Energy for the Future

Solar Energy

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Overview of presentation

- The solar resource
- Global trends
  - Technologies
  - Policies
- The 'missing' energy technology
- Solar Opportunities for Queensland
  - Technologies
  - Policies
- Pros and cons of solar energy

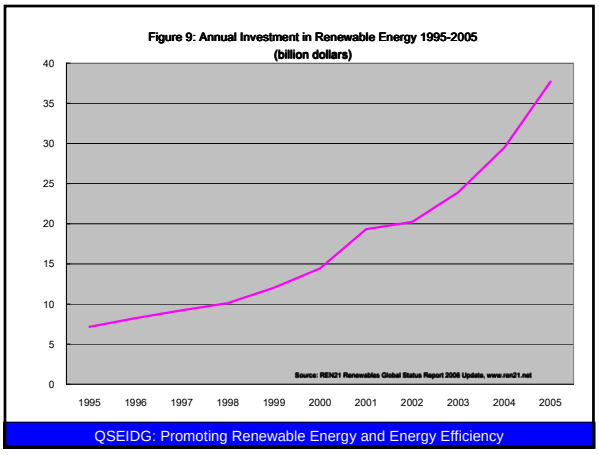
Sun on atmosphere	*1367W/m2*
Peak sun on earth	*1000W/m2*
Average annual sun on earth	*250W/m2*
Toaster	*1000-2000 W*
Bicycle at 30km/h	*150W*
Bicycle at 36km/h	*200W*
Efficiency of converting solar energy to biomass	*- around 1%*
Efficiency of converting coal to electricity at home	*- around 28%*
Efficiency of solar PV panel	*6-20%*
Peak efficiency of solar hot water	*- around 65%*

Source: CSIRO

International drivers for change

- Environmental
  - Climate change
  - Local pollution e.g. acid rain, particulates
  - Waste storage / security
- Economic
  - Life-cycle costs
  - Fossil fuel depletion
  - Energy independence
- Political
  - Energy security
- Social
  - Employment generation
  - Growth in energy demand
  - Regional development

QSEIDG: Promoting Renewable Energy and Energy Efficiency



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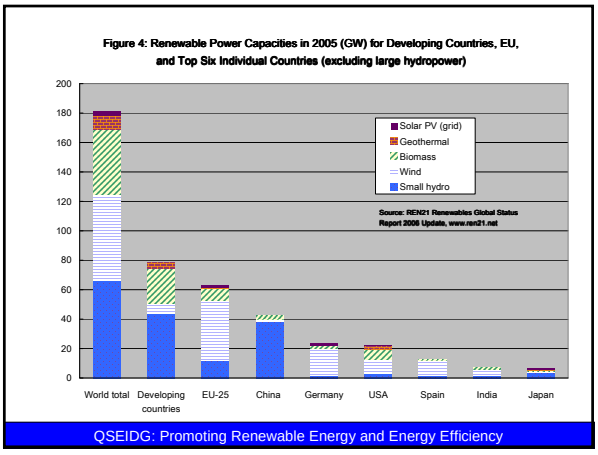

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EU Case Study

Renewable Energy House Brussels

- Energy Load Reduction (>50%)
  - Insulation
  - Low emission glazing (double glazed windows inside / single glaze façade)
  - High efficiency lighting
  - Ventilation with heat recovery
- Energy Management
  - Integrated heating / cooling systems from multiple energy sources
  - Advanced control system: occupancy sensors; IAQ sensing / response
- Energy Supply
  - 80 kW biomass (pellet heating) boiler
  - 42 kW / 60 m^2 solar thermal collectors
  - 25 kW ground source heat pump
  - 37.5 kW thermally driven cooling machine
  - 4*115 m deep geothermal energy loops
  - Photovoltaics

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Denmark

- Energy Management / Efficiency
  - Denmark has the lowest energy intensity in the European Union
  - Standards (for buildings and appliances)
  - Distribution companies have mandatory savings targets
- Renewable Energy
  - The share of renewables in electricity generation rose from 3% in 1991 to around 25% in 2004
  - reduced emissions, enhanced energy security and promoted Danish industry
  - Cost of RE subsidies estimated in 2004 at 20% of wholesale electricity price

