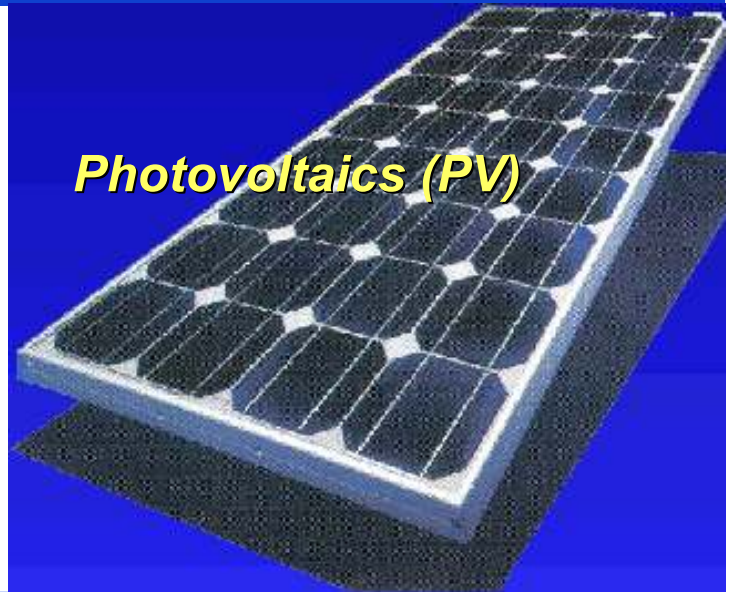
Photovoltaics Centre of Excellence

- supported by the Australian Research Council

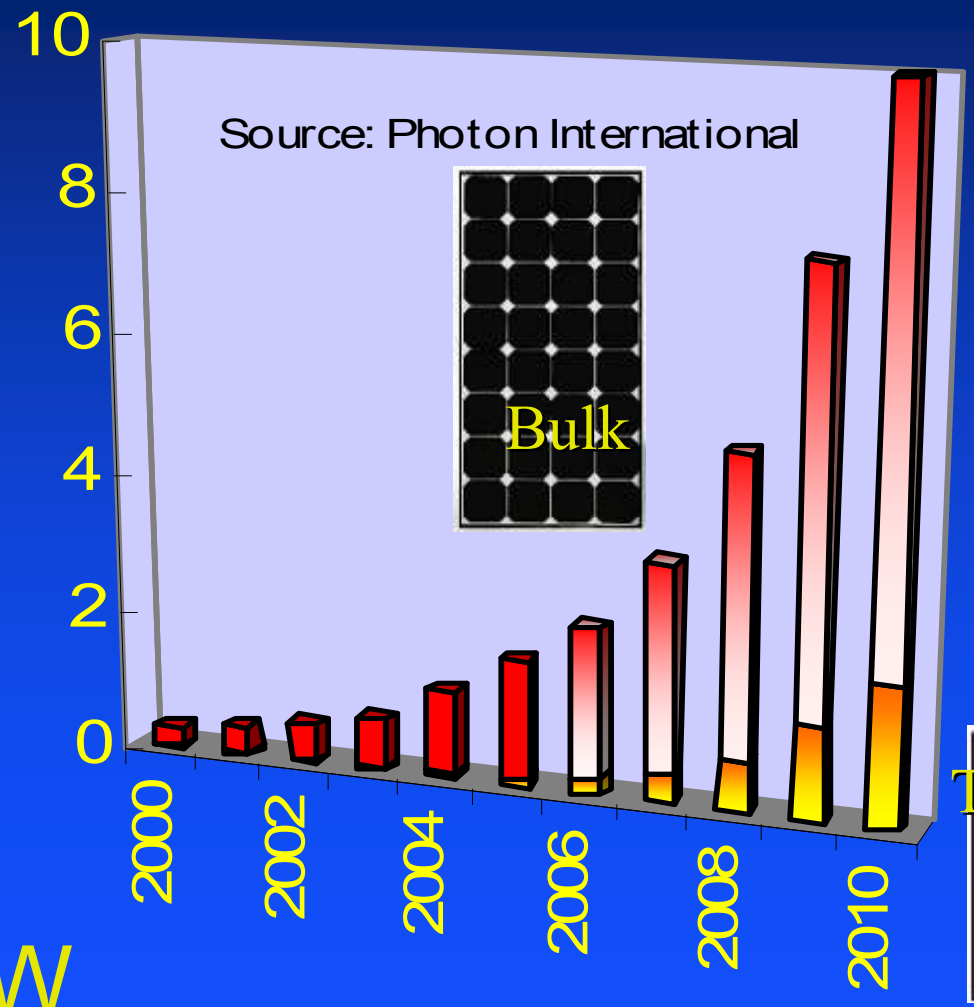
Solar Energy

Martin A. Green

University of New South Wales, Sydney



Solar booming



Thin-film

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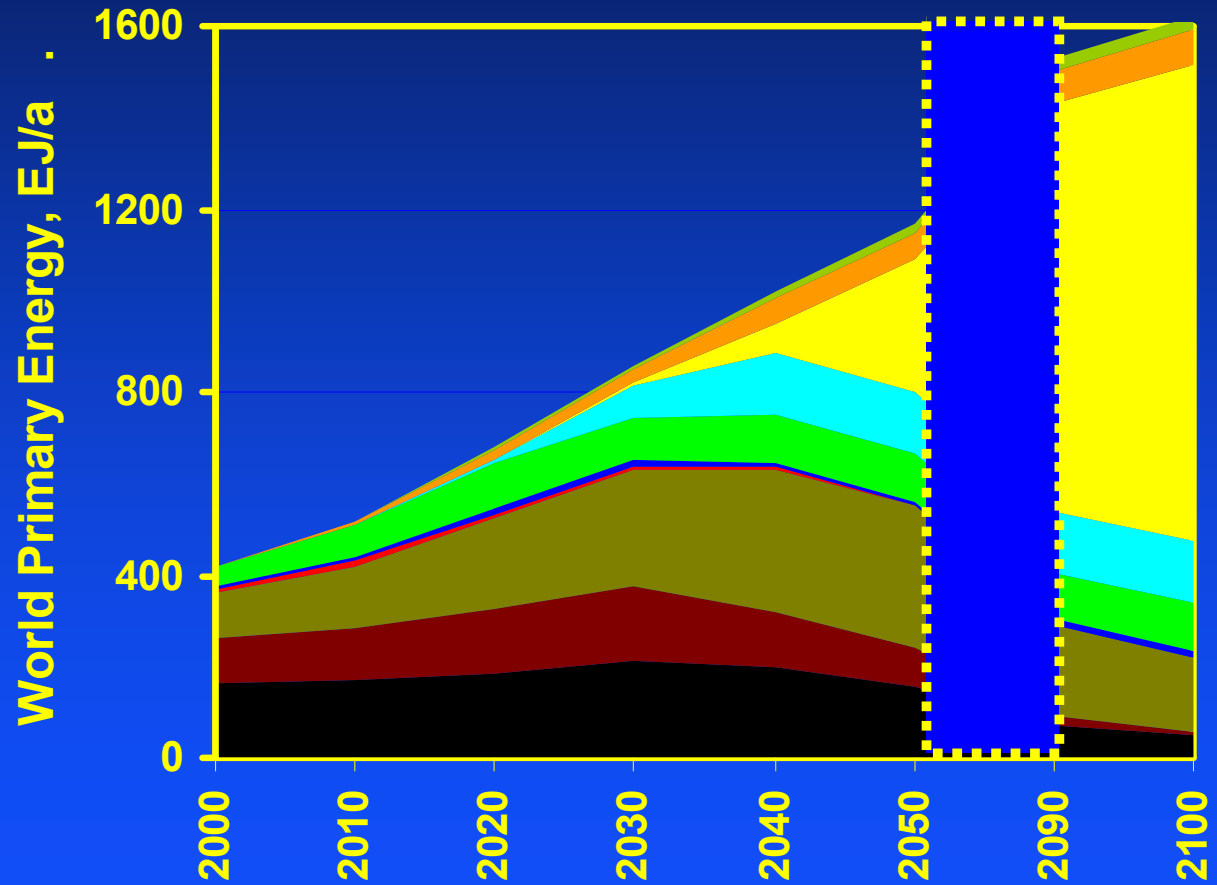
Transition scenario

