PV Industry Trends

from IEA PVPS Trends Report

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Izumi Kaizuka,
Deputy OA, IEA PVPS Task 1/Director, RTS Corporation, Japan

Contents

- Industry Trends from trends
- What happen in 2019?
- Conclusion for the TW era

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How we conduct analysis

- Information in the National Survey Reports from each member country
- RTS's primary survey for non-member/ member countries
- Available information and figures from
  - Industry associations such as CPIA
  - Press releases, etc.

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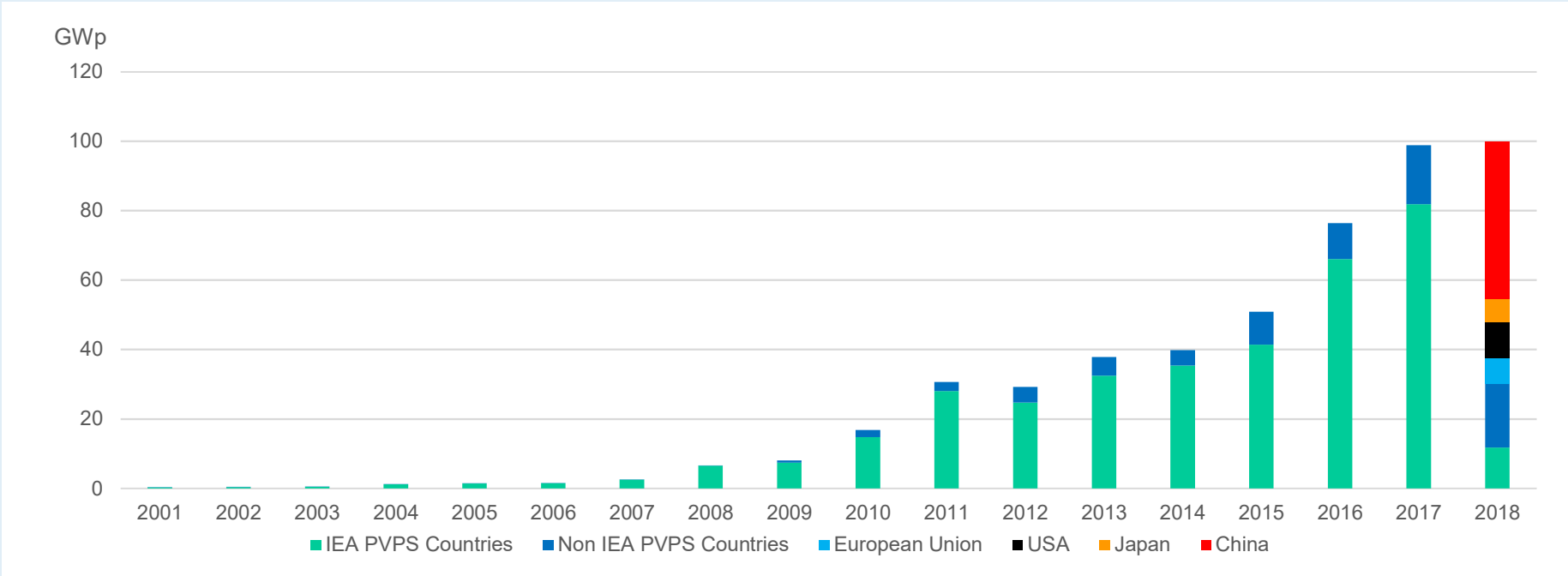
Trends of annual capacity

