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The Role of the Australian Solar Thermal Energy Association

Andrew Want, Chairman

Solar Power Australia 2012 – Brisbane 28/29 February, 2012

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The industry body solely representing concentrating solar thermal power in Australia

- Overview of the main concentrating solar thermal energy (STE) technologies
- Introduction to AUSTELA's members – who we are and what we're doing in CSP
- Helicopter view of some of the recent international and local Australian projects delivering major technological progress
- 2011-2015: a critical period for energy policy and market design in Australia
- Urgent priorities for CSP in Australia
- Why concentrating solar thermal power fits Australia's energy needs (and helps both PV and wind to grow)
- International connections and collaboration
- A view to 2050

Benefits of solar thermal power

Solar thermal power has unique attributes that make it highly valuable in 21st century electricity systems

- Output aligned to growing daytime peak demand
- With mature thermal energy storage technology now available, also meets rapidly growing evening peak demand
- Load-firming qualities enable higher levels of variable renewable generation (PV, wind) in the grid
- Steam turbine generation technology – steady, predictable generation profile
- Able to work in hybrid configuration with other thermal energy sources
 - Co-firing with gas, oil or biomass provides 100% supply reliability
 - Can be partnered with existing coal, gas or other thermal cycles to reduce fossil-fuel usage and emissions
- Applications beyond electricity production (industrial steam applications, solar fuels)

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STE technologies



Parabolic trough: >90% of global CSP ~2011



Central receiver 'power tower'



Compact Linear Fresnel



Parabolic dish

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Specific, sustained focus - at a critical time

AUSTELA's sole focus is the development of Australia's concentrating solar thermal power industry.

Goal:

To significantly improve the investment environment for solar thermal power generation in Australia. AUSTELA:

- Works collaboratively with other solar, clean energy and research bodies
- Seeks to identify and facilitate access to the most current information available globally on the value and benefits of solar thermal power generation
- Focuses on the role of solar thermal power in the electricity system ('STE')
- Concentrates mainly on utility scale (50MW+) and large-scale (5MW-50MW) infrastructure
- Also addresses potential for large-scale thermal industrial power (non-electric) applications

FOUNDING MEMBERS



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CURRENT MEMBERS



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AUSTELA members are leaders in the global CSP industry



- Leading specialist constructor and developer of CSP facilities
- Gemasolar (24 hour generation), Crescent Dunes Nevada



- Leader in solar innovation and development (STE and PV)
- Recently won 2 CSP projects (trough, tower) in South Africa



- Majority Australian owned, 2 significant plants underway
- 2011 - demonstrated steam generation >500°C



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- Australian developed Linear Fresnel technology (Ausra)
- Solar Dawn Project (250MW); Kogan Creek Solar Boost (44MW)



- Major energy and heavy engineering firm; significant Australian business in thermal systems
- Large shareholder in BrightSource Energy (392MW Ivanpah)



- Australian firm developing novel power tower plant design

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Recent international projects



Gemasolar – Fuentes de Andalucia, Seville, Spain

Vital statistics

- Turbine rating: 19.9MW
- Output: 110,000MWh/yr
- Energy storage: 15 hours
- Daily operation: 24hrs
- Capacity factor: 75%
- Land area: 195ha
- Mirror area: 304,750m²
- Heliostats: 2,650
- Cost: ~€230 million
- Technology: SENER
- Owners:
 - MASDAR (UAE)
 - SENER (Spain)
- Construction: ACS Cobra

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Recent international projects



Abengoa Solar - Solana – Phoenix, Arizona, USA
(under construction)

Vital statistics

- Turbine rating: 280MW
- Energy storage: 6 hours
- Land area: 1,900 acres (770ha)
- Technology: Abengoa Solar
- Owner:
 - Abengoa Solar
- Construction: Abengoa

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Recent international projects



Abengoa Solar - Khi power tower – Northern Cape Province
South Africa (announced)

Vital statistics

- Turbine rating: 50MW
- Energy storage: 2 hours
- Land area: 600ha
- Technology: Abengoa Solar
- Owners:
 - Abengoa Solar
 - SA Industrial Development Corp.
- Construction: Abengoa

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Recent international projects



Novatec Solar – Puerta Errado 2 (PE2) Linear Fresnel Power Station
Calasparra, Murca, Spain (under construction)

Vital statistics

- Turbine rating: 30MW
- Output: 49,000MWh/yr
- Direct steam generation
- Land area: 70 ha
- Mirror area: 28 lines x 940m x 16m
- Technology: Novatec Solar
- Owners:
 - Elektra Baselland
 - Industrielle Werke Basel
 - Novatec Biosol
- Construction: Novatec Biosol AG

