PV Industry Status from Trends Report plus 2021 Trends

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11 November 2021, Task 1 Meeting

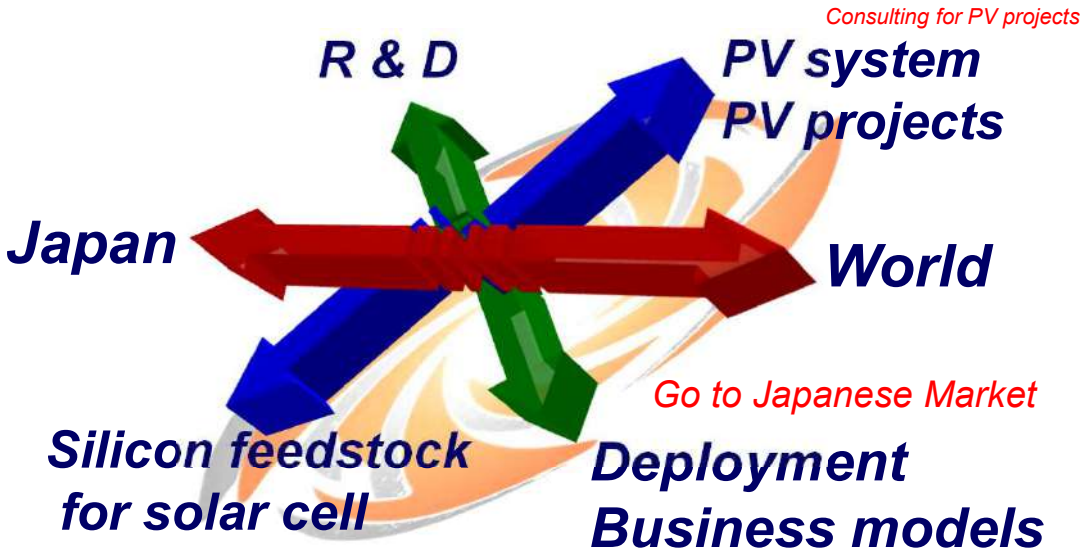
Technology Collaboration Programme
by IEA

RTS Corporation – founded in 1983, 36 year experience

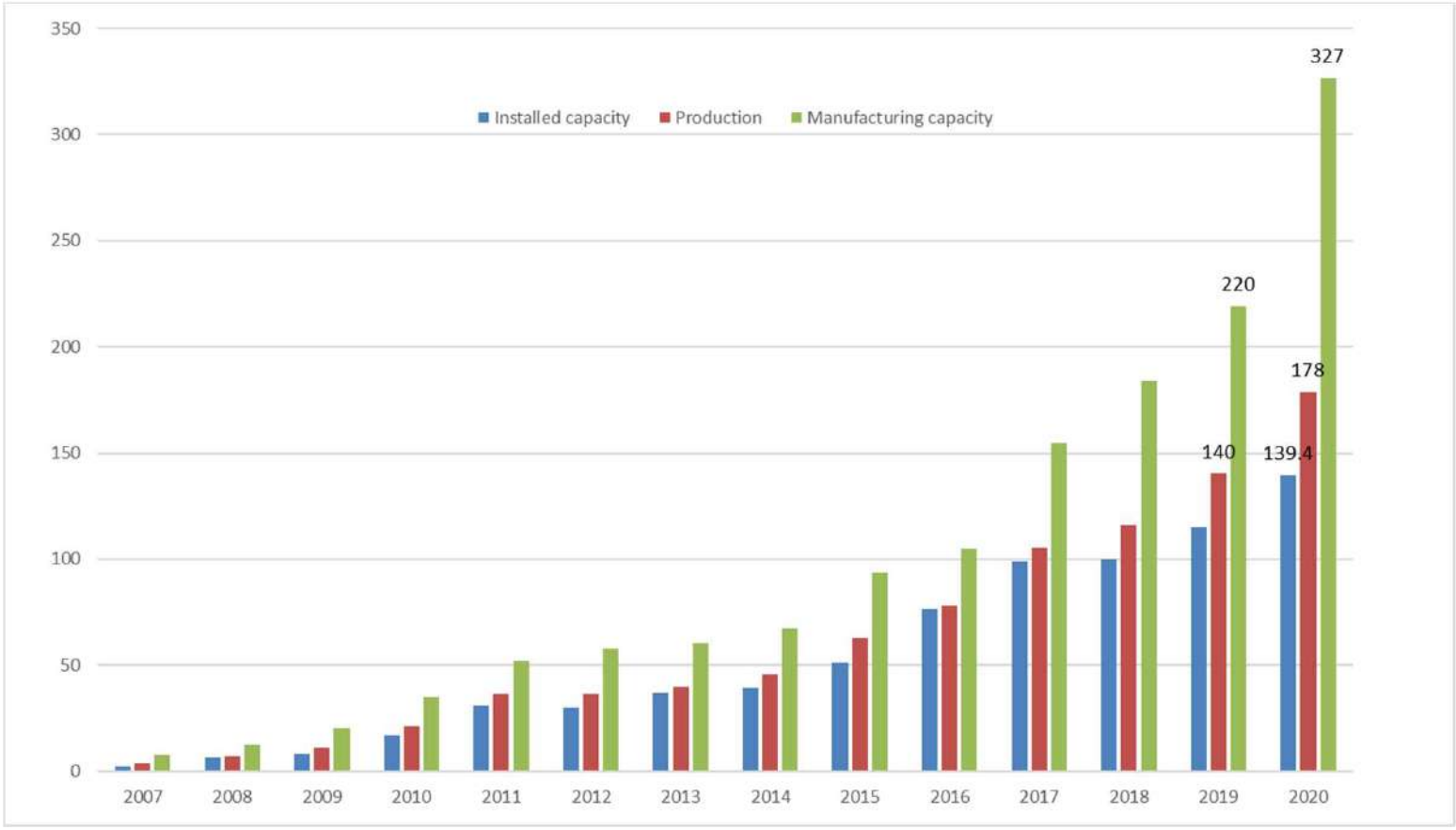
Comprehensive Consulting company on Photovoltaics (PV)

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.



Yearly PV Installation, PV Module Production & Production capacity



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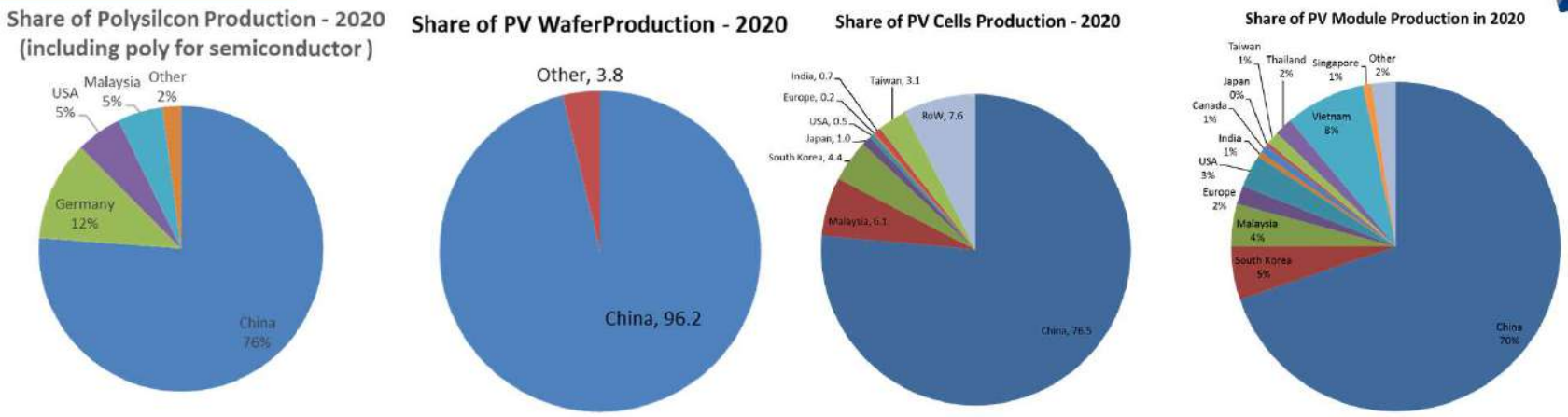
Share of manufacturing countries along the value chain (2020)



- China is No1 producer along the value chain
- Wafer production dominated by China or Chinese companies
- PV module : ASEAN countries production and capacities increased

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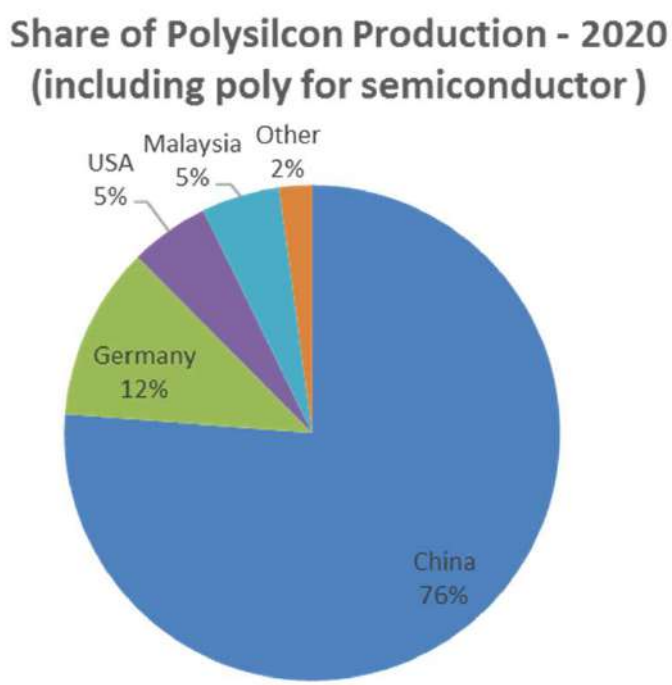
Source: IEA PVPS and Trends Report 2021, to be published

