

## Entwicklung von Kunststoffkollektoren in Norwegen

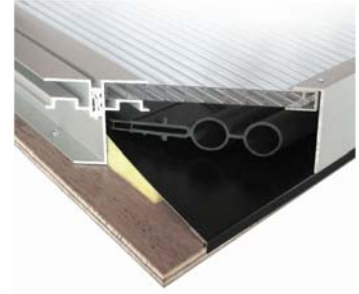
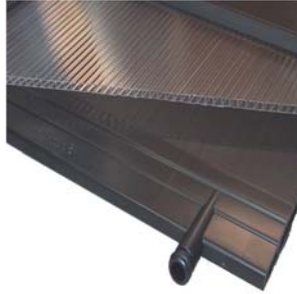
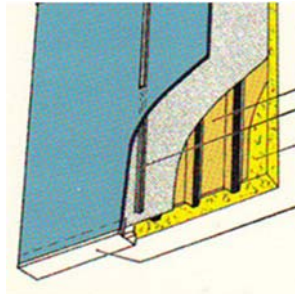
Michaela Meir  
University of Oslo, Dep. of Physics, Norway



"Kunststoff als Wachstumsmotor für die Solarthermie", JKU, Linz, 6. Juli 2011

**aventa solar**

## ... started in 1977



1977: 1st solar heated house in Norwegen

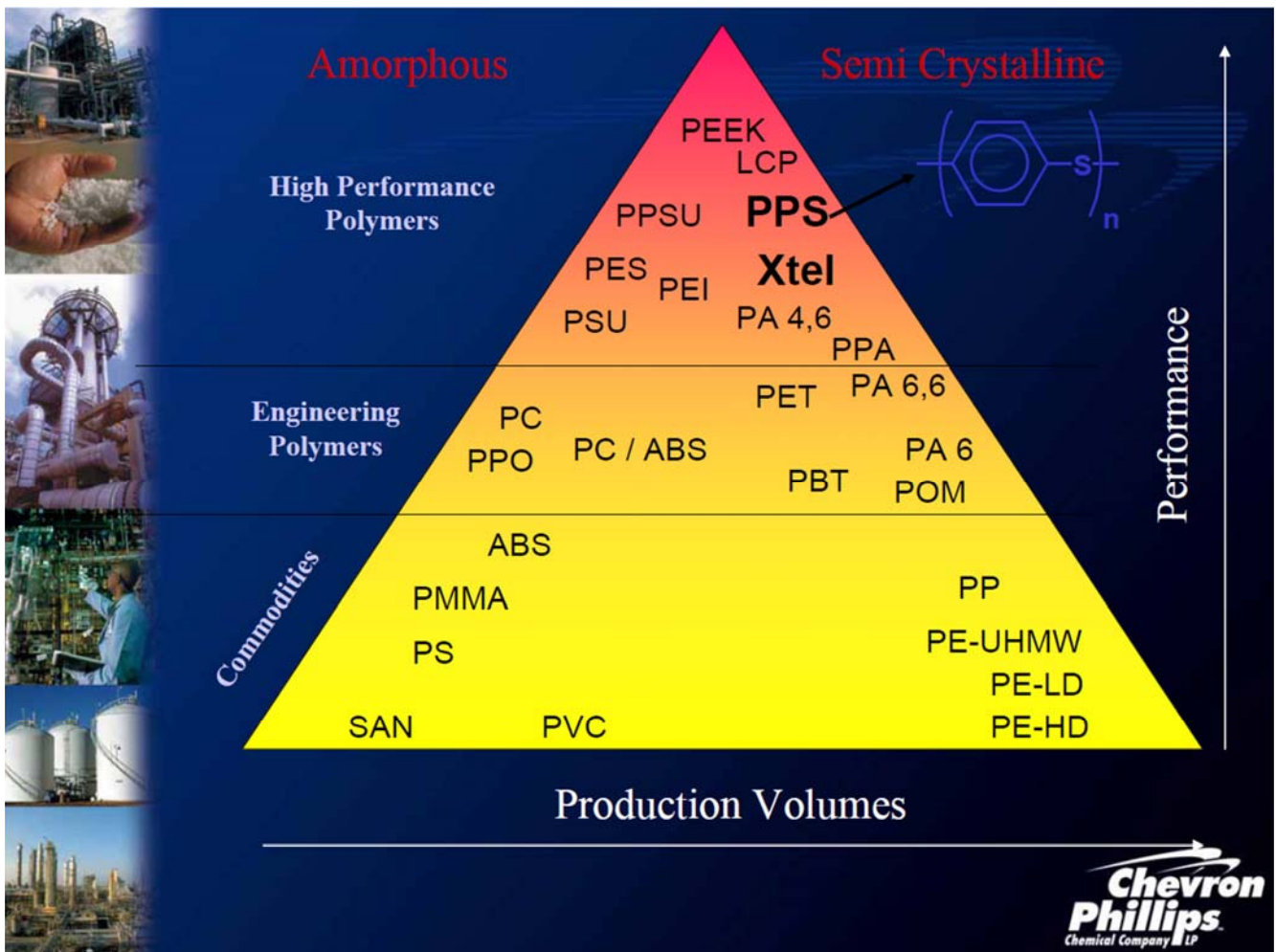
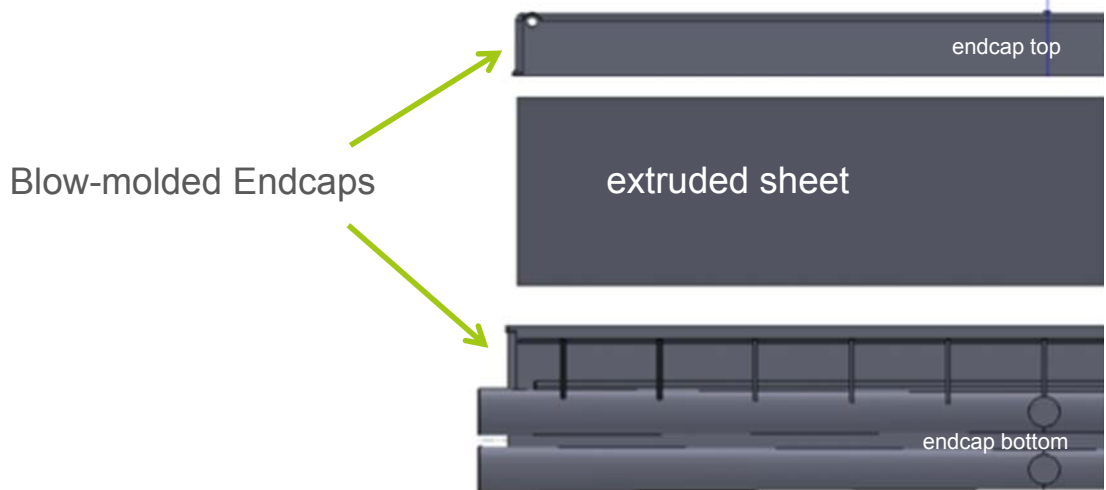
**SOLNOR-Konzept:**  
Aluminiumabsorber mit Kunststoffabdeckung

