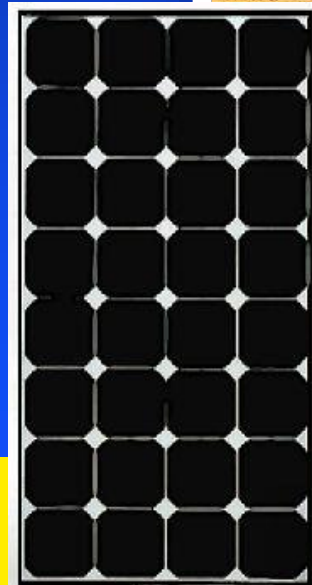




Australian Centre for Advanced Photovoltaics

“Where is the solar industry headed”

Martin A. Green
UNSW Sydney
November 2017



ARENA

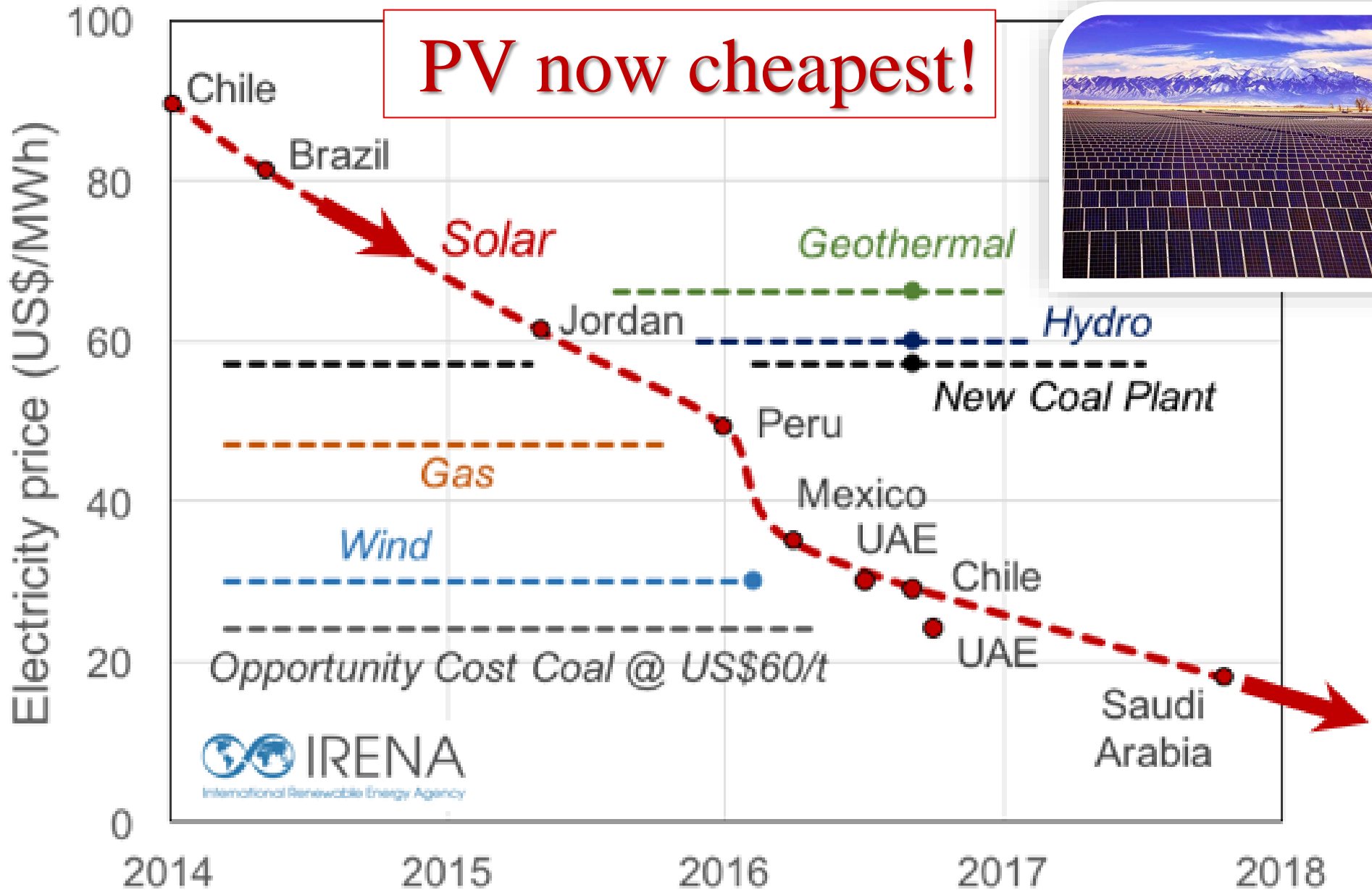


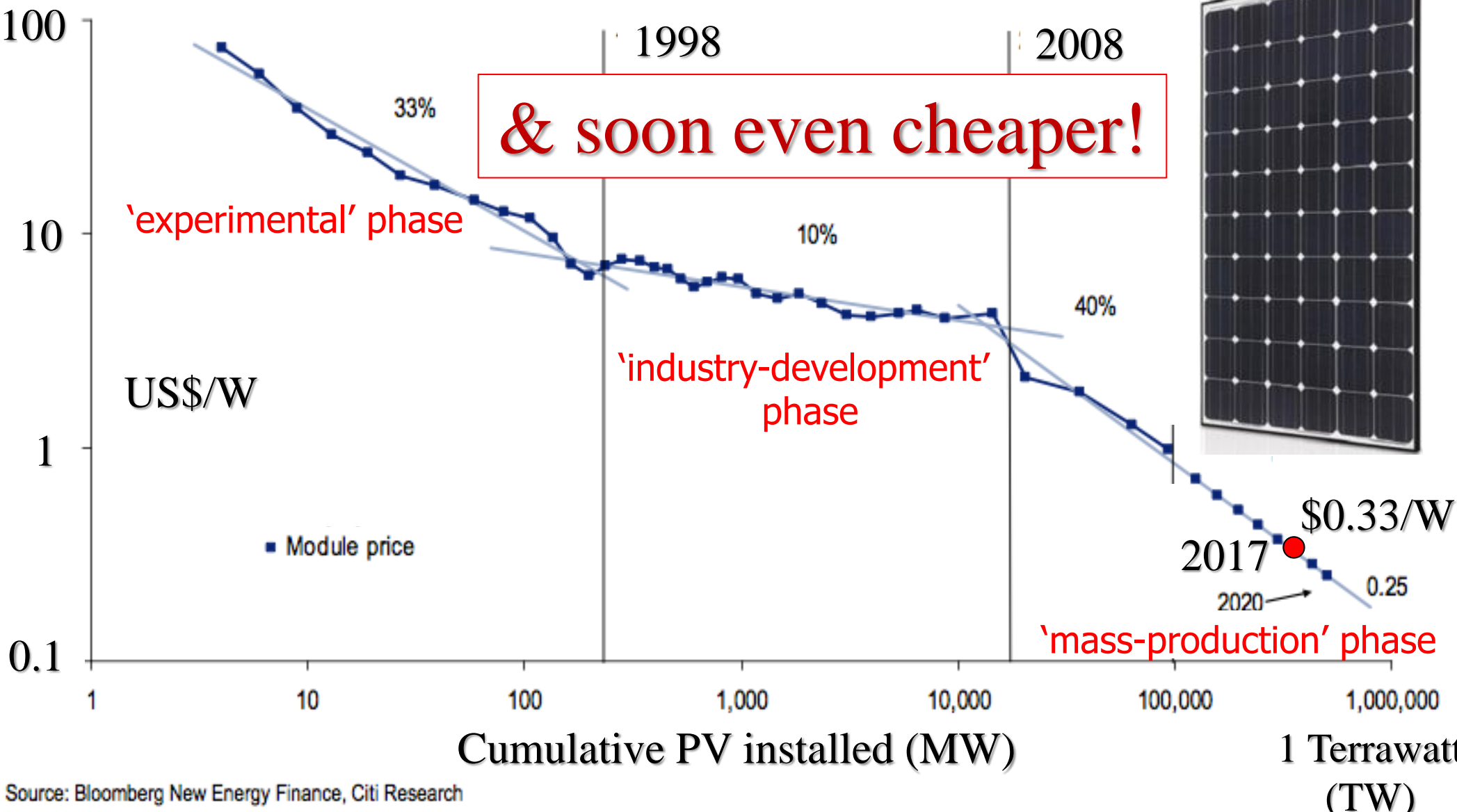
Australian Government
Australian Renewable
Energy Agency



UNSW
SYDNEY

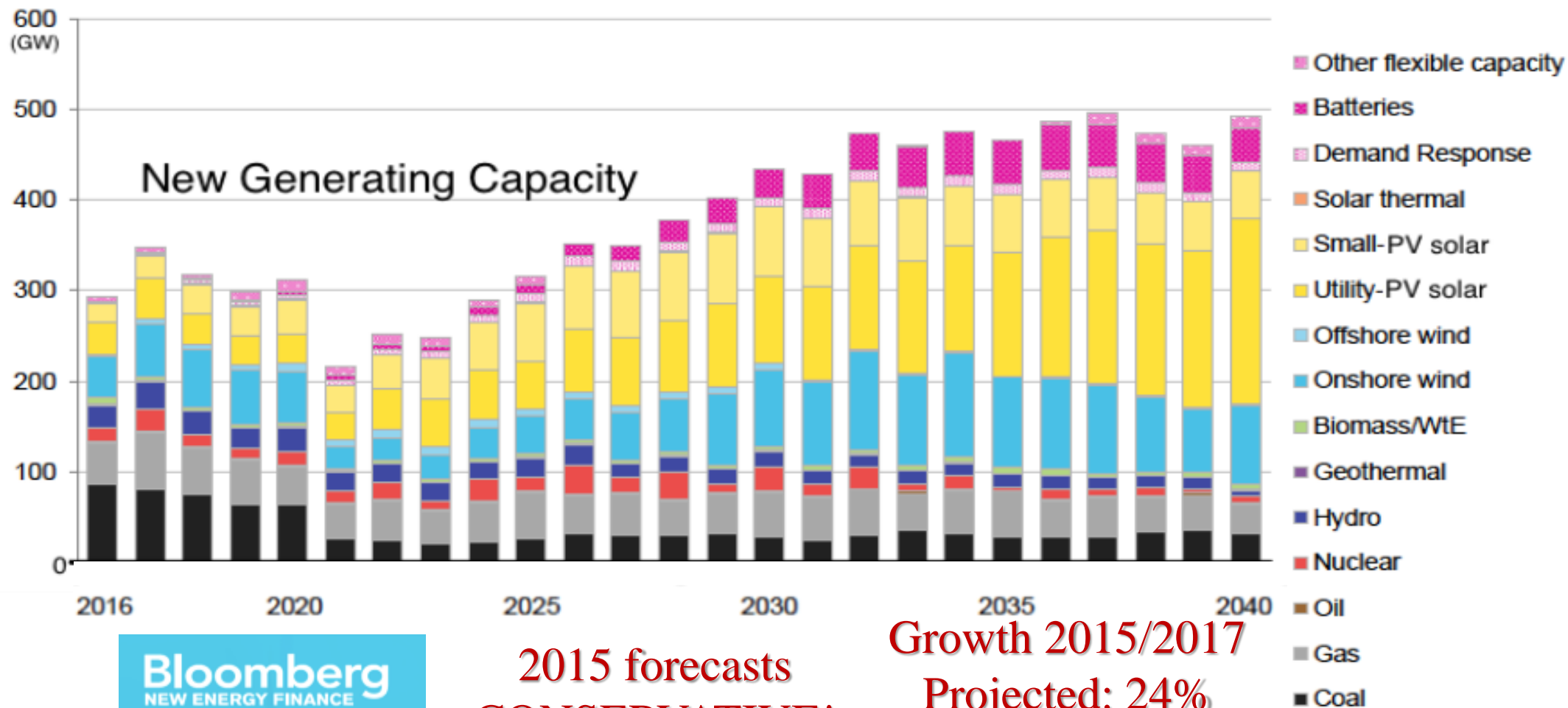
Low Bids: International Electricity Auctions



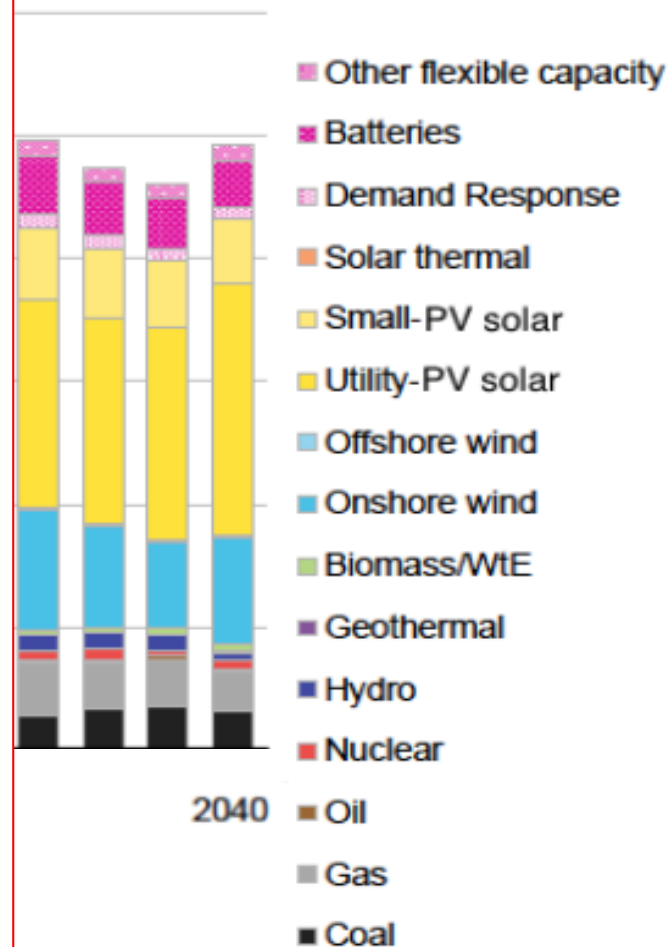
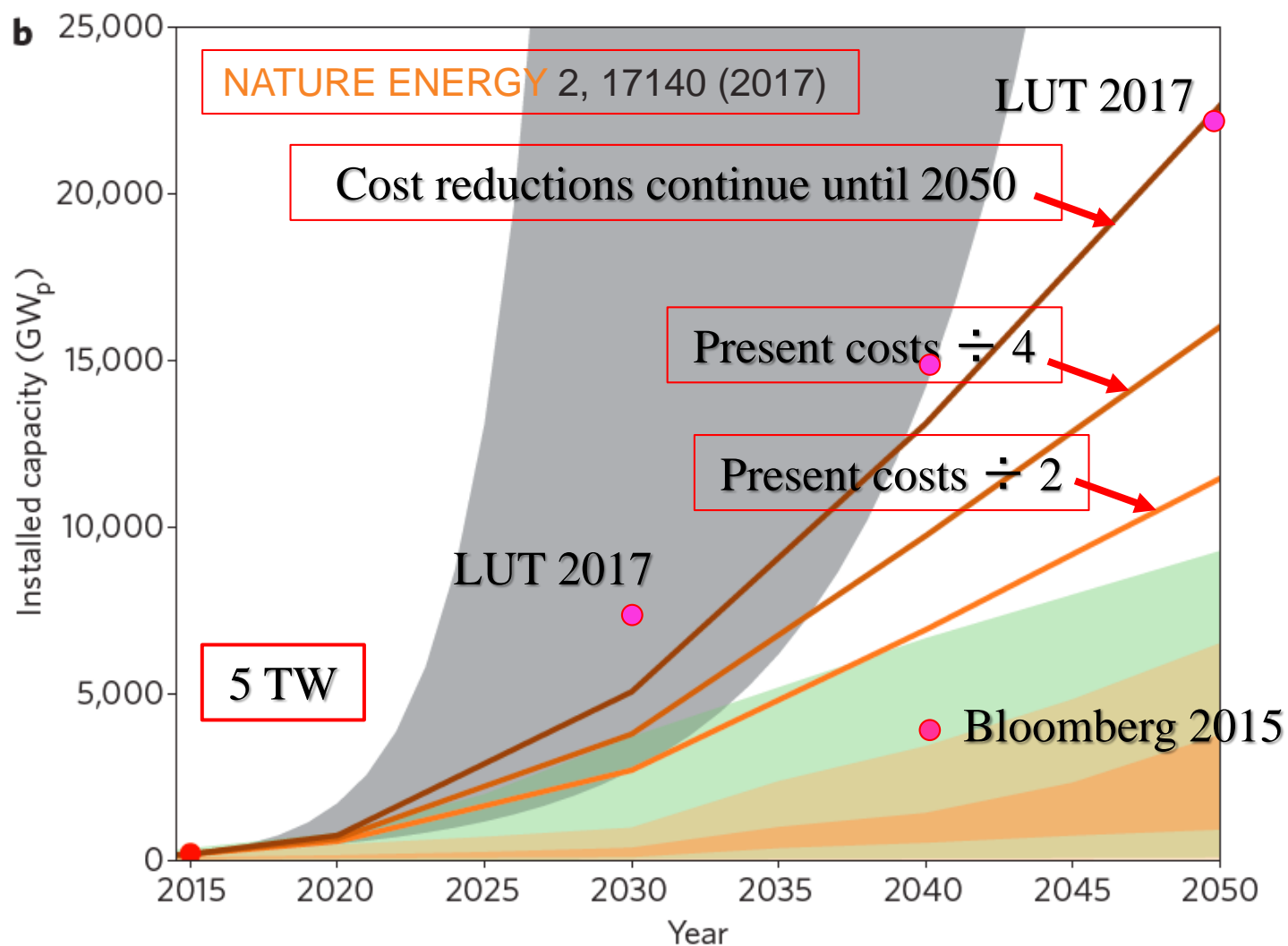


