



Photovoltaics

February 2013



Illawong



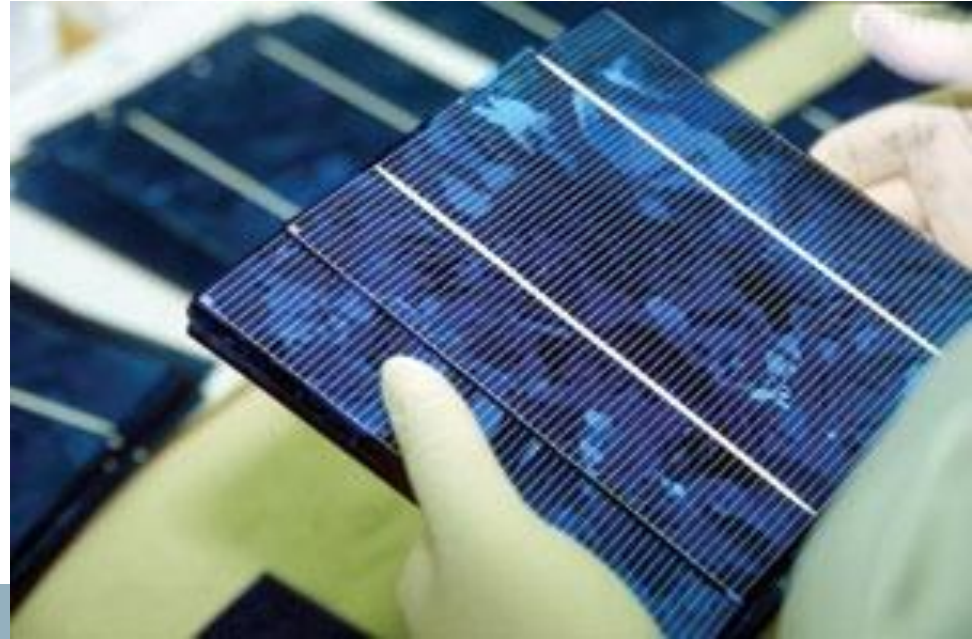


Kings Canyon



Australian
National
University





- Long history
 - Kaneff & Carden, 1971
- 80 staff and PhD students
- 30 contractual partners
- Education
- Applied and basic research
 - Silicon engineering
 - Silicon solar cells
 - Plasmons/nanomaterials
 - Solar concentrators
 - Solar cooling

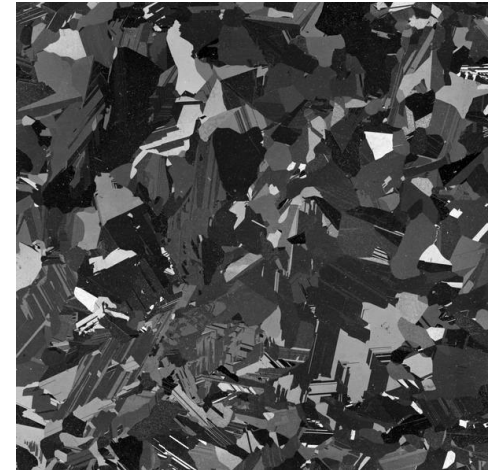
- From silicon chunks → ingots → wafers
- Defects and impurities play a key role in cell performance



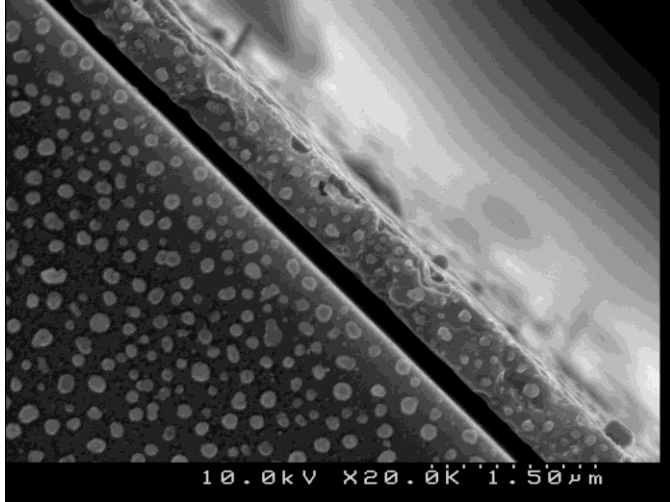
source: www.schott.com



www.silfex.com



pvcfrom.pveducation.org

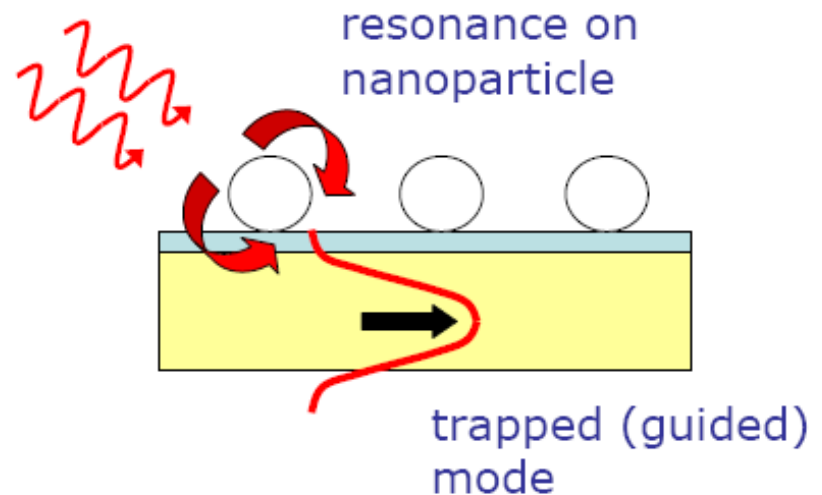


- Applicable to any type of solar cell
- Does not damage cell surface
- Simple processing techniques