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Recent international projects



BrightSource Energy - Ivanpah SEGS – Mojave Desert, California, USA
(under construction)

Vital statistics

- Turbine(s) rating: 392MW
- Output: 1.08m MWh/yr (140,000 homes)
- Direct steam generation
- Capacity factor: 29%
- Natural gas backup
- Land area: 3,600 acres
- Mirror area: 2,295,000m²
- Heliostats: 214,000
- Cost: ~US\$2.2 billion
- Technology: BrightSource LTP Solar Thermal
- Owners:
 - NRG Energy
 - Google
 - BrightSource Energy
- Construction: Bechtel

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Recent Australian projects



CS Energy – Areva – Kogan Creek Solar Boost – Chinchilla, Qld
(under construction)

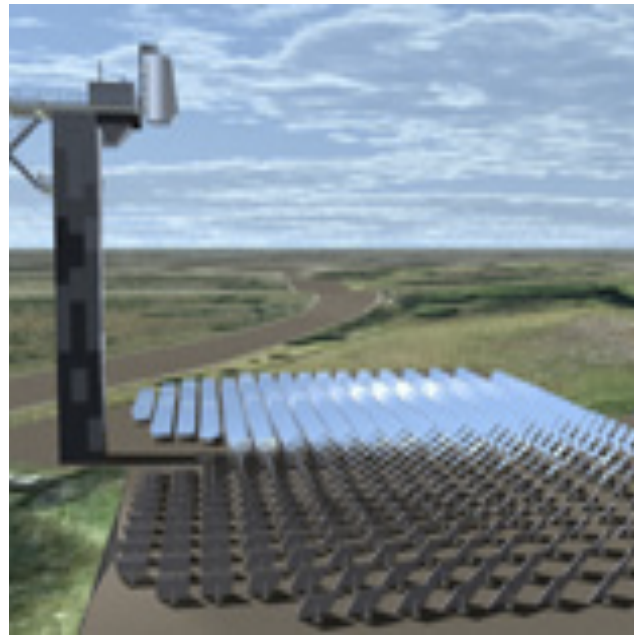
Vital statistics

- 44MW augmentation of Kogan Creek 750MW Power Station
- Direct steam generation
- Output: 5,000 extra homes
- Land area: 30ha
- Cost: \$98.8 million
- Ownership/funding:
 - Renewable Energy Demonstration Program
 - CS Energy
 - Areva

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Recent Australian projects



CSIRO National Solar Energy Centre, Mayfield West (Newcastle) NSW

Vital statistics

- 450 heliostats
- 30m tower
- 500kW_{th}
- Peak temp. >1,000°C
- 'SolarGas' – hydrogen enhanced syngas (25% more energy than LPG)
- World's largest Brayton cycle (air turbine) CSP system

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CSP – poised for global growth?

The major obstacle to rapid uptake of solar thermal power is the lack of consistent, supportive policy and market settings that take a long term view.



Solar Energy Generating System (SEGS), Kramer Junction, California, USA (354MW) – operating since 1986

- 1984-1991: SEGS (I – IX)
- 1996: Solar 2 (tower + storage)
- Nearly 20 years dormant
- 2004 - 2011:
 - >1.5GW operational
 - >1.2GW under construction
- 2020: wide range of forecasts – between 7GW and 84GW
 - India – Solar Mission 22GW
 - China – up to 8.5GW CSP (target 15GW solar power by 2015)
 - MENA (World Bank Plan) – 9 large plants 1.2GW
 - Chile – mandating miners use renewable energy

2011-2015: A critical period for energy policy in Australia

Australia is now in an unprecedented period of investment and change in our electricity system – decisions made in this period will determine energy policy directions to 2030

- Potential \$240 billion in energy investments to 2030*
- Major overhaul of an ageing, carbon-intensive generation fleet
- Huge upgrade, replacement and augmentation task in networks
- Energy White Paper
- AEMC Transmission Frameworks Review
- AEMO National Transmission Network Development Plan (NTNDP)
- Solar Flagships Round 2
- Carbon reform package ‘Clean Energy Future’ – ARENA and CEFC

* Source: Draft Energy White Paper

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An urgent need for CSP to explain its business case

- ‘Solar’ in Australia dominated by (very important) issues relating to PV
- Low awareness of CSP across the Australian energy policy and business spectrum
- Significant confusion and misinformation about CSP costs and cost reduction potential
- A need to articulate and quantify the unique value-added capabilities of CSP
 - Output aligned to peak demand
 - Predictable, dispatchable power to grid
 - Mature thermal energy storage technology
 - Hybrid capability - fossil fuels and biomass
 - Solar fuels potential

