Comparison of different wafer based bifacial and monofacial module technologies at different sites

06.12.2017 André Richter; Meyer Burger Technology AG

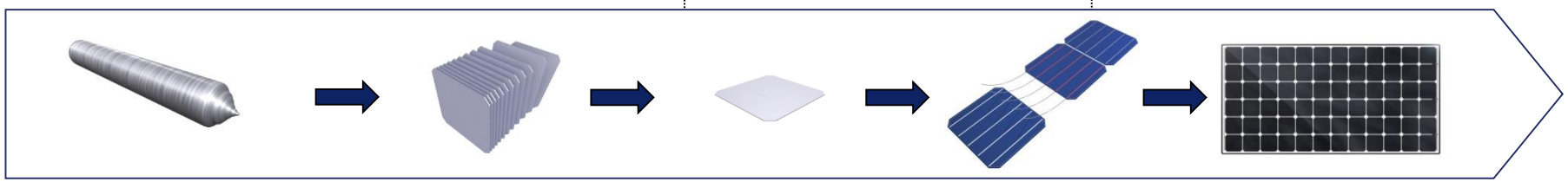
Meyer Burger is providing technology and equipment

MEYER BURGER

wafer
from ingot to wafer

cell
from wafer to cell

module
from cell to module



Diamond wire saw

DW 288 Series 3

DW 288	
Market share	~30%
Industry Standard	

Wafer inspection system

WIS-06

Hennecke WIS	
Market share	~80%
Industry Standard	

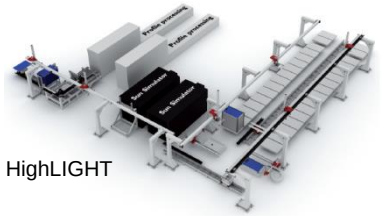
PECVD coating systems

SiNA

MAiA 2.1

MB PERC	
Market share	>80%
Industry Standard	

Module inspection system



HighLIGHT

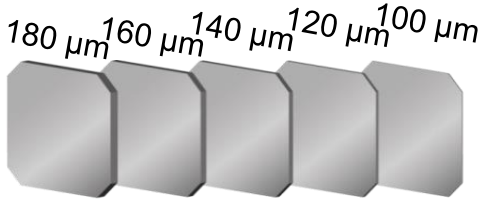
PASAN HighLIGHT	
Market share	~80%
Industry Standard	

Meyer Burger's Holistic Approach

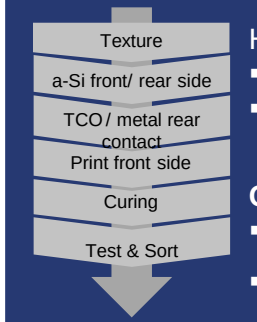
MEYER BURGER

A Diamond Wire

Thinner wafer ➔ Lower costs



Heterojunction (HJT)



High efficiency
- Lower system cost (BOS)
- Independent of wafer thickness

Only 6 process steps
- Low COO
- Low temperature coefficien and bifacial cell design

➔ Higher energy yield

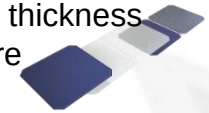
C

D Adapted test metrology

- High cap cells
- Busbarless cells
- Pasan grid touch
- PED (Chipping)

E SmartWire Connection (SWCT)

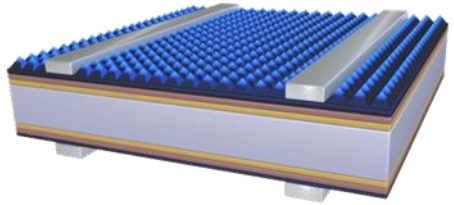
TCO layer and wafer thickness suitable for SmartWire

