Rear contact modules vs. bifacial and other technologies

Radovan Kopecek

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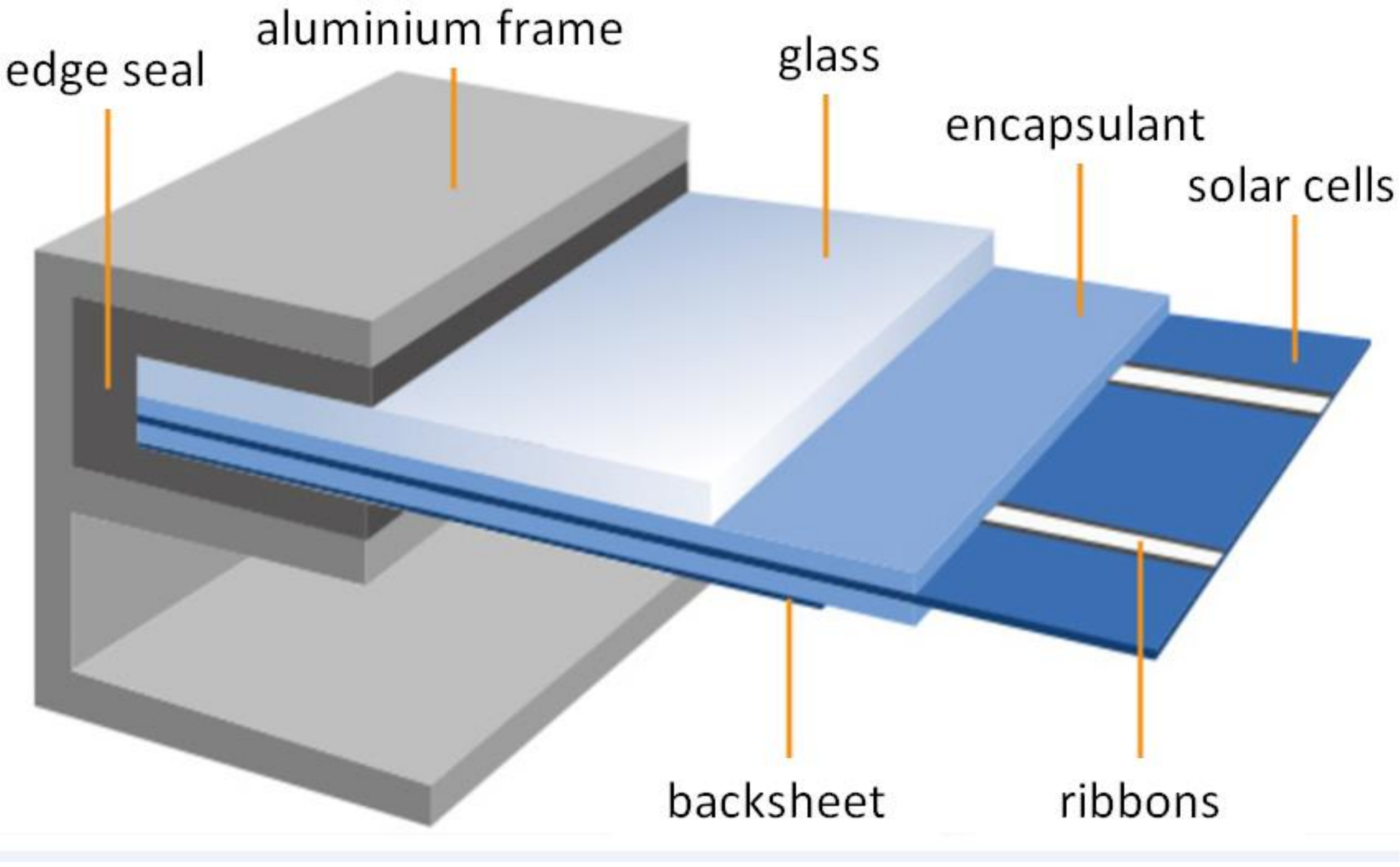
standard module



new trends

Module technologies for high-efficiency solar cells: The move away from powerful engines in old-fashioned car bodies

Joris Libal, Andreas Schneider, Andreas Halm & Radovan Kopecek, ISC Konstanz, Konstanz, Germany

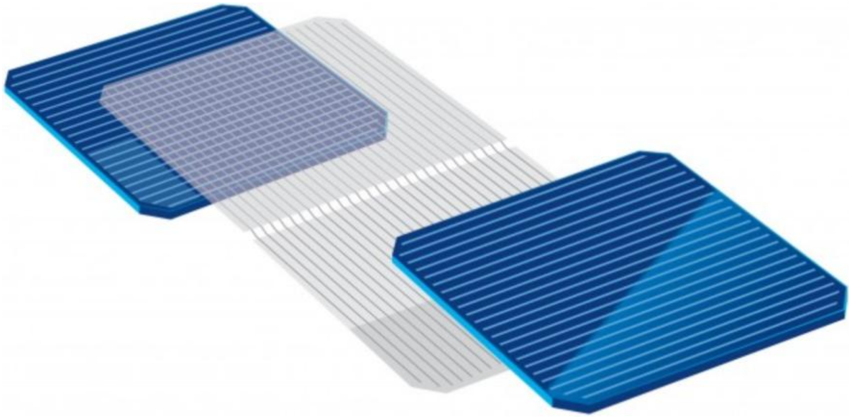
Fab & Facilities
Materials
Cell Processing
Thin Film
PV Modules
Power Generation

ABSTRACT

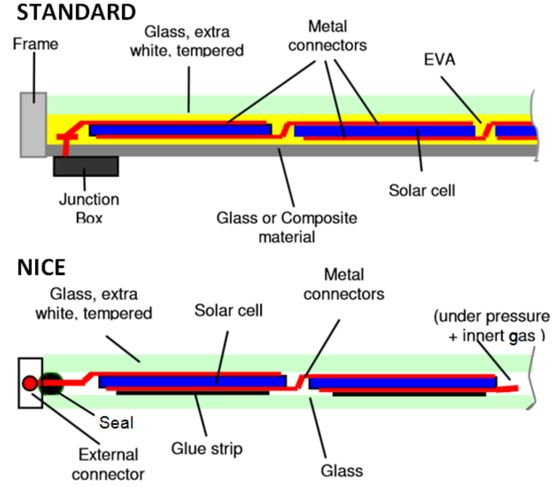
Why change a product which can be sold in high quantities with a large margin? This is one of the reasons why crystalline silicon modules look the same today as they did 30 years ago. In addition, a module has to last for more than 20 years; to change the technology, or even just the material, many complicated, long-lasting and costly tests are necessary. And even after a series of successful tests there is no guarantee of a long-lasting product. Moreover, during the PV crisis starting in 2009, module manufacturers did not have the manpower and budget for introducing novelties into the module market. All the above are reasons why module architecture and materials did not significantly change with time and did not adapt to the introduction of powerful, highly efficient solar cells. After the crisis, however, many module manufacturers became aware that in order to be able to sell modules on the market with a high margin, their products not only have to be cost effective but also must differentiate themselves from the mass product. Consequently high-power, optically nice, colourful, back-contact, transparent, bifacial, light and highly durable modules are now being developed and are gradually being introduced into today's market. This paper reports on current trends and discusses future developments.

J. Libal et al., PV international 25, 2014

standard or bifacial



Smart wire, multi busbar (Mayer Burger, Schmid)



NICE (Apollon)

back contact with CBS (also bifacial?)