Immediate priorities for Australian CSP

1. A thorough review of CSP cost assumptions
2. Highlight recent international projects, industry experience and research
3. A detailed review of the potential for solar thermal power in Australia (STE Industry White Paper)
4. Highlight market gaps and failures acting as barriers to CSP development
5. Ensuring CSP has a seat at the table on market and policy settings

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Understanding where solar thermal power fits for Australia

AUSTELA is engaging directly in the major policy development processes, to highlight the potential role of concentrating solar thermal power in Australia's energy system in the 21st century

- Australian Solar Institute's 'Review of the Potential for CSP in Australia' – April 2012
- AEMO Scenarios Working Group (NTNDP) – June 2012
- Australian Energy Technology Assessment (AETA) and Energy White Paper
 - Cost modelling for the Energy White Paper – April 2012
 - Biennial reviews, reflecting the pace of technology development (2014 onwards)
- CEFC – business model and investment mandate
- AUSTELA/UTS/UNSW study into potential for distribution network cost reductions (\$120 billion capex required to 2030)*

* Source: Draft Energy White Paper

Understanding where solar thermal power fits for Australia

A challenging context for solar energy in Australia: the 'Golden Age of Gas' and the dream of CCS

*'While conventional coal-fired electricity accounts for 75 per cent of generation today and gas around 15 per cent, by the middle of the century ... gas could expand to up to 44 per cent. By 2050 – assuming technological breakthroughs – most of Australia's conventional coal-fired power generation could have been replaced. Carbon capture and storage for coal- and gas-fired generation, like other potential baseload technologies such as geothermal and large-scale solar, could play a major role in our long-term energy mix.'**

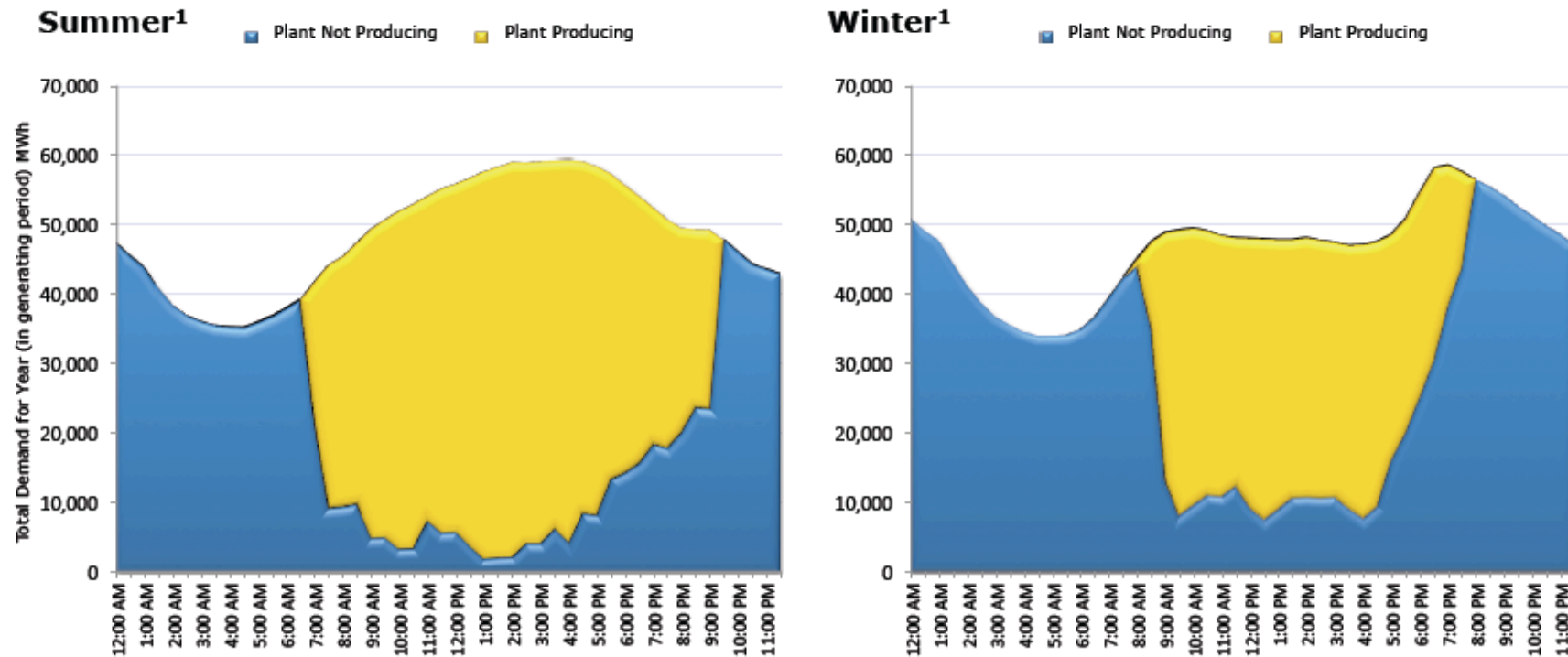
- 44 references to 'solar' in the Energy White Paper; most preceded by 'carbon-capture and storage, geothermal and ...' or by 'coal-seam gas, geothermal and...'
- EWP forecasts for 2050 large-scale electricity*
 - CCS (90-125 TWh/yr) 26-32%
 - Geothermal (50-80 TWh/yr) 13-23%
 - Wind (45-60 TWh/yr) 13-15%
 - **Solar (10 TWh/yr) 3%**