Source: Bloomberg New Energy Finance, Citi Research

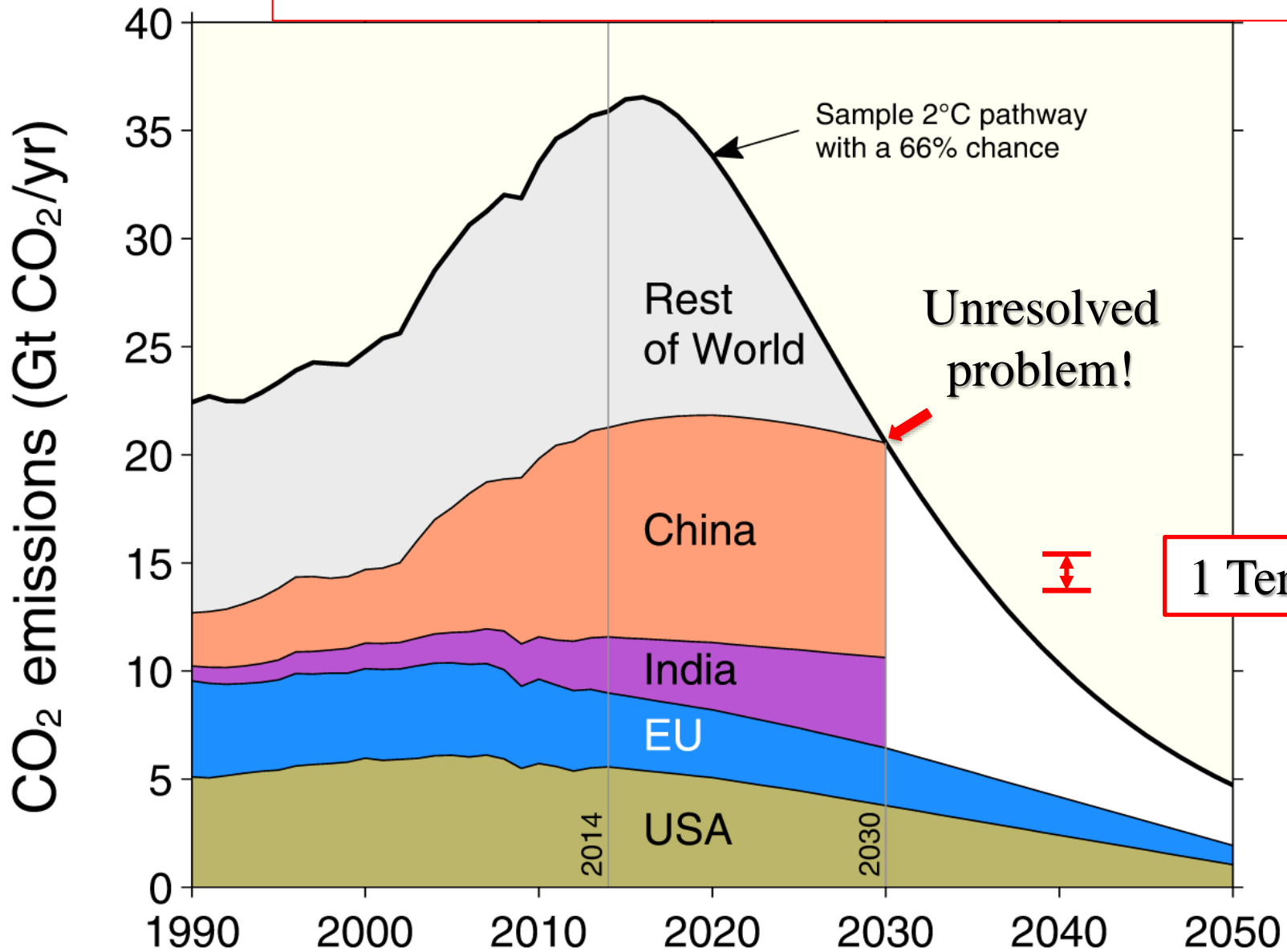
Over the next 25 years, 68% of new electricity capacity will be renewable



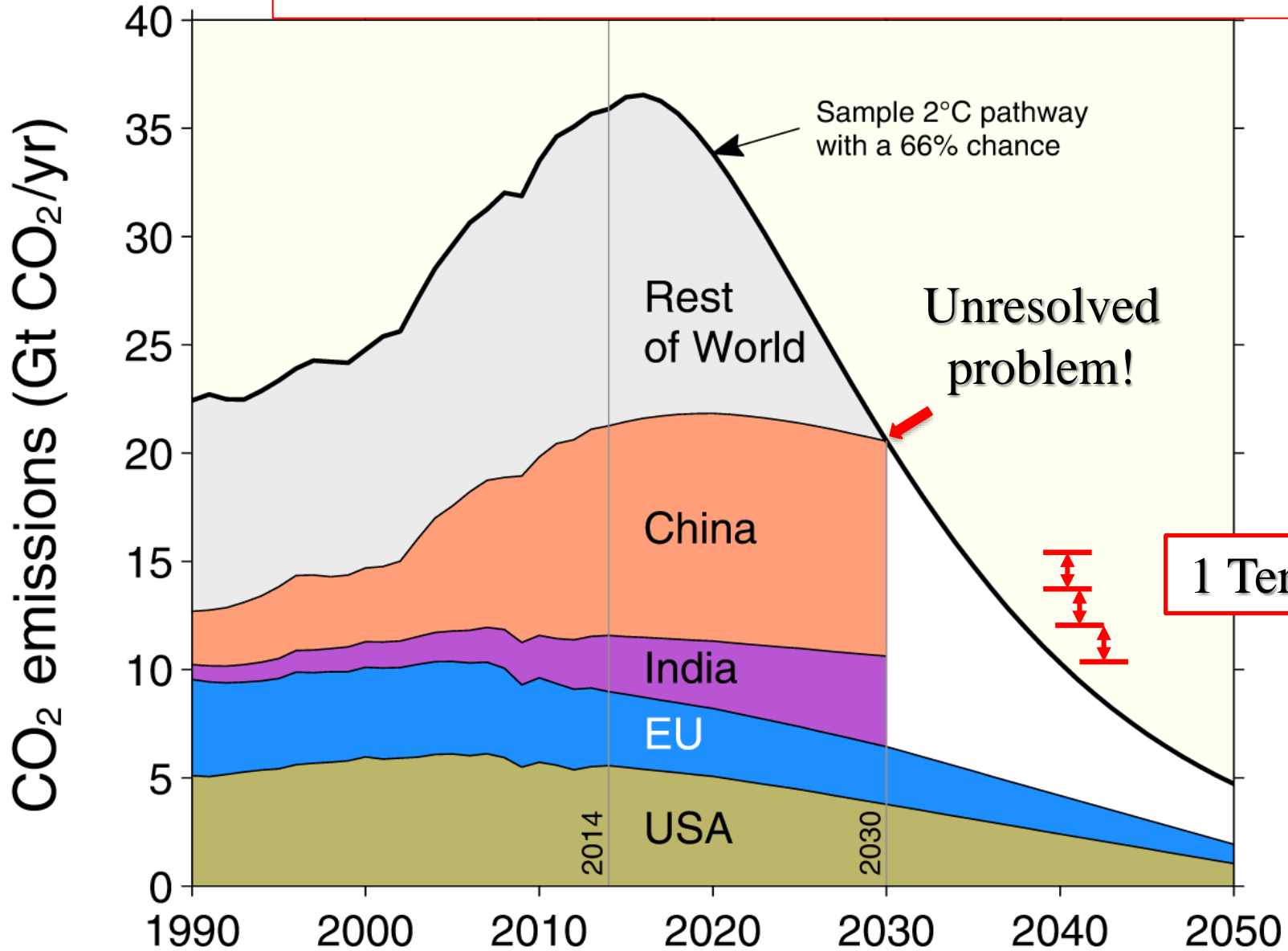
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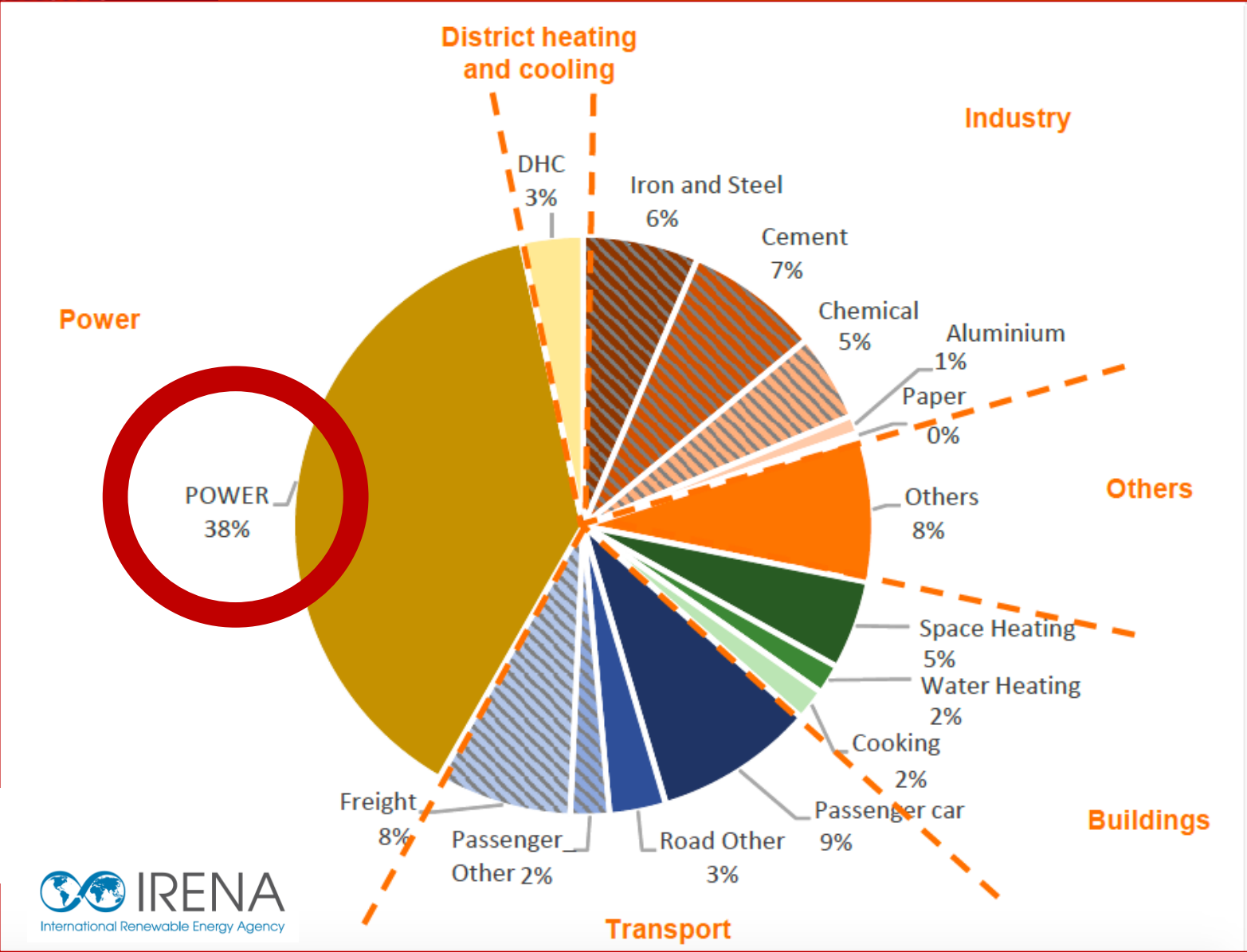


Can PV make a major impact on global warming?

