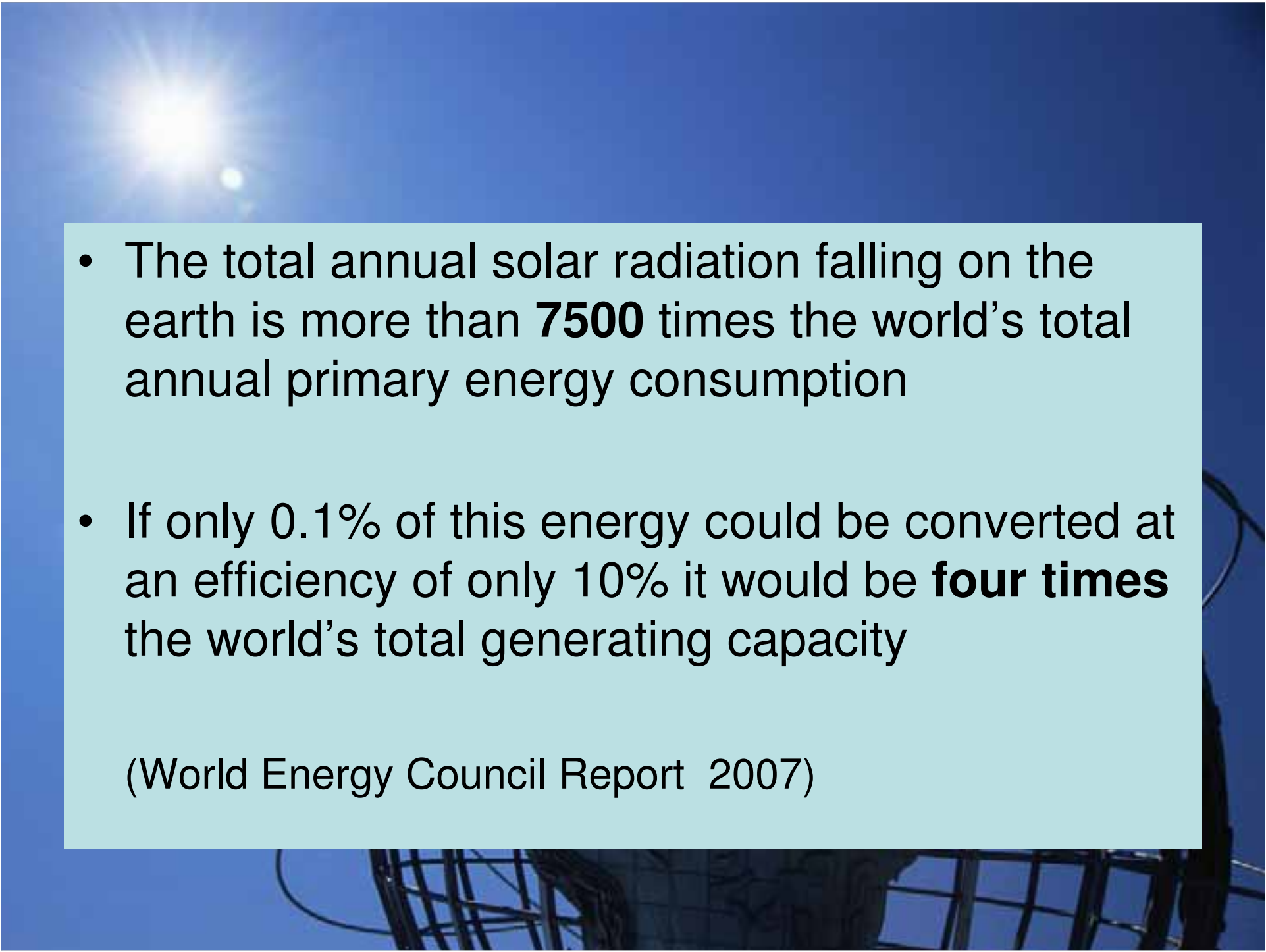


Solar Energy

An Australian Perspective



- 
- The total annual solar radiation falling on the earth is more than **7500** times the world's total annual primary energy consumption
 - If only 0.1% of this energy could be converted at an efficiency of only 10% it would be **four times** the world's total generating capacity

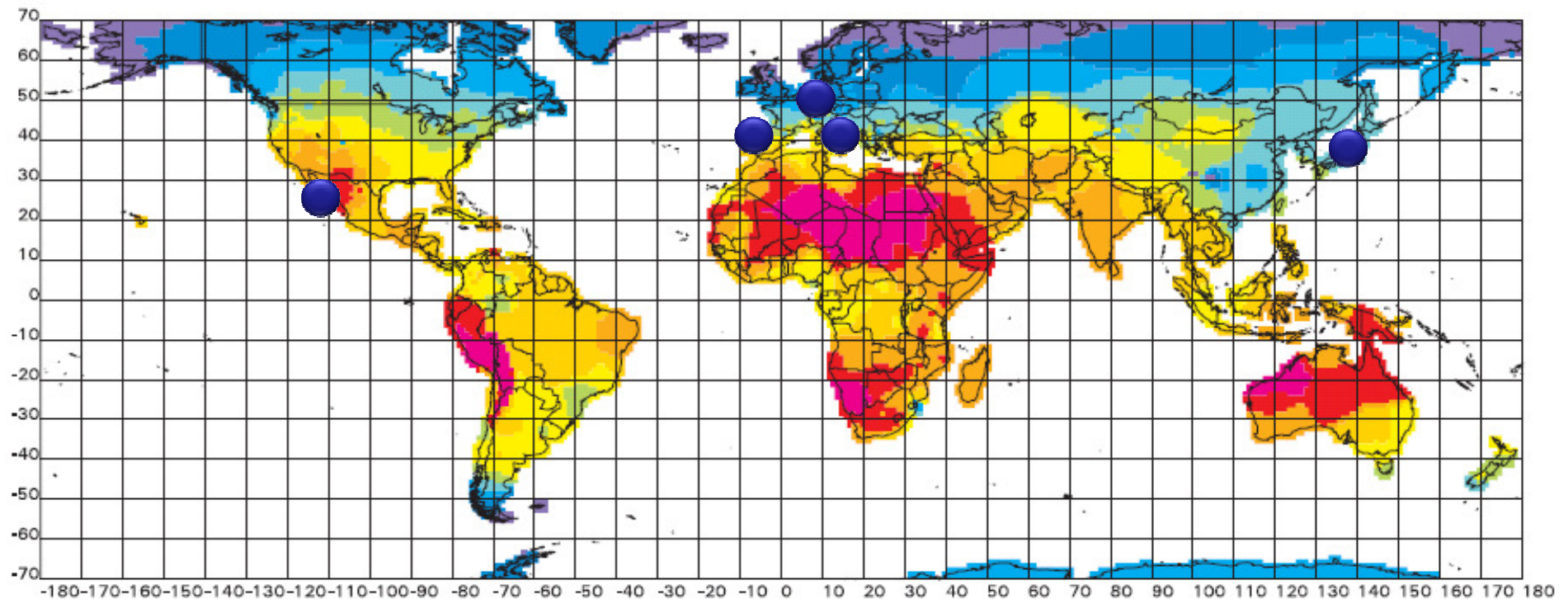
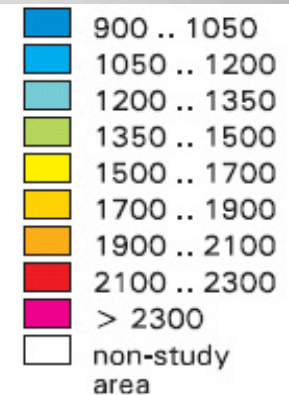
(World Energy Council Report 2007)

How much do we get?