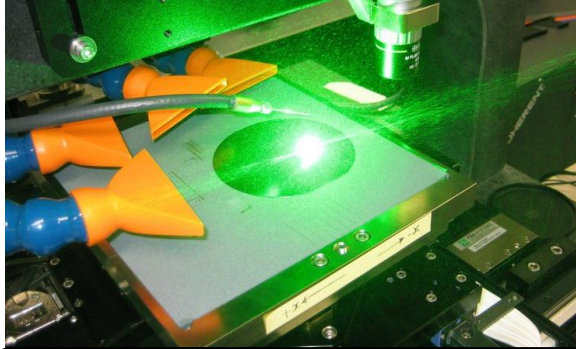
Listed as one of MIT Technology Review's 'Top 10 emerging technologies' 2010

Featured in news sections of 'Science' and 'The Economist'.

Episode winner on ABC TV 'New Inventors'



Laser Technologies



Traditional Laser Systems

Ultraviolet Excimer Laser

Visible Solid-State Laser

Infrared Solid-State Laser

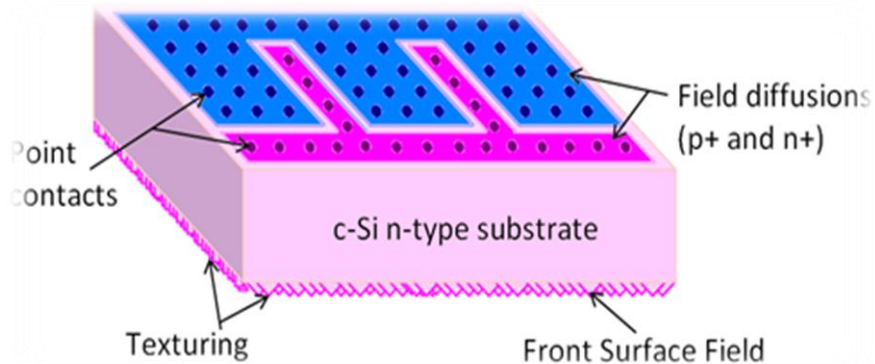


Cutting-Edge Technologies

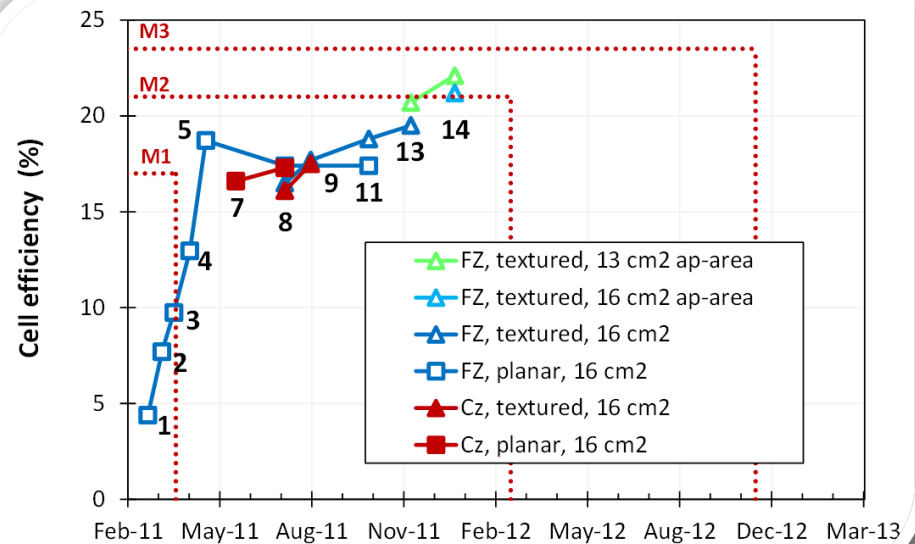
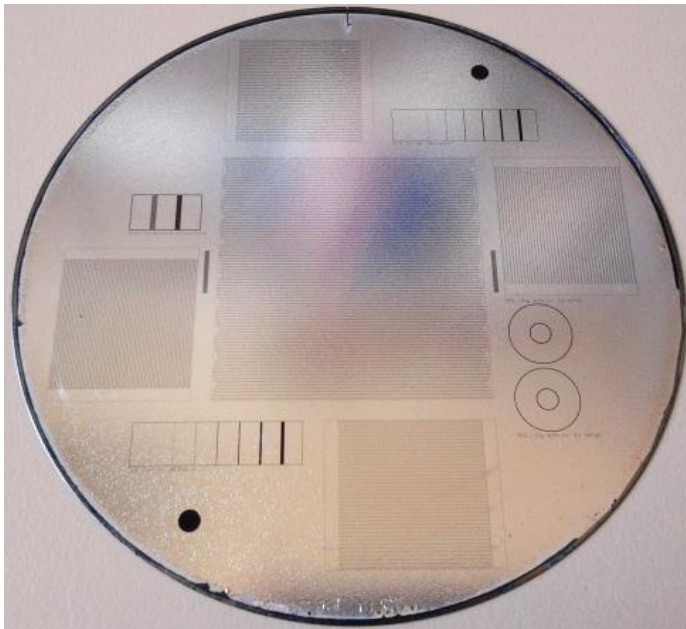
“Water-Jet”
Laser Chemical Processing

