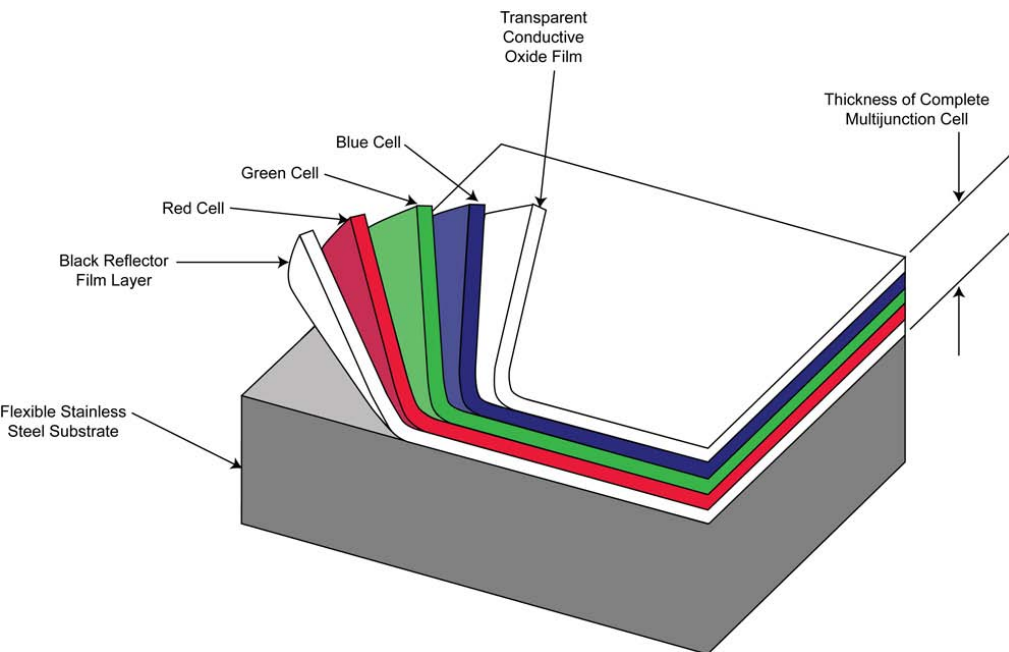


UNI-SOLAR
Flat Roof Performance Data

- *UNI-SOLAR* triple-junction amorphous silicon technology performance
- *UNI-SOLAR* performs as well when installed flat as most traditional crystalline PV installed at an angle
 - Lugano, Switzerland
 - Schwaerzelbach, Germany
 - Santa Cruz, California, USA
- *UNI-SOLAR* measured flat roof performance mostly above solar calculators estimation:
 - WfB Mainz, Germany (76 kWp)
 - Gleisbergschule Mainz, Germany (78 kWp)
 - Muenster, Germany (261 kWp)
 - Dresden, Germany (786 kWp)
 - Santa Olivia, Barcelona, Spain (104 kWp)
 - Riverside, CA, USA (104 kWp)

UNI-SOLAR triple junction technology captures more of the light spectrum, especially the blue part.

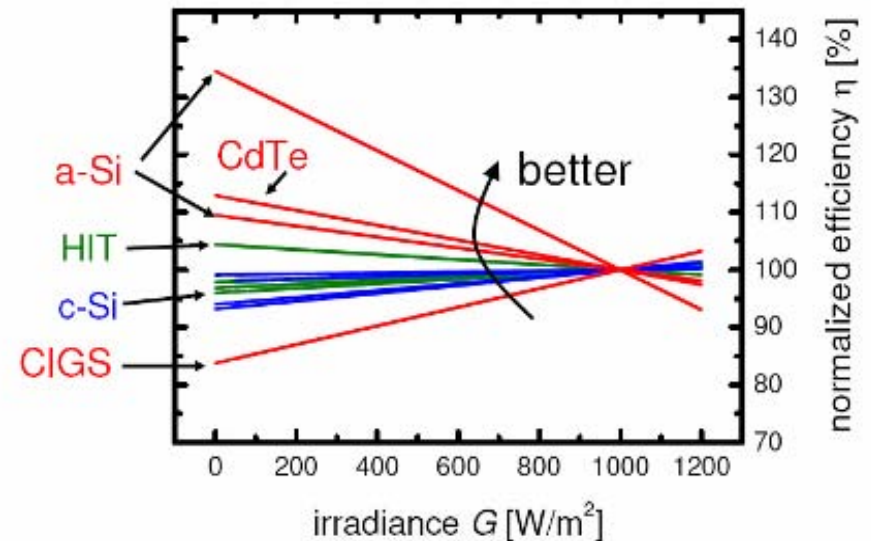
»better performance at non-ideal angles of incidence and in low and diffuse light.



Amorphous silicon has a superior irradiance coefficient.

»better performance at non-ideal angles of incidence and in low and diffuse light.

Irradiance Coefficients δ



UNI-SOLAR efficiency increases at low light conditions. All other technologies have lower efficiencies at low light.