**Solarnor-Konzept:**  
NORYL-Absorber mit Kunststoffabdeckung

**AventaSolar-Kollektor:**  
PPS-Absorber mit Kunststoffabdeckung

# All-polymeric collectors with PPS Absorber

- PPS : **Polyphenylene sulfide**, semi crystalline;  
 Xtel®XE: Series of PPS/Elastomer alloys:  
 Increased flexibility and ductility and enhanced impact resistance



# Collaboration, industrial partners



- Chevron Philipps Chemicals International N.V (Belgium)**  
 subsidiary of Chevron Phillips Chemical Company LLC with headquarters in the Woodlands, Texas.  
 Producers of styrenics and aromatics a leading supplier of olefins and polyolefins, alfa olefins, specialty chemicals and proprietary plastics.

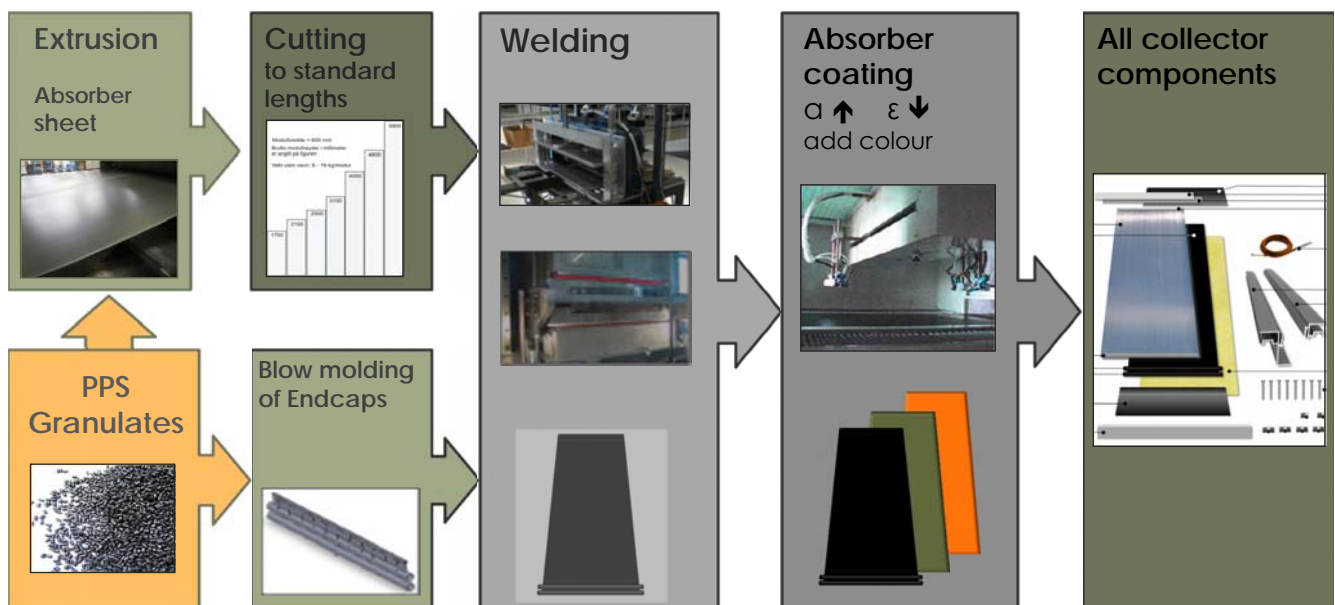


- DS Smith Kaysersberg Plastics (France)**  
 - manufacturer of plastic sheet and finished plastic products with manufacturing sites in France, Spain and the UK.



- Aventa AS (Norway)**  
 R&D of solar collectors in polymer materials together with Chevron Phillips Chemicals, Smith Group Kaysersberg Plastics and the University of Oslo.

# Production steps PPS-Absorber



# Extrusion of PPS

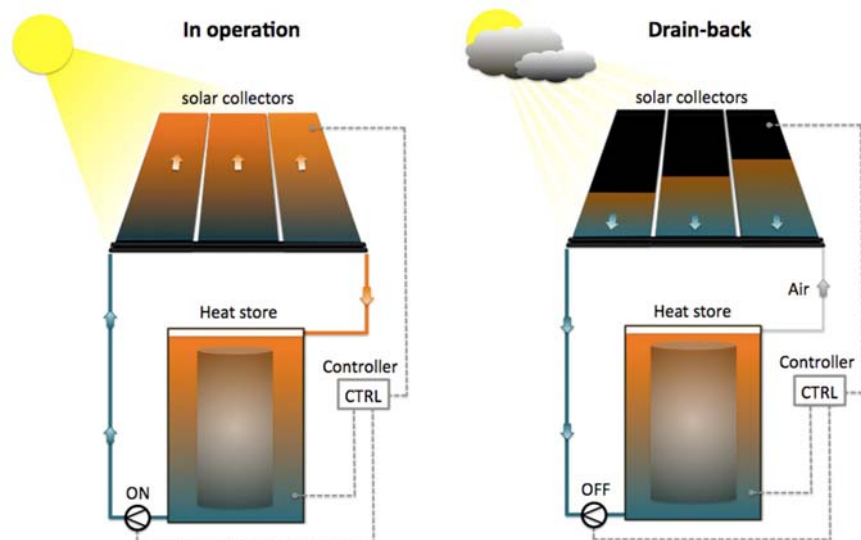
First worldwide sheet extrusion of PPS performed by Chevron Philipps, Kaysersberg Plastics and Aventa



# Prinzip - I

Solaranlage:

- Drain-back
- Druckloser Solarkreis
- Wasser als Wärmeträger
- "Direct system" (Drain-back-Reservoir)