METEONORM 4.0



Global Irradiation: year [kWh/m²]



Solar Energy

- Solar energy provides energy as
- Heat (Solar Thermal)
 - Solar Hot water systems
 - Heating of houses
 - Power generation
- Light
 - Building natural lighting
 - Power from photovoltaics

Small scale solar thermal

- Hot water
 - Rebates
 - Gas boosted (not electric boosted)
- Passive solar design
 - Building energy ratings
 - Estate layout
 - Retrofitting

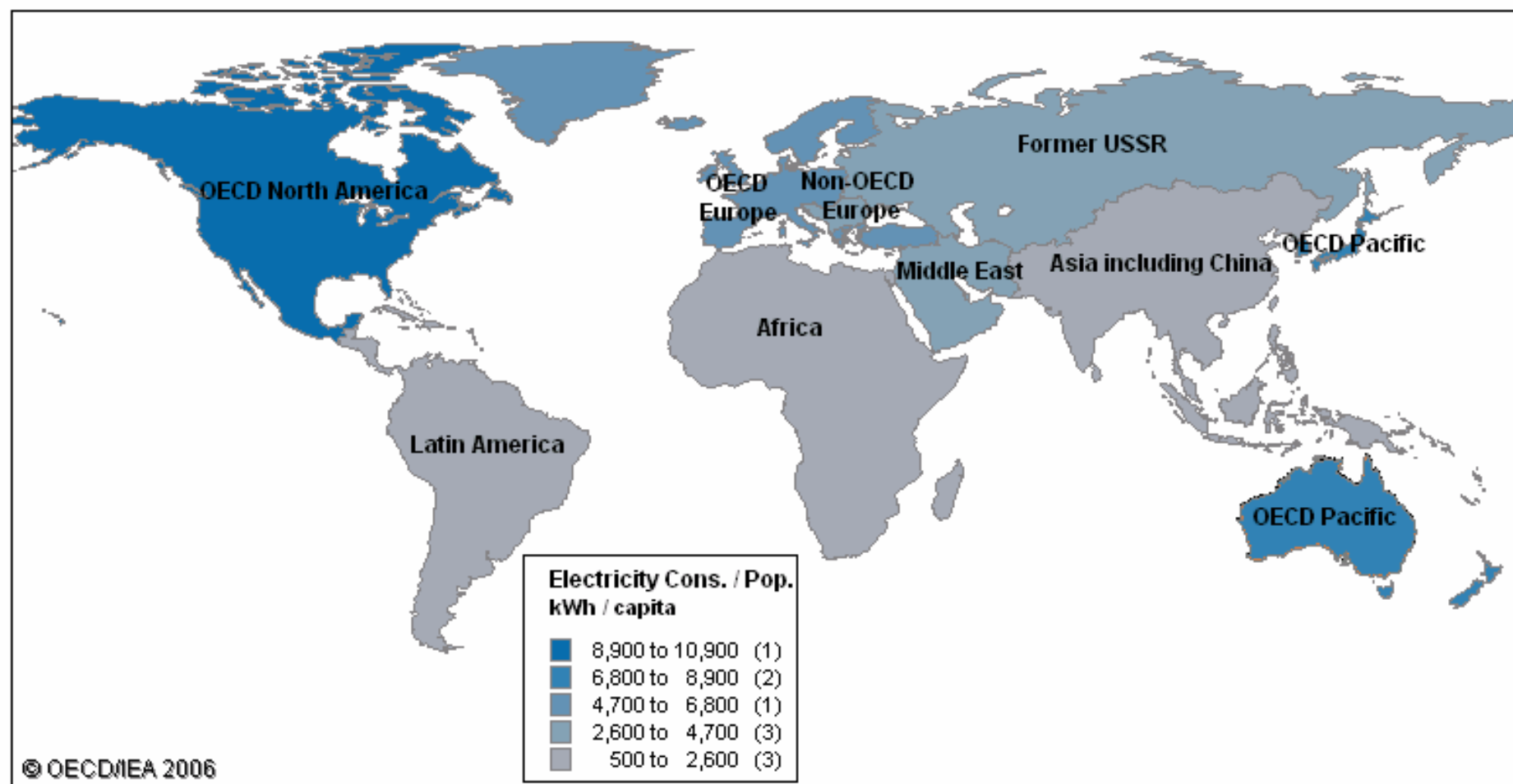
Sustainable House Day



Power generation

