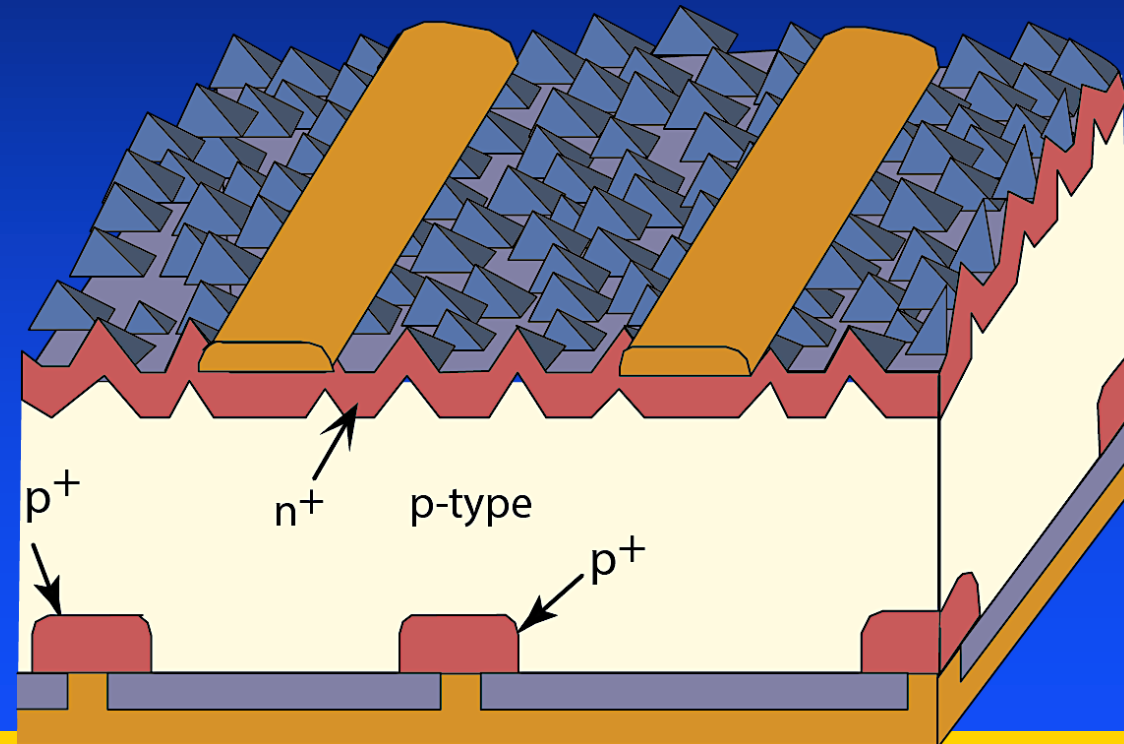




Australian Centre for Advanced Photovoltaics

# “UNSW PV Impact”

*Martin Green,  
UNSW Australia*



UNSW  
PERC cell

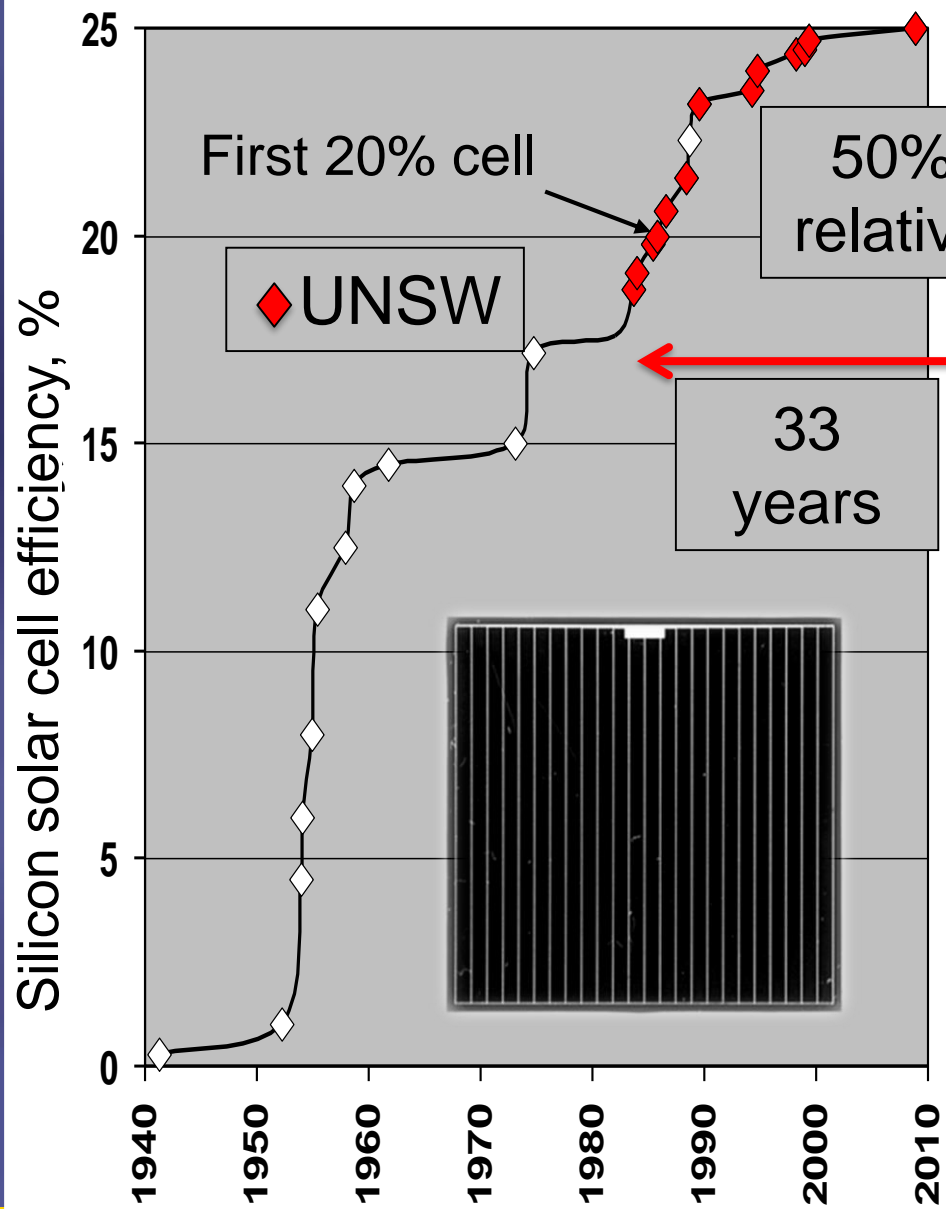
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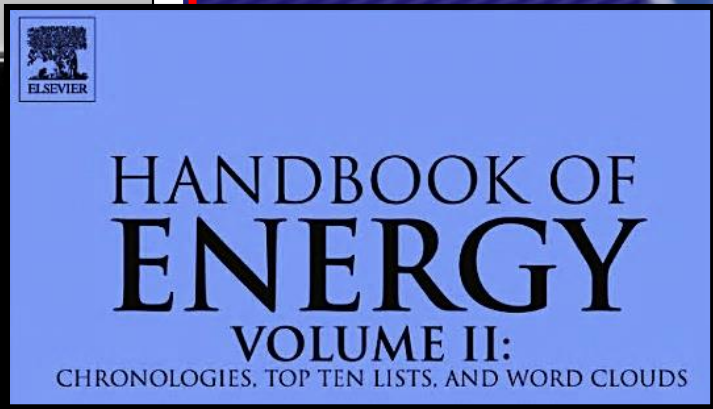
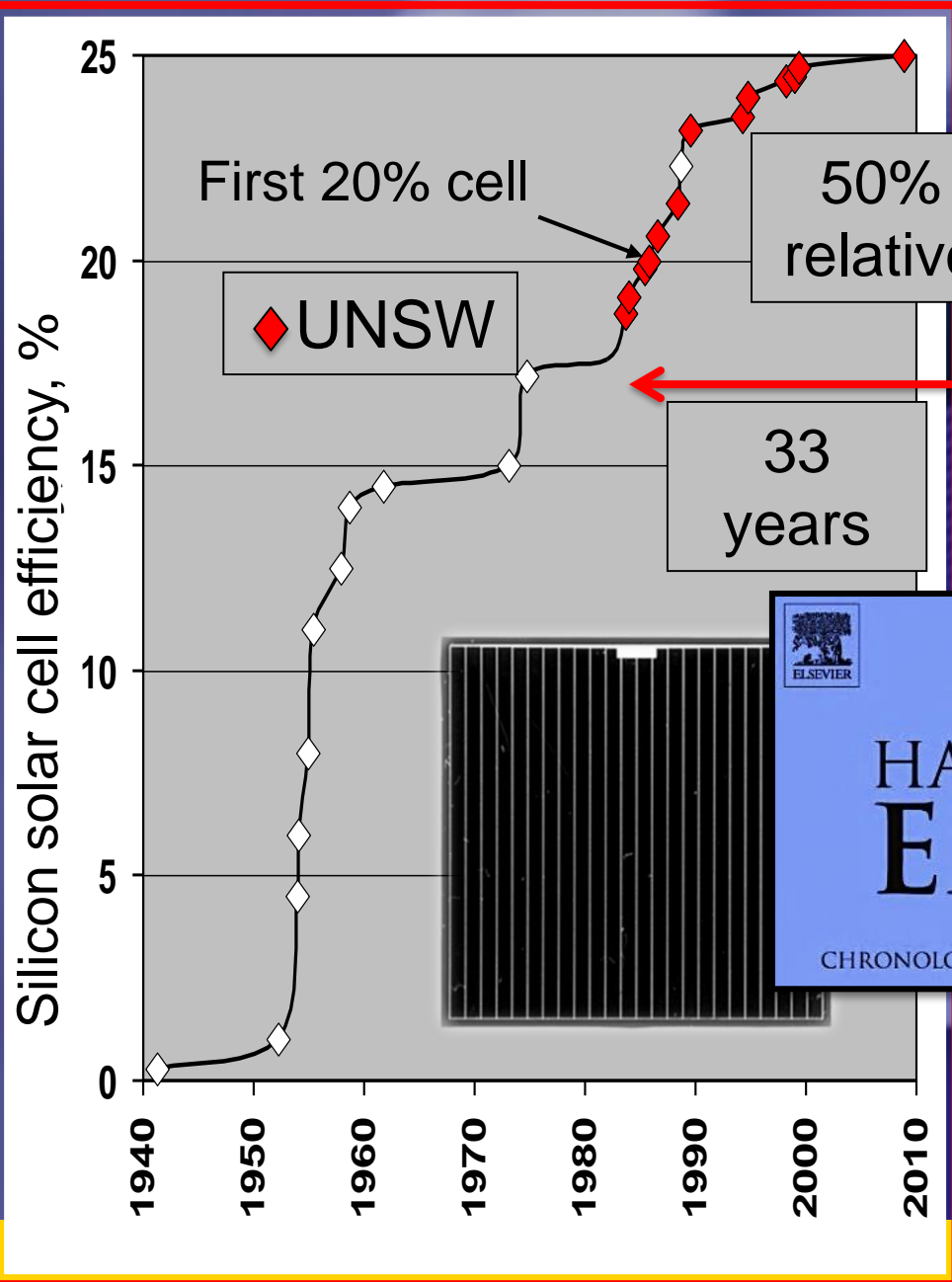