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USA

- California
  - Main drivers: environment (public push) and help increase affordability
  - Public policy has decoupled utility commodity sales from infrastructure provision
  - $3.4BILLION (USD) in solar roofs project
  - Carbon Cap and Trade scheme
  - PG&E: 54% of electricity provision carbon neutral
- Western Governors
  - 20% energy efficiency by 2020
  - Security, diversity, environmentally responsible, affordable
- National:
  - 30% tax credit for installing PV (and tax credit for EE as well!)
  - Main drivers are energy independence and environment
- Corporate America
  - Starting to equate options with social responsibility as well as with economics

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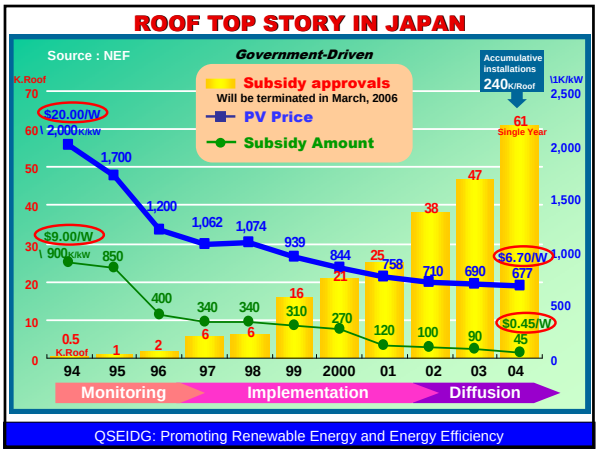

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Top 5 countries

Source: REN21

Capacity added in 2005					
Grid-connect PV	Germany	Japan	USA	Spain	France
SHW	China	Turkey	Germany	India	Austria / Greece / Japan / Australia
Established Capacity as of 2005					
Grid-connect PV	Germany	Japan	USA	Spain	Nether-lands
SHW	China	Turkey	Japan	Germany	Israel