Back contact for MTW and IBC (Eurotron, Formula E, Cencorp, Line Solar)

who rules the PV world in 2014

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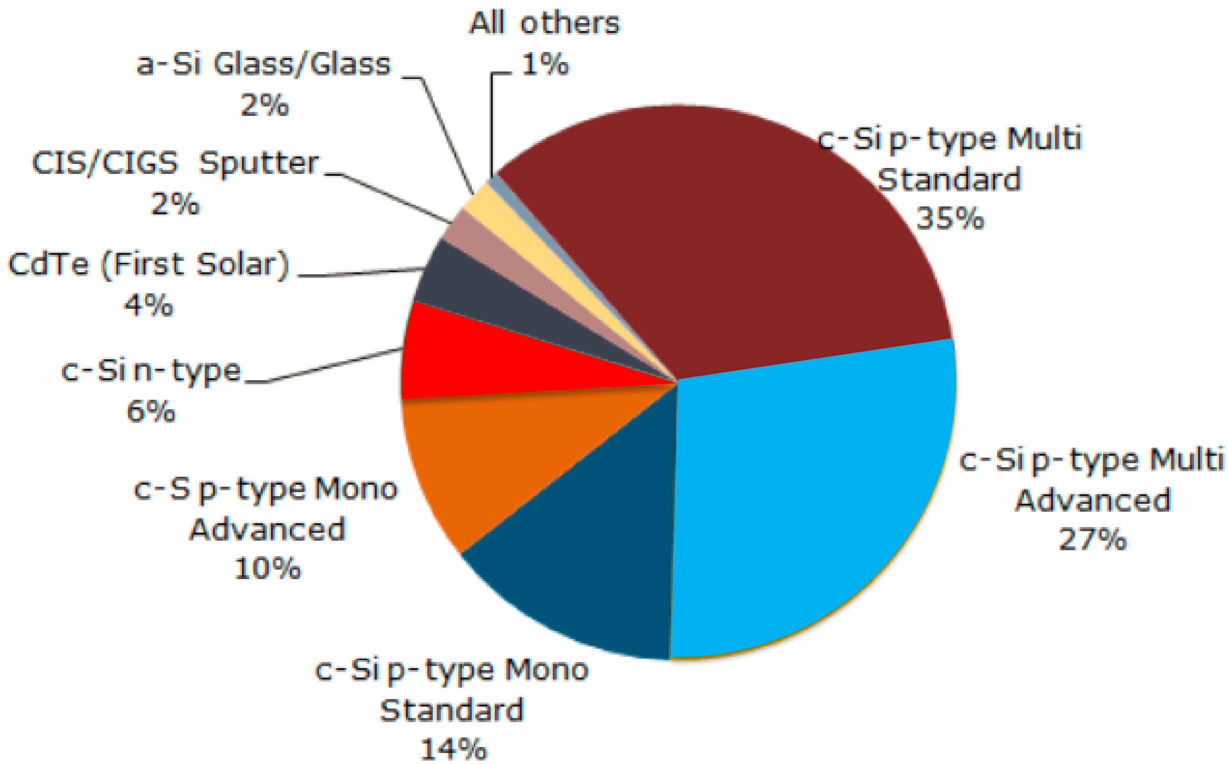
Figure 1: 2014 Solar PV Module Production by Technology



Source: NPD Solarbuzz *PV Equipment Quarterly*

http://www.solarbuzz.com/news/recent-findings/multicrystalline-silicon-modules-dominate-solar-pv-industry-2014

ITRPV roadmap

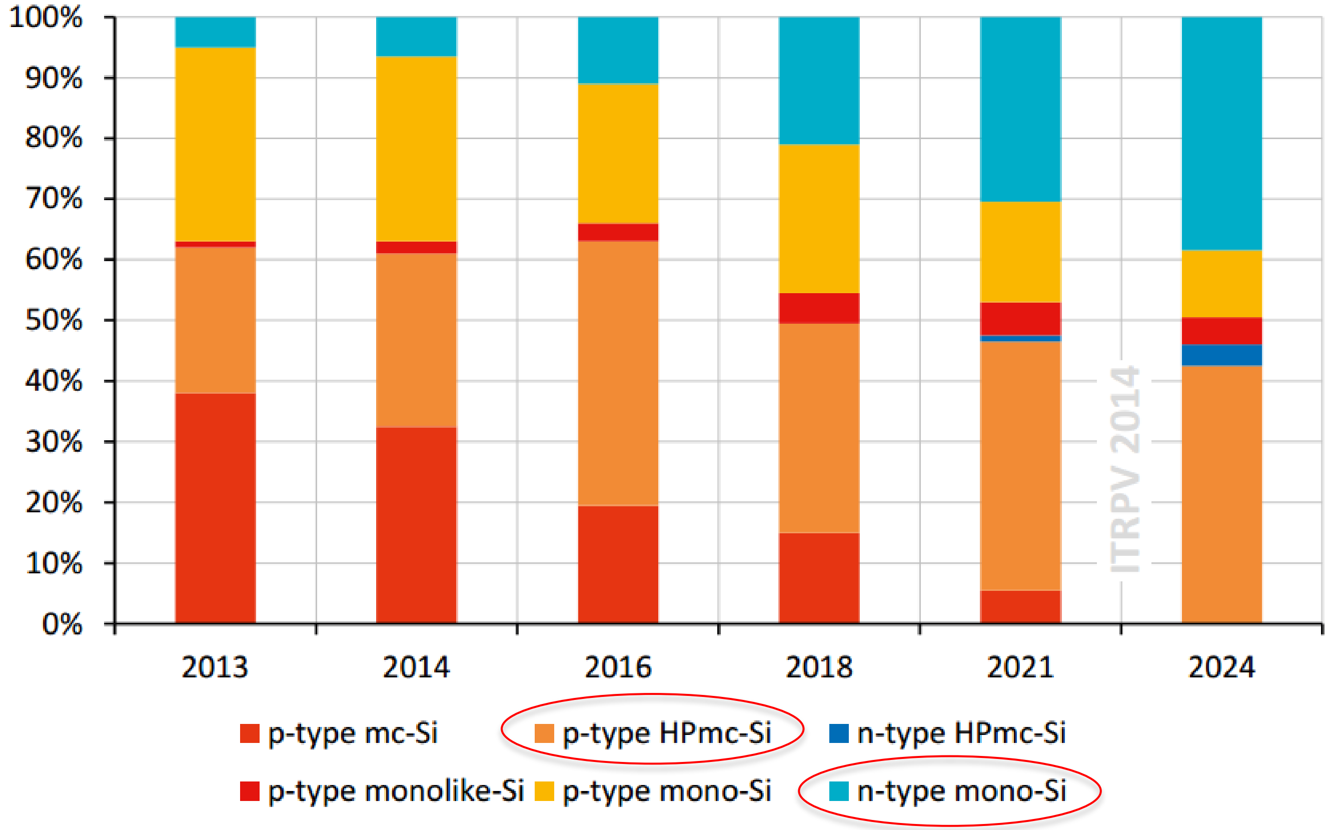
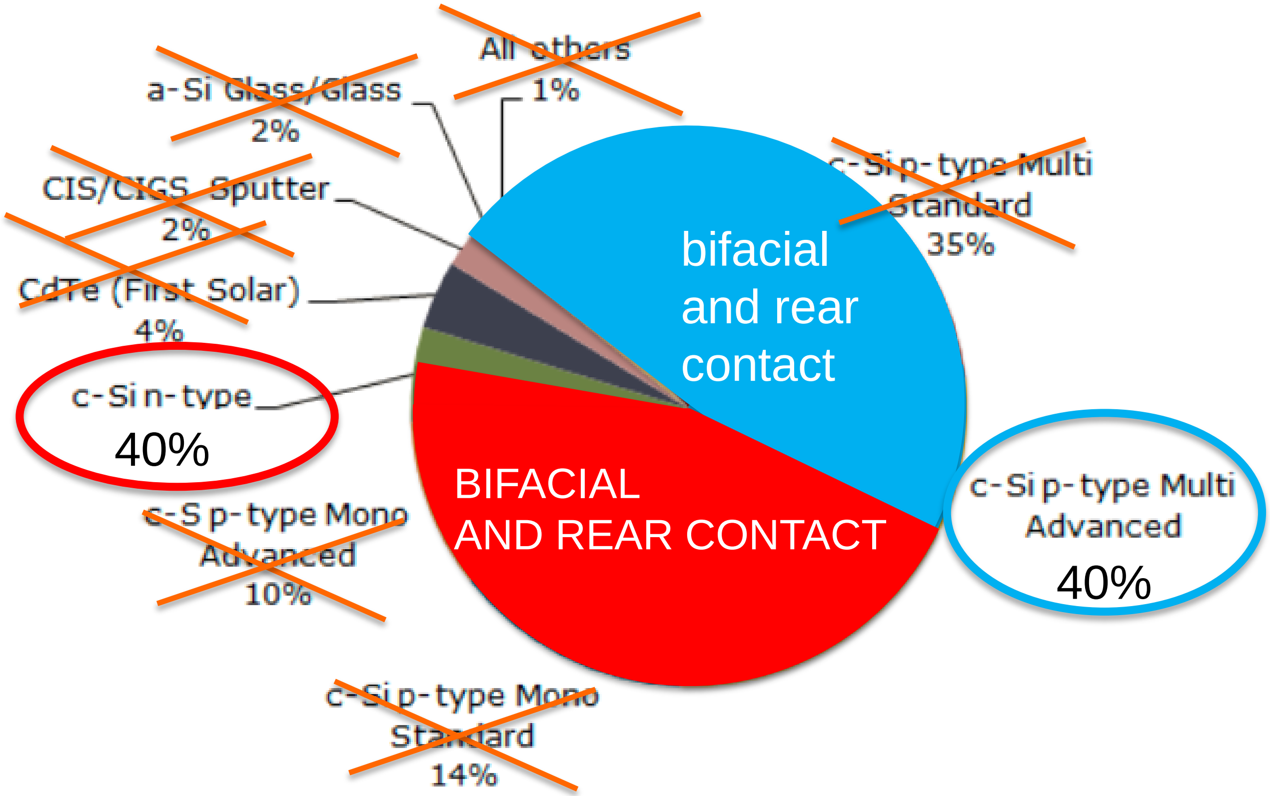