Australian Government  
Australian Renewable  
Energy Agency



UNSW  
AUSTRALIA



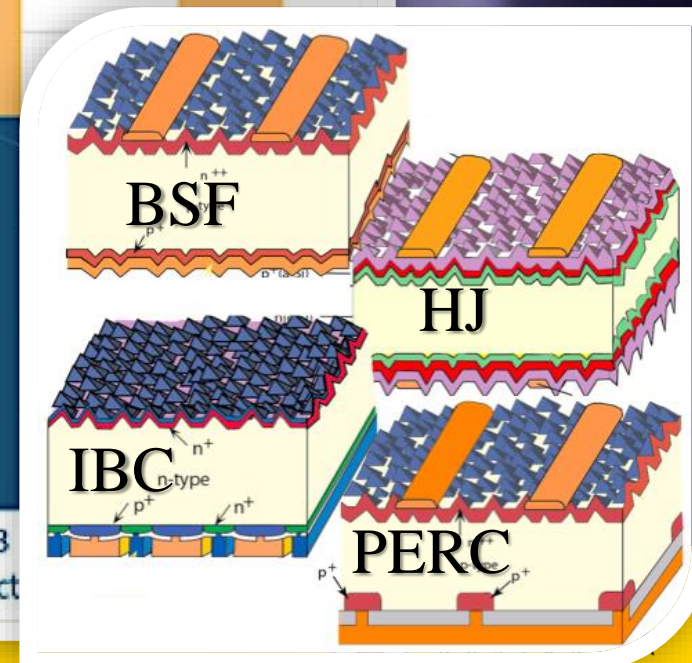
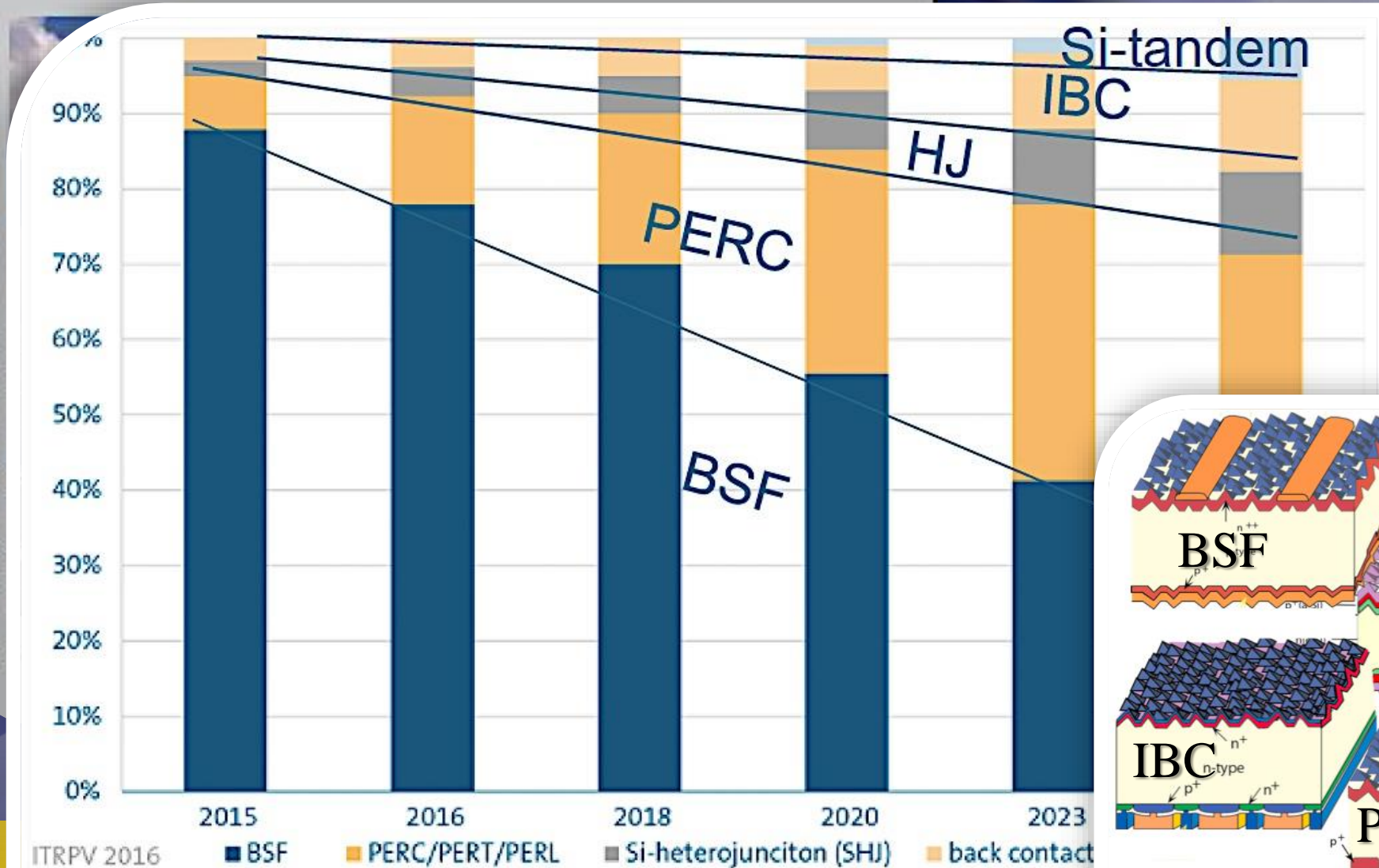


“Top 10” Milestone in Photovoltaics

# International Technology Roadmap for Photovoltaic (ITRPV)

2015 Results

## Cell technology



ITRPV 2016

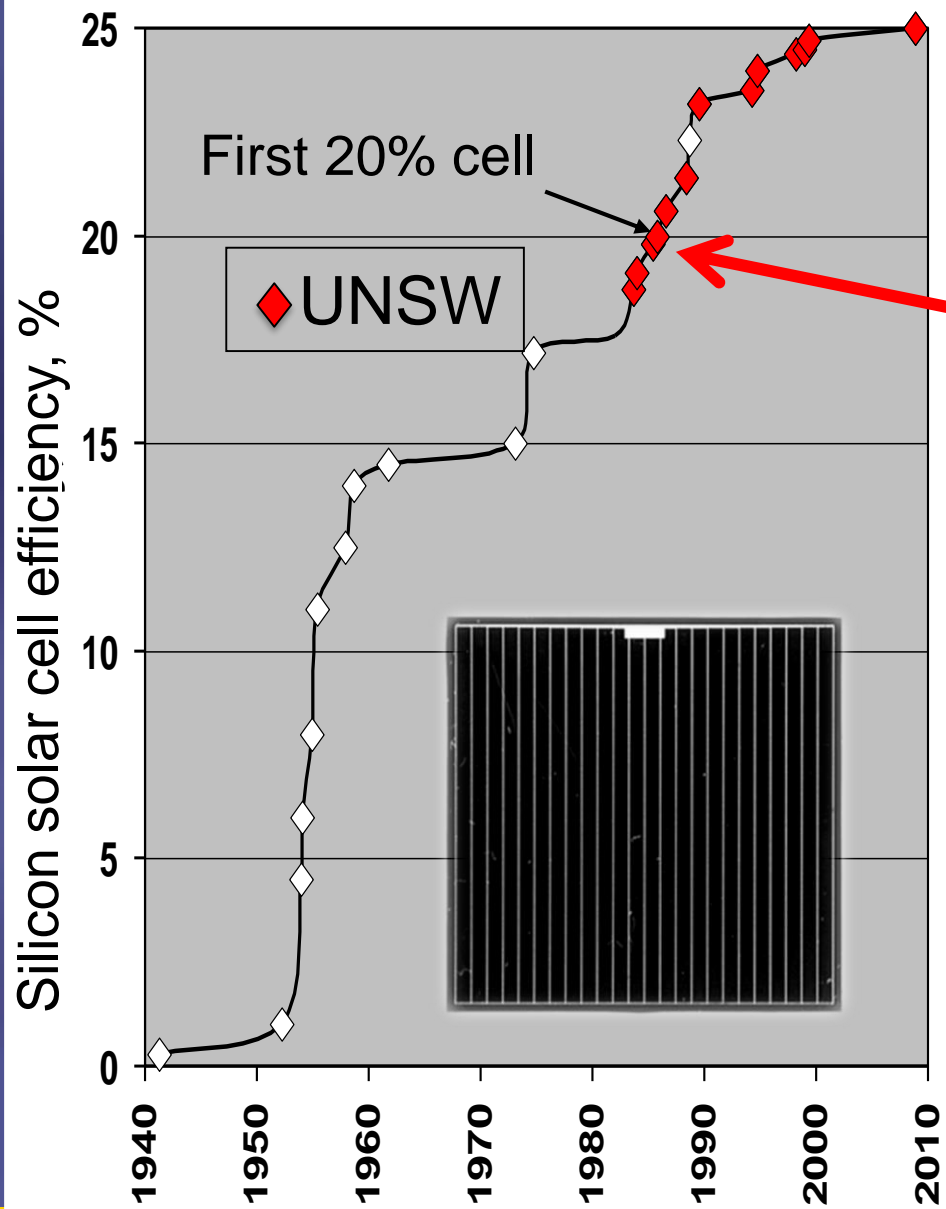
■ BSF

■ PERC/PERT/PERL

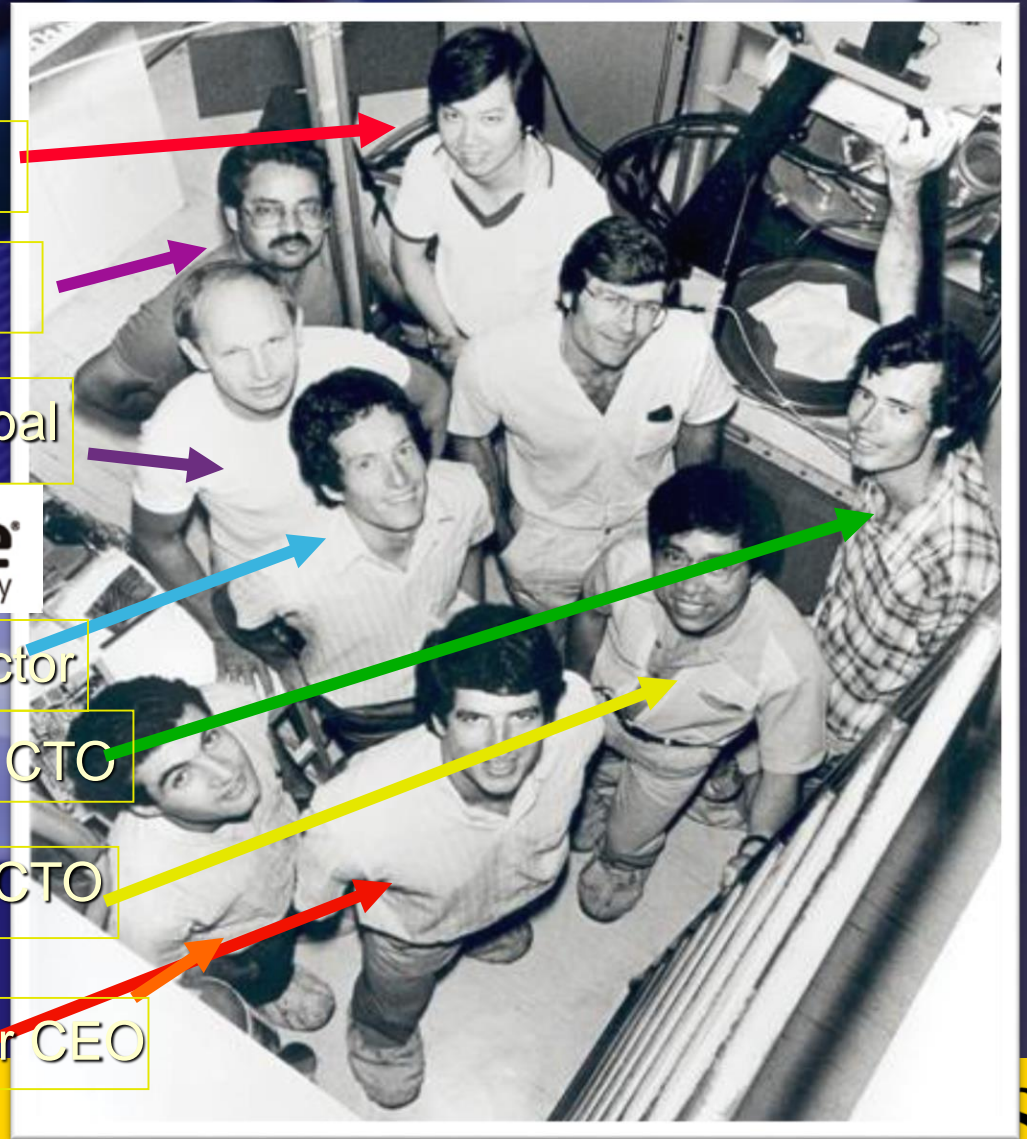
■ Si-heterojunction (SHJ)

■ back contact

# First 20% Si cell



# First 20% Si cell



UNSW Tech Transfer

Trina, Hanwha CTO

Suntech/ Sunergy/ JA Solar/ Sunrise Global



ANU Director



UNSW PV CoE/ Suntech CTO



China Sunergy CTO



CSG Solar CEO



ACAP Director)



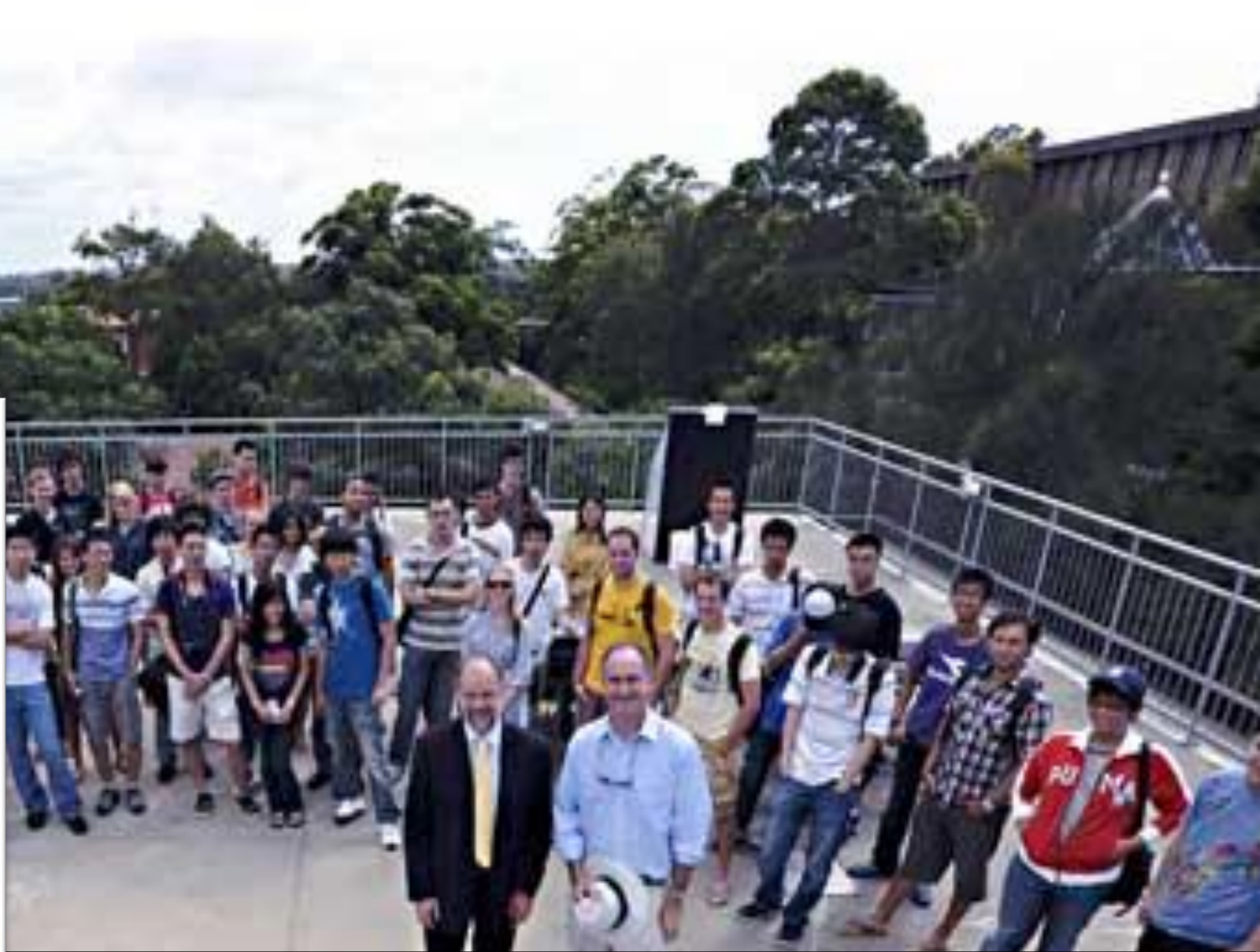
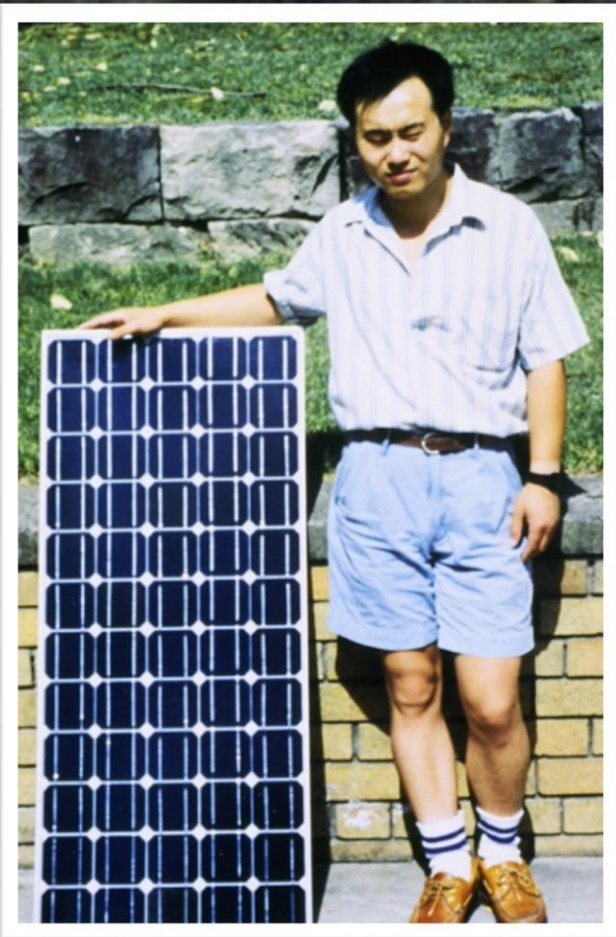


