

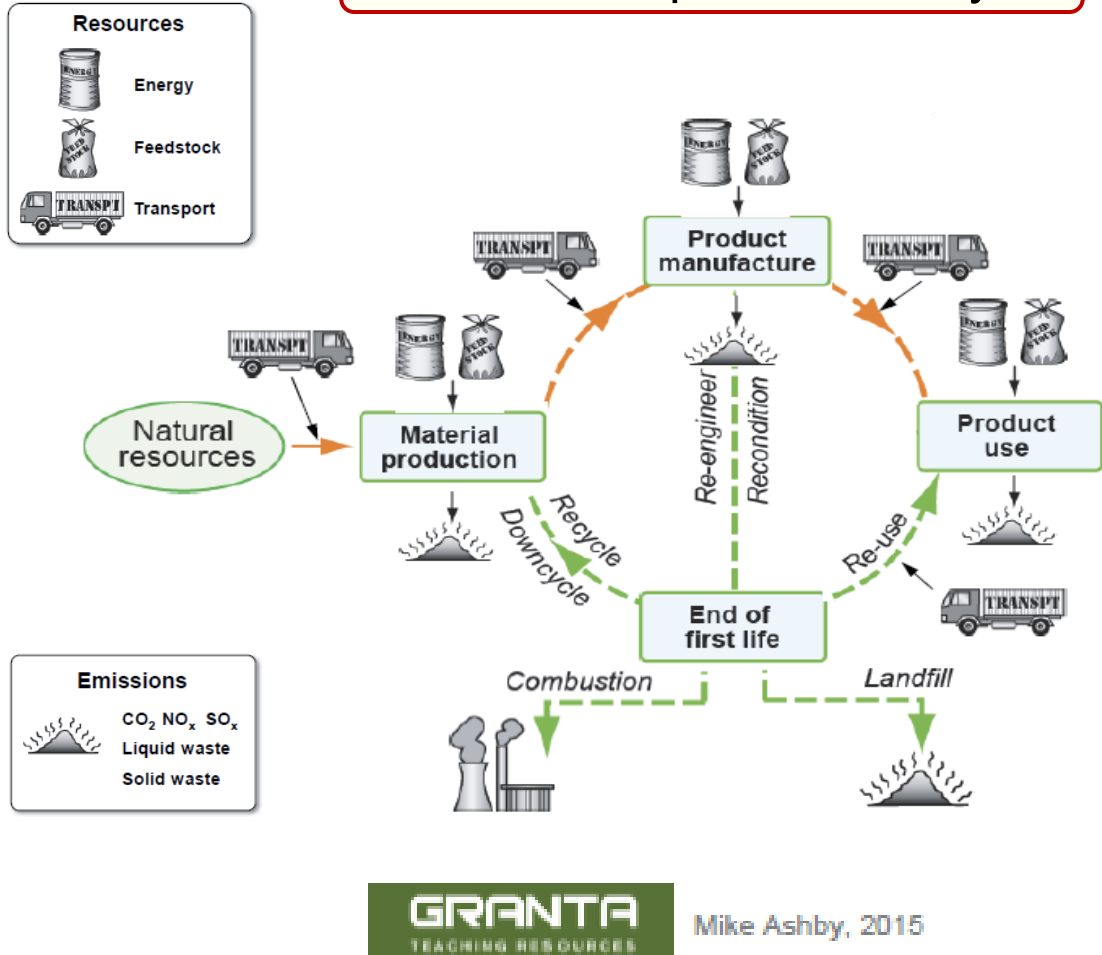


# VERGLEICHENDE LEBENSZYKLUSANALYSE FÜR DIE „SIDE BY SIDE“ THERMOSIPHON- UND PV TO HEAT-ANLAGE IN NAMIBIA

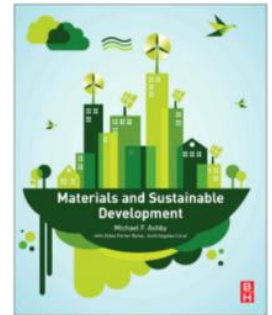
Harald Kicker, Monika Spörk-Dür, Joseph Shigwedha, Rudi Moschik,  
Harald Poscharnig, Gernot M. Wallner