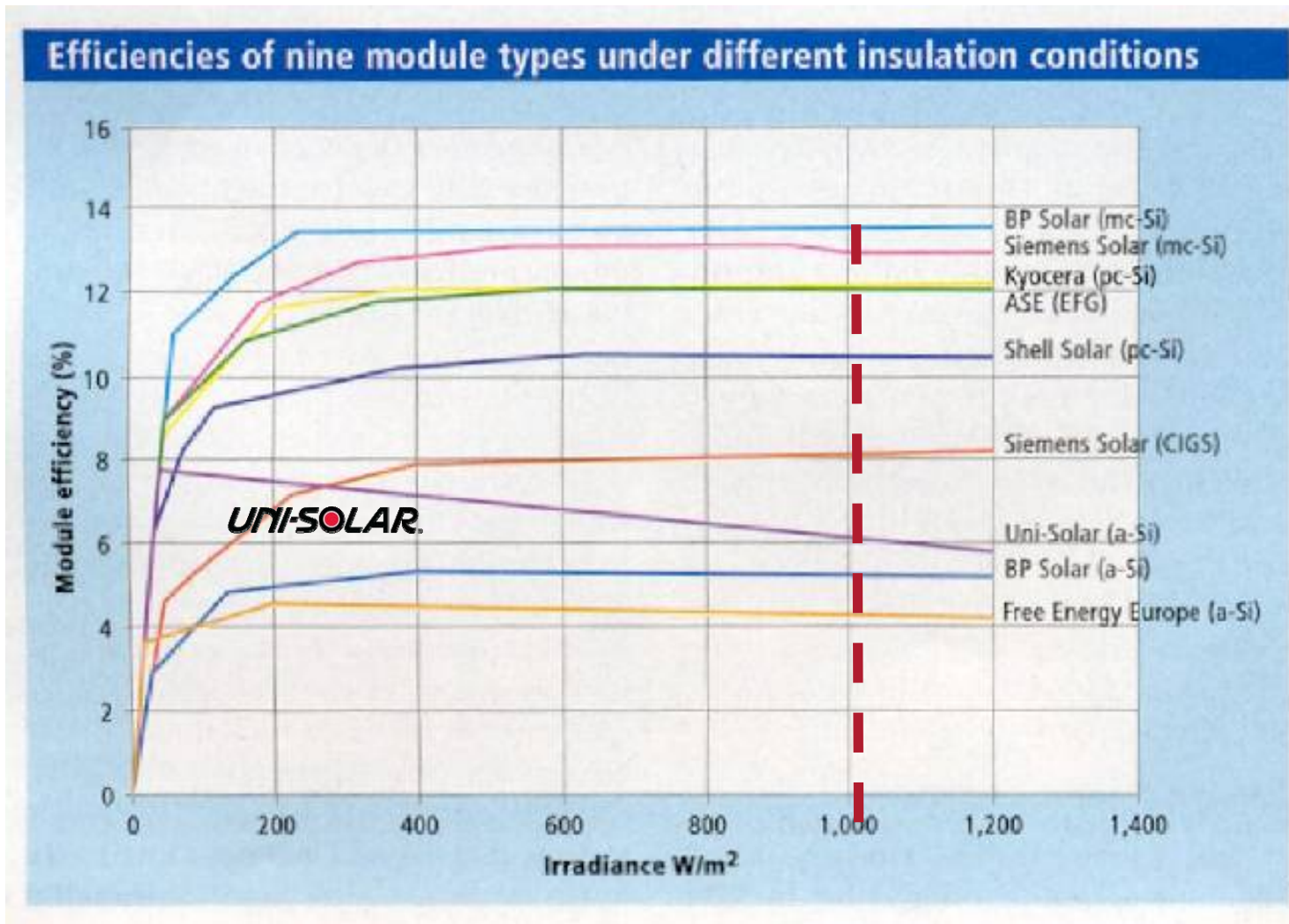


Figure 2 - Test rig for PV modules

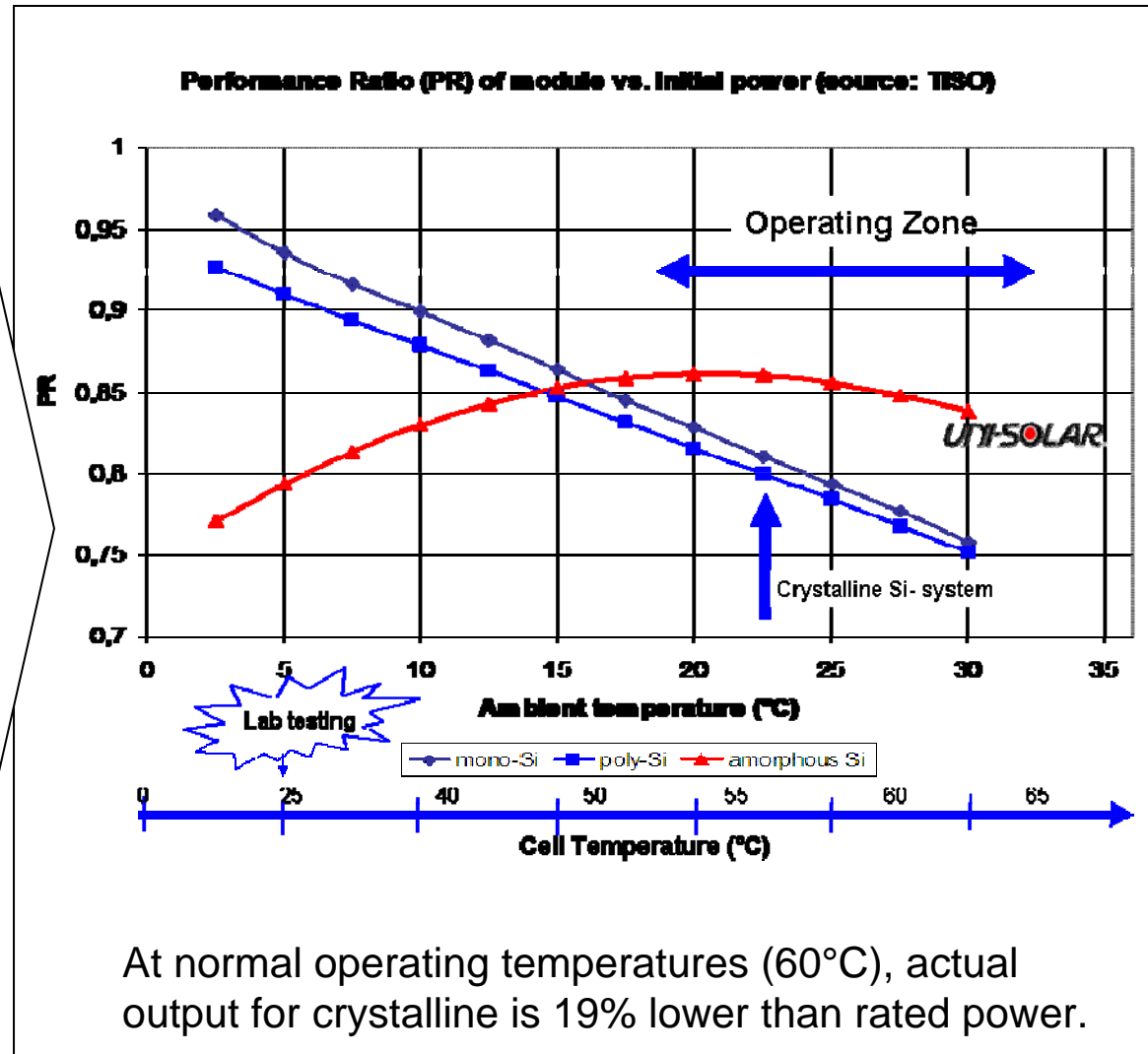
Site: Petten, The Netherlands
Horz. Irradiance: 1000 kWh/m²
Tilt: 30°
Size: two modules
Installed Year: 2000
Source: Energy Research Centre,
Petten, Netherlands, report nr. c0067

Temperature performance...

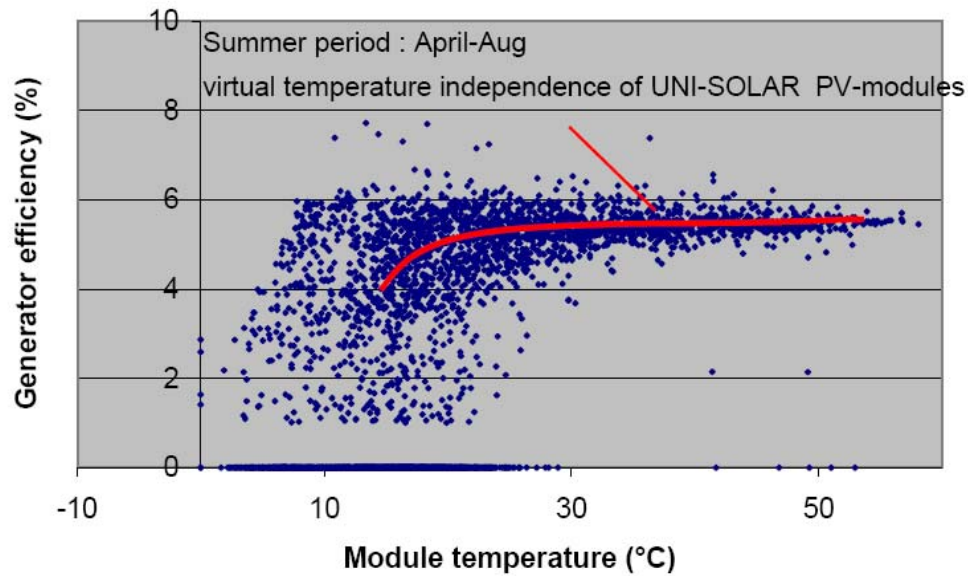
- High summer temperatures improve amorphous silicon cell efficiency due to thermal annealing effect
- High summer temperatures decrease strongly crystalline cell efficiency
- Rated PV module output is measured at a cell temperature of 25°C.
- Normal operating cell temperatures range from 50°C to 70°C, especially for flat roofs with no back ventilation.