World's 1st Bachelor of Photovoltaic Engineering program in 2000

Presently 526 students enrolled (including 108 PhD students)



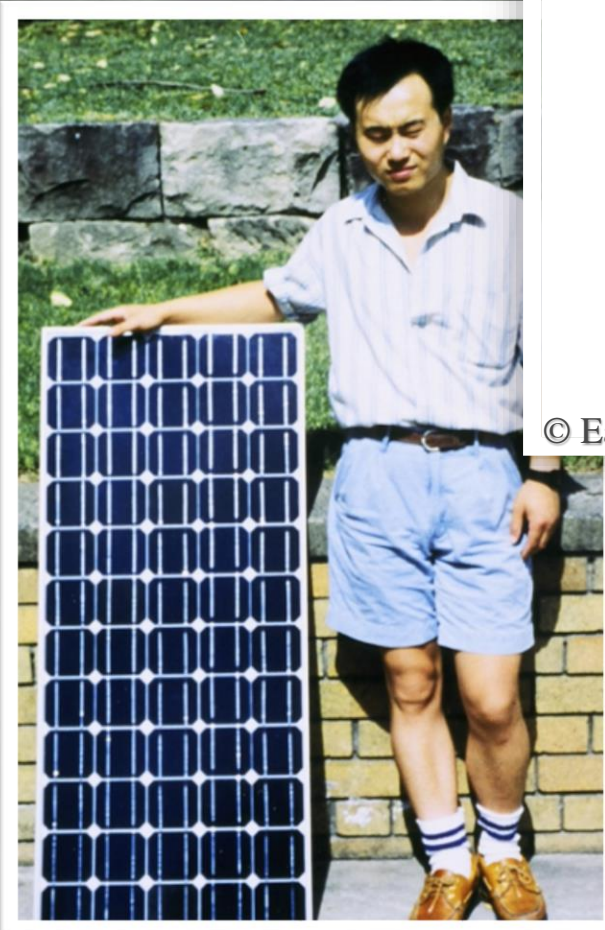
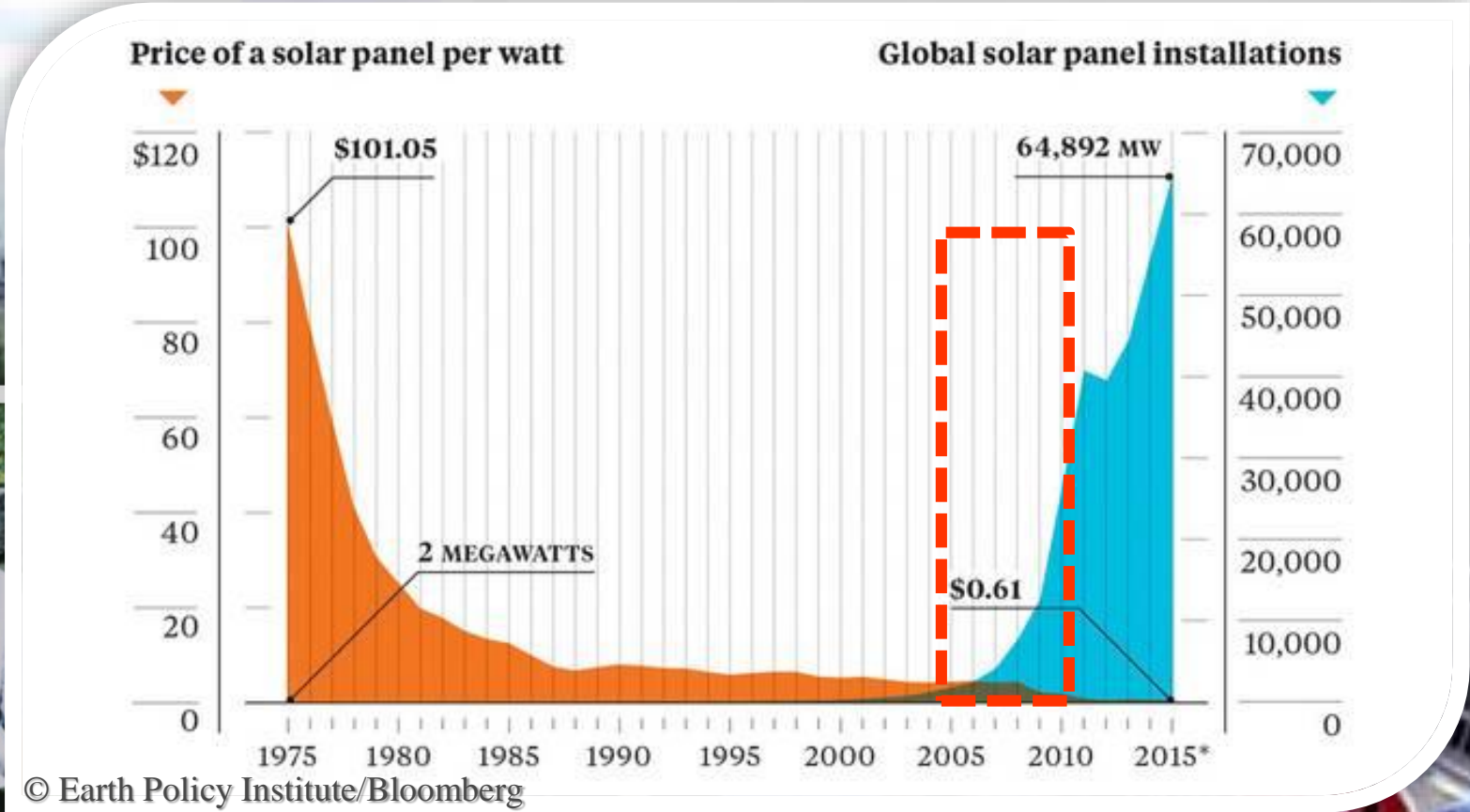
UNSW  
AUSTRALIA



Director of Photovoltaic Engineering program in 2000

1000 students enrolled (including 108 PhD students)

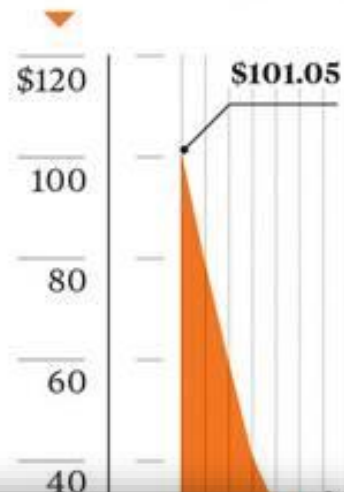




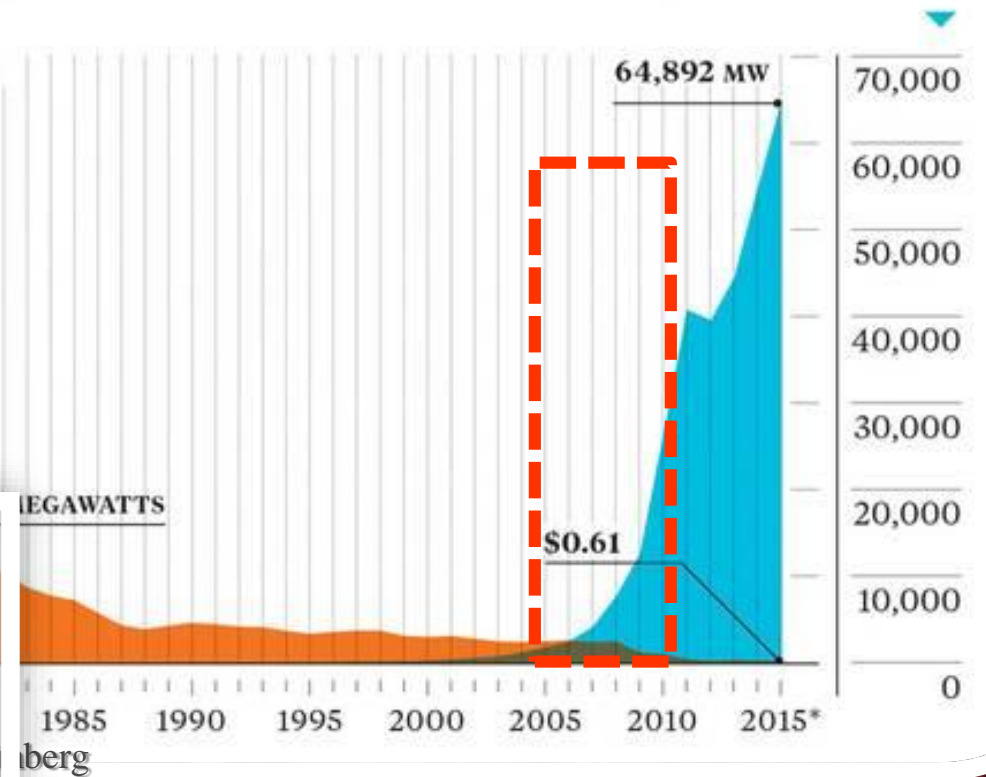
Director of Photovoltaic Engineering program in 2000

1,000 students enrolled (including 108 PhD students)