# PRE-RESEARCH – ECO-AUDIT APPROACH

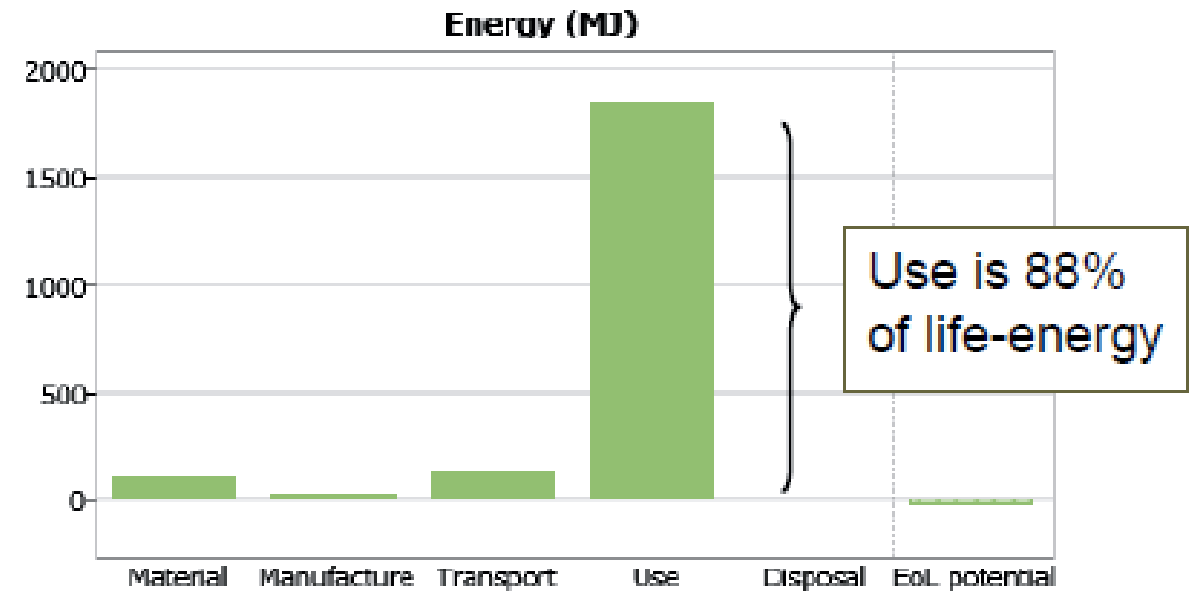
## The material/product life cycle



M. Ashby  
*Materials and Sustainable Development*  
 Elsevier, 2015



## Typical eco-audit result

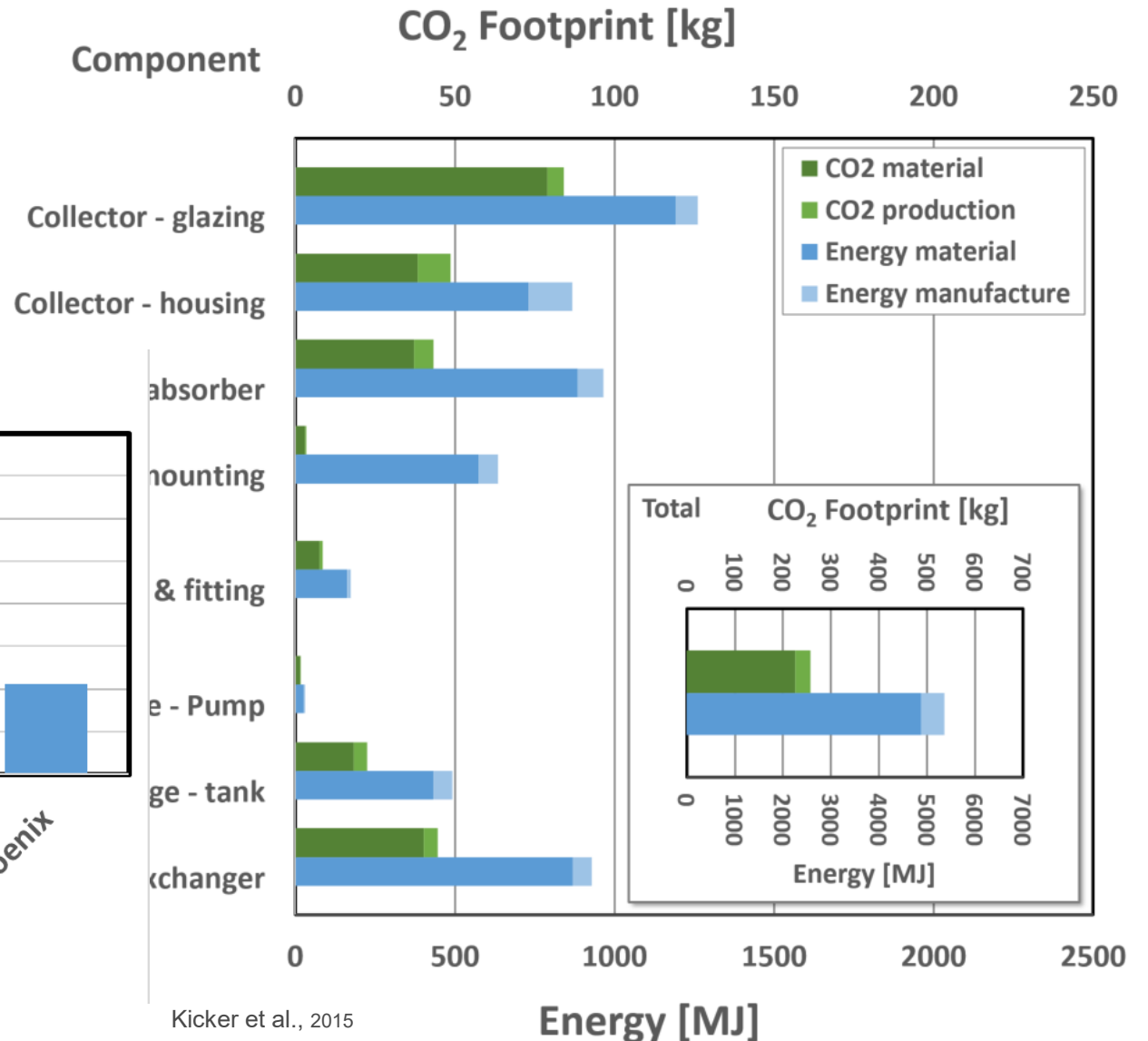
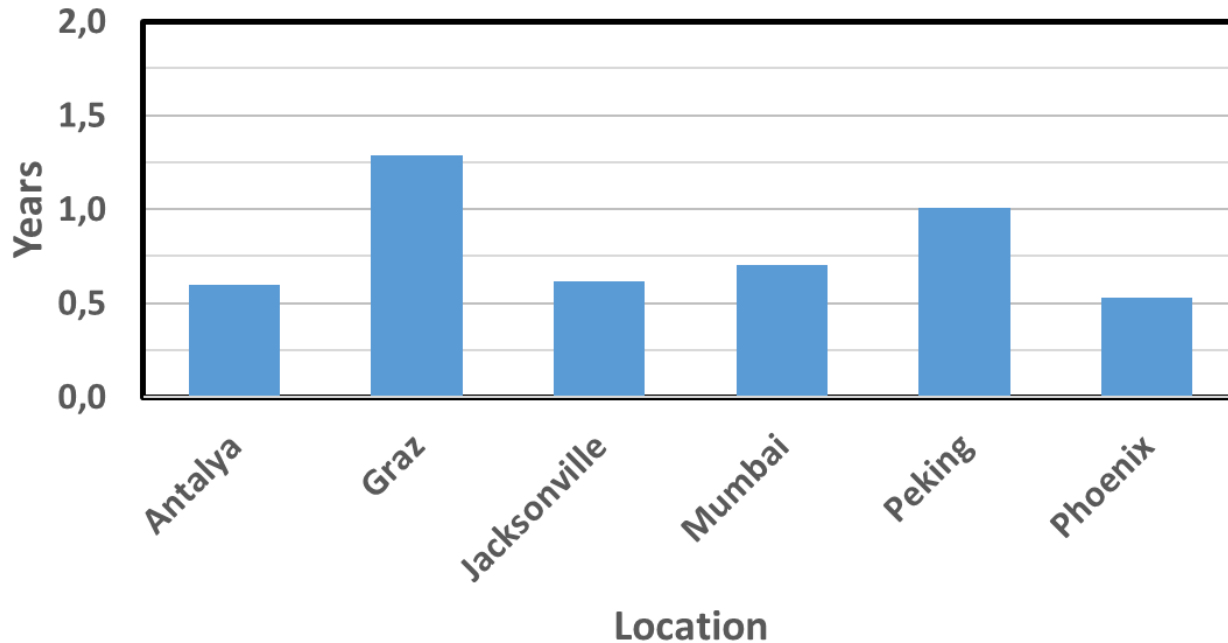