German Advisory Council on Global Change (WBGU) *2003*



- Geothermal
- Solar Heat +
- Solar Power
- Wind
- Biomass
- Hydro
- Nuclear
- Gas
- Coal
- Oil

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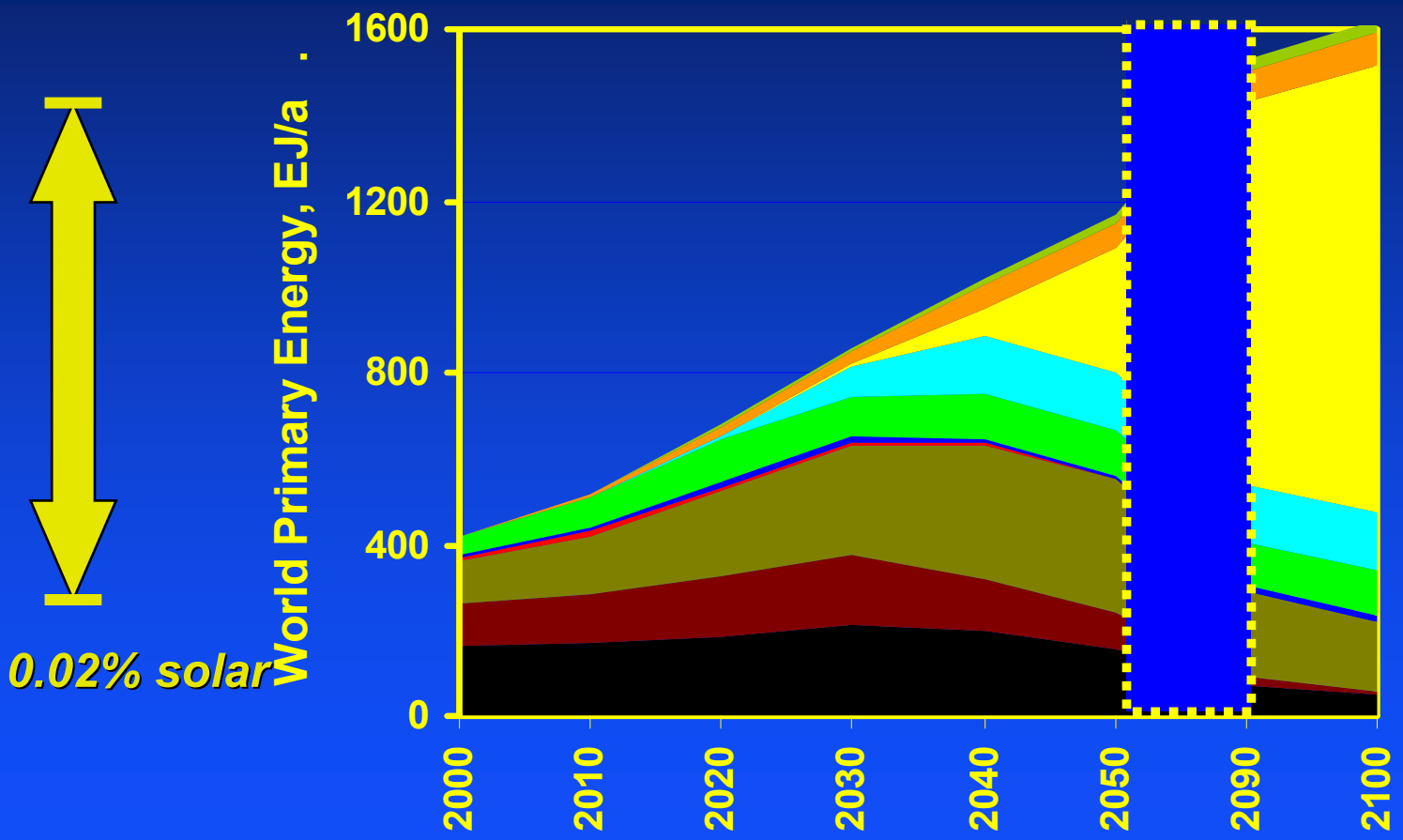
Photovoltaics - Electricity from Sunlight

Transition scenario

German Advisory Council on Global Change (WBGU) *2003*



0.02% solar

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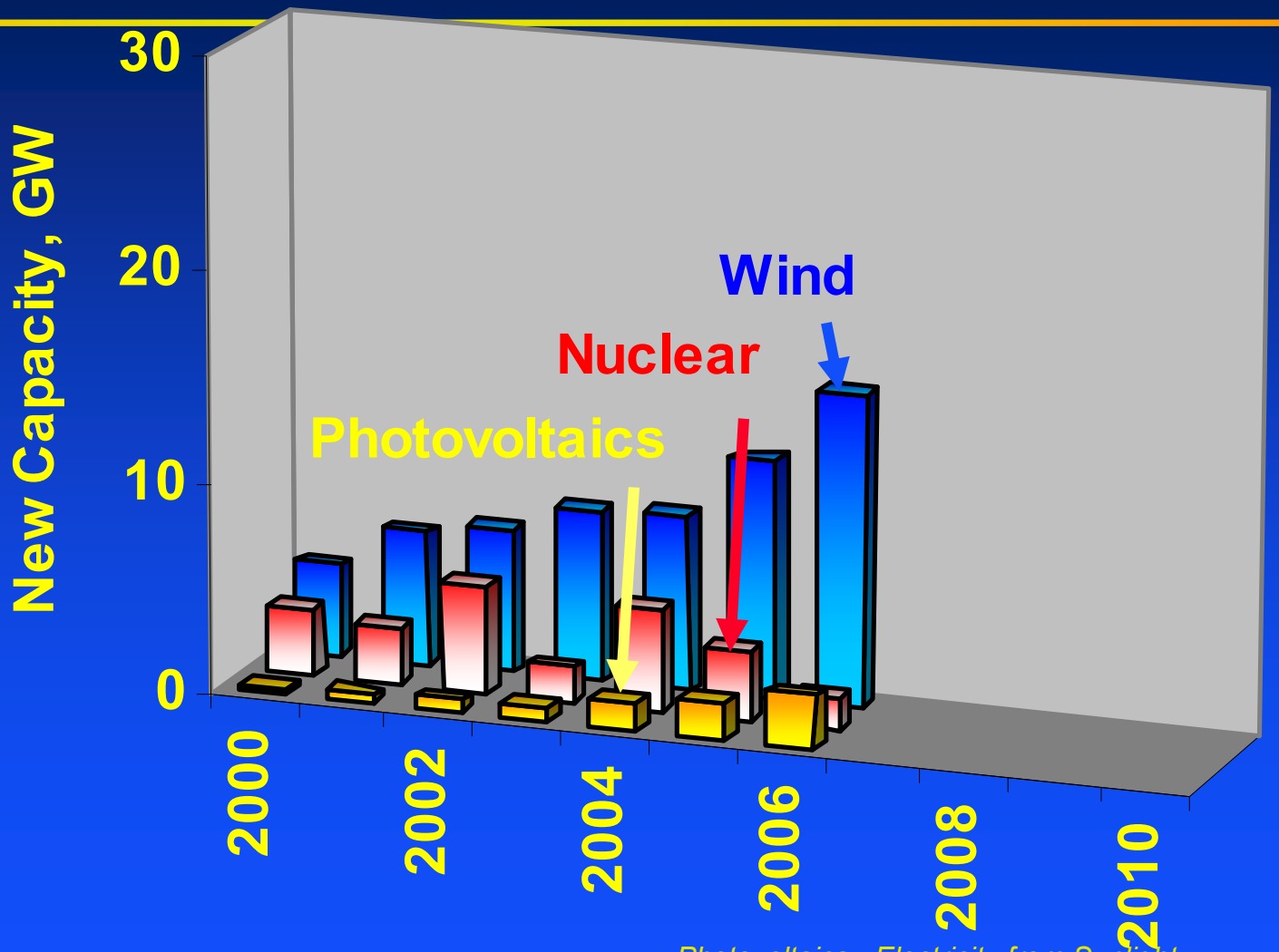
Photovoltaics - Electricity from Sunlight

