



## PV Industry Now and Then

Izumi KAIZUKA, Deputy Operating Agent Task 1 IEA PVPS/ Principal Analyst, RTS Corporation, Tokyo

27<sup>th</sup> September 2022, WCPWC-8, IEA PVPS Task 1 Workshop

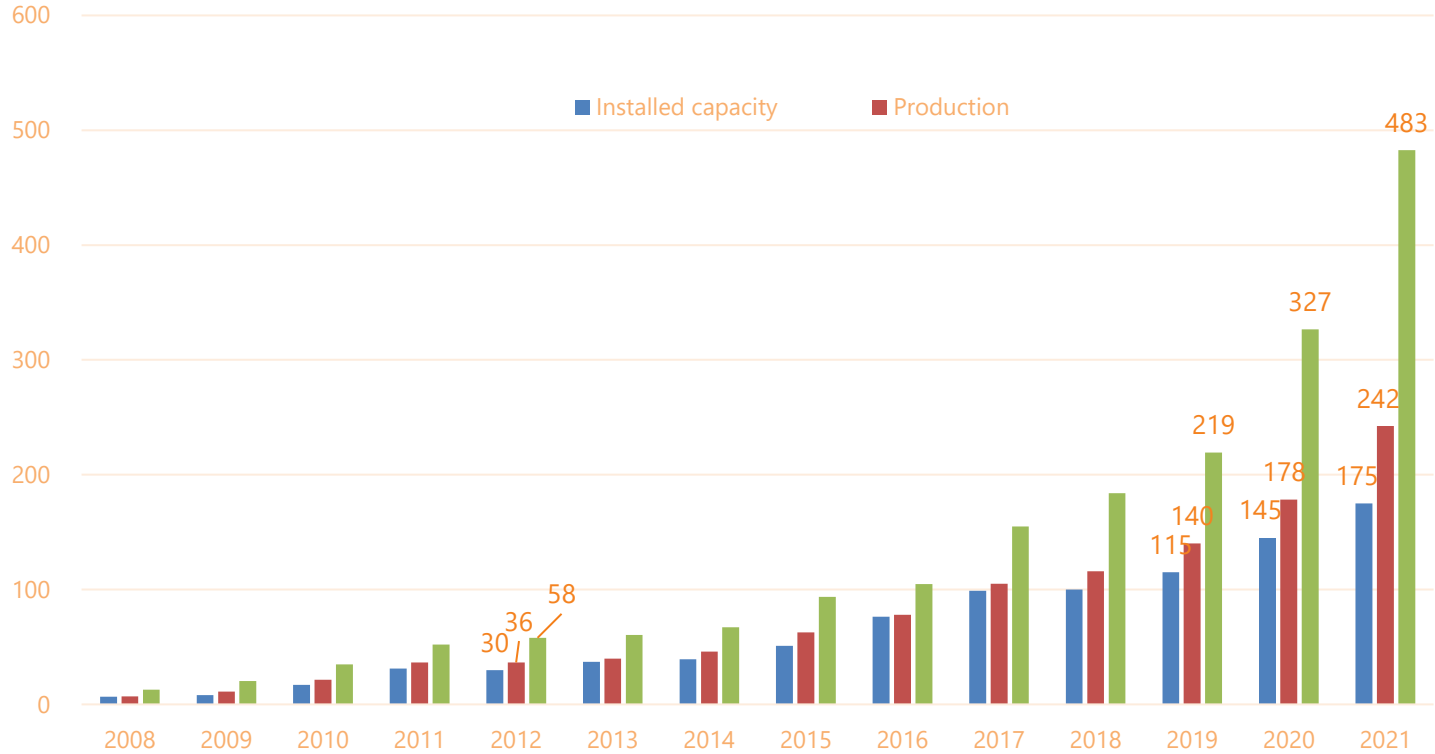


# Contents

- Looking present
  - Industry status 2021 and 1H2022 status
- Looking back past
  - Technology share of PV
  - Chinese roadmap: crystalline Si, TF and 3rd technologies
- Looking future for TW manufacturing



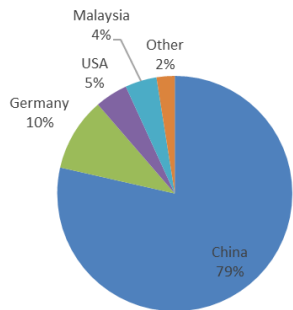
# 2021 Installation, production, Manufacturing capacity, preliminary numbers



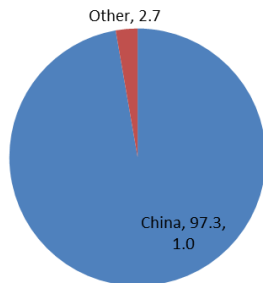
# Share by country along the value chain in 2021



