Rear contact modules vs. bifacial and other technologies

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new trends

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

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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.
new trends

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

Figure 1: 2014 Solar PV Module Production by Technology

- c-Si p-type Multi Standard 35%
- c-Si p-type Multi Advanced 27%
- c-Si p-type Mono Advanced 10%
- c-Si p-type Mono Standard 14%
- c-Si n-type 6%
- CdTe (First Solar) 4%
- CIS/CIGS Sputter 2%
- a-Si Glass/Glass 2%
- All others 1%

Source: NPD Solarbuzz *PV Equipment Quarterly*


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

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who rules the PV world in 2025

Figure 1: 2014 Solar PV Module Production by Technology

- c-Si n-type: 40%
- c-Si p-type Multi Advanced: 40%
- BIFACIAL AND REAR CONTACT: 35%
- c-Si p-type Multi Standard: 14%
- c-Si p-type Mono Advanced: 10%
- CdTe (First Solar): 4%
- CIS/CIGS, Sputter: 2%
- a-Si Glass/Glass: 2%
- All others: 1%

Source: NPD Solarbuzz *PV Equipment Quarterly*
bifacial n-type technologies

PERT technology
Passivated Emitter Rear Totally Diffused

HTJ technology
Heterojunction

IBC technology
Interdigitated Back Contact

Courtesy of ISC Konstanz

Courtesy of Sanyo-PANASONIC

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

monofacial 250W
PV system in Atacama
daily energy production: N direction

monofacial 280W

monofacial 280W
monofacial 250W
PV system in Atacama
daily energy production: N direction

up to 30% gain

bifacial 280W (e.g. BiSoN)
PV systems world wide
bifacial gain in dependence of albedo

<table>
<thead>
<tr>
<th>surface</th>
<th>albedo [%]</th>
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<tbody>
<tr>
<td>water</td>
<td>8</td>
</tr>
<tr>
<td>dry dark soil</td>
<td>13</td>
</tr>
<tr>
<td>grass</td>
<td>17-28</td>
</tr>
<tr>
<td>dry sand</td>
<td>35</td>
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<td>dune sand</td>
<td>37</td>
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<tr>
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<td>40-70</td>
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<td>reflective roof coatings</td>
<td>80-90</td>
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<td>fresh snow</td>
<td>75-95</td>
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</table>
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

bifacial 280W: east west
single axis tracking

up to 50% gain

bifacial 280W: east west
single axis tracking
standard mc-Si versus BiSoN lifetime energy production

![Graph showing the performance of BiSoN N-Type modules compared to Mono P-type standard modules.]

- **Average energy production with bifaciality (+25%) & tracker (+25% on front)**
- **Average energy production with bifaciality (front+back)**
- **Average energy production BiSoN module, only front side**
- **Theoretical energy production of Monofacial 280Wp P-Type**
- **Actual energy prod. of monofacial P-Type 250Wp market standard module**

- *BISO/N N-Type, front side only, 280Wp Pnom*
- *Comparison mono P-type 280Wp*
- *Actual performance P-Type 250Wp market standard module*
- *BISO/N with 25% backside contribution, Pequivalent= 350We*
- *BISON bifacial + tracker (+50%)*

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

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

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

roof back contact (e.g. Netherlands)

BI bifacial

residential

flat roof

bifacial

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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)