Annual capacity increase

Sources:

Photon International,

WNA, WWEA, IEA



Annual capacity increase

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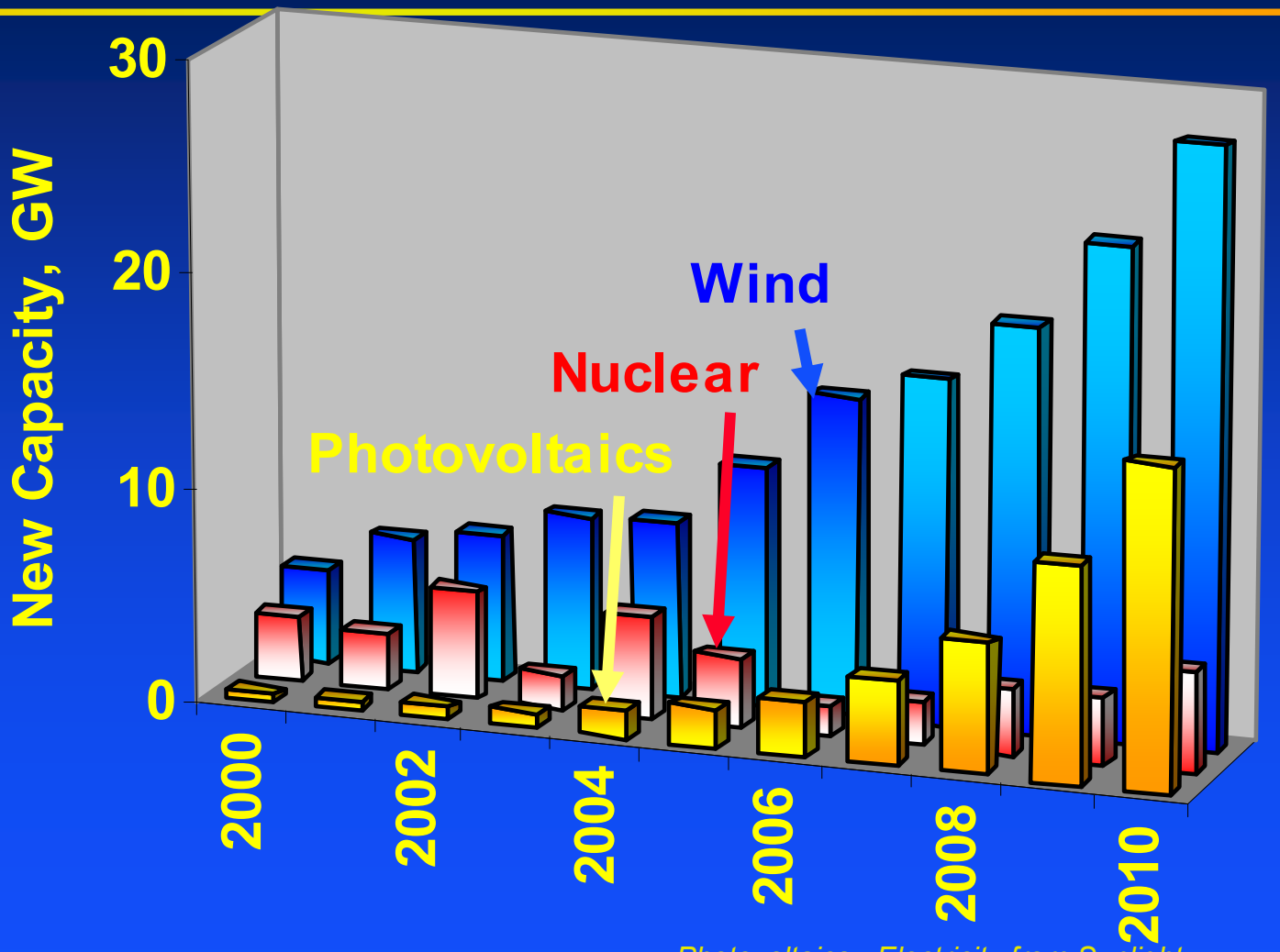
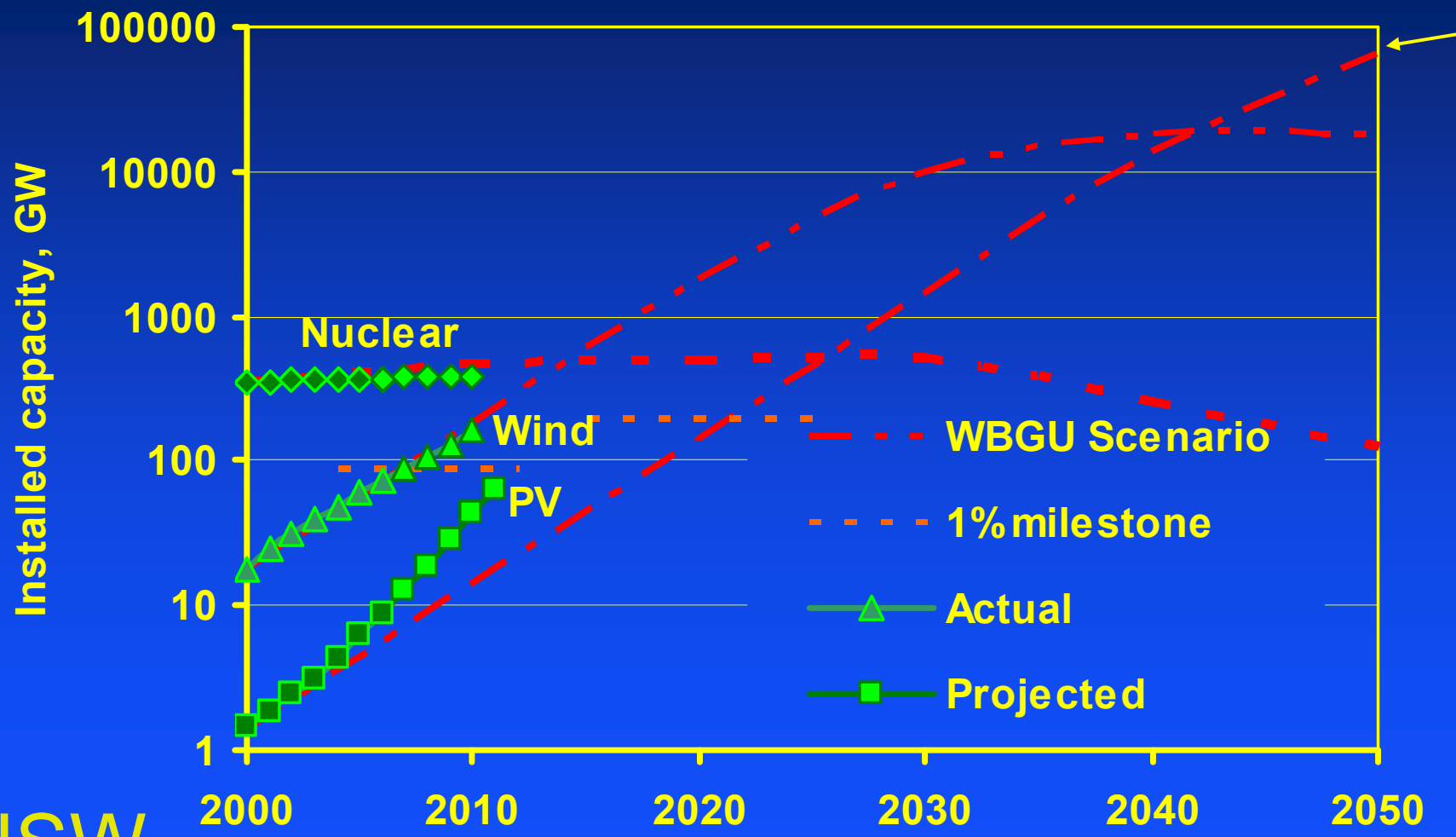