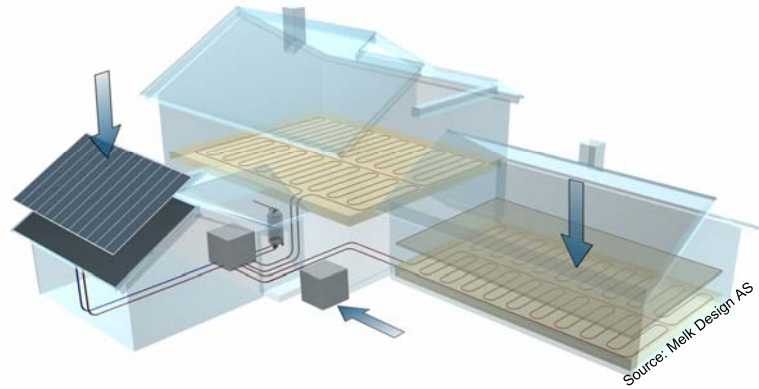




## Prinzip - II

Solaranlage:

- Niedertemperaturheizung
- Gebäudeintegration: Dach- oder Fassadenintegrierte Kollektoren ersetzen konventionelle Baumaterialien
- Architektur!



"Kunststoff als Wachstumsmotor für die Solarthermie", JKU Linz, 6. Juli 2011 | 9

## Applications, favourable systems

### Solar Domestic Hot Water Systems

Target market:  
Existing residential homes



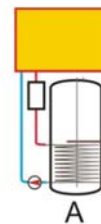
### Solar Combi Systems for hot water and space heating

Target market:  
New residential homes



### Solar Heating Systems for larger buildings

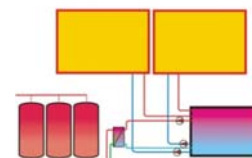
Target market:  
New and existing buildings



A



B



C

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# Kollaboration mit Bauindustrie



140 000 apartments in Oslo area

Largest Norwegian housing company OBOS invests in Aventa AS (autumn 2010).

HubroHansen AS & Aventa AS:  
Collaboration: Integration of absorbers in pre-fabricated glass / facade modules



## MULTIFUNCOAT

Multi-funktionelle Beschichtungen für Kunststoffkollektoren



AVENTA - Kollektor

Abdeckung, PC

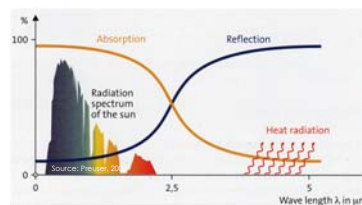
Absorber, PPS

**Projekt 1:**  
Selbstreinigende und kratzbeständige Oberflächenbeschichtungen (Kollektorabdeckung)

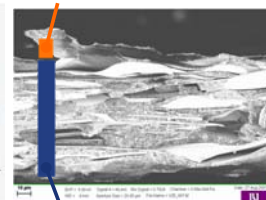


"Lotus effect"

**Projekt 2:**  
Thickness Insensitive Spectrally Selective paint coatings  
Increase efficiency  
Colours => Esthetics



Solar radiation absorbing layer

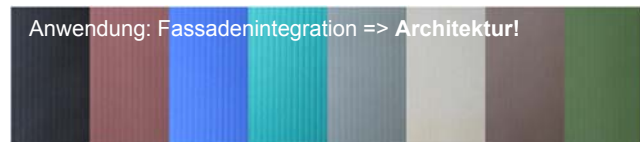


IR reflective layer.

### CONSORTIUM PARTNERS

National Institute of Chemistry, Slovenia  
COLOR, HELIOS Group; Slovenia  
AVENTA AS, Norway

Anwendung: Fassadenintegration => Architektur!

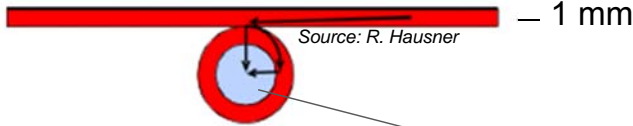


# Geringe Wärmeleitfähigkeit

Kein Nachteil bei richtigem Design!