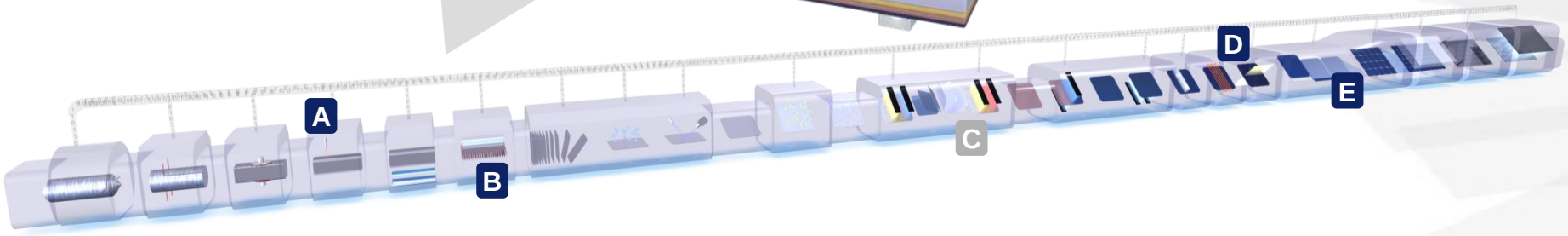


- 80% less silver
- Higher energy yield
- Higher efficiency
- Longevity and micro-crack resistant

B Single Wafer Tracking

Quality & performance control





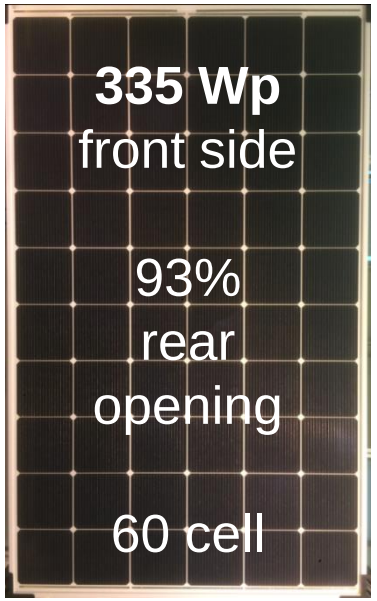
The need for outdoor measurements

Targets:

- Describe physical model for module
- 1-to-1 comparison of technology at same outdoor conditions
- Real data, no lab measurements and complicated calculations
- No PV system influences like grid, inverter, shading

Irradiation:

- DNI
- GHI
- DHI
- Spectrum
- AOI
- Homogenity front/rear
- soiling



Temperature:

- Absorption of solar cell
- Resistive losses
- Resitivity of bulk, fingers, wires
- Heat-transfer cell to module surface