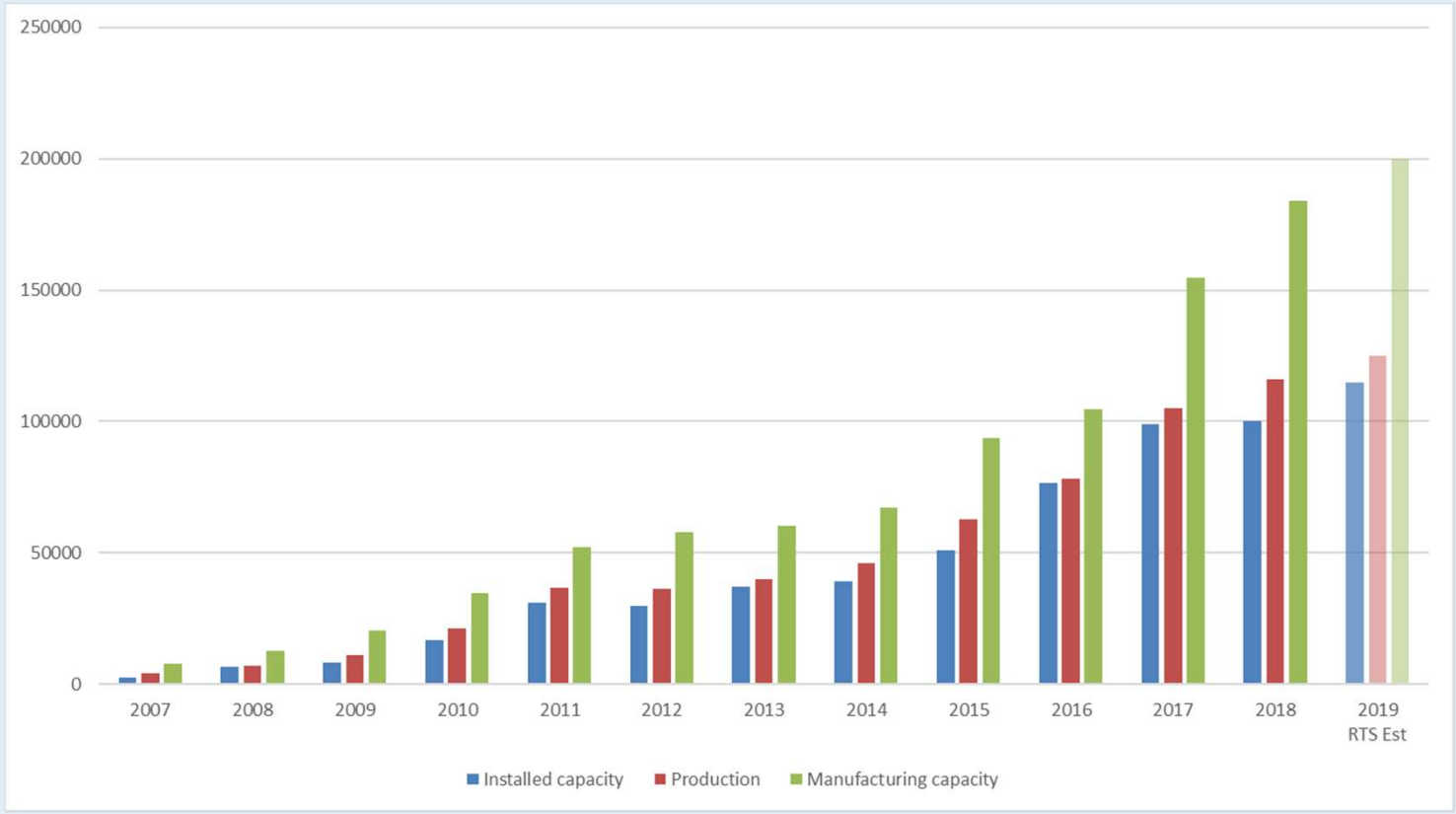
Evolution of PV capacity installed annually worldwide



Sources: IEA-PVPS

Installation, PV module production & capacity

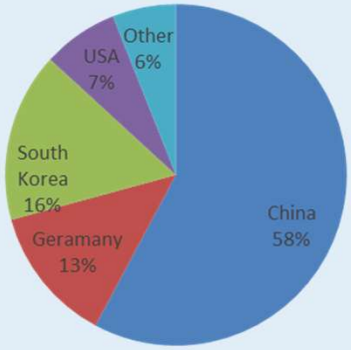
Unit (MW)



- Effective capacity: less than reported figure
- Gap is widening due to Chinese 5.31 policy in 2018