Polysilicon



- 519600 ton produced in 2020 (507500 t in 2019)
- 76% of polysilicon produced in China (396,000 t)
- China imported polysilicon from Germany and Malaysia mainly for high efficiency single crystalline silicon (99,000 t, 30% decrease from previous year)
- In 1H2021 China produced 238000 tons of polySi, a 16.1% increase from 1H 2020
- Price increase : stabilization expected in 2022

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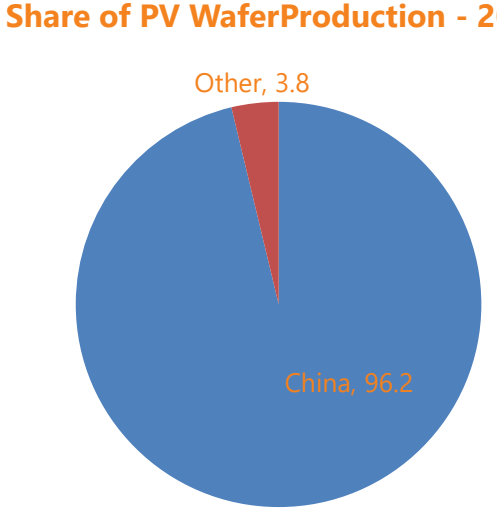
Source: China nonferrous metals industry association

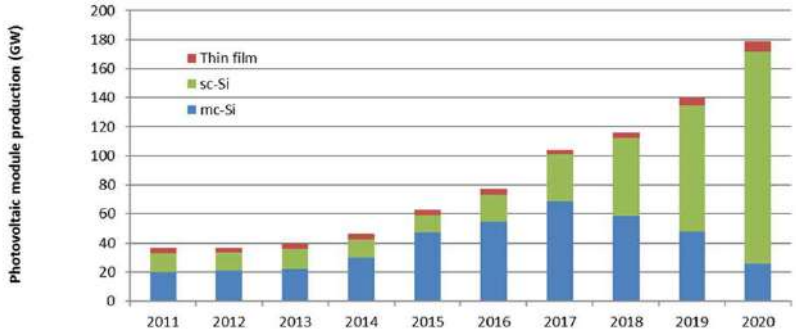
Wafer production



- 168 GW produced in 2020 (142GW in 2019)
- Global capacity : ~220GW/year in 2020 → 300 GW/year
- 96.2% of wafer produced in China (161GW)
- Outside of China

  Malaysia (Longi), Vietnam (JA Solar), Norway (NorSun)

- Single crystalline silicon share in 2020 : 81.9%
- In 1H 2021, China produced 105GW, a 40% increase
- Share of 182mm and 210mm wafers increased to about 25%



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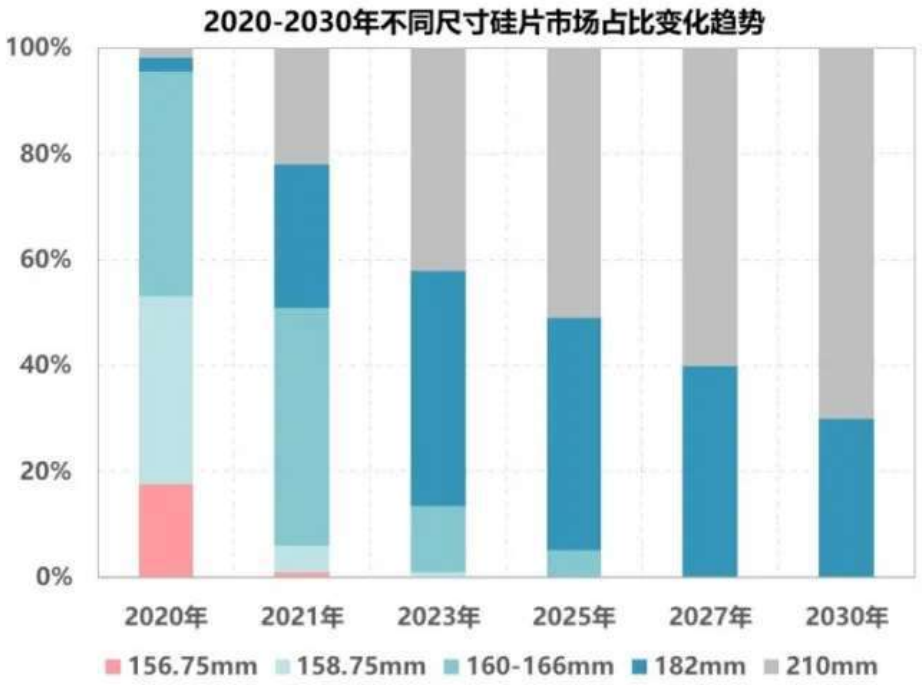
Trends of wafer size : outlook by CPIA (released 3rd February 2021)

Trends of larger-sized wafer towards 2030

27



2021 trends

50% / 210+182
Large-sized wafer share increase is expected

500W+、600W+
Higher output products rapidly introduced in the market

45% / 160-166mm
160-166mm share 45% in 2021

5% / 158.75mm
158.75 mm share decreased to 5% in 2021

中国光伏行业协会CPIA

210mm VS 182 mm

27th November 2020: 8 companies along the value chain proposed standardization of 210 mm

Polysilicon：Tongweiグループ

Wafer： Zhonghuan Semiconductor
Wuxi Shangji Automation

Cell： Jiangsu Runyang New Energy Technology（Runergy）

PV module:
Trina Solar
Risen Energy
Canadian Solar
Huansheng Photovoltaic（HSPV) Technology

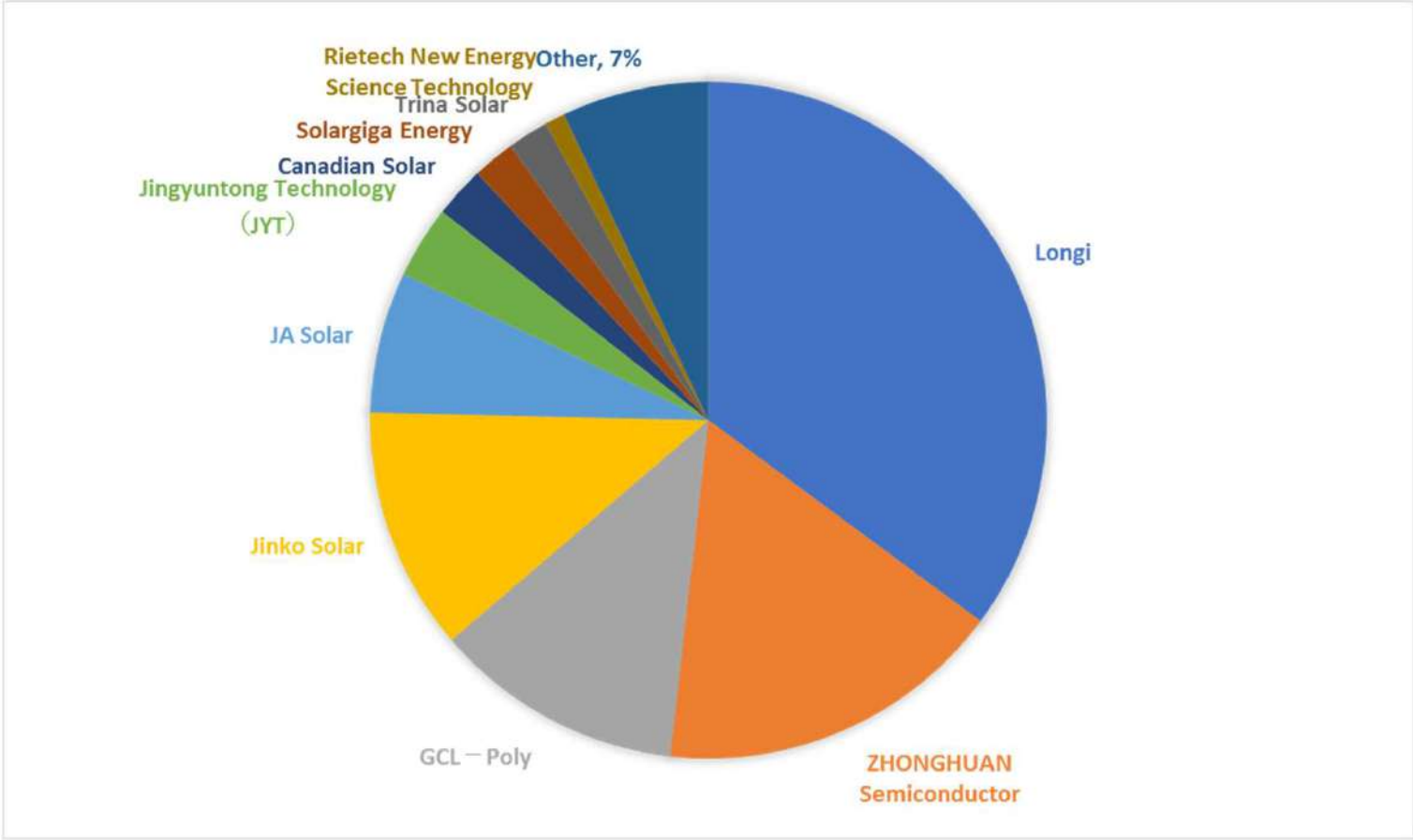
June 23rd 2020: Seven companies proposed standardization of 182 mm

