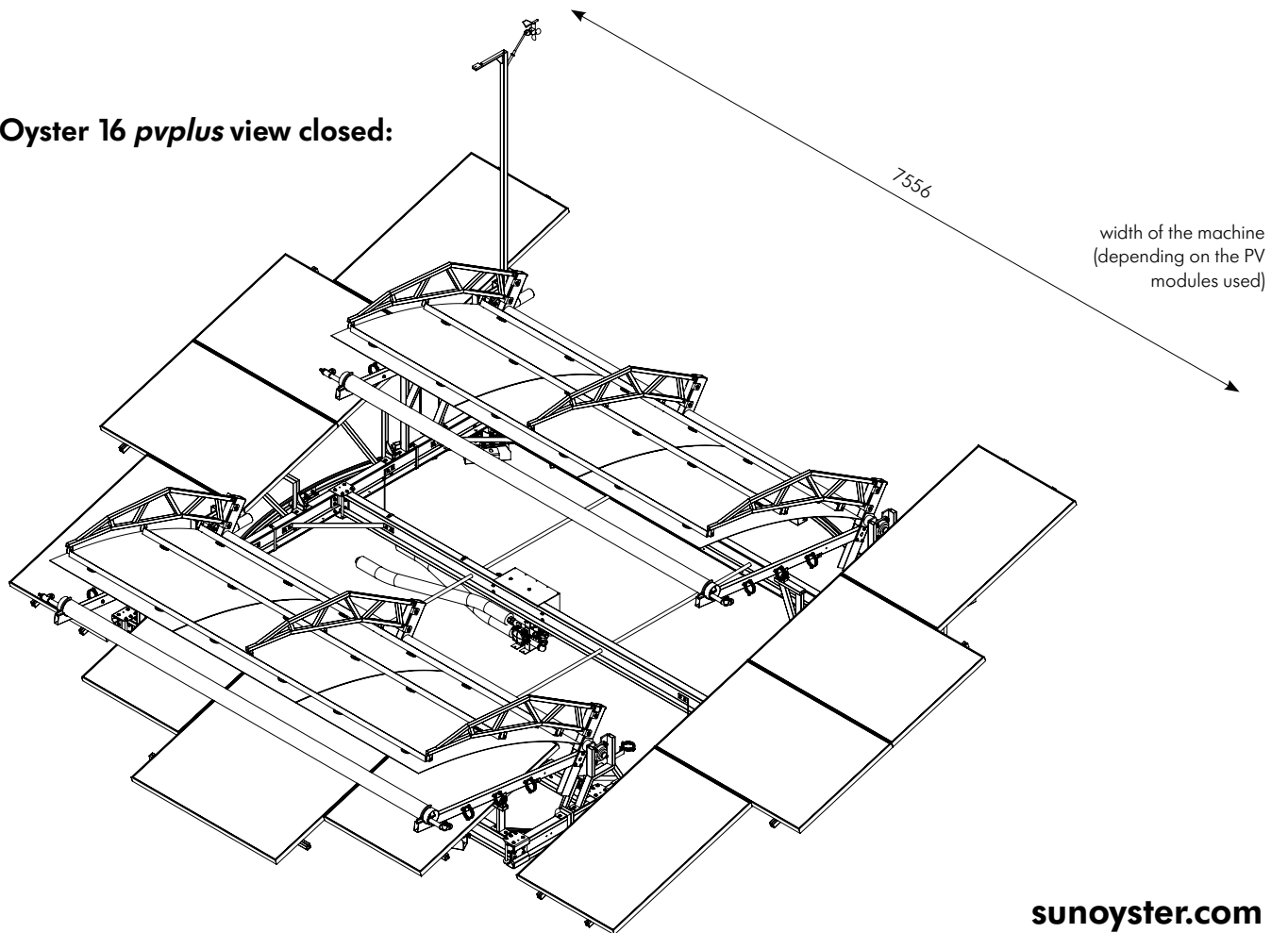
SunOyster 16 *pvplus* side view closed:

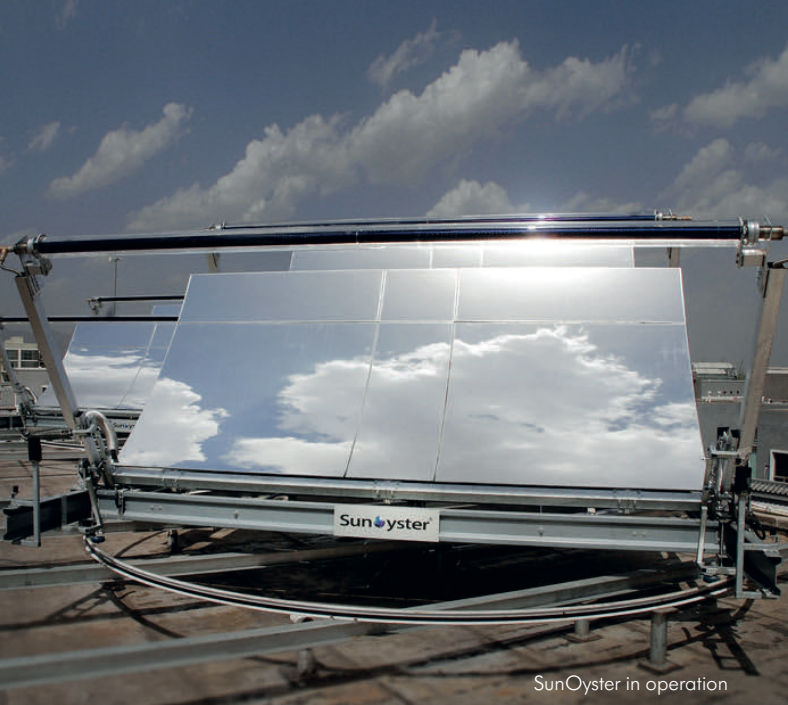


SunOyster 16 pvplus view open:



SunOyster 16 pvplus view closed:



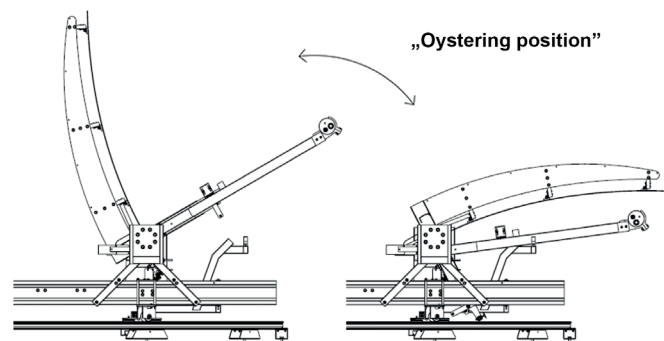


SunOyster in operation

Discover how the SunOyster generates MORE solar energy!

SunOyster technology – doubles the power

SunOyster Systems has developed a **new concentrating solar technology** which can produce heat or both heat and electricity from the same device – achieving efficiencies higher than anything else available in the market: The SunOyster can convert **up to 75%** of the direct solar radiation!



Inspired by nature

The heart of the SunOyster is a **hybrid receiver** which combines the best of Concentrated Solar Power (CSP) and Concentrated Photovoltaics (CPV) technology: The cost-efficient CSP mirrors track the sun bi-axially. The 4 m long receiver is protected by a borosilicate glass tube filled with nitrogen. Inside the tube, special glass lenses concentrate the light a second time to reach 500 times the power of the sun. Highly efficient (44%) CPV solar cells developed for spacecraft convert this directly into electricity. The cells are liquid cooled. This fluid can reach temperatures up to 110°C. The purely thermal receiver can reach even higher temperatures e.g. for process heat.

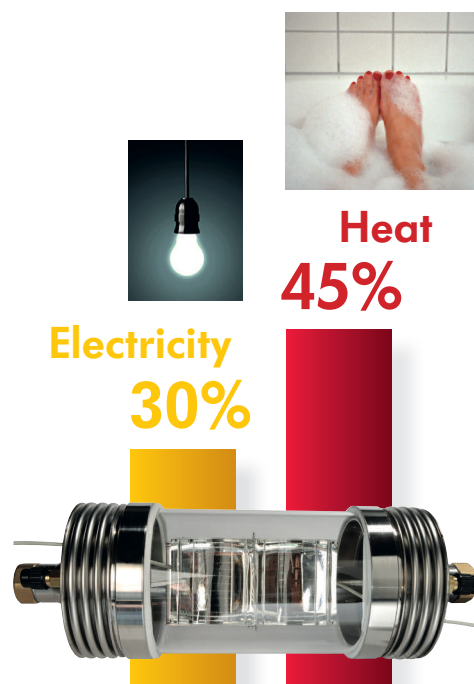
The proprietary **control system** of the SunOyster tracks the sun automatically all day. It allows online monitoring, so that the customer can admire the energy generation via a SunOyster App.

The first model of the SunOyster, the **SO 16**, has two 8m² toughened glass mirrors. The mirrors are a proven technology as used in solar thermal power plants (CSP).

The SO 16 is **light enough** to be installed horizontally on rooftops. When installed on the ground, it can be easily mounted on steel anchors, avoiding complex concrete foundations.