# PRE-RESEARCH – POLYMERIC COLLECTOR SYSTEMS

**Ecological Assessment:** From “*function units*” at the materials level to “*material indices*” at the systems level



Energy Payback Time



# PRE-RESEARCH – POLYMERIC COLLECTOR SYSTEMS

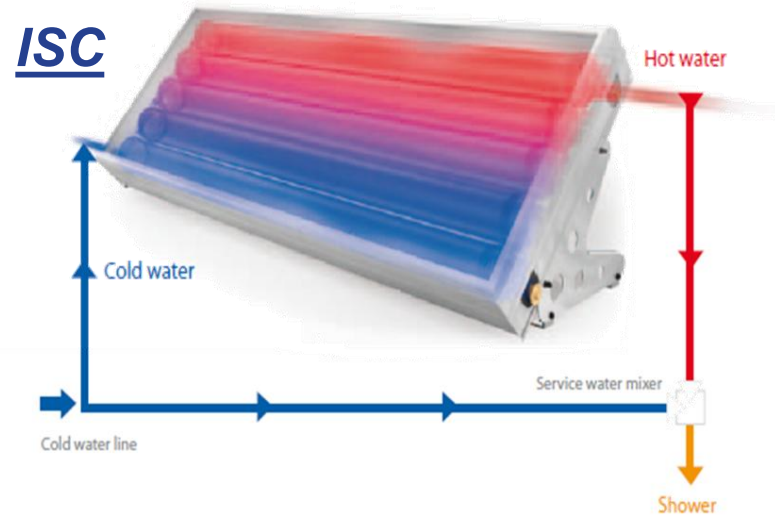
Comparative analysis of different polymeric collector systems