Temporal Pulse Control Laser

High Performance IBC Silicon Solar Cells

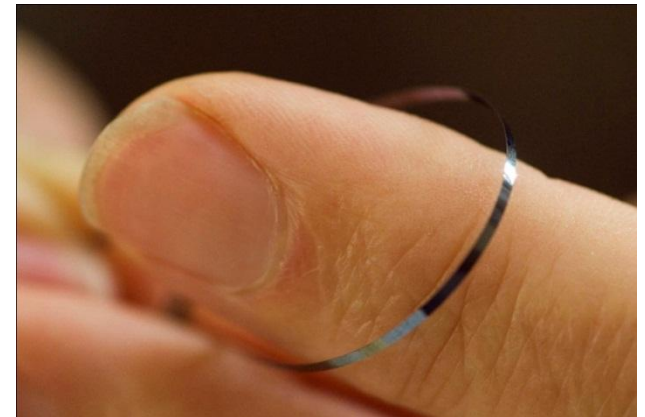
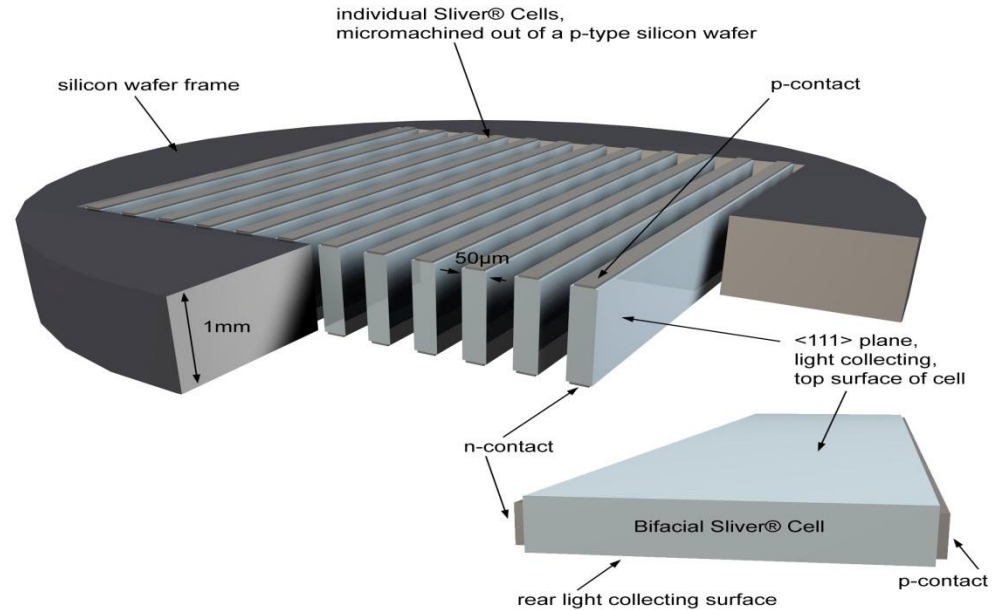


- A partnership between Trina Solar, NUS and ANU

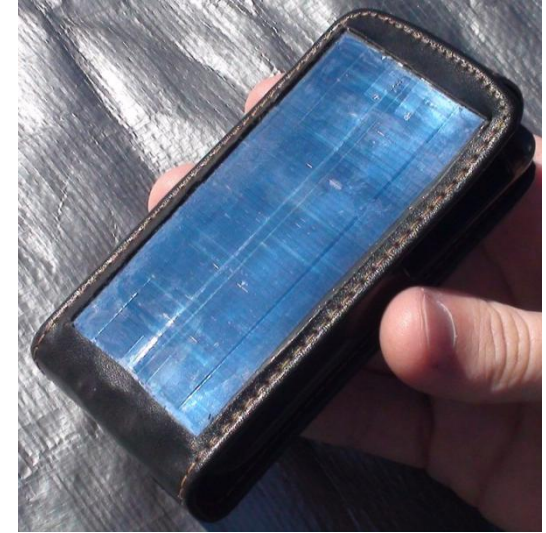
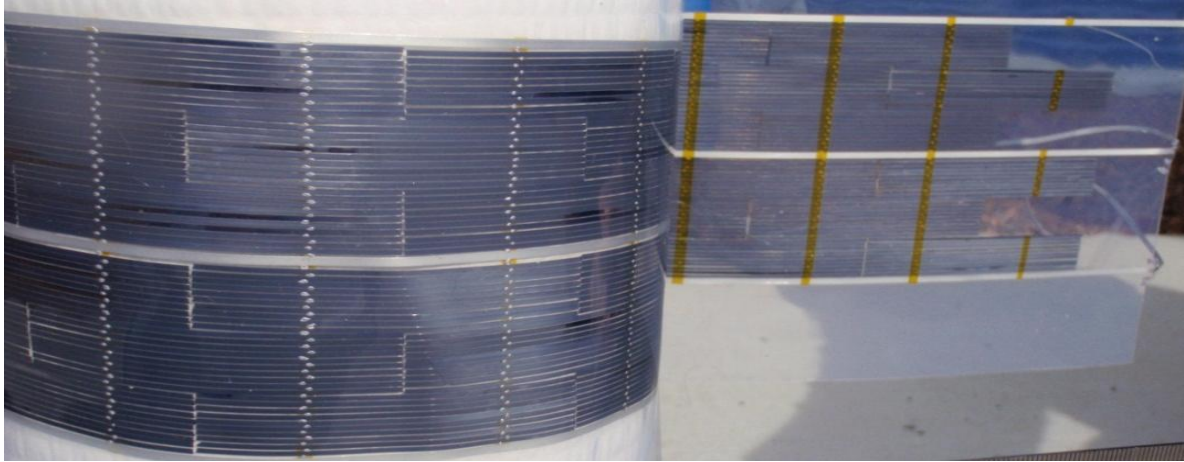


Sliver solar cells

- ANU originated technology
 - Long (5 – 10 cm long)
 - Narrow (1-2 mm wide)
 - Thin (20 – 60 μm thick)
 - Flexible
 - Bifacial
 - Inherent high efficiency design
-
- Cell efficiencies > 20% in labs
 - Diffusions more complex due to topology
 - Cost competitive at module level