Technology	Temp Coefficient (%/°C)
UNI-SOLAR	-0.21%
c-Si	-0.49%
CIGS	-0.36%

... large impact on outdoor performance

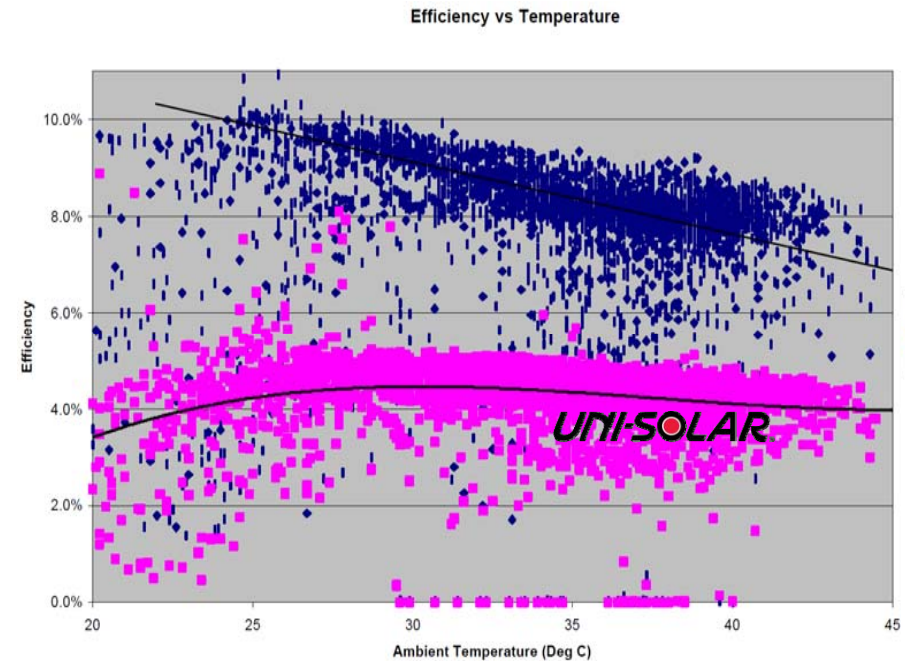


Results in Germany



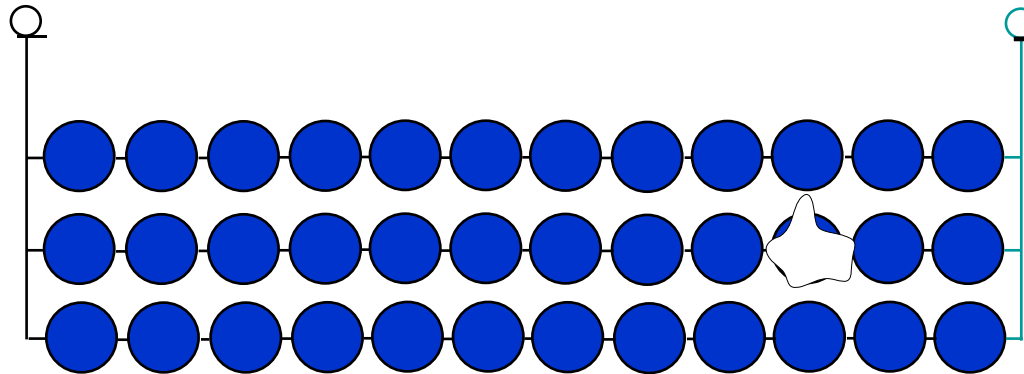
Site: Fraunhofer ISE, Freiburg, Germany
Horz. Irradiance: 1200 kWh/m²
Tilt: 30°
Size: 1.5 kWp
Inverters: Fronius IG20
Installed Year: 2001
Source: ISE Freiburg, Germany

Results in Australia



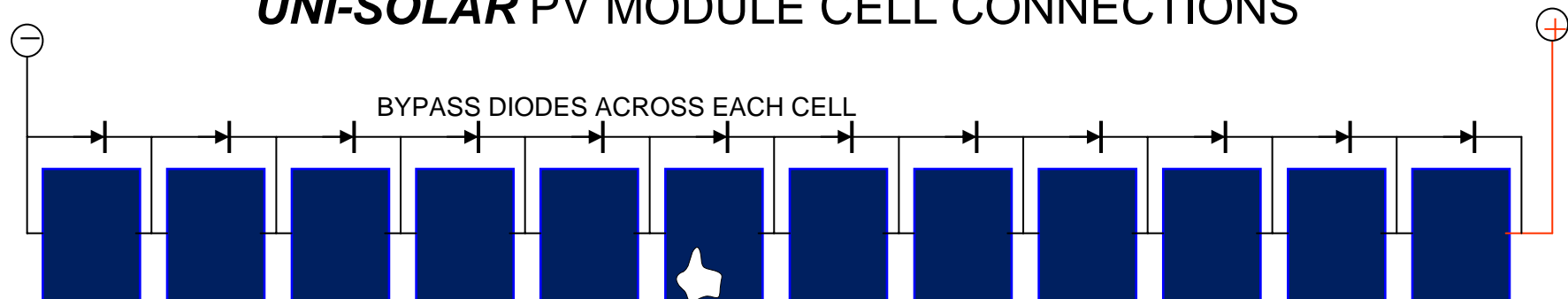
Site: Jilmingkan, NT, Australia
Horz. Irradiance: > 2100 kWh/m²
Tilt: 25°
Size: 1.1 kWp
Modules: Canon triple junction a-Si (pink)
Solarex poly-silicon (blue)
Installed Year: 1996
Source: Northern Territory Centre for Energy Research
Australia

CRYSTALLINE PV MODULE CELL CONNECTIONS



Shade/Soil any one cell = **Output loss of 30%** (loss of one cell string)
Area of shade/soiling required to cover one cell = 4" x 4" (16 sq in)

UNI-SOLAR PV MODULE CELL CONNECTIONS



Shade/Soil any one cell = **Output loss of <4.5%** (22-cell Laminate)
Area of shade/soiling required to cover one cell = 9" x 14" (126 sq in)

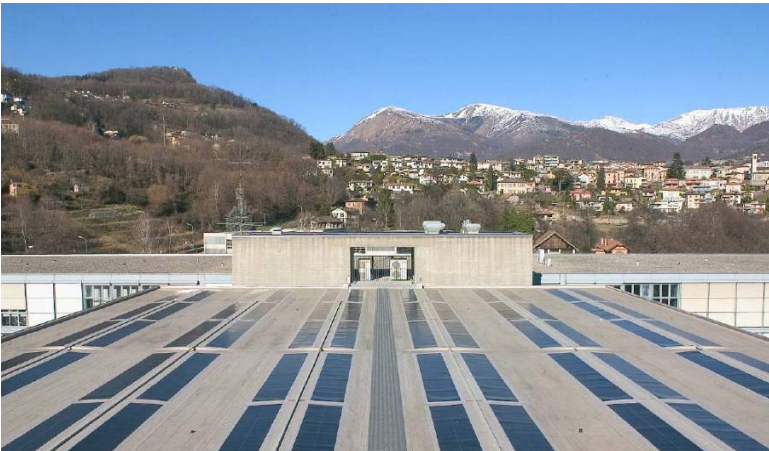
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Lugano, CH: *UNI-SOLAR* equal performance when flat vs. tilted c-Si