## Konventioneller Flachkollektor

$F \approx 0.93 - 0.97$



$\lambda_{\text{cop}} = 384 \text{ W/(m K)}$   
 $\lambda_{\text{alu}} = 220 \text{ W/(m K)}$   
 Volumenstrom, Wärmeträger ca.  $0,3 \text{ l/(min m}^2\text{)}$

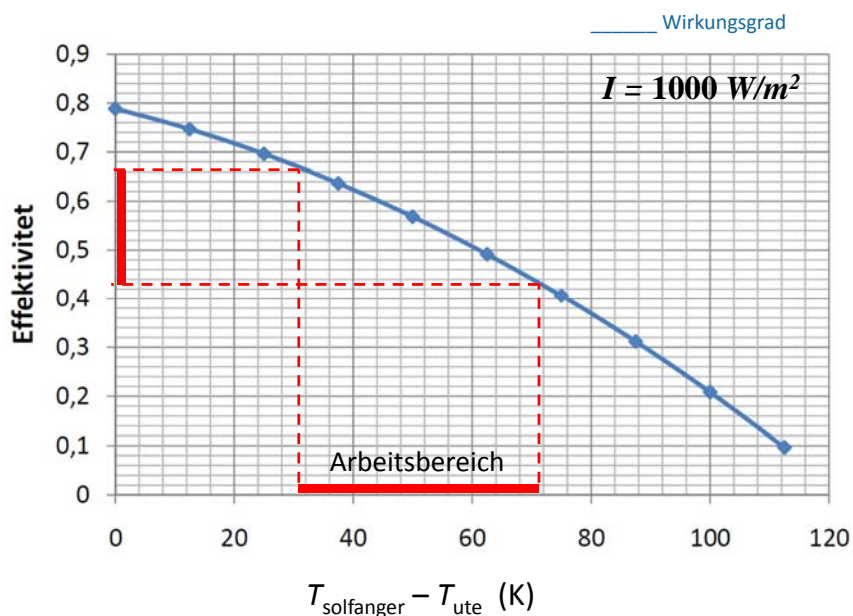
## Flachkollektor aus Kunststoff (mit Abdeckung) Doppelstegplatte, ca. 1 mm Wandstärke

$F \approx 0.97 - 0.98$

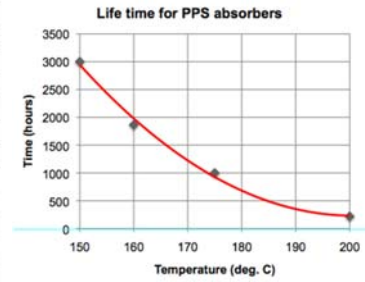
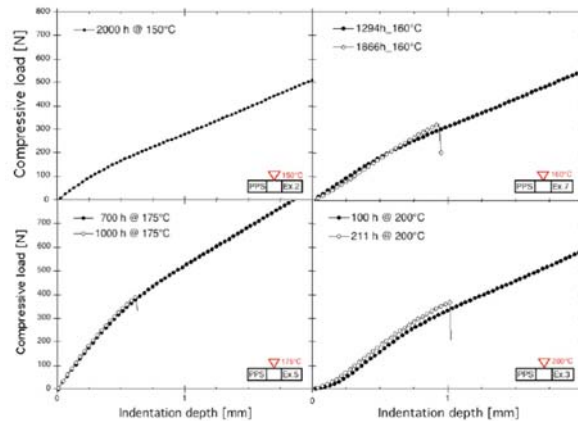
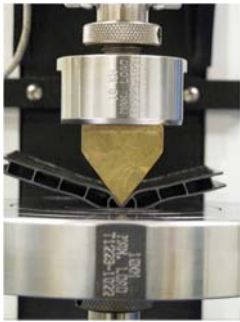


$\lambda_{\text{K}} \approx 0.2 \text{ W/(m K)}$   
 Volumenstrom, Wärmeträger ca.  $1 \text{ l/(min m}^2\text{)}$

# Kollektorwirkungsgrad



# Service-life-estimations: Indentation tests



Assumptions: System is passive (stagnation temperature) 36 hours pr. month with clear sky.

| Ambient temperature | Jan – Febr:  | 20 ° C |
|---------------------|--------------|--------|
|                     | Mar – April: | 30 ° C |
|                     | May – Aug:   | 40 ° C |
|                     | Sept – Oct:  | 30 ° C |
|                     | Nov – Dec:   | 20 ° C |

- Results, method, further reading: Service-life estimations: Rekstad et al., 2010. SOLAR COLLECTOR ABSORBERS IN HIGH-PERFORMANCE POLYMERIC MATERIALS, Eurosun 2010, Graz, Austria, 28.09. - 01.10.2010