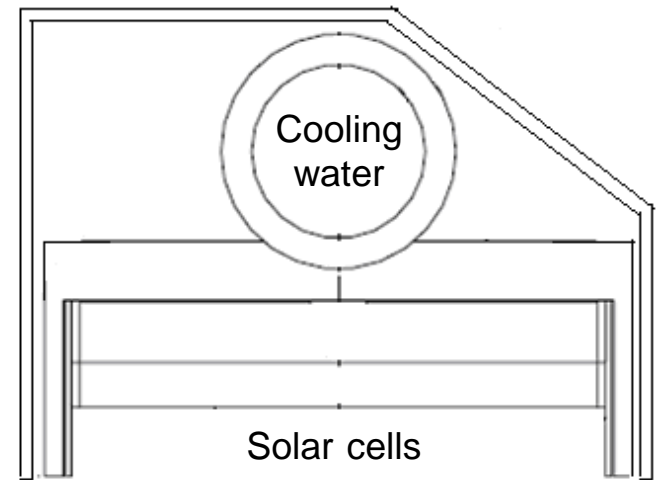


Flexible micro modules



- SLIVER cell technology
- Flexible, bifacial, efficient
- High power/weight and power/volume ratio
- Defence
- Consumer electronics applications

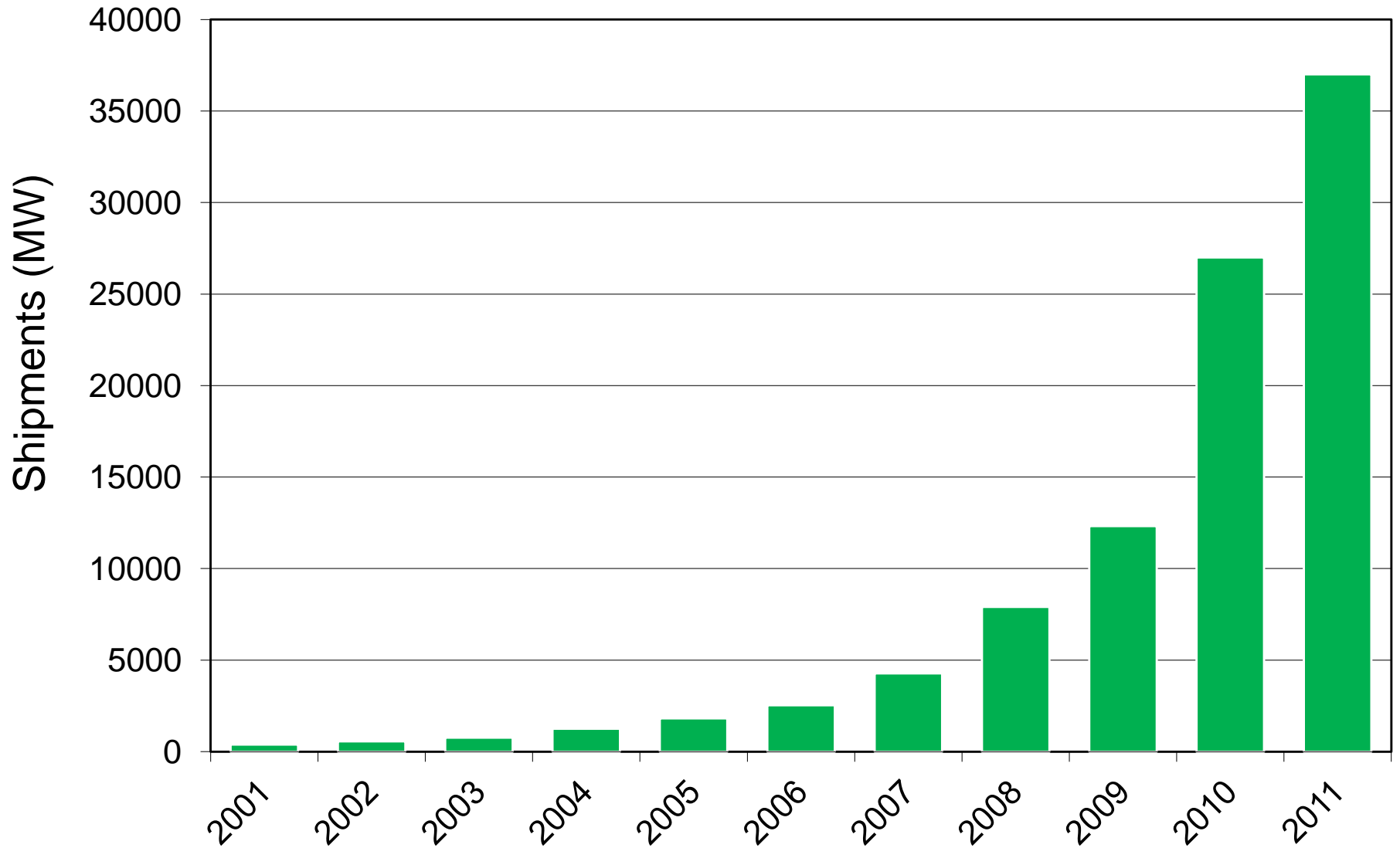