Fig. 25
Expected relative market shares for casted and mono-Si materials.

who rules the PV world in 2025

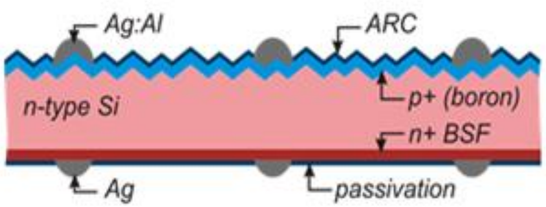
Figure 1: 2014 Solar PV Module Production by Technology



Source: NPD Solarbuzz *PV Equipment Quarterly*

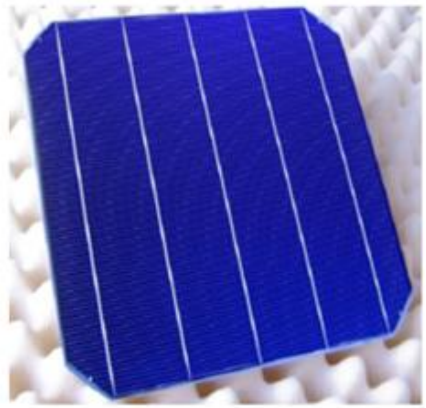
bifacial n-type technologies

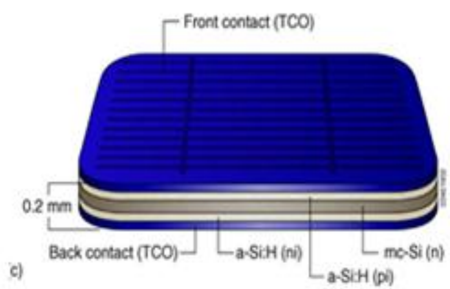
PERT technology
Passivated Emitter Rear Totaly Diffused