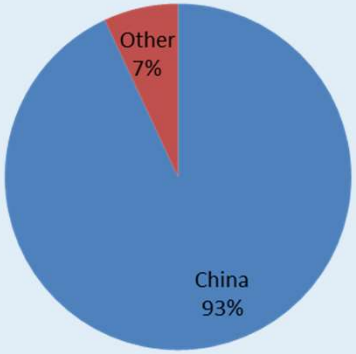
Production share by country

Share of PolySi production - 2018

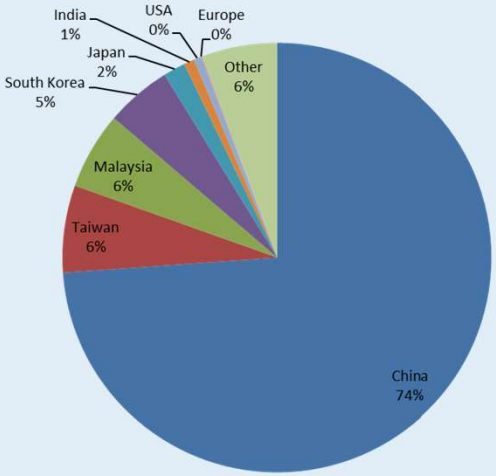


Including poly for semiconductors

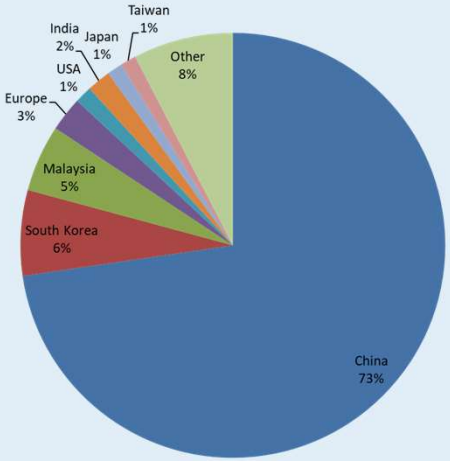
Share of PV WaferProduction - 2018