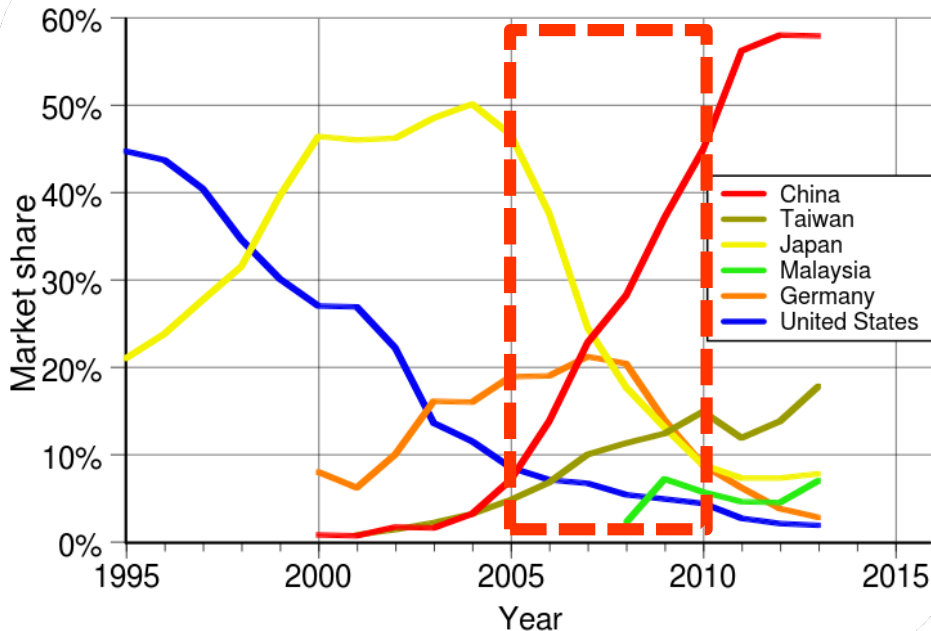
Price of a solar panel per watt



Global solar panel installations



Market Share of Photovoltaic Cells



Photovoltaic Engineering program in 2000

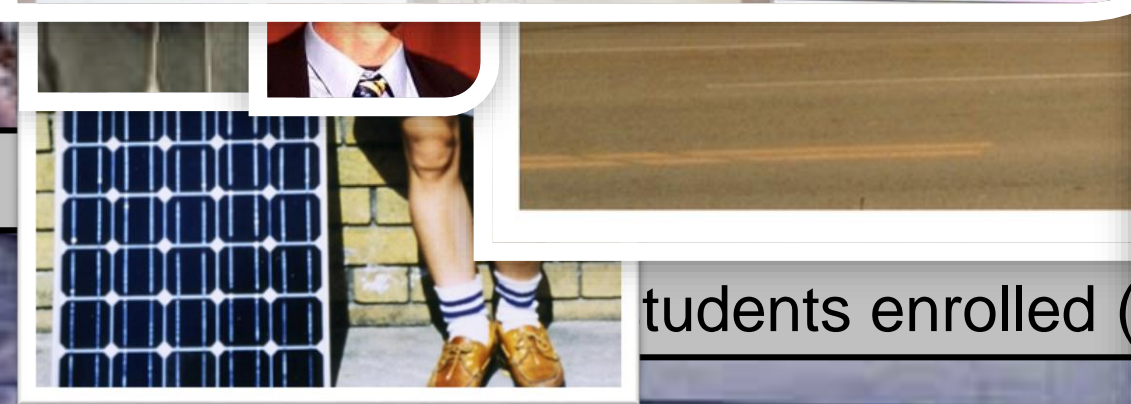
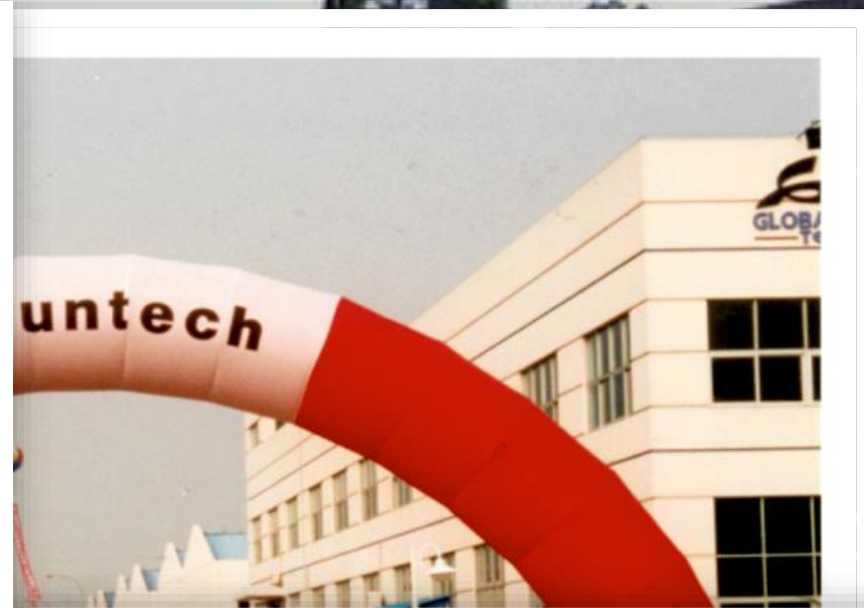
led (including 108 PhD students)



UNSW AUSTRALIA



tudents enrolled (

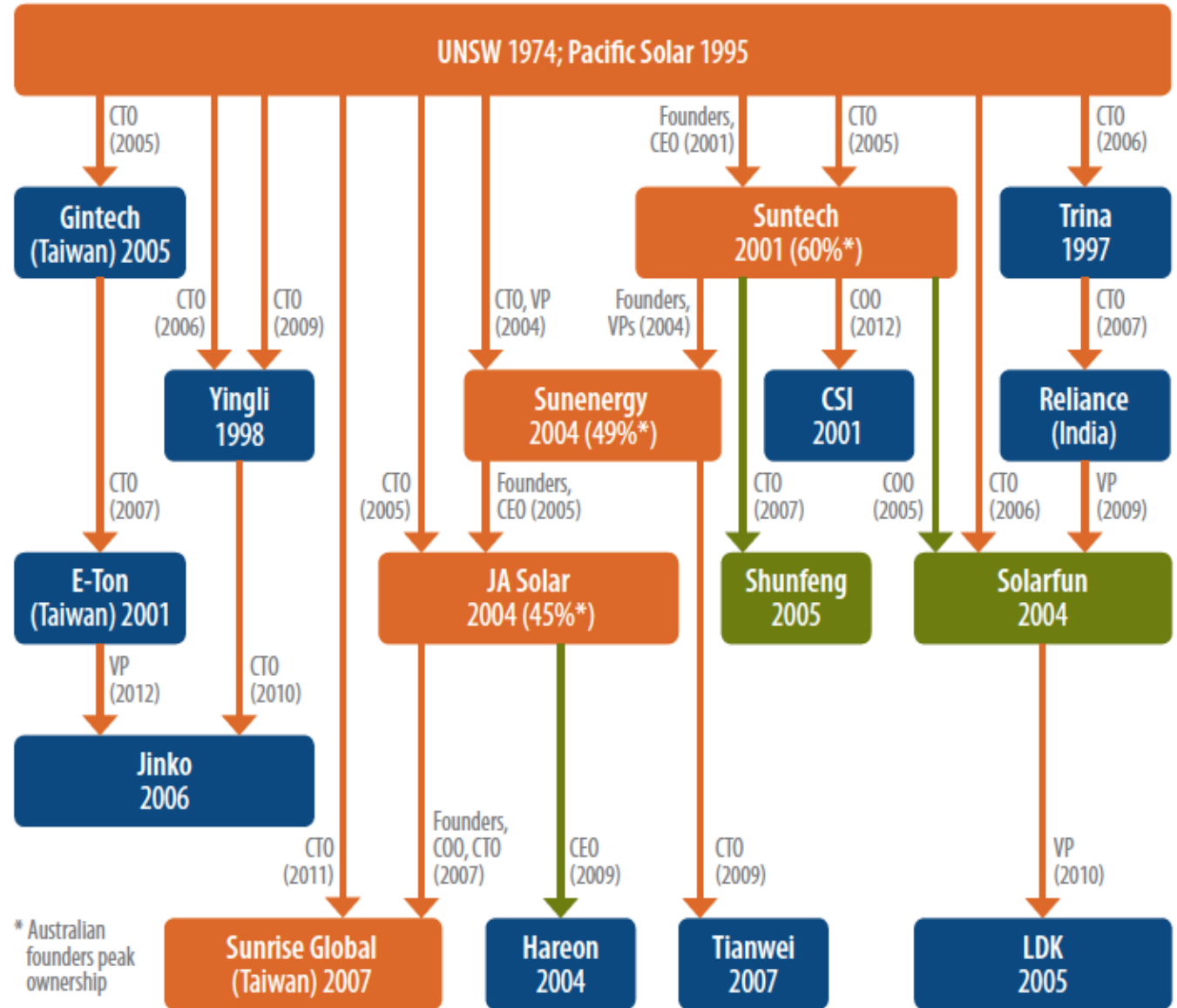


tudents enrolled (



Master diploma of the executive directors of 4 biggest Chinese PV companies

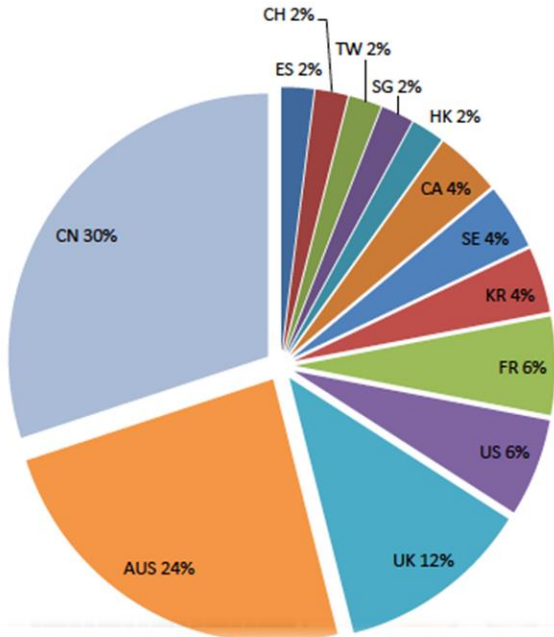
## Australian links to some of the key firms in the Chinese PV Industry



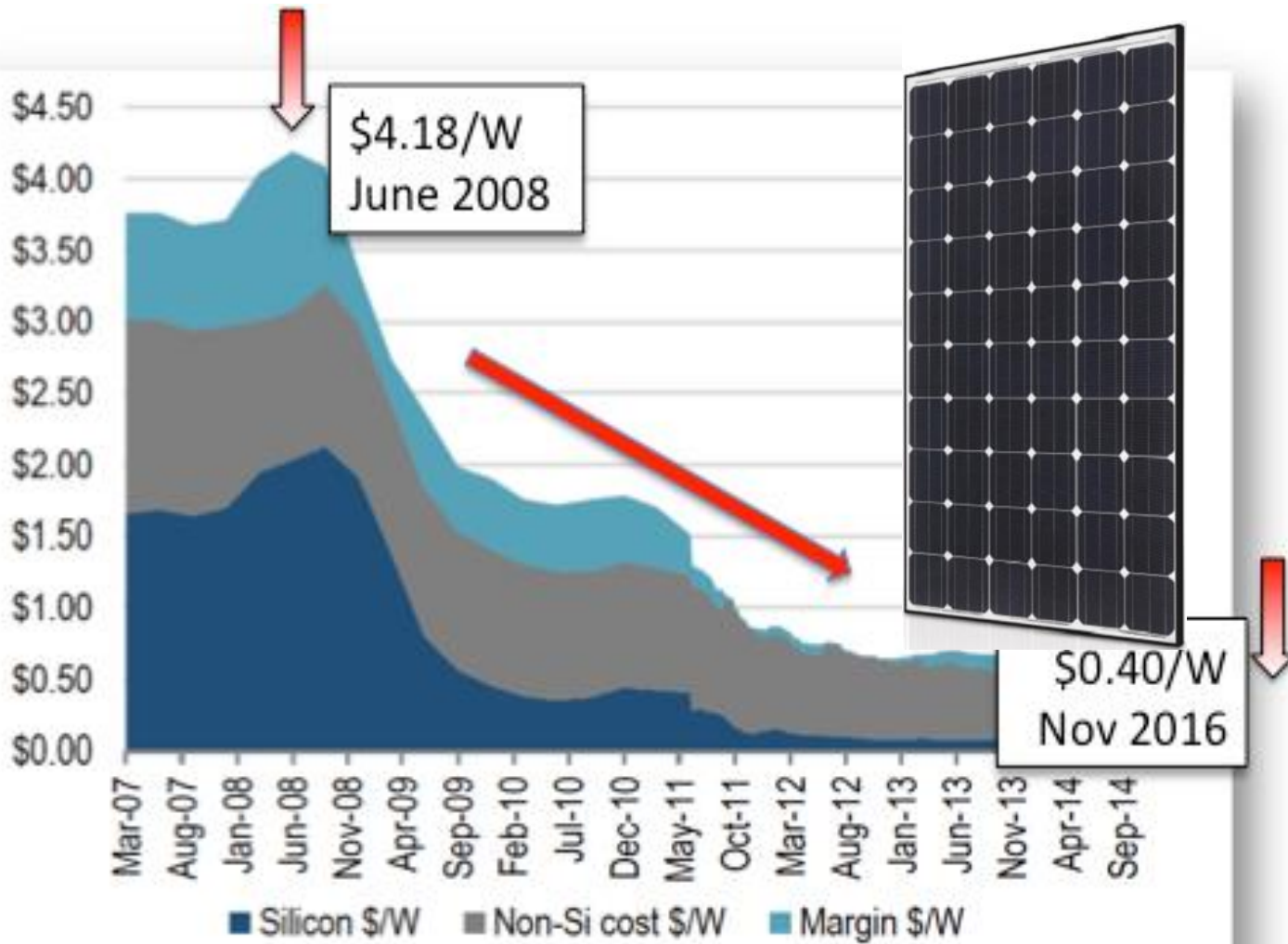
\* Australian founders peak ownership

Source: UNSW

Orange represents UNSW/Pacific Solar trained or co-founded, green represents "second generation" linkages, and blue "others".