Courtesy of ISC Konstanz

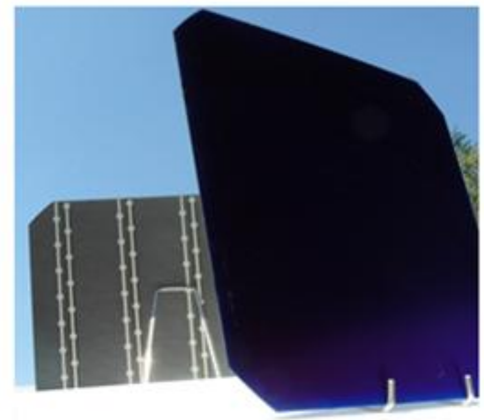
HTJ technology
Heterojunction

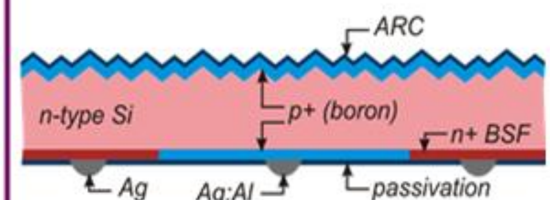




Courtesy of Sanyo-PANASONIC

IBC technology
Interdigitated Back Contact

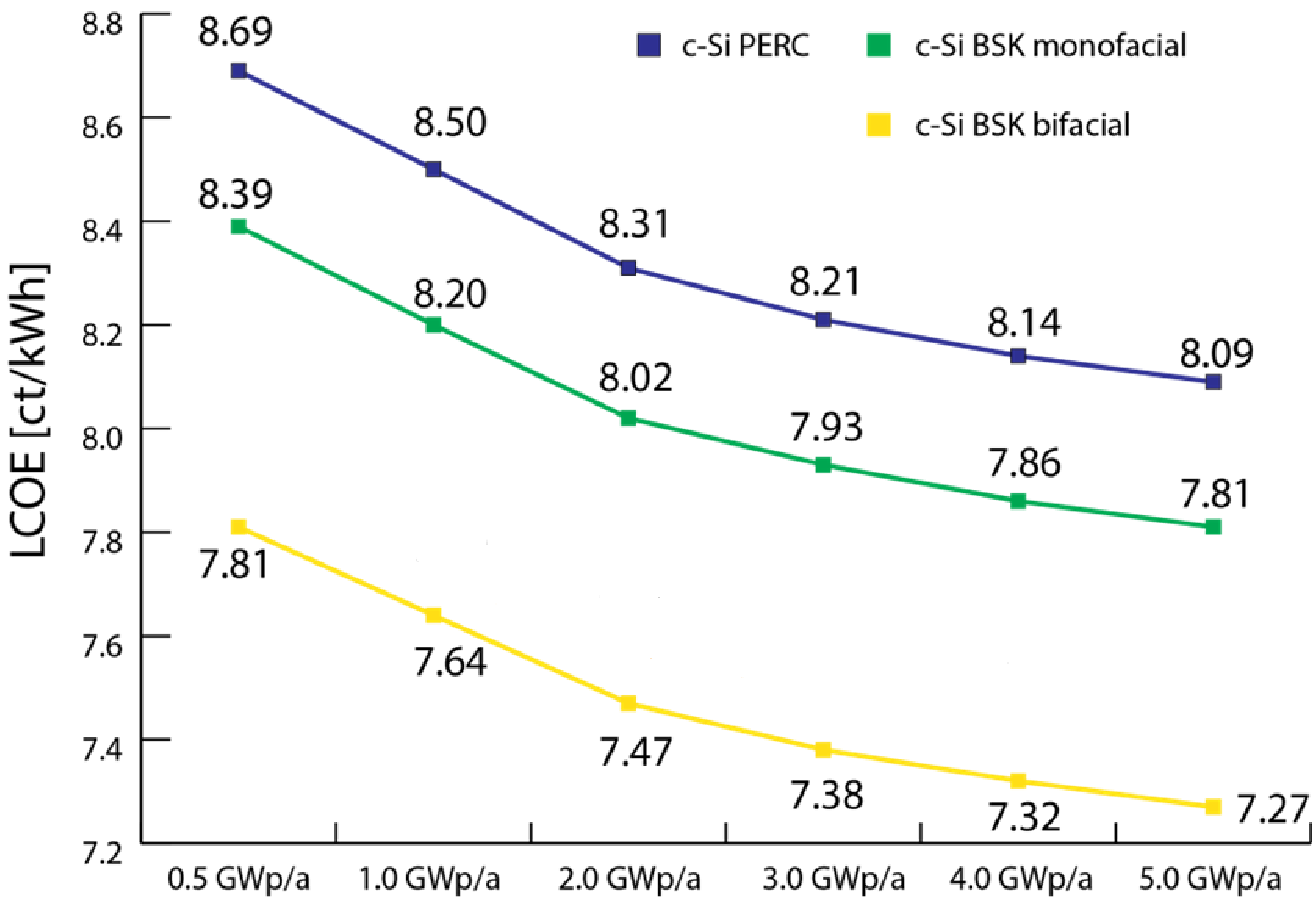




Courtesy of ISC Konstanz

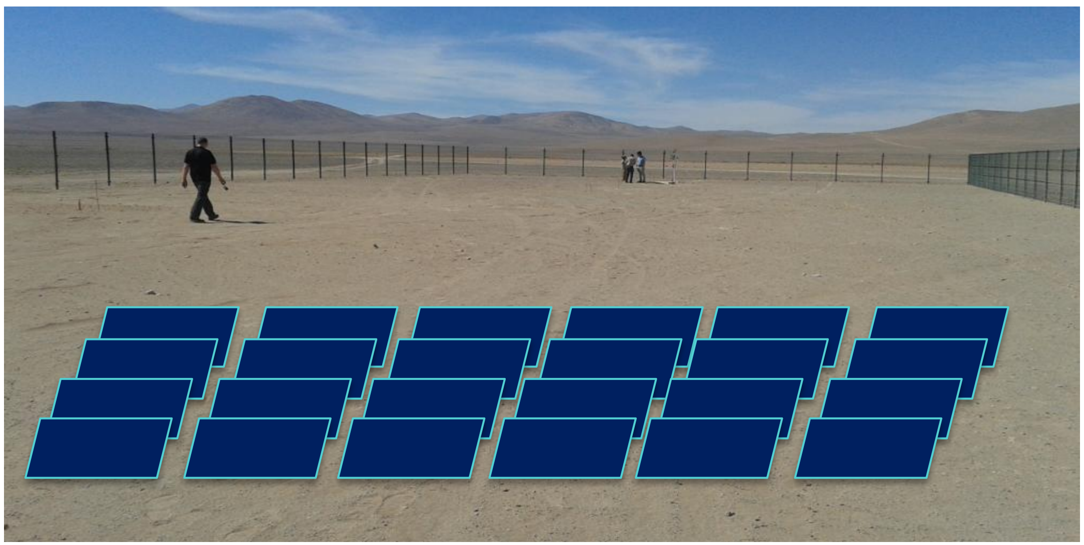
R. Kopecek et al., PV international, December 2014

LCOE for large systems in Germany

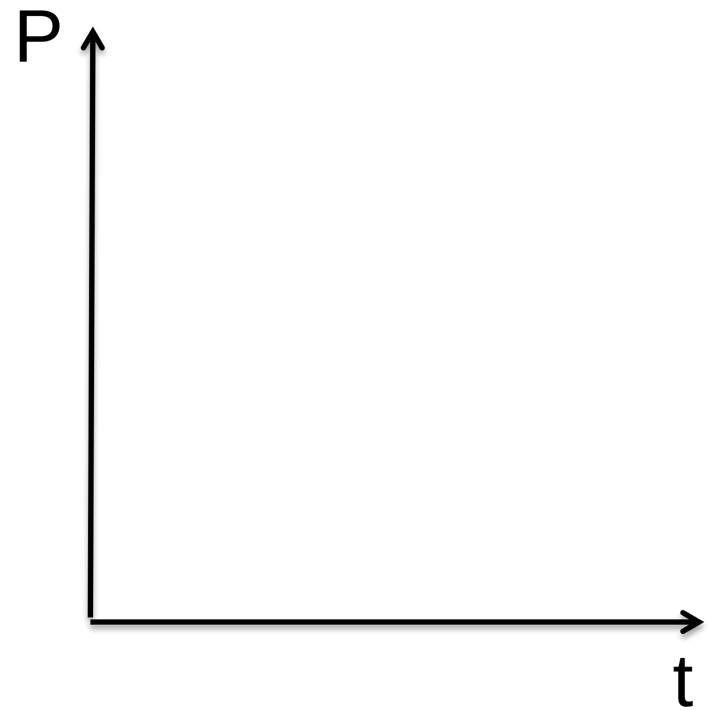


from 1GW study 2014, FHG IPA and ISE

PV system in Atacama
daily energy production: N direction



monofacial 250W



PV system in Atacama
daily energy production: N direction

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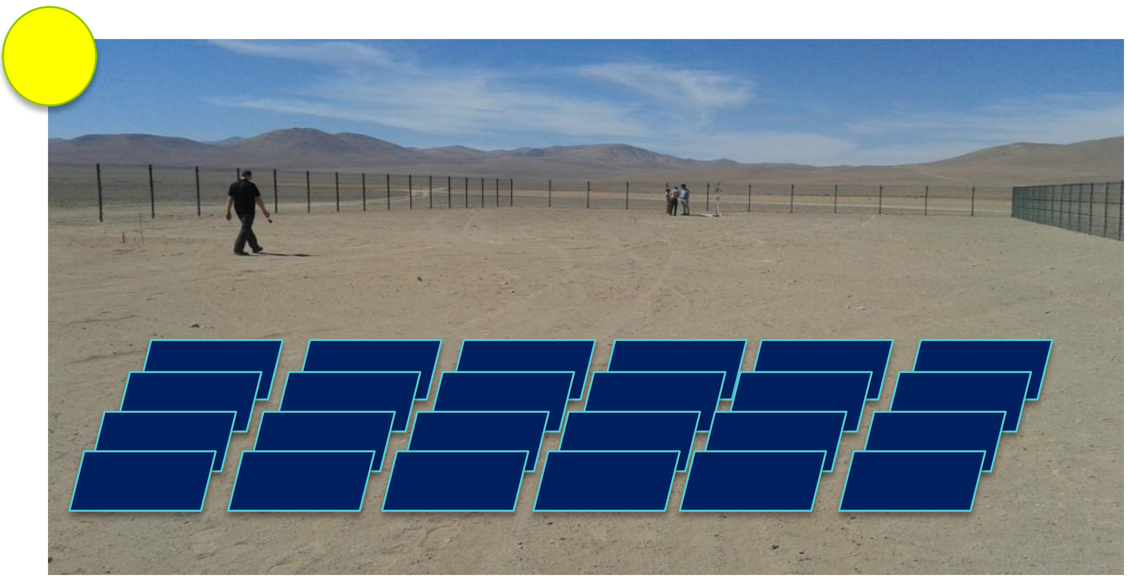
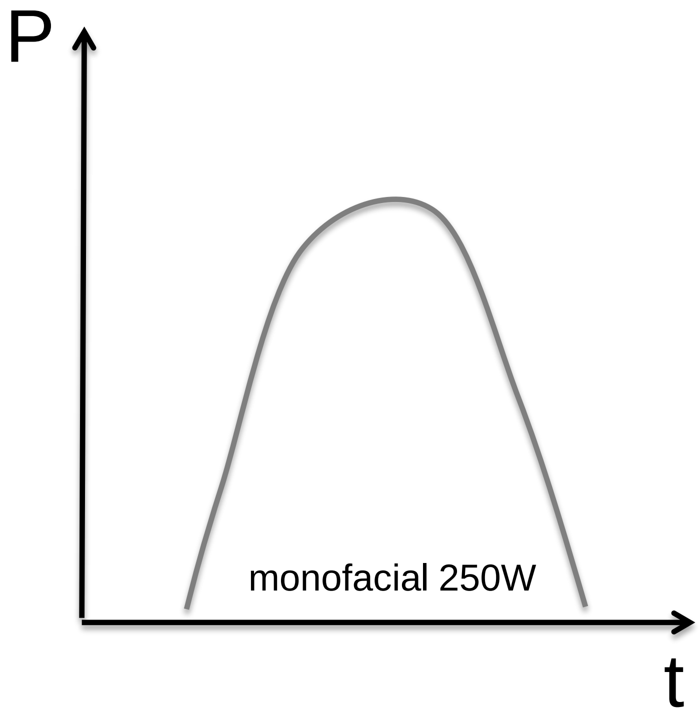
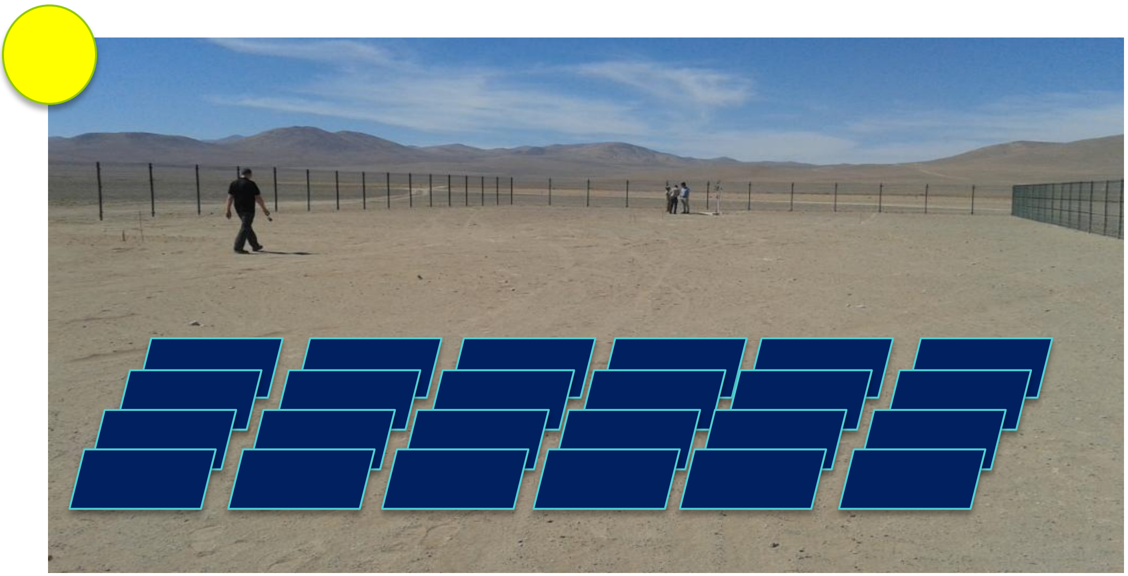


