PV INDUSTRY TRENDS 2016

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About RTS Corporation, founded in 1983

-- Comprehensive Consultancy on Photovoltaic Power Generation (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, etc.

30 year experience

Visiting our booth at PV System EXPO : E42-57
Chapter four
Trends in the PV industry

• **Upstream PV sector**
  – Polysilicon, PV cell and modules
  – Crystalline Si PV and Thin-films
  – Impacts of trade conflicts
  – BOS (inverters, trackers, batteries, etc.)

• **Downstream sector**
  – Project developers, EPCs, financers, etc.
PolySi production

- **2015 Production for solar cell**
  - Production: >30 000 tons, (Consumption: 33 000 tons)
  - Capacity: 446 000 t/year

- **China:**
  - largest producer (16 500 t, > 50% of global) & consumer (importing 9 5000 t)

- **Other major producing countries**
  - Germany, South Korea, USA, Japan, Malaysia and Norway

- **Price decline**

- **Efforts for cost down**
  - Higher quality
  - Lower manufacturing cost (2010: 80 kWh/kg → <55 kWh/kg)
  - Debottlenecking of Siemens process
  - FBR process
  - Meturagical process
Trends of Polysilicon production capacity and consumption

Source: RTS Corporation, “Crystalline Si solar cell, Monthly Update”
PV cell production (crystalline Si + Thin-film)

- Global production: ~ 63 GW in 2015
- Largest producer and consumer: China
PV module production (crystalline Si + Thin-film)

- Global production: ~ 63 GW in 2015
- Largest producer and consumer (installed capacity): China
<table>
<thead>
<tr>
<th>Rank</th>
<th>Solar cell</th>
<th>Production volume *1 (MW)</th>
<th>PV module</th>
<th>Shipment volume *1 (MW)</th>
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<tbody>
<tr>
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</tr>
<tr>
<td>1</td>
<td>Hanwha Q CELLS (Korea/ China/ Malaysia/ Germany)</td>
<td>3,935</td>
<td>Trina Solar (China)</td>
<td>5,873</td>
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<td></td>
<td></td>
<td>Trina Solar (China)</td>
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<tr>
<td>2</td>
<td>Trina Solar (China)</td>
<td>3,884</td>
<td>JinkoSolar (China/ Portugal/ Malaysia/ South Africa)</td>
<td>4,400</td>
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<td>Canadian Solar (China/ Canada)</td>
</tr>
<tr>
<td>3</td>
<td>JA Solar (China/ Malaysia)</td>
<td>3,600</td>
<td>Canadian Solar (China/ Canada)</td>
<td>4,316</td>
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<td></td>
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<td></td>
<td>JinkoSolar (China/ Portugal/ Malaysia/ South Africa)</td>
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<td>4</td>
<td>First Solar (USA/ Malaysia)</td>
<td>2,618</td>
<td>Hanwha Q CELLS (Korea/ China/ Malaysia/ Germany)</td>
<td>4,200</td>
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<td></td>
<td>JA Solar (China/ Malaysia)</td>
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<tr>
<td>5</td>
<td>JinkoSolar (China/ Portugal/ Malaysia/ South Africa)</td>
<td>2,500</td>
<td>JA Solar (China/ Malaysia)</td>
<td>3,510</td>
</tr>
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<td></td>
<td>Hanwha Q CELLS (Korea/ China/ Malaysia/ Germany)</td>
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<tr>
<td>6</td>
<td>Motech (Taiwan)</td>
<td>2,350</td>
<td>First Solar (USA/ Malaysia)</td>
<td>2,618</td>
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<td></td>
<td></td>
<td>First Solar (USA/ Malaysia)</td>
</tr>
<tr>
<td>7</td>
<td>Yingli Green Energy (China)</td>
<td>1,942</td>
<td>GCL System Integration Technology (China)</td>
<td>2,219</td>
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<tr>
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<td></td>
<td></td>
<td></td>
<td>Yingli Green Energy (China)</td>
</tr>
<tr>
<td>8</td>
<td>Canadian Solar (China/ Canada)</td>
<td>1,734</td>
<td>Yingli Green Energy (China)</td>
<td>1,942</td>
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<tr>
<td></td>
<td></td>
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<td></td>
<td>GCL System Integration Technology (China)</td>
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<tr>
<td>9</td>
<td>Suntech Power/ Shunfeng (China)</td>
<td>1,696</td>
<td>SunPower Corporation (Philippines/ France)</td>
<td>1,376</td>
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<td></td>
<td>ReneSola (China)</td>
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<tr>
<td>10</td>
<td>Neo Solar Power (Taiwan/ China)</td>
<td>1,650</td>
<td>Risen Energy (China)</td>
<td>1,359</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>SunPower Corporation (Philippines/ France)</td>
</tr>
</tbody>
</table>
Manufacturing capacity of major PV players