Cell：Jiangsu Runyang New Energy Technology（Runergy）
Jiangsu Zhongyu Photovoltaic Technology（SolarSpace）

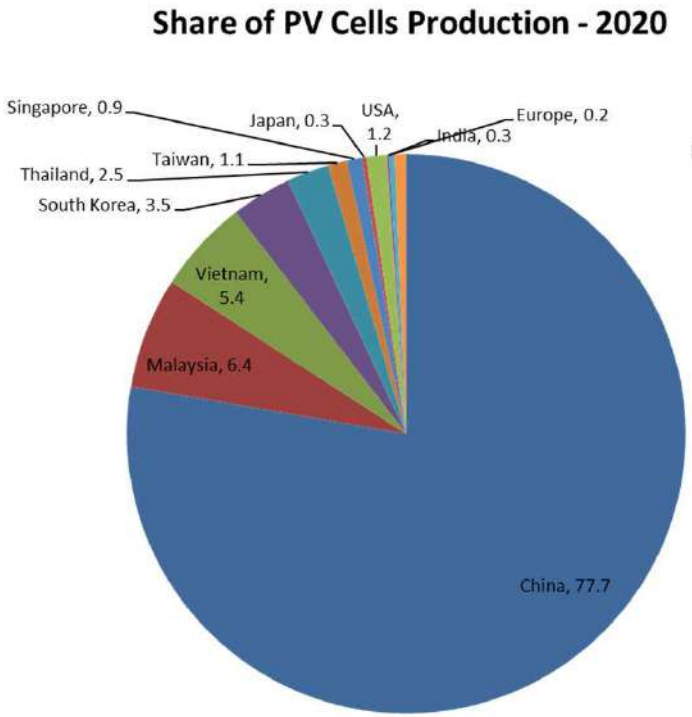
PV module：
JA Solar Technology
JinkoSolar
Canadian Solar
LONGi Green Energy Technology
Lu'An Photovoltaics Technology

Source：RTS Corporation

Winner takes all? : top 10 wafer manufacturers in 2020



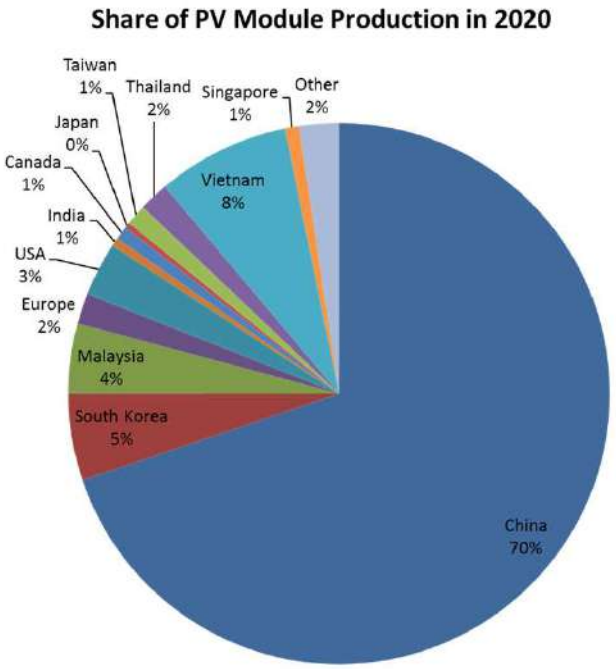
Cell production



RoW, 0.7

- 173.5 GW produced in 2020 (144GW in 2019)
- Global capacity : ~257GW/year in 2020 → > 300GW
- ~78% of cells produced in China (134.8GW)
- Outside of China
  - Malaysia (11.16), Vietnam (9.4), South Korea (6.3) Thailand (4.26)
  - Shipment from ASEAN countries goes to USA to avoid Sec 301 duty (25% to Chinese companies in addition to Sec 201 duty plus 2012 AD and 2014 AD)
- Single crystalline silicon share : 81.9%
- Cell-specialized manufacturer and vertical integrated players in top companies
- 2021 1H cell production was 92.4GW, a 56.6% increase from 2020
- Increase of commercialization of n-type mono Si, HJT

PV module production



- 178 .5 GW produced in 2020 (140GW in 2019)
- Global capacity : ~326GW/year → 2021: 400GW/year??
- ~69% of cells produced in China (124.6GW)
- Outside of China
  - Vietnam (14.13), South Korea (9.3) , Malaysia (7.4)
- Thin film: 6.5GW (3.6%): mainly from First Solar and CIGS companies (Solar Frontier etc.)
- BIPV production : <1GW?? (700 MW in China 2020)
- Bifacial PV adopted for utility scale PV
- Price hike due to material and **logistic cost**
- 2021 1H production: 80.22GW, a 50.5% increase (36.9GW exported)
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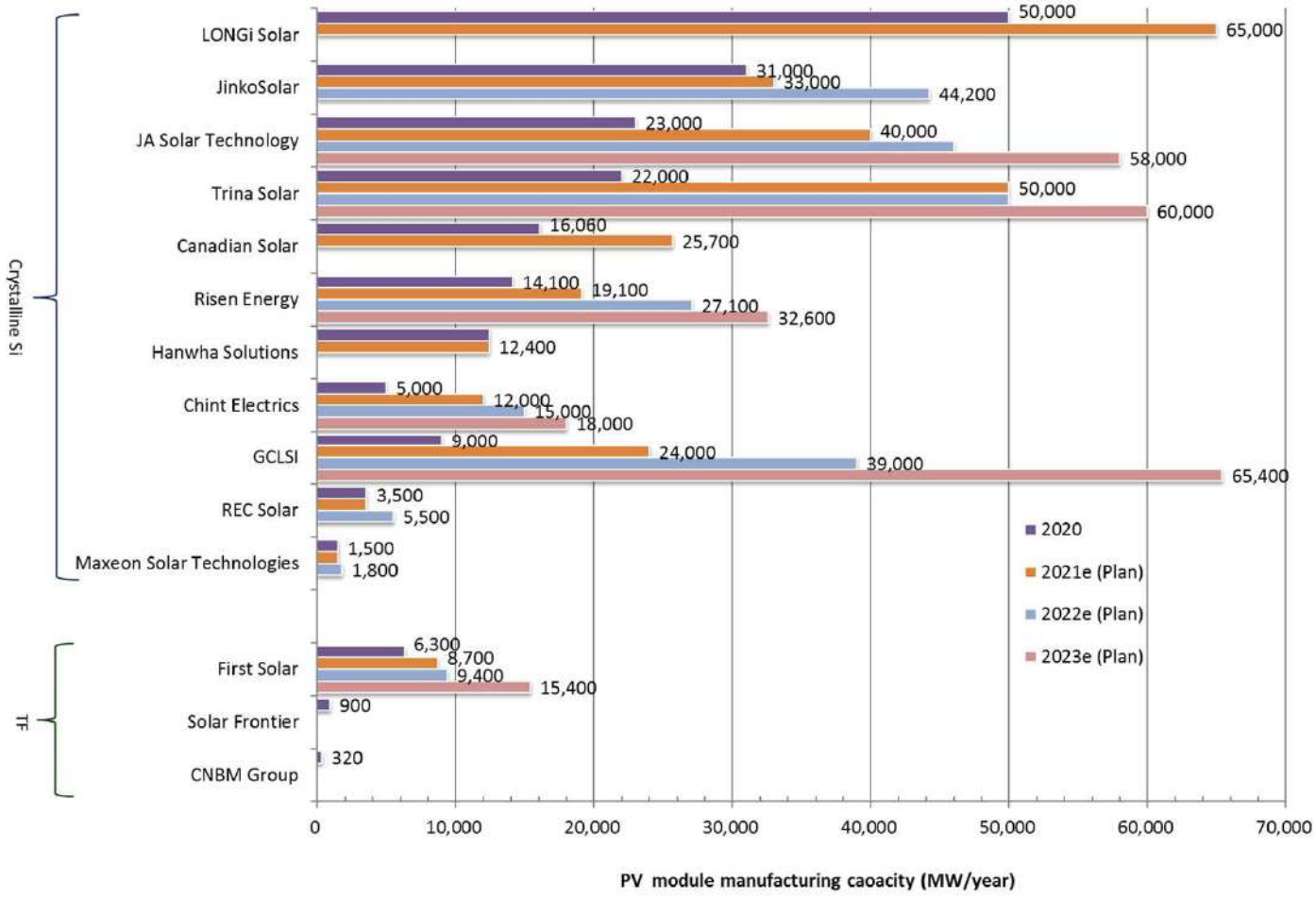
PV module top 10 suppliers in 2021H

