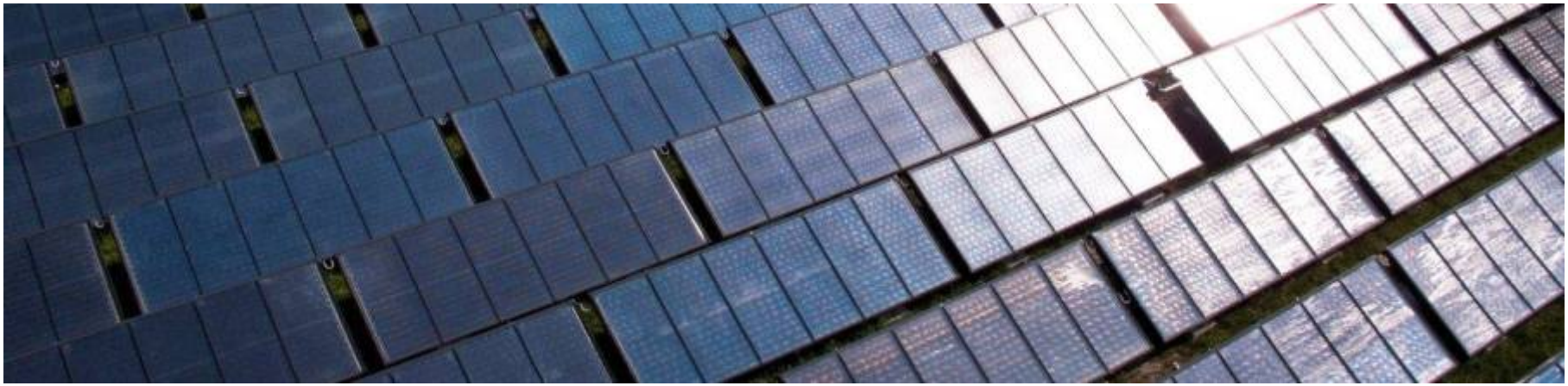
SOLAR COOLING

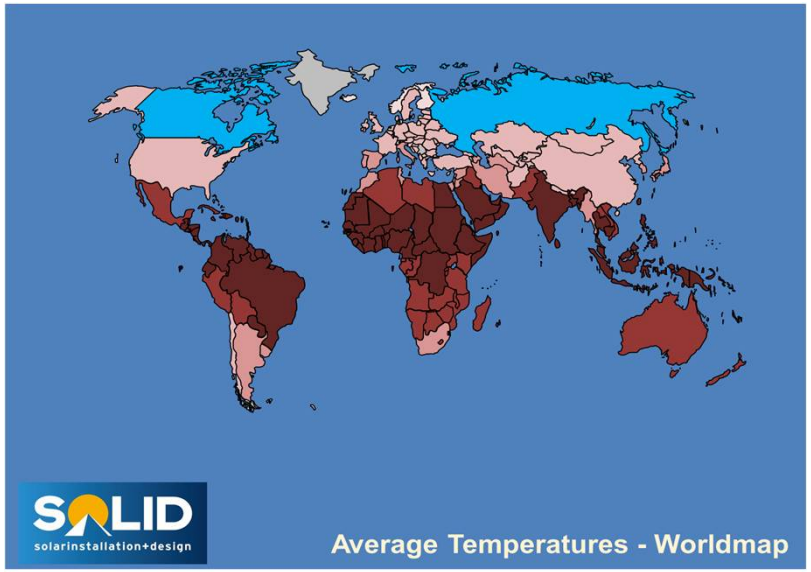
Measurement Results and Operating Experience of Large-Scale Solar Thermal Air Conditioning Systems



S.O.L.I.D. GmbH
www.solid.at
2018

✓ **SOLID:**

- Trendsetter for large-scale solar thermal systems
- 26 years of experience
- More than 300 references worldwide