Average  
Selling  
Price

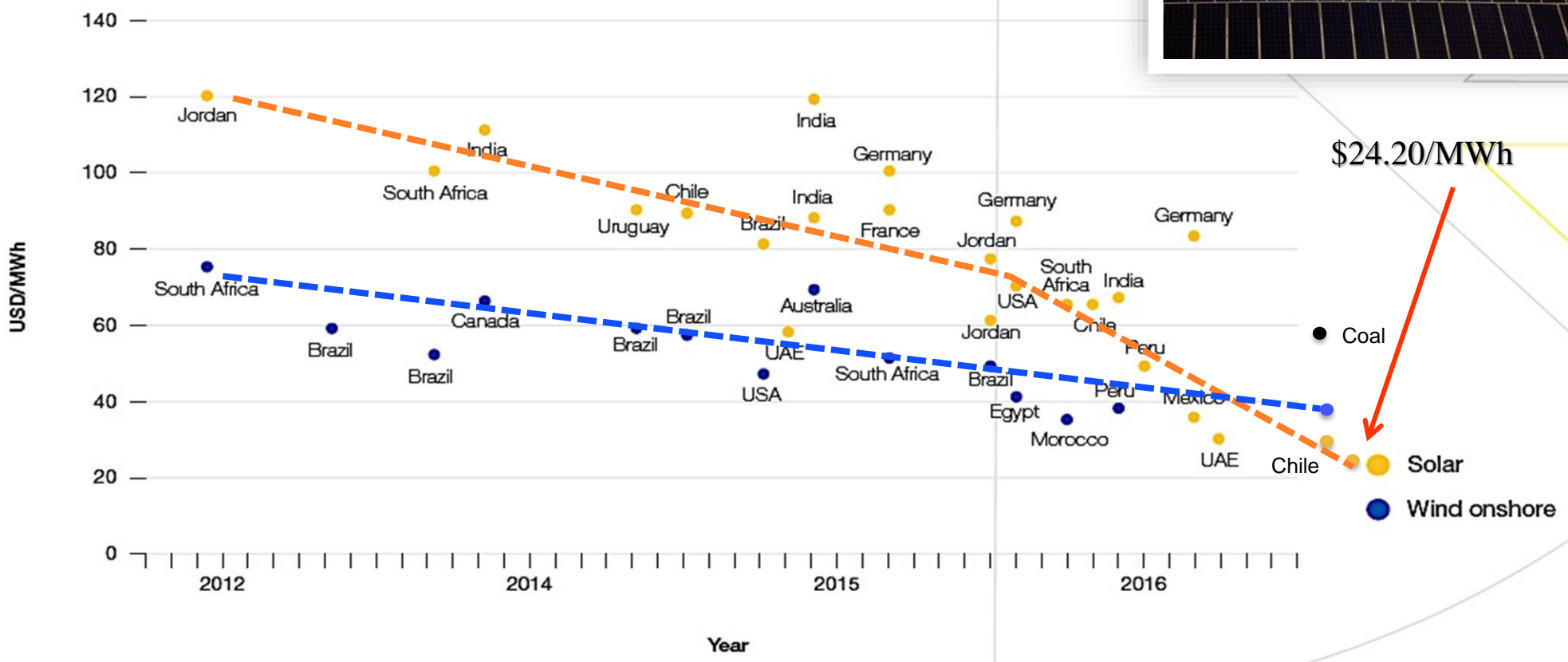


Source: EnergyTrend, Company data, Credit Suisse estimates.



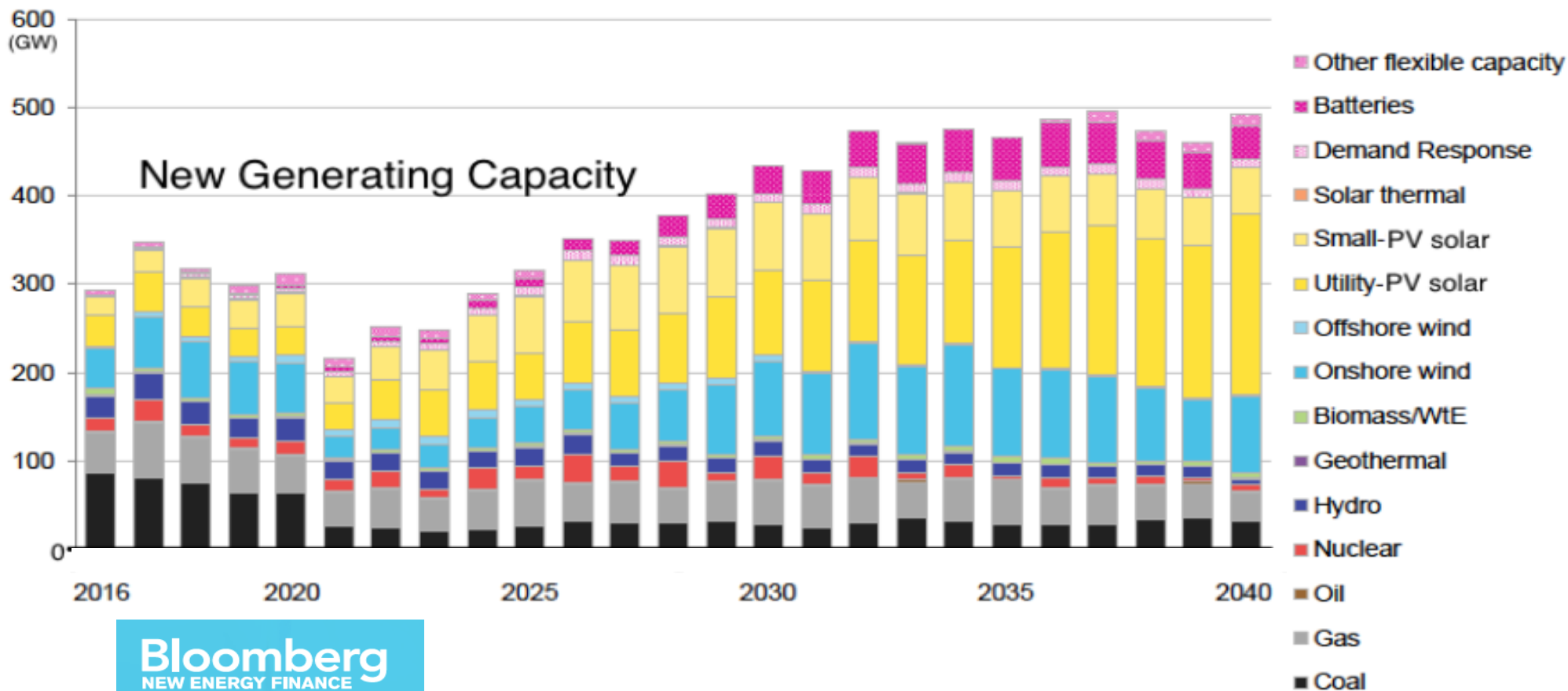
# Recent PPAs (power purchase agreements)

FOR SOLAR PV AND WIND ONSHORE POWER PLANT



Source: International Energy Agency 2016

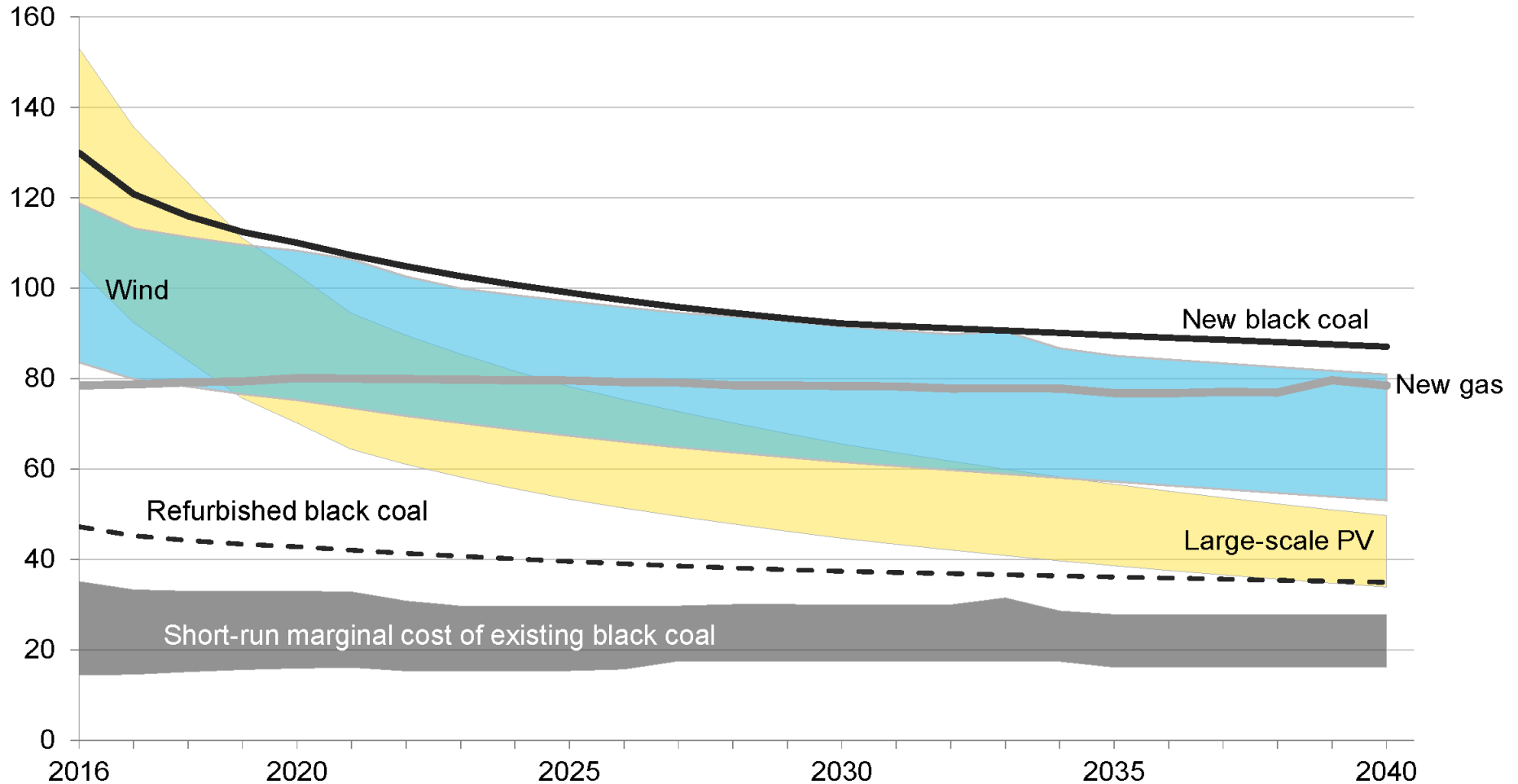
Over the next 25 years, 68% of new electricity capacity will be renewable





# POLICY WILL BE REQUIRED TO FACILITATE AN ORDERLY EXIT

Levelised cost of generation (real 2016 AUD/MWh)

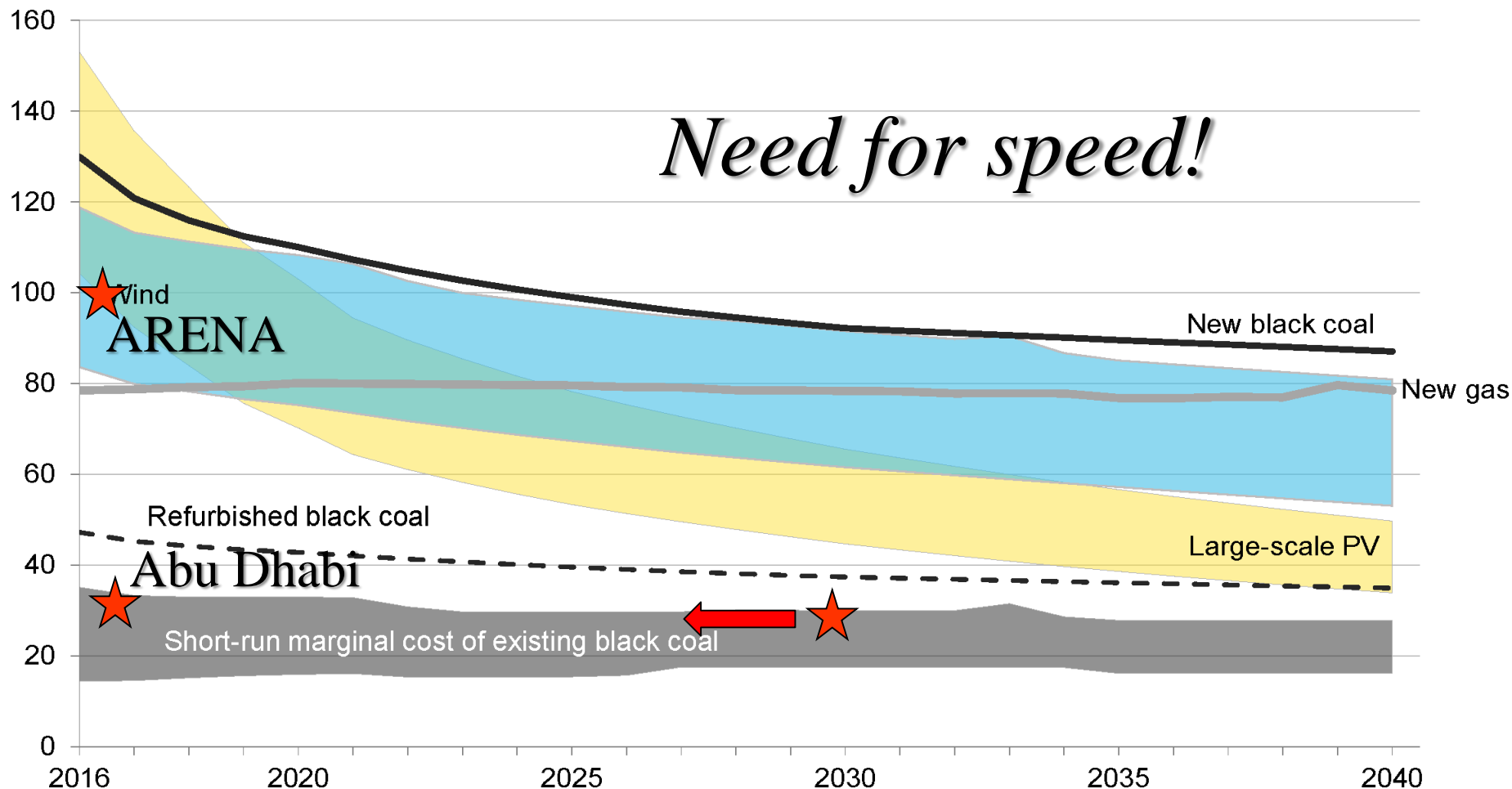


Note: assumes coal refurbishment capex is 25% of new build cost. Short-run marginal cost includes fuel, fixed and variable costs, assuming 83% capacity factor. Capacity factor of utility-scale PV: 15-22%; wind: 27-45%, New gas (CCGT): 85%. For details see: [New Energy Outlook 2016: Australia Seminar](#)