Novel (nearly)  
all-polymeric ST collectors



PCS

Pumped All-Polymeric Solar Thermal Collector System



ISC

Integrated Storage Collector System



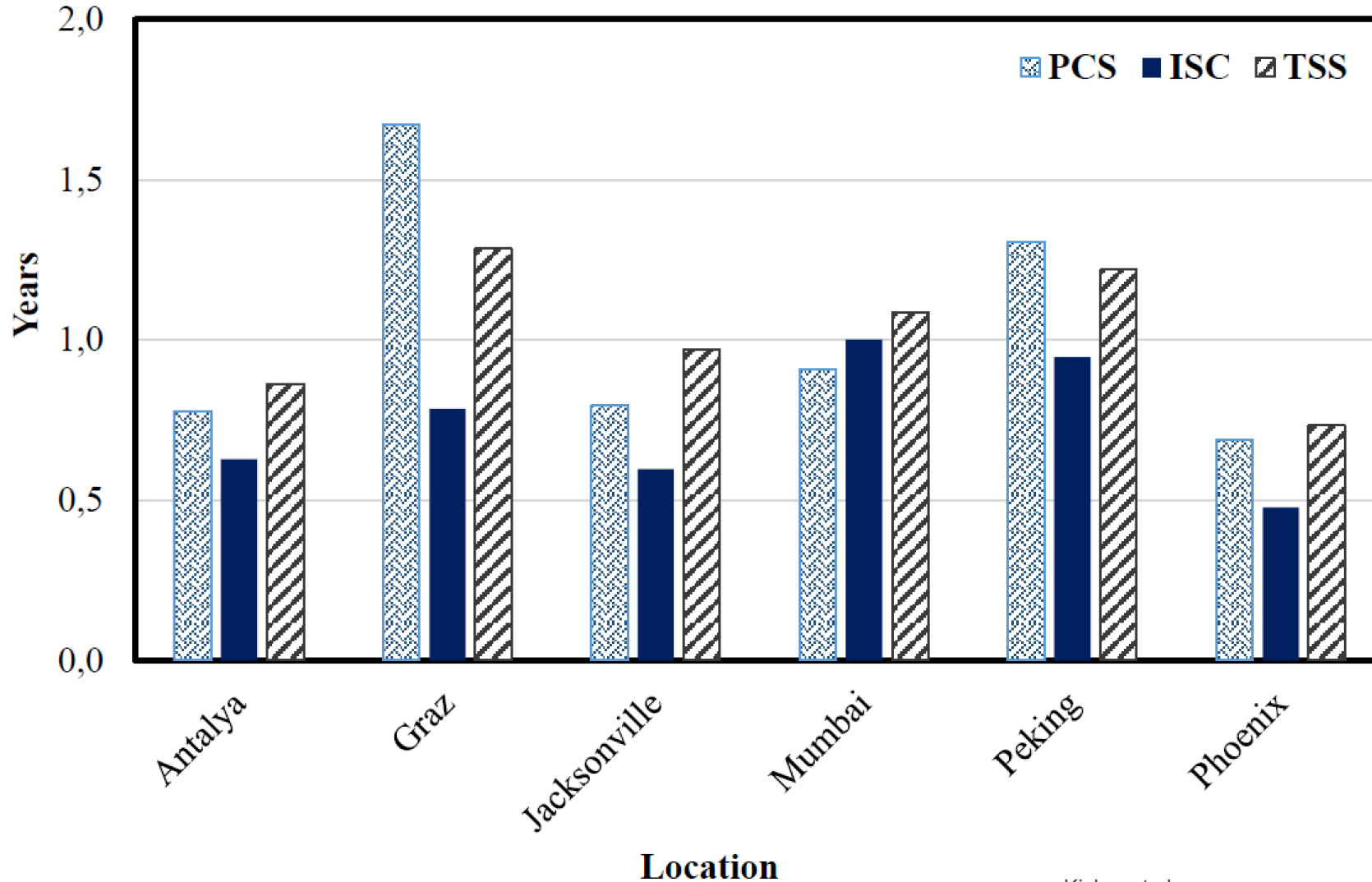
TSS

Thermosiphon System

# PRE-RESEARCH – POLYMERIC COLLECTOR SYSTEMS

## Comparative analysis of different polymeric collector systems

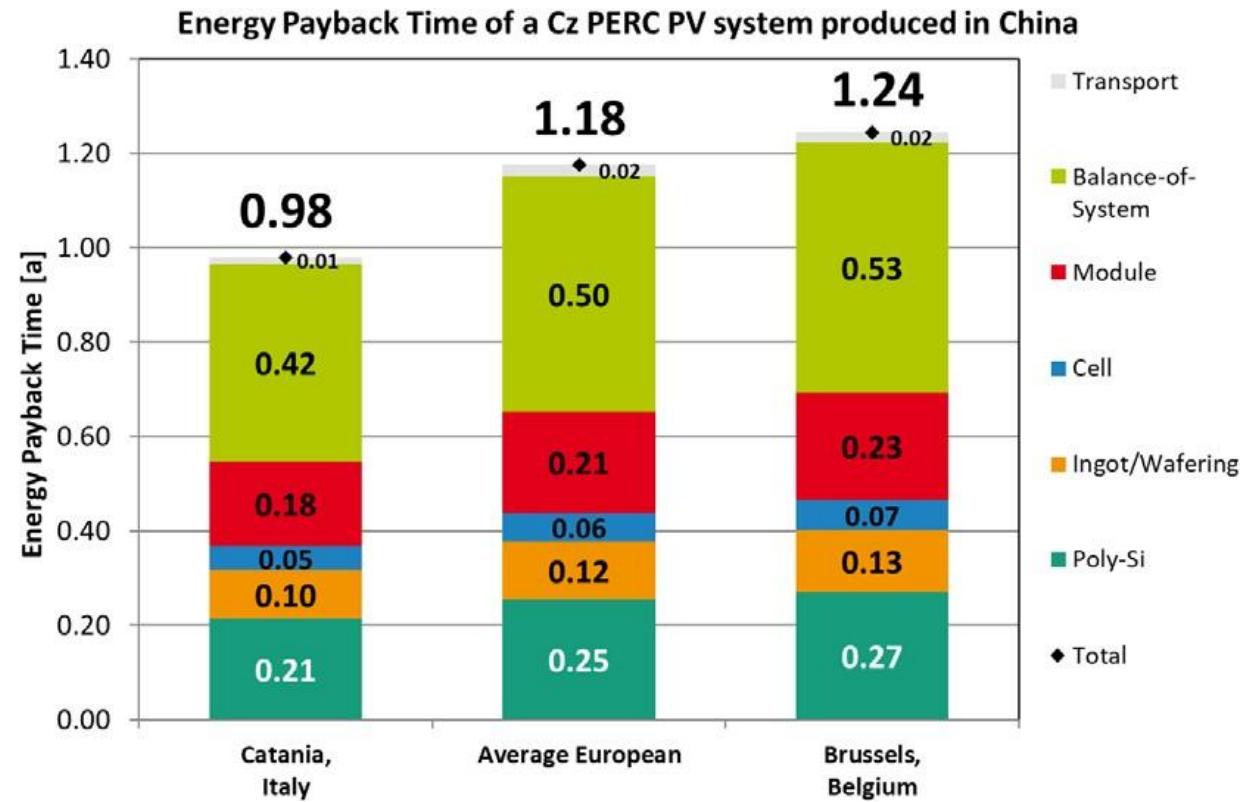
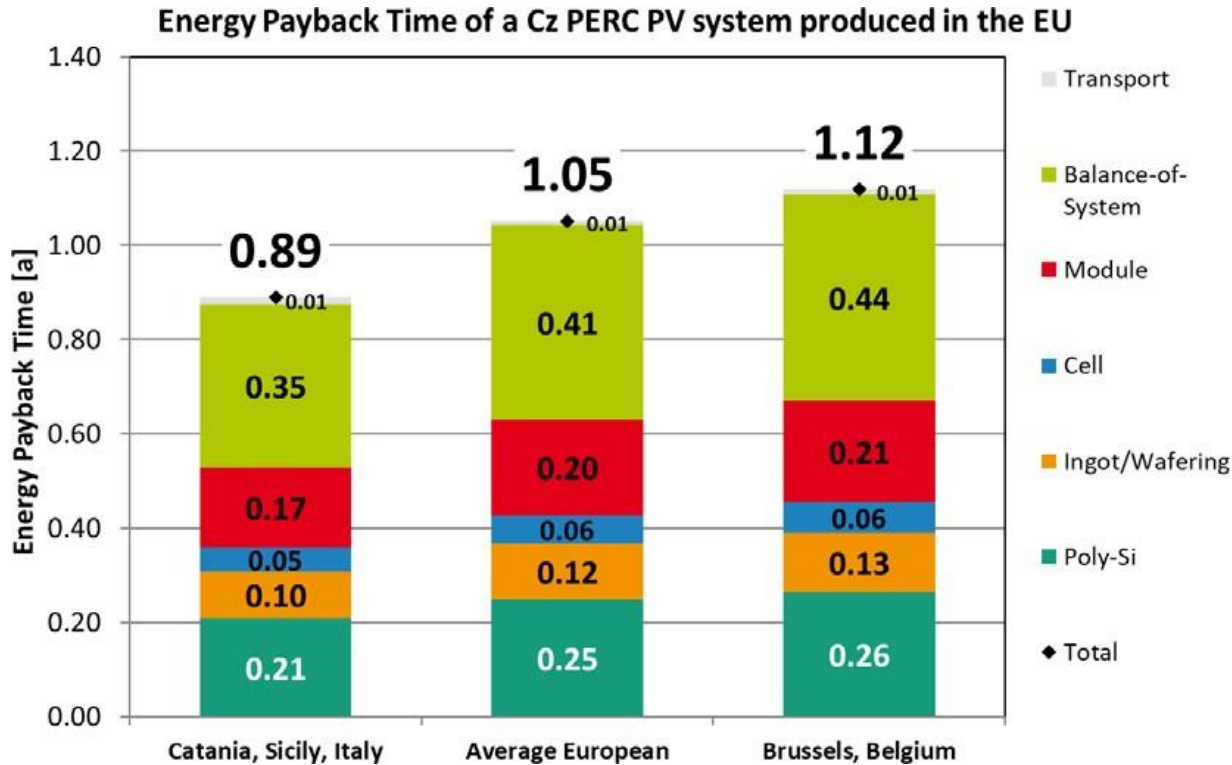
### Energy Pay Back Time by comparism



