PV Industry Trends from Trends Report 2020 and some update

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Septe10th November 2020, PVPS Workshop@PVSEC-30
RTS Corporation – founded in 1983, 36 year experience

Comprehensive Consulting company on Photovoltaics (PV)

Business: Helping establish PV business strategy, “Go to Japanese market”

Clients: Government agencies, utilities, manufacturers (entire value chain of PV) project developers, financial institutes, industry associations, etc.
in JP, US, DE, IT, FR, AT, NR, CHE, AUS, CHN, IND, KOR, Taiwan, Thailand, Norway, etc.

Consulting for PV projects
Contents

- Highlights from PV industry from Trends Report 2020
- Update of 2020 trends
- Conclusion

Trends with more focus on downstream sectors will be presented on Thursday, Date: 14:50-18:00, Nov. 12 (Thu), 2020

PVSEC SPECIAL FORUM - PV INDUSTRY IN THE POST-PANDEMIC ERA - CHALLENGES AND SOLUTIONS
Yearly PV Installation, PV Module Production & Production capacity

Preliminary (Trends 2020)
Share of manufacturing countries along the value chain (2019)

Source: IEA PVPS and Trends Report 2020, to be published
PV Module production by technology

- sc-Si share increased to 62%, mc-Si share decreased from 50.4% to 34%
- Thinfilm share: 4.1%, majority from First Solar, then, Solar Frontier, etc.
Some update trends

- 1H 2020 Module shipment rankings
- Further enhancement of manufacturing capacity
- PV module prices
- Higher output & efficiency technologies
## PV module top 10 suppliers in 1H 2020 and major manufacturing sites

<table>
<thead>
<tr>
<th>Rank</th>
<th>1H 2020 Shipment preliminary (GW)</th>
<th>2019 Shipment preliminary (GW)</th>
<th>2018 Shipment (GW)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>JinkoSolar (China/ Malaysia/ USA)</td>
<td>8</td>
<td>14.3</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>11.17</td>
</tr>
<tr>
<td>2</td>
<td>LONGi Green Energy Technology (China/ Malaysia)</td>
<td>6.8</td>
<td>10.3</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>8.5</td>
</tr>
<tr>
<td>3</td>
<td>Trina Solar (China/ Thailand)</td>
<td>5.84</td>
<td>10</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>7.54</td>
</tr>
<tr>
<td>4</td>
<td>JA Solar Technology (China/ Malaysia/ Vietnam)</td>
<td>5.46</td>
<td>8.6</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>6.82</td>
</tr>
<tr>
<td>5</td>
<td>Canadian Solar (Canada/ China/ Brazil/ Vietnam/ Taiwan)</td>
<td>5.12</td>
<td>8.4</td>
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<tr>
<td></td>
<td></td>
<td></td>
<td>6.58</td>
</tr>
<tr>
<td>6</td>
<td>Hanwha Solutions (S. Korea/ China/ Malaysia/ USA)</td>
<td>4</td>
<td>7.3</td>
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<tr>
<td></td>
<td></td>
<td></td>
<td>5.60</td>
</tr>
<tr>
<td>6</td>
<td>Risen Energy (China/ Mexico)</td>
<td>3.37</td>
<td>6.3</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>4.57</td>
</tr>
<tr>
<td>8</td>
<td>First Solar (USA/ Malaysia/ Vietnam)</td>
<td>2.5</td>
<td>5.4</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>3.35</td>
</tr>
<tr>
<td>8</td>
<td>Zhejiang Chint Electrics (Astronergy) (China)</td>
<td>2.22</td>
<td>3.7</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>3.30</td>
</tr>
<tr>
<td>10</td>
<td>GCL System Integration Technology (GCLSI) (China/ Vietnam)</td>
<td>2</td>
<td>3.6</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>3.15</td>
</tr>
</tbody>
</table>

Source: RTS Corporation based on annual report, etc., including estimates, as of August 2020
Capacity expansion of PV modules by major companies