Point: The Energy White Paper regards solar as a long shot; the lessons being learned internationally are not yet being absorbed in Australia

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Solar thermal power and PV – complementary technologies



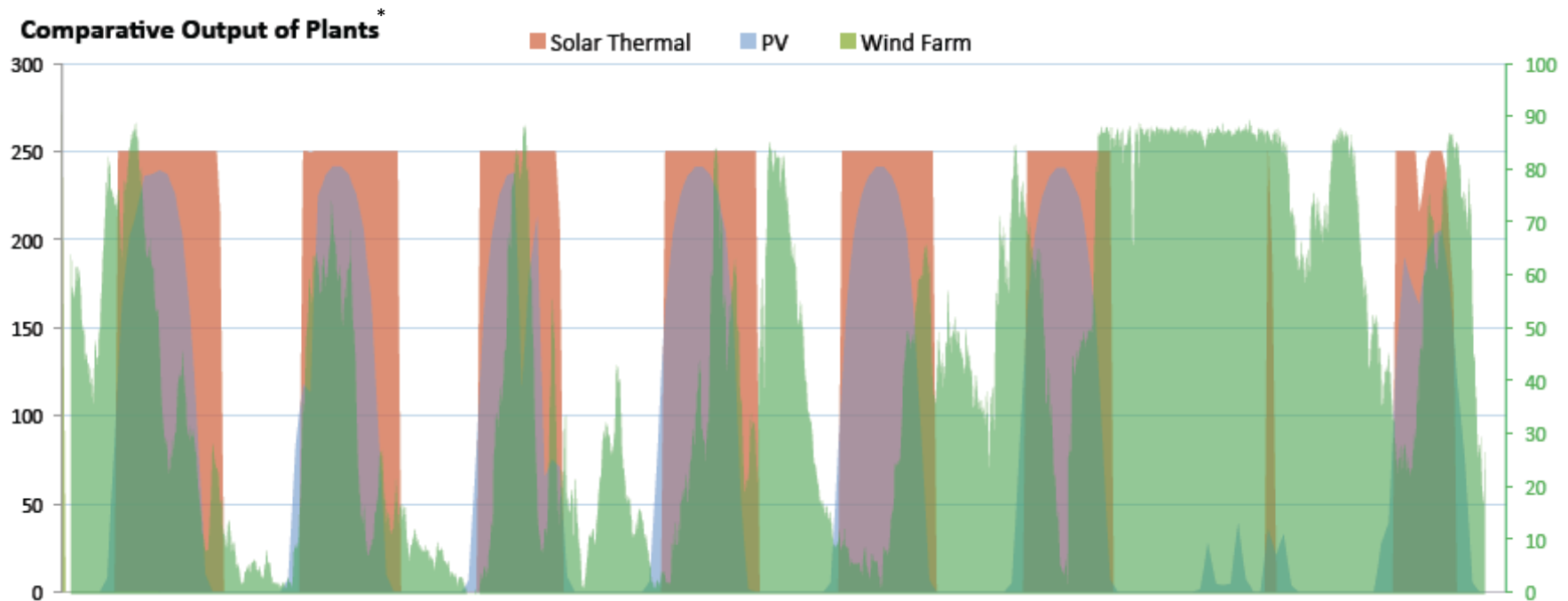
- Both produce during high daytime peak periods; CSP extends into the evening peak
- Recent analysis from the US shows thermal storage from CSP enables higher penetration of solar power in the grid; PV is more 'highs and lows', CSP 'load firming'

*Denholm, Mehos 'Enabling Greater Penetration of Solar Power via Use of CSP with Thermal Energy Storage', NREL 2011

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Solar thermal and wind – also complementary