- EPBT: 0.7-1.7 years
- Site-dependent
- Energetic amortization factor > 10!  
(lifetime = 20 years)

## Ecological Assessment: World Map Energy Pay-Back Time (EPBT) of Silicon PV Rooftop Systems

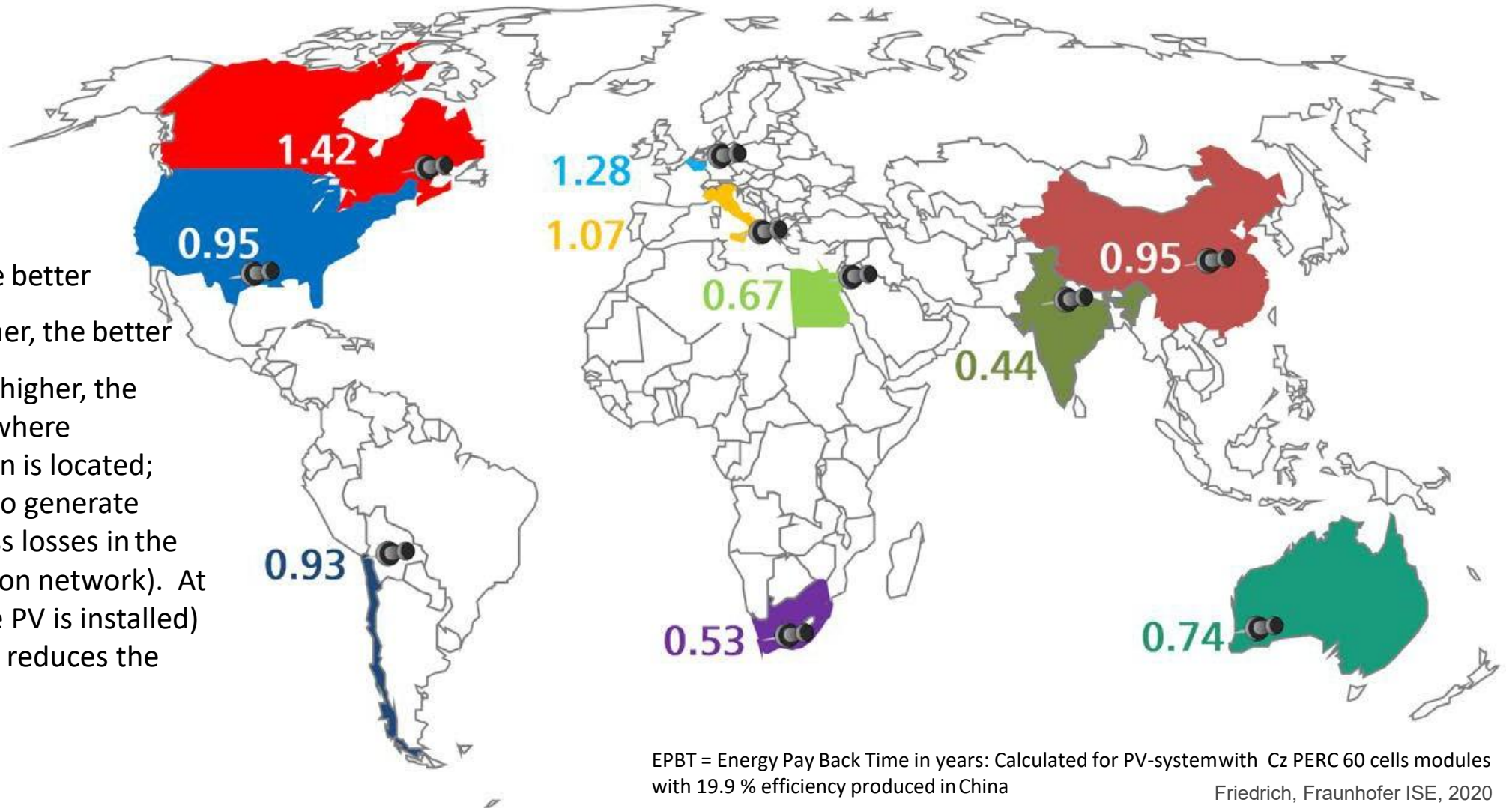
### Comparison of EPBT China / EU, local Irradiation and Grid Efficiency 2021



EPBT for PV systems produced in Europe is shorter than for those produced in China because of better grid efficiency in Europe.