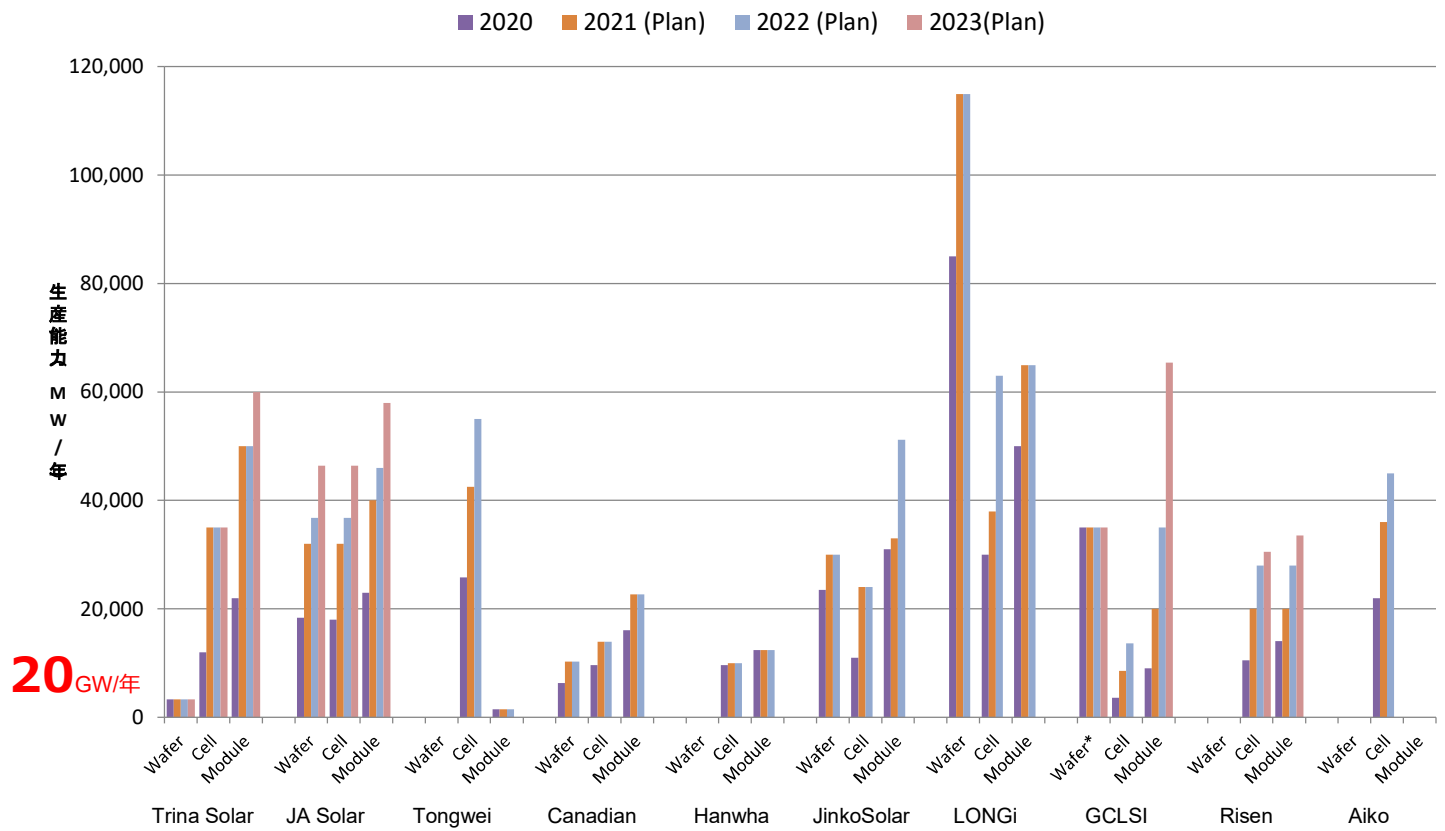
Rank	2021 1H Shipment preliminary（GW）		2020 Shipment preliminary（GW）		2019 Shipment pleriminary（GW）	
1	LONGi Green Energy Technology	17.01	LONGi Green Energy Technology (China/ Malaysia)	24.53	JinkoSolar (China/ Malaysia/ USA)	14.3
2	Trina Solar	10.5	JinkoSolar (China/ Malaysia/ USA)	18.8	JA Solar Technology (China/ Malaysia/ Vietnam)	10.3
3	JA Solar Technology	10.12	JA Solar Technology (China/ Malaysia/ Vietnam)	15.92	Trina Solar (China/ Thailand)	10
4	JinkoSolar	10??	Trina Solar (China/ Thailand)	15.88	Canadian Solar (Canada/ China/ Brazil/ Vietnam/ Taiwan)	8.6
5	Canadian Solar	6.8	Canadian Solar (Canada/ China/ Brazil/ Vietnam/ Taiwan)	11.3	LONGi Green Energy Technology (China/ Malaysia)	8.4
6	Hanwha Solutions	3.5?	Hanwha Solutions (S. Korea/ China/ Malaysia/ USA)	8～10	Hanwha Solutions (S. Korea/ China/ Malaysia/ USA)	7.3
6	First Solar中	3.6	Risen Energy (China/ Mexico)	約7.5	Risen Energy (China/ Mexico)	6.3
8	Risen Energy	3.4	Zhejiang Chint Electrics（Astronergy）（China）	5.5	First Solar (USA/ Malaysia/ Vietnam）	5.4
8	Wuxi Suntech Power		First Solar (USA/ Malaysia/ Vietnam）	5.2	Zhejiang Chint Electrics（Astronergy）（China）	3.7
10	Zhejiang Chint Electrics		Wuxi Suntech Power	4.0	GCL System Integration Technology（GCLSI）（China/ Vietnam）	3.6

Source：RTS Corporation based on IR report, etc., including estimates

PV module manufacturing capacity enhancement plan



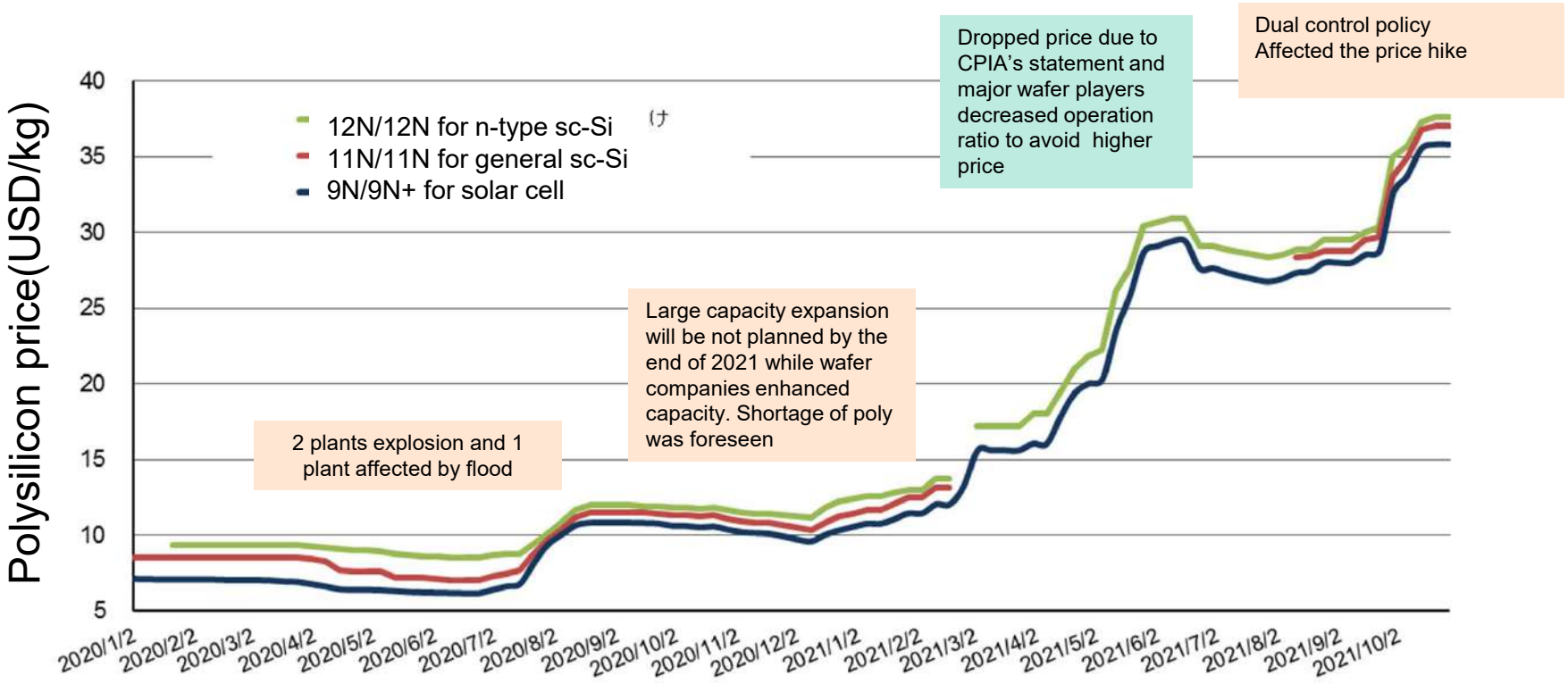
Major players manufacturing capacity over supply Chain