Electricity & hot water



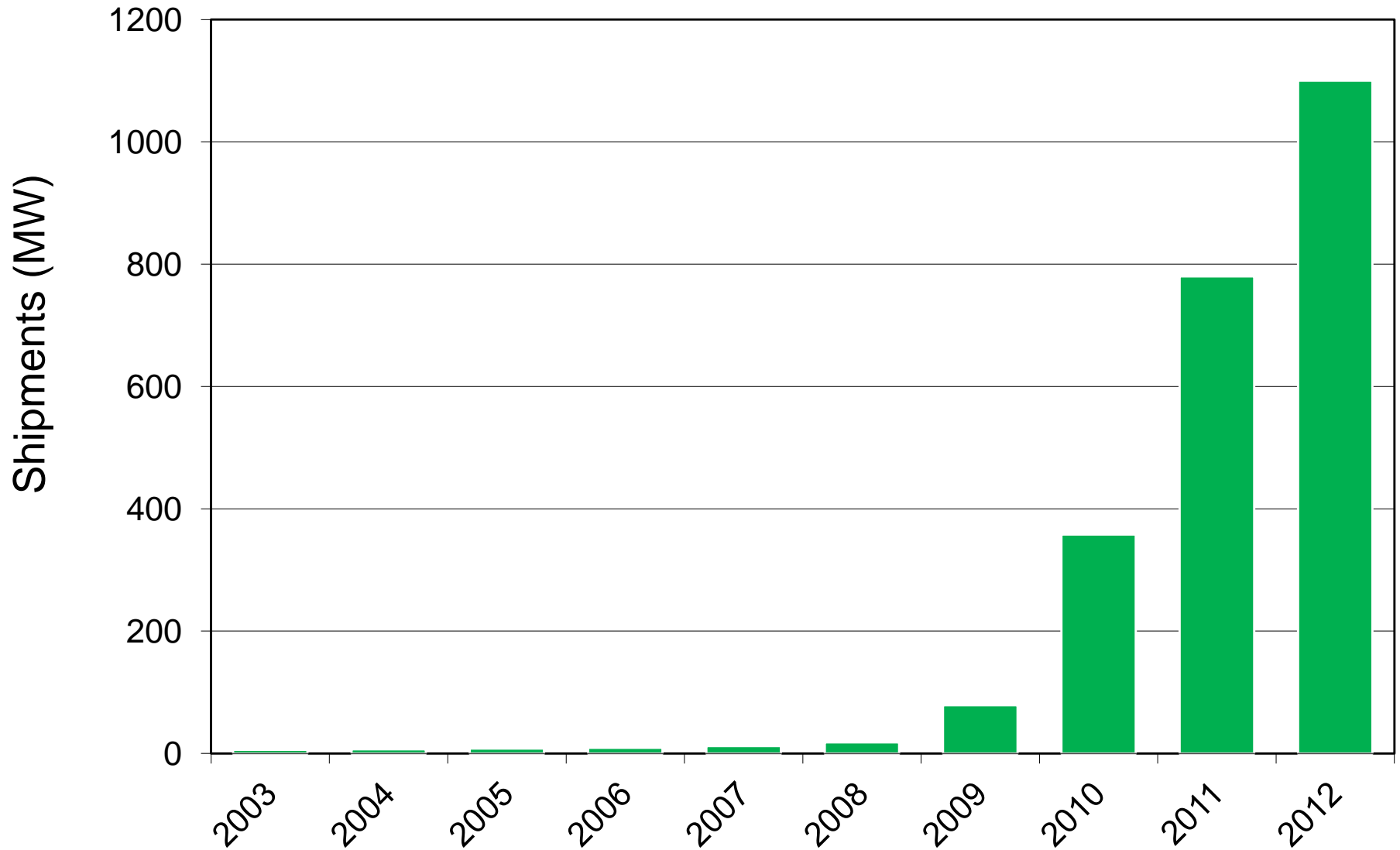
- Silicon PV dominates (80-90%)
- Severe industry shakeout
 - PV production overcapacity
- 4-fold reduction in price in 5 years
- Massive growth opportunities due to low price