# PRE-RESEARCH – PHOTOVOLTAICS

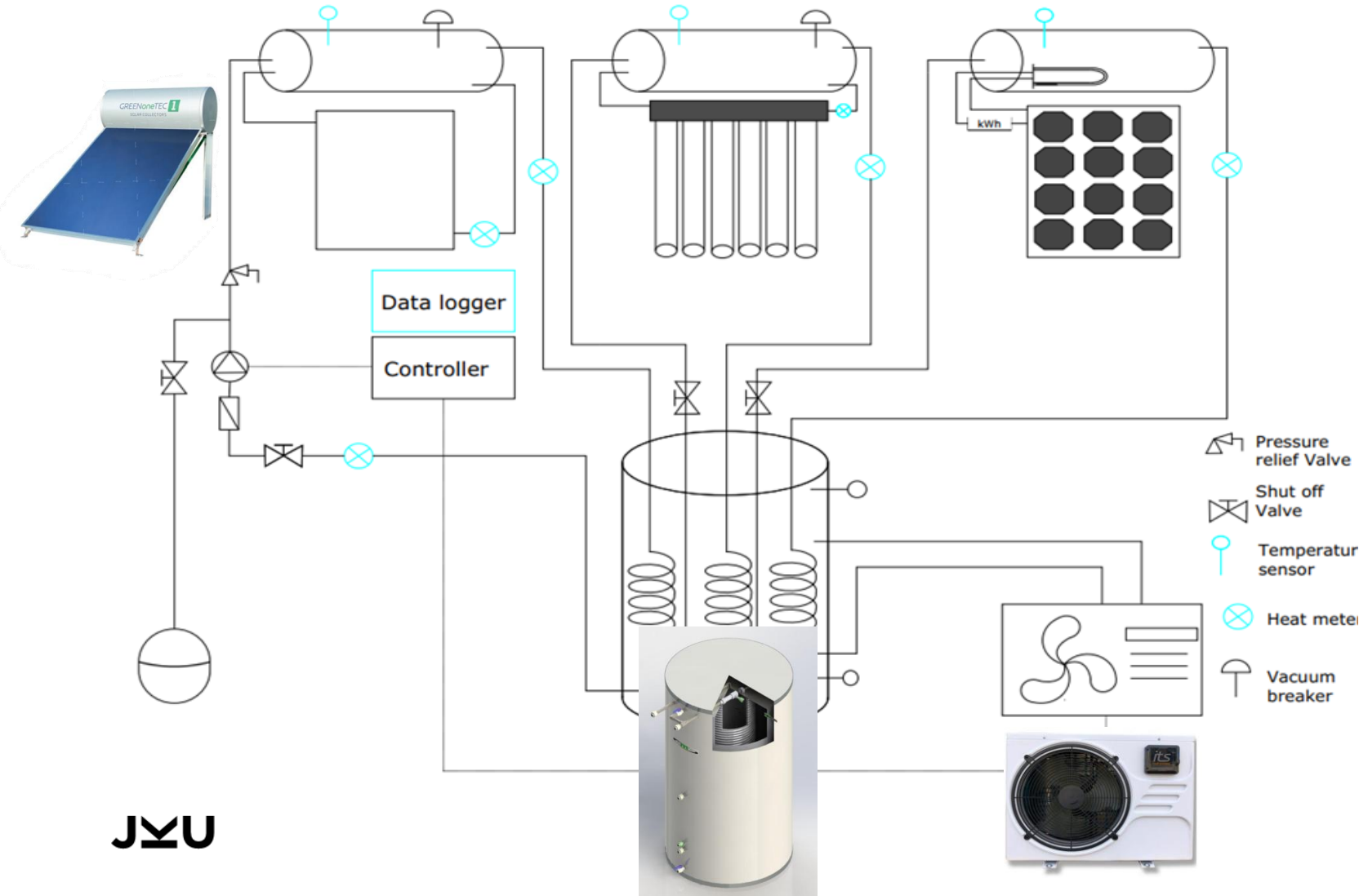
## Ecological Assessment: World Map Energy Pay-Back Time (EPBT) of Silicon PV Rooftop Systems



- EPBT: The lower, the better
- Irradiation: The higher, the better
- Grid efficiency: The higher, the better in countries where upstream production is located; (better energy mix to generate electrical power; less losses in the electrical transmission network). At downstream (where PV is installed) a low grid efficiency reduces the EPBT.

# IEA SHC TASK 39 – NAMIBIA

## Side-by-Side Experimental Setup



**Top -**

**Thermosiphon systems:**

- **FP:** Flat-plate collector ( $2\text{m}^2$ )
- **VT:** Vacuum tube ( $2\text{m}^2$ )
- **PV** to heat ( $1,4 \text{ kW}_{el}$ )
- + 200 litre storage tank

**Bottom -**

**Small-scale hot water demand system**

# IEA SHC TASK 39 – NAMIBIA

## Side-by-Side Experimental Setup



**Top -**

**Thermosiphon systems:**

- Flat-plate collector (2m<sup>2</sup>)
- Vacuum tube (2m<sup>2</sup>)
- PV to heat (1,4 kW<sub>el</sub>)
- + 200 litre storage tank

**Bottom / Container -**

**Small-scale hot water demand system**

# IEA SHC TASK 39 – NAMIBIA

## Demonstration systems NHE houses



1 house is equipped with SWH  
4 m<sup>2</sup>  
300 Liter

### Demonstration houses - 3 systems:

- SWH - 2m<sup>2</sup> - 150 litre
- SWH - 4m<sup>2</sup> - 300 litre
- 6 PV - 300 litre

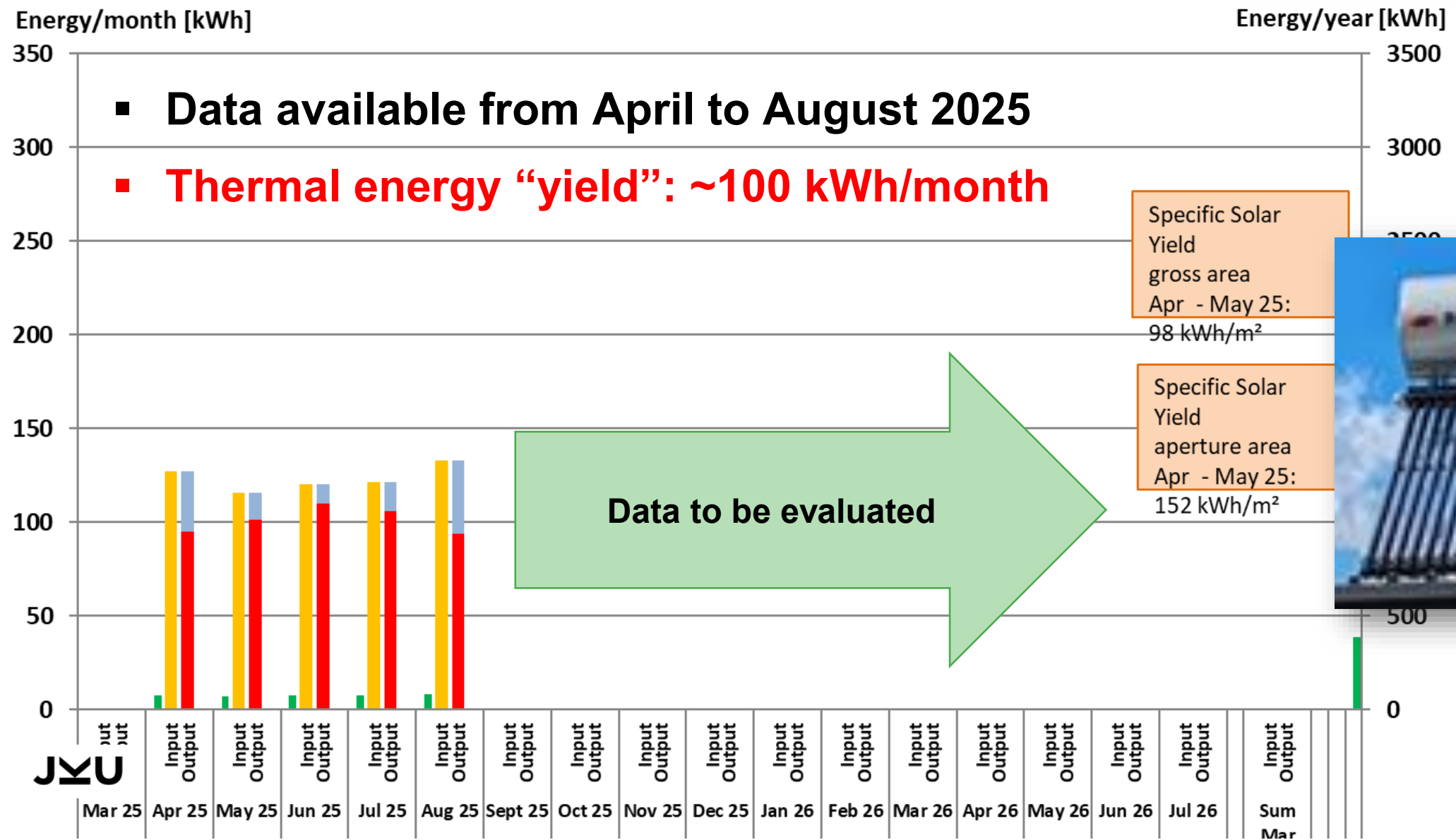
1 house is equipped with 300 Liter tank heated directly by 6 PV-Modules