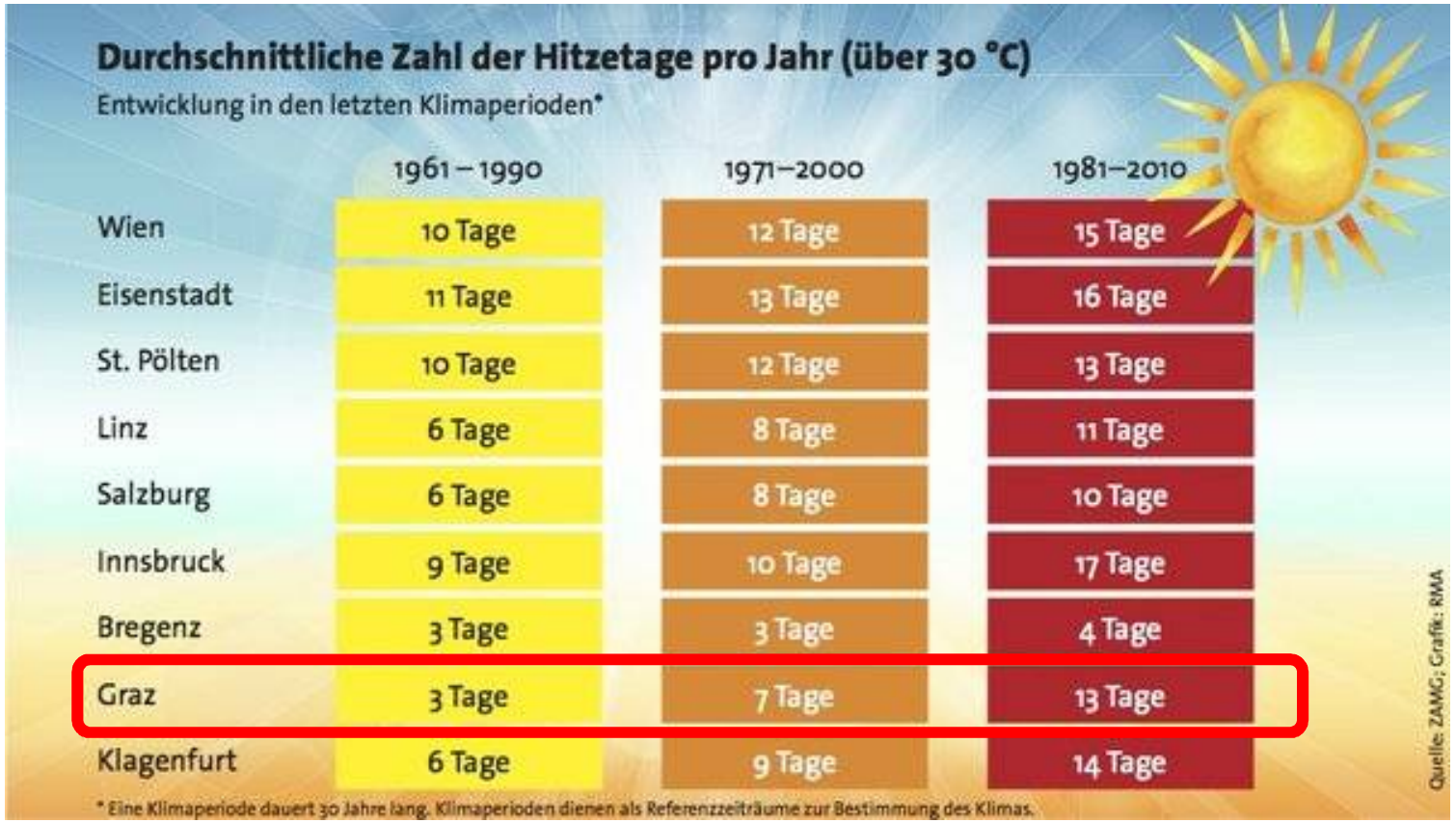
✓ **Motivation:**

- IEA 2018: increasing cooling demand

✓ **Aim:**

- Analyse KPI of solar thermal cooling systems (>1MW)
- Outline Cost- and Performance Trends

Future demand on AC increasing



Durchschnittliche Zahl der Hitzetage pro Jahr (über 30 °C)

Entwicklung in den letzten Klimaperioden*

	1961 – 1990	1971–2000	1981–2010
Wien	10 Tage	12 Tage	15 Tage
Eisenstadt	11 Tage	13 Tage	16 Tage
St. Pölten	10 Tage	12 Tage	13 Tage
Linz	6 Tage	8 Tage	11 Tage
Salzburg	6 Tage	8 Tage	10 Tage
Innsbruck	9 Tage	10 Tage	17 Tage
Bregenz	3 Tage	3 Tage	4 Tage
Graz	3 Tage	7 Tage	13 Tage
Klagenfurt	6 Tage	9 Tage	14 Tage

* Eine Klimaperiode dauert 30 Jahre lang. Klimaperioden dienen als Referenzzeiträume zur Bestimmung des Klimas.

