The impact of the Chinese PV industry on Silicon markets

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Typical Services
Areas of Expertise

Plant and Systems Engineering

Plant and Process Optimization

Training and Knowhow

Technology Development

Market Intelligence Advisory

Commissioning and Start Up

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Silicon Metal
Major end use markets

**Chemicals**
- Silicons, Siloxanes
- Lithium batteries, 3D printing, medical
- Requires fine grain silicon powder, high quality
- Grade 2202, 3303, other

**Photovoltaics / Semi**
- Solar cells and semiconductors
- Requires fine grain silicon powder, high quality
- 1.2 kgs mgSi / 1 kg polysilicon
- Grade 3303, 441, other

**Aluminium**
- Primary Castings (wheels, brakes, suspension)
- Secondary Castings (blocks, cylinders, heads, shafts)
- Requires lump silicon powder, low to med quality
- Grade 441, 553, others
Global PV market
Strong annual growth

- China: 39 GW in 2018
- USA: 10 GW in 2018
- India: 11 GW in 2018
- ROW: 52 GW in 2018

Strong long-term market growth

- China: 39 GW in 2018
- USA: 10 GW in 2018
- India: 11 GW in 2018
- ROW: 52 GW in 2018

However, large uncertainties exist about future markets

- Subsidy schemes
- Trade barriers
- Chinese growth
- Other Markets

Source: Solar Power Europe
Global PV market
Strong annual growth

Chinese subsidy policy causes possible wide disparity in market development

Still large demand growth foreseen for next 5 years
Global PV market
Strong annual growth

Substantial long-term growth expected:

- Wind and solar are set to surge to almost “50 by 50” – 50% of world generation by 2050 – on the back of precipitous reductions in cost ..” Bloomberg New Energy Outlook 2018 (NEO)

- In 2016, growth in solar PV capacity was larger than for any other form of generation; since 2010, costs of new solar PV have come down by 70% ...” International Energy Agency: World Energy Outlook-2017 (WEO-2017):

- In 2017, Solar deployed nearly twice as much capacity as wind, ... three times as much as gas and coal, and 9 times as much as nuclear additions. Global Market Outlook for Solar Power 2018-2022, Solar Power Europe

- “Renewable energy will be consistantly cheaper than fossil fuels by 2020”, IRENA, Jan 2018

PV market volatility: Near term growth expected to be somewhat lower than in the past which is a result of large concentrations of the PV market being tied to the dominance of China, but long term growth is expected to be strong
Global PV market
Dominance of China

Interesting Fact: In 2017 almost as much PV generation capacity was installed in the world in 12 months than the entire accumulated global PV generation in 2012.

Source: Viridis.iQ
Global PV market
Dominance of China

Chinese PV Production vs Demand
(GWp basis)

Chinese manufacturing capacity is covering almost 80% of its own domestic consumption.
Chinese PV industry
What happened on May 31, 2018

On June 1st, 2018, new regulations were released from the NDRC (China’s National Development and Reform Commission), MOF (Ministry of Finance), NES (National Energy Administration) that fundamentally changes the governmental subsidy scheme that was in place to support the Chinese PV industry.

**2018 Change:**
- Affects utility and distributed grid Solar connections
- 10GW cap on qualifying projects
- Halt of utility projects for rest of 2018
- National Feed In Tarrif (FIT) reductions
- Poverty alleviation and roof top solar programs untouched
- Push toward local governments absorbing subsidy costs

<table>
<thead>
<tr>
<th></th>
<th>Before 31/5 policy</th>
<th>After 31/5 policy</th>
<th>Change</th>
</tr>
</thead>
<tbody>
<tr>
<td>IHS Markit</td>
<td>113</td>
<td>105</td>
<td>-7%</td>
</tr>
<tr>
<td>Solar Power Europe</td>
<td>107</td>
<td>102</td>
<td>-5%</td>
</tr>
<tr>
<td>GTM Research</td>
<td>112</td>
<td>85,2</td>
<td>-24%</td>
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**Results**
Some analysts forecast this substantial change in China’s regulatory program will push the PV market into its first real recession in its young history and result in a reduction of the PV demand to 2016 levels:

- GTM forecasts 2018 Chinese market down from 48.2 GW to 28.8 GW
- AECEA lowered 2018 forecast from 40-45GW down to 30-35 GW
- Solar Power Europe lowered its projections to 39 GW
Chinese PV sector in tailspin after the May 31 announcement resulting in huge production overhang and building inventories, falling polysilicon and cells and module prices.

As of September 2018, 165 GW of PV had been installed in China, 50% more than the 2020 target.