4 houses are equipped with SWH  
2m<sup>2</sup>  
150 Liter

# IEA SHC TASK 39 – NAMIBIA – SIDE-BY-SIDE VT



■ E\_th\_Solar\_Sys2 kWh 
 ■ E\_th\_Hot\_water\_Sys2 kWh 
 ■ E\_loss kWh 
 ■ E\_el\_ehe\_Sys2 
 ■ E\_th\_Sol

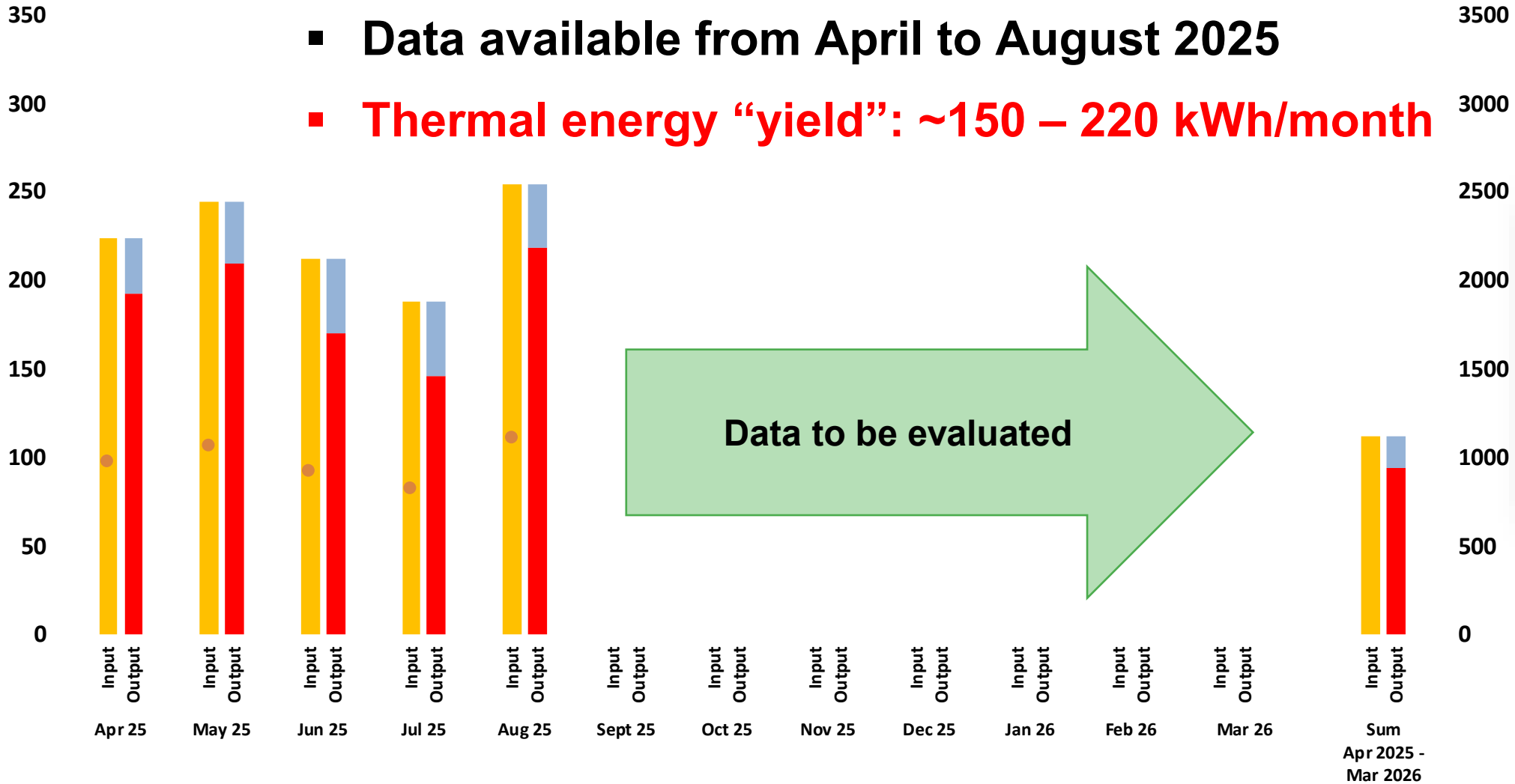


# IEA SHC Task 39 – NAMIBIA – SIDE-BY-SIDE FP

■ E\_th\_Solar\_Sys1 kWh   
 ■ E\_th\_Hot\_water\_Sys1 kWh   
 ■ E\_loss kWh   
 ■ E\_el\_ehe\_Sys1 kWh   
 ● E\_th\_Solar\_Sys1/m<sup>2</sup>