Quelle: ZAMG; Grafik: RMA

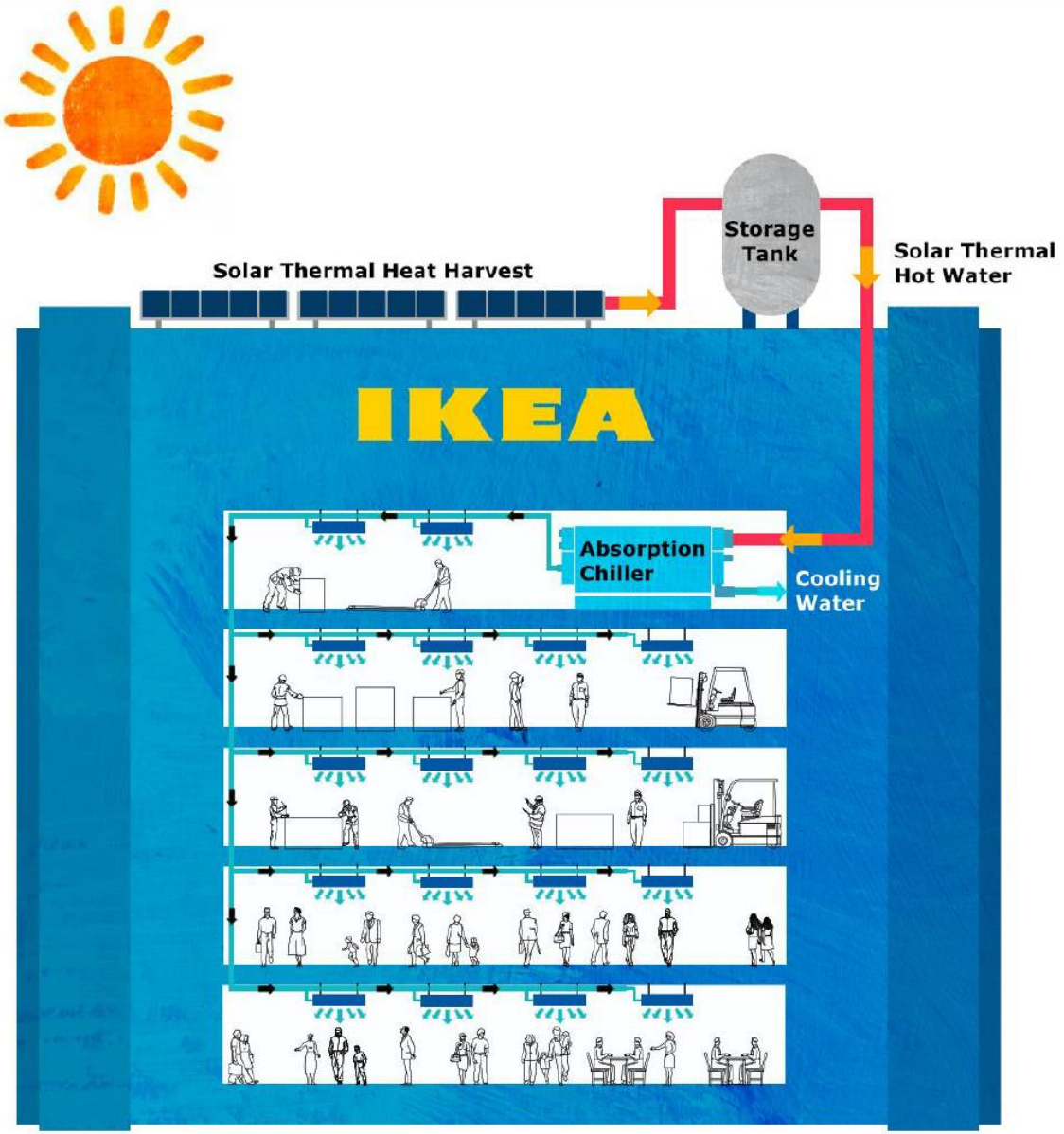
Tropical days Graz 2012-2017: 23 days per year