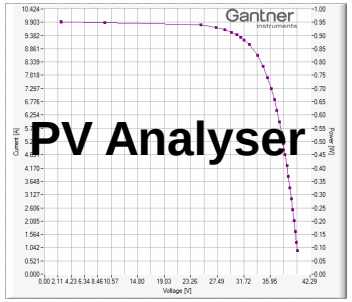
Meyer Burger's solution

1 Pyranometer
1 ambient Temp
1 wind

8 electronic loads
synchronous ADCs
communication

Local DB

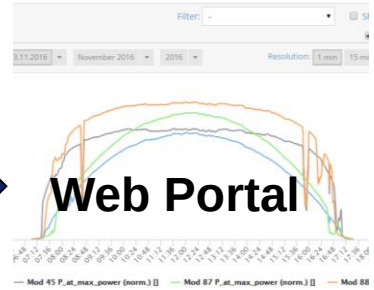
RAW DB

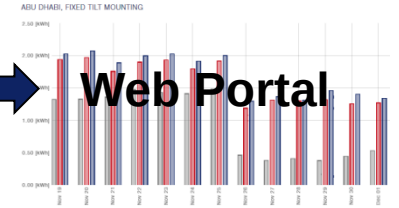


Gantner instruments

Filtering
Channel processing

Web DB





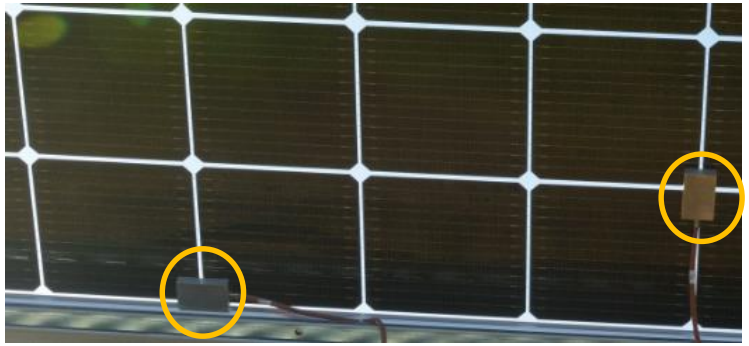
2 Si-Sensors in POA

8 channels:
- 4pole U,I
- 2x Temp

- Initial lab measured

Excurs: Module temperature measurement

- TC-Power is between -0.20%/K to -0.45%/K. With max. module temperature of 85°C, power loss to STC is between 11% to 24.75%
- Calculation of cell temperature via Voc possible, but not accurate
- In configuration with 3rd party modules: temperature sensor should be placed always in same way to have “same error” for all modules
- Cell has slightly higher temperature because of heat resistivity of backsheet or glass



Bifaciale module not be affected by temperature measurement between cells

Different temperature for g/g and g/bs expected

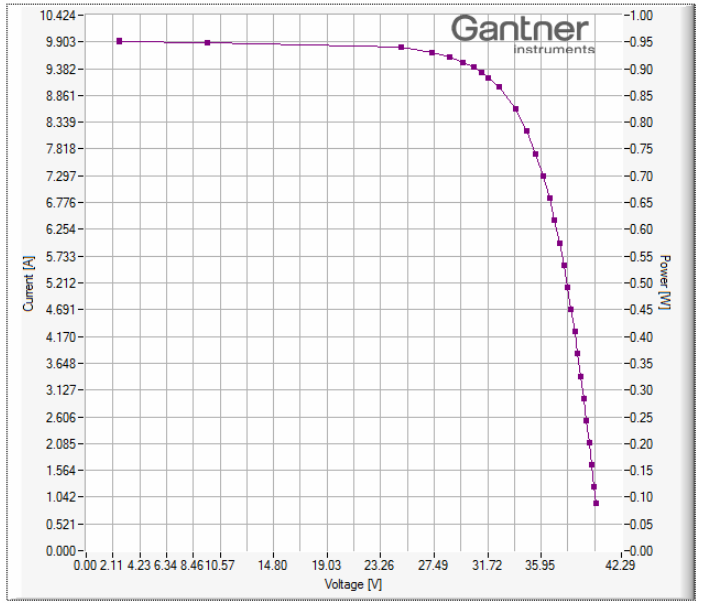
Excurs: Mounting height

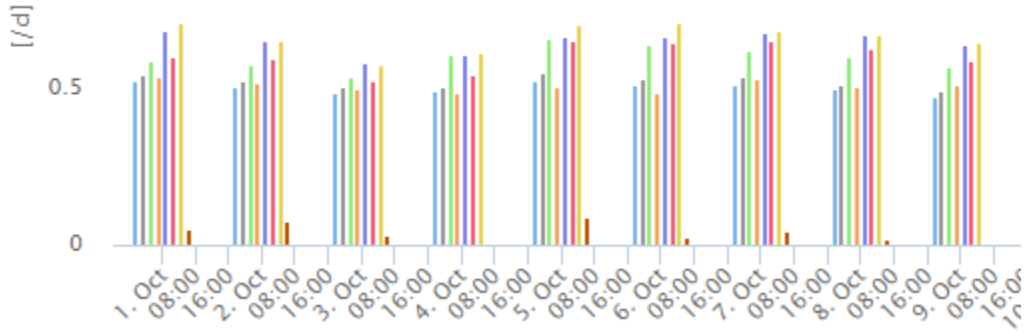
Mounting system:

unshaded rear side of module

Height difference of 0.7m to 1.4m has already influence on energy yield of ca. 2% on bifacial modules