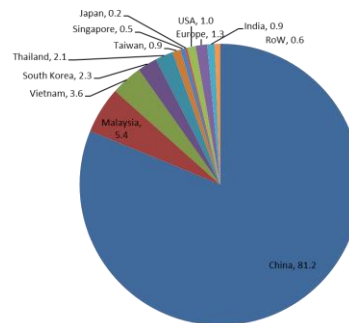
Share of Polysilicon Production - 2021  
(including poly for semiconductor)



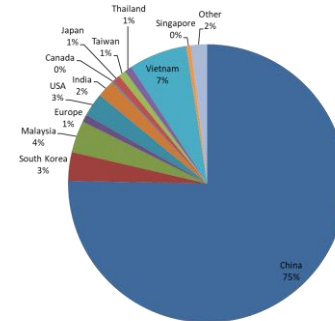
Share of PV Wafer Production 2021



Share of PV Cells Production - 2021

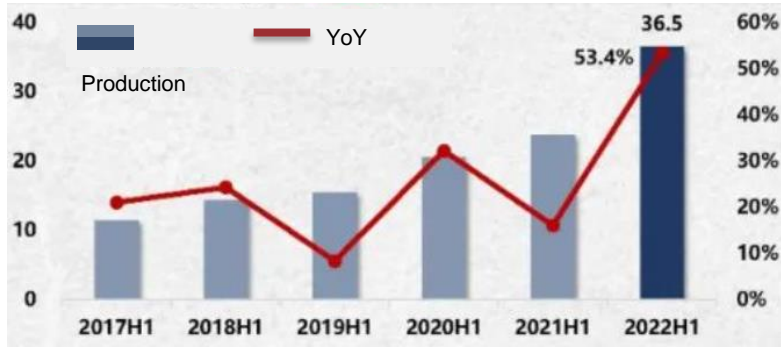


Share of PV Module Production in 2021



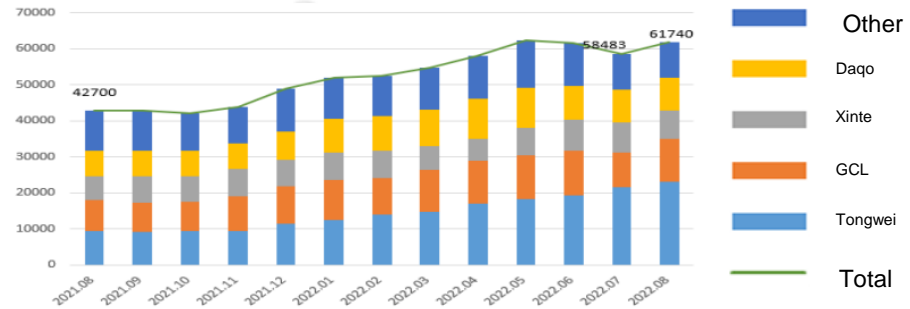
# Polysilicon Production in 1H2022 in China

Polysilicon Production (Unit : 10,000 t)



Source: CPIA, 2022年光伏行業上半年發展回顧·下半年形勢展望, compiled by RTS Corporation

Monthly production by company

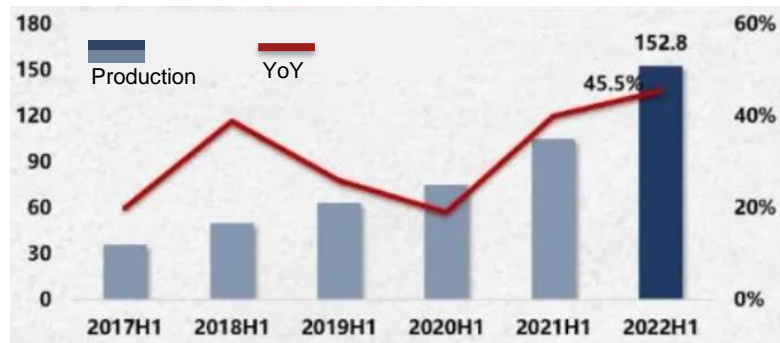


Source: China Nonferrous Metal Industry Association

- 365,000 tons of polysilicon produced in China, a 53.4% increase, YoY basis
- Production in July was dropped and expected to increase in the 2<sup>nd</sup> half of 2022
- Power control in Sichuan affected the production
- GCL started production by FBR process (100,000 tons/year)
- Enhancement plans are announced
  - Inner Mongolia : Tongwei, Dago, TCL/GCL, East Hope, Risen Energy
  - Qinghai: Canadian Solar, Trina Solar