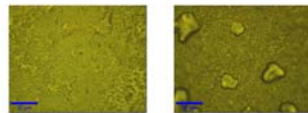
# Non-destructive methods

Investigation methods, material changes / degradation



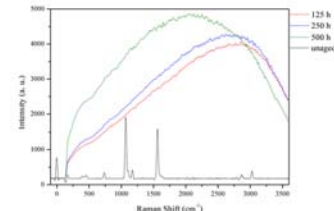
## A) Ramanmikroskopische Untersuchung

Micrographs von PPS-Proben vor (oben) und nach (unten) 500 h UV Bestrahlung



Karl-Anders Weiss et al., Fraunhofer ISE Germany

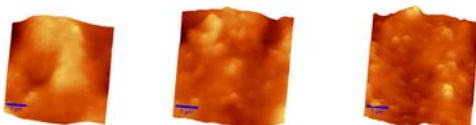
## C) Raman-spectra of PPS, after different times of exposure to UV irradiation.



Karl-Anders Weiss et al., Fraunhofer ISE Germany

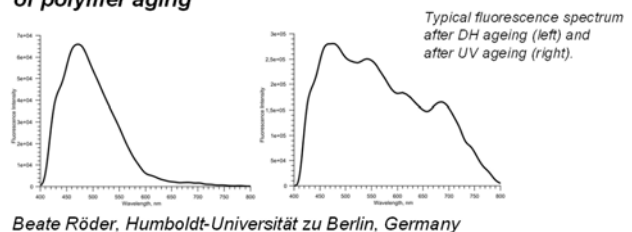
## B) Rasterkraftmikroskopische Untersuchung

Topography von PPS-Proben vor (links), nach 500 h UV irradiation (Mitte) und 500 h bei 85 ° C, 85% r.h. (rechts).



Karl-Anders Weiss et al., Fraunhofer ISE Germany

## D) Fluorescence spectroscopy for observation of polymer aging

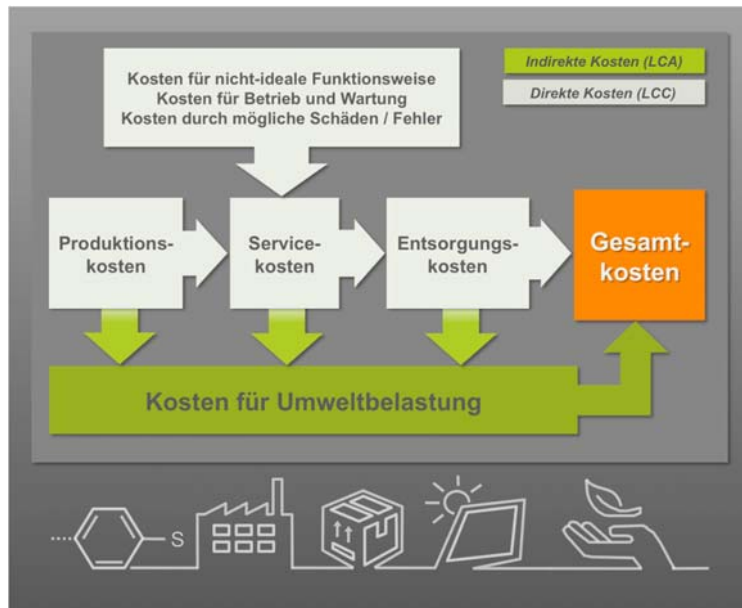


Beate Röder, Humboldt-Universität zu Berlin, Germany

Further reading: Summary of preliminary analysis in IEA-SHC Newsletters: <http://www.iea-shc.org/task39/newsletter>



# Total cost accounting approach



Mit Hilfe eines Gesamtkostenverfahrens soll die Wahl von Polymermaterialien beim Produktdesign im Rahmen von Subtask A (IEA-SHC Task 39) analysiert werden.

*Bo Carlsson and Helena Persson  
Linnæus University, Kalmar, Sweden*

*Aventa AS, Oslo, Norway*

Further reading: Follow IEA-SHC Newsletters: <http://www.iea-shc.org/task39/newsletter>

# Kollaboration mit Partnern in Österreich



- PCCL : Doktorarbeit Susanne Kahlen (Prof. Dr. G. Wallner, Prof. Dr. R. Lang)



- AEE - Institute for Sustainable Technologies (AEE-INTEC)



- AIT – Austrian Institute of Technology



- IEA-SHC Task 39: Polymeric Materials in Solar Thermal Applications  
Operating Agent: Dr. M. Köhl, Fraunhofer Institute for Solar Systems, Freiburg Germany;  
<http://www.iea-shc.org/task39/>