Forecast Graz 2050: 50-80 days per year

Quelle: ZAMG, Grafik RMA

Solar heating &cooling for hospitals

IKEA Singapur

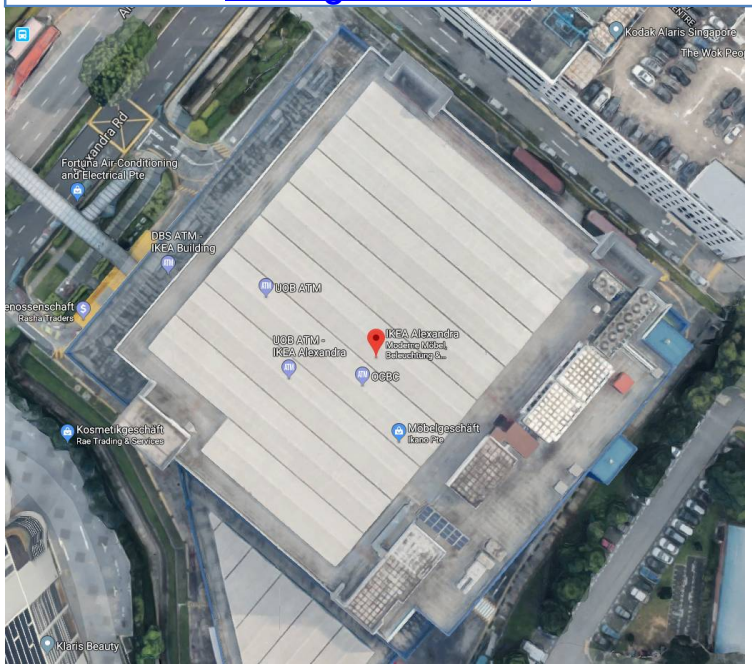


IKEA Singapur

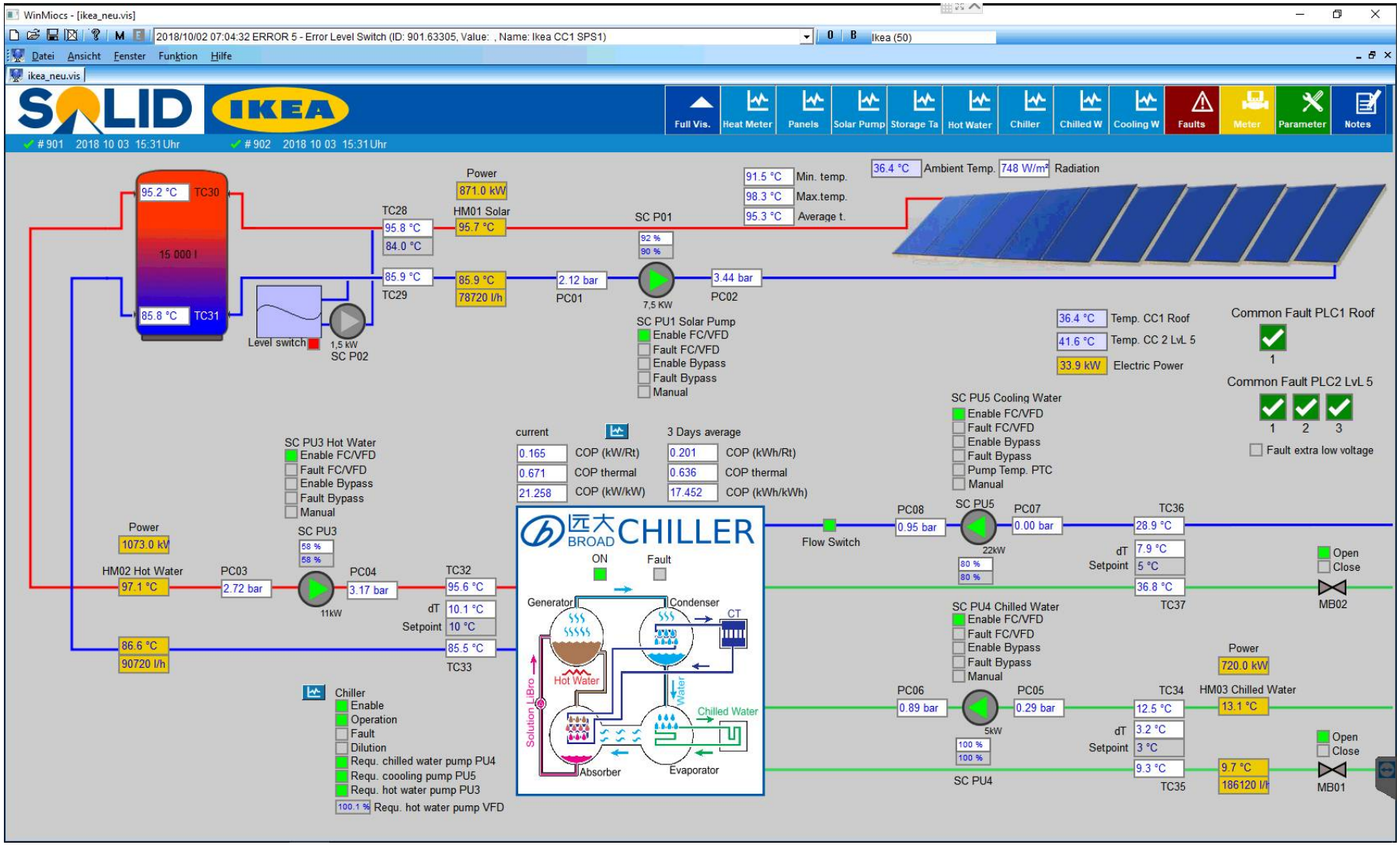
Collector Area	2.472 m²
Volume Heat Storage Tank	15 m³
Nominal Capacity Chiller	250 RT / 880 kW