*GCLSIのウエハーは、同グループGCL-Poly Energyの生産能力

出典：プレス・リリース資料等から（株）資源総合システムが作成（2021年8月末現在）

Trends of Polysilicon price

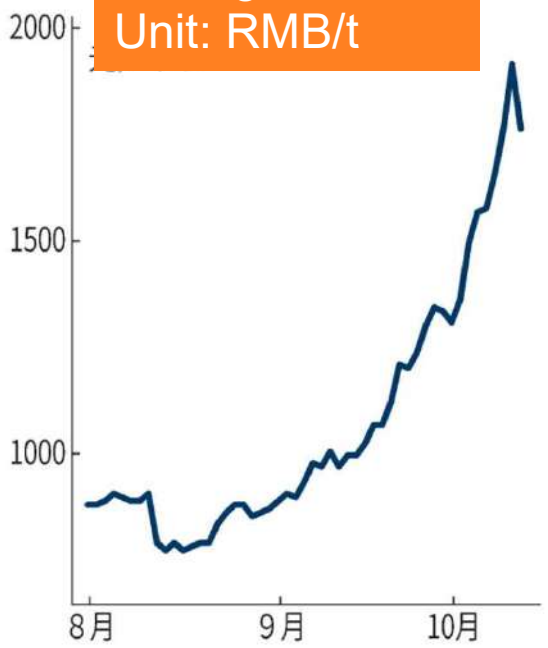


Source: PVInsight, compiled by RTS

Dual Control Policy and Power shortage in China (Sept 2021)

- "Dual Control Policy in China" to reduce energy intensity and to limit total energy consumption to stop electricity supply and halted operation of coal fired power plants in China due to soaring price of coal → Five Tier 1 manufacturers jointly issued “request to avoid rush of installation (30 Sept 2021) also companies issued notice of shipping delay due to ”Force Majeure”
- Affected over supply chain
  - Metal Silicon (Low material of polysilicon) : Doubled in a month
  - Polysilicon: 153% increase from Jan 2021
  - Glass: 18.2% increase from August
  - Encapsulants, 35% increase in August
  - Steel for support structures and trackers
  - Aluminum (for module flame)

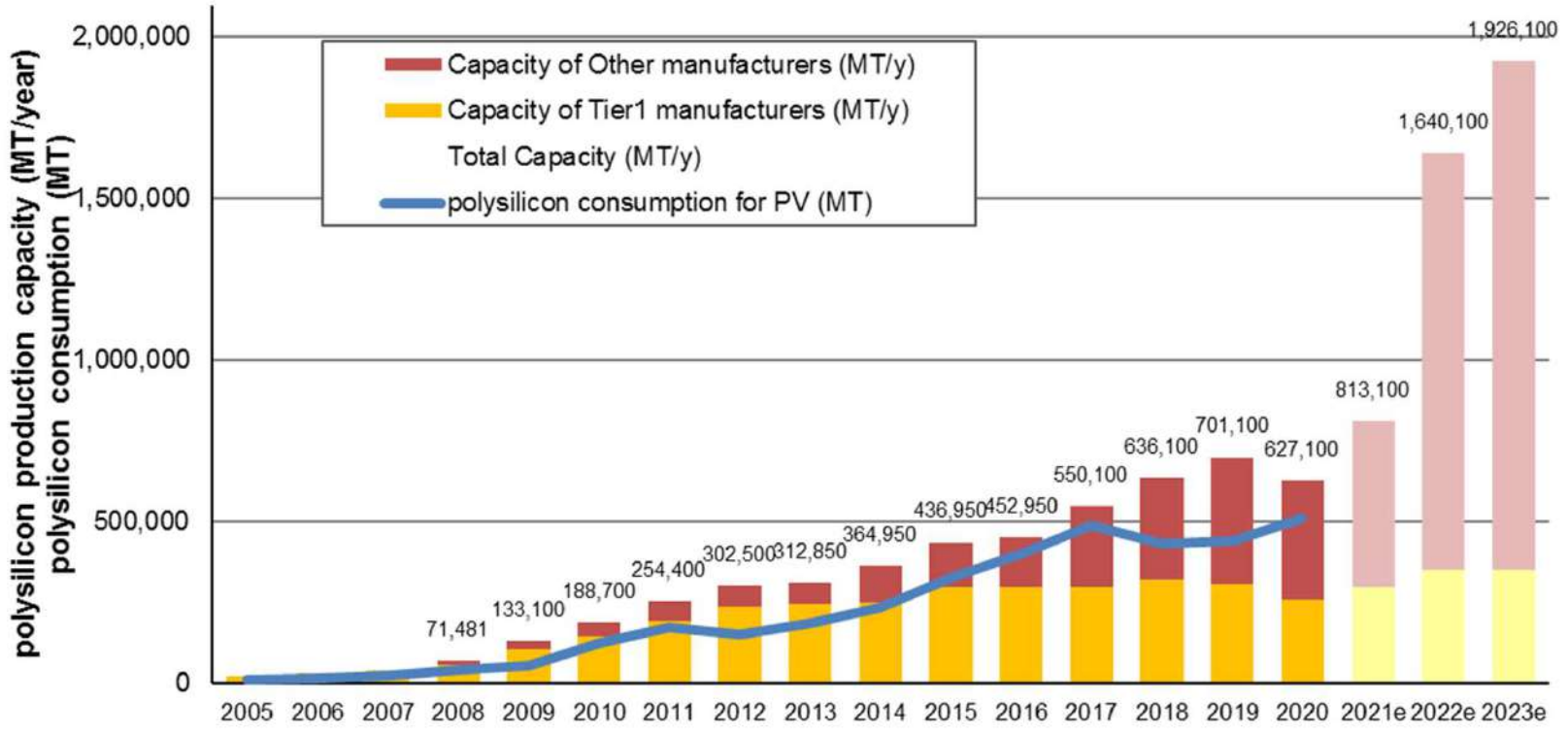
Coal price is still higher level
Unit: RMB/t