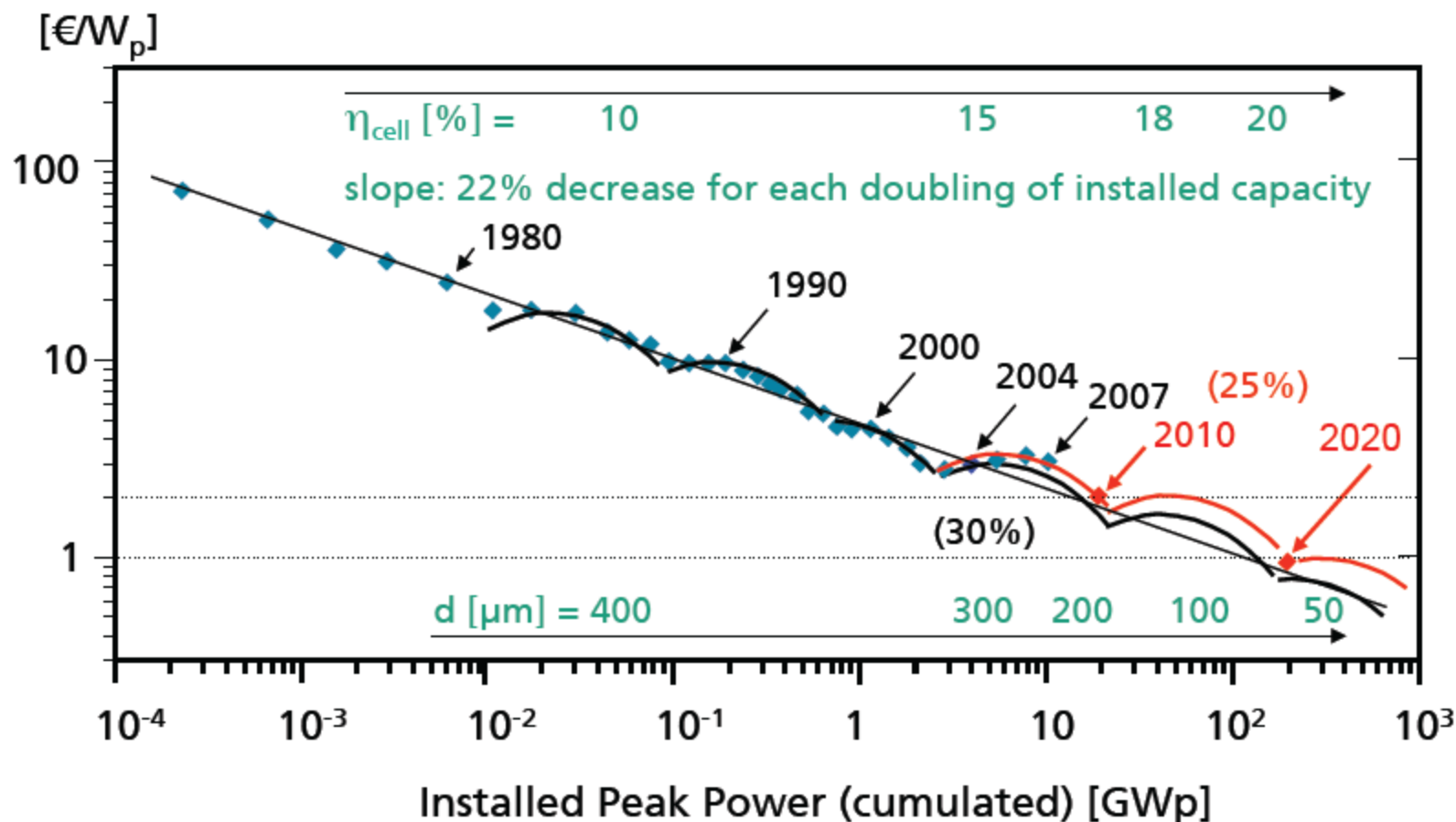
Global Photovoltaic Sales



Australian Photovoltaic Sales

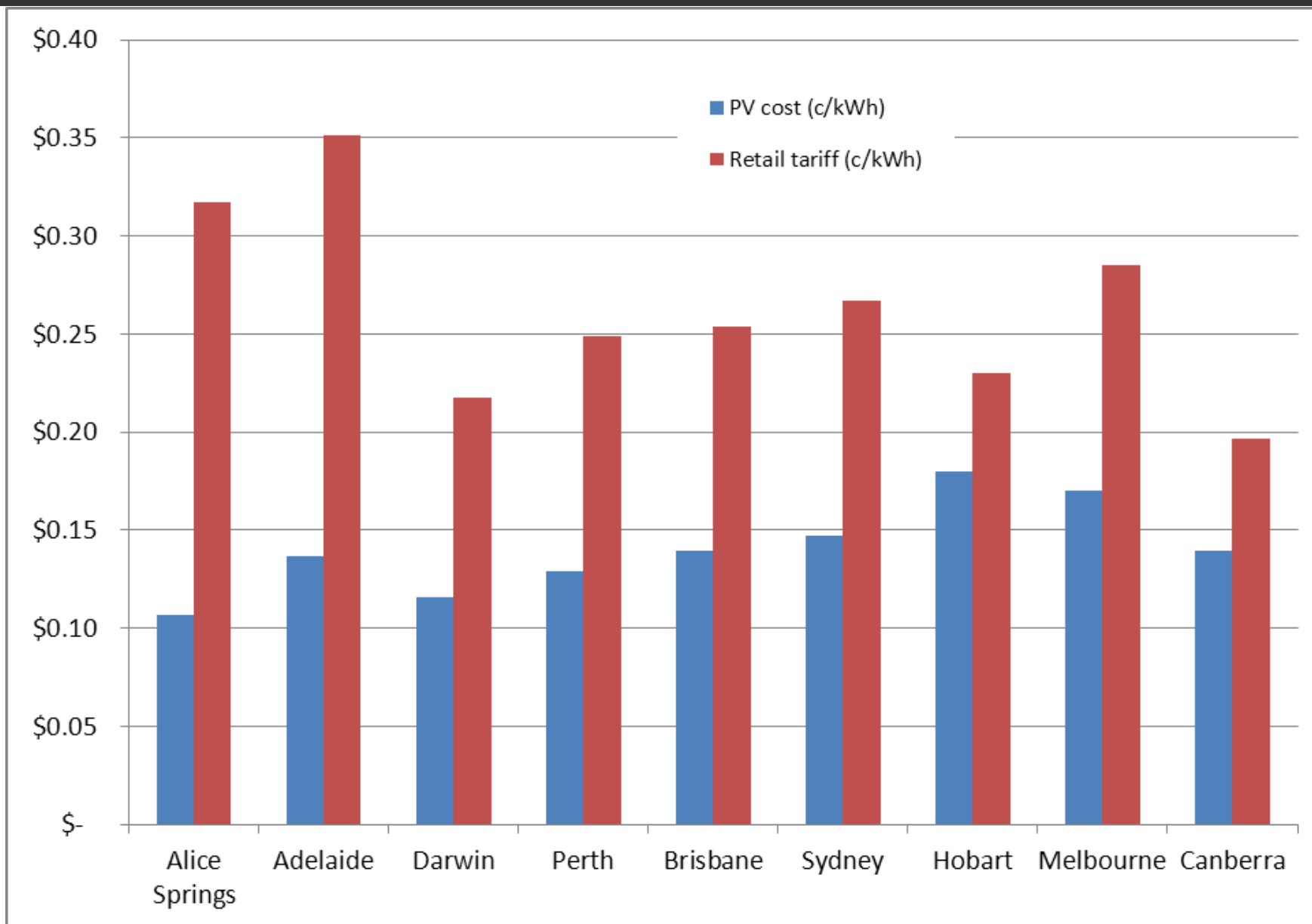


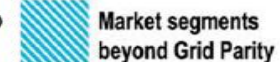
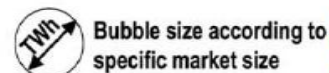