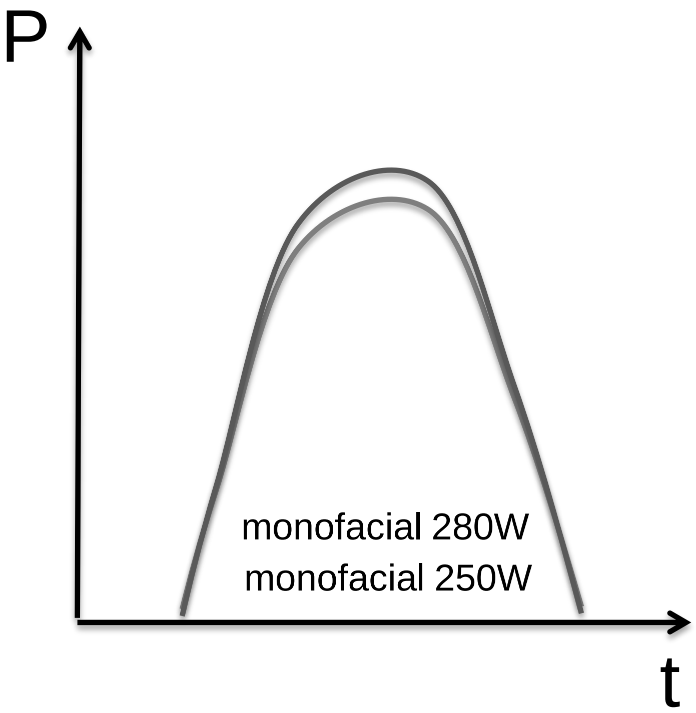
monofacial 250W



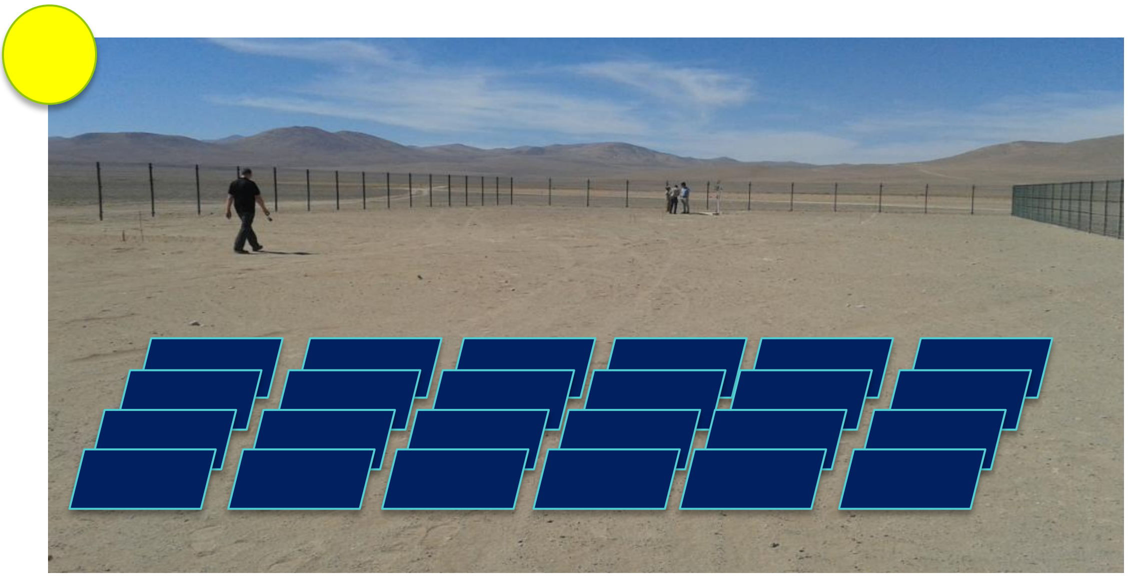
PV system in Atacama
daily energy production: N direction



monofacial 280W

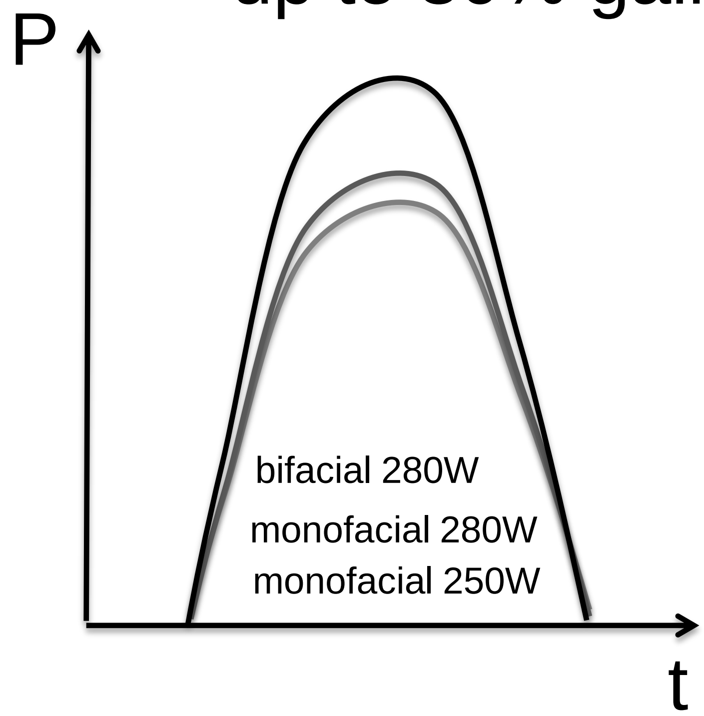


PV system in Atacama
daily energy production: N direction



bifacial 280W (e.g. BiSoN)