“Submerged” progress



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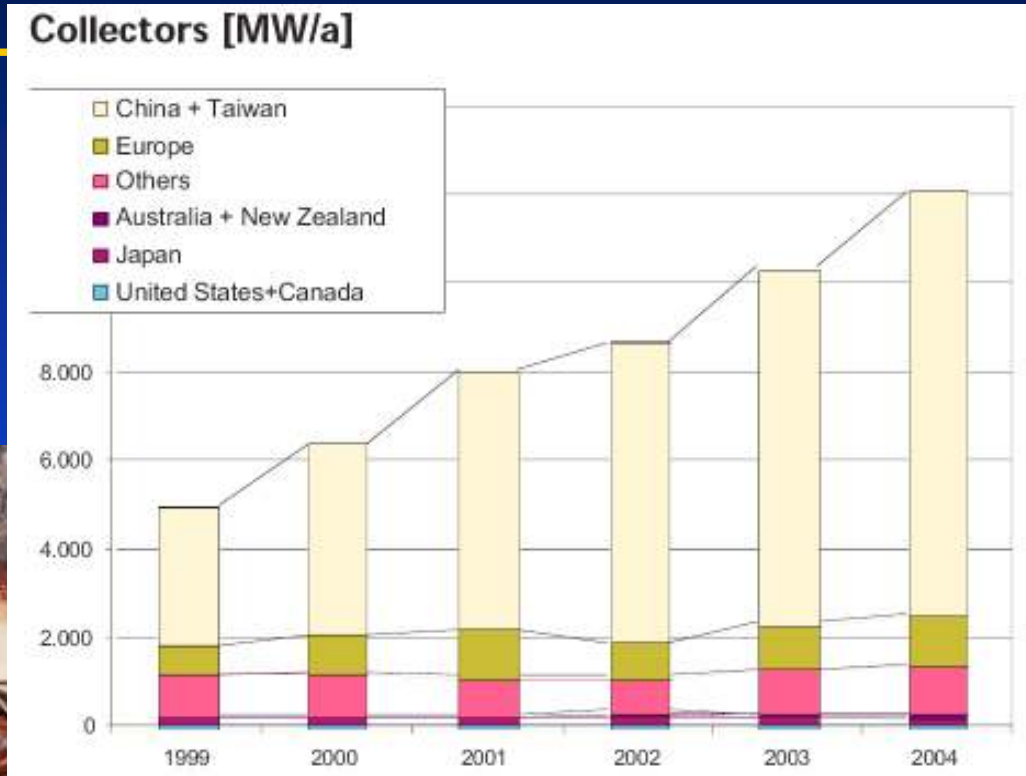
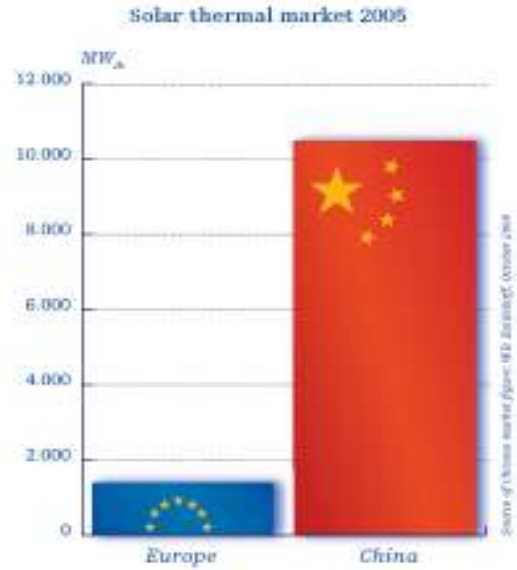
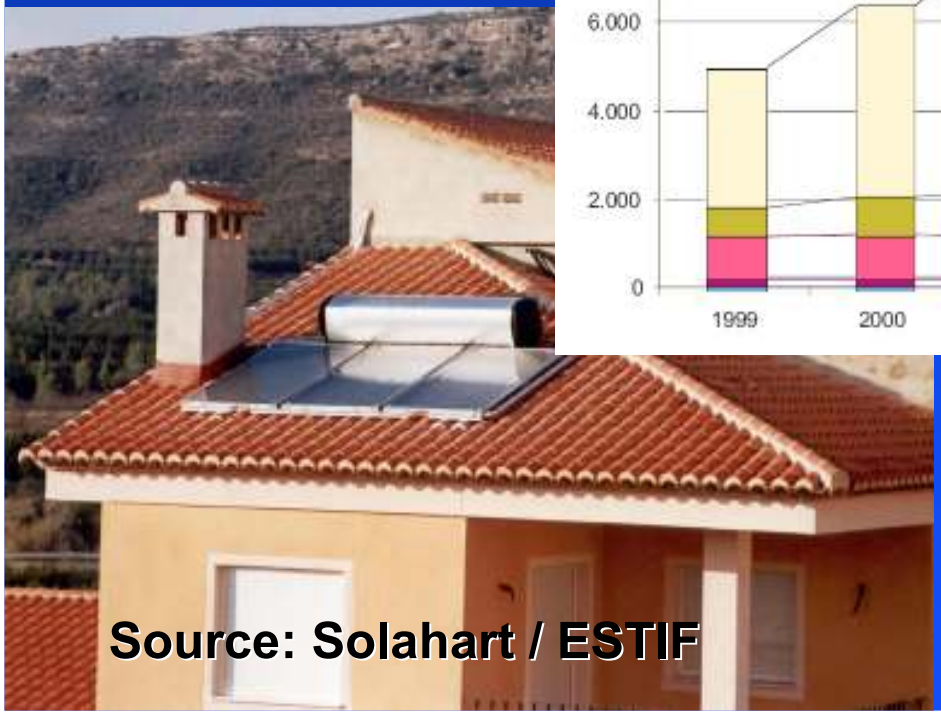
Solar heating