Integral concept with electric and solar cooling.
(300+300+300+250 RT), Solar Cooling to reduce peak loads

You Tune: [Ikea goes solar]



IKEA Singapur



Hospital Managua, Nicaragua

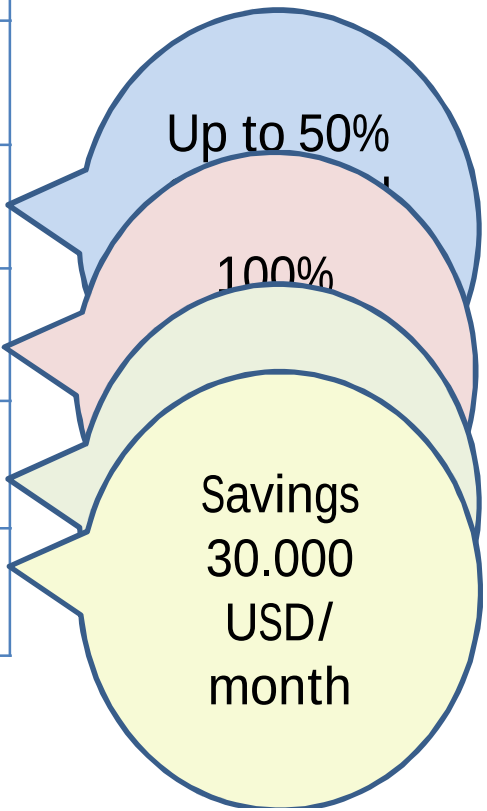
Hospital Militar Escuela Dr. Alejandro Dávila Bolaños
Managua, Nicaragua

World's 3rd most powerful Solar Cooling System

Most powerful Solar Cooling System of Latin America

Technical data

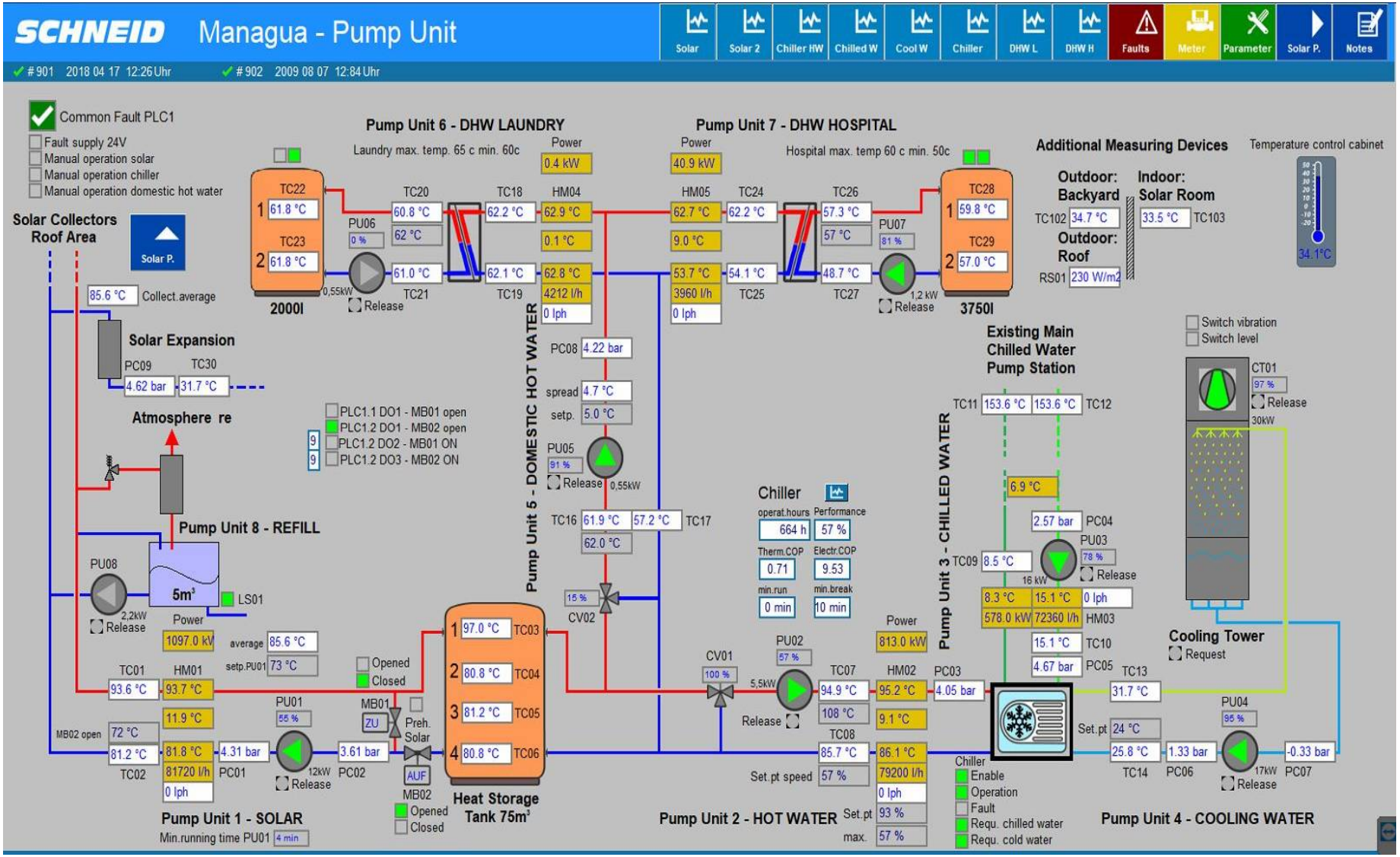
Collector Area	4.450 m²
Inclination / Orientation	20 ° South
Volume Heat Storage Tank	75 m³
Nominal Capacity Chiller	291 RT / 1023 kW
Solar Cooling Fraction	approx. 30 %
Hot Water Hospital	up to 100 %
Hot Water Laundry	up to 100 %
Payback time	6-8 years