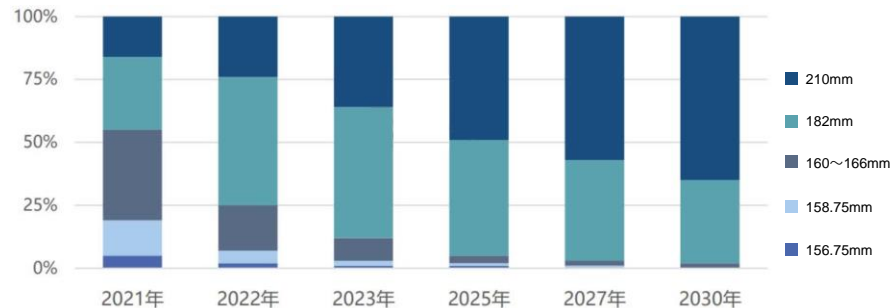
# Wafer Production in 1H2022 in China

## Wafer production (Unit : GW)



Source: CPIA, 2022年光伏行業上半年發展回顧·下半年形勢展望

## Wafer size outlook by CPIA

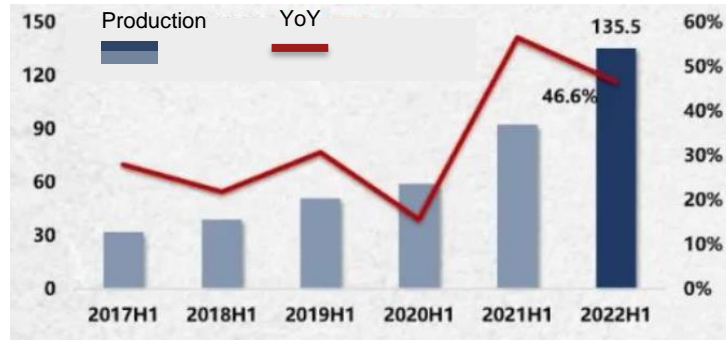


Source: CPIA, CPIA Roadmap

- Wafer production in 1H2022: 152.8GW, a 45.5% increase on YoY basis
- Share of larger sized wafer is increasing
- Tier 1 manufacturers modified manufacturing lines for 182mm (M10) and 210mm(M20). M10 will be major size in 2022
- Tungsten wire saws are introduced in place of diamond wire saws for cost reduction
- Thickness of wafer :165 $\mu$ m  $\rightarrow$  160 $\mu$ m

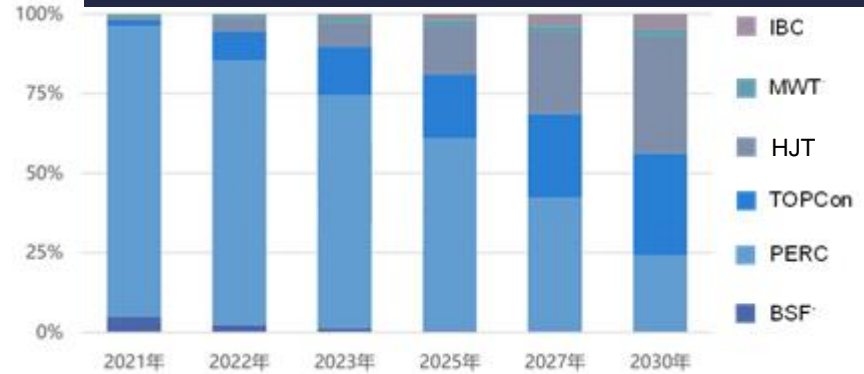
# Cell Production in 1H2022 in China

## Cell production (Unit : GW)



Source: CPIA, 2022年光伏行業上半年發展回顧・下半年形勢展望

## Cell technology outlook by CPIA

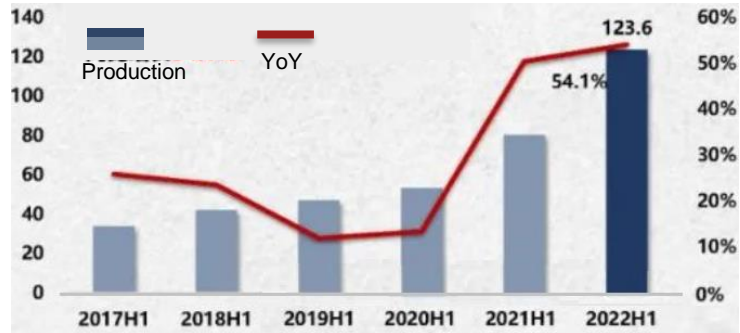


Source: CPIA, CPIA Roadmap

- 1H 2022 production : 135.5 GW , a 46.6% increase YoY basis
- Major technology is PERC but share of n-type technologies will increase towards 2030
- One third of recent new manufacturing capacity plan to adopt n-type technologies