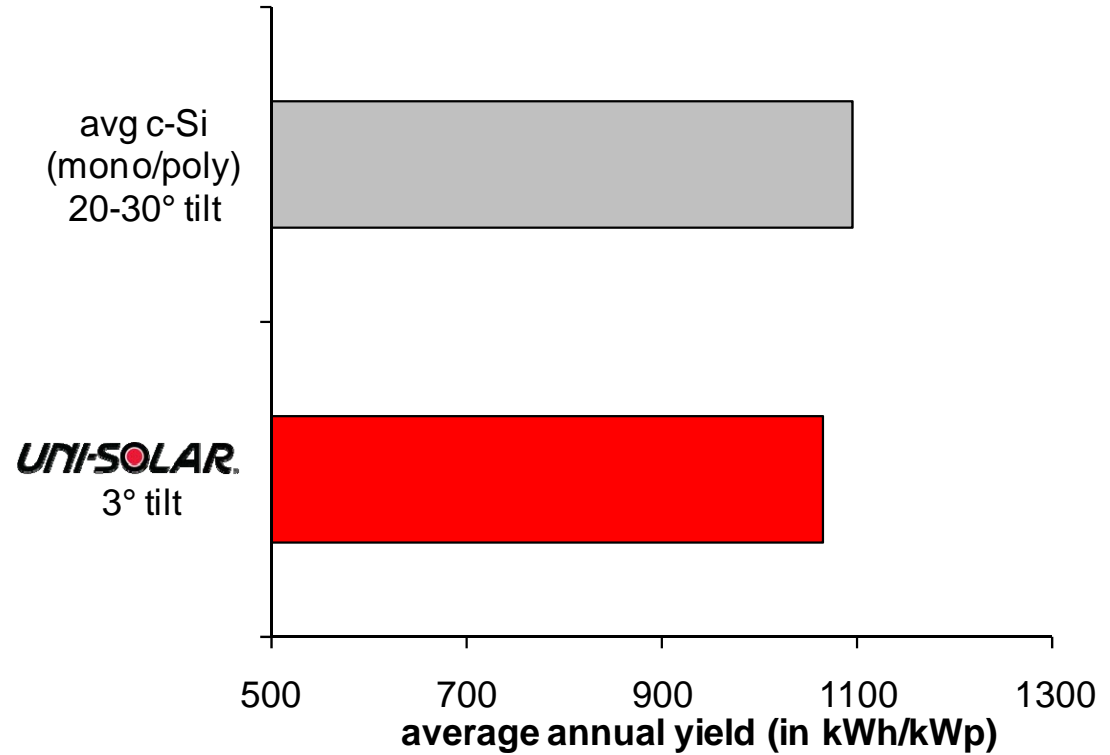
Results CPT, Canobbio, CH



One of many 20-30° tilted poly and mono-Si roof systems monitored by ISAAC in same region



UNI-SOLAR laminates at 3° tilt, installed on a flat membrane roof (TPO) of a school (CPT Solar)



Site: Canobbio, Ticino, Switzerland

Horz. Irradiance: 1234 kWh/m²

Tilt: 3°

Size: 15.4 kWp

Inverters: SMA SB 5000TL

Installed Year: 2003

Source: TISO –ISAAC institute- SUPSI – University of Ticino, Switzerland, see final report CPT SOLAR 2003-2006 and statistica impianti Ticino downloadable at www.lee.ee.supsi.ch/

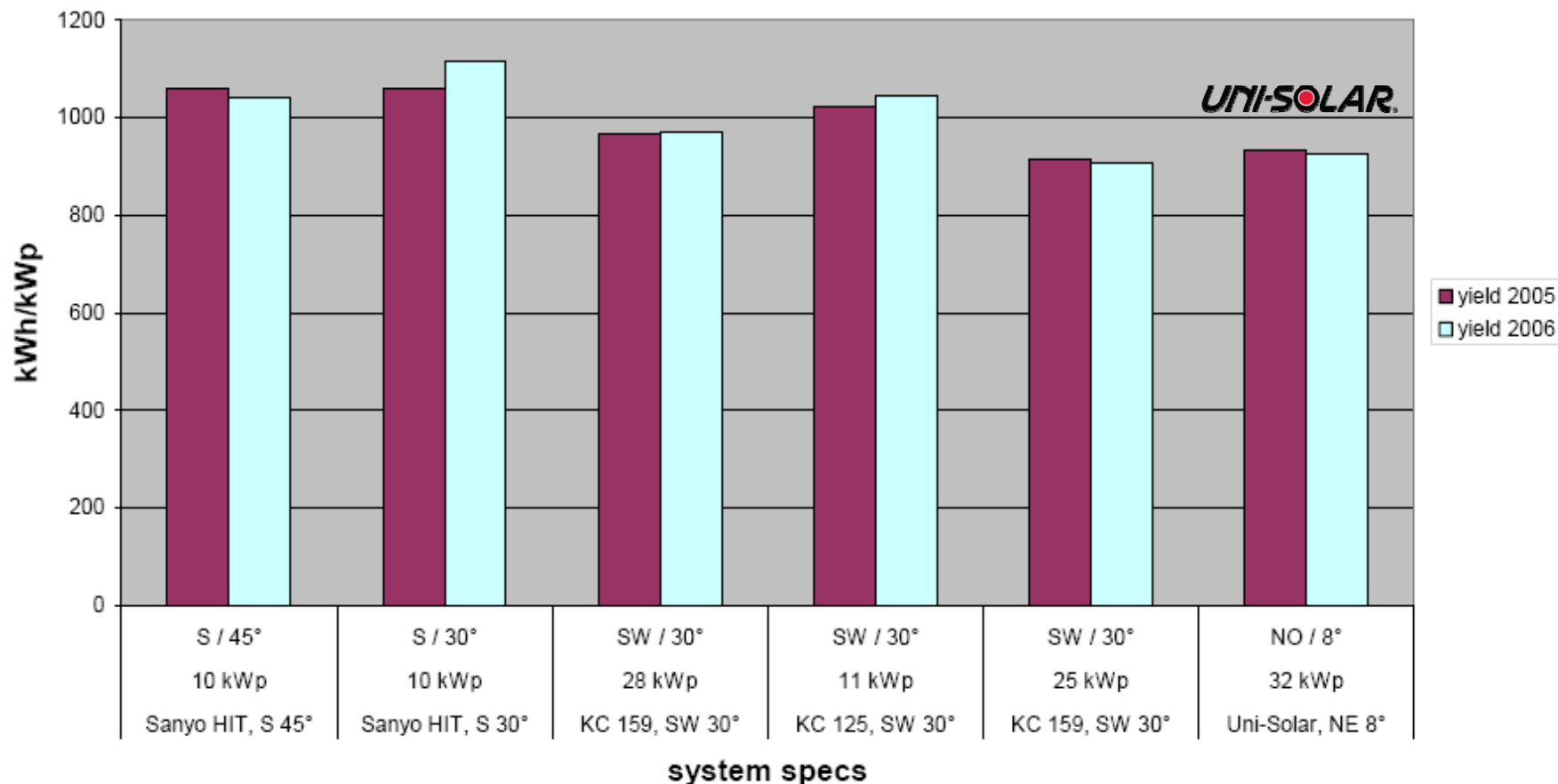
Schwaerzelbach : *UNI-SOLAR* equal performance at 8° tilt North compared to traditional crystalline at 30° tilt South or SW.