Source: Bloomberg New Energy Finance

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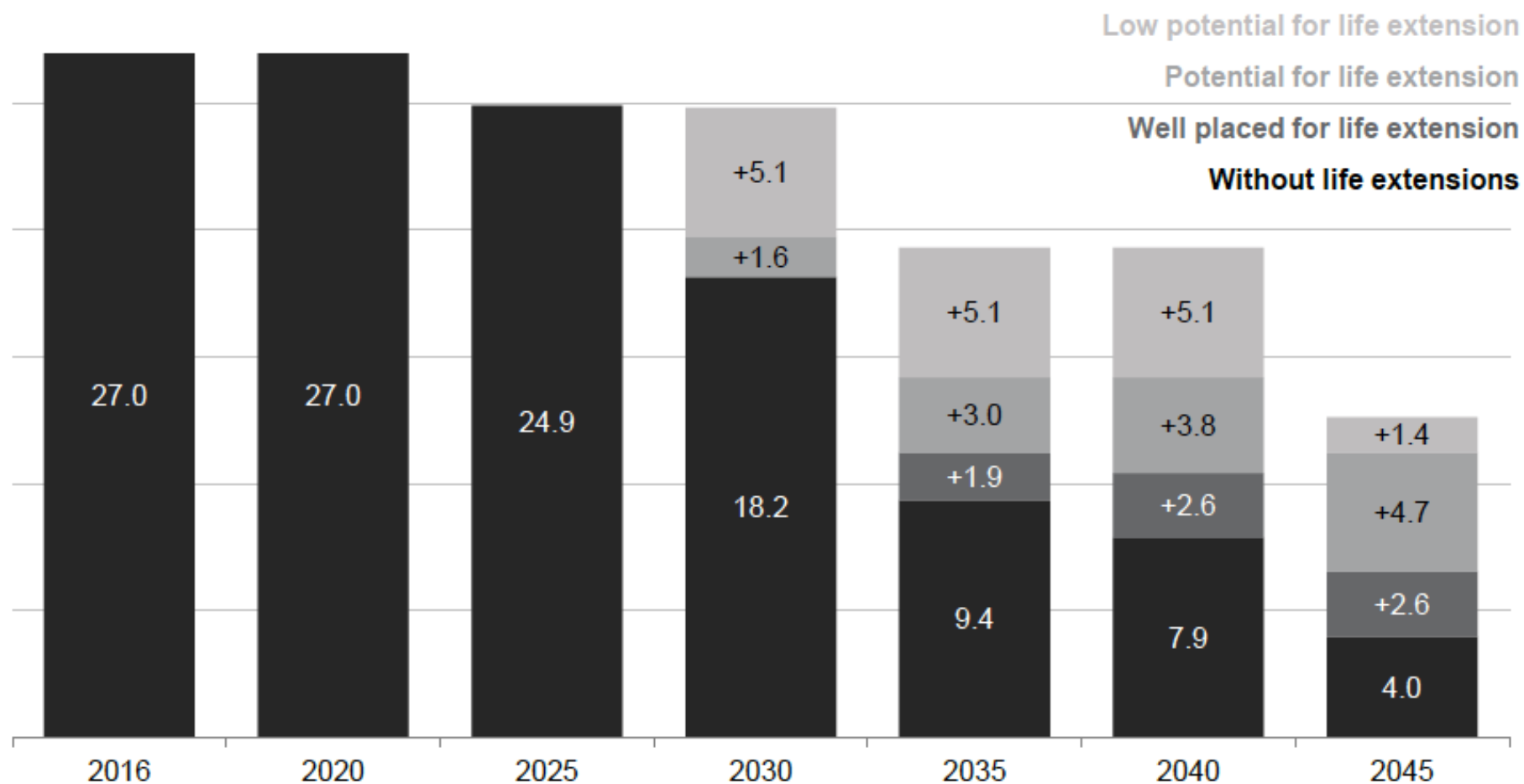


Note: assumes coal refurbishment capex is 25% of new build cost. Short-run marginal cost includes fuel, fixed and variable costs, assuming 83% capacity factor. Capacity factor of utility-scale PV: 15-22%; wind: 27-45%, New gas (CCGT): 85%. For details see: [New Energy Outlook 2016: Australia Seminar](#)

Source: Bloomberg New Energy Finance

# AUSTRALIA'S COAL FIRED GENERATORS WILL BE LONG-LIVED

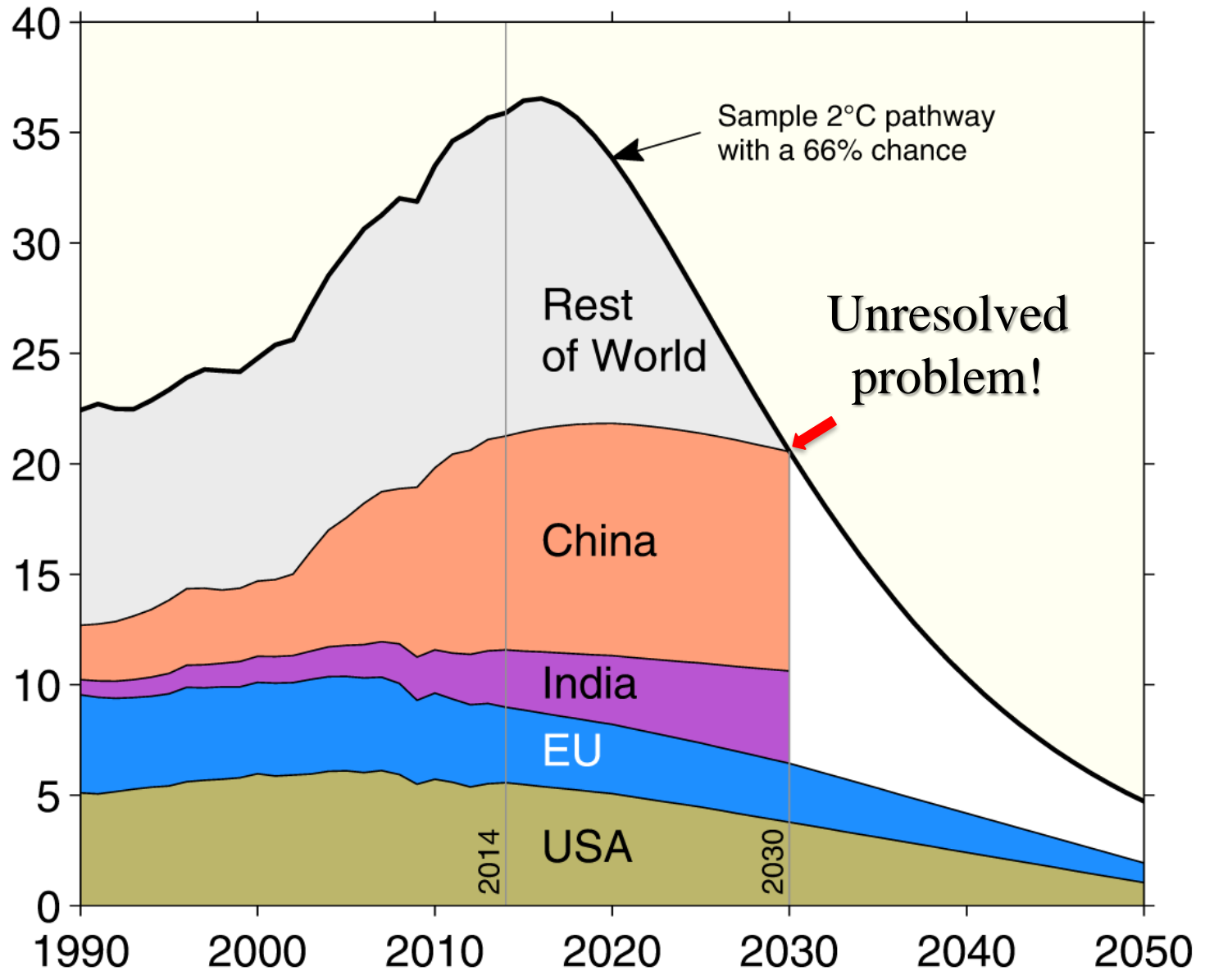
## Coal capacity and potential life extensions (GW)



Note: Assumes life extensions of 15 years at end of technical life for plants with different levels of potential for life extension. For details see: [When will Australia's coal-fired generators retire?](#)

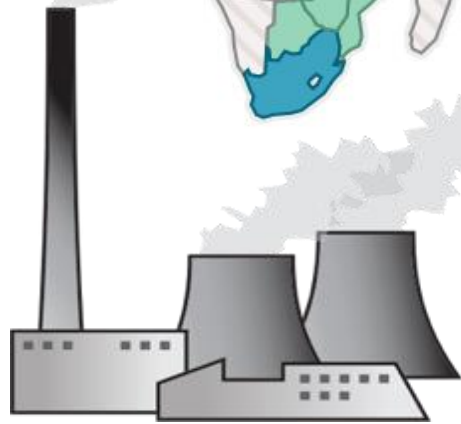
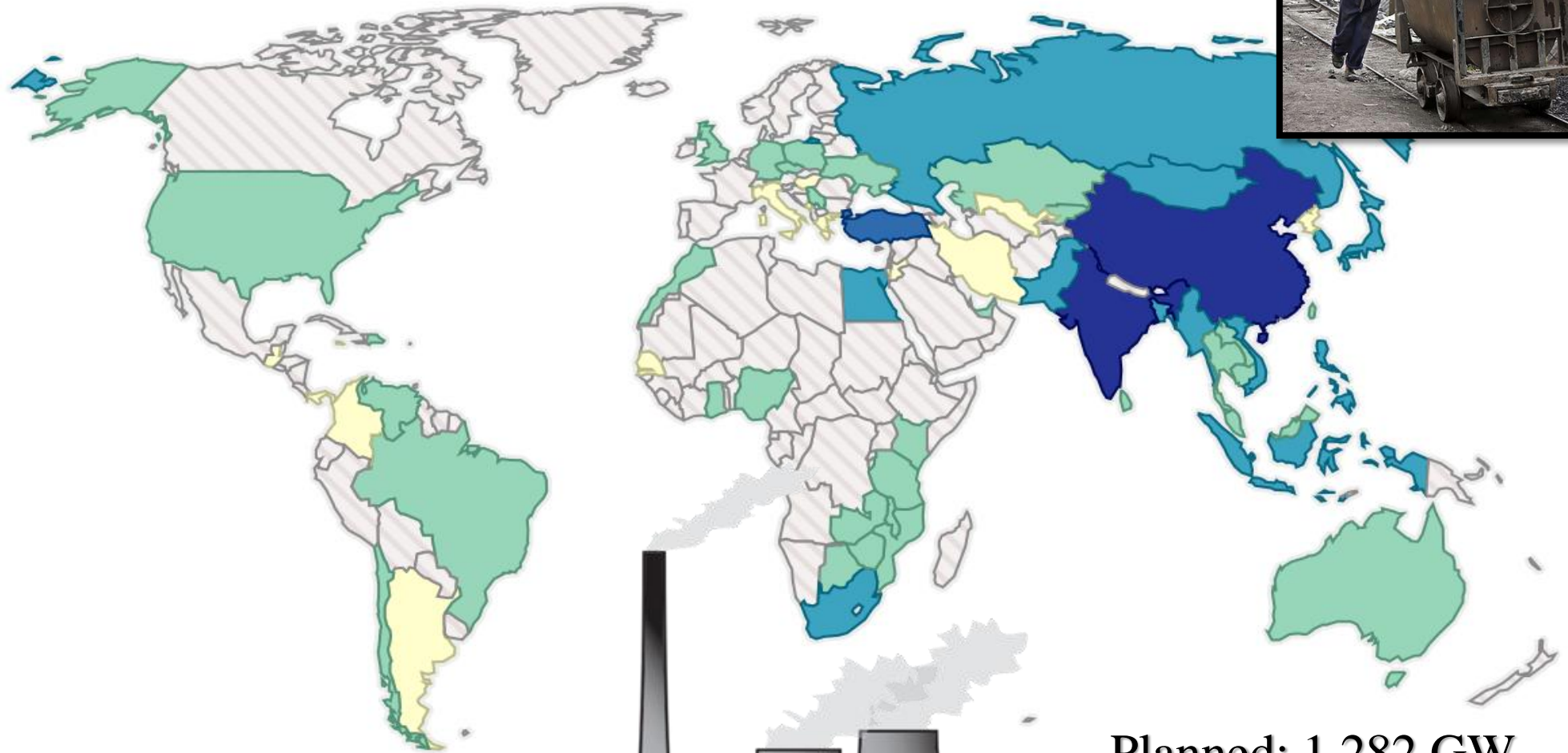
Source: Bloomberg New Energy Finance

CO<sub>2</sub> emissions (Gt CO<sub>2</sub>/yr)