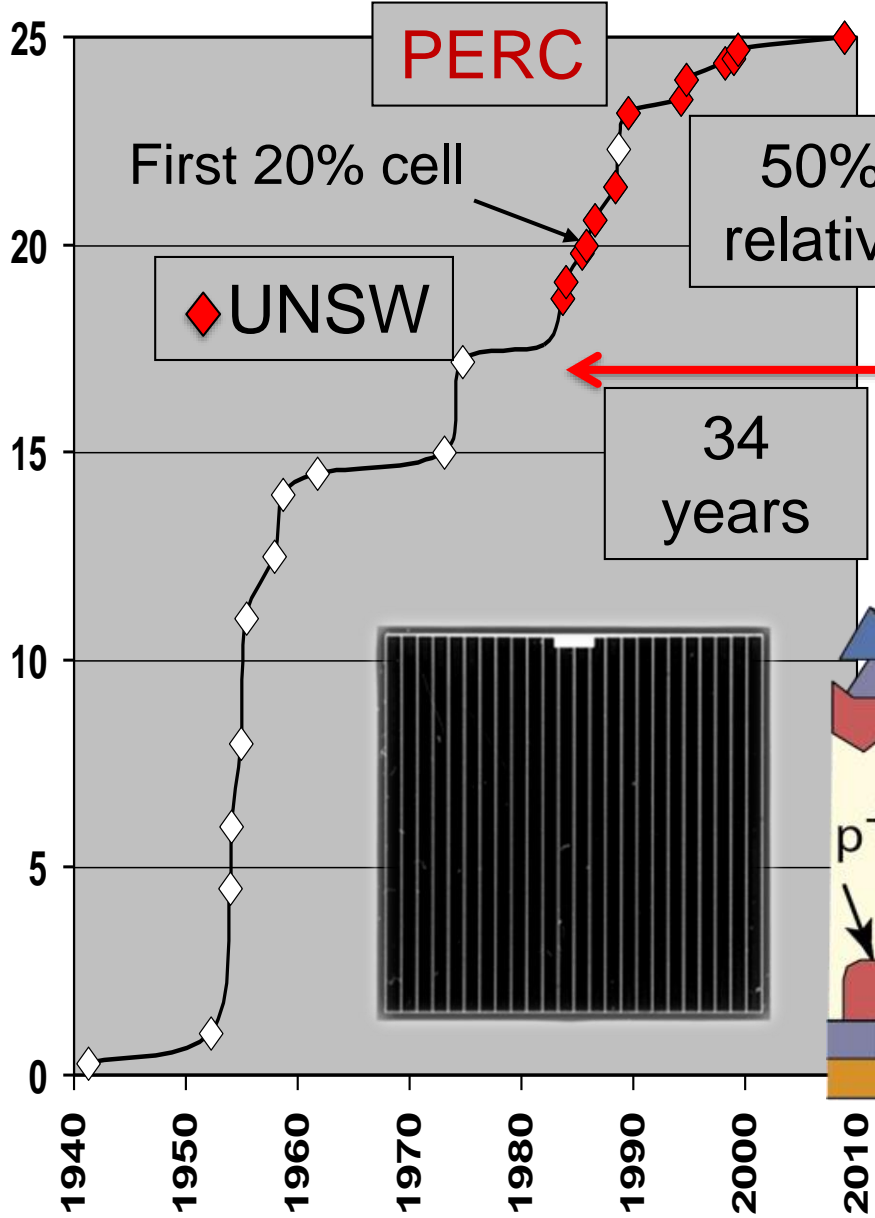


Can PV make a major impact on global warming?

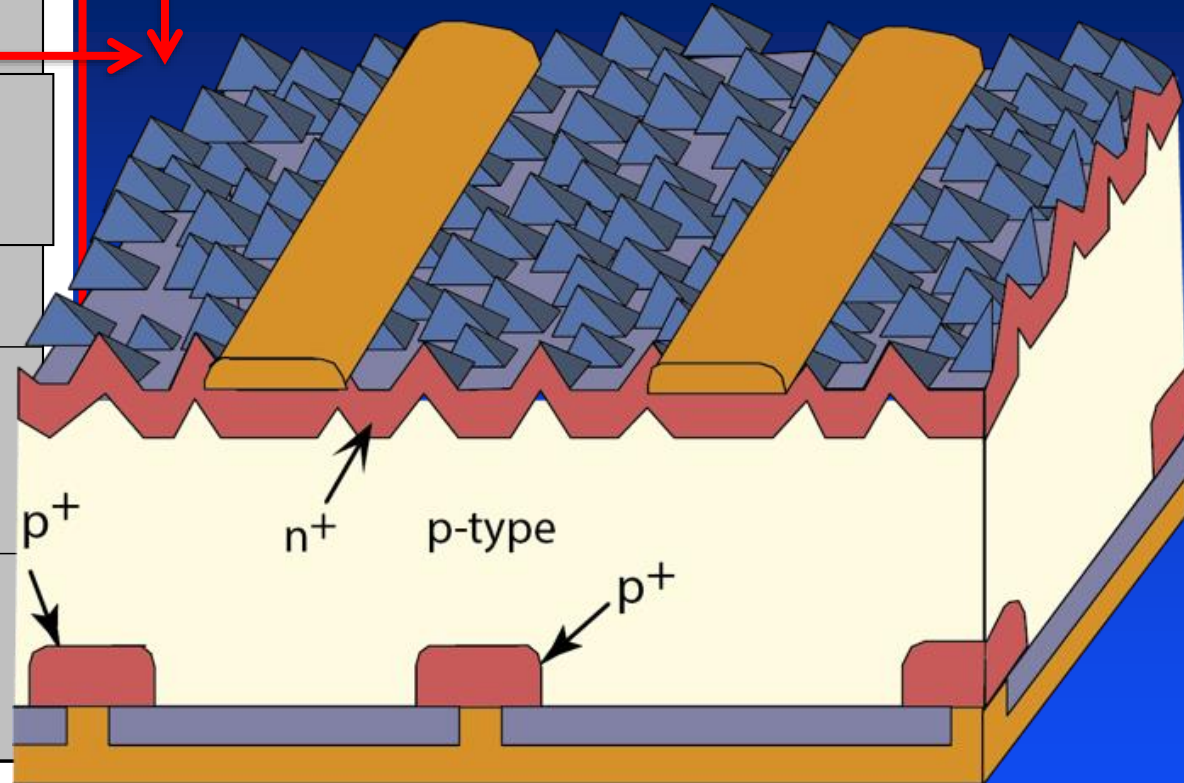




Silicon solar cell efficiency, %



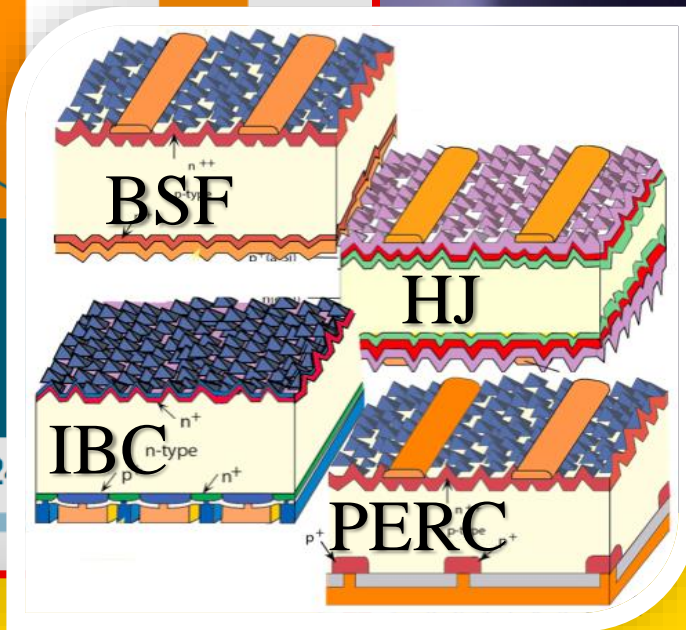
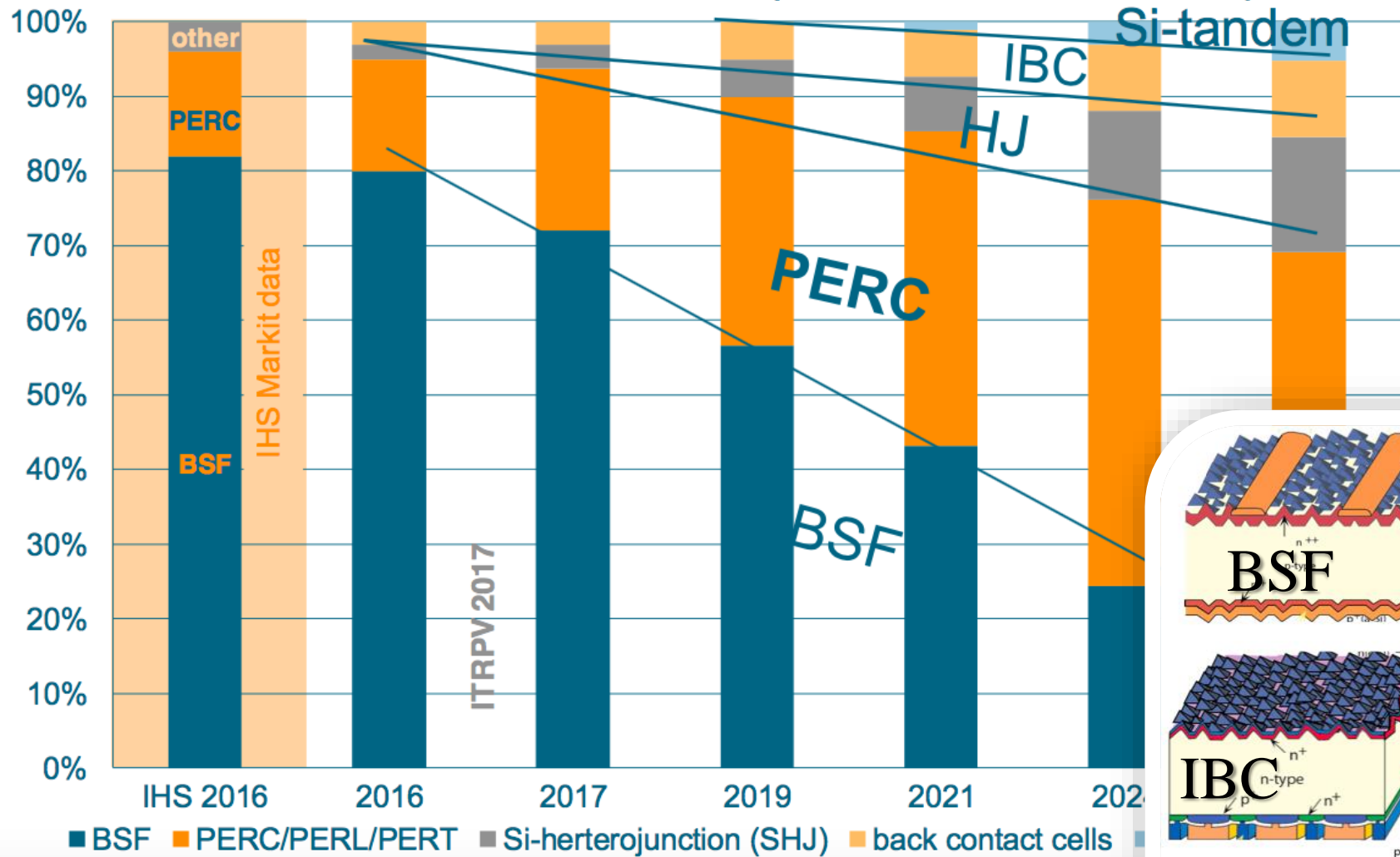
UNSW PERC cell



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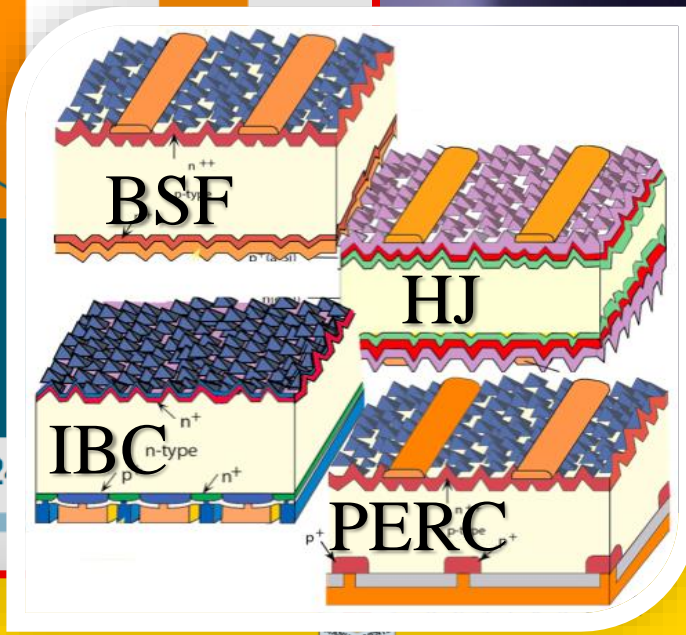
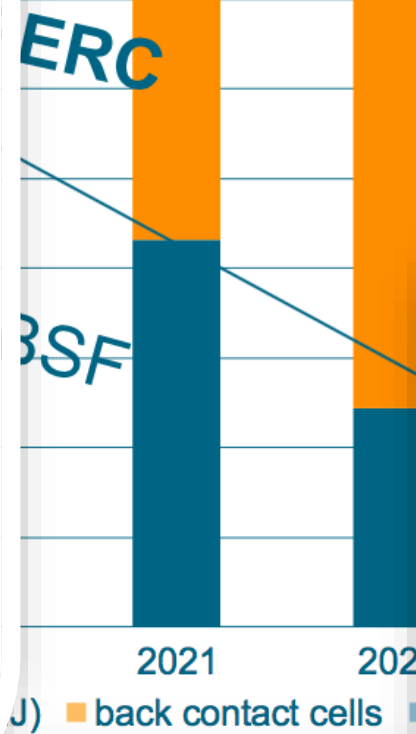
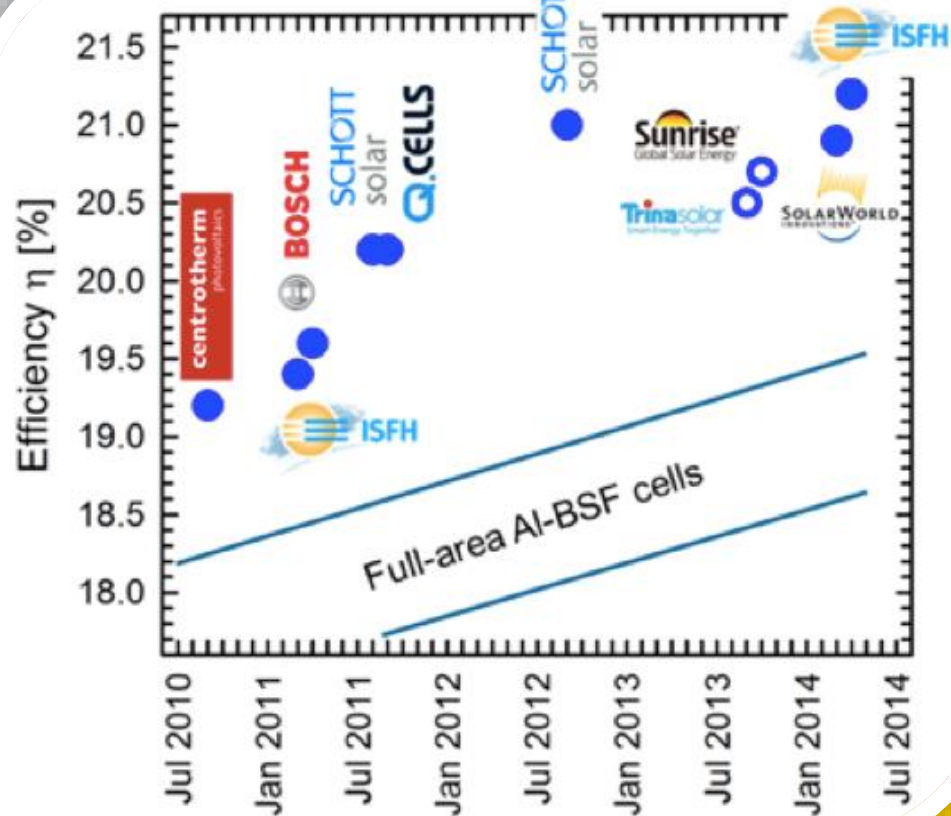
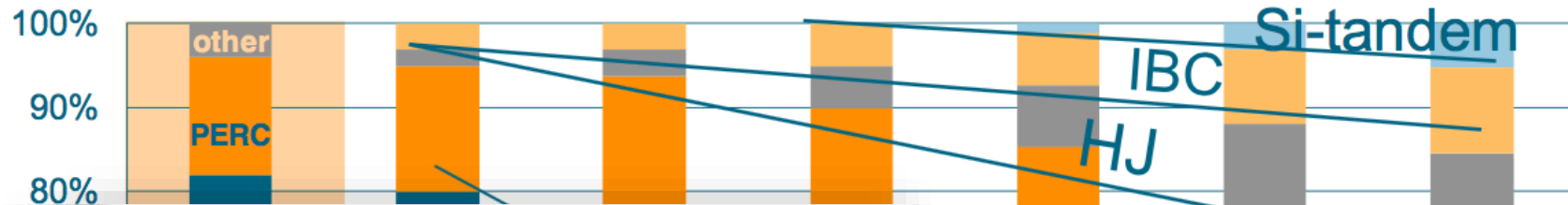
International Technology Roadmap for Photovoltaic (ITRPV)