In early November, China’s National Energy Agency NEA is now planning to revise the 2020 target upward to 210 GW - 270 GW, allowing for an annual installed capacity of PV in China of 25GW to 50GW for next two years.
Impact on the PV Market

Is this the “end of the world as we know it?”

Chinese effect will not necessarily be the end of the PV market as we know it.

- Dropping PV prices (up to 30%!) due to overcapacity in the China will lead to make solar PV more competitive
- Markets with high demand can take advantage of these lower prices and create a mitigating effect for Chinese demand
- Even in depressed markets like Europe and combined with reduction of minimum import price regulations, could spur higher demand for PV
- Higher competition will drive further reductions in material costs (g/Wp) and efficiency improvements which lead to lower costs and LCOE and thus, higher demand

Despite China’s obviously market share for PV, the industry as a whole has shown its resilience as it transitions from subsidy driven to market based demand.

Other markets have room to absorb Chinese impact
Impact on the PV Market

What about other markets

Range of PV additional PV demand 2017-2021

- India
- USA
- Europe
- China

Possible Variation in demand in mgSilicon for PV markets

- China
- Europe
- USA
- India
- Total

Metric kilotons of additional demand
Impact on the PV Market
What are the moving parts?

Strategic
- Geothermal
- Bioenergy
- Nuclear
- Hydro
- Wind
- Solar
- Total installed power generation capacity from renewables

Subsidies
- Household power price
- Industry power price

Technology
- Wafer thickness (µm)

Cost reduction
- Total installed cost
- Capacity factor
- Levelized cost of electricity

Demand

Efficiency
- Total area module efficiency (%)
Impact on the PV Market

LCOE – Cost of Solar electricity

As the LCOE for Solar and other renewables enters the shaded area, the more incentive there is for governments, companies, utilities and individuals to implement renewables as an electricity source.

When these costs go below the shaded area, fossil fuels will cost more than any renewables.

Source: IRENA, Viridis.iQ
Impact on the PV Market
Technology - Grams per Wp

Higher efficiency
- Passivated Emitter and Rear Cell
- Higher recycling rates
- Lower cell-to-module losses
- Passivated Emitter and Rear Cell
- Thinner wires and wafers

Larger ingot size

$g/W_p$

2018: 1 GW = approx 5500 tons mgSi
2021: 1 GW = approx 4800 tons mgSi

Less polysilicon consumption = less MgSi consumption
Impact on the PV Market

PV Market Cycles – The Basics

Subsidies
Subsidies are removed from regulatory environment

Demand
Demand falls as there is less incentive for PV installations

Inventory
Inventory increases as fewer buyers are in the market or as buyers wait out the fall

Cost
Cost increases as producers have lower scale

Prices
Prices fall as sellers seek to liquidate and build cash from market fall

Innovation
Innovation and consolidation increases as producers seek competitive advantage, stagnation also can occur

LCOE
LCOE falls as PV devices are cheaper and more attractive vis-a-vis other electricity sources

New Demand
Pent up demand in new or existing market surges as investment in PV is more attractive

Capacity
Capacity expands as producers try to reduce costs and capitalize on upswing
China Impact on MgSilicon Markets

What does it matter?

Polysilicon and mgSi demand curves for various scenarios

..or maybe not…

Possible market correction

Source: Viridis.iQ, SPE
## Impact on MgSilicon Markets

### Conclusion

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<thead>
<tr>
<th></th>
<th>2018</th>
<th>2019</th>
<th>2020</th>
<th>2021</th>
<th>2022</th>
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<tbody>
<tr>
<td>Likely Scenario (MgSi tons/yr from PV)</td>
<td>583,000</td>
<td>590,810</td>
<td>640,160</td>
<td>685,900</td>
<td>752,070</td>
</tr>
<tr>
<td>Optimistic Scanario (MgSi tons/yr from PV)</td>
<td>733,970</td>
<td>798,420</td>
<td>875,350</td>
<td>964,570</td>
<td>1,104,480</td>
</tr>
<tr>
<td>Possible Delta (MgSi tons/yr)</td>
<td>150,800</td>
<td>207,600</td>
<td>235,200</td>
<td>278,700</td>
<td>352,400</td>
</tr>
<tr>
<td>Possible additional SAFs</td>
<td>~8</td>
<td>~10</td>
<td>~12</td>
<td>~14</td>
<td>~18</td>
</tr>
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Even considering the May 31 China regulatory changes, aggressive gram/watt reductions and trade barriers, most analysts report strong growth in PV worldwide due to dropping LCOE and low solar prices, which will result in additional growth in mgSi production requiring an extensive expansion of existing capacity.
Not **ALL** broken eggs end up in the trash...it just depends on how they land
Thank You!