Source: RTS Corporation
2016 PV module manufacturers ranking may change

Ranking of shipment in the Q3 2016

<table>
<thead>
<tr>
<th>Ranking</th>
<th>Company</th>
<th>1Q–3Q 2016 (MW)</th>
<th>Guidance of 2016 (GW)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>JinkoSolar (No.3)</td>
<td>4,992</td>
<td>6.6 - 6.7</td>
</tr>
<tr>
<td>2</td>
<td>Trina Solar (No.1)</td>
<td>4,443</td>
<td>6.3 - 6.55</td>
</tr>
<tr>
<td>3</td>
<td>Canadian Solar (No.2)</td>
<td>3,673</td>
<td>5.4 - 5.5</td>
</tr>
<tr>
<td>4</td>
<td>JA Solar (No.5)</td>
<td>3,254</td>
<td>4.9 - 5</td>
</tr>
<tr>
<td>5</td>
<td>Hanwha Q CELLS (No.4)</td>
<td>N.A</td>
<td>4.8 - 5.5</td>
</tr>
</tbody>
</table>
- Focusing on CdTe Thin film
- Decided to discontinue TetraSun

Trade friction over PV cell/module and polysilicon

- AD, 2014
- AD, CVD 2012
- AD, CVD
- AD, CVD (Wacker: MIP)
- Investigation on MIP and roopholes
- MIP & Max.amount
- No AD
- Restudy started for AD
- AD
- AD, CVD
- Decide No Ads New investigation requested
- Unfair subsidy
- Anti damping
Manufacturing site by Chinese and Taiwanese companies (Italic: under planning)

**Europe**
- Germany: Chint 200MW, acquired Conergy
- Poland: ReneSola 312 MW

**Pakistan:**
- Csun considering new capacity

**Korea:**
- CSun: 200MW (cell)

**South Africa:**
- Znshine 150MW
- Jinko 120MW
- ReneSola 78MW

**Japan**
- ReneSola 78MW
- Znshine 100MW
- EVERSOL: E-SOLAR 20MW

**US:**
- Shunfeng: Acquired majority of Suniva

**India**
- Renesolar 246MW
- JA Solar/ Essel: Cell/ Module 500MW
- Trina Solar/ Wellspun Energy: Cell/ Module 500MW
- Canadian Solar / Sun Group: Module

**Thailand**
- Trina Solar 700MW Cell, Module 500MW
- Talesun 500MW Cell/module
- Gintech 350MW

**Malaysia**
- ReneSola 204MW
- Jinko Solar 500MW Module/ 450MW Cell
- JA Solar 400MW (Cell)
- Gintech/ Green Energy Technology: Cell

**Vietnam**
- Canadian Solar: 300 MW

**Indonesia**
- Canadian Solar 30MW

**Brasil:**
- BYD: 400MW
- Canadian Solar: 30MW
Challenges the industry facing

- Overcapacity
- Lower margin for manufacturing
- Lowering stock performances
  - Consolidation will continue
- Financing
  - Manufacturing for new technologies
  - Recent IPO cases: downstream companies
Overcapacity continues
Lower margins: recent spot prices

Source: Pvinsight, compiled by RTS Corporation
Challenges the manufacturing industry facing

• Overcapacity: entire value chain
• Lower margin for manufacturing
  – Consolidation will continue in 2017
• Financing
  – Manufacturing for new technologies
  – Recent IPO cases: downstream companies
The way forward

- **Differentiation**
  - Manufacturing cost:
    usage of materials, operation ratio, yield, standardization of materials and parts, etc.
  - **Products**
    - Higher efficiency, Reliability, added-value (BIPV, PV + HEMS + Batteries)
  - Customers: High-end or volume zone?
  - **Business models**
    - Towards downstream
      Equipment provider to energy provider
    - Towards upstream???
      SolarCity acquired Silevo
**Overview of Downstream Sector (Utility PV Application)**

<table>
<thead>
<tr>
<th>Suppliers</th>
<th>EPC / Installers</th>
<th>O&amp;M</th>
<th>IPP / Developer</th>
</tr>
</thead>
<tbody>
<tr>
<td>PV Modules</td>
<td>INTEGRATED DEVELOPER / EPC</td>
<td>OPERATION</td>
<td>TAX EQUITY INVESTOR</td>
</tr>
<tr>
<td>Inverters</td>
<td></td>
<td>MONITORING</td>
<td>FINANCIAL INSTITUTE</td>
</tr>
<tr>
<td>Support Structures / Tracker</td>
<td></td>
<td></td>
<td>DEVELOPER / IPP</td>
</tr>
<tr>
<td>Other BOS</td>
<td>Instalers</td>
<td></td>
<td>YIELDCO</td>
</tr>
</tbody>
</table>

- Integrated players from upstream
- Integrated players from downstream???
Outlook of the Global PV Market

Source: Global PV Market Alliance, “GLOBAL PV MARKET REPORT 2015-2020” (May 2016)
Reference
IEA PVPS, “2015 A Snap Shot of Global PV Market”

Global PV Market Alliance, “GLOBAL PV MARKET REPORT 2015-2020”

RTS Corporation
PV Activities in Japan and Global PV Highlights

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