Source: Nikkei

Source：China Nonferrous Metals Industry Association, compiled by RTS Corporation

Trends of polysilicon manufacturing capacity



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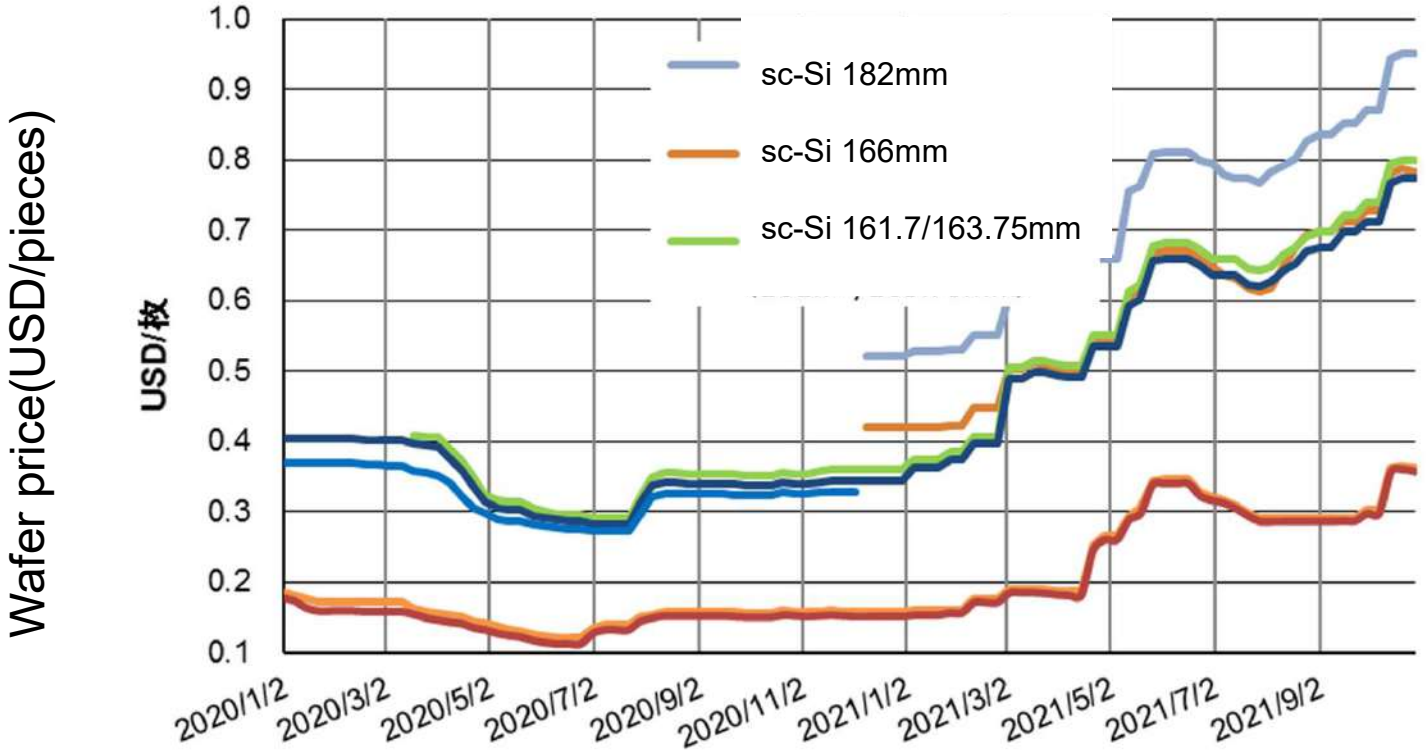
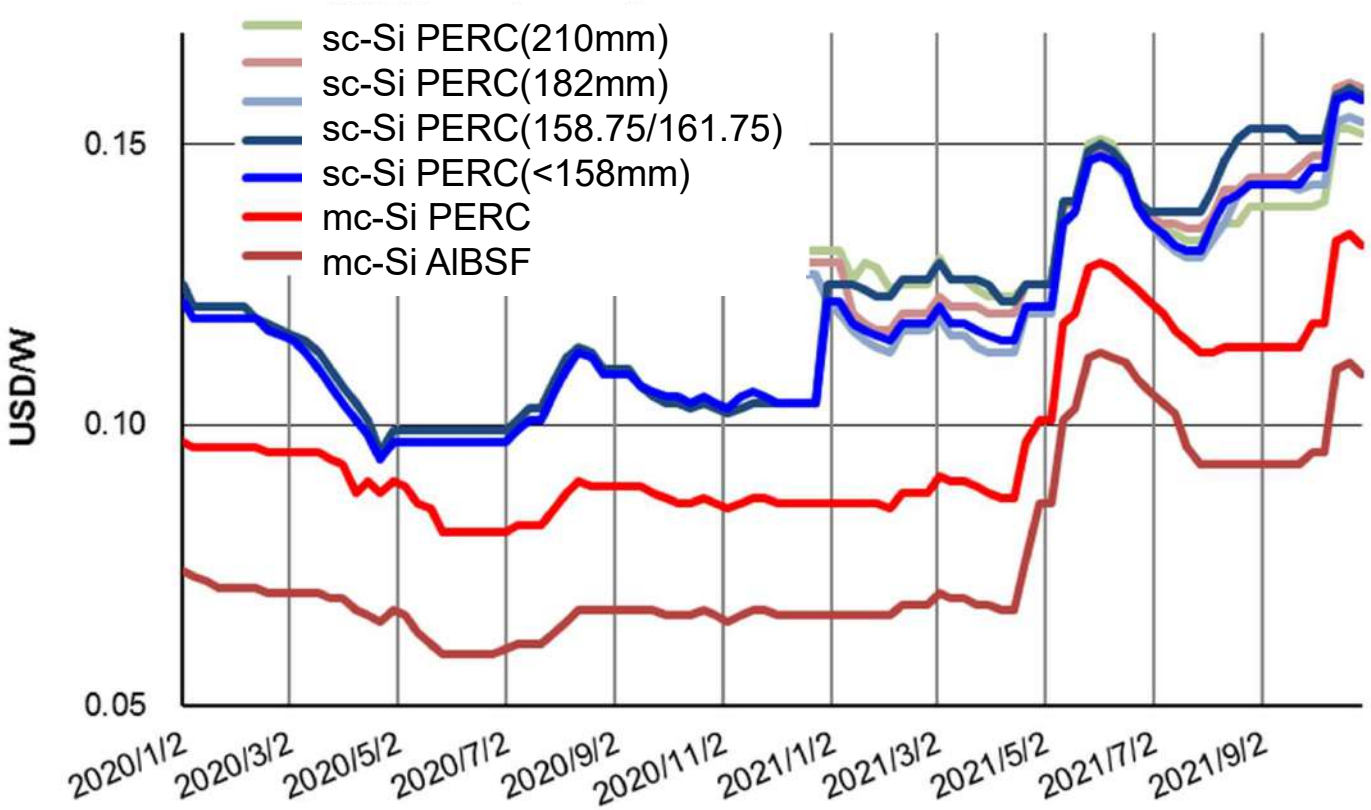
Trends of wafer price