up to 30% gain



PV systems world wide
bifacial gain in dependence of albedo

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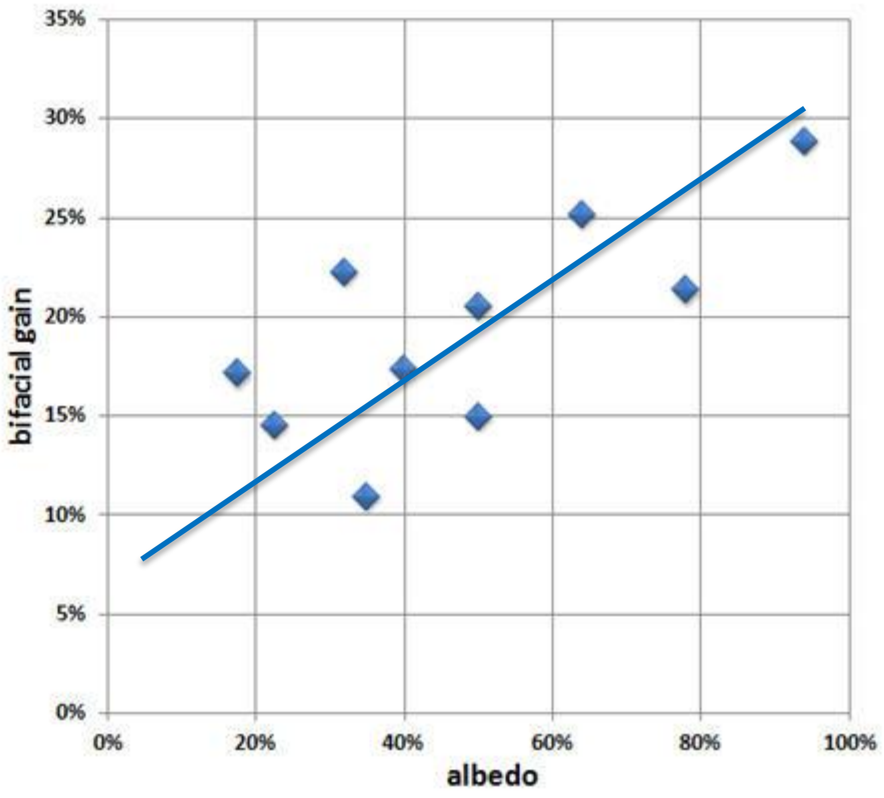
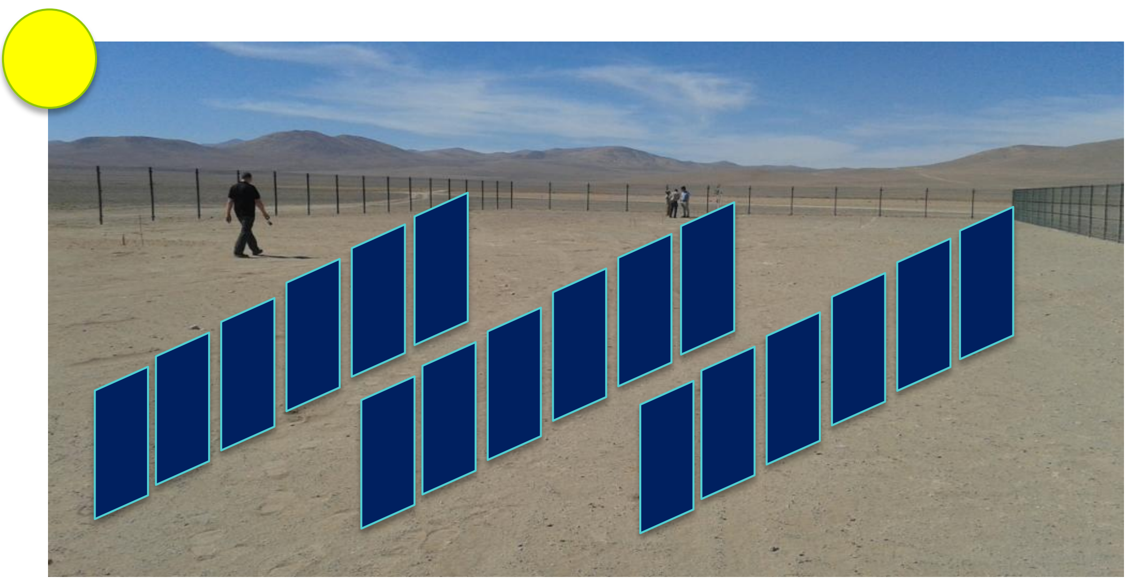
surface	albedo [%]
water	8
dry dark soil	13
grass	17-28
dry sand	35
dune sand	37
old snow	40-70
reflective roof coatings	80-90
fresh snow	75-95