Cell technology



International Technology Roadmap for Photovoltaic (ITRPV)

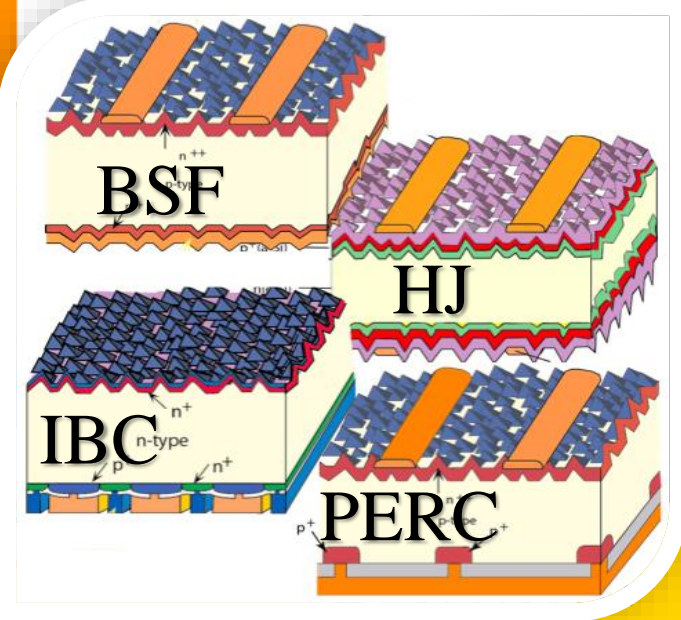
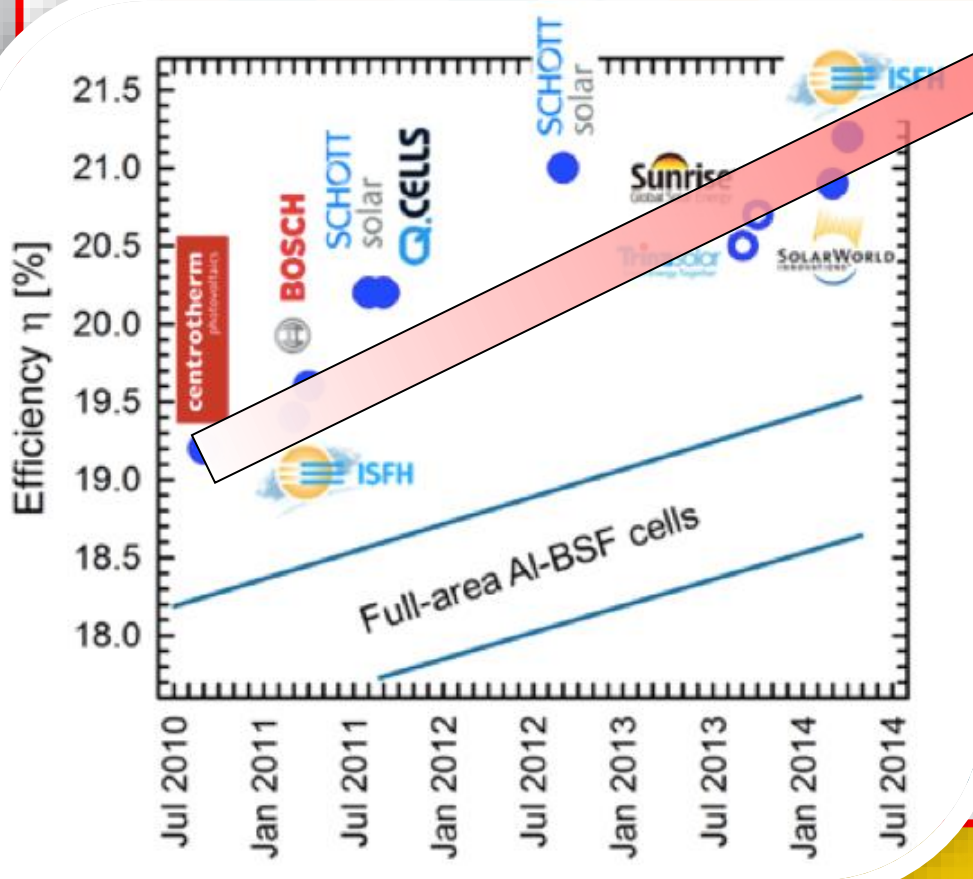
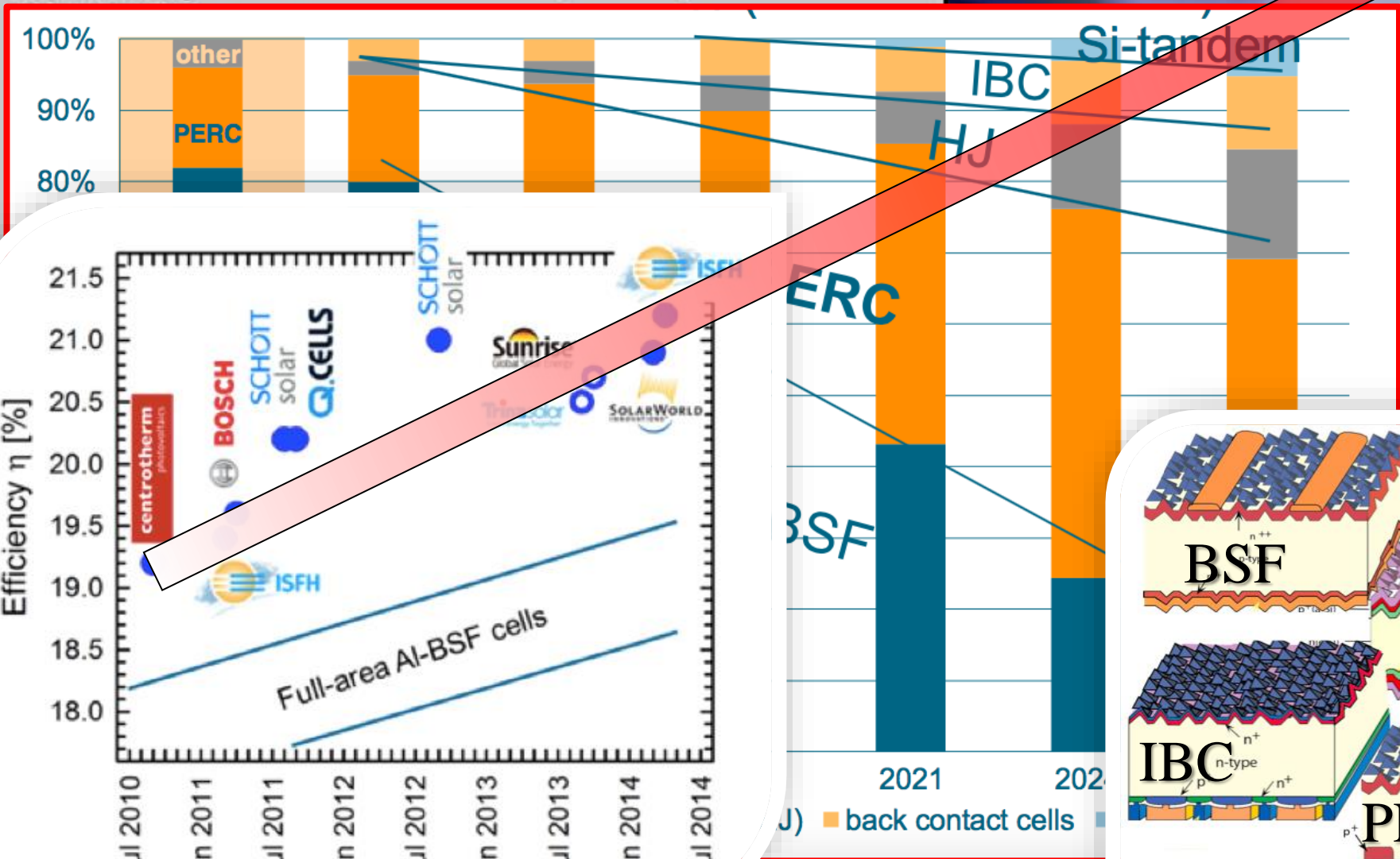
Cell technology



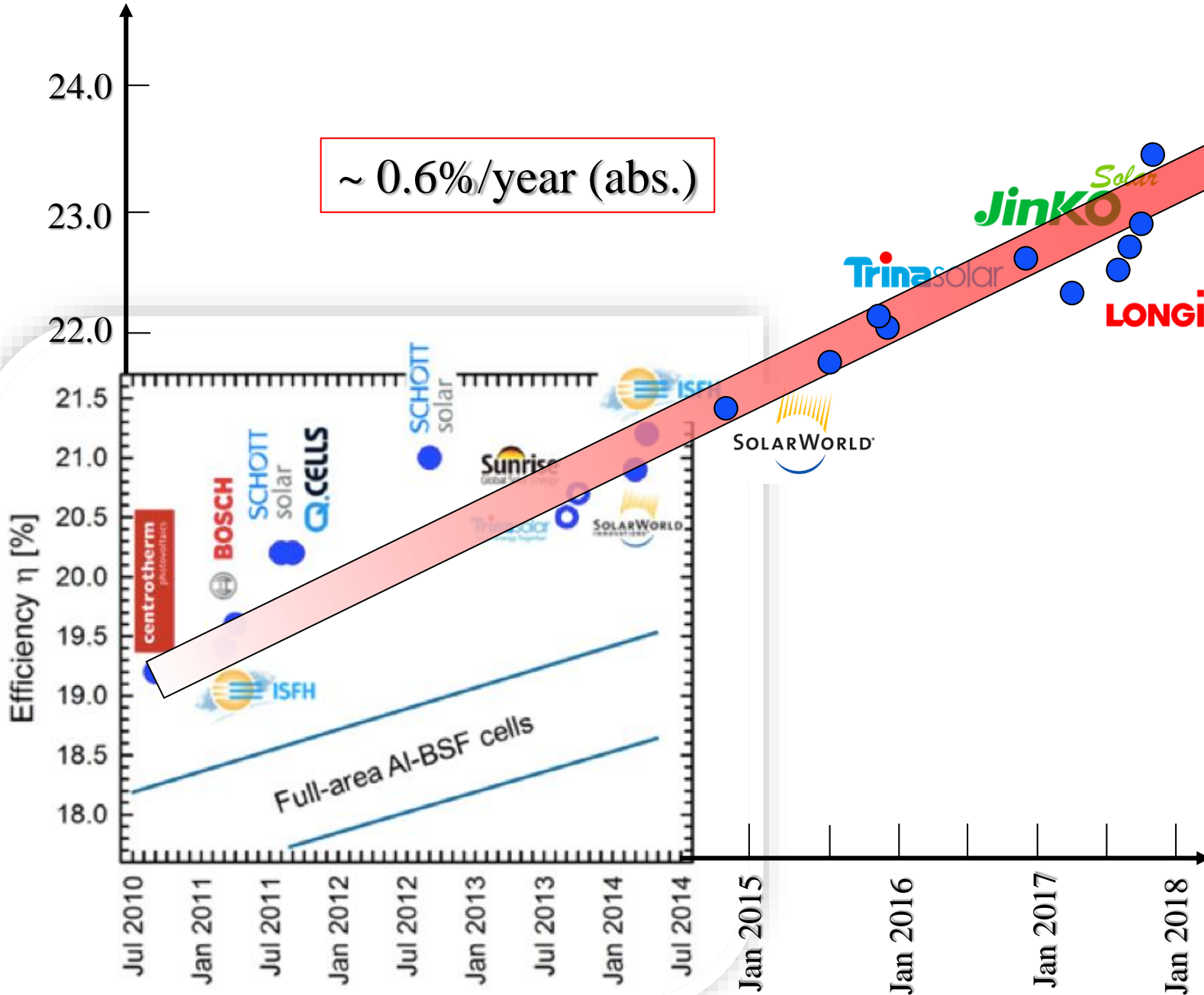
International Technology Roadmap for Photovoltaic (ITRPV)