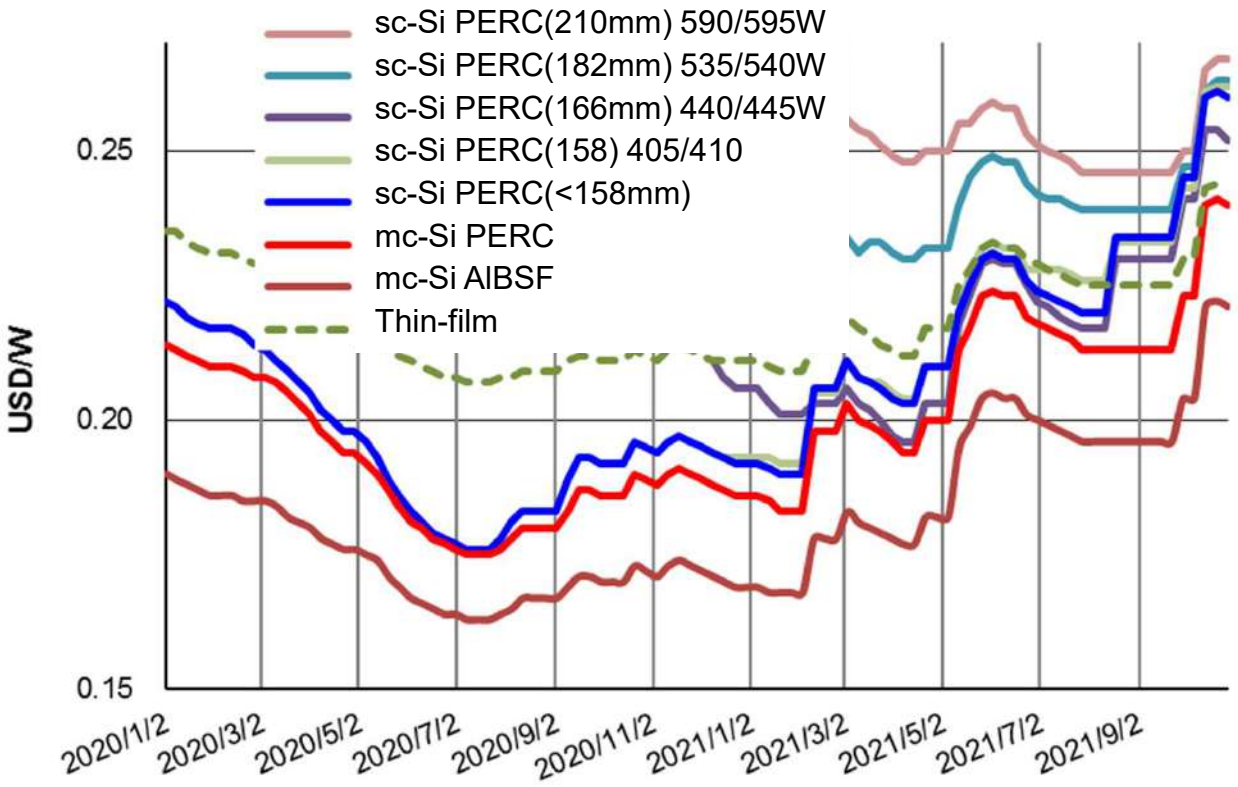
Source: PVInsight, compiled by RTS

Trends of cell price



Source: PVInsight, compiled by RTS

Trends of PV module price



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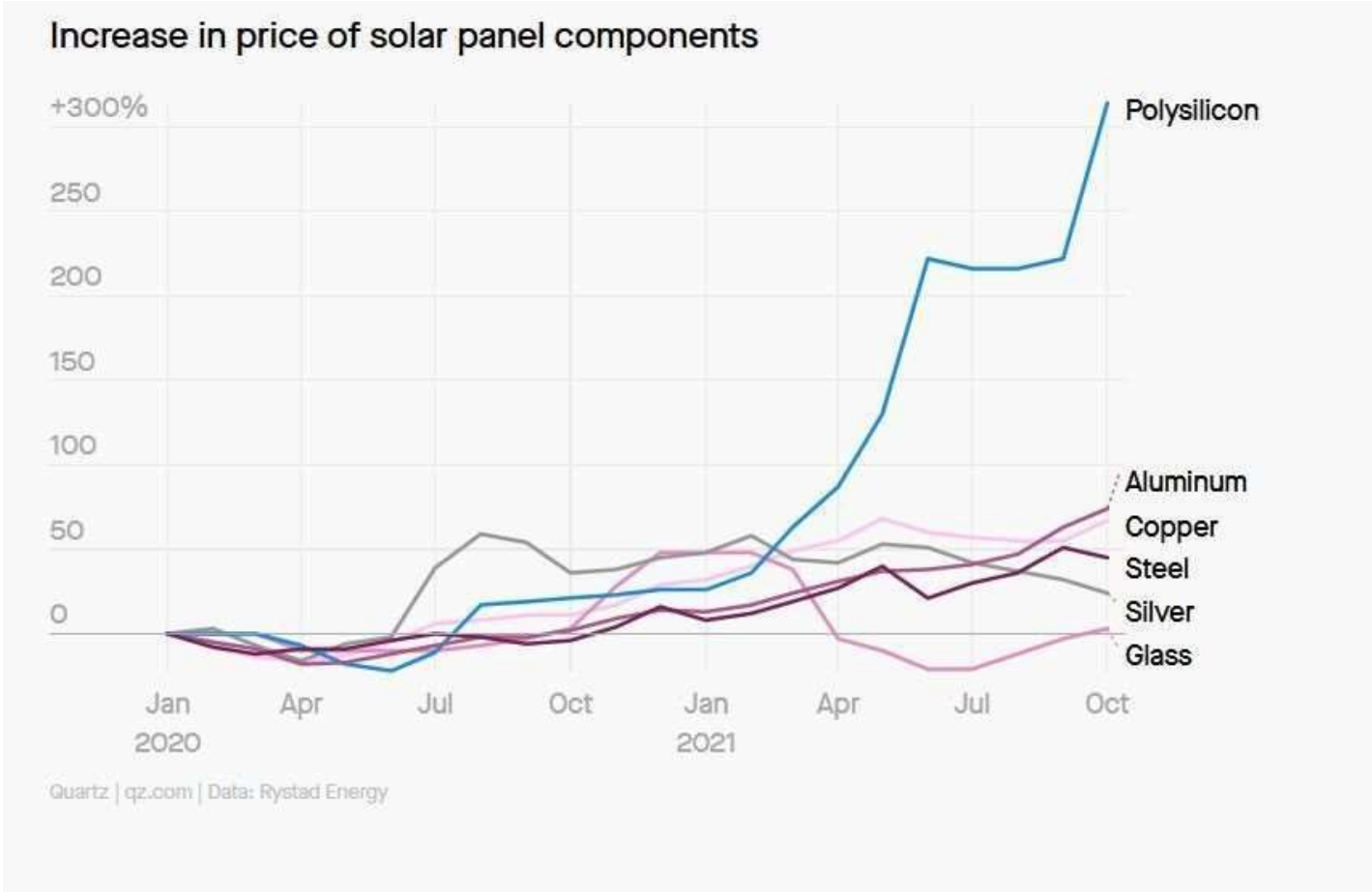
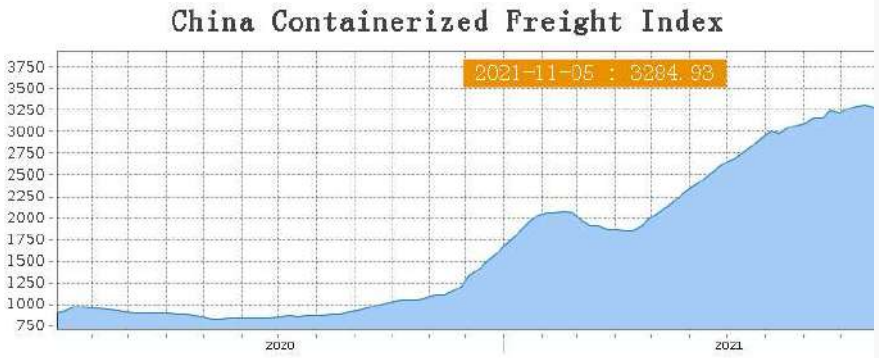


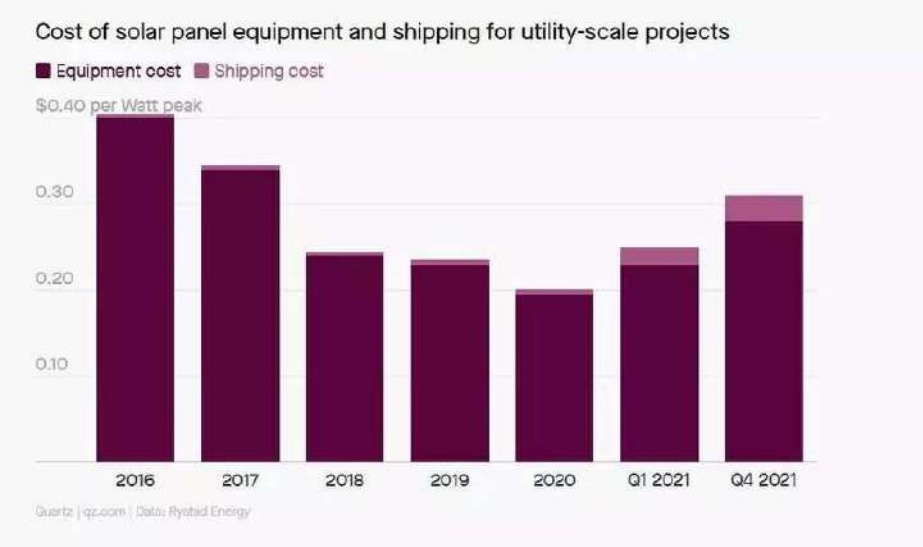
https://www.weforum.org/agenda/2021/11/supply-chain-problems-solar-power-renewable-energy

Other factors affected recent price hike

- https://www.weforum.org/agenda/2021/11/supply-chain-problems-solar-power-renewable-energy



https://en.sse.net.cn/indices/ccfinew.jsp

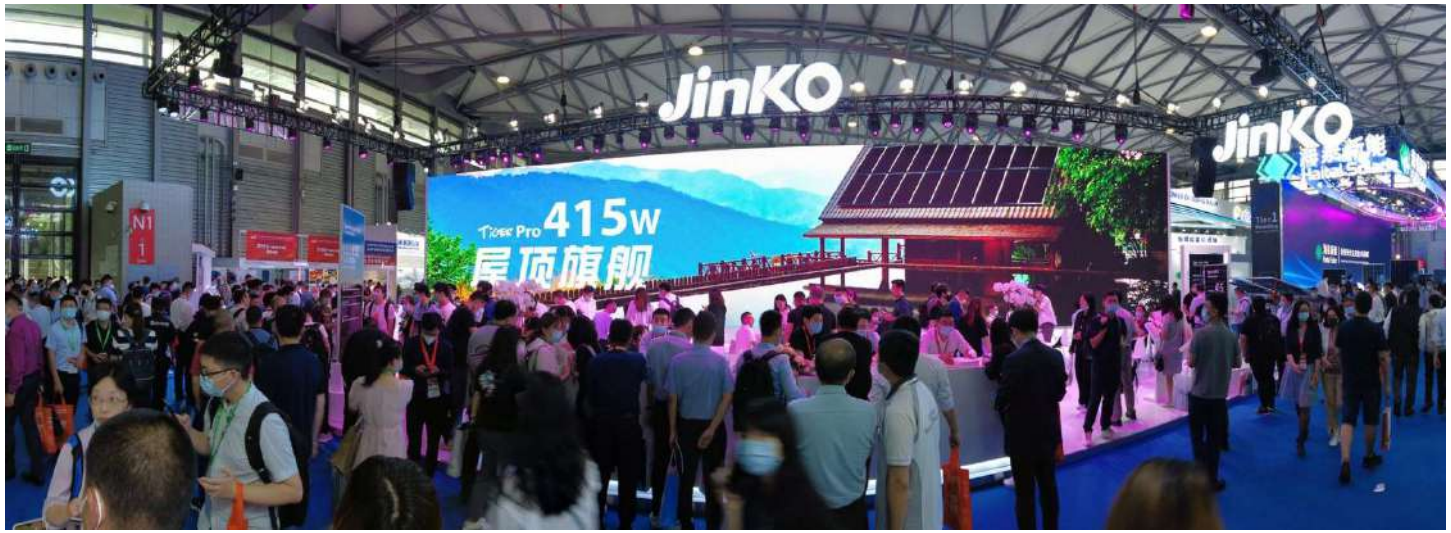


https://www.weforum.org/agenda/2021/11/supply-chain-problems-solar-power-renewable-energy

BIPV@SNEC 2020

（株）資源総合システム（写真）

BIPV@SNEC 2020

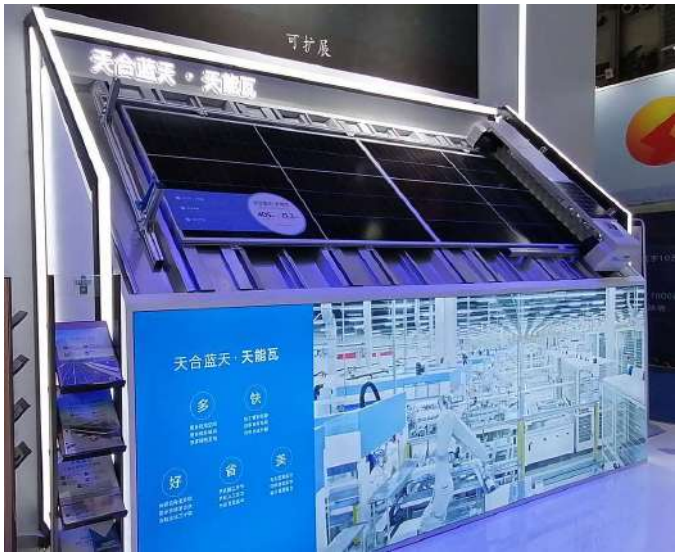


（株）資源総合システム（写真）

BIPV@SNEC 2020

Trina Blue Sky Tile system

PVinfoLink（写真）



Trina: Trinamount

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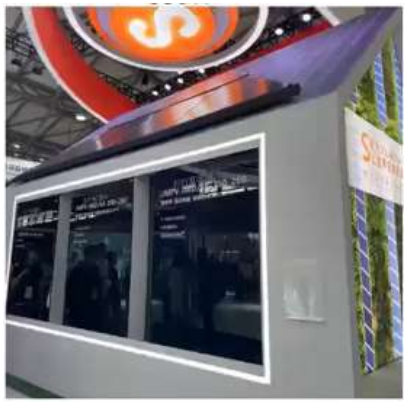