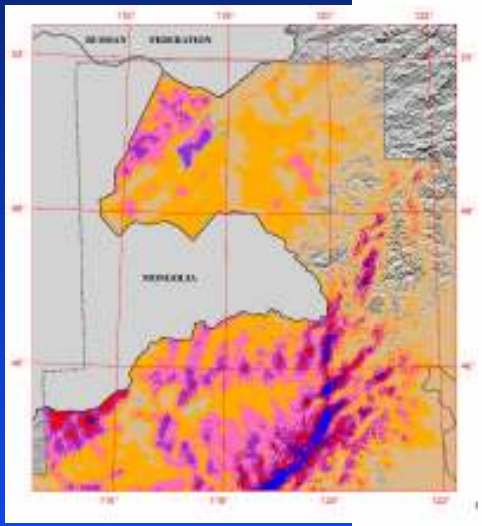






Source: Solahart / ESTIF

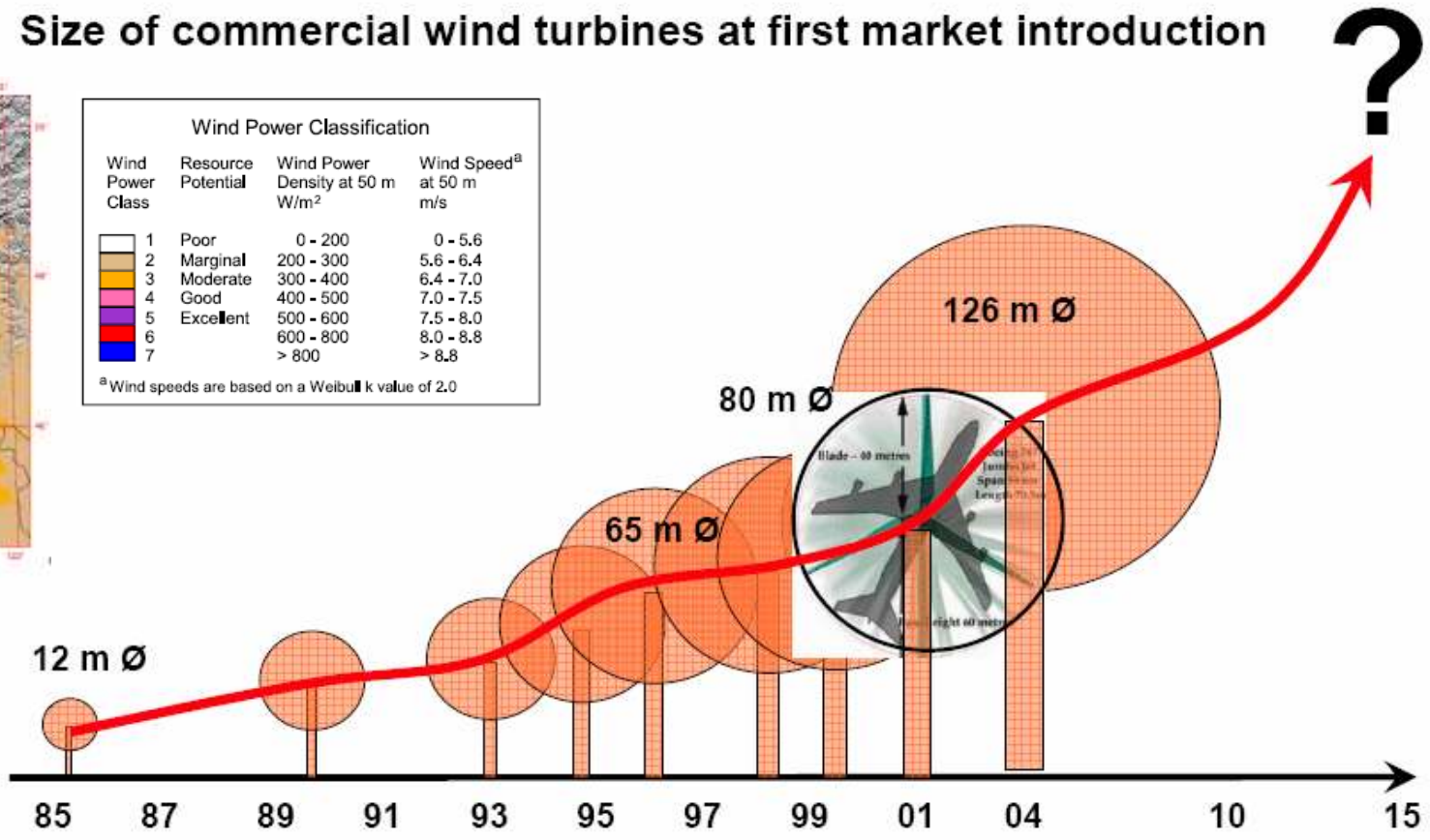
Wind



Wind Power Classification

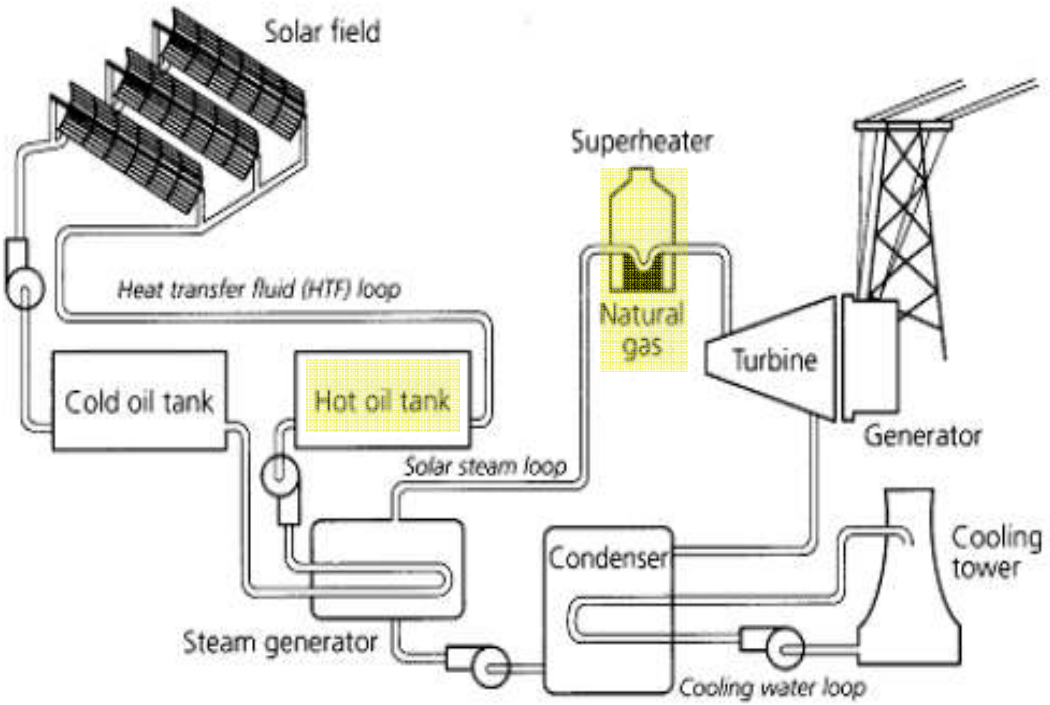
Wind Power Class	Resource Potential	Wind Power Density at 50 m W/m²	Wind Speed[a] at 50 m m/s
1	Poor	0 - 200	0 - 5.6
2	Marginal	200 - 300	5.6 - 6.4
3	Moderate	300 - 400	6.4 - 7.0
4	Good	400 - 500	7.0 - 7.5
5	Excellent	500 - 600	7.5 - 8.0
6		600 - 800	8.0 - 8.8
7		> 800	> 8.8

[a] Wind speeds are based on a Weibull k value of 2.0



Concentrating Solar Power (CSP)

Parabolic trough



Oil storage, gas boosting (25%)

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Issues

Positives

. Integrate with fossil-fuel plant

. Heat storage relatively cheap

. Lower capital cost than standard PV (at present)