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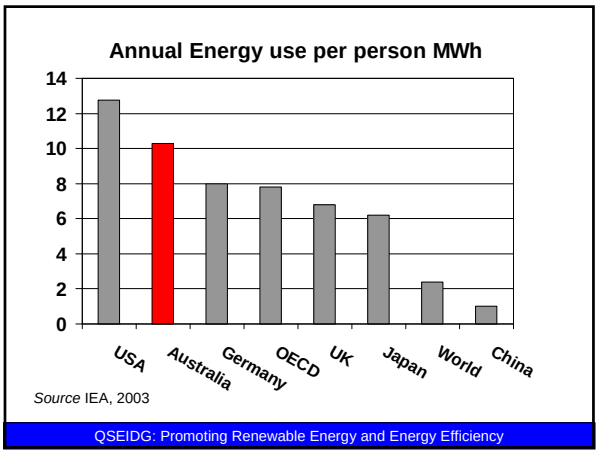
Annual Energy use per person MWh
14
12
10
8
6
4
2
0
USA
Australia
Germany
OECD
UK
Japan
World
China
Source IEA, 2003
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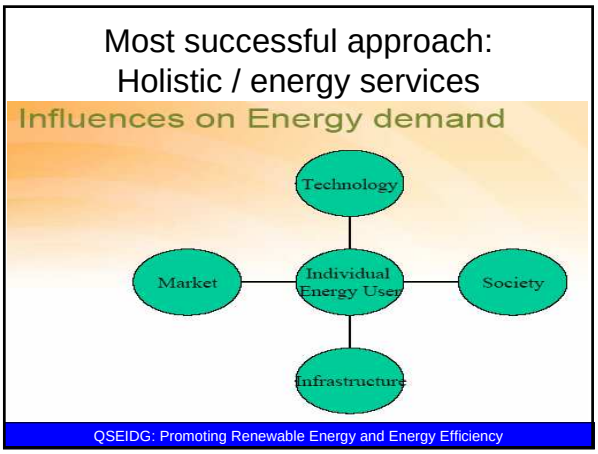
Most successful approach:
Holistic / energy services
Influences on Energy demand
Technology
Market
Individual Energy User
Society
Infrastructure
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Most cost-effective
'sustainable energy' Technology
Negawatts
ENERGY RATING
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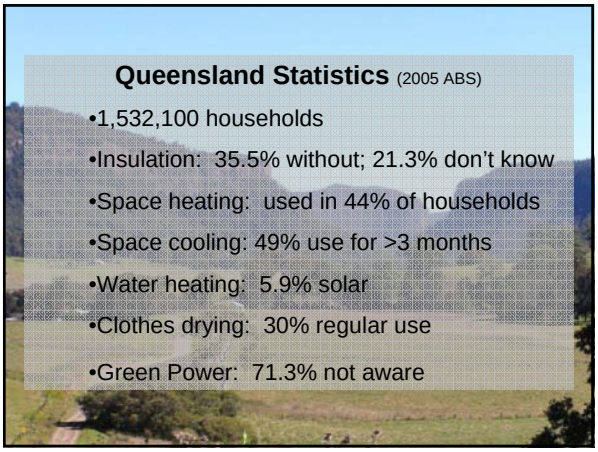
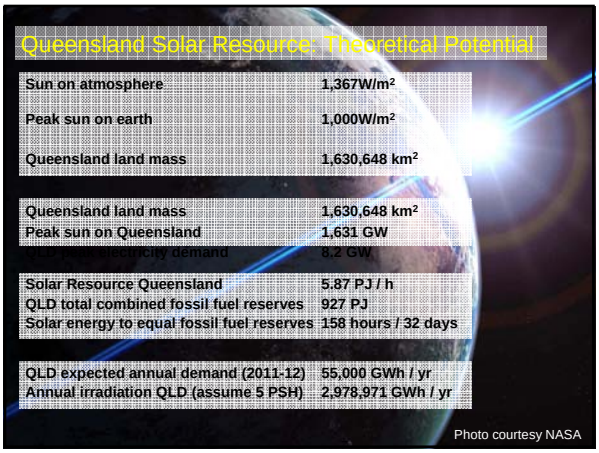
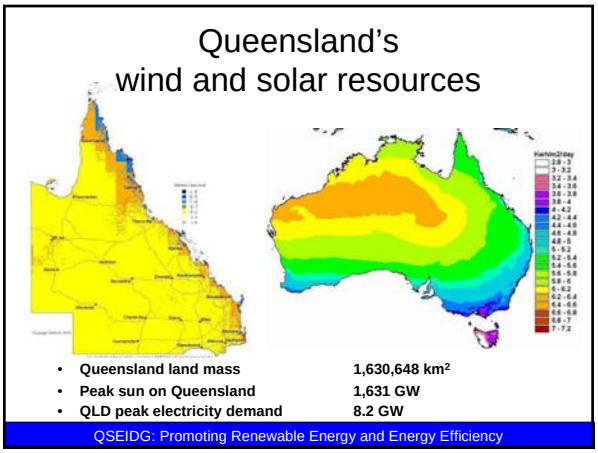

Queensland Statistics (2005 ABS)
•1,532,100 households
•Insulation: 35.5% without; 21.3% don't know
•Space heating: used in 44% of households
•Space cooling: 49% use for >3 months
•Water heating: 5.9% solar
•Clothes drying: 30% regular use
•Green Power: 71.3% not aware


Queensland Solar Resource: Theoretical Potential
Sun on atmosphere 1,367W/m²
Peak sun on earth 1,000W/m²
Queensland land mass 1,630,648 km²
Queensland land mass 1,630,648 km²
Peak sun on Queensland 1,631 GW
8.2 GW
Solar Resource Queensland 5.87 PJ / h
QLD total combined fossil fuel reserves 927 PJ
Solar energy to equal fossil fuel reserves 158 hours / 32 days
QLD expected annual demand (2011-12) 55,000 GWh / yr
Annual irradiation QLD (assume 5 PSH) 2,978,971 GWh / yr
Photo courtesy NASA


Queensland's
wind and solar resources
• Queensland land mass 1,630,648 km²
• Peak sun on Queensland 1,631 GW
• QLD peak electricity demand 8.2 GW
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Distributed Energy

Meeting end-user energy services (e.g. electricity / heat / transport fuels as close as possible to the end-user

Photovoltaics

- Photo – light; Voltaic – electricity
  - Converting sunlight to electrical energy
- Considered to be very green by public
- Easily accessible / available
- Average residential roof can provide more than enough for self-sufficiency