Solargiga: IBC, 250-260W

Sunport: integrated color coated metal roof

Drivers for local manufacturing

- Made locally policy (India, USA, EU, Turkey…)
- Green Deal
- Subsidies and tariffs with some requirement
  - Local Contents Requirement
  - Requirement (benefit for local manufacturing)
- Ongoing trade conflicts (Antidumping, etc.)
- Sustainability, low carbon footprint
- Compliance for sustainability, low carbon footprint
- Forced labor issues
- Soaring logistic cost

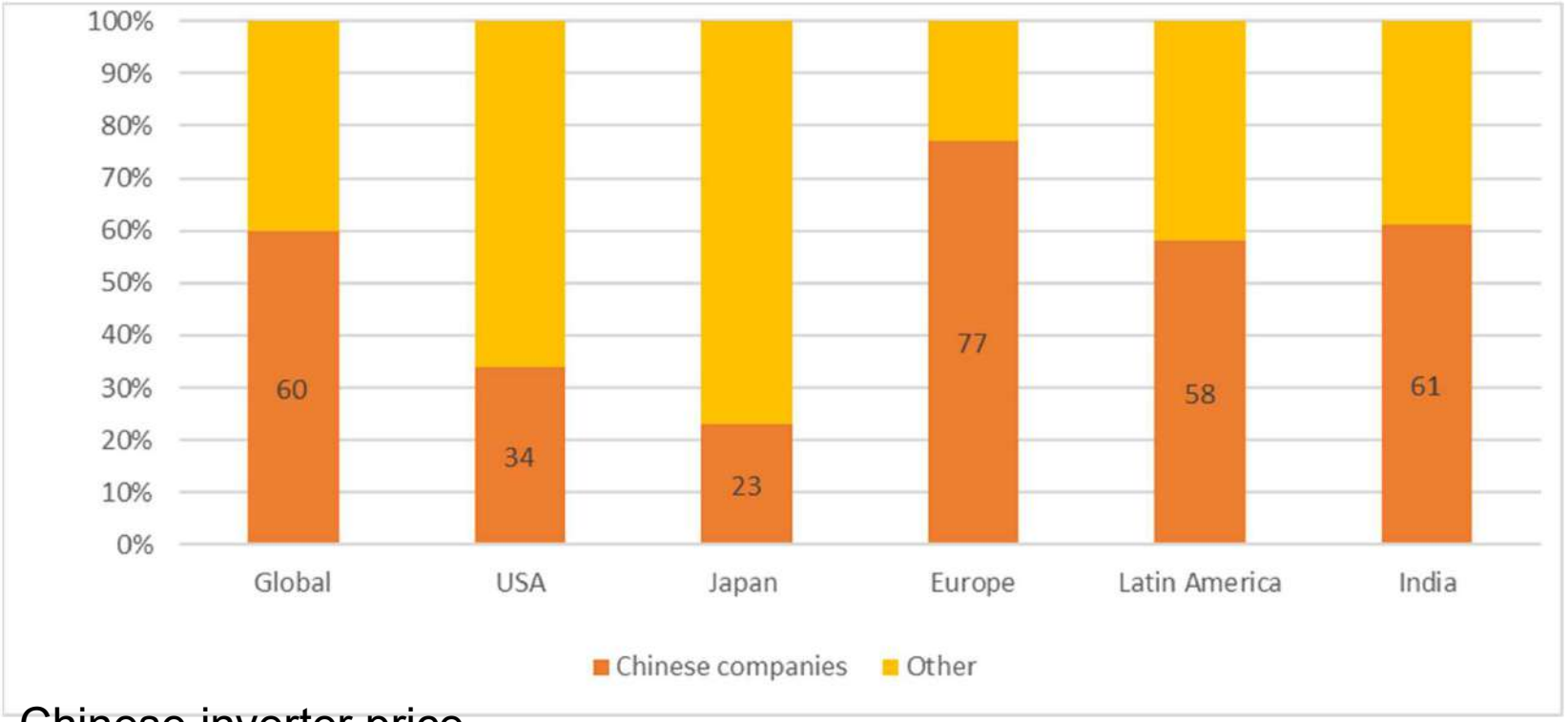
Downstream trends

- Inverter
- Trackers

Inverter

- Evolution of DC/AC ratio for higher capacity factor
- Share of Chinese inverter : 65%++ of shipment , regional differences observed
- Consolidation continuing
- Products
  - String (~64%) vs Centralized (~34%)
  - 1500V or more???,
  - SiC power modules for higher efficiency, also compact and light weigt
  - Transformer integrated for utility scale (solution type)
  - Storage integrated for DG
  - MLPE : growing in specific market (e.g. US regidential)
- Requirement for grid code and regulation
  - Smart inverters → Grid forming/ grid supporting inverters
- Suppliers provide O&M, repowering, etc.

Inverter : China has 60% share in the global supply (2019)



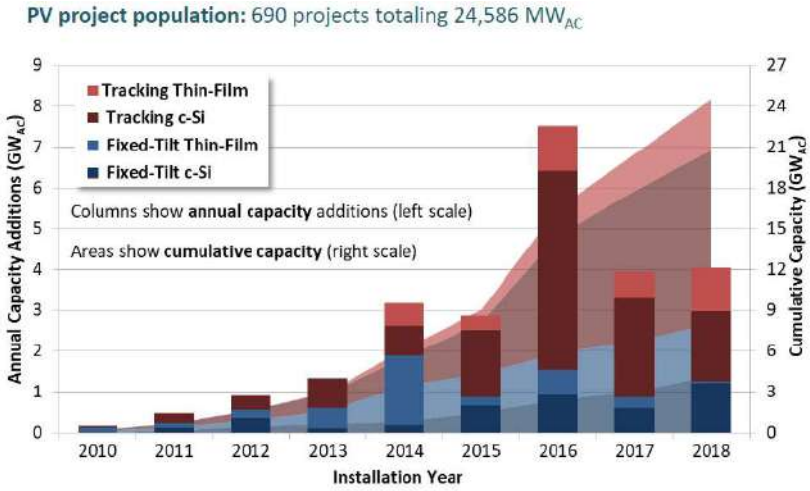
Chinese inverter price
2019: 0.20 RMB/W (0.03 USD/W) → 2020 : 0.18 RMB/W (0.027USD/W)

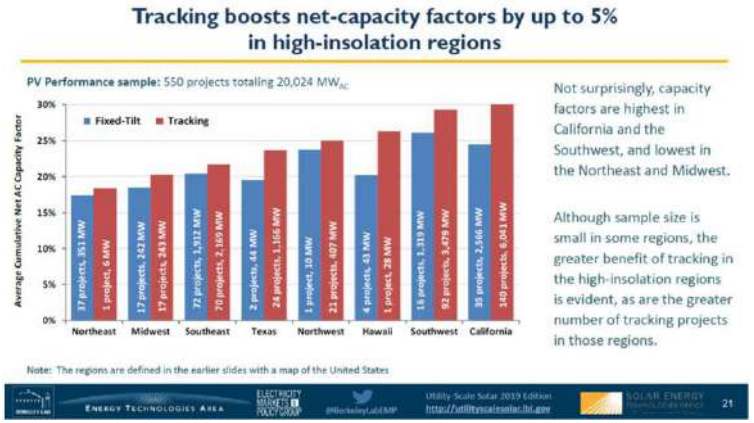
Source: CPIA

RTS Corporation

Downstream trends: Trackers

- Increase of trackers in utility scale: >70% of utility scale projects deploy trackers in US
- Capacity Factor : maximum 5% up
- Centralized or distributed control?
- Successful IPO in 2020: Array Technologies, Soltec
- Bifacial + trackers





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Source： M. Bolinger, LBNL, "Utility-Scale Solar- Empirical Trends in Project Technology, Cost, Performance and PPA Pricing",(2019年12月)

Summary

- While impacts of PV module price concerned, 1H of 2021 production volume along the value chain showed PV market growth
- Stabilization of price is expected in 2022 with the increase of poliSi capacity and glass capacity but logistic cost depends on COVID-19 situation
- Opportunities for local manufacturing attracts attention with various motivation. Finance and how to value the products are key
- Shift to higher efficiency and output products contribute lower LCOE
- Downstream:
  - Inverters are advanced along with grid integration
  - Tracker plus bifacial PV adopted for utility scale application

Thank you for your kind attention !

感谢您的关注

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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

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