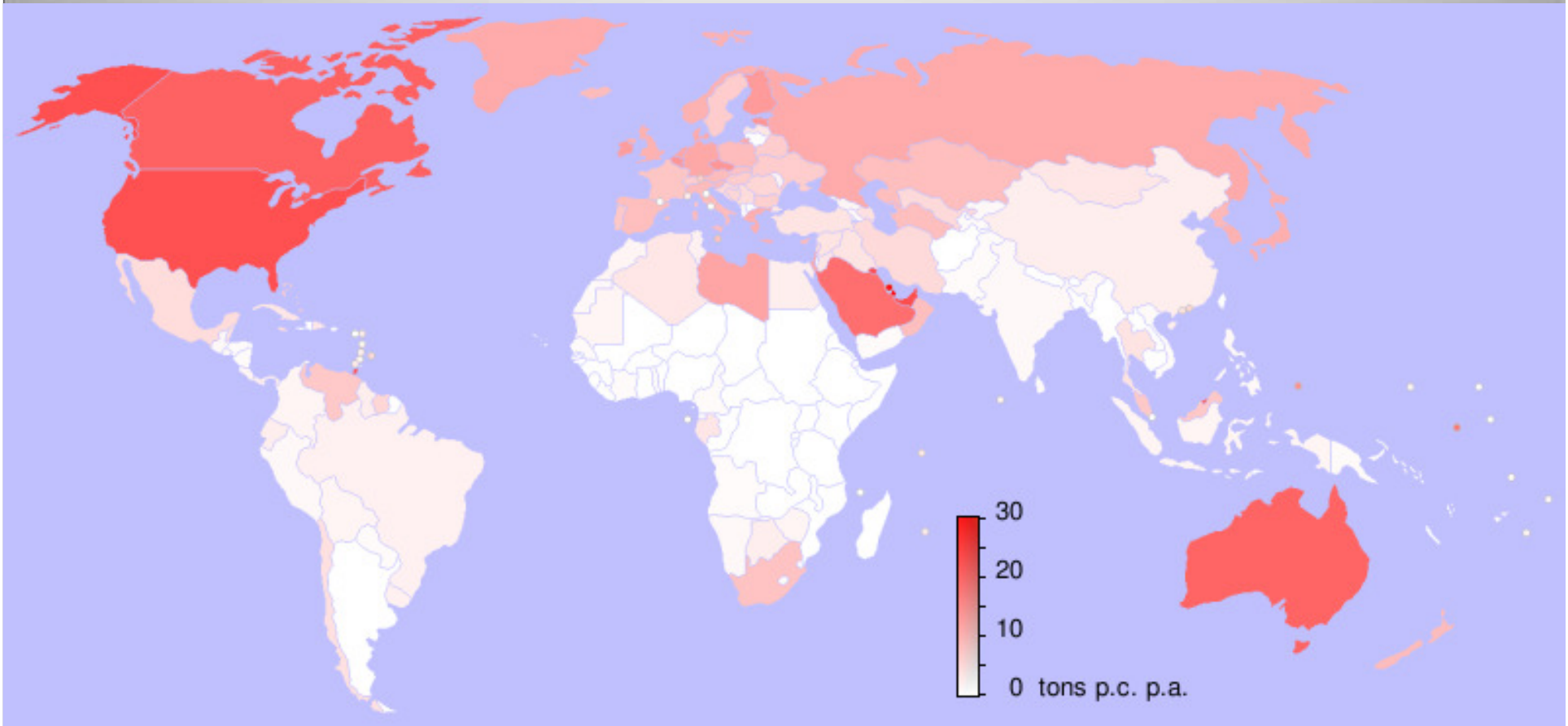
- This presentation focuses on power generation
 - It is the biggest challenge to replace our present dependency on coal
 - It's our greatest economic threat for both internal usage and export
 - **What if the world doesn't want to use coal any more?**
 - **What do we export then?**

Map Energy Indicators - World - Electricity Consumption / Population



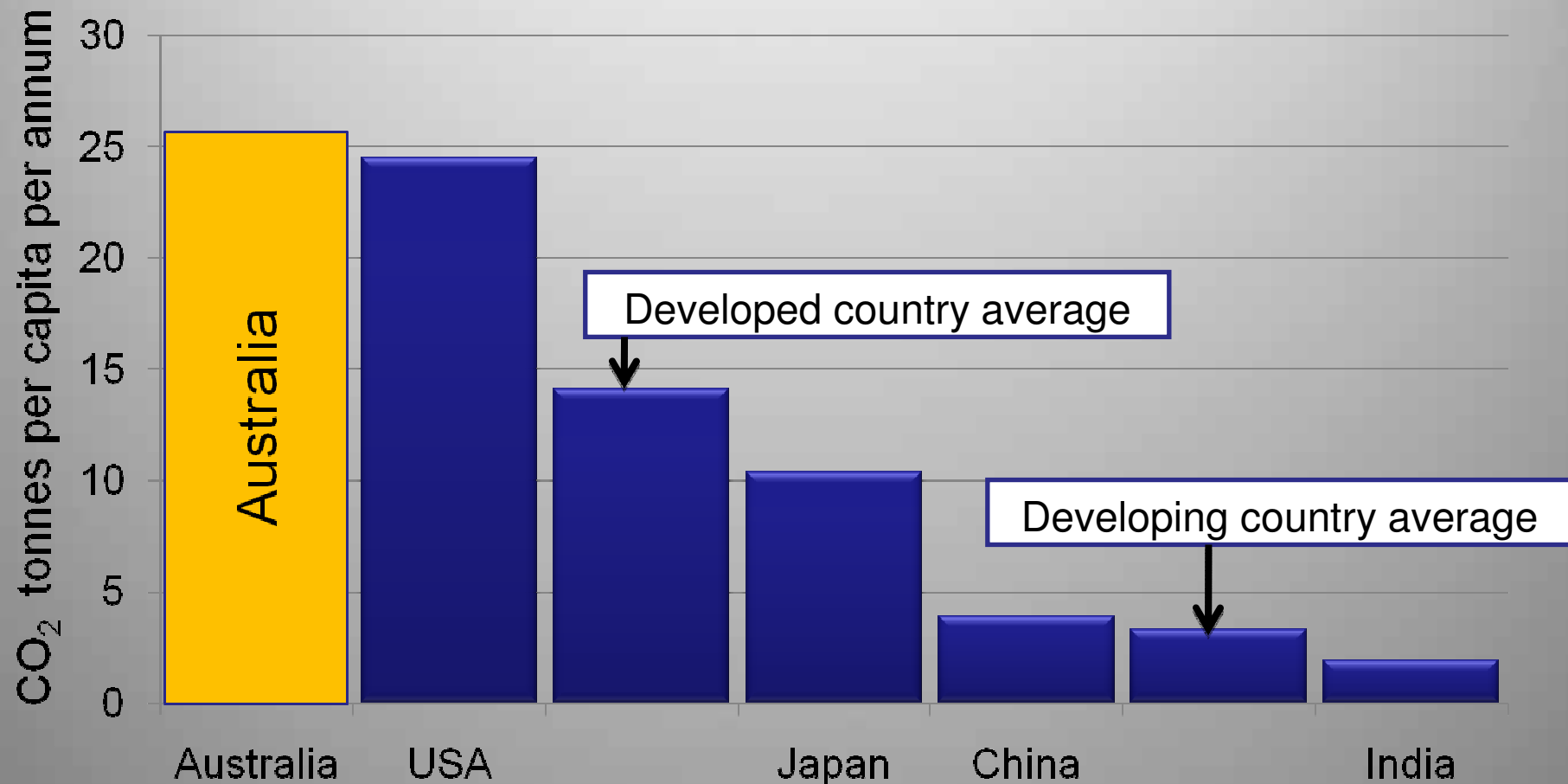
Electricity Consumption: Gross production + imports - exports - transmission/distribution losses of electricity.