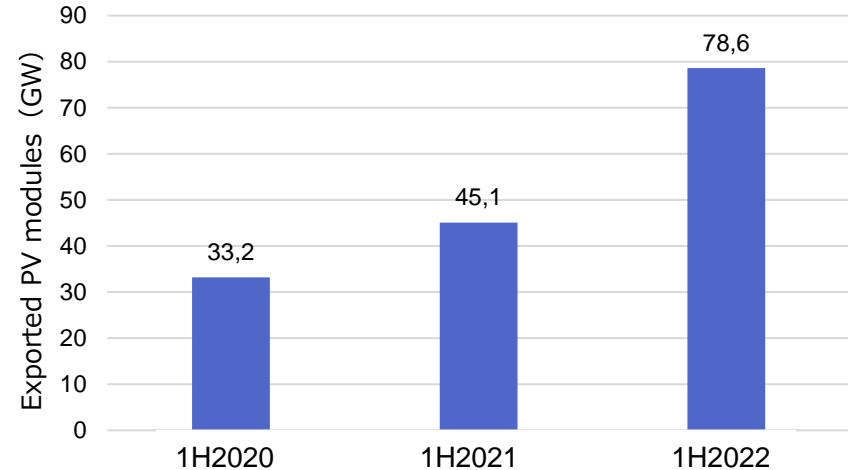
# Module Production in 1H2022 in China

## Cell production (Unit : GW)



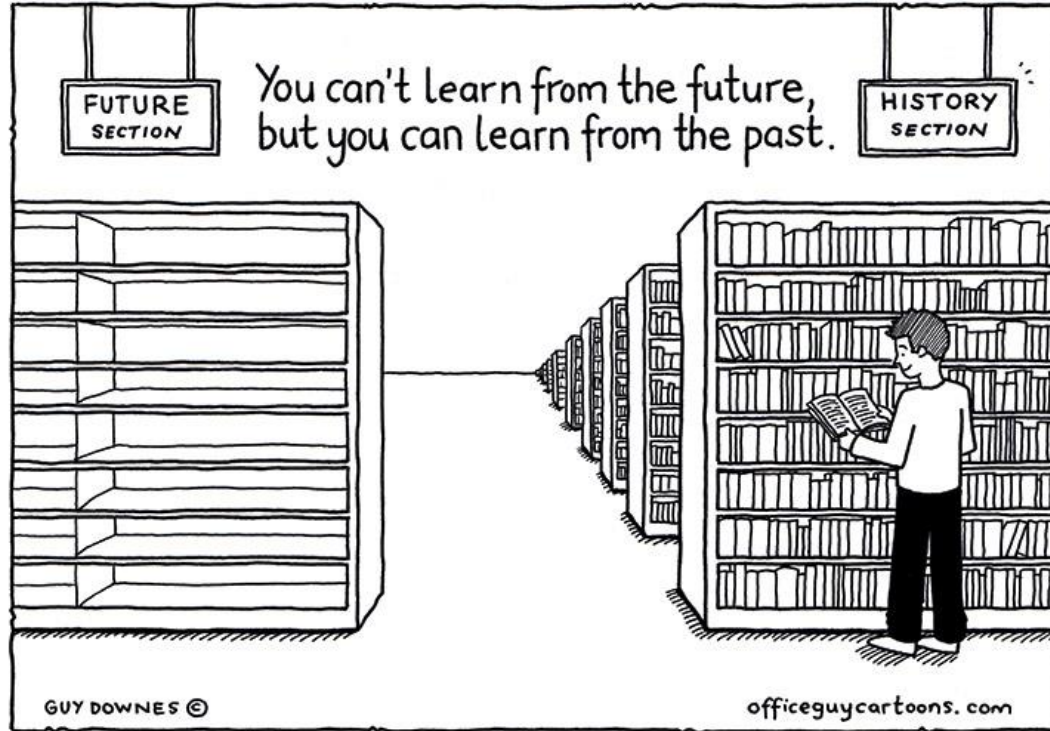
Source: CPIA, 2022年光伏行業上半年發展回顧·下半年形勢展望

- 1H2022 production : 123.6GW , a 54.1% increase on YoY basis
- Production of higher output PV modules (540W or more) is increasing because of requirement for large scale PV projects tender. N-Type PV module specific tender is also implemented (4GW of demand)
- Operation halted or operation ratio reduced in some companies due to price hike of PV modules
- Exported PV module in 1H2022: 78.6GW, @ 74.8% increase
  - Major destination in 1Q 2022 was India (Before India started BCD)
  - In 2Q 2022, demand from Europe increased. Over half amount of export went to Europe