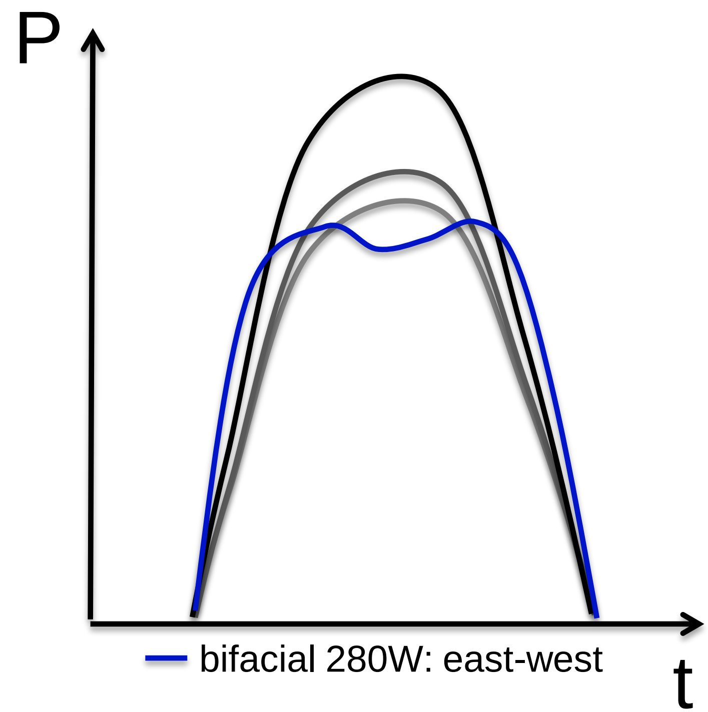


PV system in Atacama
daily energy production: E-W



bifacial 280W: east-west

energy same to monofacial 280W in N



PV system in Atacama
daily energy production: E-W

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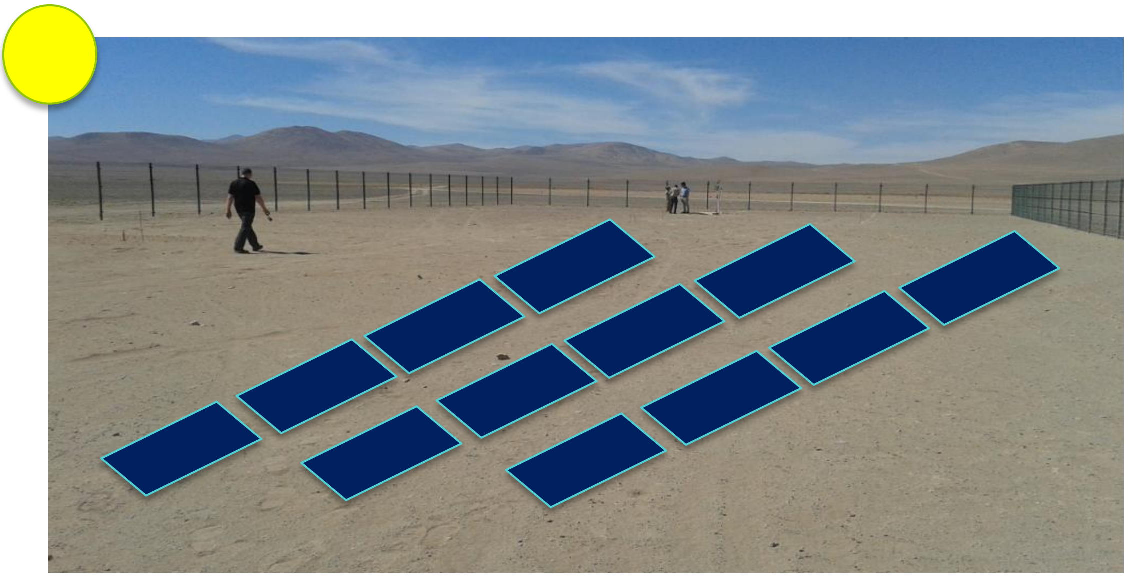
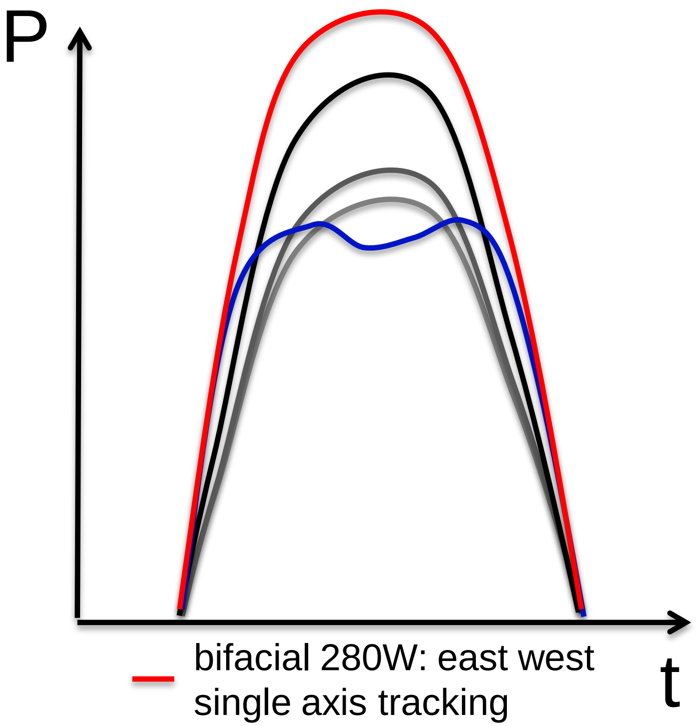
up to 50% gain



bifacial 280W: east west
single axis tracking



standard mc-Si versus BiSoN lifetime energy production

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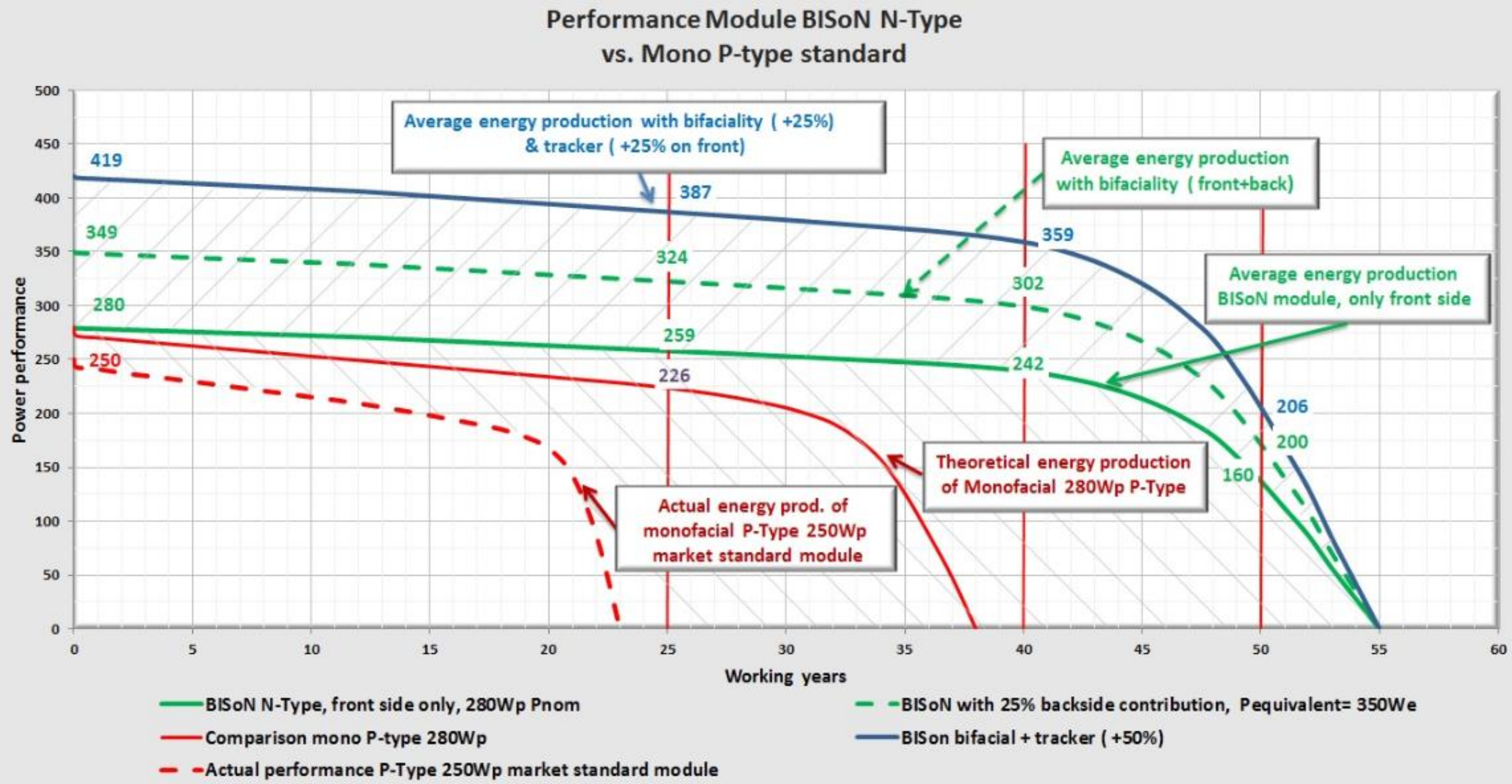

outdoor test results of 60 cell modules results from ISC's test site in el Gouna

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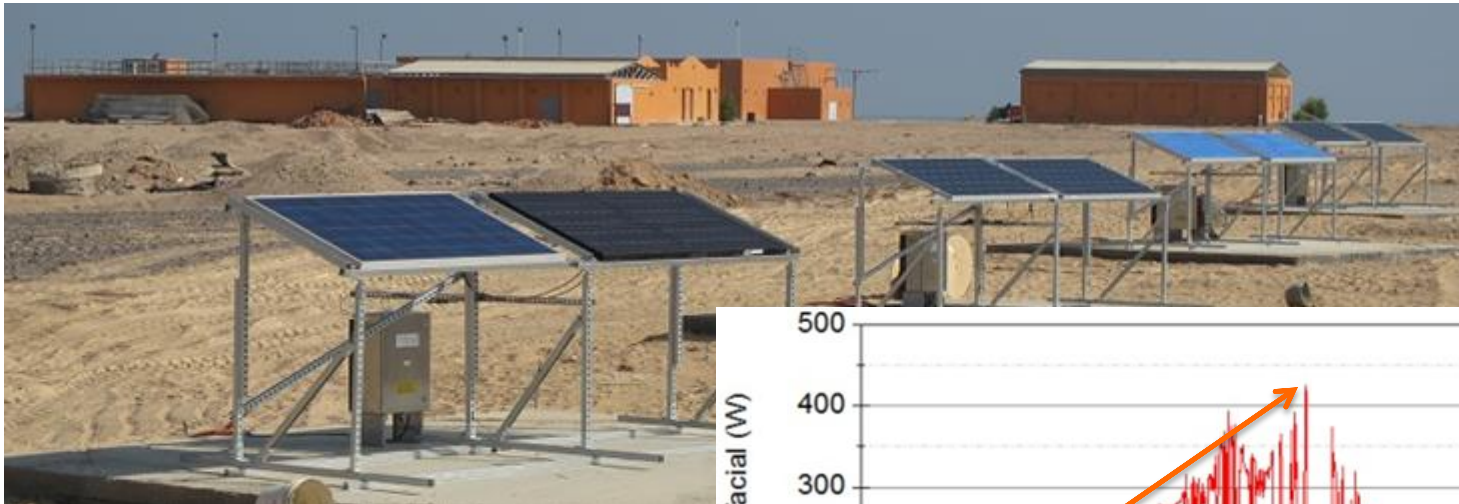