# Coal plants under development

As of July 2016



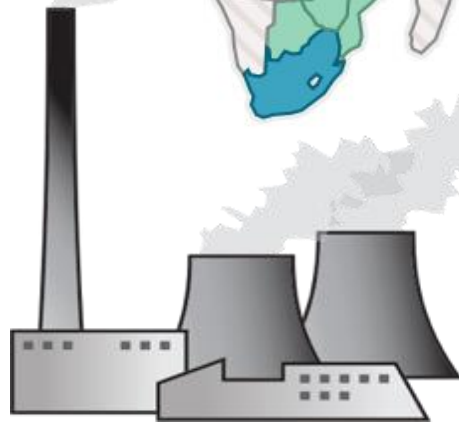
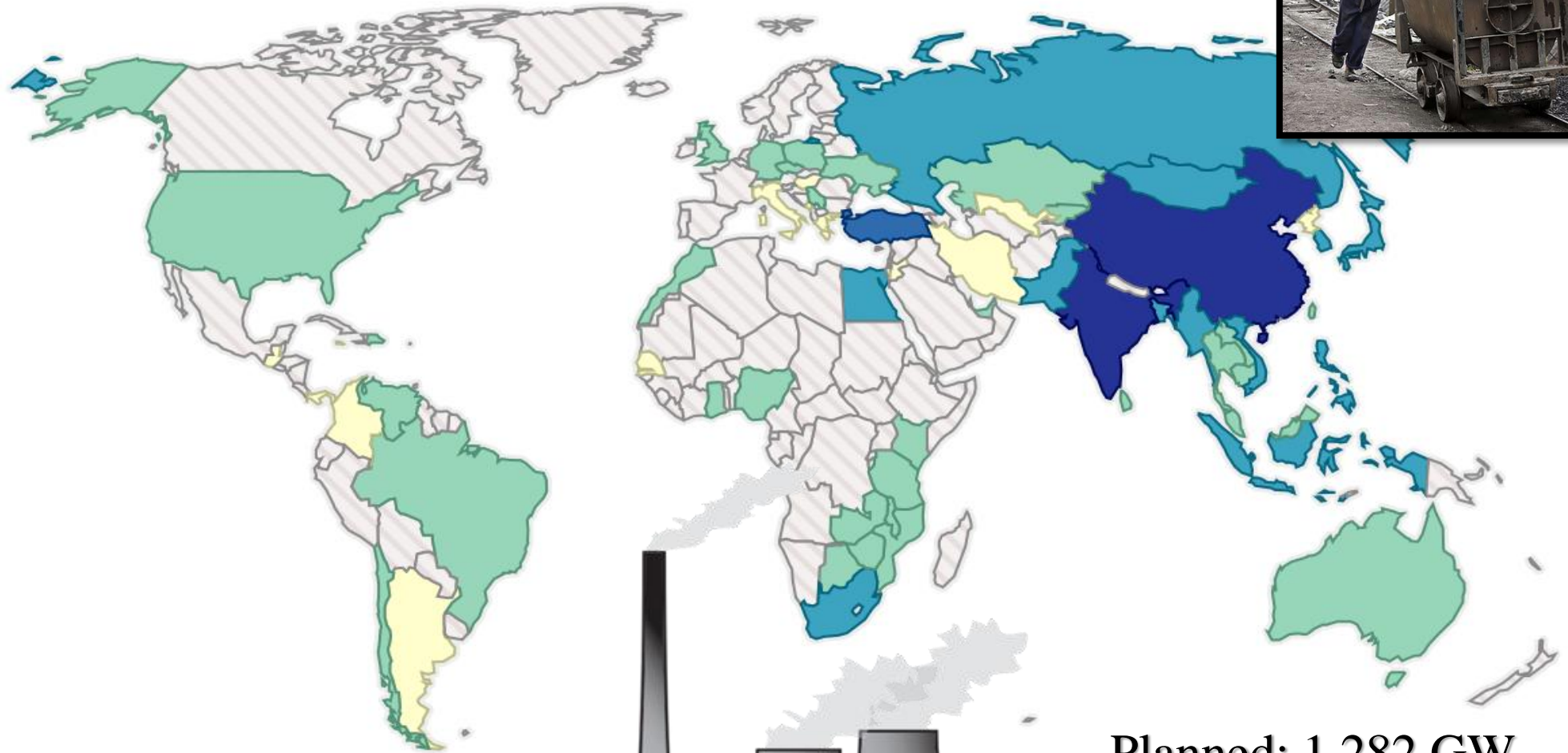
Planned: 1,282 GW  
(Existing: 1,940 GW)

Capacity (MW)



# Coal plants under development

As of July 2016



Planned: 1,282 GW  
(Existing: 1,940 GW)

Capacity (MW)

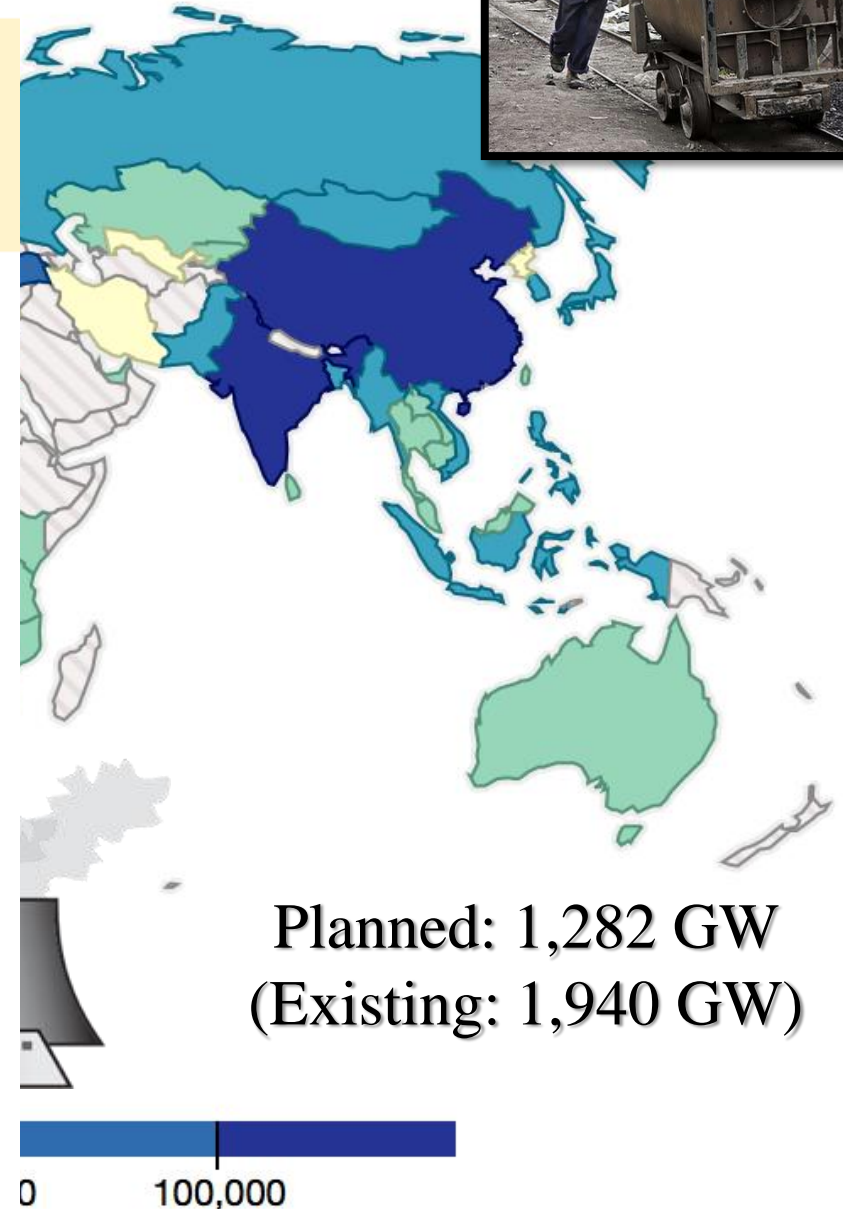


# Coal plants under development

As of July 2016

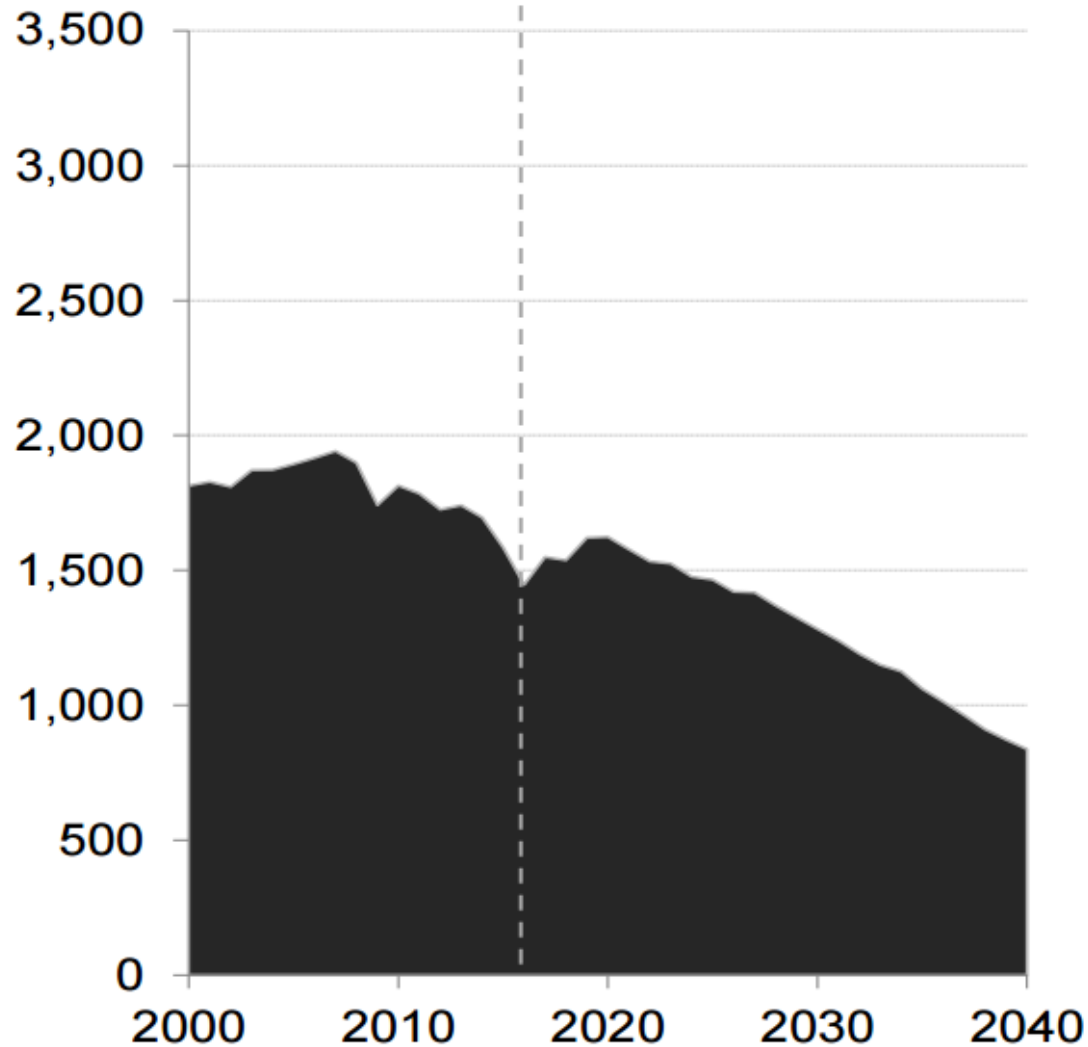


Country	Announced + Pre-permit + Permitted	Construction
China	405,852	205,144
India	178,215	64,669
Turkey	70,149	3,645
Indonesia	39,630	8,215
Vietnam	30,620	15,789
Japan	19,045	3,059
Pakistan	18,408	2,880
Egypt	17,240	0
Myanmar	14,050	445
Bangladesh	13,045	0
Mongolia	11,590	900
South Korea	10,420	9,254
Philippines	10,046	3,780



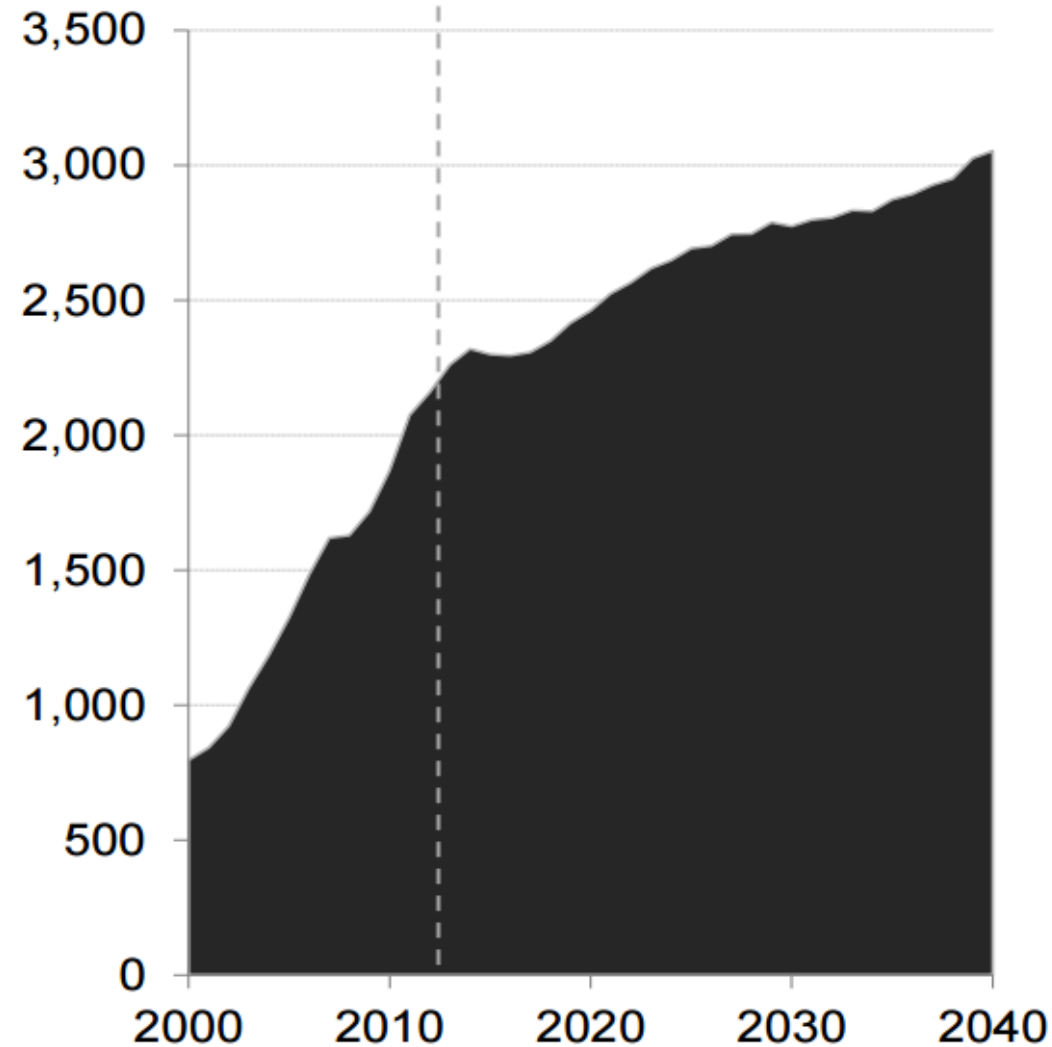
# THERMAL COAL CONSUMED IN POWER GENERATION (MT/YR)