Cell technology

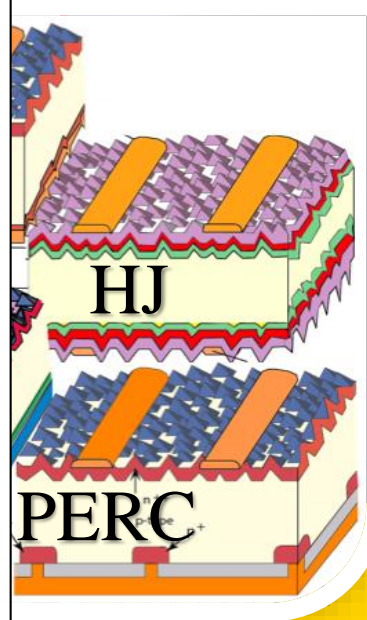
24.4%



Legend: ■ back contact cells ■ BSF

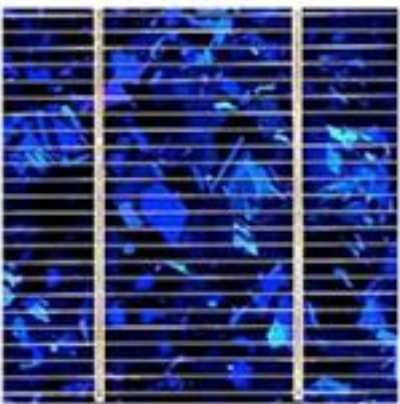
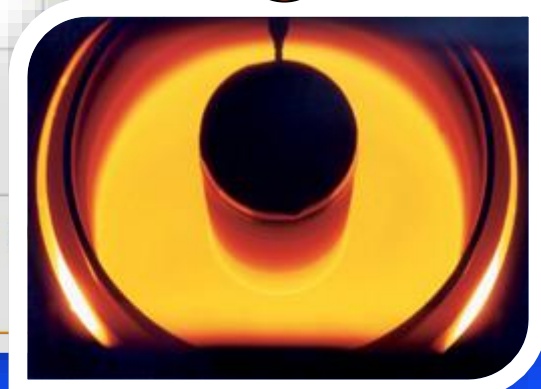
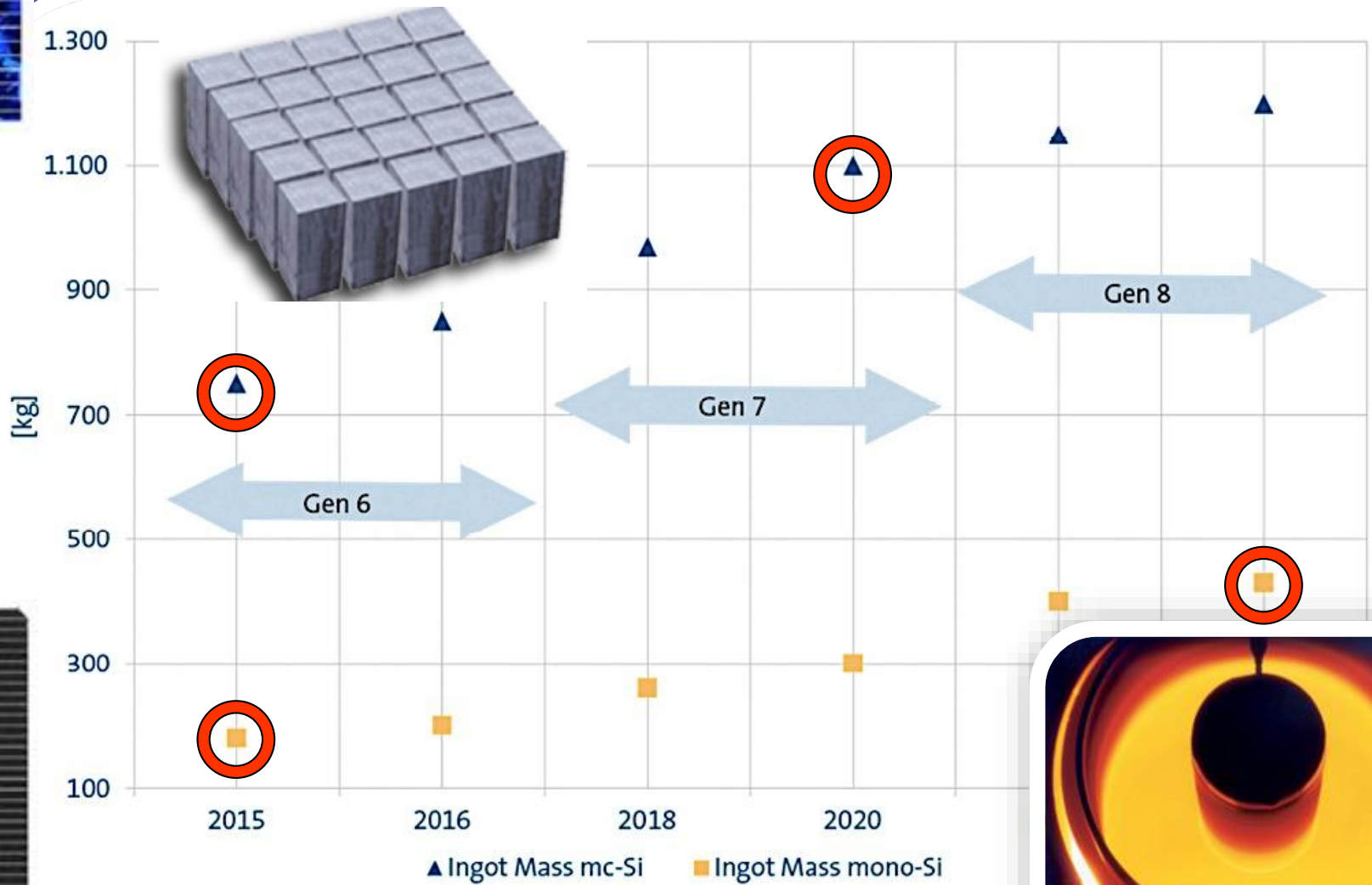


24.4%



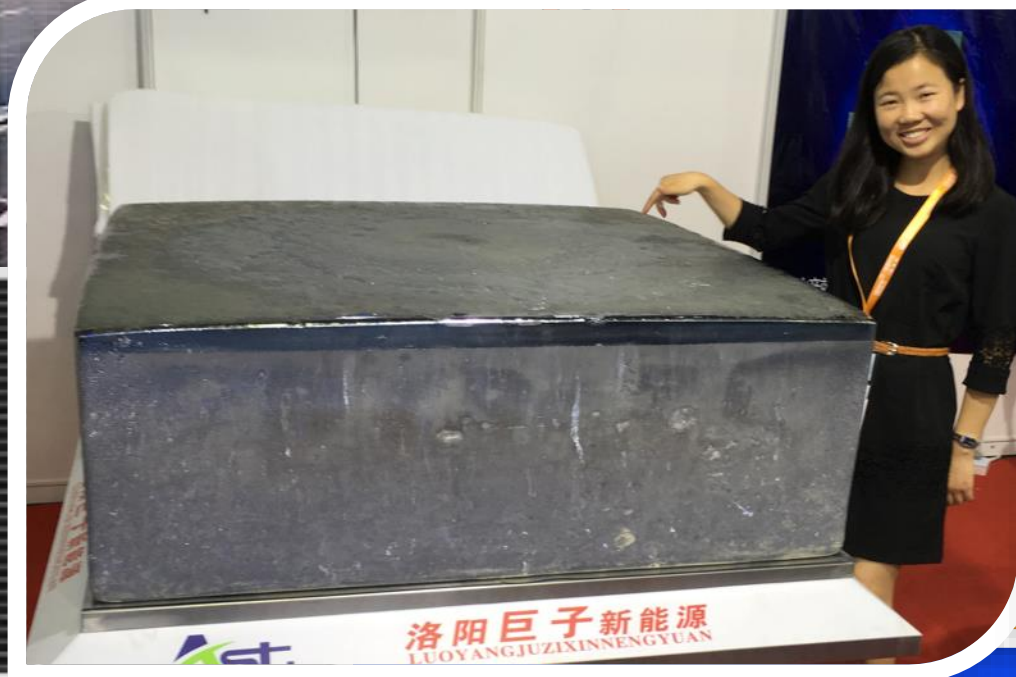
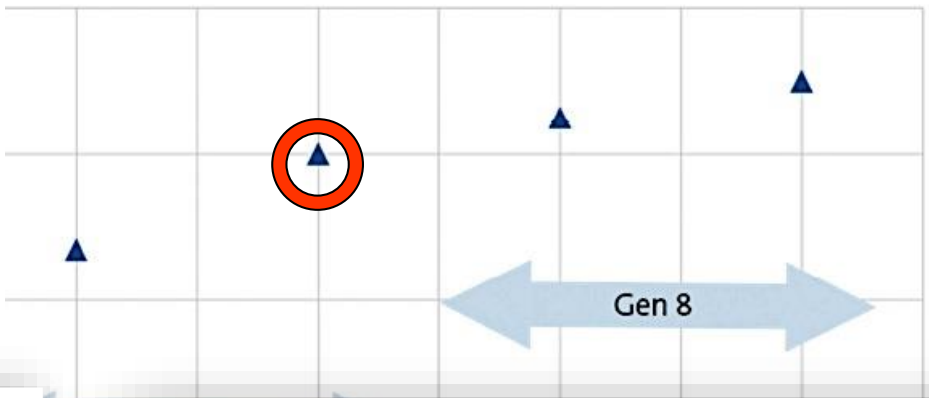
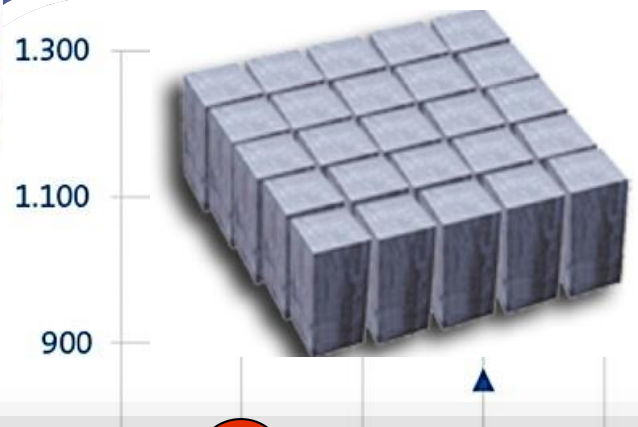
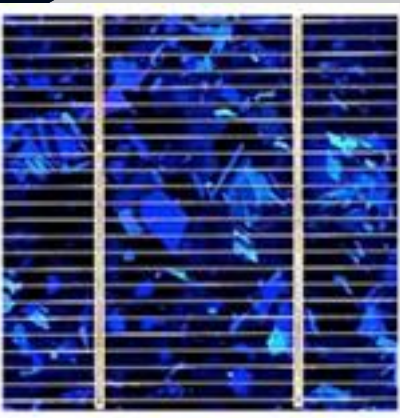
Technology Photovoltaic (ITRPV)

Ingots



Technology Photovoltaic (ITRPV)

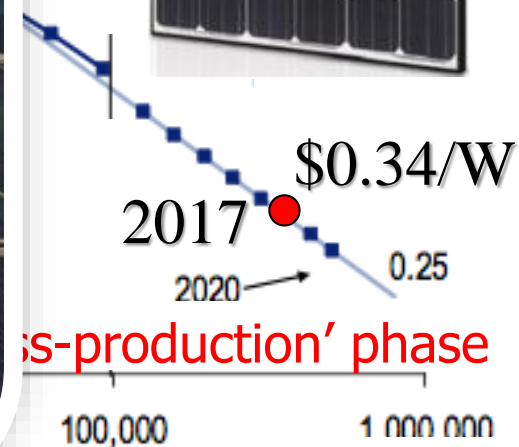
Ingots





2008

paper!



1 Terrawatt (TW)

Accelerate PV cost reductions:

1. Perfect production & transfer PERC
2. Increase performance by 50% by stacking cells

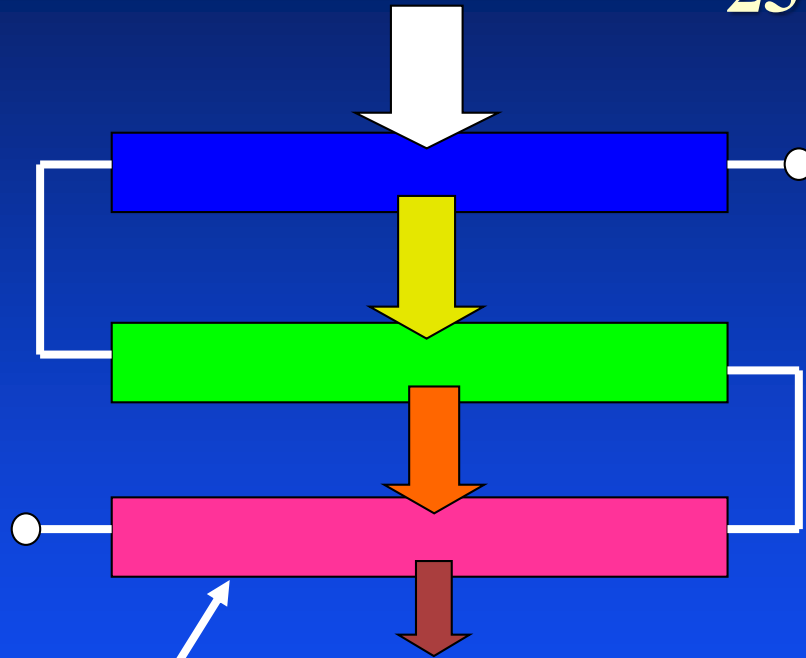


UNSW SYDNEY



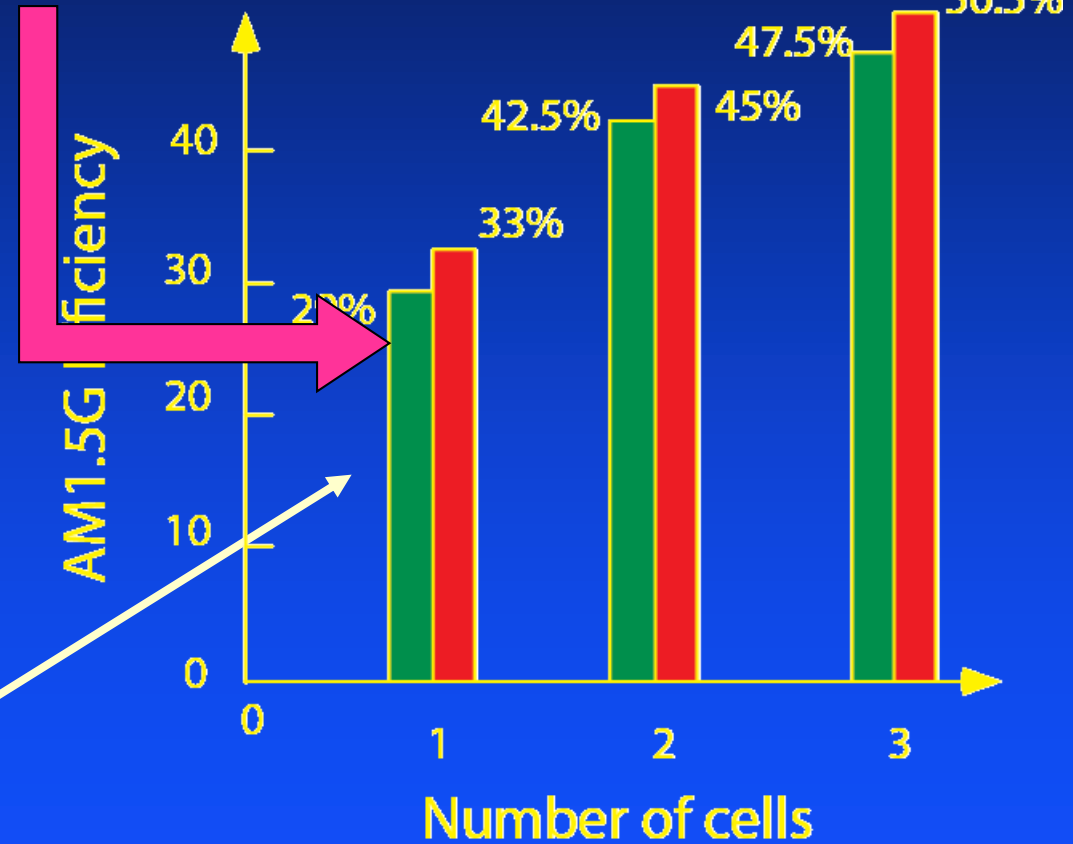
c-Si tandem: efficiency gain

25% PERC



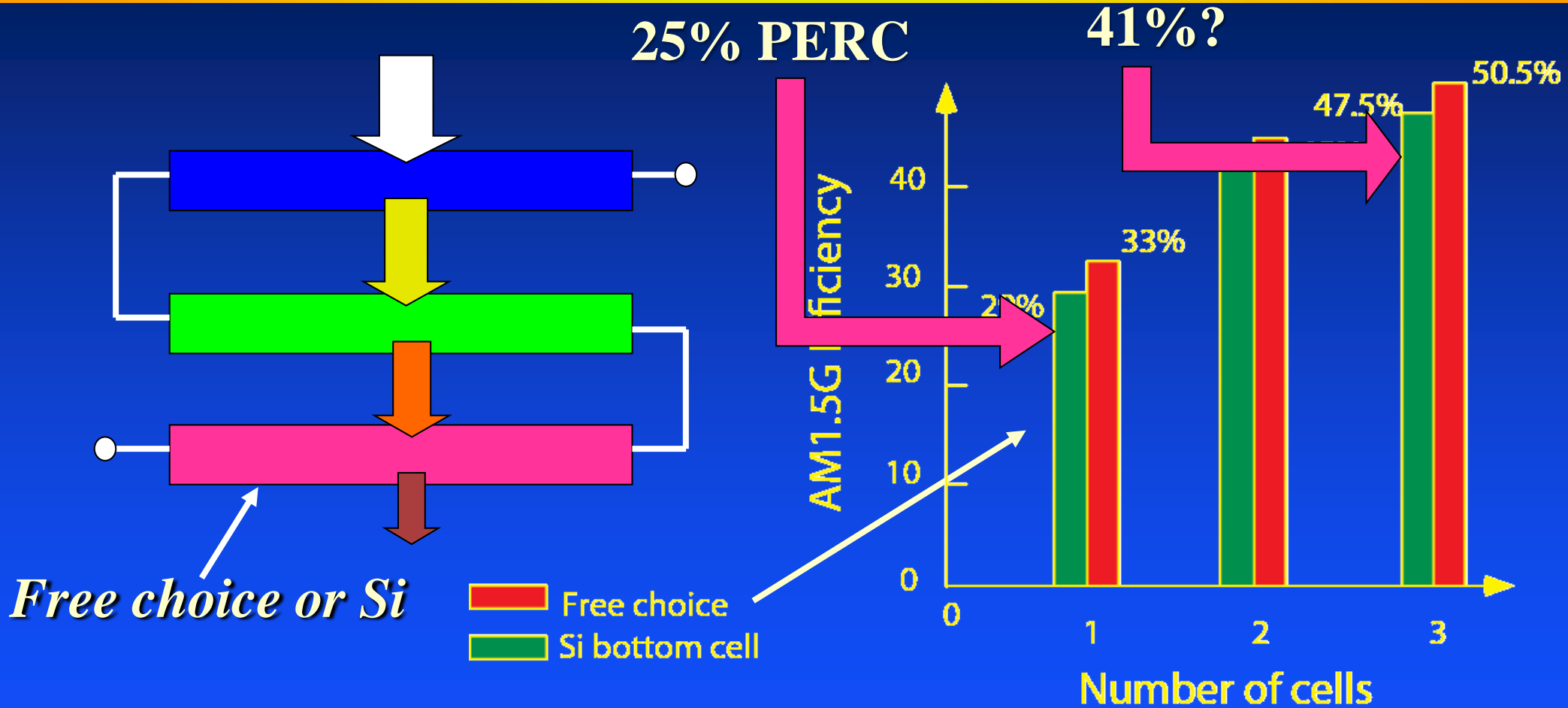
Free choice or Si

- Free choice
- Si bottom cell



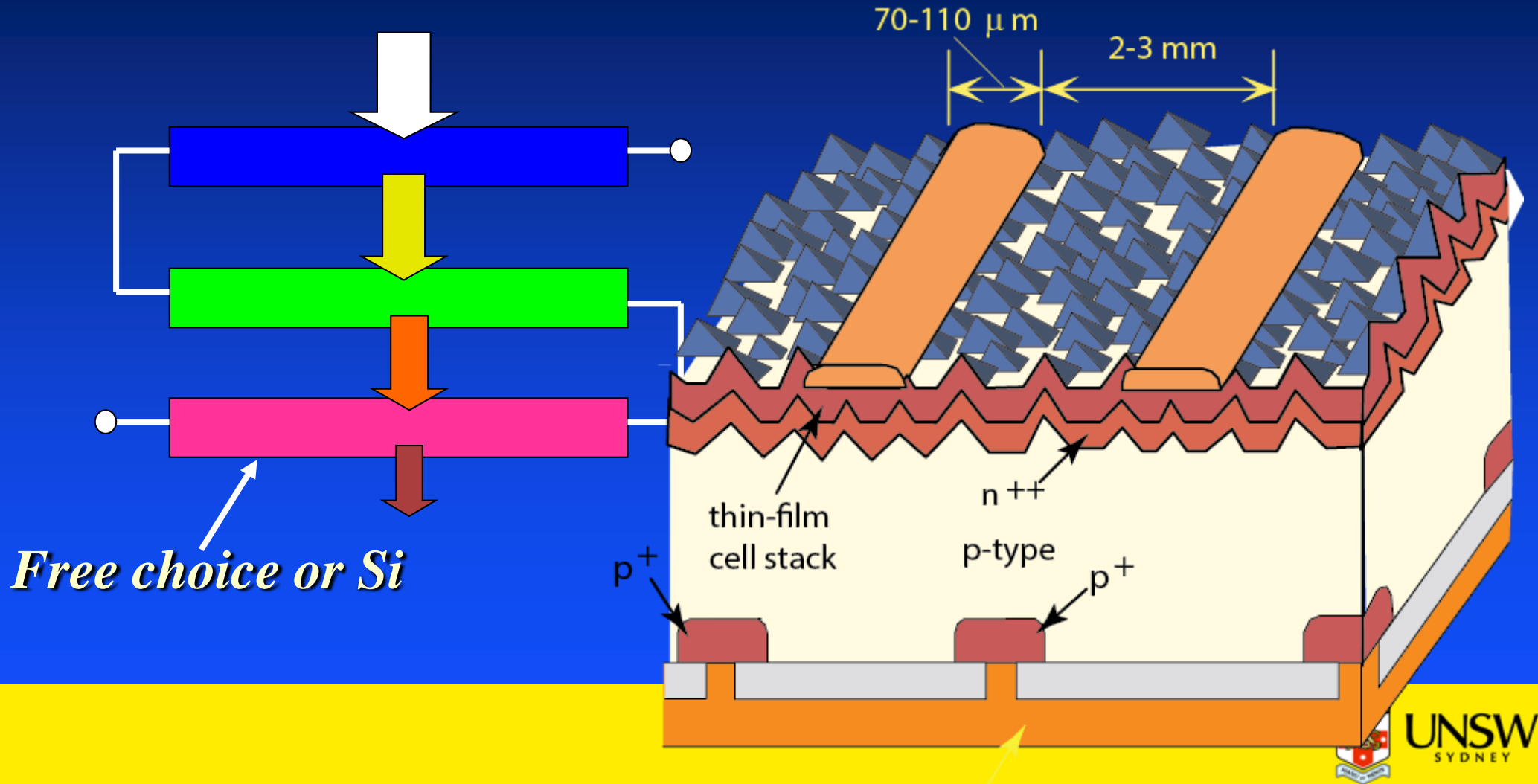


c-Si tandem: efficiency gain





c-Si tandem: efficiency gain





c-Si tandem: efficiency gain

SEMICONDUCTOR MATERIALS



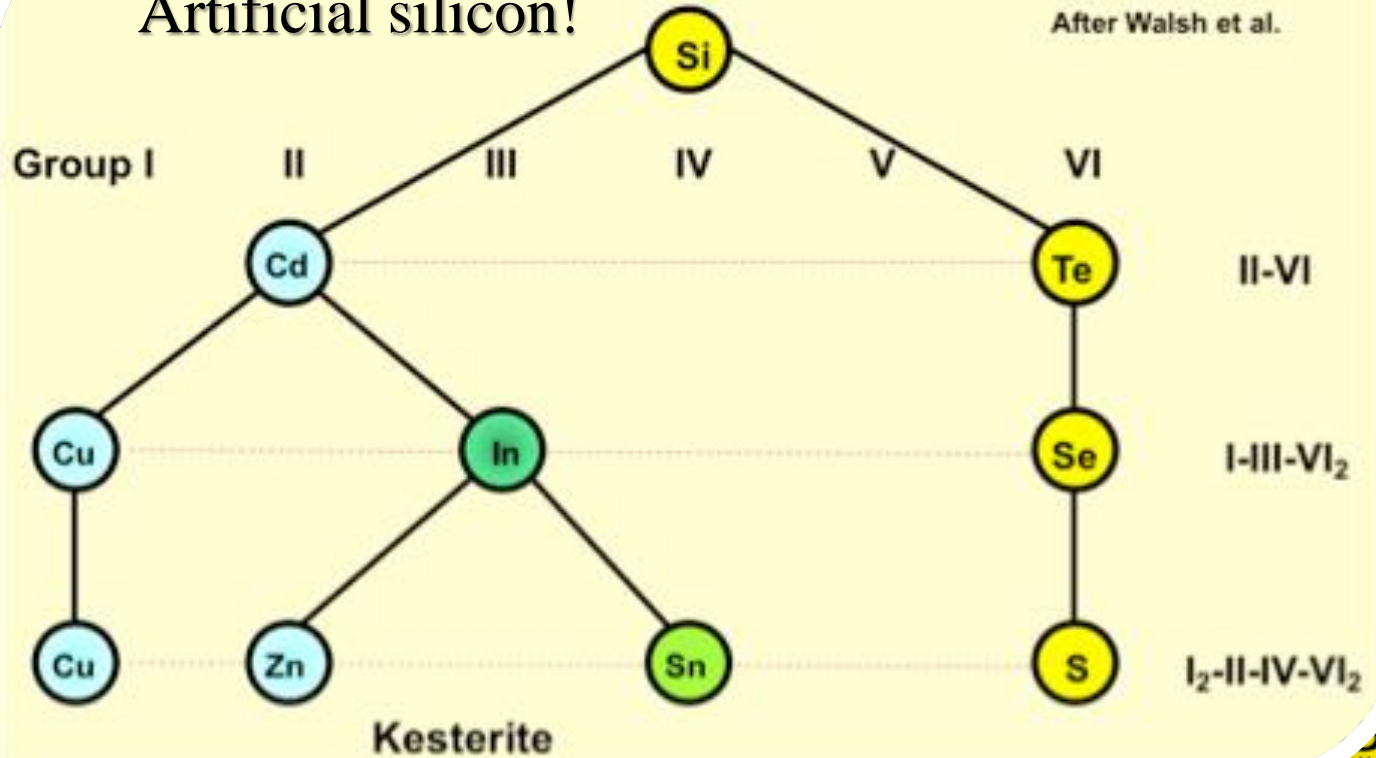
Lev I. Berge

70-110 μm

2-3 mm

Artificial silicon!

After Walsh et al.

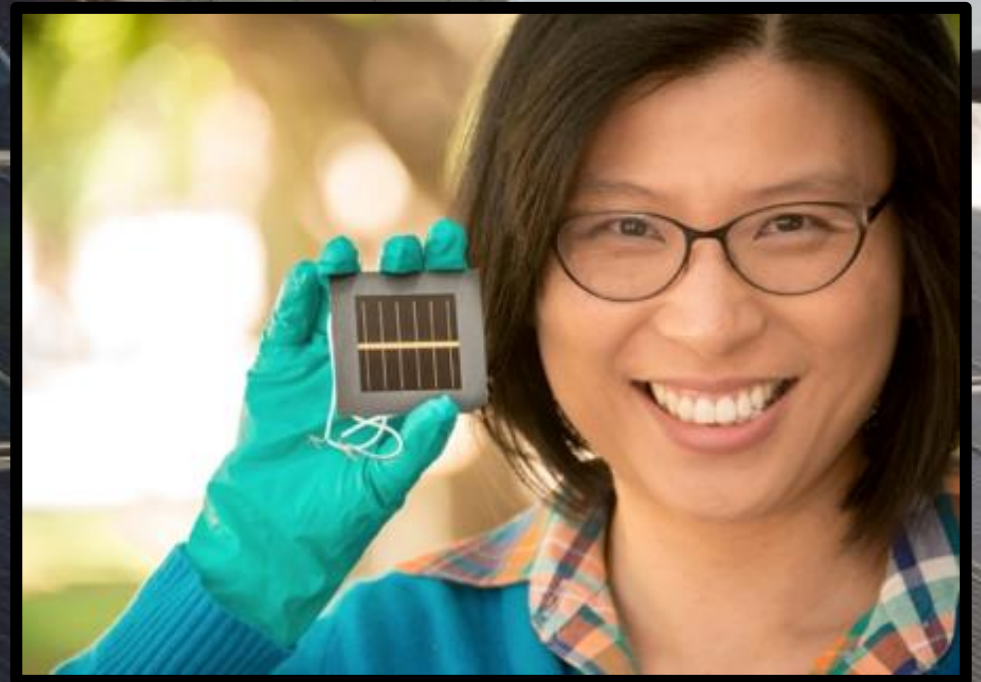
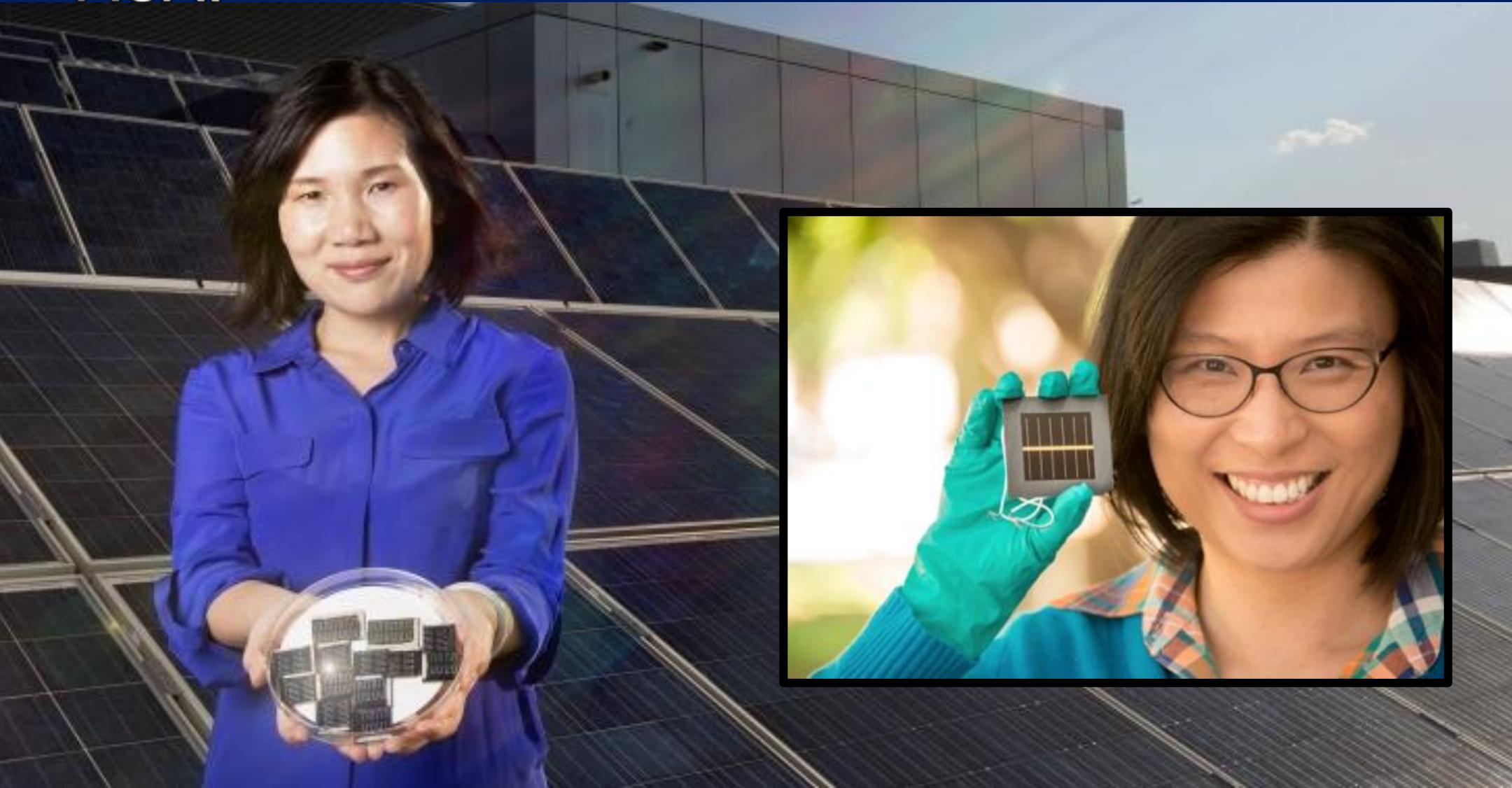