- JinkoSolar
- LONGi Green Energy Technology
- Trina Solar
- JA Solar Technology
- Canadian Solar
- Hanwha Solutions
- Risen Energy
- First Solar
- Wuxi Suntech Power

As of the end of 2019
As of the end of 1H 2020
As of the end of 2H 2020
Manufacturing capacity along the value chain, as of 22nd October
Recent PV module trends

Source: PV Insight
Glass for PV modules

Glass Shortage Threatens Solar Panels Needed for Climate Fix

Bloomberg News
2020年11月5日 13:46 JST Updated on 2020年11月6日 11:00 JST

► PV glass output seen 20%-30% short of demand next year
► Price have risen 71% since July, hurting solar power economics

The world's biggest solar power company says a shortage of glass is raising costs and delaying production of new panels, throwing a wrench into
Technology trends along the value chain: Crystalline Silicon

- **Poly Silicon**
- **Ingot**
- **Wafer**
- **Solar Cell**
- **Module**

**mc-Si**
- Cast-mono

**sc-Si**
- Recharging
- Multiple use of
- Crucibles
- Longer pulling
- Ga doping

- **Larger sizes**
  - 156 → 158 → 161/166 → 180/182 → 210mm
- **Standazation**

- **Higher efficiency:**
  - n-PERT, TOPCon (Passivated Contact), SHJ, IBC, Tandem
- **Bifacial**
- **Contacts** (finer, multiple, MBBs)

- **Higher power**
  - ½ Cut, 1/3 Cut or more
- **Bifacial** (Glass-Glass, Glass-Polymer)
- **Interconnection** (Shingled, Paving/Tiling, etc.)
- **Light weight, bendable**
- **Colored/Printed glass**
- **BIPV/BAPV**

**Location of manufacturing sites, Low-cost equipment, Smart manufacturing (Automation plus highly efficient process management with IoT, Bigdata, AI and machine learning), Sustainable manufacturing/lower carbon footprint**
Trends for higher output for crystalline silicon PV modules

- Larger wafers (182/210mm)
- Cut cells (1/2, 1/3..., Demageless cutting)
- MBBs/Multiwire, Smart wire
- Interconnections Shingled/Paving/Tiling...
- Bifacial (PERC, HJT), Glass-Glass, Glass-polimer
Recently announced high efficiency PV modules

- SPI Solar (IBC)
- Canadian Solar
- JinkoSolar
- LONGI Solar
- Canadian Solar Technology
- ETEC
- JA Solar Technology
- Trina Solar
- Hanwha Q CELLS
- Hanwha SolarOne
- JinkoSolar
- JinkoSolar
- HT Solar (Hitai Solar)
- JinkoSolar (TOPCon)
- Jing Sun
- JinkoSolar (HIT)
- Trina Solar
- Trina Solar
- IBC Solar
- Alikec
- Alikec
- Trina Solar
- Hanwha Q CELLS
- Suntech Power
- Trina Solar
- Jing Sun
- JA Solar Technology
- Yingli (HiPER)
- Maxeon (SunPower)
- Maxeon (SunPower)
- DZ Solar
- Tongwei Solar

Cell count and cut sizes:
- 158.75mm (G1)
- 166mm (M6)
- 182mm (M10)
- 210mm (M12/G12)

*If not noted, cell type is p-mono silicon PERC
*Cell number based on fullsize wafer
Technology trends along the value chain: Thinfilms

**CdTe, CIGS, etc.**

- Higher efficiency (tandem)
- Larger size module
- Light weight
- Flexible/ bendable
- Coloured/ Printed surface
- BIPV/BAPV
Conclusion

• Still gap exists between demand and production capacities
• Price affected by supply issues of polysilicon and glass but eventually stabilized
• Cost competition → Higher output and efficiency to reduce LCOE
• COVID-19 may diversify of manufacturing location
• But lower margins cast some questions for future investment for TW era
• Reliability and sustainability are essential
Acknowledgement for the support of PVPS activities

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