## WORLD EXCLUDING ASIA



Note: Assumes coal quality of 6,000kcal/tonne

## ASIA

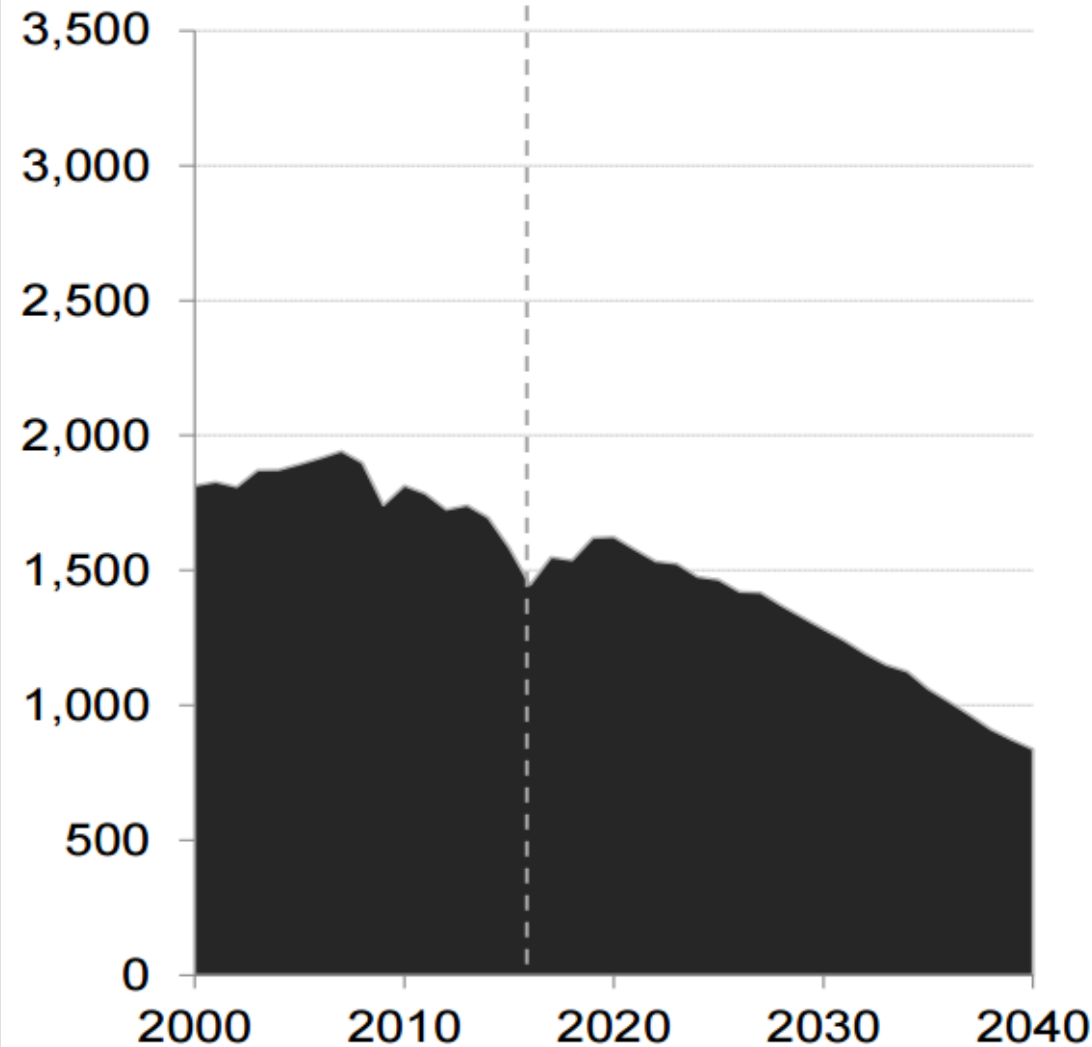


Source: Bloomberg New Energy Finance, IEA

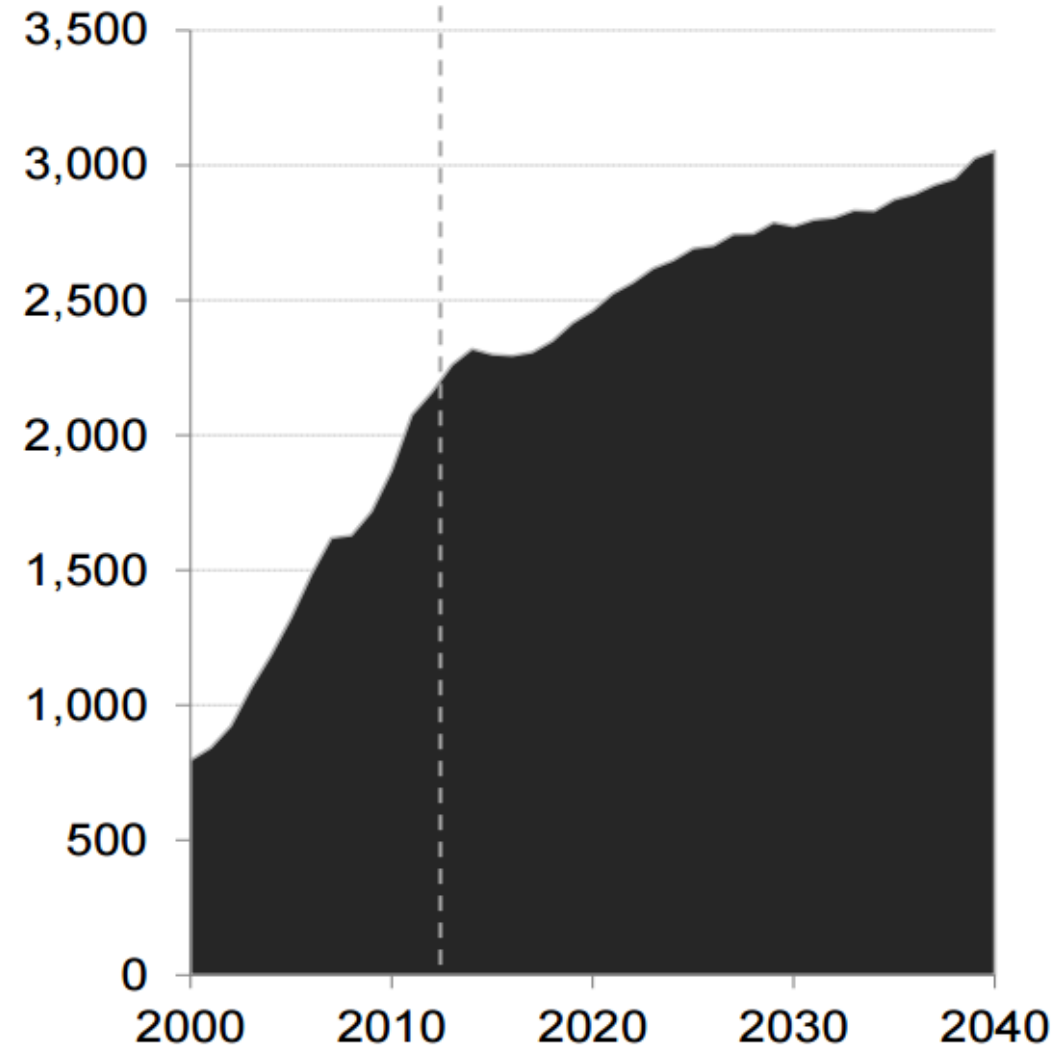


# THERMAL COAL CONSUMED IN POWER GENERATION (MT/YR)

## Future Impact: Accelerate PV cost reductions



Note: Assumes coal quality of 6,000kcal/tonne



Source: Bloomberg New Energy Finance, IEA

# THERMAL COAL CONSUMED IN POWER GENERATION (MT/YR)

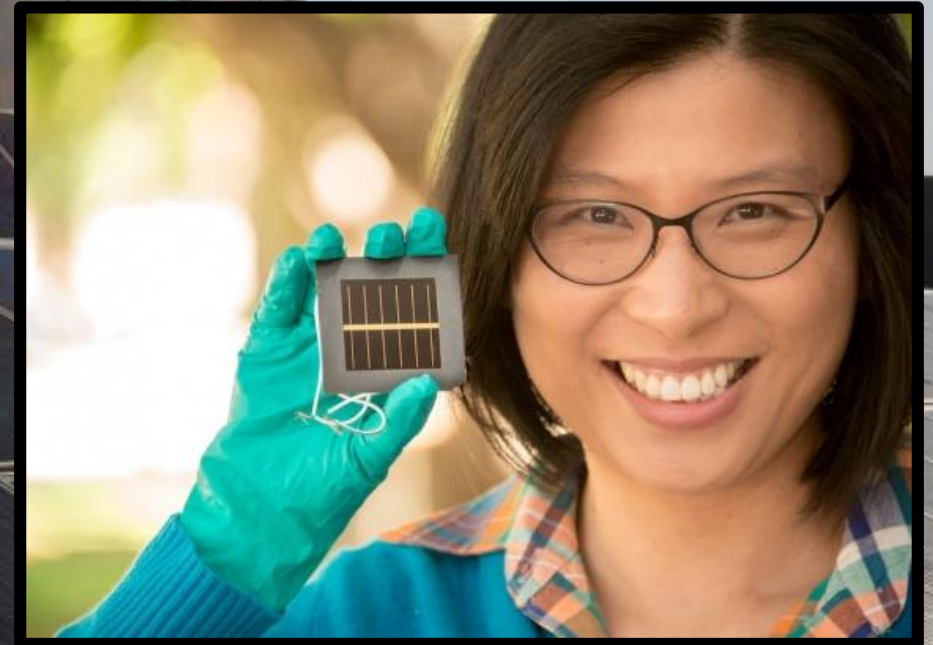
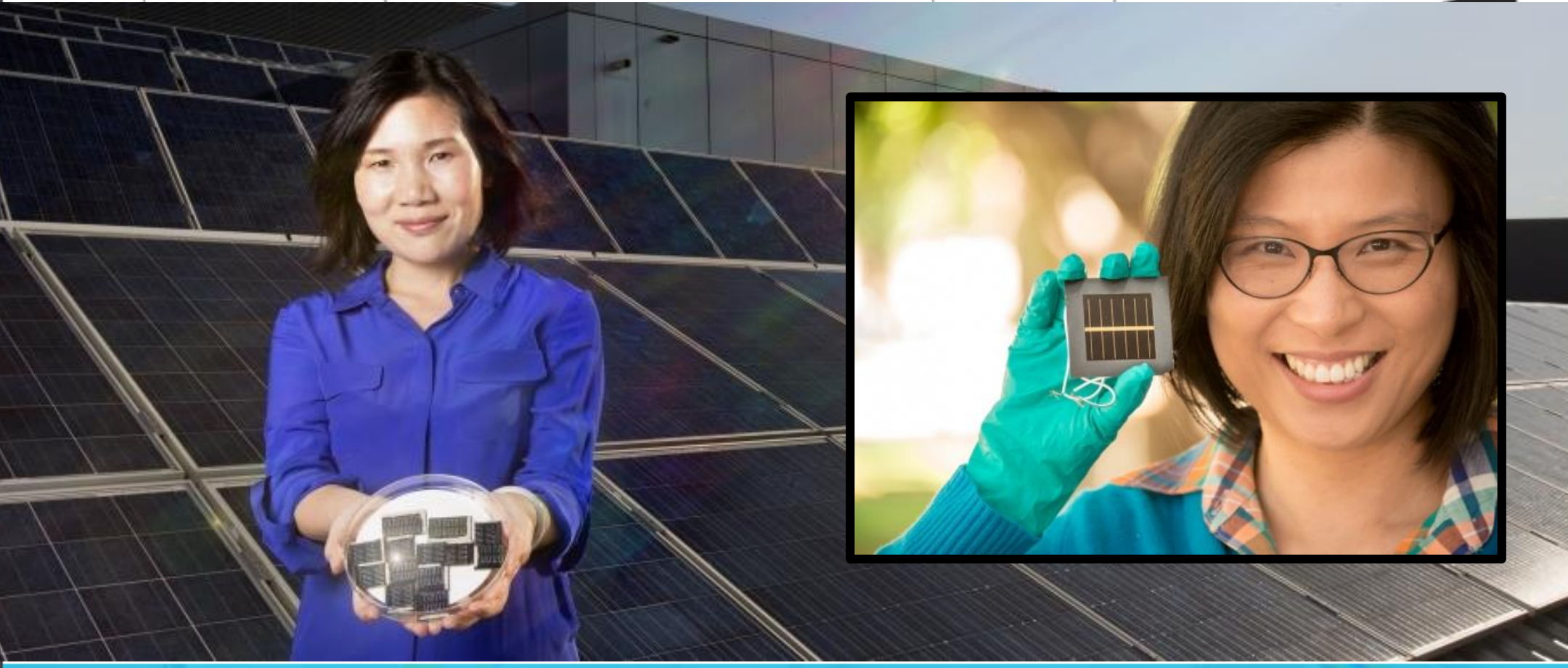
Future Impact: Accelerate PV cost reductions  
1. Perfect production & transfer PERC



# THERMAL COAL CONSUMED IN POWER GENERATION (MT/YR)

Future Impact: Accelerate PV cost reductions

1. Perfect production & transfer PERC
2. Develop viable tandem cells (5-10yr)



*Thank you!*