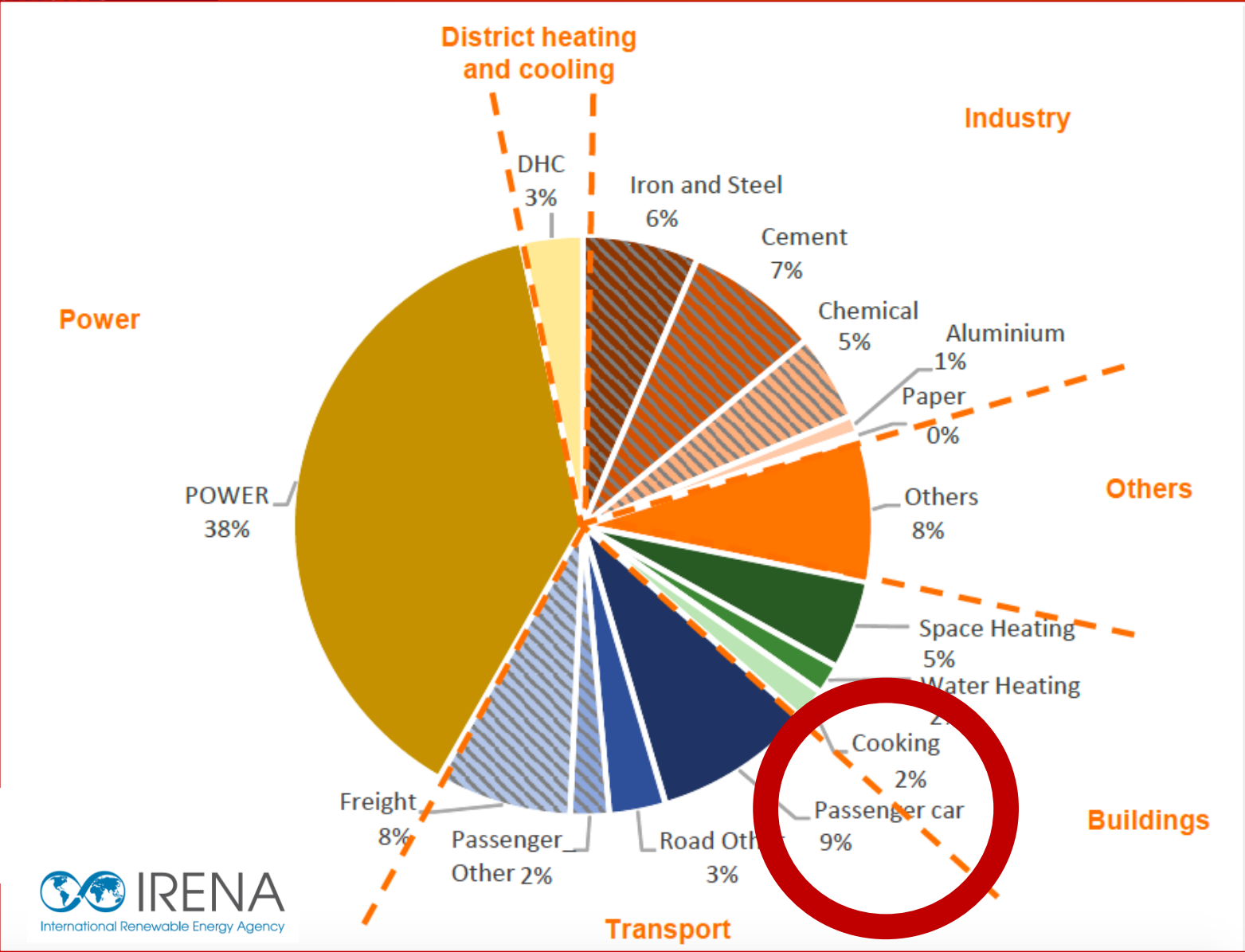
F

SW
ONEY



Earth abundant, non-toxic (CZTS: $\text{Cu}_2\text{ZnSnS}_4$)





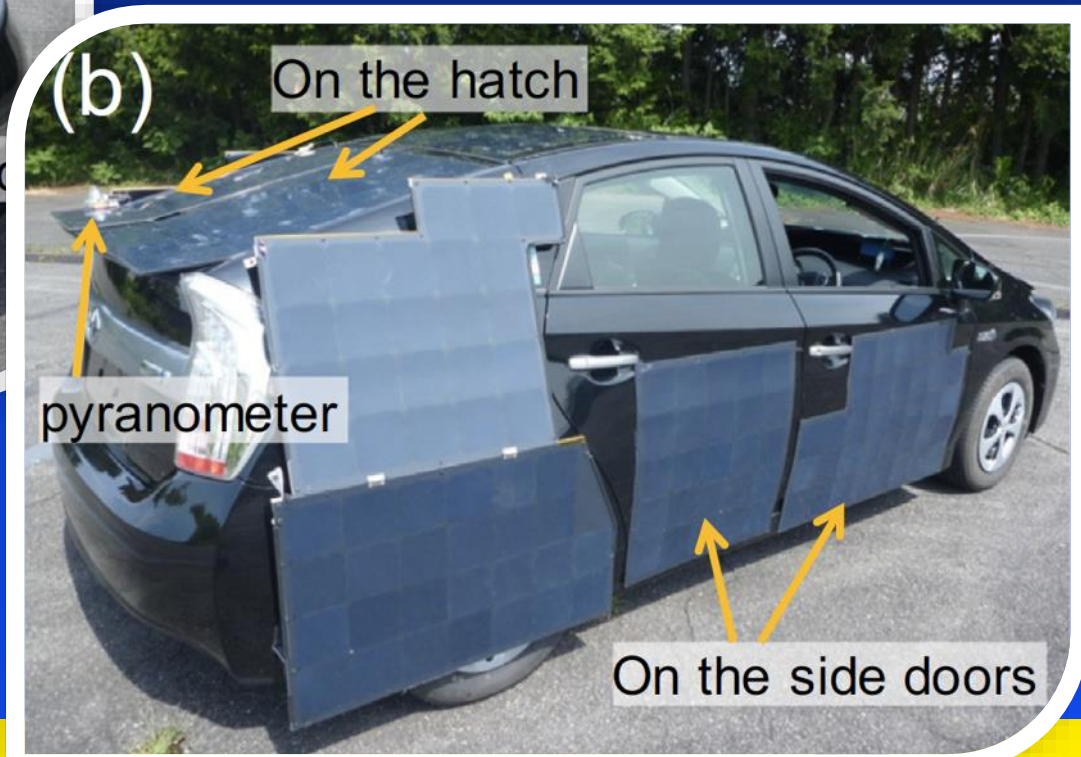
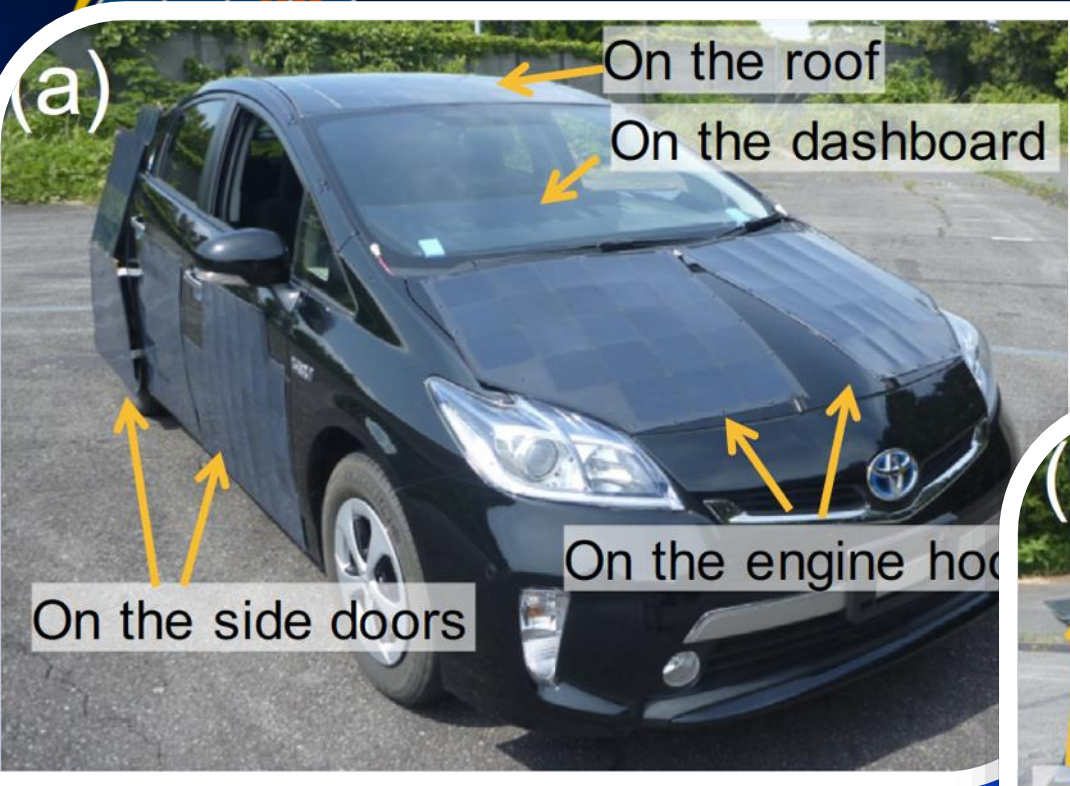