Comparison of different technologies and orientations, Rhön

NOTE: Uni-Solar orientation: north east

The UNI-SOLAR installation is the only installation facing Northeast, with 8° inclination



Site: Schwaerzelbach, Rhön, Germany
 Horz.Irradiance: 1084 kWh/m2
 Size: 10-32 kWp
 Installed Year: 2004
 Source: building owner Hoos - Centrosolar

Santa Cruz, USA: *UNI-SOLAR* equal performance at 3° tilt compared to traditional crystalline at 30° tilt.

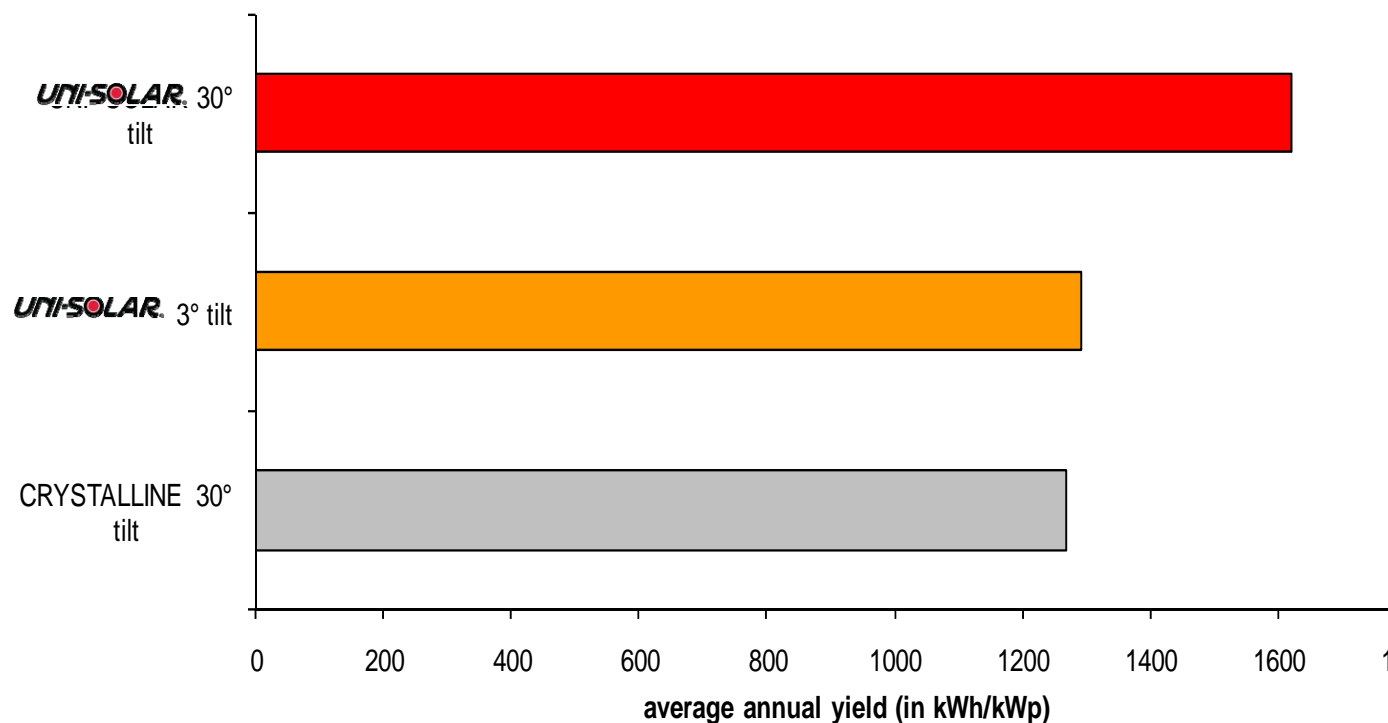
Results Live Oak Business Park, Santa Cruz, CA, USA



UNI-SOLAR framed modules and poly-Si modules at 30° tilt, on flat roof (SPF)



UNI-SOLAR laminates at < 3° tilt, on membrane roof (SPF)



Site: Santa Cruz, California, USA
Horz. Irradiance: 1738 kWh/m²
Tilt: 3° and 30°
Size: 2-3 kWp
Inverters: SMA2500
Installed Year: 2003
Source: Solarquest report

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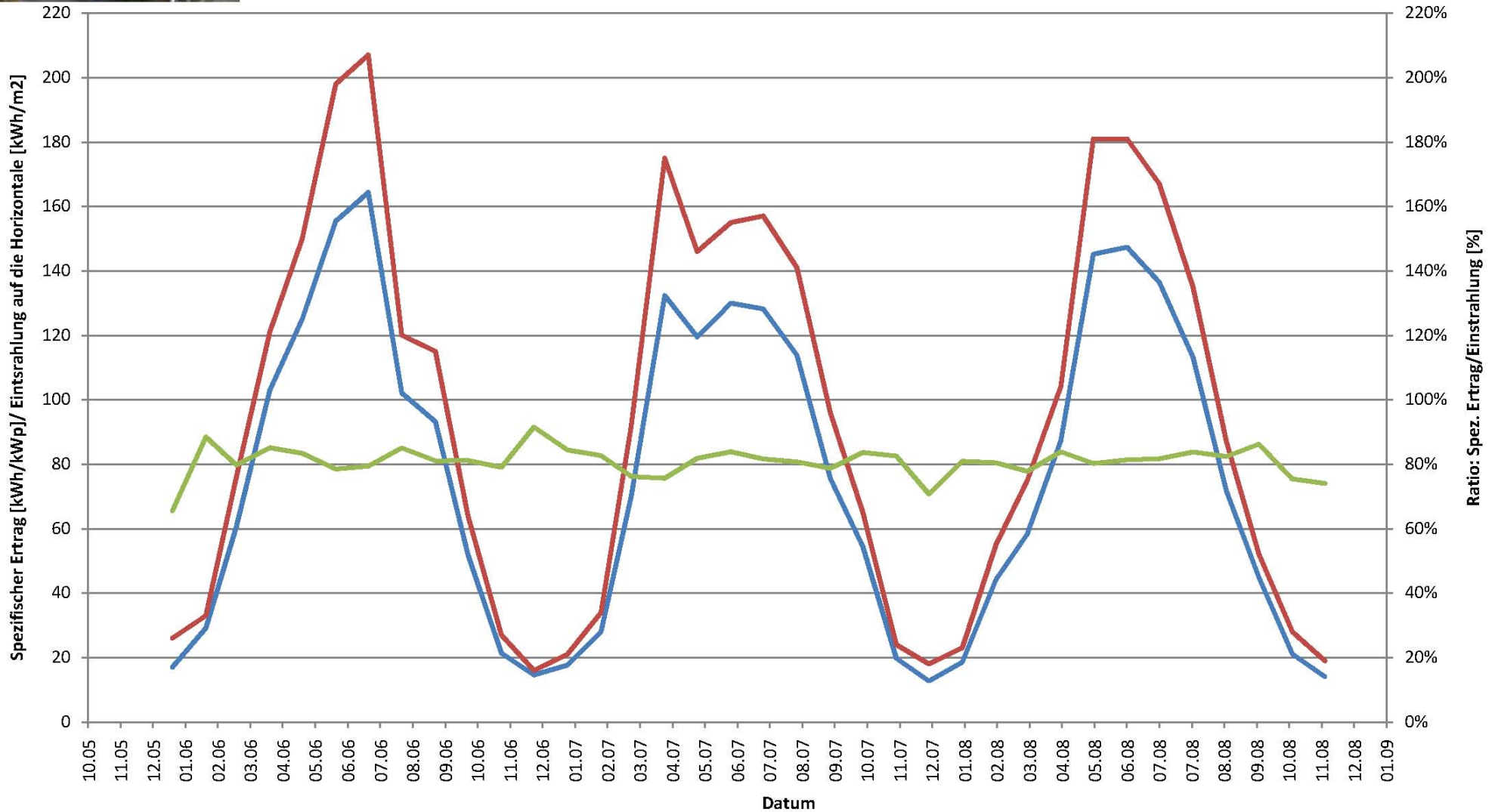