Data processing is critical



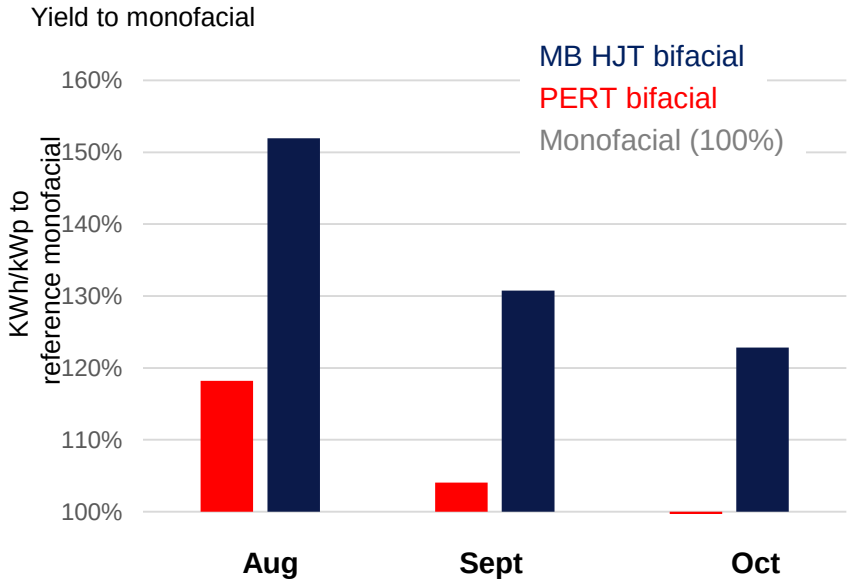


- Raw data ca. 50 MB/ch/year
- Full IV curve and measurements
- Wrong shaped curve > non-homogen irradiation

- Processed data ca. 100 MB/ch/year
- Fast filtering available
- Flexiblity to create right filters

Time based results for site in Yinchuan

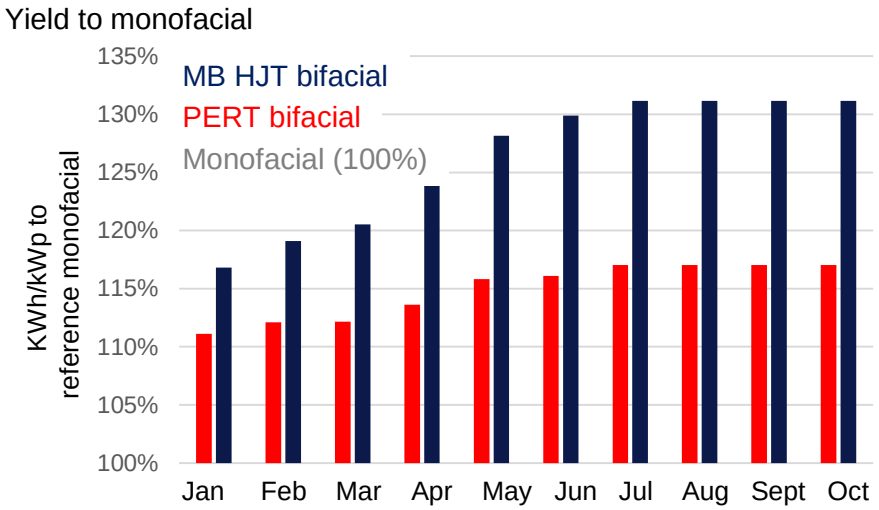
CN: normalised monthly yields to monofacial
Aug 2017 to Oct 2017



Albedo_POA: average albedo measured in tilt of module with silicon sensors.