CO₂ emission per capita per year



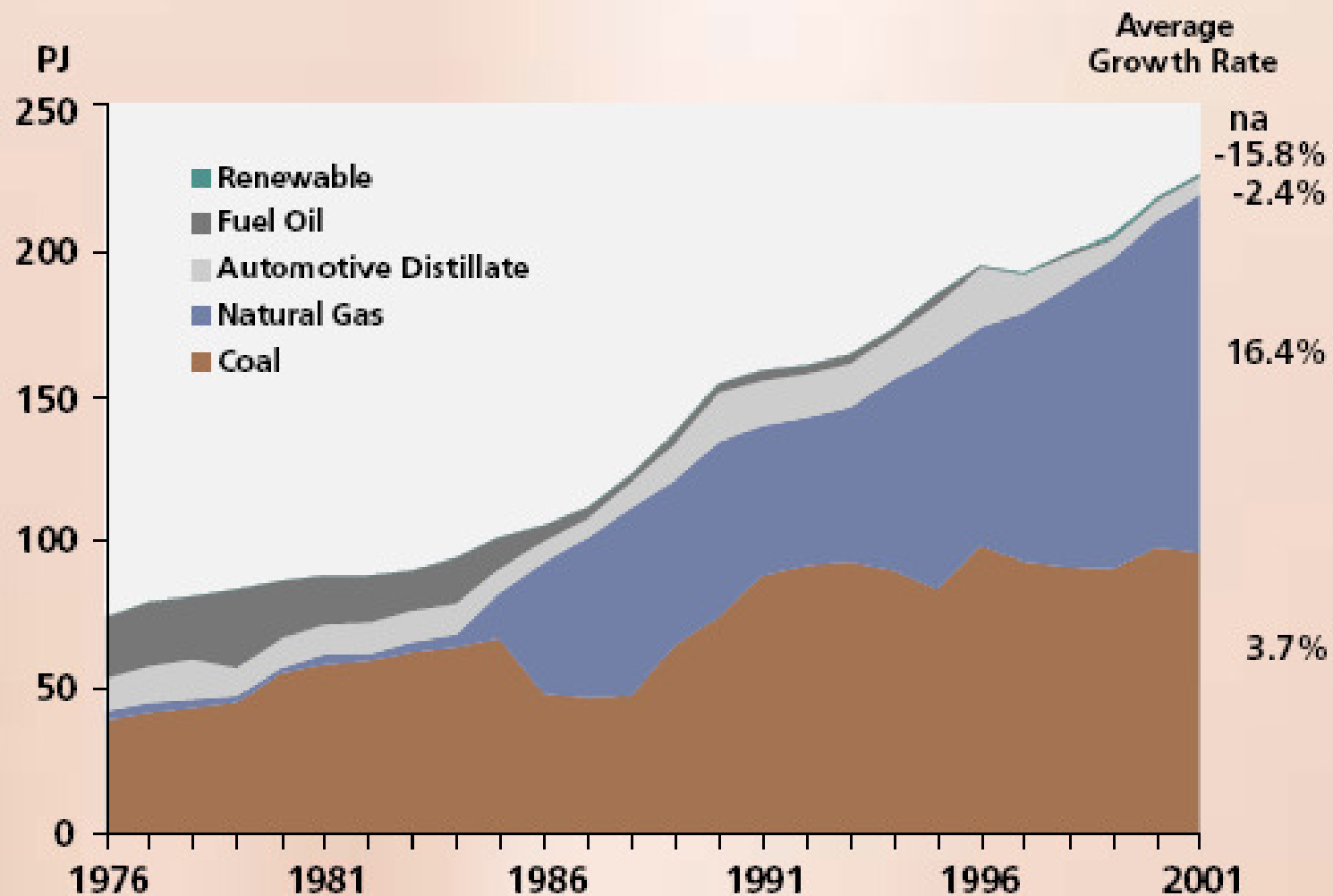
Australia in Perspective

Chart Title



SOURCE: World Resources Institute 2005

WA Electrical Statistics



Source: Office of Energy estimates, based on Australian Bureau of Agricultural and Resource Economics data.

WA August 2006

- 6192MW installed capacity
 - 4.5% renewable
 - 95.5% non-renewable
- South West Interconnected System (SWIS)
- 4769MW installed capacity
 - 5% renewable
 - 95% non-renewable

Land area required Collie Coal



WA Coal fired Power

- Kwinana
- Collie
- Muja
- Total capacity $\approx 2\text{GW}$
- If run at full capacity would produce

$\approx 50\text{GWhr/day}$

- Average solar energy striking the earth in the south west of WA
- $4.4\text{kWhr/m}^2/\text{day}$
- Energy landing on the Collie coal area

$\approx 800\text{GWhr/day}$

WA load growth

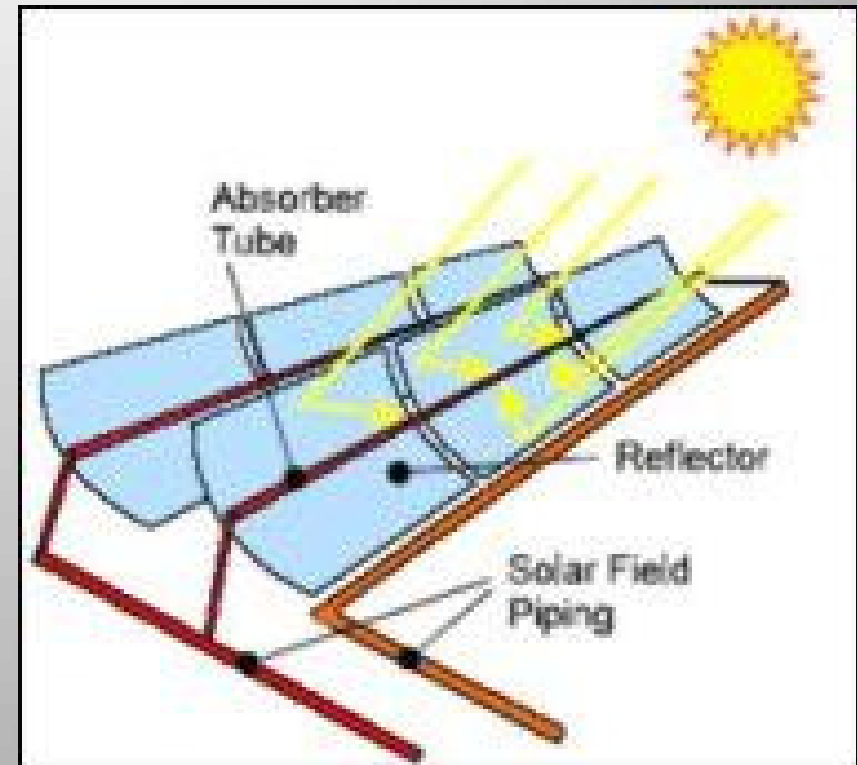
- Energy demand
 - Increasing 2.2% per annum to 2015/2016
 - Peak power demand
 - Increasing 3.2% per annum
 - Attributed to air conditioning
- Source: Office of Energy