Negatives

. Compete on wholesale market against wind & fossil-fuels

. Clear sky needed

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Photovoltaic Applications

Conventional Generators

PV Central Station

PV Mini-Utility

Diesel

PV Residential

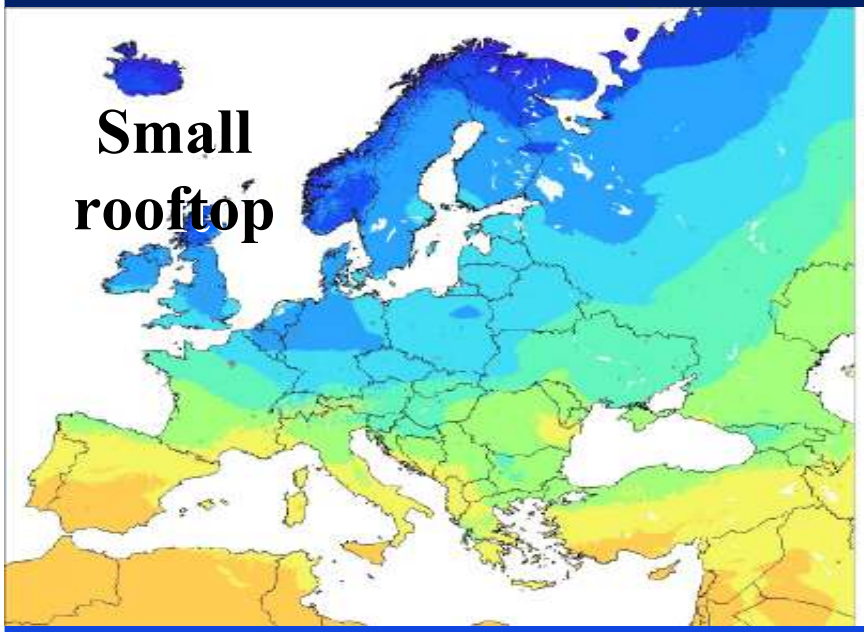
PV RAPS

Thermal overload

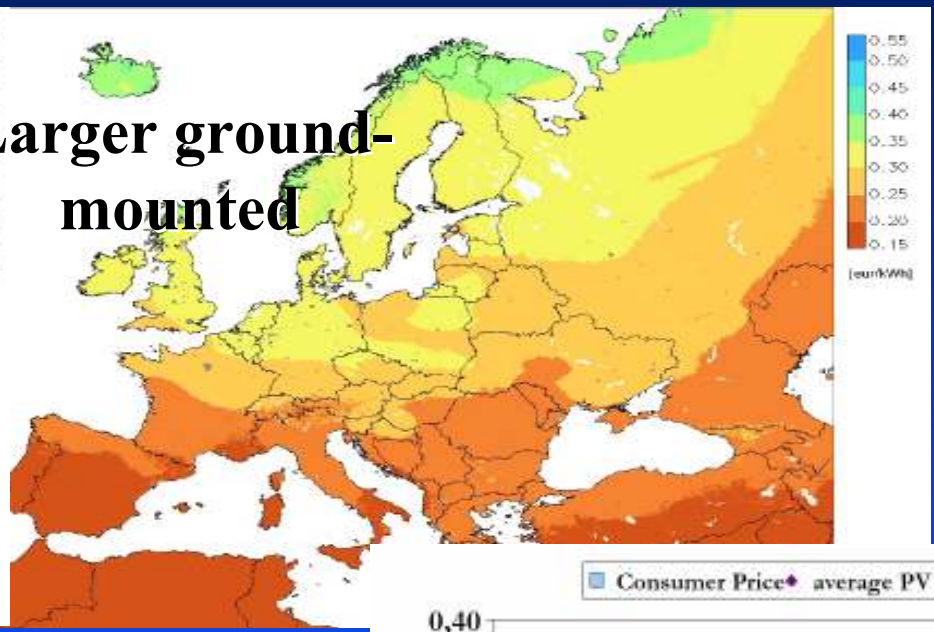
Photov

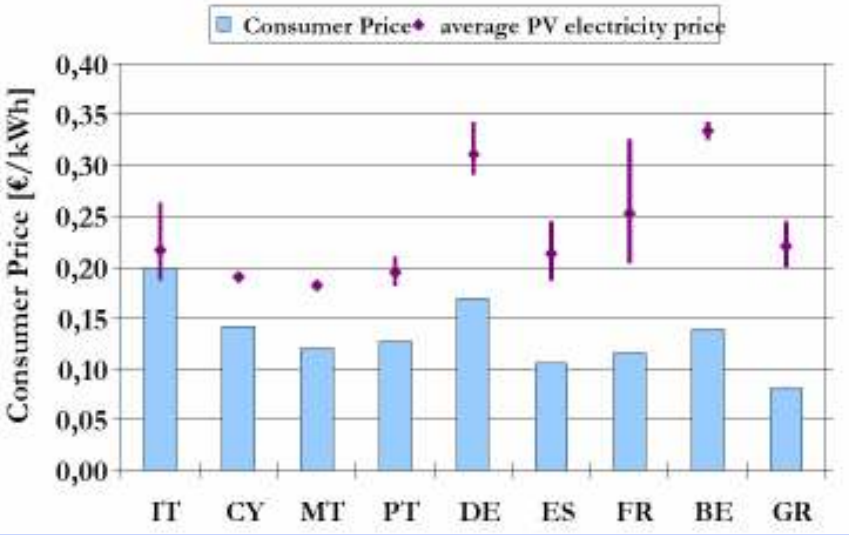
Present costs: Europe

Small rooftop



Larger ground-mounted





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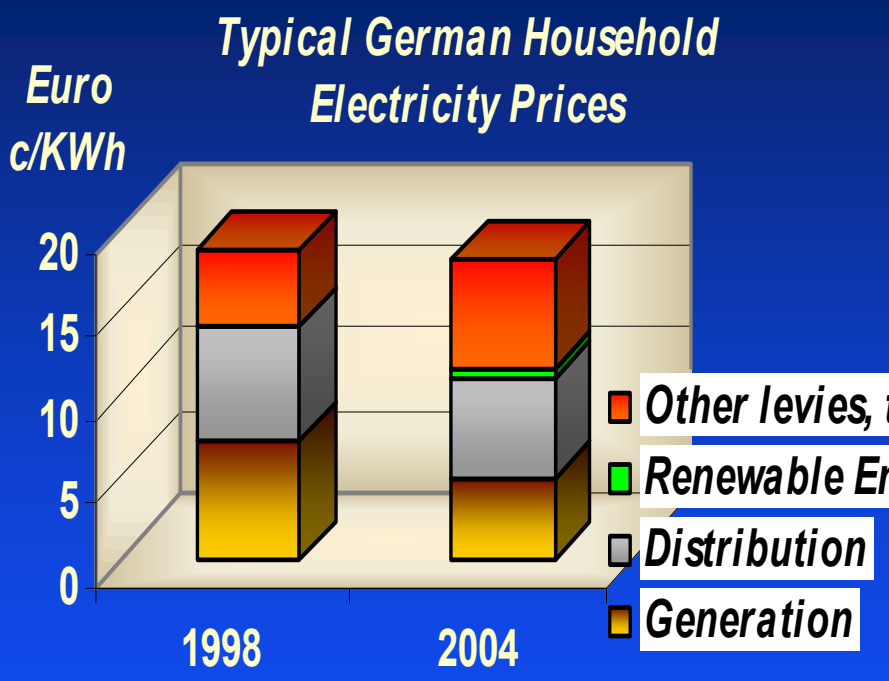
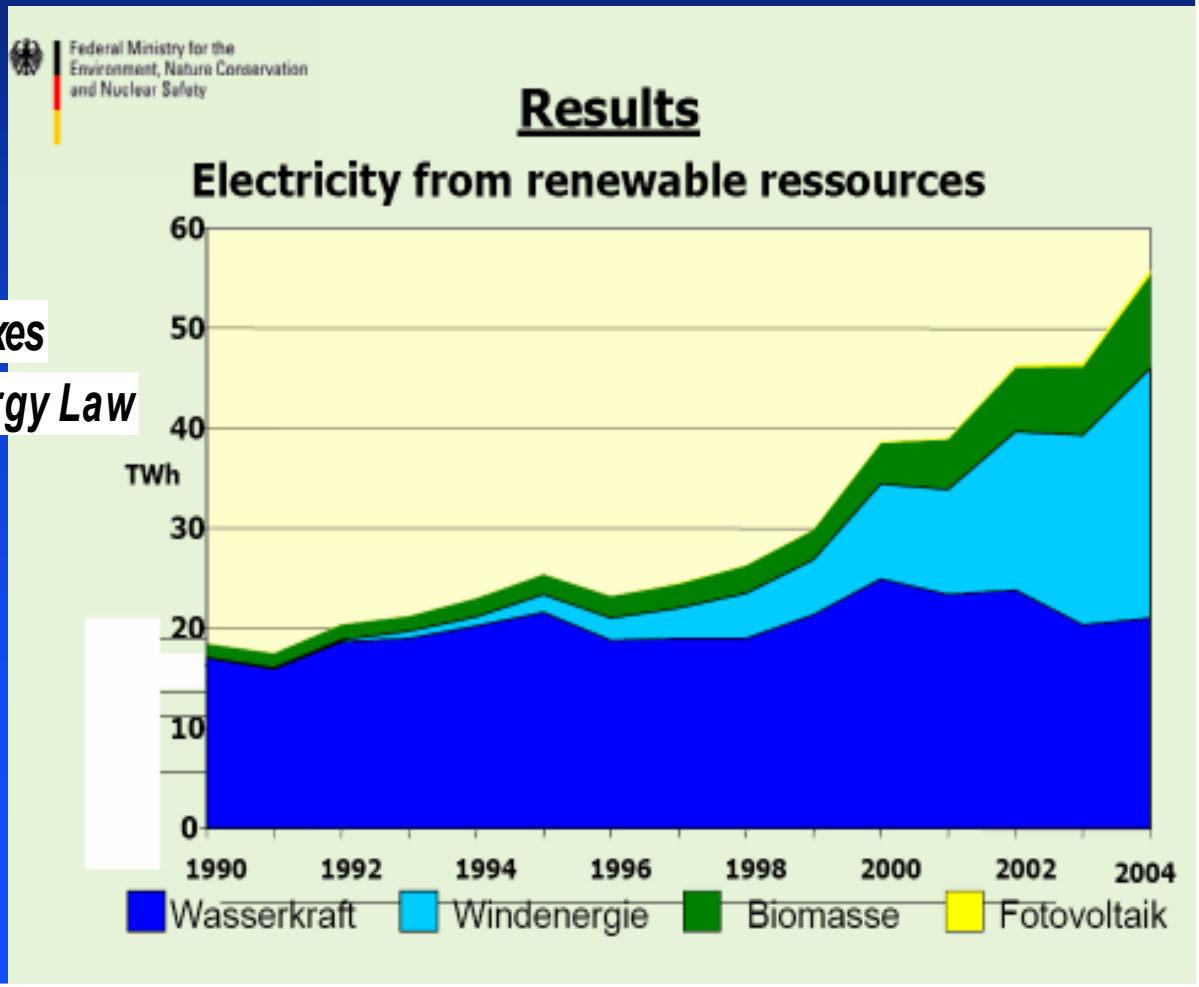
Joint Research Centre