Take advantage of the benefits

- The SunOyster can generate at least **twice as much energy** from a given surface area as the best photovoltaic (PV) modules.
- In case of danger such as strong wind the SunOyster closes down the mirrors to a **secure position** – like an oyster closes its shell.
- In sunny regions the SunOyster produces the **cheapest solar energy** wherever heat or cold are needed.



Model of receiver with concentrator cells

SunOyster power, heat & cost efficiency

The SO 16 *hybrid* from serial production will **generate** almost 5 kW peak electrical, and at the same time up to 7.5 kW thermal power. In the middle of Europe (eg Munich) this means up to 5,000 kWh electricity and 7,500 kWh heat energy p.a. SO 16 *heat* has 12 kW thermal and generates 12,000 kWh heat p.a. In regions with higher direct sunshine this production increases dramatically – twice as much in areas like in Florida or Southern Spain, even more in California or Australia, and up to 3 times in Chile or South Africa.

The **sales price** for volume production matches that of high quality PV systems. But the SunOyster also produces heat, so the total costs can be allocated to both electricity and heat. Then the electricity from the SunOyster is one third cheaper than from PV.

The resulting **cost** of electricity is far below the cost from the grid, and the cost of heat far below the cost from oil or gas boilers. Depending on the price of conventional energy the SunOyster can often achieve a total payback time less than 5 years, falling to less than 2 years on the equity if a loan is used for the investment.

SunOyster applications

Thanks to the **high temperature** level, the SunOyster can supply a broad variety of heat applications.



Room heating



Warm water



Process heat



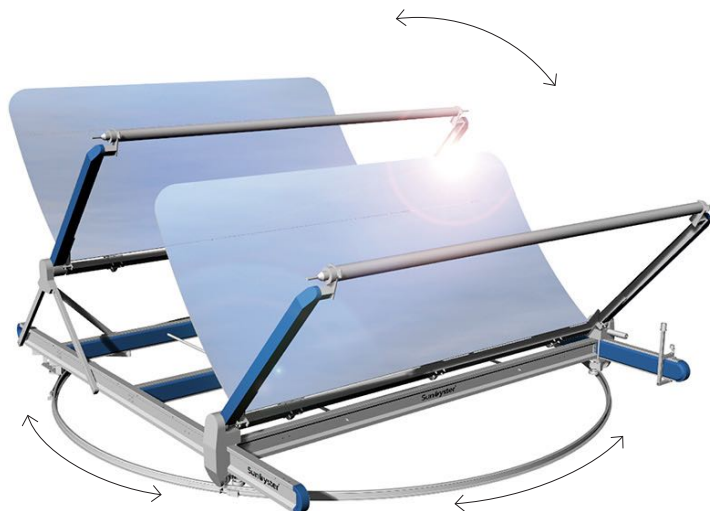
Desalination



Cooling



Pre-heating steam plants



Industrial design with rounded edges (design patent), with the bi-axial automatic tracking and the brilliant mirror surface – it simply looks cool!

Commercial users in particular can save money. By using thermal refrigeration systems to convert the heat into cold, the SunOyster can cover the complete energy demand of **hotels, office buildings, shopping centres or cool stores**. The SunOyster can also cover the power and high grade heat requirements of many industries such as food, textile or chemical manufacturers.

For **private users** the SunOyster can be mounted on the top of roofs, garages, carports or simply placed on the ground. Taking the example of a house with a swimming pool in Southern Italy the SunOyster can cover domestic hot water demand throughout the year. In winter, it can heat the house. In summer, the heat can be converted by small thermal chiller into cold to air-condition the house. If the waste heat of the chiller is further used to heat domestic hot water or the pool, this tri-generation is extremely efficient. In spring and autumn the SunOyster can heat the swimming pool.

Multiple SunOysters can contribute energy to **large scale applications**: for example the heat can be used to dry fuel, pre-heat combustion air or be injected in the steam cycle of a power plant. The solar heat thereby substitutes for fossil fuel or biomass consumption. Another possible use is desalination plants.

In particular, there is great potential in the field of solar cooling. The areas of highest direct sunshine also require a lot of cooling. The European Union generously supports our project „**SunOyster cooling – SOcool**“. It includes setting up a pilot production, testing and certification of our technology, and demo projects in hotels, offices and villas with pool.



SunOyster®

Double the Power.

SO 16 pvplus

Both the SunOyster 16 *heat* and *hybrid* are available as version **pvplus**: With additional 4 kW of PV modules.



SunOyster pvplus in operation

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SunOyster®

Double the Power.



This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 778106.