Global PV Industry Trends and Impacts of COVID-19

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Contents

• About RTS Corporation
• Trends of PV industry from Trends Report
• Impacts of COVID-19 on PV industry
• PV for after COVID-19 and future
**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.

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**Key Points:***

- **R & D**
- **PV system**
- **PV projects**
- **Silicon feedstock for solar cell**
- **Deployment Business models**

**Go to Japanese Market**

**Consulting for PV projects**

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Trends in the PV Industry
Trends in the upstream sector

• Production capacity increase
• China dominate production share
• Major companies have >10 GW/yr of manufacturing capacity
• Higher efficiency & output
  • Combination of several technologies
  • Full shift from conventional to PERC cells
  • Increase of commercial production of HJT
• sc-Si increases the share (sc-Si > mc-Si in 2019)
• Bifacial PV module shipment increases
• Further cost reduction from polysilicon and wafer
• Consolidation continues due to price reduction and impacts of COVID-19
Yearly PV Installation, PV Module Production & Production capacity

YEARLY PV INSTALLATION, PV PRODUCTION AND PRODUCTION CAPACITY 2008 - 2019 (GW)

PV installations | Total production | Total production capacity

Preliminary (RTS)

SOURCE: IEA PVPS, RTS CORPORATION.
Countries share in different segments of the production.
### PV module top 10 suppliers and major manufacturing sites in 2019

<table>
<thead>
<tr>
<th>Rank</th>
<th>2019 Shipment (GW)</th>
<th>2018 Shipment (GW)</th>
<th>2017 Shipment (GW)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>14.3</td>
<td>JinkoSolar (China/Malaysia)</td>
<td>11.17 JinkoSolar (China/Malaysia)</td>
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<tr>
<td></td>
<td></td>
<td>11.17</td>
<td>9.8</td>
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<tr>
<td>2</td>
<td>10.3</td>
<td>JA Solar (China/Malaysia)</td>
<td>8.5 Trina Solar (China/Thailand/Vietnam)</td>
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<tr>
<td></td>
<td></td>
<td>8.5</td>
<td>9.0</td>
</tr>
<tr>
<td>3</td>
<td>10</td>
<td>Trina Solar (China/Thailand)</td>
<td>7.54 JA Solar (China)</td>
</tr>
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<td></td>
<td></td>
<td>7.54</td>
<td>7.2</td>
</tr>
<tr>
<td>4</td>
<td>8.6</td>
<td>Canadian Solar (Canada/China/Brazil/Vietnam)</td>
<td>6.82 Canadian Solar (Canada/China/Brazil/Vietnam)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>6.82</td>
<td>6.8</td>
</tr>
<tr>
<td>5</td>
<td>8.4</td>
<td>LONGi Green Energy Technology (China/Malaysia)</td>
<td>6.58 Hanwha Q CELLS (S. Korea/China/Malaysia)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>6.58</td>
<td>5.4</td>
</tr>
<tr>
<td>6</td>
<td>7.3</td>
<td>Hanwha Q CELLS (S. Korea/China/Malaysia)</td>
<td>5.60 GCL System Integration Technology (GCLSI) (China)</td>
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<td></td>
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<td>5.60</td>
<td>4.8</td>
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<tr>
<td>6</td>
<td>6.3</td>
<td>GCL System Integration Technology (GCLSI) (China)</td>
<td>4.57 LONGi Green Energy Technology (China)</td>
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<td></td>
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<td>4.57</td>
<td>4.7</td>
</tr>
<tr>
<td>8</td>
<td>5.4</td>
<td>Risen Energy (China)</td>
<td>3.35 Yingli Green Energy (China)</td>
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<td></td>
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<td>3.35</td>
<td>3.0</td>
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<tr>
<td>8</td>
<td>3.7</td>
<td>Shunfeng International Clean Energy/Suntech Power (China)</td>
<td>3.30 Risen Energy (China)</td>
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<td></td>
<td></td>
<td>3.30</td>
<td>2.8</td>
</tr>
<tr>
<td>10</td>
<td>3.6</td>
<td>Chint Electrics (China)</td>
<td>3.15 First Solar (USA/Malaysia)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>3.15</td>
<td>2.7</td>
</tr>
</tbody>
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Source: RTS Corporation based on annual report, etc., including estimates, as of 8th May 2020.
PV module production capacity by major companies

Source: RTS Corporation as of 8th May 2020
PV Module production per technology

CPIA reported the share of sc-Si wafer was 65% of 134.6GW of production

Source: CPIA, 14th February 2020
Technology trends along the value chain: upstream