Types of Solar Power Generation

- Two main types
 - Large scale solar thermal power generation
 - Small to medium scale photovoltaic power generation

Solar Thermal

- Uses the heat from the sun
- Transferred to boiler
- Generates steam
- Traditional technology from steam to electricity



USA



USA



Spain



Australia - Liddell



Australia - Liddell



Australia - ANU



Cost of Advanced Solar with Storage vs New Coal

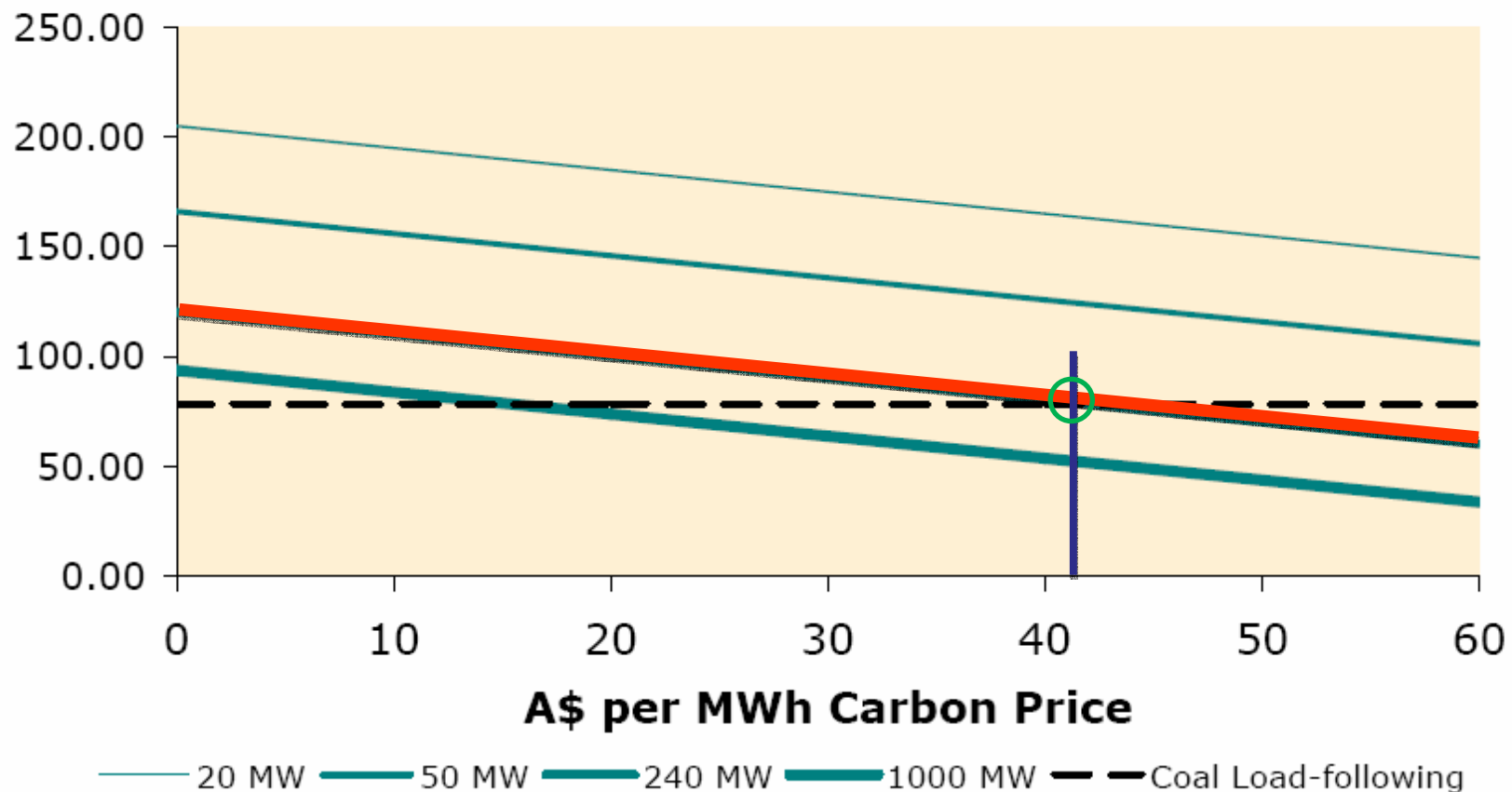
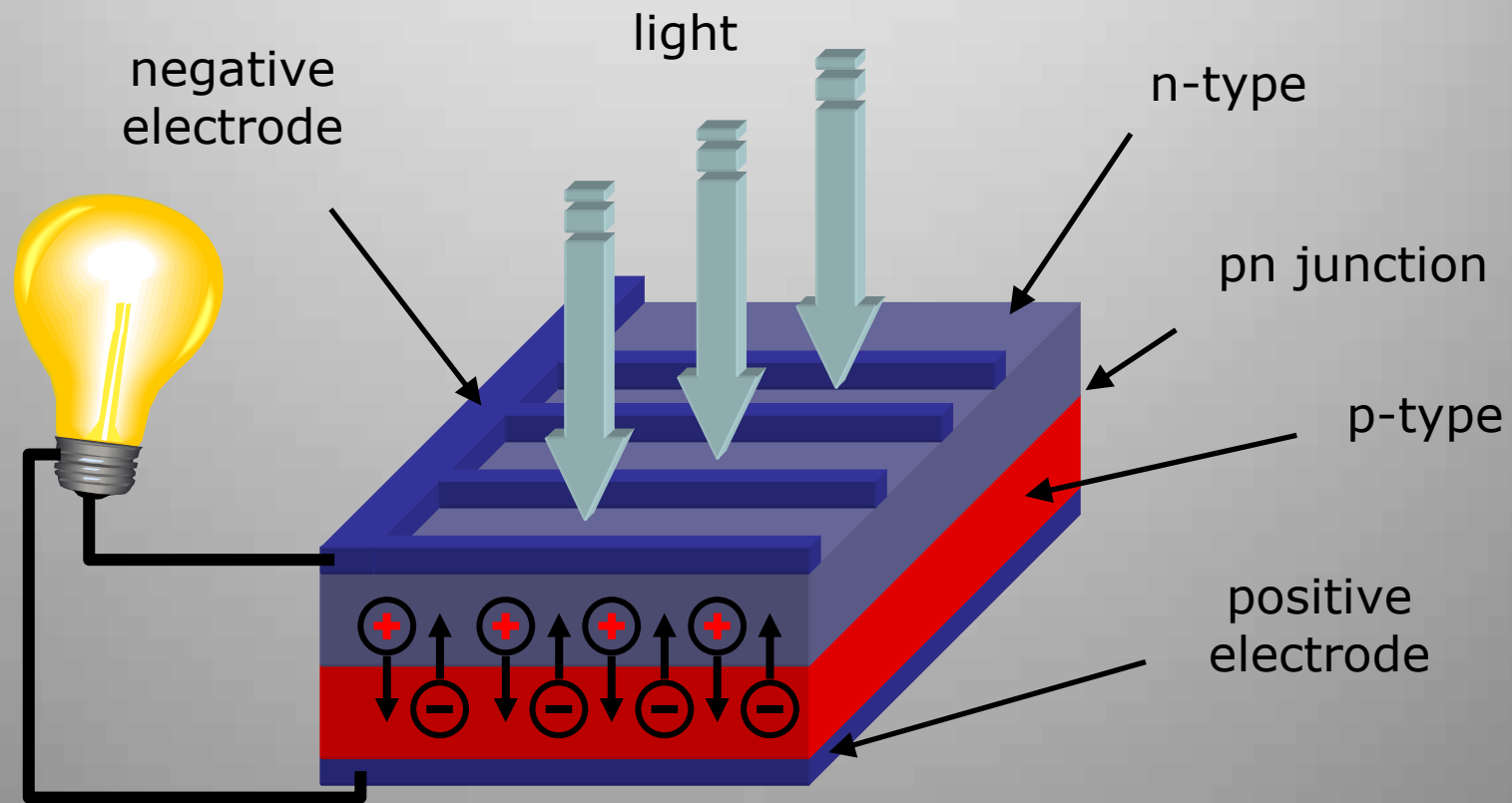