Germany: feed-in tariff results





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USA: Power Purchase Agreements?

Press Release, 5 June 2007
Macy's Goes Green In California
Macy's to install solar power in 26 stores

Googleplex, Google's Mountain View campus

Solar Services Model

Host (Staples)
- Receives solar power from on-site system under long-term PPA
- Provides space and access but does not own array
- No capital required

On-site solar PV system ⇄ *10 year PPA*

Project developer (Sun Edison)
- Receives income from electricity sales
- Arranges financing, design and construction

equipment, installation, warranties ⇄ *sales and O&M revenue*

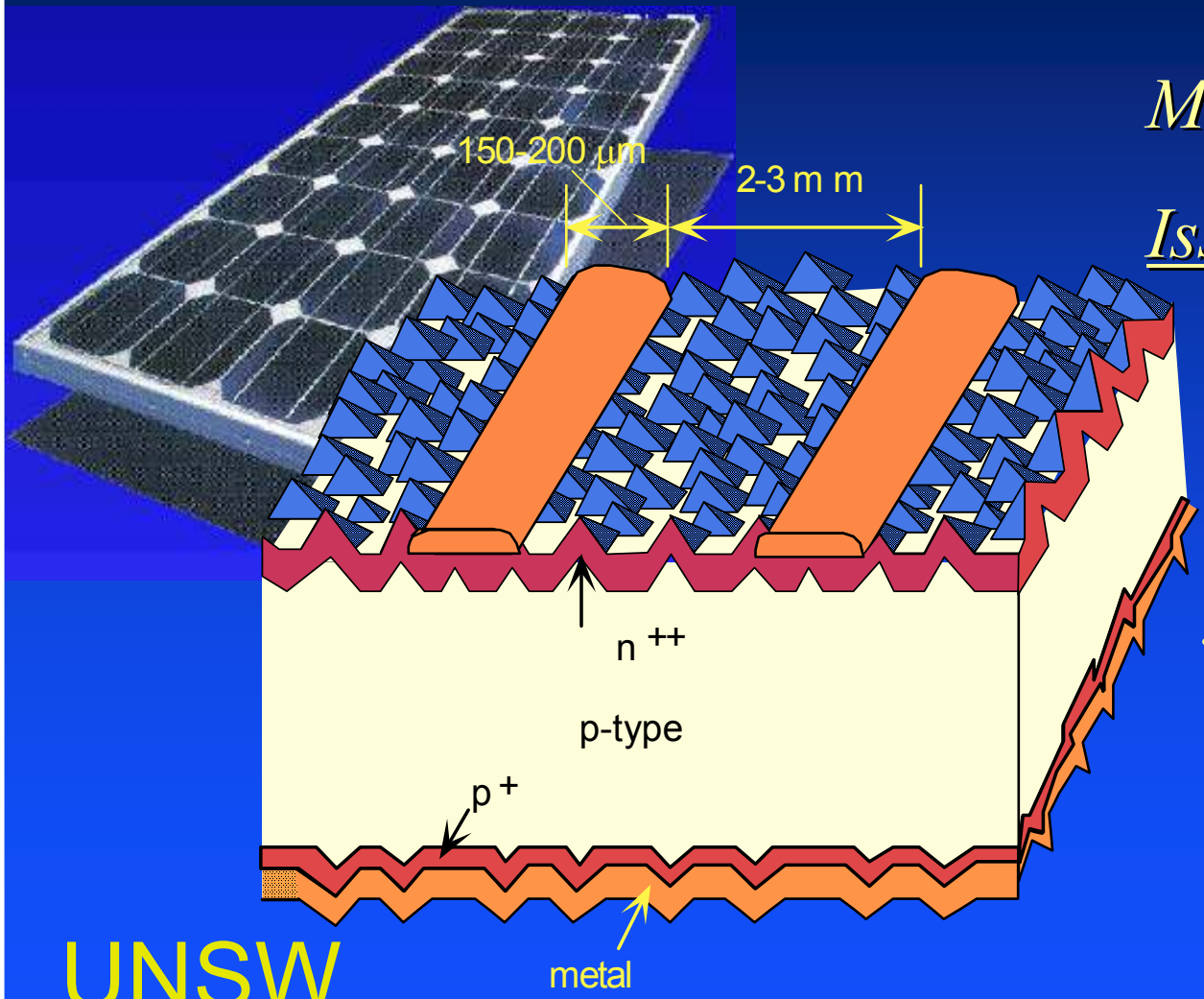
Manufacturer/ installer (BP Solar)
- Receives revenue from sale of panels, inverters, O&M, etc.
- Provides warranties (equipment & performance)

financing ⇄ *ROI*

Investor (Hudson United, Goldman Sachs)
- Receives low-risk ROI from electricity sales and from state and federal incentives
- Provides capital and owns system for 5+ years