Prognose spez. Ertrag
PV SOL: 872 kWh/kWp

WfB Mainz Ertrag & Performance 140 x SI-T2 544 = 76,16 kWp

Spez. Ertrag 2006: 939 kWh/kWp
Spez. Ertrag 2007: 903 kWh/kWp
Spez. Ertrag 2008: 902 kWh/kWp

— Spez. Ertrag [kWh/kWp]* — Einstrahlung [kWh/m2] ** — Ratio: Spez. Ertrag/Einstrahlung [%]



* Quelle: Datenlogger PV Anlage - Ausrichtung der PV Elemente 5° Süd / 5° Nord

** Quelle: Deutscher Wetterdienst (DWD) - Einstrahlung auf die Horizontale



Prognose spez. Ertrag
PV SOL: 872 kWh/kWp

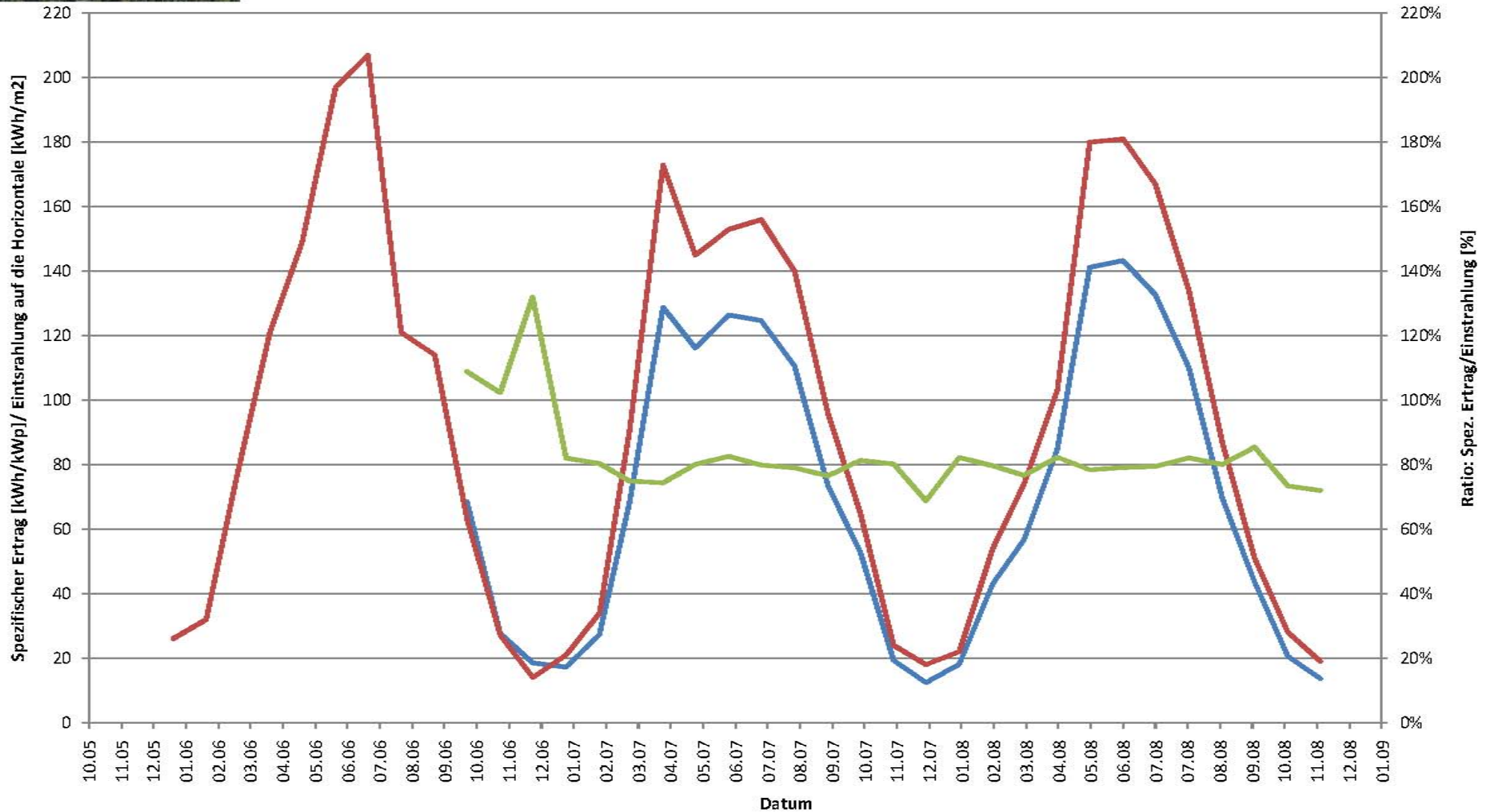
Gleisbergsschule Mainz

Ertrag & Performance

144 x SI-T2 544 = 78,336 kWp

Spez. Ertrag 2007: 877 kWh/kWp
Spez. Ertrag 2008: 877 kWh/kWp

— Spez. Ertrag [kWh/kWp]* — Einstrahlung [kWh/m2] ** — Ratio: Spez. Ertrag/Einstrahlung [%]