Share of PV Cells Production - 2018



Share of PV Module Production in 2018



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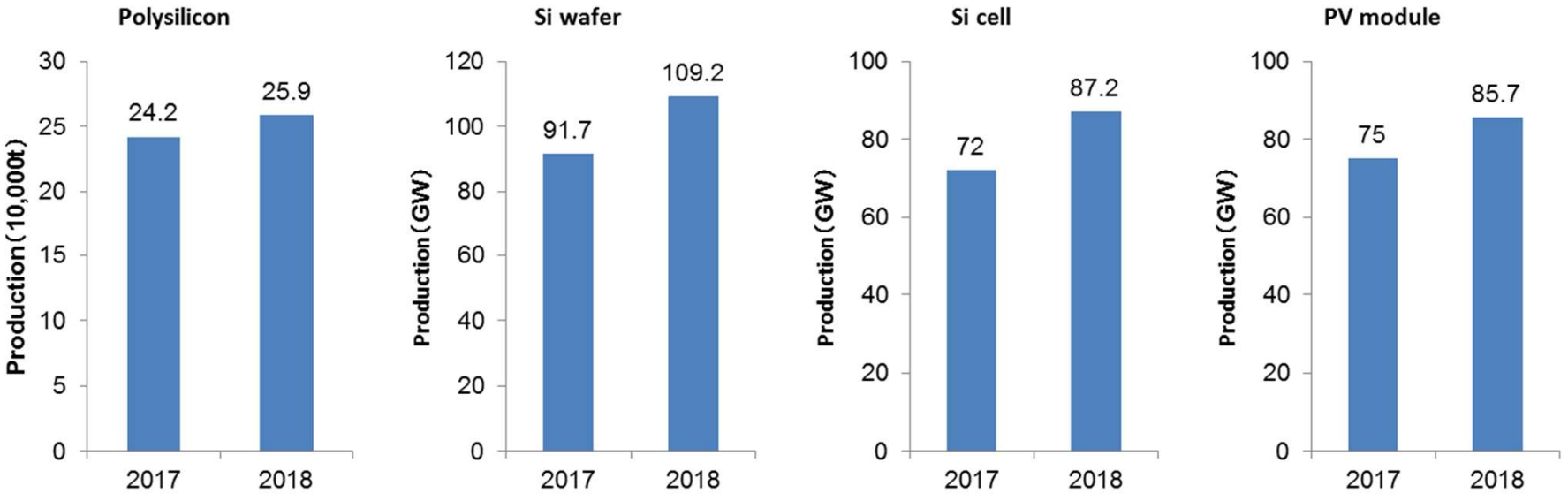
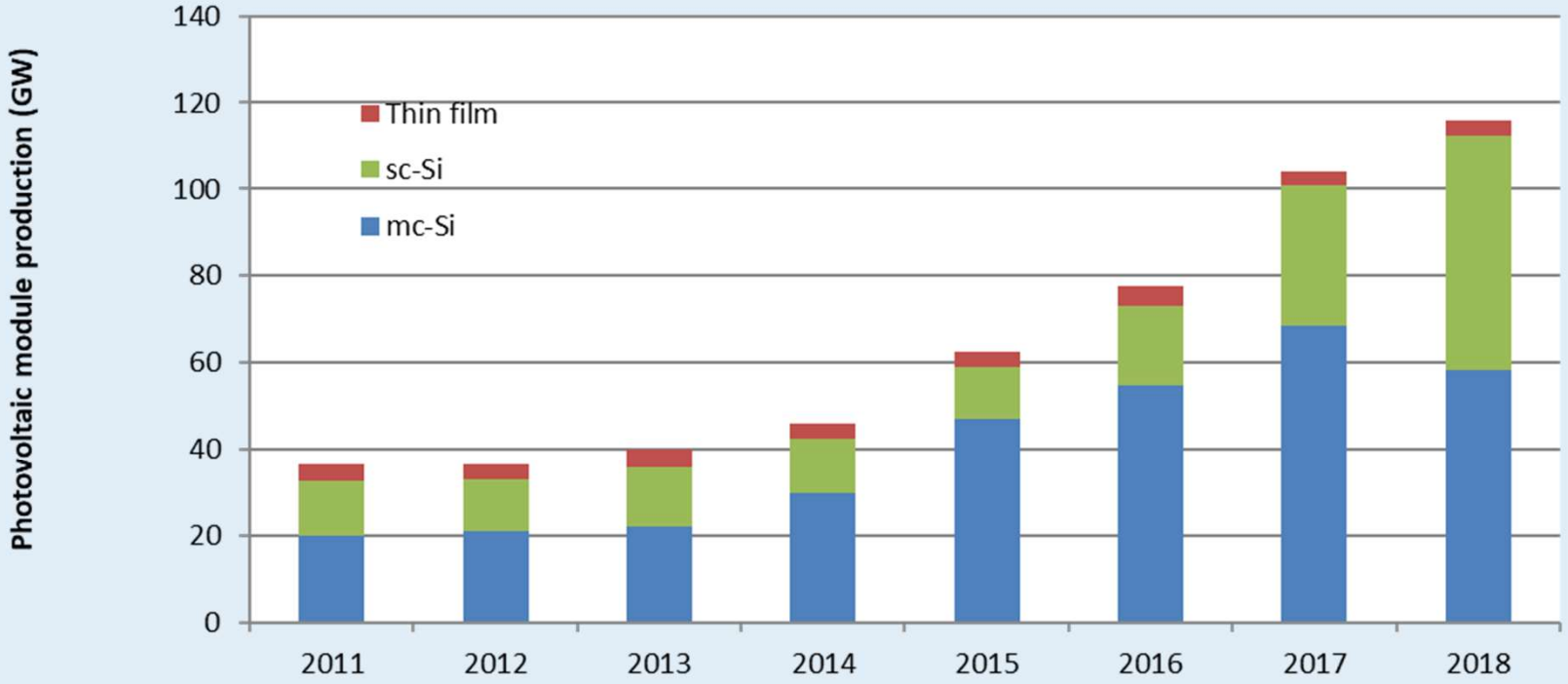
Chinese market gave non-negative impacts on production