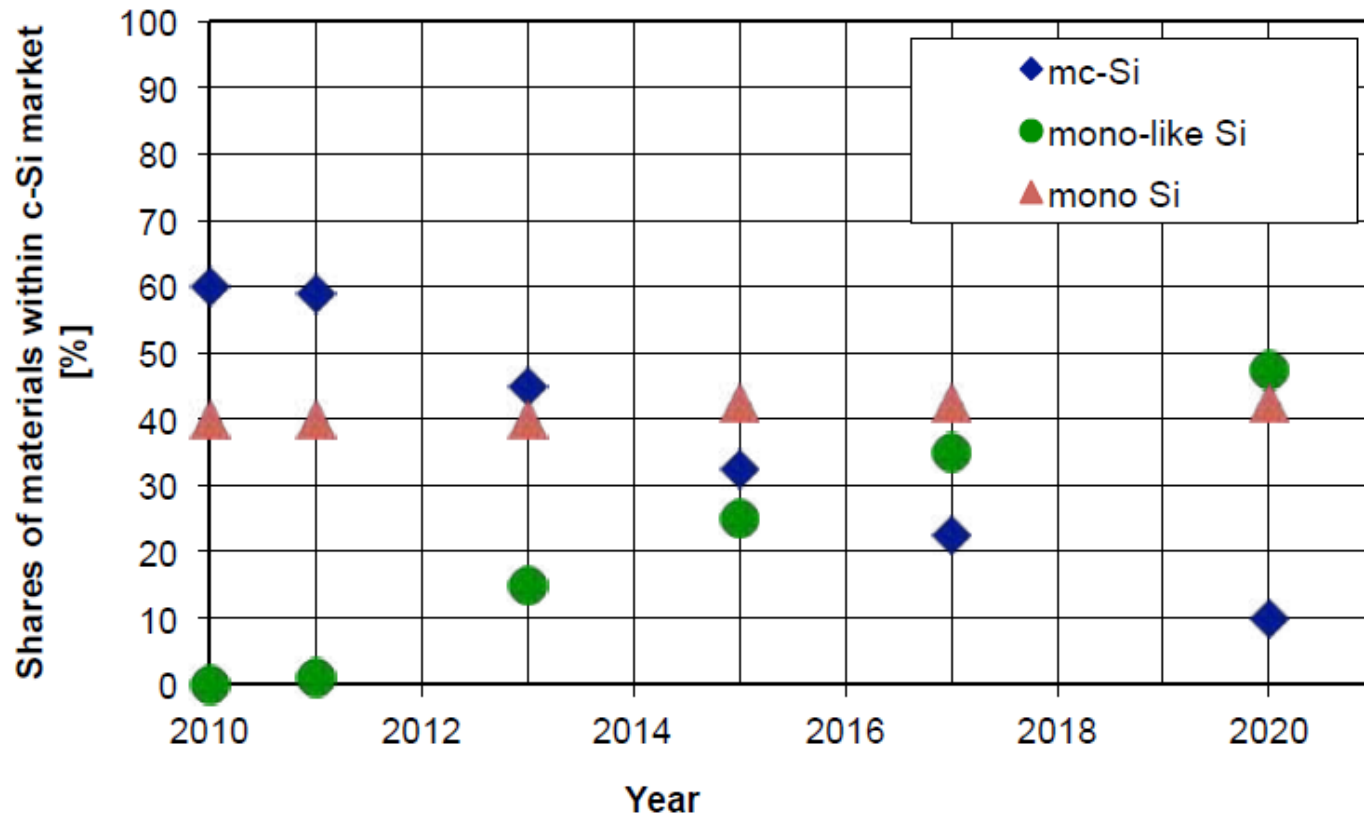




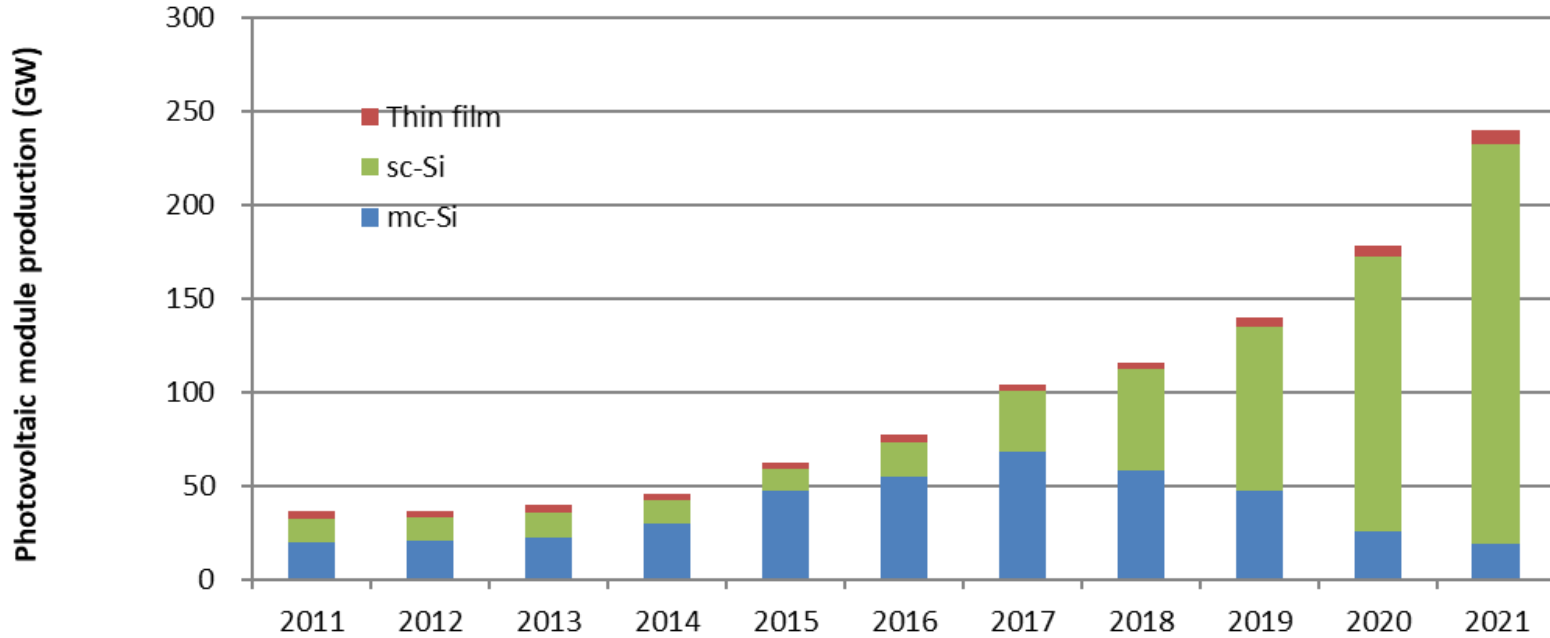
# Looking past



# ITRPV published in 2012 predicted more mono-like Si

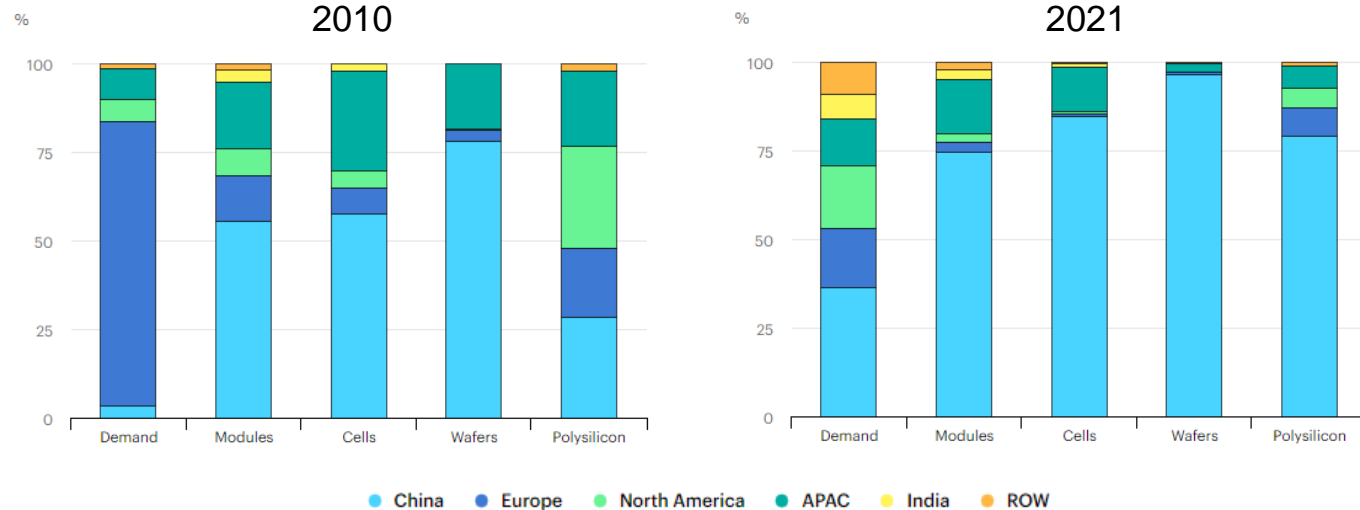


# Trends of PV module technologies



sc-Si (mono-Si) dominated the share with 88%,  
mc-Si: 7.7%, TF:3.4%

# Looking back industry situation in 2010 and 2021 situation



Source : IEA. "Solar PV Global Supply Chains", July 2022)

- While PV markets diversified more and more, supply chain concentration in intensified
- China heavily invested polysilicon production and wafer production China also became a major producer of PV glass, EVA, back sheets and junction box, etc.

## Chinese PV Target set in 2010 and 2021 status: Crystalline silicon technology

	Unit	2009	2015	2020	2021	2030
Efficiency	%	16 – 19	18-20	20-22	19.5-24.2	> 25
Thickness	μm	180-200	160-180	120-150	150 – 178 Avg, 165	100
PolySi consumption	g/Wp	7.0-9.0	6.0-8.0	4.0-6.0	2.7	4.0
Production target	GW	4	10	20	181.8GW	100
Domestic deployment (Cumulative installed capacity)	GW	0.3	5	50	308.5GW	500
Polysilicon price	\$/kg	50-60	30-40	20-30	10.79 - 35.8	20
PV module price	RMB/W	12.0-15.0	8.0-10.0	6.0-8.0	1.9	5.0
System price	10000RMB/kW	18-20	12-15	8-10	4.15	0.8
PV generation cost (1,500h/annual)	RMB/kWh	1.50	1.00	0.80	0.25	0.60

Source : 2009, 2015, 2020, 2021, 2030 figure: Li Junfeng, Wang Sicheng, 11<sup>th</sup> PV Conference and Exhibition (November 2010)