* Quelle: Datenlogger PV Anlage - Ausrichtung der PV Elemente 3° Ost / 3° West

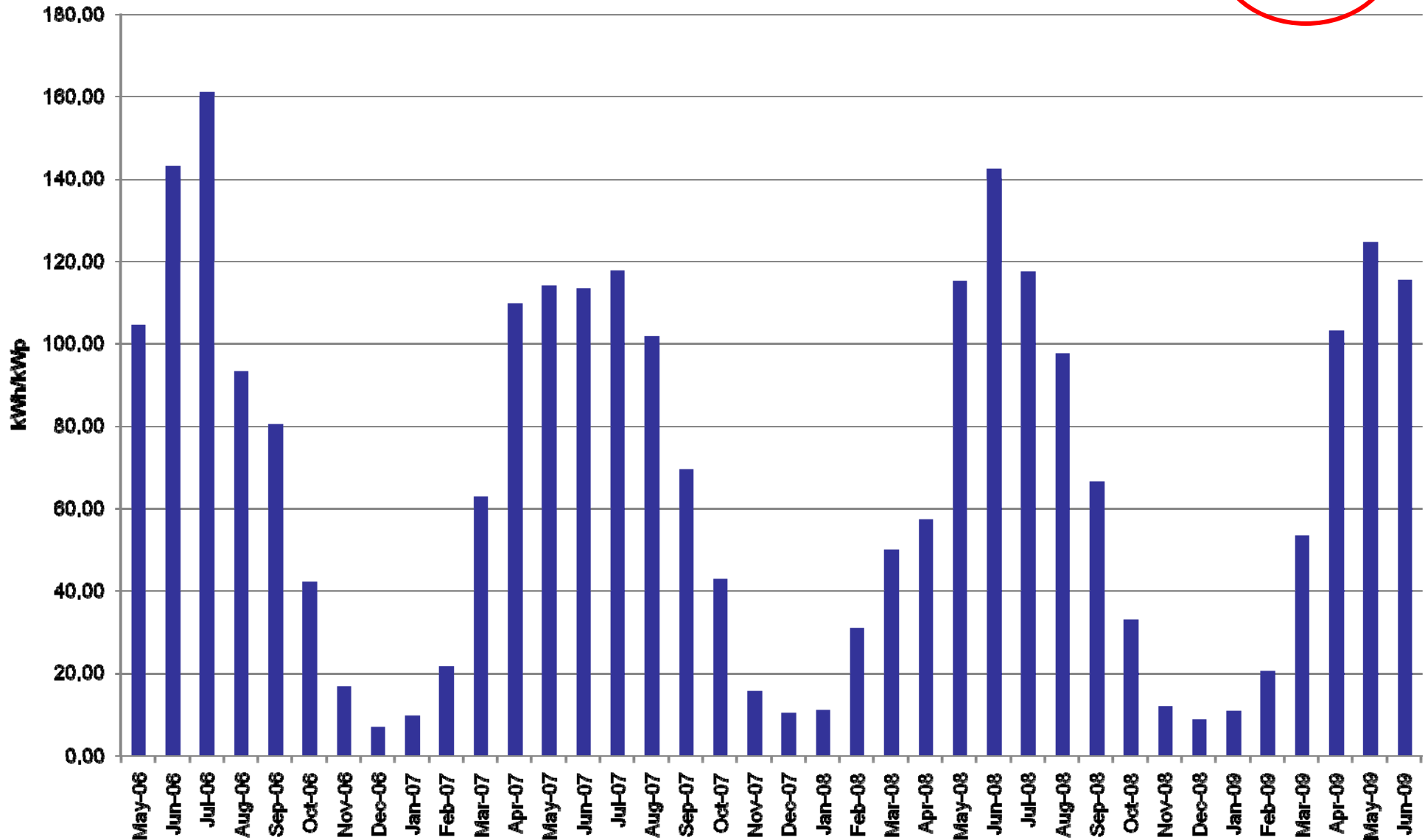
** Quelle: Deutscher Wetterdienst (DWD) - Einstrahlung auf die Horizontale

PVSOL Prediction: 802 kWh/kWp

Darley Park - Muenster, Germany

Spec. Yield 06-07: 882 kWh/kWp
Spec. Yield 07-08: 731 kWh/kWp
Spec. Yield 08-09: 777 kWh/kWp