Energy/month [kWh]

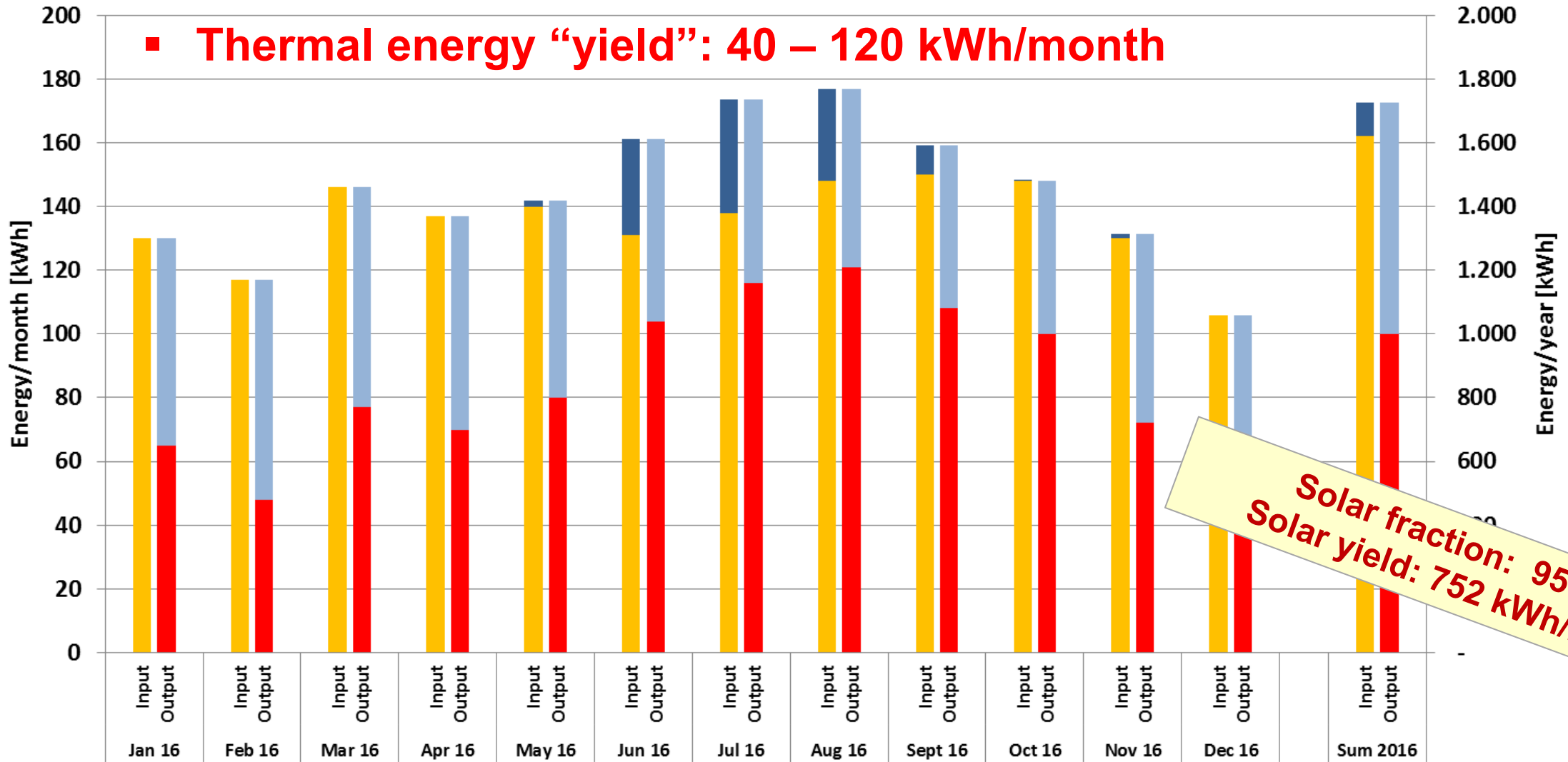
Energy/year [kWh]



# IEA SHC Task 39 – NAMIBIA – DEMONSTRATION FP



■ E\_th\_Solar\_NHE2140 kWh   
 ■ E\_th\_Hot\_water\_NHE2140 kWh   
 ■ E\_loss kWh   
 ■ E\_el\_ehe\_NHE2140 kWh



# IEA SHC Task 39 – NAMIBIA – DEMONSTRATION FP



## Ecological Assessment: Energy & CO<sub>2</sub> Pay-Back Time (EPBT, CPBT)

Phase	Energy (MJ)	CO <sub>2</sub> footprint (kg)
Material	8834	590
Manufacture	533	40
Transport	0	0
Use	0	0
Disposal	1	0
Total (for first life)	<b>9 368</b>	<b>630</b>
End of life potential	-139	-10

EPBT

1,5 y

GHG Reduct. Pot.

1,05 t/y\*

CPBT

0,6 y

\* acc. to EPA GHG

- **EPBT: exp. & theor. values are comparable**
- **1 t CO<sub>2</sub>/y savings → ~20% of per capita emissions**



- **Environm. impact dominated by material supply**

# SUMMARY & CONCLUSIONS



- **Energy Pay-Back Time:**
  - **Similar range for solar thermal and PV technologies → 0.5 – 1.5 years**
  - **mainly dependent on site (climate), and less on technology**
  - **good agreement of experimental and theoretical data**
- **CO<sub>2</sub> savings by solar hot water preparation:**
  - **1050 kg/year → ~20% of per capita emissions (EU)**
- **Side-by-side solar hot water technology evaluation:**
  - **further data evaluation to be done**
  - **better performance of flat-plate thermosiphon collector system**

more details provided at:

JYU

**ISEC**

4<sup>th</sup> INTERNATIONAL  
SUSTAINABLE ENERGY  
CONFERENCE 2026

14 – 16 April 2026  
Messecongress Graz  
Austria