Figure 4. Future cost in A\$ per MWh of CLFR plants using low temperature turbines, as a function of plant array area. Anticipated coal cost at 75% capacity factor is shown as a dashed line.

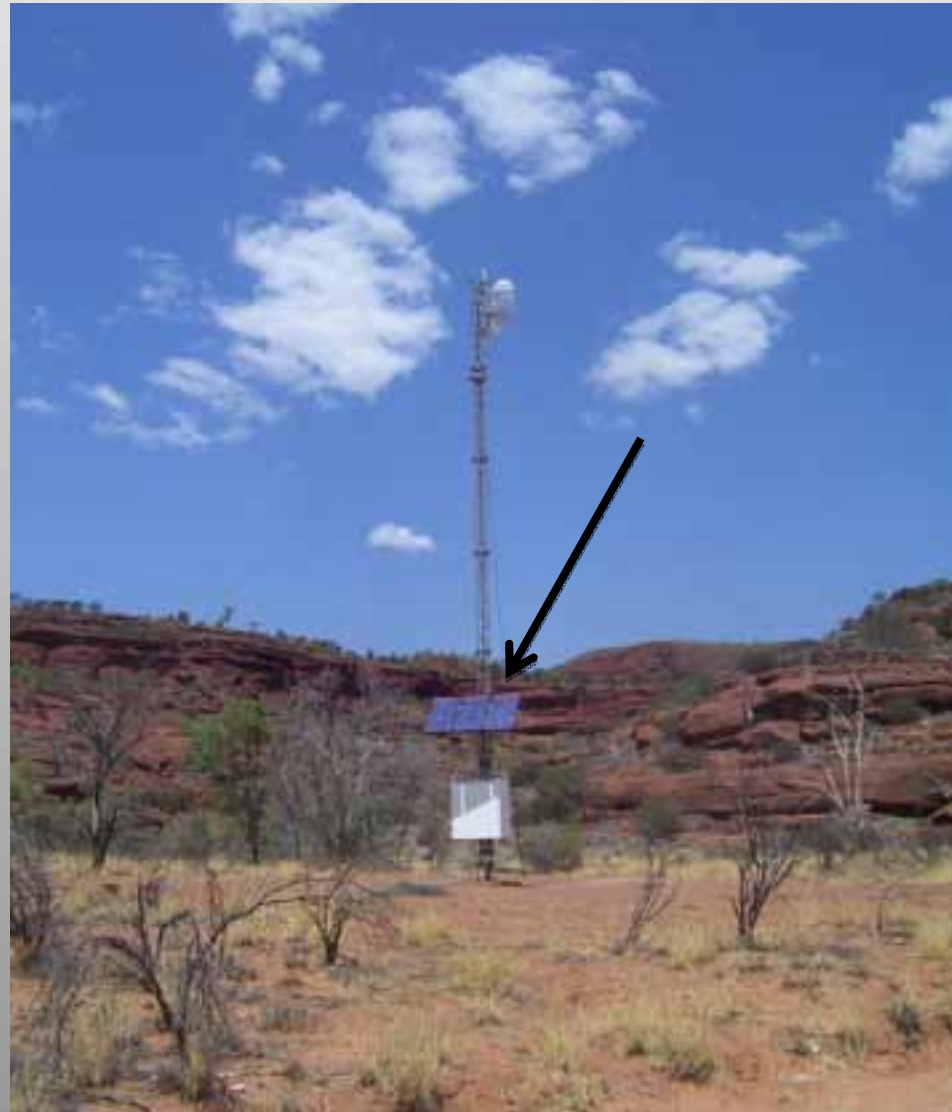
Constraints

- Energy Storage
 - Thermal storage is possible at relatively low cost
- Track Record
 - Financing is still difficult
- Only works on a large scale

Energy from Light Photovoltaics



Australia



Australia



Australia



Australia



Australia 84kW



Australia 225kW



Australia 225kW



USA 5MW



Germany 5MW



16/11/2005

Italy 13MW



Italy



IEA countries PV power (Cumulative)