Souce: 2021 figure : CPIA, RTS Corporation, IEA PVPS SnapShot Report

# Success of Chinese Industry

- Identify challenges in early stage
  - Local polysilicon production
  - Local material supply chain : glass, encapsulants, etc.
  - Manufacturing equipment
- Economy of the scale backed
- Technology enhancement (efficiency gains, larger and thinner wafers, throughput, etc.)
- Policies to stimulate market
  - Golden Sun Program (subsidy)
  - FIT Program
- Policy to encourage higher efficiency products: Top runner program
- Financing

## Chinese PV Target in 2010 and 2021 status: Other technologies

		Unit	2009	2015	2020	2021	2030
Efficiency	TF silicon	%	5-8	8-10	10-12	N.A.	15
	CdTe		9-11	11-13	13-15	Products:15.3% Best products : 16.6% Lab : 20.5%	18
	CIGS		10-12	13-15	16-18	Products:16.5% Best products : 17.6% Lab : 22.92% (Flexible) Products:16.5% Best products : 17.6% Lab : 22.92%	20
3 <sup>rd</sup> Generation PV				Technological break-through	Commercialization	Pilot production and commercialization Underway	

Source : 2009, 2015, 2020, 2021, 2030 figure: Li Junfeng, Wang Sicheng, 11<sup>th</sup> PV Conference and Exhibition (November 2010) and RTS

# Companies Perovskite PV commercialization plan in China

Company	Technology	Status
 <p>Hangzhou Microquanta Semiconductor (杭州纖納光電科技)</p>	PVK	<ul style="list-style-type: none"> <li>• 100MW/year commercial line</li> <li>• Shipped 5,000 pieces of modules</li> </ul>
 <p>GCL Optoelectronics Material (協鑫光電材料)</p>	PVK, Tandem	<ul style="list-style-type: none"> <li>• Pilot operation of 100MW/year line in Dec 2021</li> </ul>
 <p>DaZheng (Jiangsu) Micro-Nano Technologies (大正微納科技)</p>	Flexible PVK	<ul style="list-style-type: none"> <li>• 10MW/year line, started commercial operation in July 2022</li> <li>• Plans to increase 100 MW/year</li> </ul>
 <p>Wonder Solar (万度光能)</p>	PVK	<ul style="list-style-type: none"> <li>• Established pilot line in August 2021</li> </ul>
 <p>UtmoLight Technology (極電光能)</p>	PVK	<ul style="list-style-type: none"> <li>• Plans to star pilot production in Q32022</li> </ul>
 <p>寧德時代新能源科技 (CATL)</p>	PVK	<ul style="list-style-type: none"> <li>• Pilot plant construction in underway (May 2022)</li> </ul>
 <p>Shenzhen Infinite Solar Energy Technology (深圳无限光能技術)</p>	PVK (substrate?)	<ul style="list-style-type: none"> <li>• Test line will be completed in 3Q2022 and plans to start operation by the endo of 2022</li> <li>• Plans to increase the capacity to 100 MW/year in 2024</li> </ul>
<p>Xinleixin Semiconductor (鑫磊鑫半導體)</p>	PVK (substrate?)	<ul style="list-style-type: none"> <li>• Media reported to establish 1GW/year line in July 2022</li> </ul>