WORLD RESOURCES INSTITUTE
GREEN POWER MARKET DEVELOPMENT GROUP
CORPORATE CASE STUDIES

First generation cells



More Si than microelectronics

Issues

. thinner cells

. simpler Si purification

. higher conversion efficiency

Second Generation: thin-film

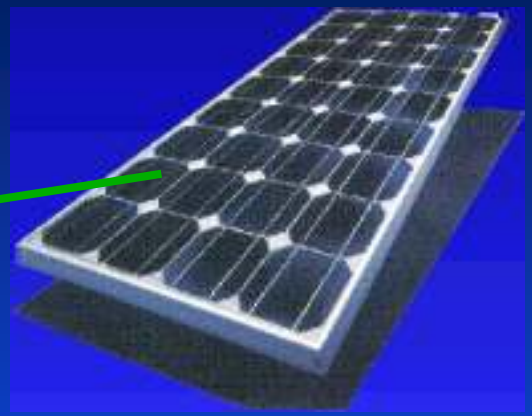
Advantages

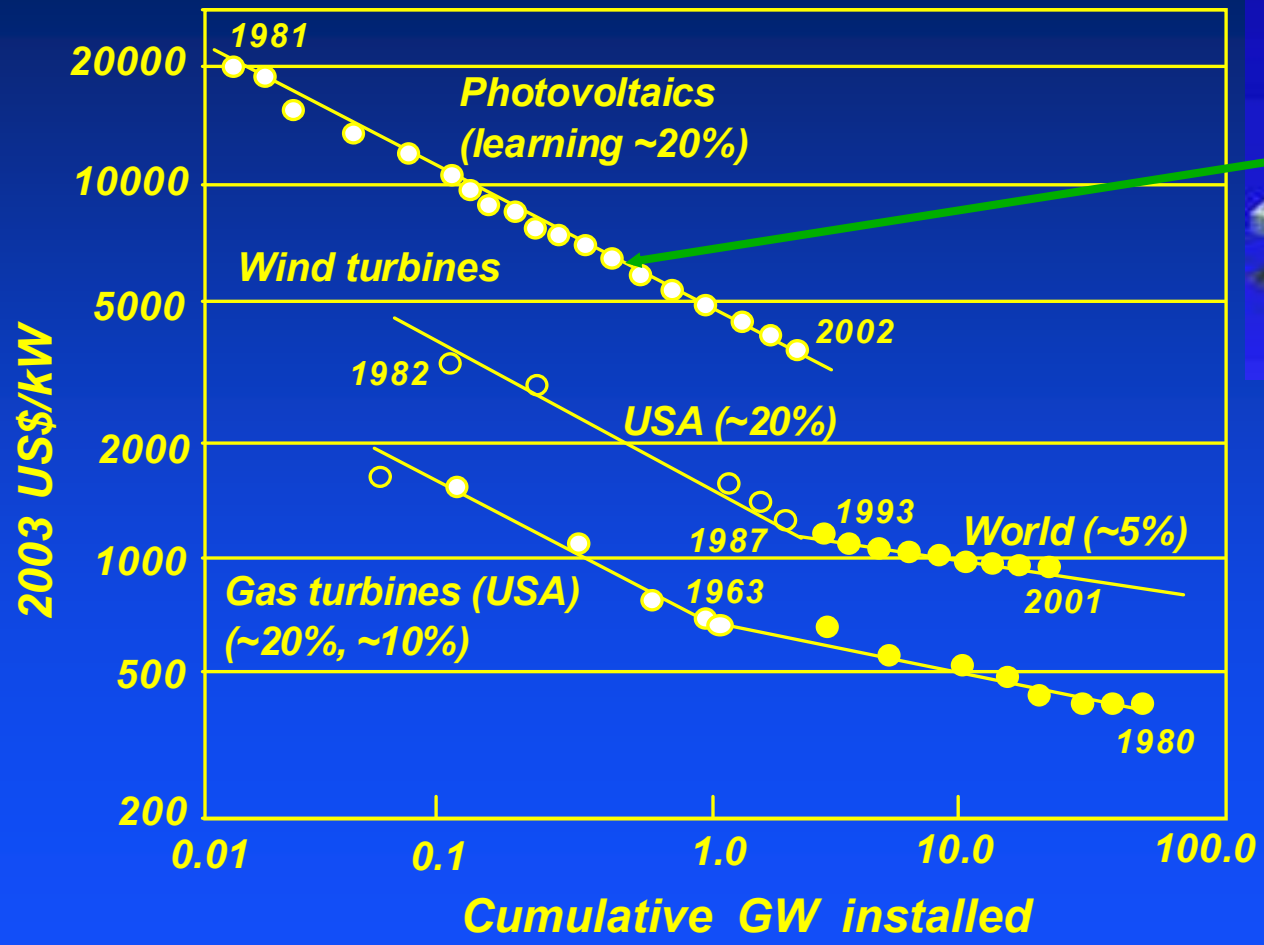
- *low materials cost*
- *large manufacturing unit*
- *fully integrated modules*
- *aesthetics, ruggedness?*

Thin-film Technologies

- ***Silicon***
  - *amorphous*
  - *microcrystalline*
  - *polycrystalline*
- ***Chalcogenide*** *(polycrystalline)*
  - *CIS, CIGS [$Cu(In,Ga)(Se,S)_2$]*
  - *CdTe*
- ***Dye sensitised, Organics***

Cost reduction





Adapted from Grübler et al.,1999

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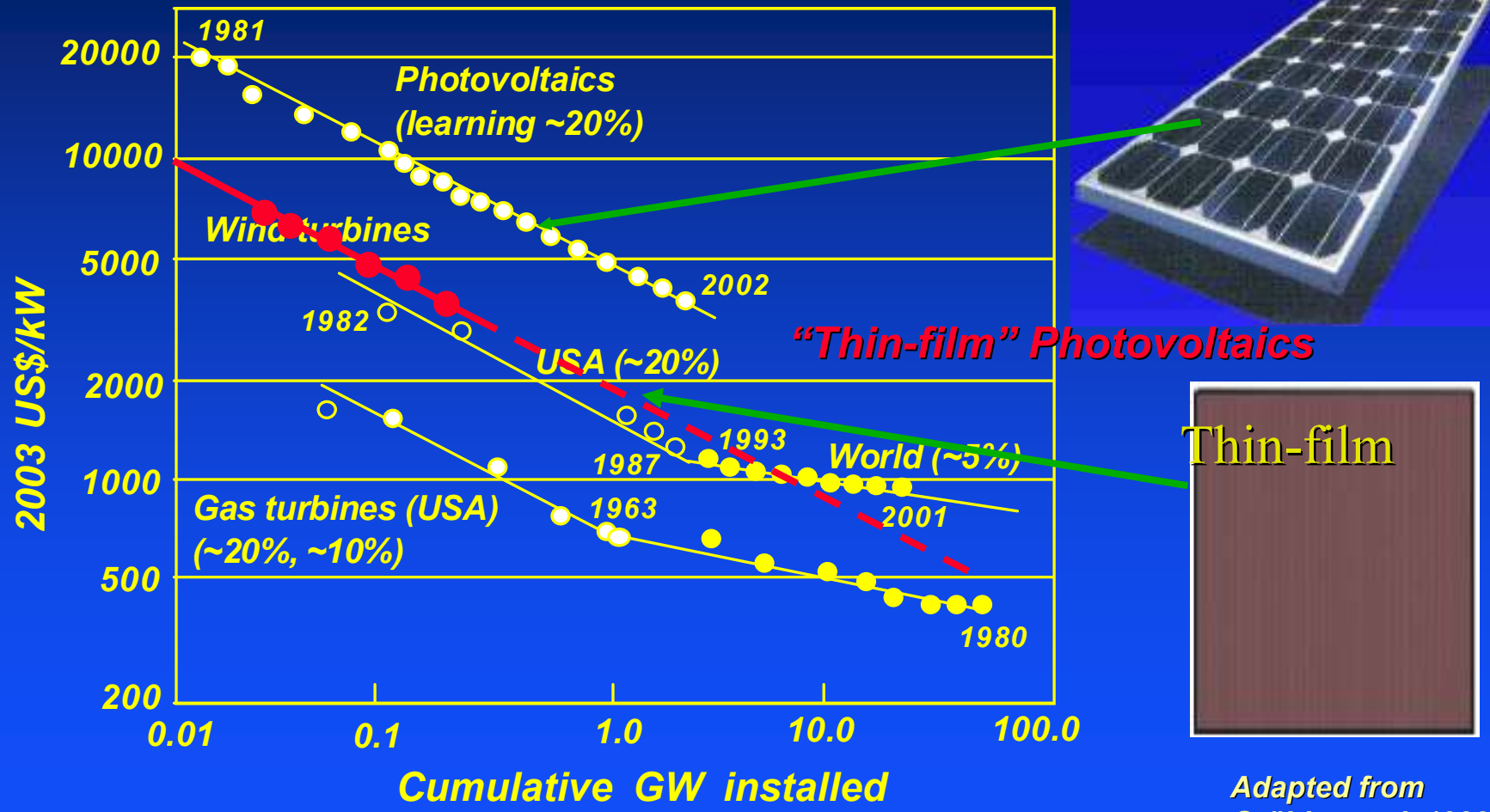
Cost reduction



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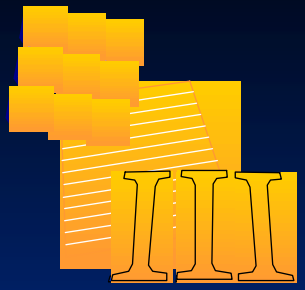

Summary

Wind

. cheapest of present active renwable options

. cheap Chinese turbines – urgently needed?

Solar Water Heating

. self-sustaining market some countries

. recent studies suggest 20-40 EJ/a contribution 2050

Photovoltaics and CSP

. market support needed

. technology change to drive PV growth

. 1% electricity by 2020 (now ahead of schedule)

. 25% primary energy by 2050 (WBGU)

. 64% primary energy by 2100?