Pictures


Militärkrankenhaus
Hospital Militar
Escuela Dr 'Alejandro...
Hospital Militar

Telemonitoring



Pictures – Construction Phase

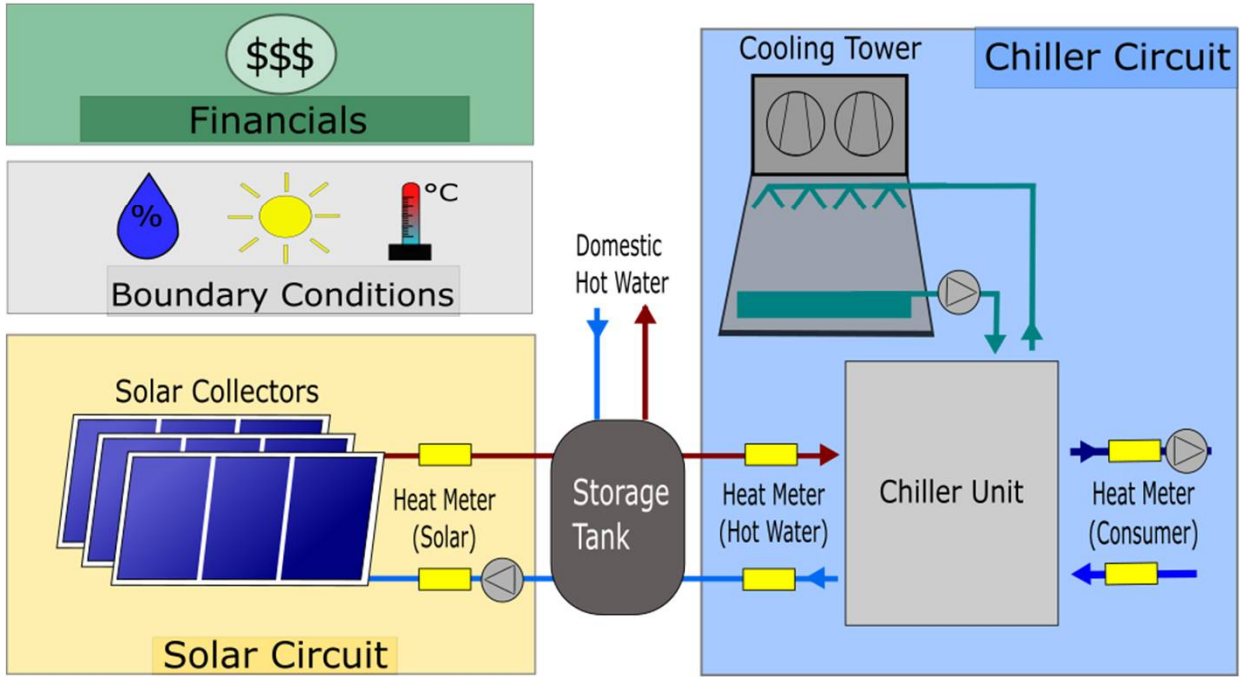
Pictures – Construction Phase

Pictures – Construction Phase

Selected Solar Systems

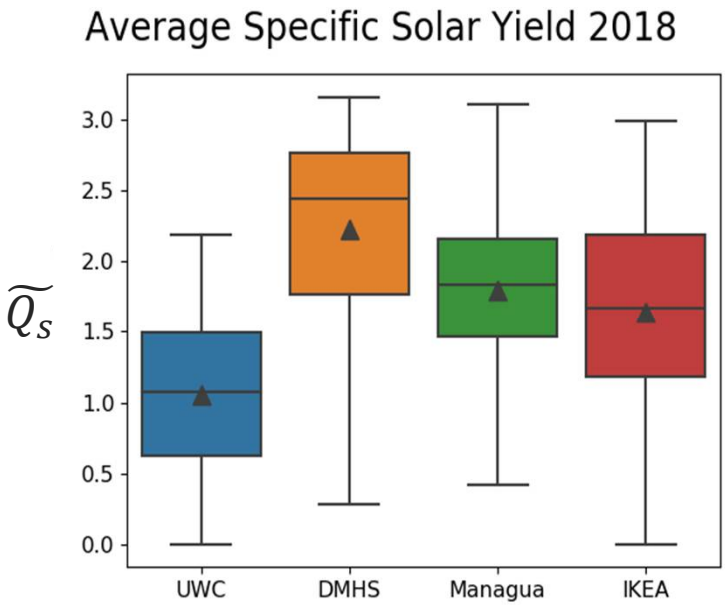
	United World Collage (UWC)	Desert Mountain High School (DMHS)	Hospital Managua (MANAGUA)	Ikea Alexandra (IKEA)
Commissioned	2011	2014	2017	2017
Location	Singapore	USA, Arizona	Nicaragua	Singapore