- Wind is highly variable (though AEMO's wind forecasting is increasingly accurate)
- Wind generation is not aligned with demand - wind + PV exacerbates grid challenges
- However the addition of CSP firms renewable energy supply, enabling more renewable energy as a proportion of total generation

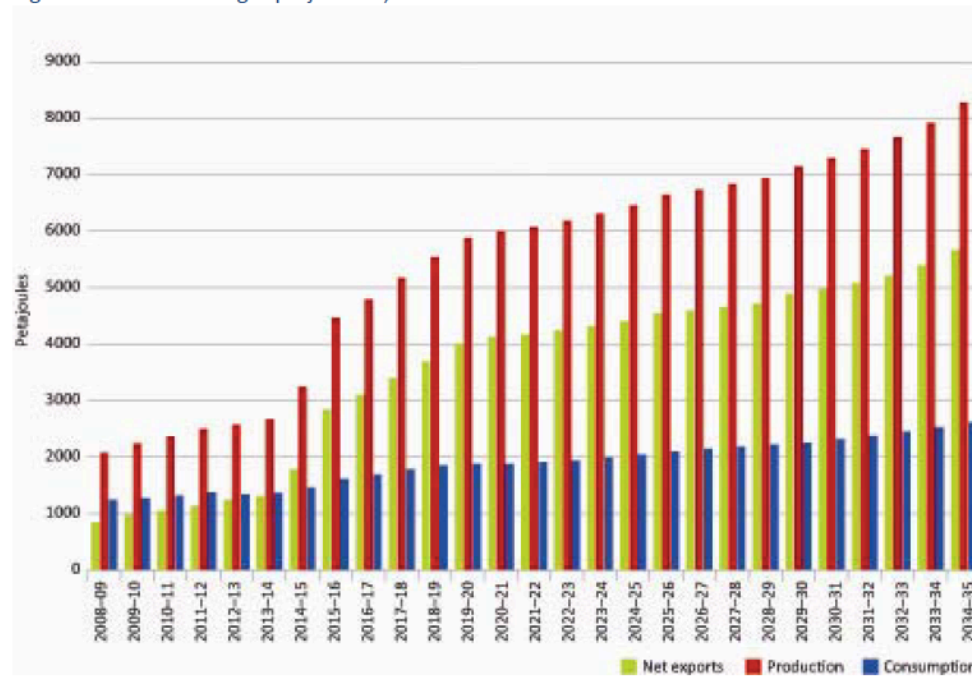
*Vast Solar analysis, South Australia, February 2008. Actual wind and PV generation compared with simulated CSP generation

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Complementary with gas too?

Figure 3.10: Australian gas projections, 2008–09 to 2034–35



Golden Age of Australian Gas

Gas growth from 2010-2035

- Production:
2,200PJ– 8,200PJ (375%)
- Domestic consumption:
1,200PJ-2,600PJ (220%)
- Net exports:
1,000PJ-5,600PJ (560%)
- Global growth – 55%

Clearly, a great economic story. But the gas industry has two major issues to address

- it is CO₂ intensive, not just at extraction but in processing
- CSG risks to water resources (and associated costs) are still to be fully understood

Solar thermal presents possibilities of more CO₂ efficient gas production processes, and acts as a large-scale electricity generation hedge against risks in Australia's gas strategy.

*Source – Energy White Paper

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CSP's role in global climate and energy policy



AUSTELA is a foundation member of the World Solar Thermal Energy Association (STELAWorld)

- ESTELA – Europe
 - SASTELA – South Africa
- (www.stelaworld.org)

AUSTELA is also engaged at IEA SolarPACES

CSP's load-firming characteristics have huge potential to support economic development in Africa, the MENA region, Central Asia and South America

- New form of 'base-load', aligned to peak demand, supporting high penetrations of PV, wind power and other renewables
- Developing economies can potentially leapfrog fossil fuel-based power generation

A view to 2050 – future roles for Australian CSP

Concentrating solar thermal power will play a key role in the world's low-carbon energy systems in the 21st century. Australian development of CSP is important for our own economy, and to support low-carbon economic development internationally.

International:

- IEA Solar Perspectives* – solar can provide 25% of global electricity by 2050 (and potentially as high as 33% by 2030)
- International development (China, India, Africa, MENA, Central Asia, South America)

At home:

Mining sector

- CSP is cost competitive in many remote locations today against diesel generation
- Challenge – to build mining sector confidence for investment

Transport sector

- Electrification, working with EVs to provide flexible energy storage
- Solar fuels

Exports

- Regional HVDC links
- Solar enhanced gas exports

Industrial processes – food and manufacturing

* International Energy Agency – Solar Perspectives, 2011

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