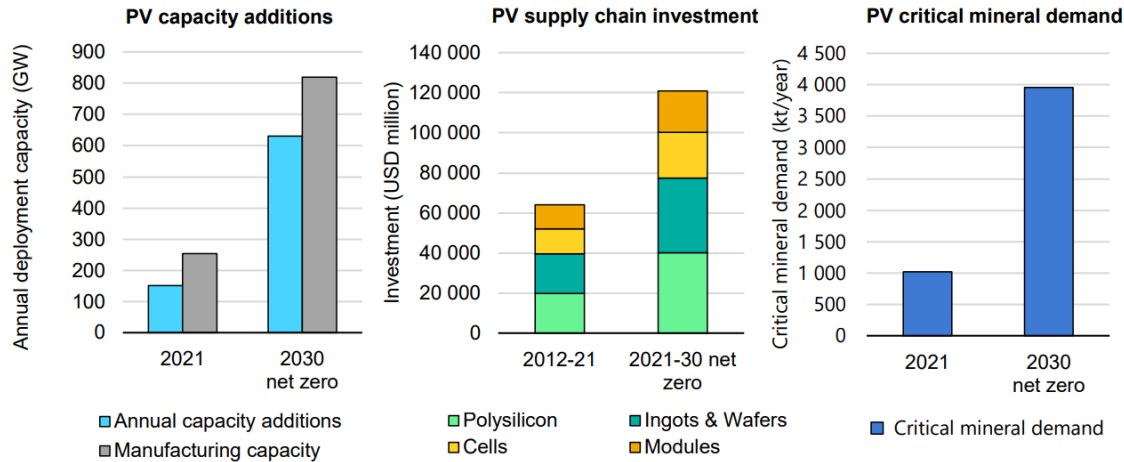


## CPIA Outlook for conversion efficiency of PVK technologies (Feb 2022)

PVK Type (Surface area)	2021	2022	2023	2025	2027	2030
Small laboratory cell (0.1cm <sup>2</sup> ) Champion efficiency	24.8%	25.8%	26.3%	26.7%	27.4%	29.0%
Glass substrate small-sized PVK module (30cm <sup>2</sup> )	21.4%	22.0%	22.8%	23.8%	24.8%	25.5%
Glass substrate (>900 cm <sup>2</sup> )	17 %	18.5%	19.3%	20.0%	21.0%	22.0%
Flexible module	20.2%	20.7%	21.2%	22.2%	23.2%	24.7%

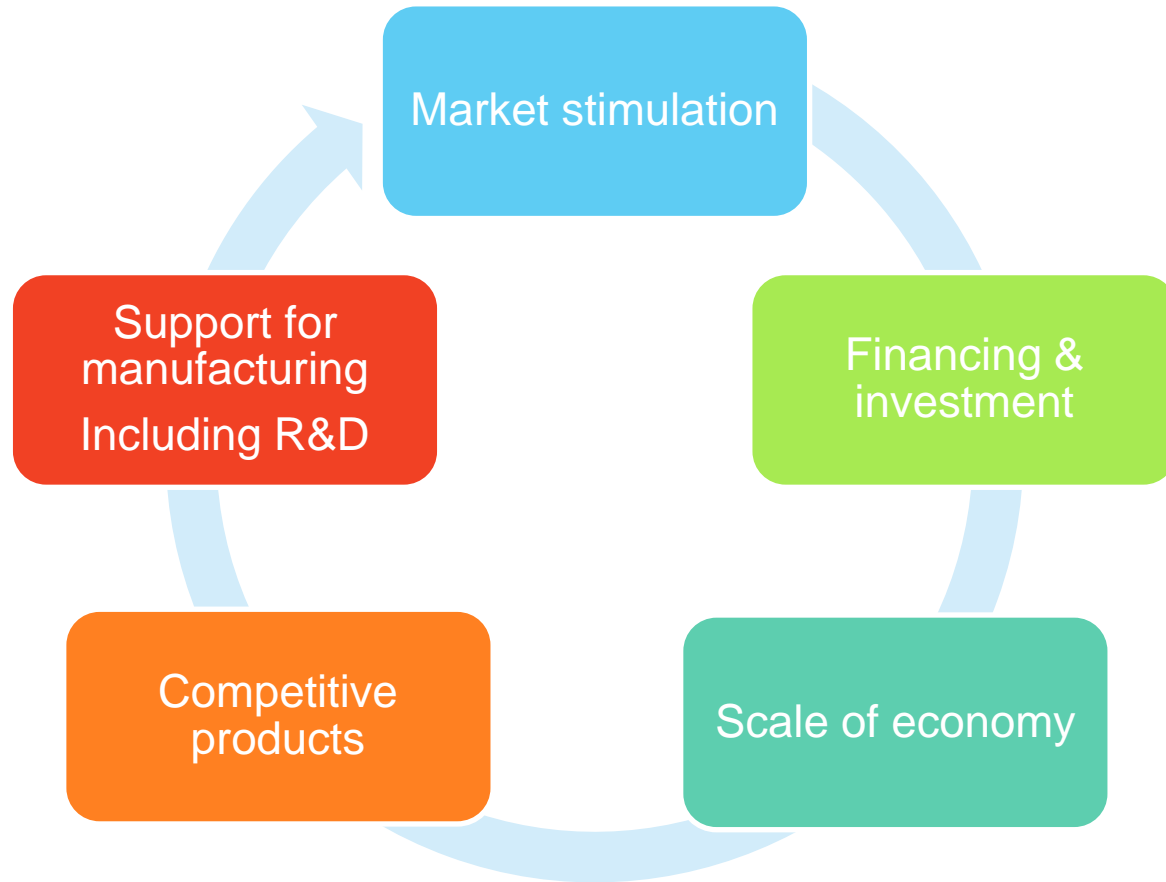
出典：中国太陽光発電産業協会（CPIA）「中国光伏産業發展路線図（2021年版）」（2021年2月）

# Outlook and policy action towards 2030 by IEA



- By 2030, to 850 GW/year of PV manufacturing capacity needs to achieve net zero GHG emission by 2050 by IEA
- IEA's five key policy action areas to ensure solar PV security of supply
  - Diversify manufacturing and raw material supplies
  - De-risk investment
  - Ensure environmental and social sustainability
  - Continue to foster innovation
  - Develop and strengthen recycling capabilities

## Lesson learned



***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



New Energy and Industrial Technology  
Development Organization

Contact : Izumi KAIZUKA, RTS Corporation, [kaizuka@rts-pv.com](mailto:kaizuka@rts-pv.com)