Time based results for site in Masdar City

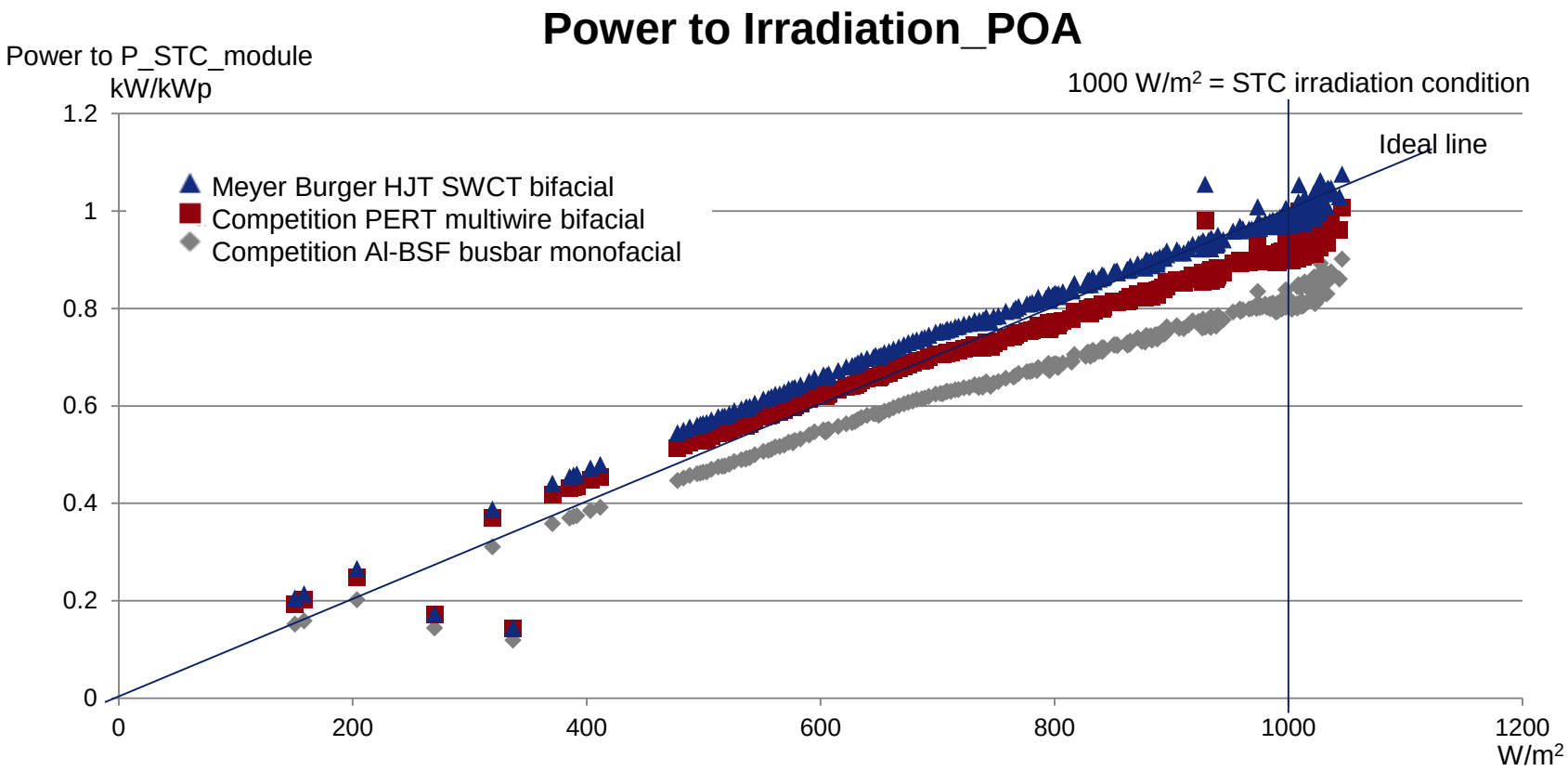
UAE: normalised monthly yields to monofacial
Jan 2017 to Oct 2017



Albedo_POA: average albedo measured in tilt of module with silicon sensors.

Outdoor behaiviour by light level

including temperature, AOI and spectral effects

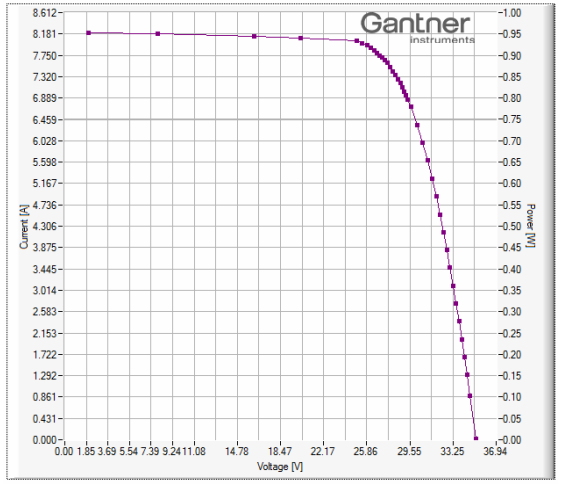


Normalised power to irradiation POA (plane of array = irradiation on module surface):