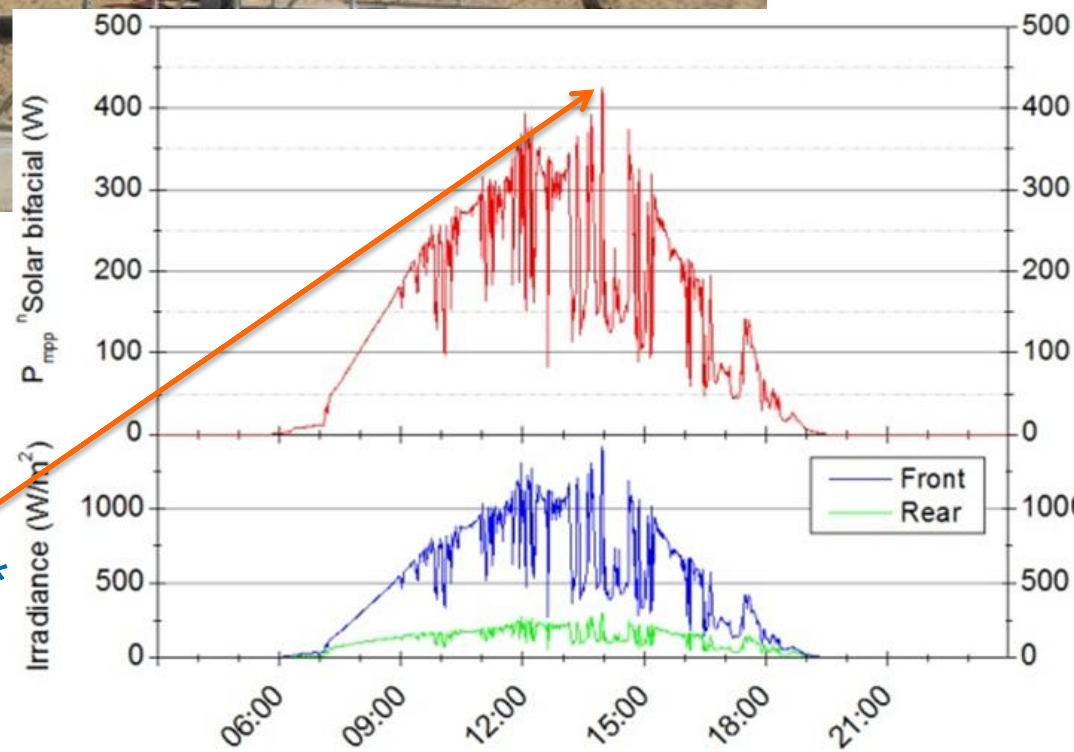

Front (indoor): 298Wp

Outdoor total: 420Wp-e*

*peak effective power output

simulations with real data of bSolar

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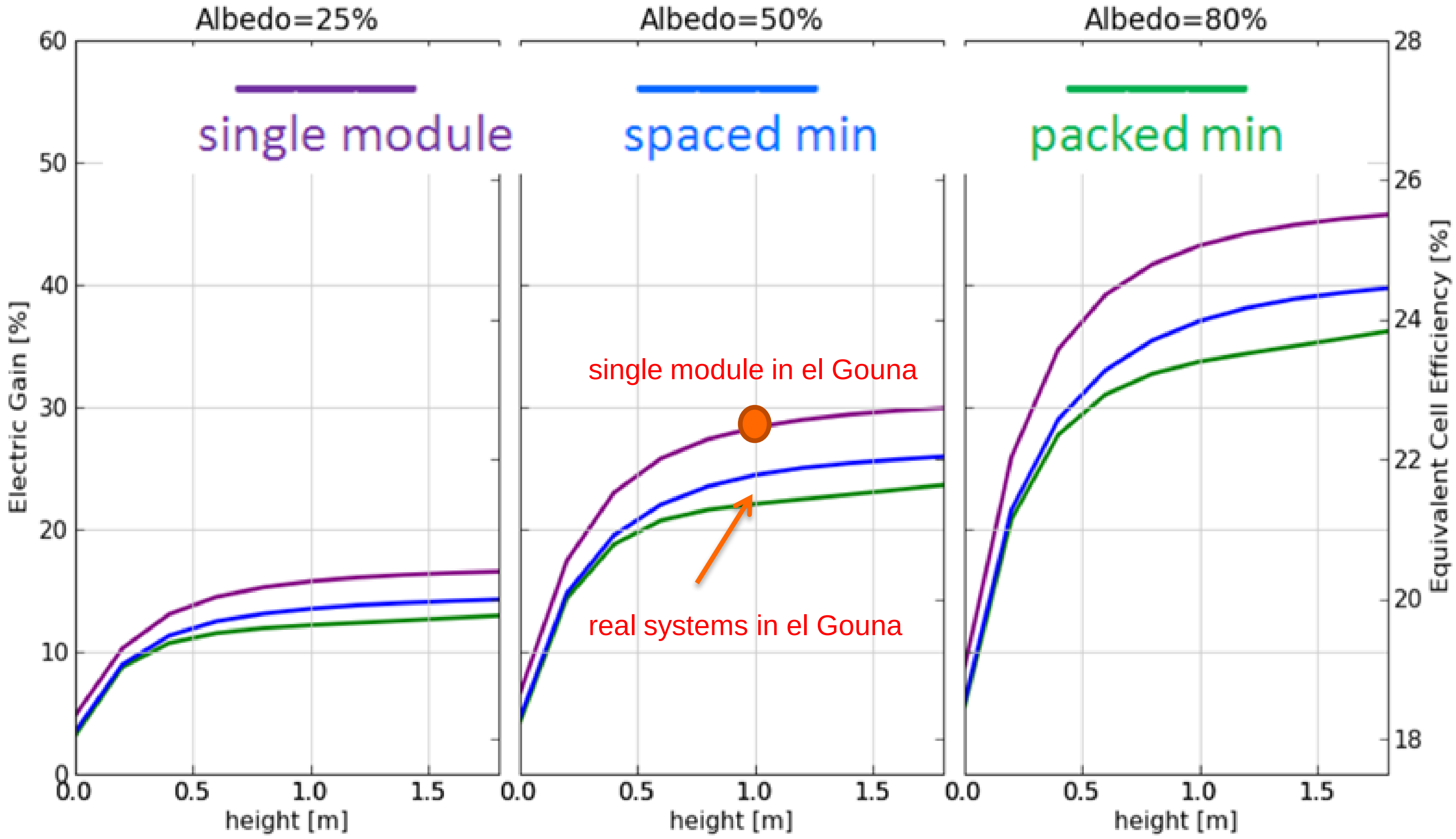

bSolar, bifiPV workshop, 2014

future of PV systems

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ground mounted

bifacial tracked

Desert modules (AtaMo)

- glass–glass module
- glass with coatings that protect against, for example, soiling and abrasion
- solar cells with high voltage
- bifacial solar cells
- half cells for improved fill factor (*FF*), enabling the use of standard bypass diodes

bifacial fixed

residential

roof back contact
(e.g. Netherlands)

BI bifacial

flat roof

bifacial

summary

- solar cells in near future will be **bifacial** anyhow

- many modules in future will be glass-glass

- the system kWh can be extremely increased by using bifacial cells and bifacial modules

>> bifacial systems have to be set up and the advantage monitored

>> measuring standards and good bifacial system simulations have to be introduced

>> **Back contact modules** will be important for roof top applications (e.g. Netherlands)