Annual installed capacity in China
2017: 54GW → 2018 : 44GW



Source: CPVIA report

sc-Si share increased



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Top 5 cell/ wafer manufactures

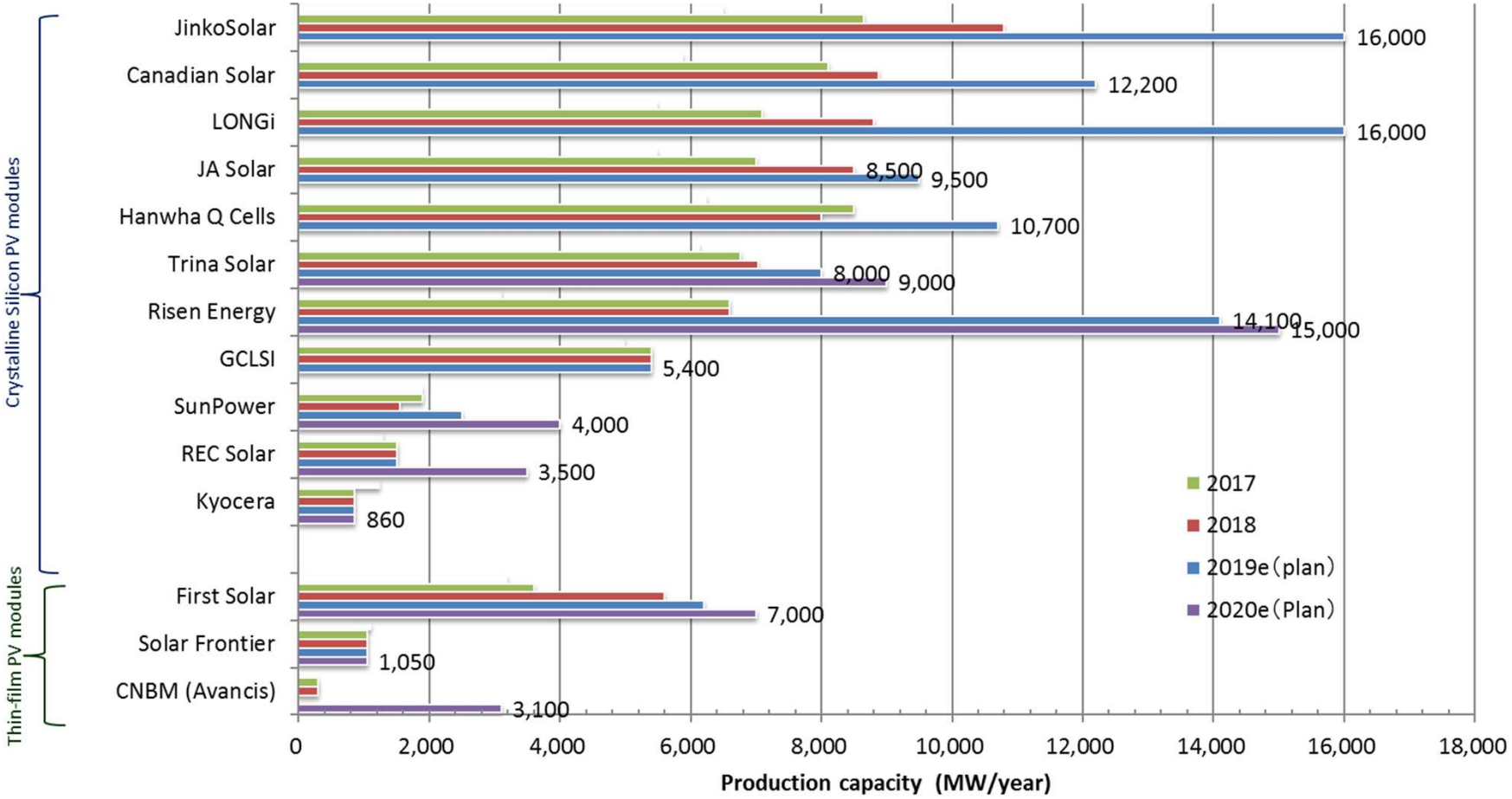
Rank	Solar cell production (GW)		PV module production (GW)		PV module shipment (GW)	
1	Hanwha Q CELLS	7,4	JinkoSolar	8,6	JinkoSolar	11,4
2	JA Solar	7,0	JA Solar	8,5	JA Solar	8,5
3	Tongwei Solar	6,5	Canadian Solar	8,0	Trina Solar	7,5
4	JinkoSolar	5,8	Hanwha Q CELLS	7,7	Canadian Solar	6,8
5	Canadian Solar	5,7	LONGi Green Energy Technology	7,5	LONGi Green Energy Technology	6,6

Note: Production volumes are manufacturers' own production, whereas shipment volumes include commissioned production and OEM procurement.
Source RTS Corporation (with some estimates)