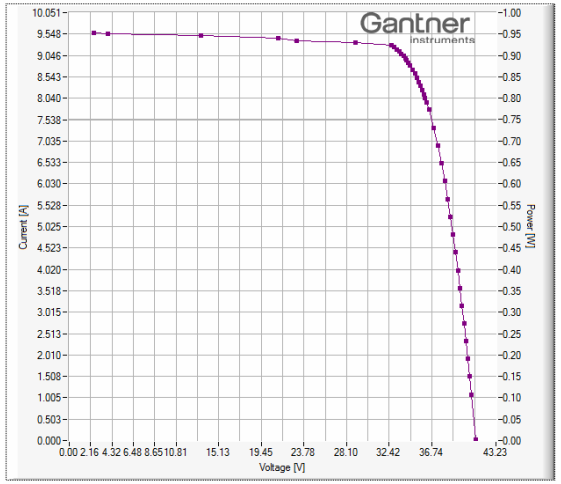
- HJT and SWCT have **higher relative power** in all irradiance conditions due to lower current and lower serial resistivity
- Bifacial power compensate high irradiance losses. **MB HJT near ideal line**
- PERT suffers from lower bifacial factor and worse temperature coefficient

IV curve – different shapes

monofacial

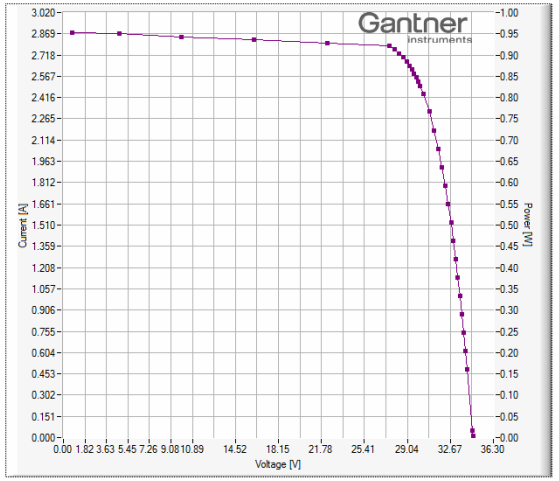


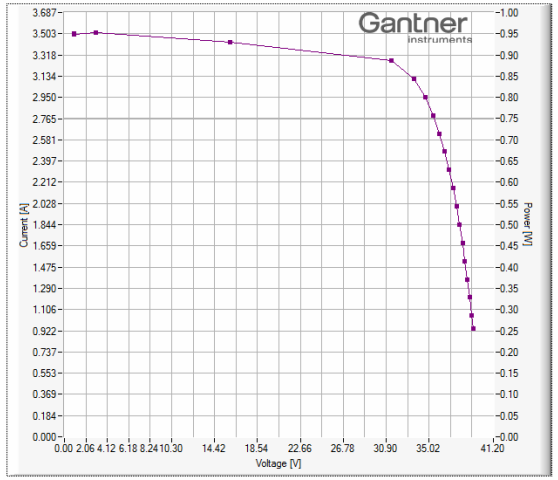
bifacial



Bifacial module has “less nice” IV curve:

- **More sharp curved**

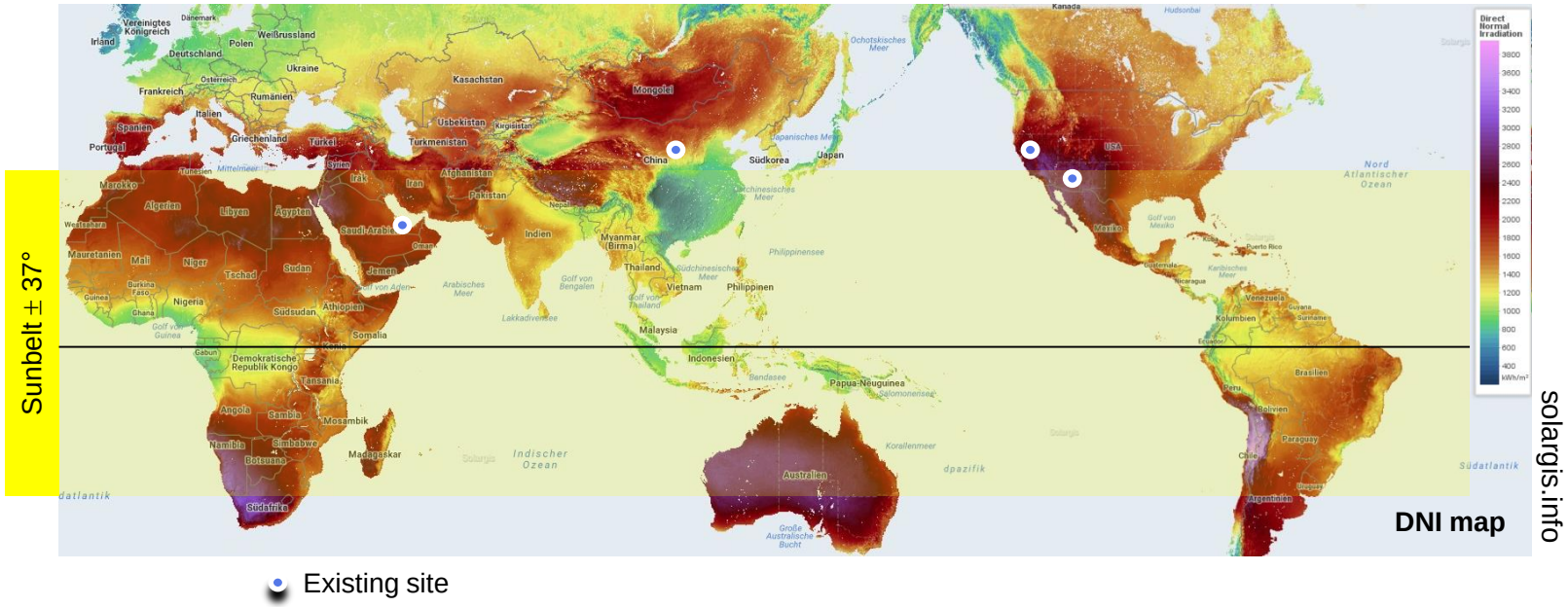




- **Area Isc to mpp more sloped**

Monofacial and bifacial curves at same day and daytime

Summary and Outlook



Data collection to cover all values between:

- Low/high irradiation
- Low/high temperature
- Different technologies
- Different sites worldwide

Daily issues:

- Changing network communication
- Power failures
- Blocking of acclimatization

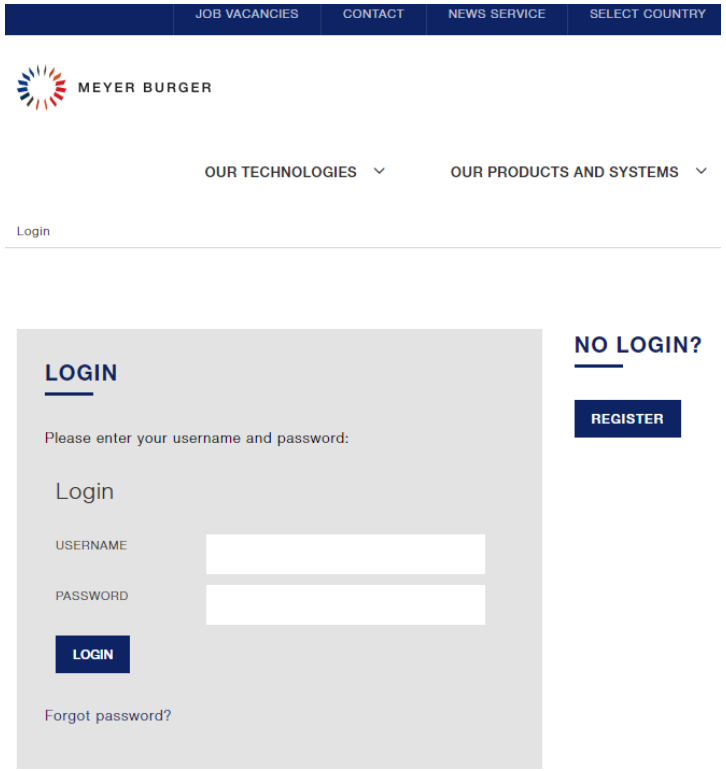
Examples for opportunities

Energy walls: add PV between the glass

PV plus: example by nature

Live Monitoring Data

https://www.meyerburger.com/ch/en/measurement-data-worldwide/



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