- Debottlenecking
- Non-EVA encapsulants
- Glass-Glass/Glass-transparent backsheets
- Higher efficiency
- Larger size
- Material/electrodes
- Process
- Flexible substrates
- Lower Ag consumption
- Bifacial
- AR coating
- Anti-Soiling
- Reliability
- Higher efficiency
- Larger size
- Material/electrodes
- Process
- Flexible substrates
Downstream trends

• Lower Capex and Opex for lower LCOE
  • Efforts on all the stage of development: design, procurement, construction and O&M
• More power with bifacial PV and trackers
• BOS Cost reduction
  • Inverter: String vs Centralized, 1500V or more???
  • Tracker: Centralized or distributed control?
  • Support structures: Prefabricated, automation
• Mitigating risks of component failures
• More cost efficient O&M
  • AI analysis for failure detection and prescheduled maintenance, using drones, etc.
Downstream Trends: business opportunities

- New applications: FPV (on-shore & off-shore), AgroPV, BIPV and VIPV
- Repowering and revamping
- Requirement for grid code and regulation
  - Smart inverters → Grid forming/ grid supporting inverters
- Requirement for building energy efficiency code and regulation
  - BIPV
  - PV and ESS
- Recycling
Impacts of COVID-19 on PV industry

https://coronavirus.jhu.edu/map.html
Major manufacturing site and number of COVID-19 infectants in China

Source: Based on Infectants number map [https://ncov.dxy.cn/ncovh5/view/pneumonia](https://ncov.dxy.cn/ncovh5/view/pneumonia), RTS Corporation
COVID-19 Impacts on downstream sector

- **Lockdown**
- **Increase of financing cost**
- **Foreign exchange loss**
- **Falling electricity demand**

### Distributed PV
- Construction delay and sales activities
- Increase of cost due to exchange rate in some markets

### Utility scale PV under operation
- Difficulty in onsite maintenance → output loss
- Revenue loss due to curtailment
- Revenue loss due to falling currency value

### Utility scale under development
- Delay of construction, administrative process, etc.
- Rush of construction might be started in 2020H2 and shortage of workers, components
- Increase of CAPEX due to exchange rate change
- Difficulty to close corporate PPA or merchant PV

### Scheduled utility scale PV auction
- Delay or cancellation of scheduled
Examples of Measures against COVID-19

- Extension of grid connection due date or lift of penalties

- 17 Results of the 3rd tender (51 projects totaling 301MW) was not disclosed in order to set non-specific due date for deposit or commission

- Government regards delay of renewable energy projects due to COVID-19 pandemic as “Force majeure”

- Extended due date for grid connection for PV projects

- Economic stimulus measures using PV

- NY states: Promotion of renewable energy development after COVID-19

- 4.7 Billion USD will be invested. Tenaga Nasional (TNB) will invest rooftop solar projects. The Ministry of Energy, Science, Technology, Environment and Climate Change plans 1.4GW auction

- Tax measures for Commercial and Industry PV application

- Immediate approval for PV with <1MW capacity
PV after COVID-19 and future
Concern: dose falling fuel price slowdown growth of PV ???

Which pathway do we follow?

Stagnation of global economy

Plunge of fossil fuel price

Slow down of energy transition

Risk of climate change

Mitigation of climate change

Acceleration of energy transition
PV: leader of energy transition

Trends of renewable energy (2010～2019年)

Source: IEA PVPS [Snapshot of Global PV Markets 2020]
PV could be a core technology for economic recovery after COVID-19

PV can stimulate economic recovery and contribute to develop sustainable society

<table>
<thead>
<tr>
<th>Sector</th>
<th>Related SDGs</th>
<th>Contribution</th>
</tr>
</thead>
<tbody>
<tr>
<td>Rural Electrification</td>
<td></td>
<td>Basic service for poor</td>
</tr>
<tr>
<td>Replacement of Diesels</td>
<td></td>
<td>Decrease of pollution, off grid power supply for medical service</td>
</tr>
<tr>
<td>Off-gird power supply for medical service</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Water pumps desalination</td>
<td></td>
<td>Clean and sustainable water supply</td>
</tr>
<tr>
<td>PV for agriculture and fishery</td>
<td></td>
<td>Sustainable agriculture and fishery</td>
</tr>
<tr>
<td>Deployment of PV</td>
<td></td>
<td>Job creation</td>
</tr>
<tr>
<td>Deployment of PV</td>
<td></td>
<td>Decarbonation of energy system</td>
</tr>
<tr>
<td>Charging /VIPV</td>
<td></td>
<td>E-mobility</td>
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