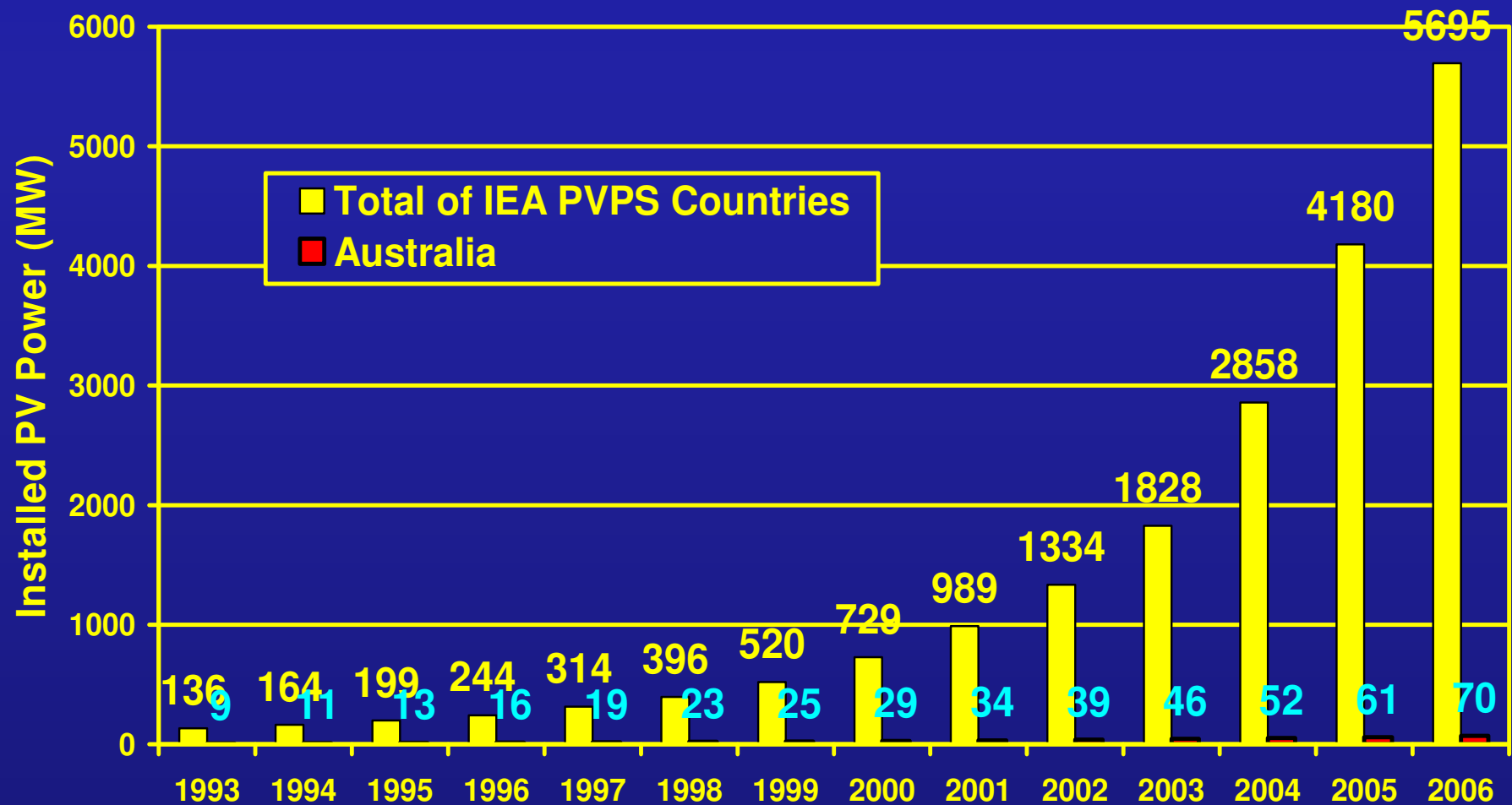
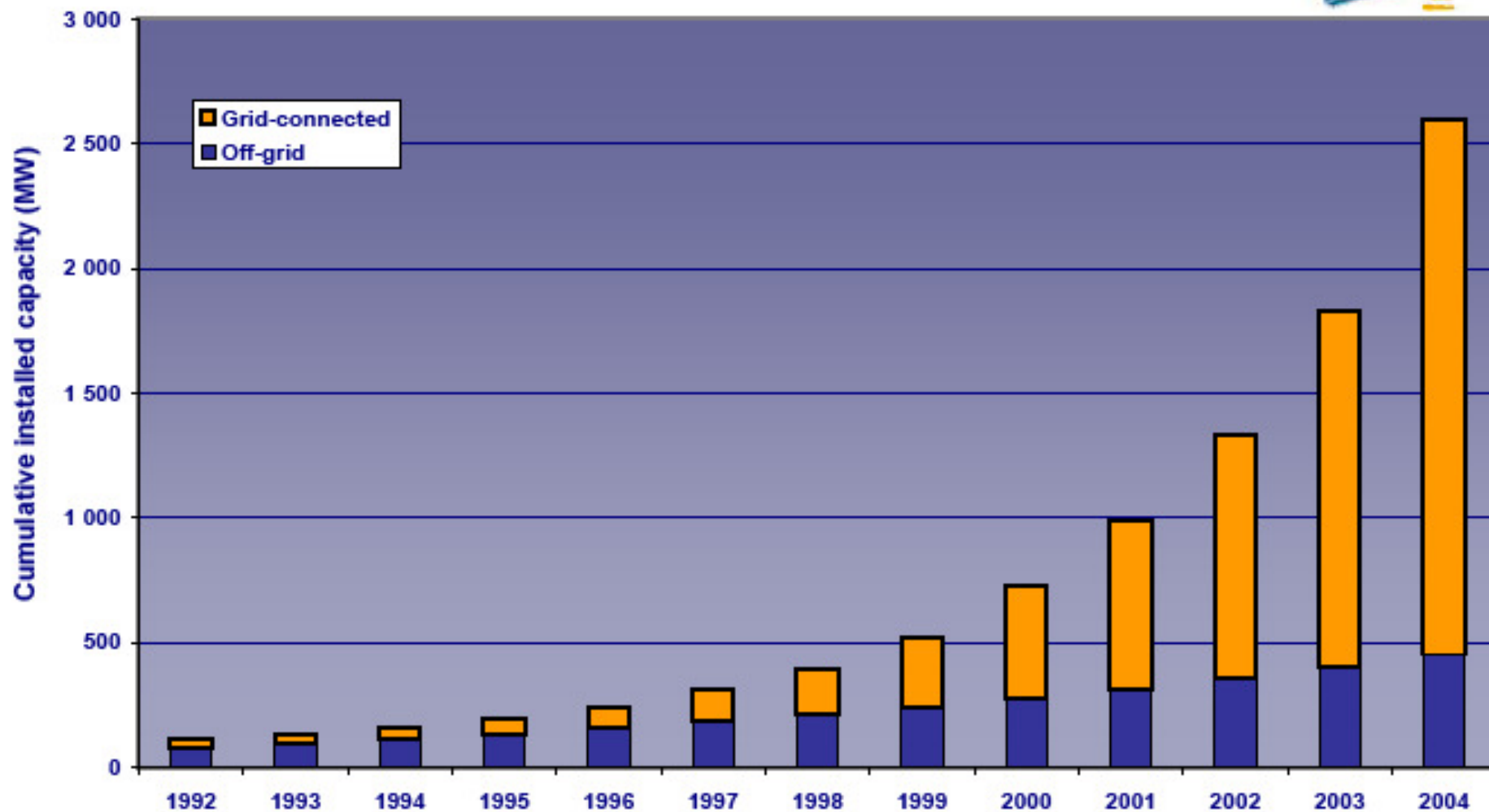


Figure 1: Cumulative installed PV power by application area in the reporting countries

Graph downloaded from the IEA-PVPS website, <http://www.iea-pvps.org>

Data may be reproduced with acknowledgement to the IEA Photovoltaic Power Systems Programme



Why PV

- Small scale to large scale
- Very modular
- Reliable
- No noise
- Suitable for remote and urban environment