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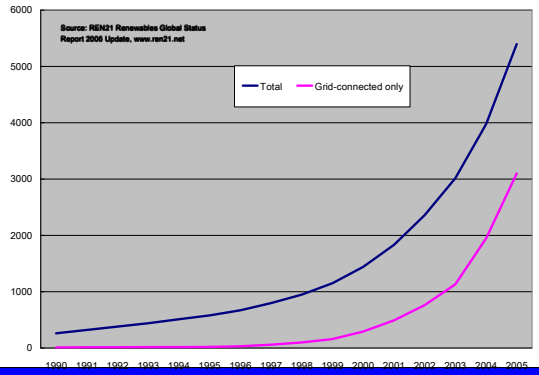
Figure 3: Solar PV, Existing World Capacity, 1990-2005 (MW)



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Photovoltaic Installations

- **Australia**
  - **4175 Off-grid systems**
  - **3188 On-grid systems**
- **Queensland**
  - **879 off-grid systems**
  - **273 on-grid systems**

•Source AGO June 2006
•Only includes systems with govt rebates i.e. 38% of total installations

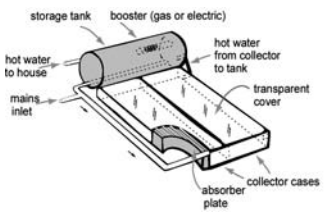
Solar Hot Water

Electric

- Sun
- Plants photosynthesis
- Fossil Fuel - millions years
- Mining- Oil and Electricity
- Transport
- Fuel Burning / Steam / turbine / generator / electricity
- Transmission km
- Heat water

Solar

- Sun



- Heat water

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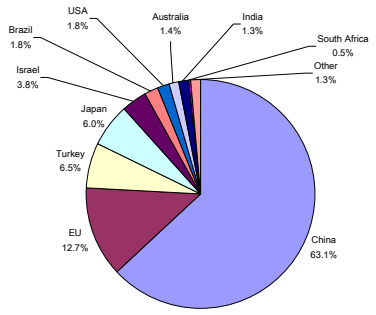
Figure 6: Solar Hot Water/Heating Capacity Existing in 2005 (Total = 88 GWth)



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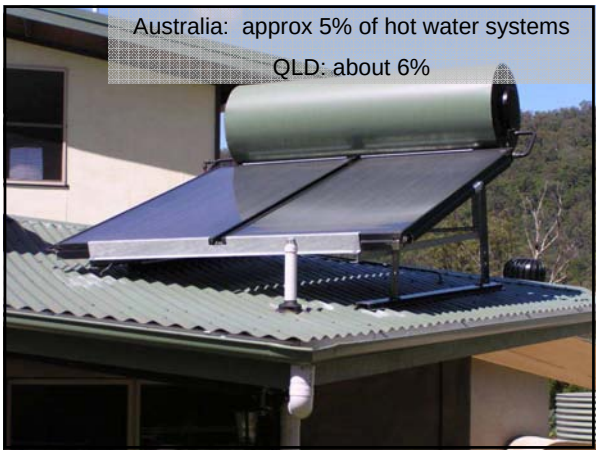