Collector Area	3872 m²	4935 m²	4450 m²	2472
Cooling Capacity	1475 kW	1750 kW	1023 kW	880kW
Domestic Hot Water	Yes	No	Yes	No
Climate	Tropical Rainforest Climate	Desert Climate	Tropical Wet and Dry Climate	Tropical Rainforest Climate

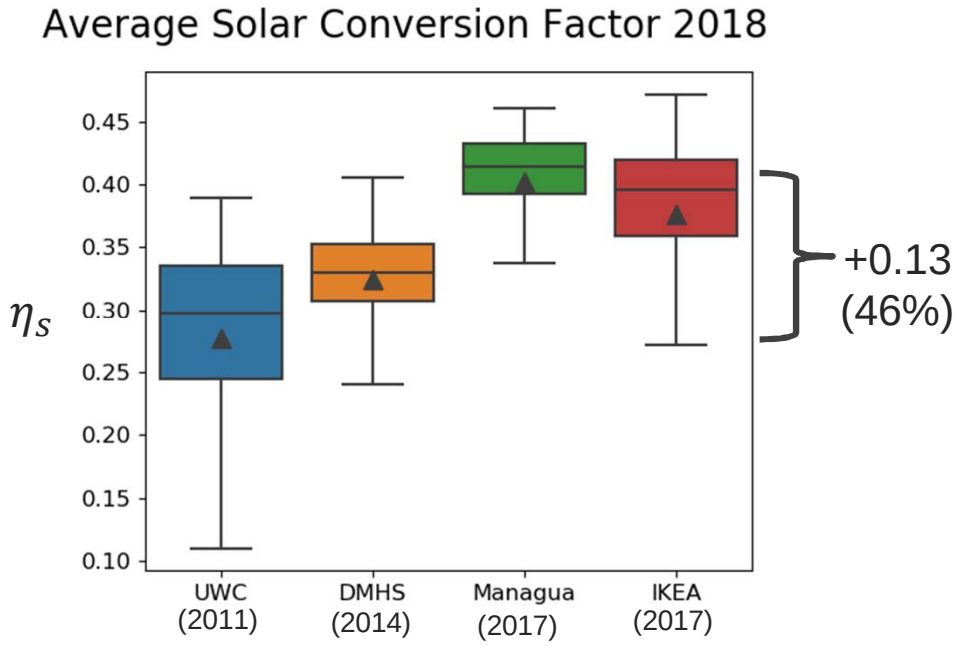
Method


$$$
Financials
%
°C
Boundary Conditions
Solar Collectors
Heat Meter
(Solar)
Solar Circuit
Domestic
Hot Water
Storage
Tank
Cooling Tower
Chiller Circuit
Heat Meter
(Hot Water)
Chiller Unit
Heat Meter
(Consumer)