PV dollars

- Cost vs Price
- Cost doesn't include return on investment
- Installation Price
 - Japan \$6.50/W
 - Germany \$6.70/W
 - USA \$8.30/W
 - Australia \$10.00/W

Reference: "The true cost of solar power: 10 cents/kWh by 2010"
Joel Conkling, Michael Rogol, Photon Consulting
April 2007

Cost

- Typical installed cost 2007

\$4.00/W

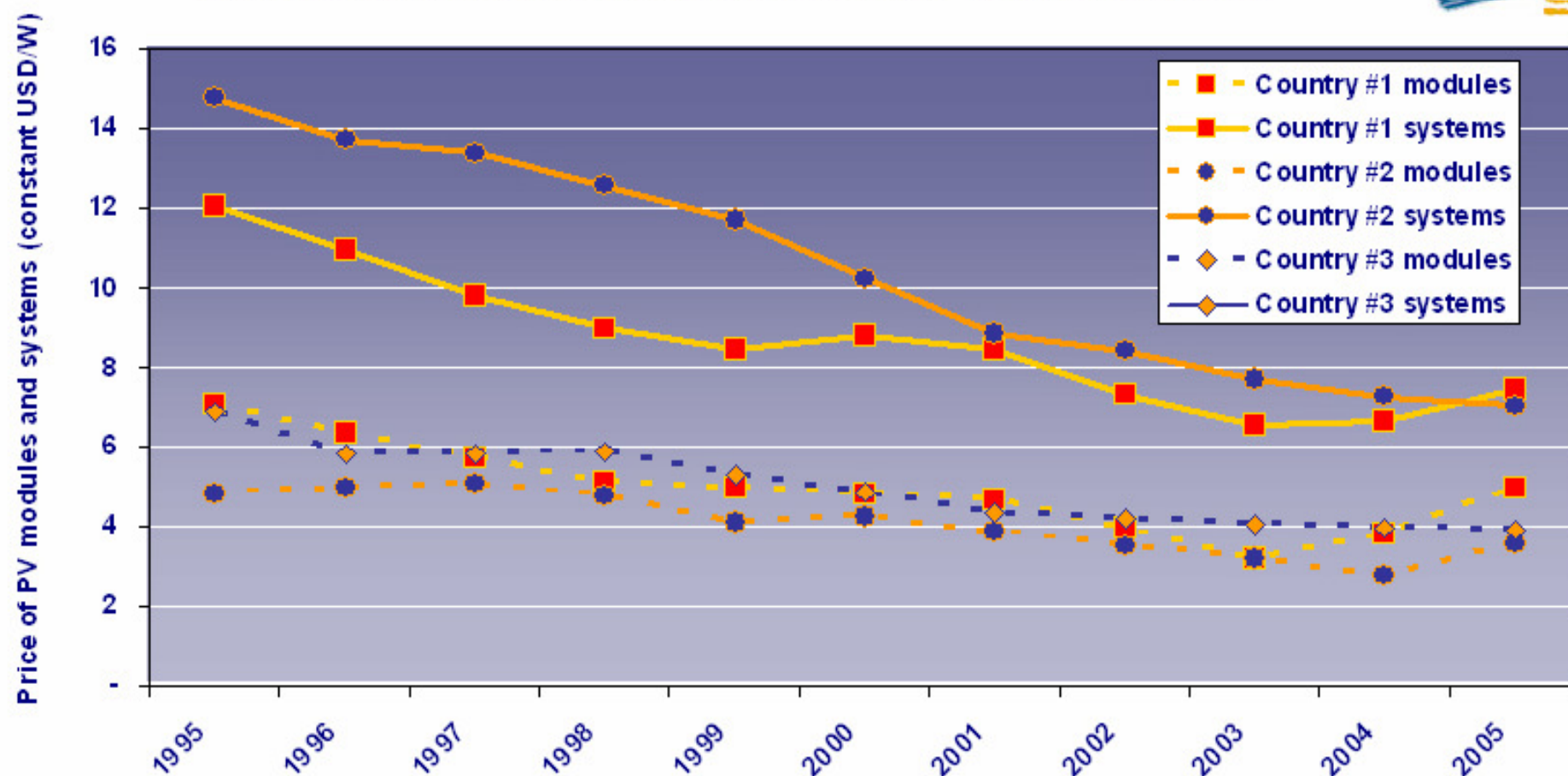
- Leads to typical levelised cost of solar power

\$0.22/kWh

Figure 9: Evolution of price of PV modules and systems accounting for inflation effects

Graph downloaded from the IEA-PVPS website, <http://www.iea-pvps.org>

Data may be reproduced with acknowledgement to the IEA Photovoltaic Power Systems Programme



The future 2010

- Typical installed cost

\$2.80/W

- Leads to typical levelised cost of solar power

\$0.15/kWh

Constraints

- Firm capacity
 - Utilities like generation on demand
- Energy storage
 - Electricity is difficult to store
 - Battery
 - Thermal
 - Hydro
 - Hydrogen

Breakthroughs

- Technology
 - Efficiency
 - 2% improvement leads to 10% cost reduction
 - Other materials
 - Manufacturing techniques
- Financing
 - Large capex with low O&M
 - Is different to traditional energy sources

Breakthroughs Required

- Acceptance of the technology
- Carbon accountability
- Energy Storage

Trends

- Vertical Integration of supply chain
- Solar fuel power purchase agreements (PPA)
- Financial packaging
- Risks for traditional energy providers

Photovoltaic Support

- Australian Government Photovoltaic Rebate Programme
 - cash rebates to
 - householders
 - schools and
 - owners of community use buildings
 - to install grid-connected or stand-alone photovoltaic systems .
 - \$8000 for grid connect systems

Photovoltaic Support

- Renewable Remote Power Generation Programme
 - financial support to use renewable generation in remote parts of Australia
 - Replace or supplement fossil fuel
 - 50% for Stand-alone systems (RRPGP)

Photovoltaic Support

- Rural Renewable Energy Program (RREP)
 - provides rebates for grid-connect renewable energy power systems
 - serving homes, businesses, government organisations and other organisations
 - specific 'fringe of grid' areas of the South West electricity grid
 - A sub-program of RRPGP in WA
 - 50% for fringe of grid GC systems

RREP Eligibility Area



Contact Details

- Australian Greenhouse Office
- <http://www.greenhouse.gov.au/>
- Sustainable Energy Development Office
<http://www.sedo.energy.wa.gov.au/>

Why should we

- Borrowing from the future
- Fossil fuels
 - Use now, pay later
- Renewable Energy
 - Pay now, take care of the future

Conclusion

- Solar Technology is ready now
- Photovoltaics
 - Suits urban environment
 - Scalable
 - Large scale possible
- Solar Thermal
 - Works on a large scale
 - Has good energy storage capability