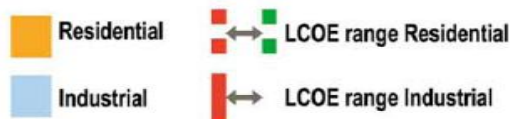
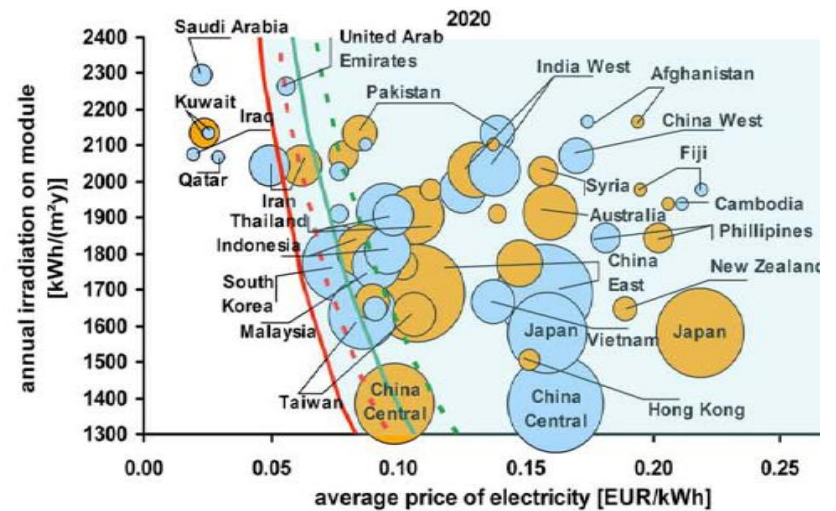
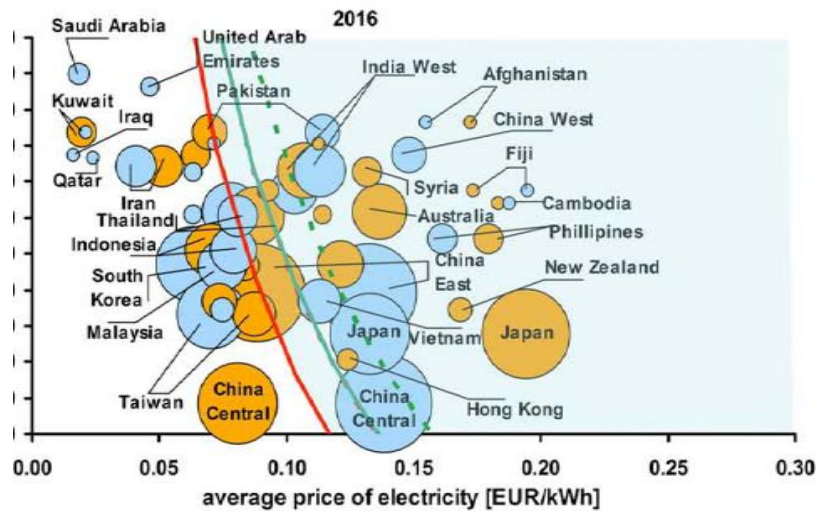
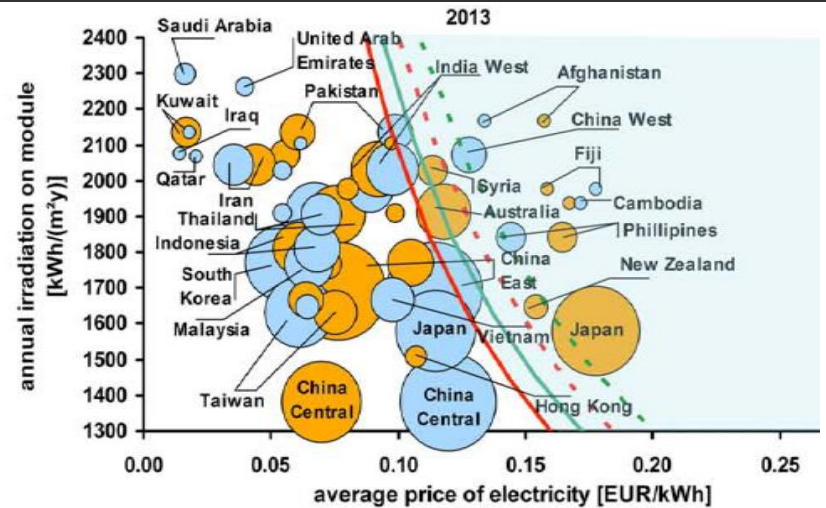
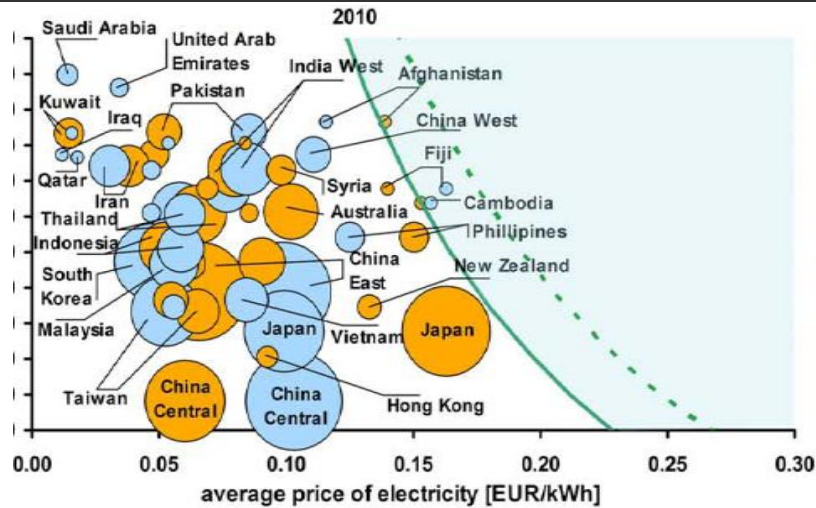
Learning Curve of Crystalline Si PV Module Prices