2019 Trends in the upstream sector

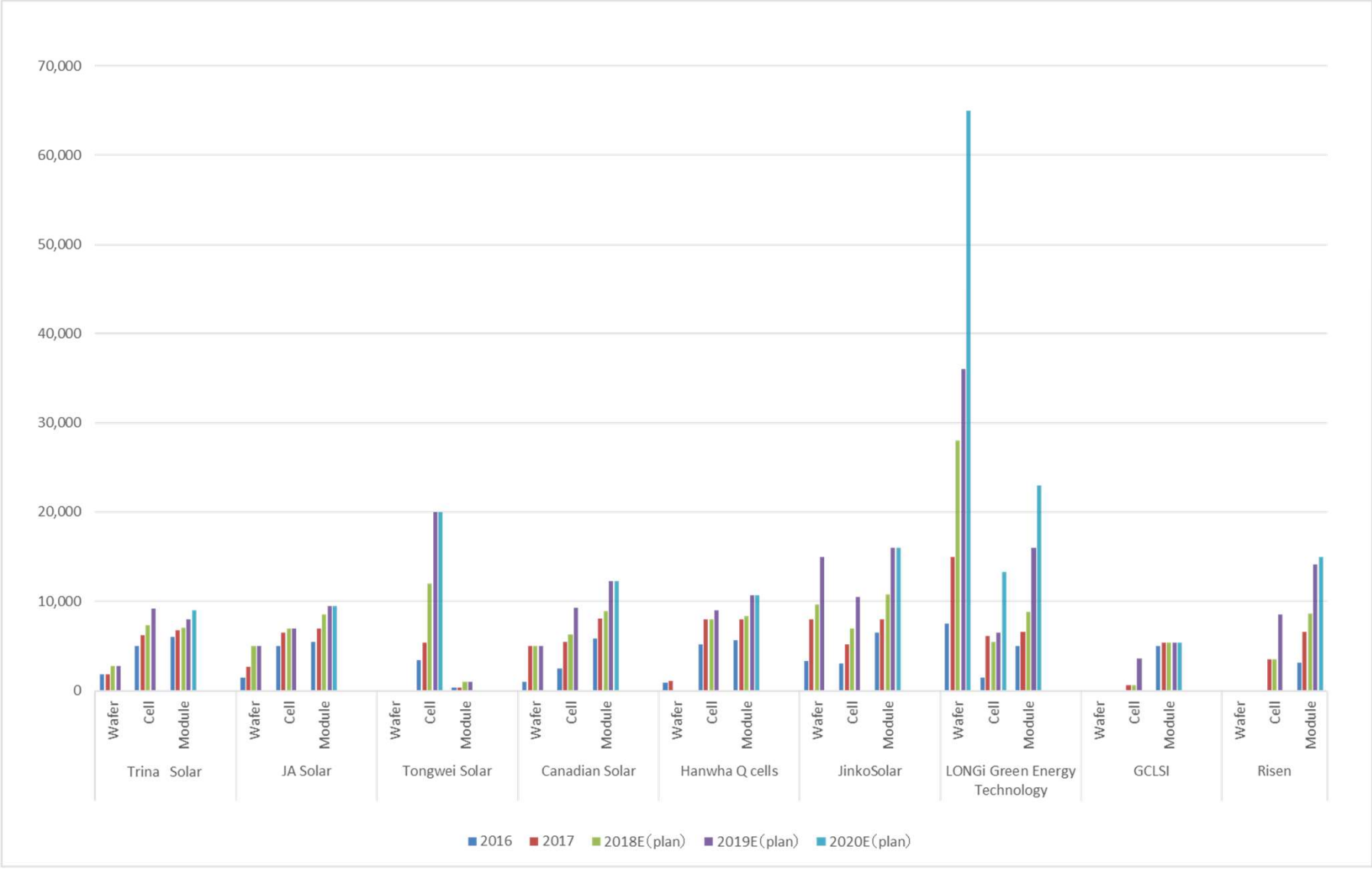
- Production capacity increase
- Higher efficiency & output
  - ✓ Combination of several technologies
  - ✓ Full shift from conventional to PERC cells
  - ✓ Increase of commercial production of HJT
  - ✓ sc-Si increases the share driven by Longi
  - ✓ Bifacial PV module shipment increase
- Further cost reduction
  - Polysilicon and wafer price reduction
  - Increase of wafer supply but oligopoly advanced
- CdTe PV module shipment increases with First Solar S6
- Consolidation continues