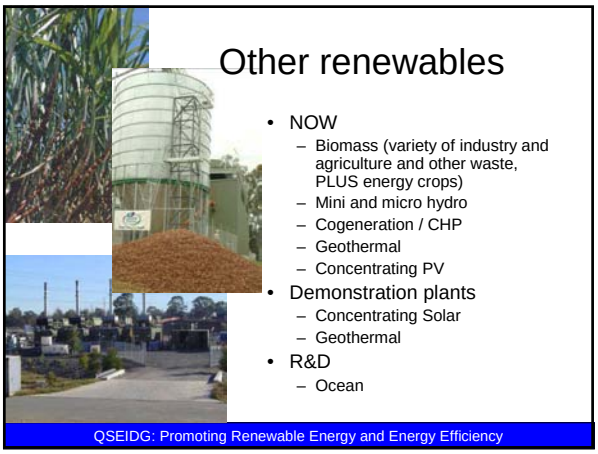

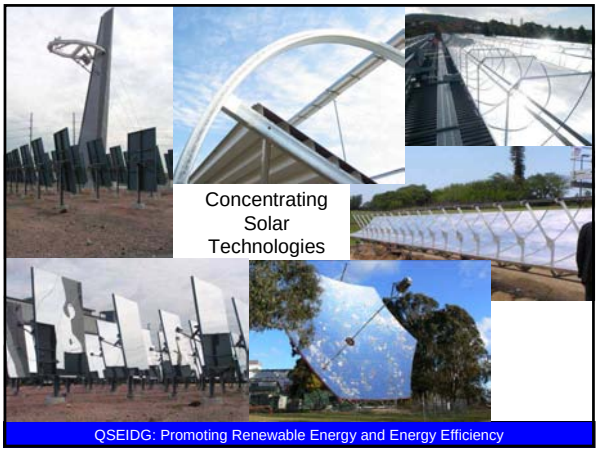

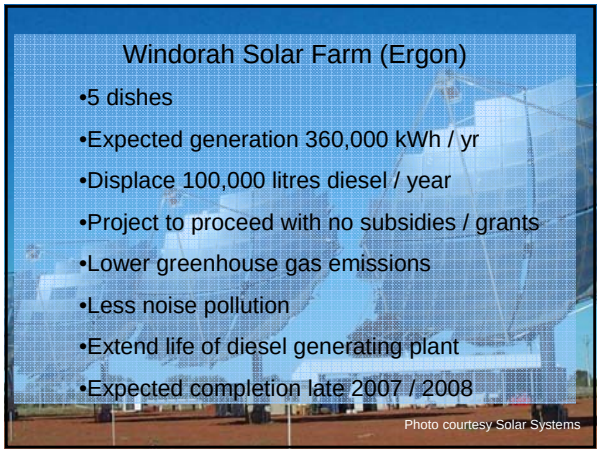

Common characteristics of renewable energy technologies

(Relative to conventional established fossil fuel technologies)

- Higher initial costs
- Smaller distributed units v larger centralised units
- Lower operating costs
- Environmentally cleaner (ghge; particulates; little or no waste)
- Often cost effective on life-cycle cost basis (consider purchase price + annual fuel and O&M costs + overhaul costs + decommissioning costs + financing costs + . . .)
- Added benefits

Acknowledgement: RETScreen International

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Added benefits of Solar

- Improve energy security / self-reliance
- Regional Development
  - Local manufacture / installation
  - higher employment ratios
  - closeness to end-use
  - indigenous energy sources
- Modular / Portable
- Assists electricity network
  - Ease peak power demand
  - Reduce infrastructure costs / losses
- Customer driven / controlled
- Universal application
- Emissions free
- No fuel costs

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Disadvantages of Solar

- Universal application
  - Solar radiation in abundance in most areas of Australia; is not accounted for in our economic model
  - Encompasses non-energy industries e.g. construction
- No fuel costs
  - Solar radiation can't be licensed / controlled (?!?)
- Assists electricity network
  - Benefits to distributors and retailers not accounted for yet and accredited to system owners
- Customer driven
  - Can exclude large corporations
- Modular / portable
  - Corporations and governments tend to want BIG projects not a lot of small ones

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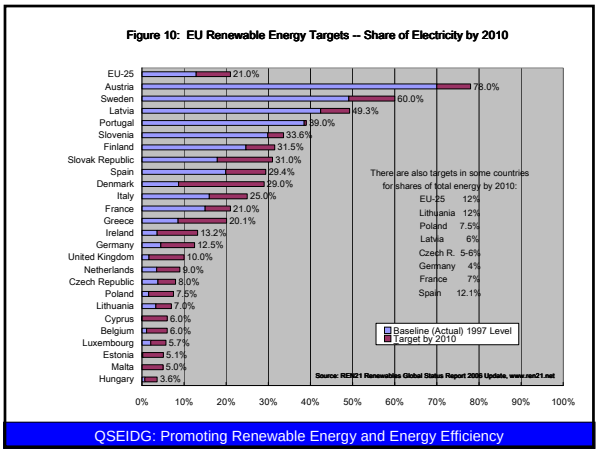
Improvements to be made

- Raw material supply (silicon for PV)
- Manufacturing processes
- Installation processes
- Institutional barriers
- Marketing
- Financing
- Policy
- Regulation



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