Solar paint

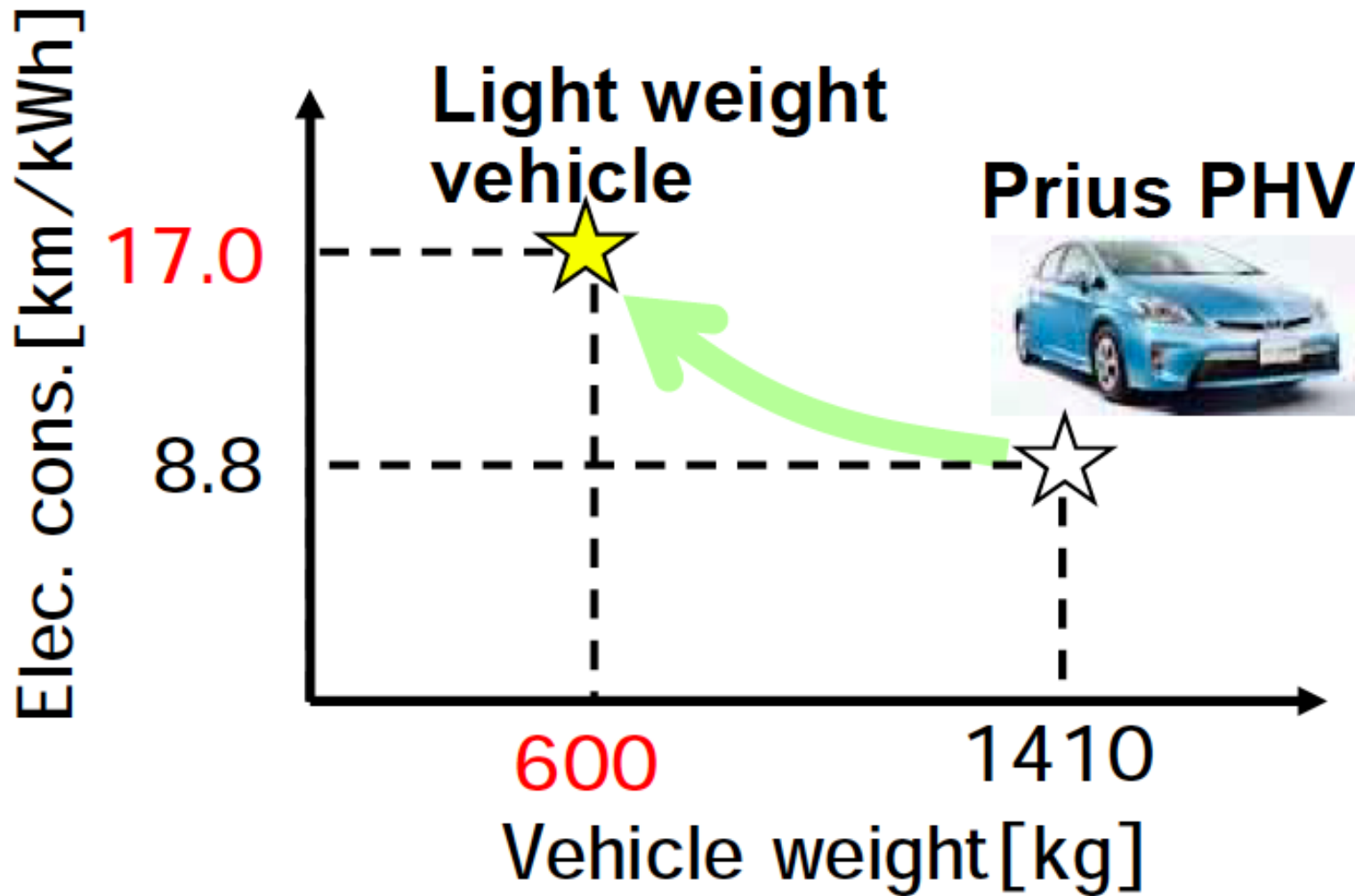




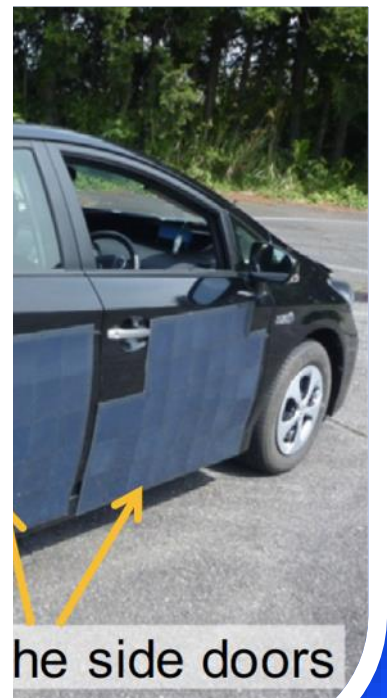
Solar Armour



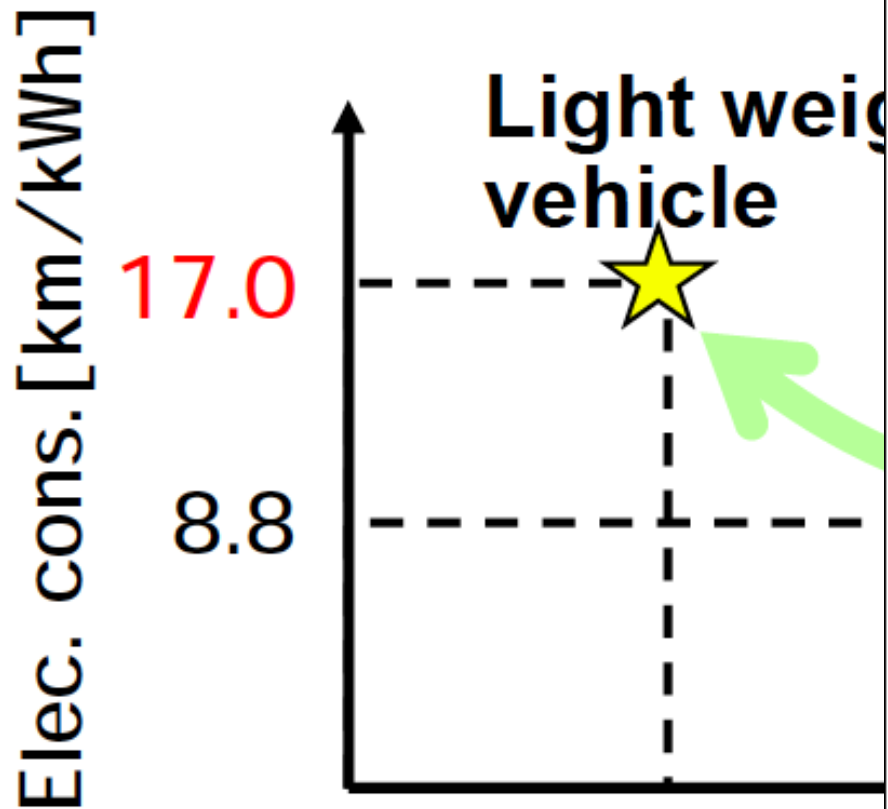
Electric consumption rate



(LA4) 8.8 → 17.0 km/kWh



Electric consumption



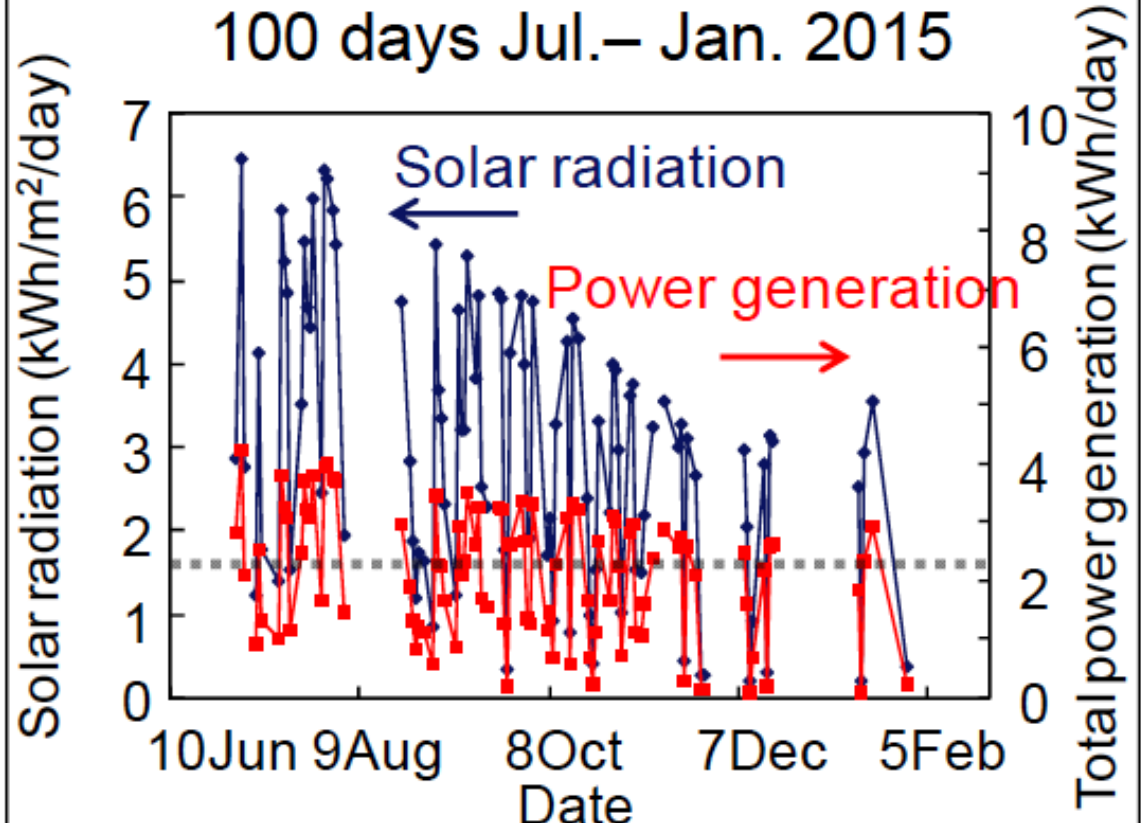
600

Vehicle v

(LA4) 8.8 → 17.

Measurement results

100 days Jul.– Jan. 2015



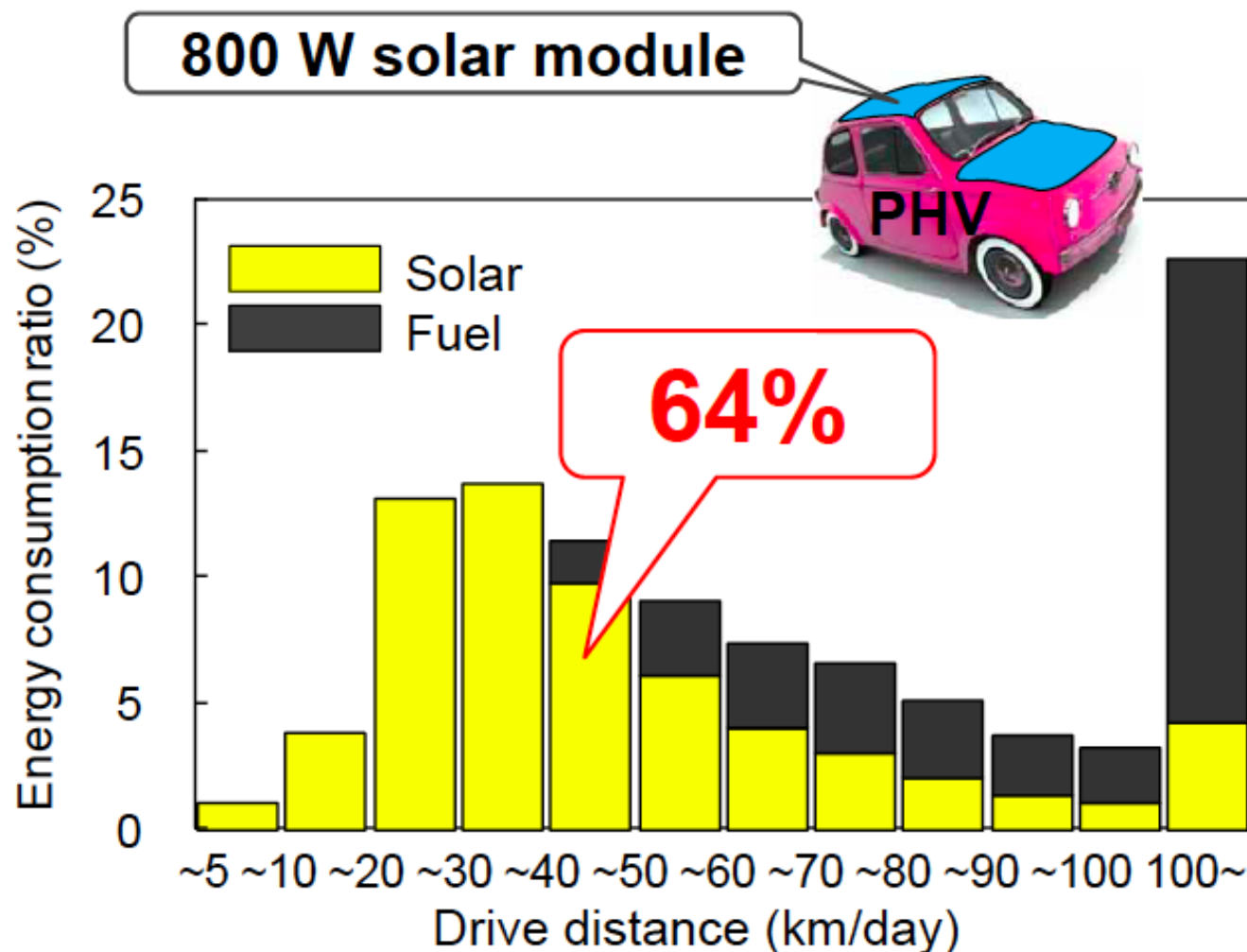
Ave. irradiance = 3.0 kWh/m²/day

Average power generation
= 2.1 kWh/day

(Drive range : 36 km/day)

Benefit of solar module on vehicle

Distribution of fuel consumption for passenger cars (Japan)



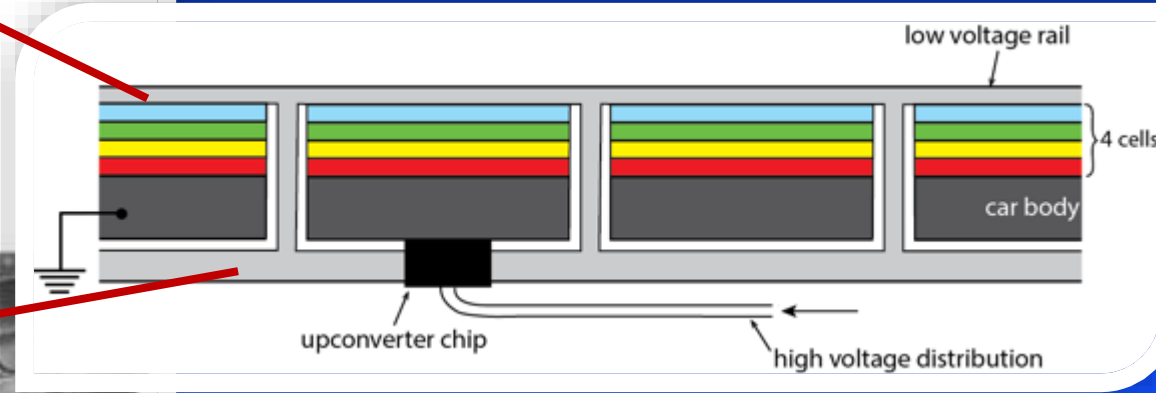
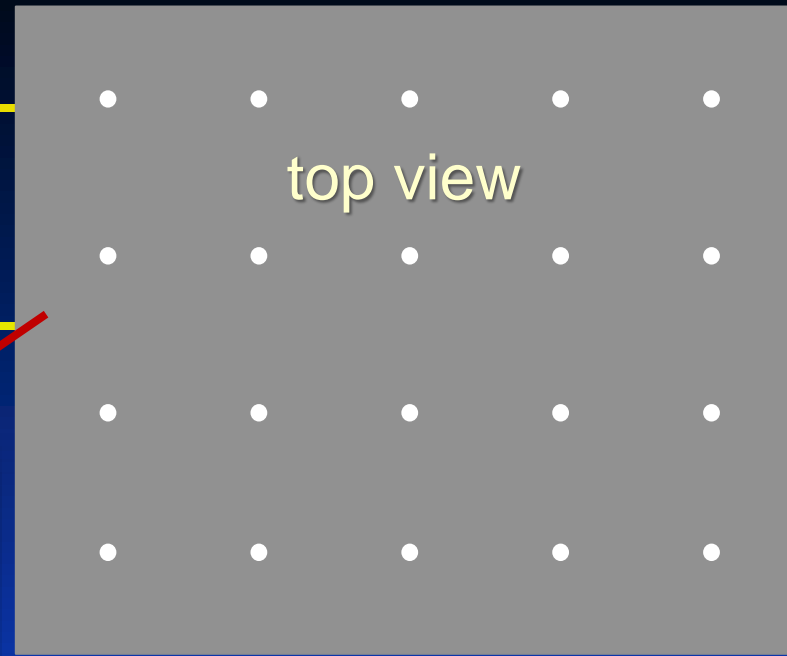
Reduce 64% CO₂ emission from passenger cars





ACAP

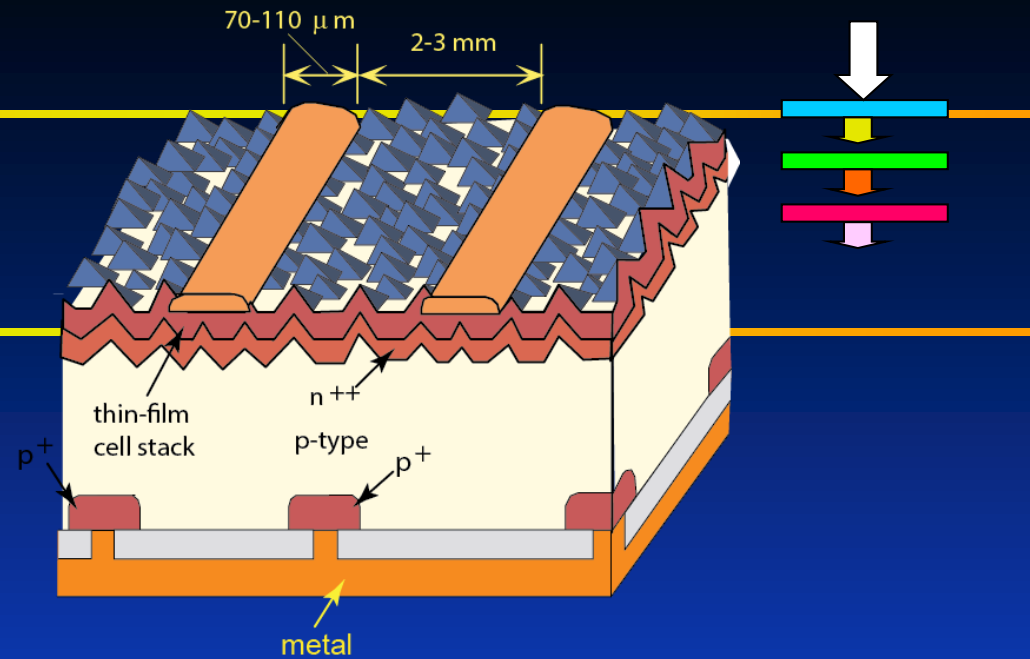
Parallel connection



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Summary



- . PV can make a big impact on global CO₂ emissions*
- . Standard silicon cells will allow very low costs*
- . Stacked cells on silicon allow even lower costs*
- . My research— stacked cells, module T, solar paint !*