PV module production capacity by major companies



Source: RTS Corporation

Production capacity of major players as of Sept 2019



2019 1H Shipment

Rank	2019 1H Shipment（GW）		2018 Shipment（GW）		2017 Shipment（GW）	
1	JinkoSolar（China/Malaysia）	6.4	JinkoSolar（China/Malaysia）	11.17	JinkoSolar（China/Malaysia）	9.8
2	JA Solar（China/Malaysia）	5	JA Solar（China/Malaysia）	8.5	Trina Solar（China/Thailand/Vietnam）	9.0
3	Trina Solar（China/Thailand/Vietnam）	4.5	Trina Solar（China/Thailand/Vietnam）	7.54	JA Solar（China）	7.2
4	Canadian Solar（Canada/China/Brazil/Vietnam）	3．7	Canadian Solar（Canada/China/Brazil/Vietnam）	6.82	Canadian Solar（Canada/China/Brazil/Vietnam）	6.8
5	Hanwha Q CELLS（Korea/China/Malaysia）	3.5	LONGi Green Energy Technology（China/Malaysia）	6.58	Hanwha Q CELLS（Korea/China/Malaysia）	5.4
6	LONGi Green Energy Technology（China/Malaysia）	3.19	Hanwha Q CELLS（Korea/China/Malaysia）	5.60	GCL System Integration Technology（GCLSI）（China）	4.8
6	Risen Energy（China）	2.78	GCL System Integration Technology（GCLSI）（China）	4.57	LONGi Green Energy Technology（China）	4.7
8	First Solar	2.2	Risen Energy（China）	3.35	Yingli Green Energy（China）	3.0
8	GCL System Integration Technology（GCLSI）（China）	2.2	Shunfeng International Clean Energy/Suntech Power（China）	3.30	Risen Energy（China）	2.8
10	Zhejiang Chint Electrics(China)	2	Chint Electrics（China）	3.15	First Solar（USA/Malaysia）	2.7

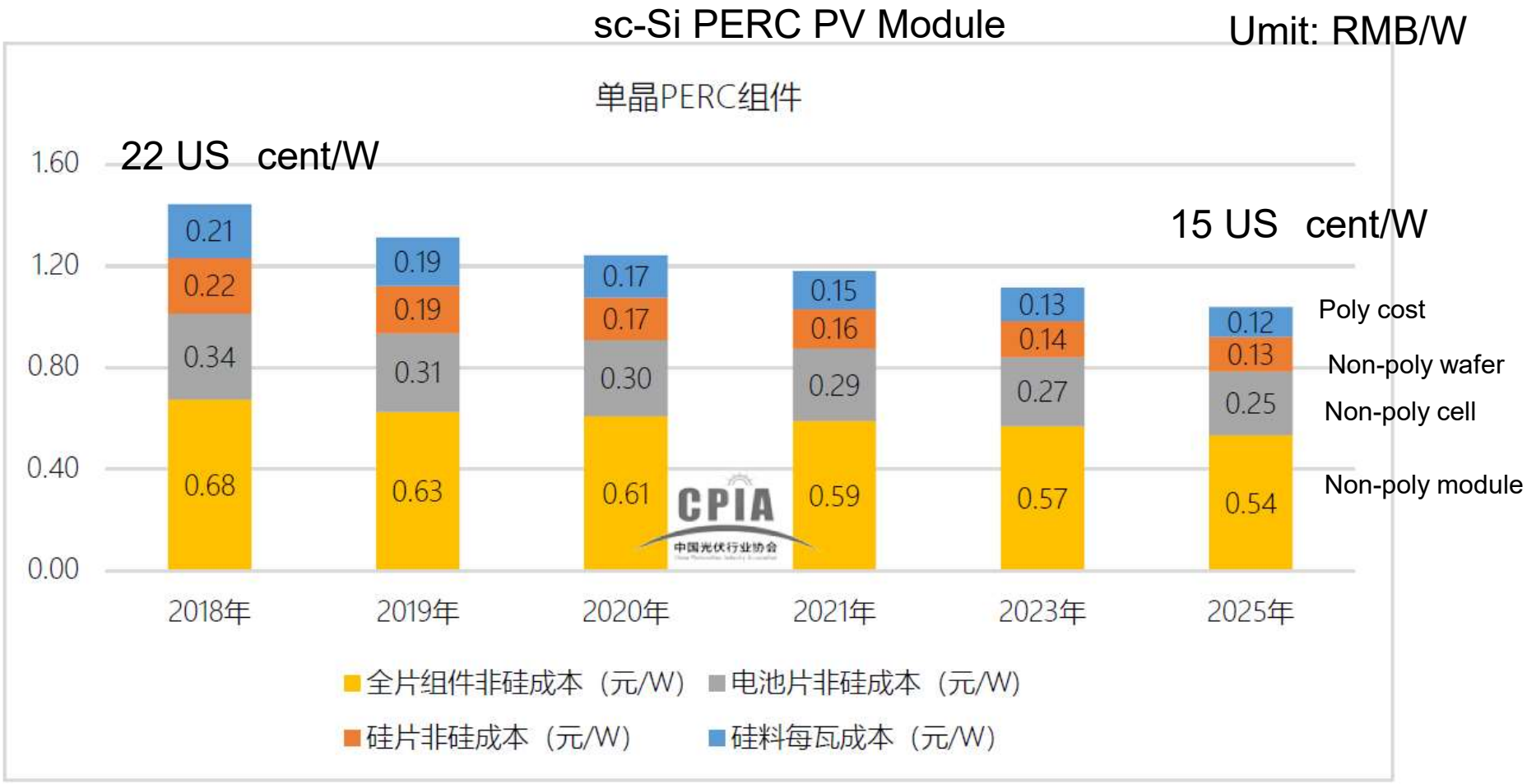
Source：RTS Corporation　Including estimates