System size: 261 kWp

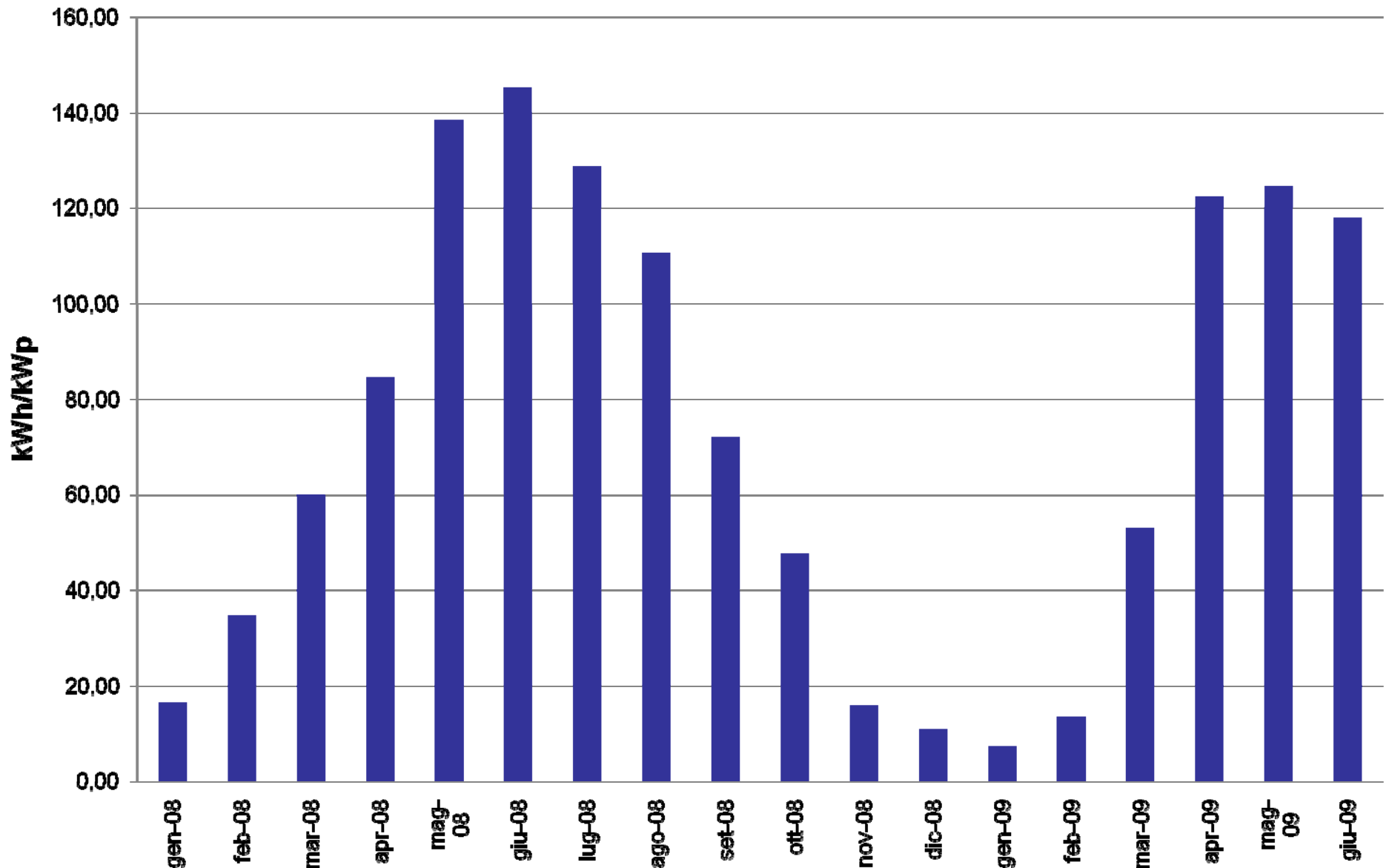


PVSOL Prediction: 822 kWh/kWp

TDDK - Dresden, Germany

Spec. Yield 2008: 864 kWh/kWp

System size: 786 kWp



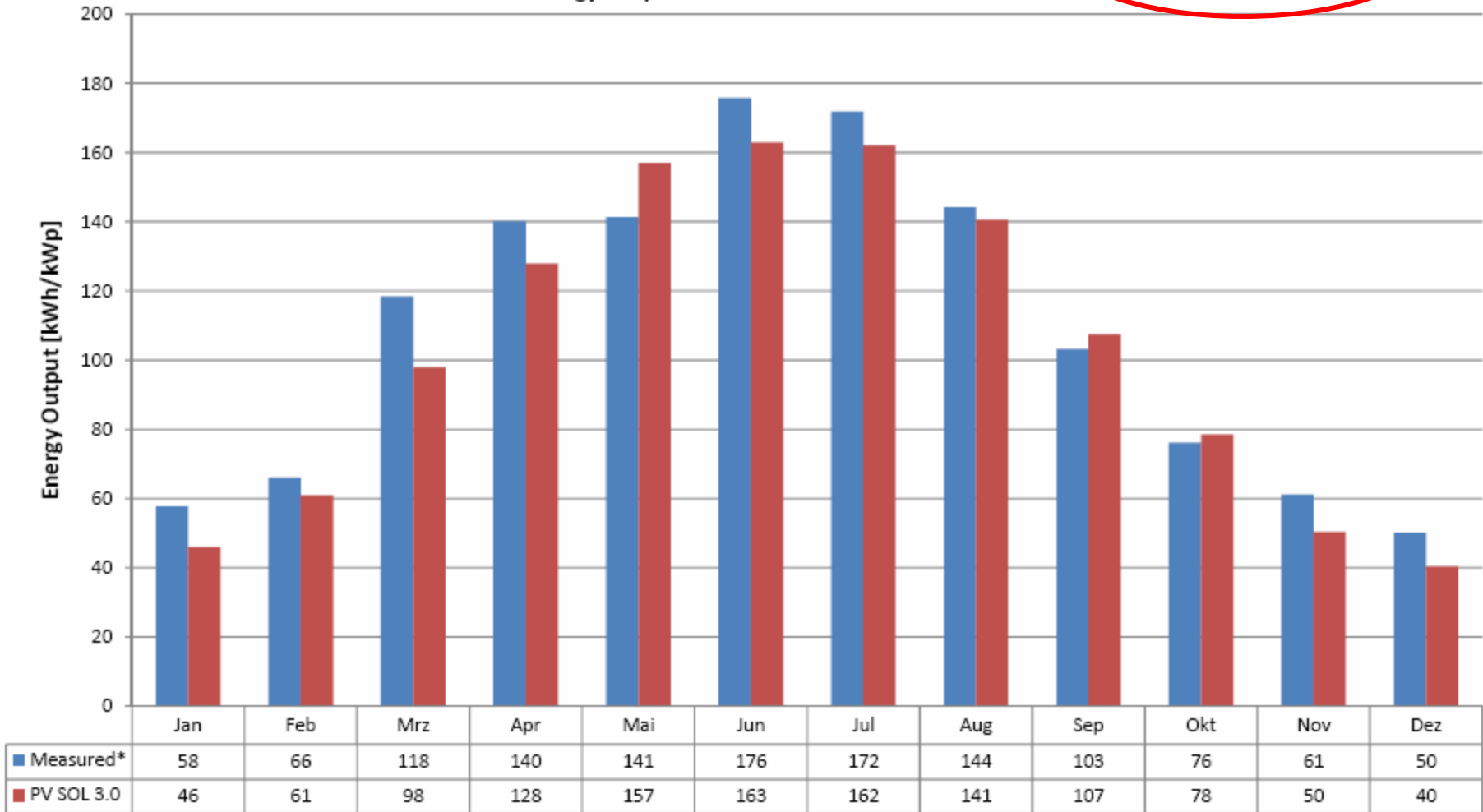
- Renovation of 8 flat roofs of a residential complex Velten South Northern Germany, 2006
- Roof type: Low sloped butterfly roof,
- North-South-orientation: 5°
- Modules: 120 kWp on 8 separate roofs
2-layered roofing membranes with integrated UNI-SOLAR® flexible PV laminates
- Inverters: Siemens SITOP Solar 4000 IP 54/65



Period	01.01.- 31.12.07	01.01.- 31.12.08
Measured production	862,7 kWh/kWp	830,3 kWh/kWp
Simulated production with PVSOL	821,6 kWh/kWp	

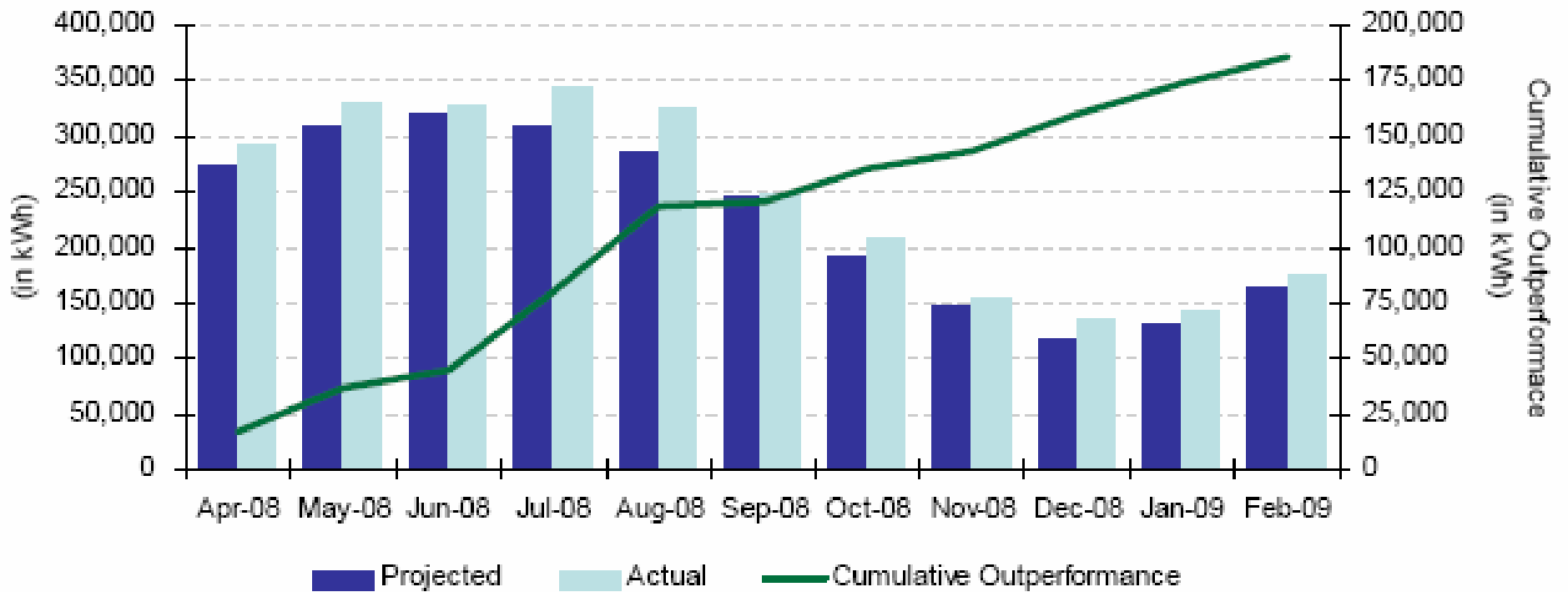
ProLogis
Santa Oliva / Barcelona
 104,4 kWp; 1xSMA SC 100
 Energy Output: 01.11.2007 - 31.10.2008

■ Measured* : 1305 kWh/kWp
 ■ PV SOL 3.0 : 1232 kWh/kWp



*Data Source: SMA Datalogger
 Jan-Dec 2007

Projected vs. Actual Production



- **UNI-SOLAR Book of Knowledge**
- **UNI-SOLAR Energy Production Handout**
- **‘Comparison of Yield, Installed Power and Costs of a typical Installation for Flat Roofs For Triple-Junction and Crystalline Modules’** – White Paper – based on Lugano, Alps and Santa Cruz, California
- **‘Flat roof integration – CPT Solar (AET IV)’** – White Paper – Based on Alps study
- **‘Losses and Gains on Thermally Insulated Horizontal a-Si PV Modules’** – White Paper – includes data on real world losses, annealing and comparison to c-Si