Results

Results: Collector Efficiency

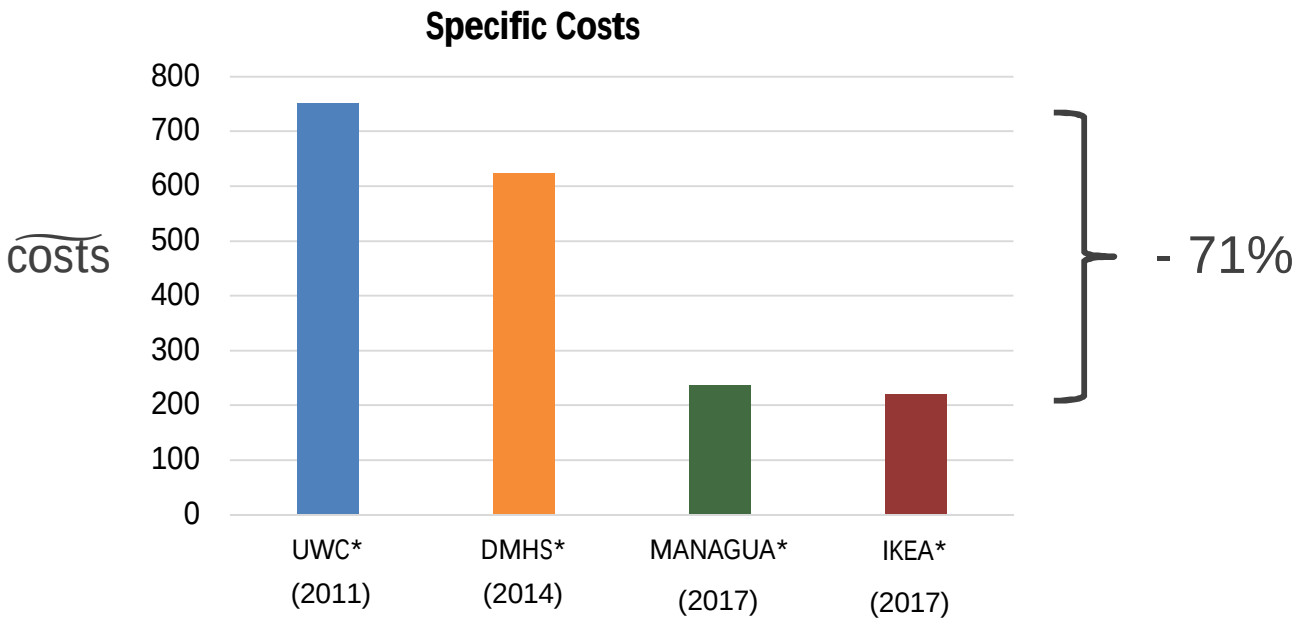




$$\widetilde{Q_s} = \frac{Q_s}{A_{col}} \qquad \eta_s = \frac{\tilde{Q}_s}{H}$$

Q_s … Solar Yield (kWh/day)
A_{col} … Collector gross Area (m²)
H … Irradiation (W/m²)
$\widetilde{Q_s}$ … Specific Solar Yield (kWh/m²/day)
η_s … Conversion Factor (/day)

Results: Costs



* cost estimates for similar scope of supply

$$\widetilde{costs} = \frac{costs}{A_{col} \cdot \eta_s}$$

η_s … Conversion Factor (/day)
A_{col} … Collector gross Area (m²)
$costs$ … Estimated total system costs (Mio.$)
$\widetilde{costs}$ … Weighted Specific costs (Mio.$/m²/$\eta_s$)

Conclusion

- Increasing solar performance
- Decreasing costs

- Other conclusions:
  - Solar systems perform as planned
  - Minor improvments for the thermal and electrical COP
  - O&M Experiences

Thank you for your attention!

S.O.L.I.D. Gesellschaft für Solarinstallation und Design mbH
Puchstrasse 85, 8020 Graz, Austria
CEO: Christian Holter & Franz Radovic
Tel: +43 316 292840-0
Fax: +43 316 292840-28
Email: office@solid.at
http://www.solid.at