Capacity for High-Efficiency Tech（2018）

Technology	Manufacture Capacity (MW)
P-PERC	60000.0
N-PERT	4000.0
HJT	600.0
IBC	100.0
MWT	1500.0
Bifacial Modules	15000.0

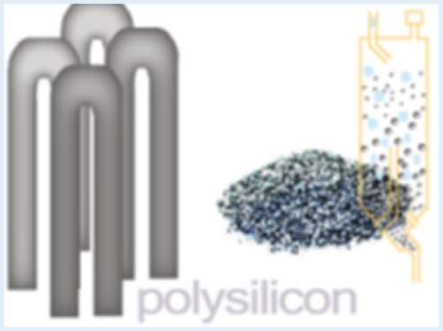
Source：CPVS

CPVIA outlook of PV module cost



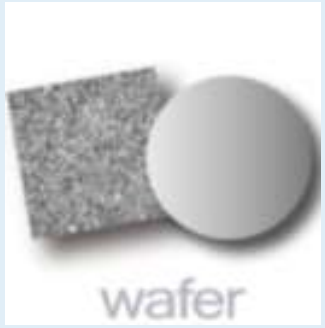
Source CPVIA roadmap 2018 (Feb. 2019)

Trends along the value chain : upstream

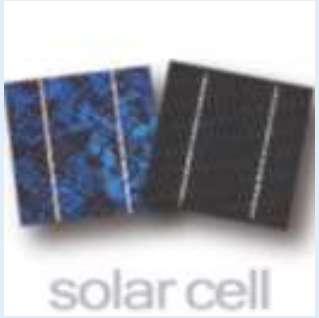


- Debottlenecking
- FBR
- Metallurgical process

- G7 → G8
- HP mc-Si
- Continuous pulling sc-Si
- Large wafer



- DW for sc-Si &mc-Si
- Texture
- Thinner sc-Si
- Using IoT for optimizing cell process

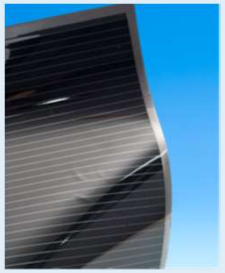


- PERC, PERT, SHJ, IBC
- Bifacial
- Multi-busbars
- Half-cut
- Shingles
- Lower Ag consumption

- Glass-Glass
- Non-EVA encupsulants
- 1,500V
- Bifacial
- AR coating
- Anti-Soiling
- Reliability

Lower cost equipment/ process / higher throughput/ location

- Higher efficiency
- Larger size
- Material/ electrodes
- Process
- Flexible substrates



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Downstream

- Bifacial PV modules
- Inverter:
  - Central vs String, 1500 V or more????
  - Consolidation on the way
  - MLPE adopted in specific markets
- Trackers (central control or distributed control)
- Floats for FPV (easier O&M, increased module area)
- Repowering
  - Replacing PV module/ inverter, optimizer
- More cost efficient O&M
  - Soiling detection, drone inspection,
    AI application to detect failures
- PV +Storage (Distributed & Utility scale)

Towards TW era

- PV competitiveness will open the new market
- Cost reduction continues but the pathway will change
  - From economy of scale to technological improvement
  - Carbon foot print !
  - Logistic cost matters
- Efforts on differentiation required
  - Higher performance, higher reliability
  - Added-value: BIPV, VIPV (Vehicle-integrated) , FPV
  - Sustainable manufacturing
- Re-definition of bankability required
- Shaking out or consolidation of upstream sector will continue. Inverter sector as well.

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Thank you for your kind attention !

感谢您的关注

끝까지 경청해 주셔서 감사합니다

ご清聴ありがとうございました

Acknowledgement for the support of PVPS activities

NEDO New Energy and Industrial Technology Development Organization

Contact : Izumi KAIZUKA, RTS Corporation, kaizuka@rts-pv.com