Retail grid parity





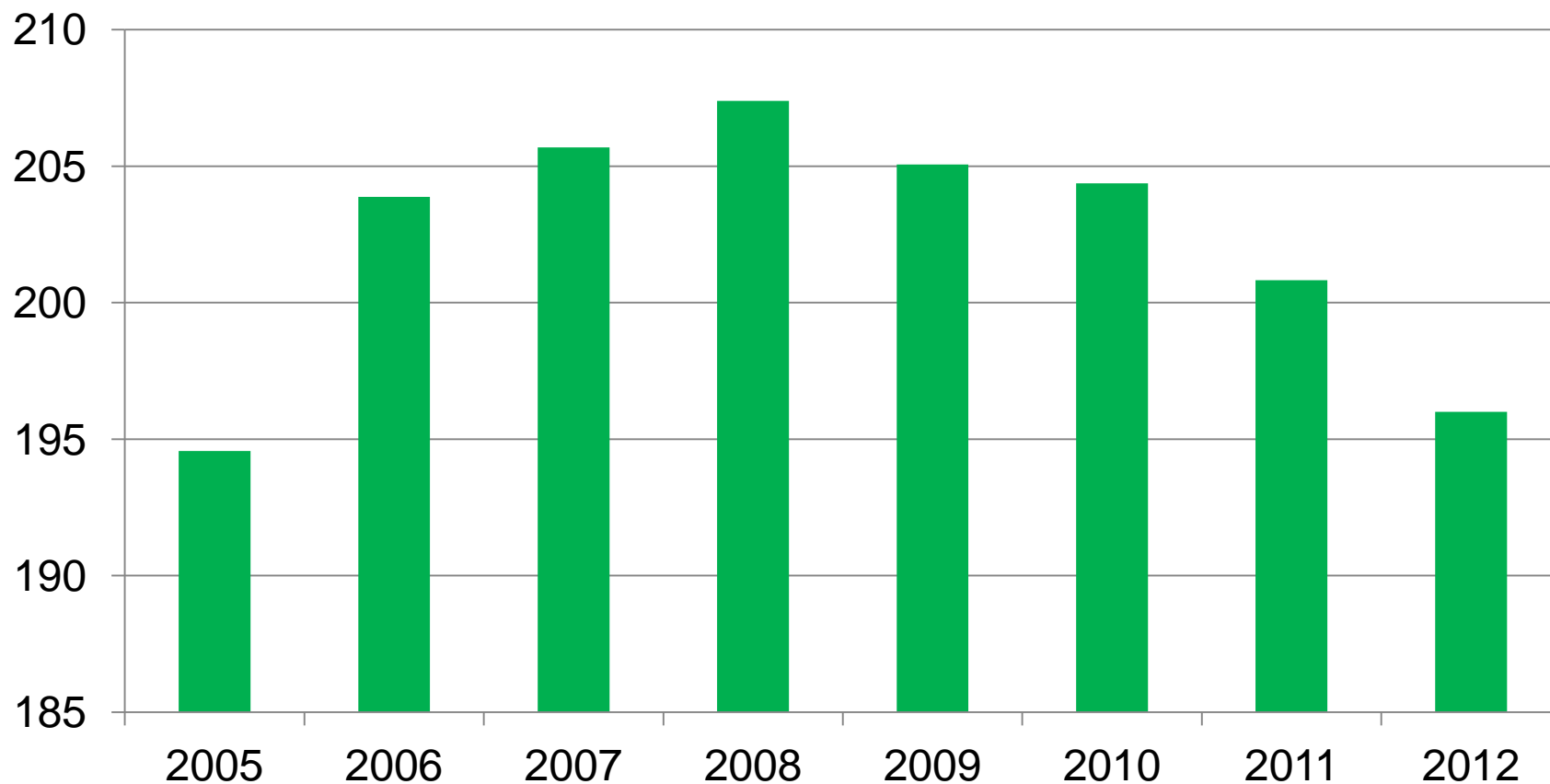
Environmental footprint of Si cells

- High solar conversion efficiency, 10-50%
 - 100 times more efficient than bio conversion
- 100 fold reduction in mining c/f fossil & nuclear
- 1 year energy payback time
 - Quick recovery of energy invested in manufacturing
- Uses 8 very common, non-toxic, elements:
 - Silicon, oxygen, carbon, hydrogen, sodium, calcium, aluminium, iron
- Minimal military and terrorist utility
- Vast, ubiquitous and indefinitely sustainable

Electricity reliability

- Geographical dispersion
- Technical diversity
 - Wind, photovoltaics, solar thermal, ocean etc
- Shift loads from night to day
- Despatchable sources
 - Biomass, hot dry rocks, thermochemicals
- Storage
 - Pumped hydro
 - Electric car batteries
 - Advanced batteries, flywheels and many others

NEM Electricity consumption (TWh/a)



The electricity revolution

- Declining electricity consumption
 - Energy efficiency, PV
- South Australia approaching 30% of its electricity from wind and PV
 - The system is stable
- No new base load fossil fuel plant needed until ~2020 (if ever)
 - Renewable Energy Target (~45 TWh = 20%)
 - Several fossil fuel power stations mothballed

2038: 100% renewable electricity

- No new coal/gas plant constructed
 - Coal/gas plant retires at end of service life
- New plant: 50% wind and 50% solar
 - 35 GW of wind and 60 GW of solar needed
 - 25 year system life
- **2.4 GW/yr** of new solar * 25 years = 60 GW
 - Cost of new solar: \$4-5 billion/year
 - Additional cost c/f coal or gas: small
- Current solar installation rate **>1 GW/yr**

