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Energy White Paper Secretariat
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AUSTELA Submission in response to the draft Energy White Paper

About AUSTELA

AUSTELA is the industry body solely dedicated to concentrating solar thermal power generation (CST) in Australia. AUSTELA's members are some of the leading corporations involved internationally in the development of solar thermal power systems on a large scale for electricity generation and industrial processes.

AUSTELA is committed to working collaboratively with clean and renewable energy organisations, research institutions and government to facilitate and improve access for policy-makers and investment decision-makers to the most contemporary information available globally about concentrating solar thermal power.

AUSTELA's goal is to significantly improve the investment environment for solar thermal power in Australia by providing information, analysis and data to assist policy and investment decision-makers to better understand the value, cost and potential importance of solar thermal power in Australia's energy system.

Background – The Need for a Fundamental Reappraisal of Australian Understanding of Concentrating Solar Thermal Power Value and Potential

For many years in Australia, significant misconceptions have persisted among policy makers and investment decision-makers about the cost potential and commercial maturity of concentrating solar thermal power. In studies hitherto relied on by Government in Australia, current costs for solar thermal power have been significantly overstated, and more importantly forecast rates of cost reduction (being achieved through economies of scale and 'learning by doing') significantly understated[1].

The significant potential economic and strategic value of solar thermal power generation for Australia has been masked by these misconceptions. Progress made internationally in investment in and deployment of large-scale concentrating solar thermal power capacity has largely been ignored in Australia.

Concentrating solar thermal energy is unique among power generation technologies in its versatility in electricity generation and in industrial processes. Among the wide range of power generation options available for Australian energy planning, CST is uniquely complementary with both fossil-fuelled generation (gas and coal) and with key renewable generation types (wind and PV).

In industrial applications requiring high temperature steam production, CST has the potential to displace existing fossil fuel consumption and to deliver significant improvements in carbon efficiency.

[1] Compare for example cost reduction projections from Electric Power Research Institute 2009 for parabolic trough and central receiver solar thermal with those of the US National Renewable Energy Laboratory 2011 and Sandia Laboratories 2011.

Concentrating solar thermal power also offers the unique potential for the development of solar fuels such as solar reforming of natural gas, solar gasification of biomass and other hydrocarbons, and (eventually) water splitting for solar hydrogen. These technologies offer the potential for Australia to develop value-adding processes and industries that will expand and enhance the long-term growth and value of Australian gas and coal exports; and in doing so, create sustainable export value from Australia's solar resources.

Another common misconception is that CST systems must be deployed at large scale in order to achieve cost competitiveness with other generation systems. Recent studies in Australia and internationally[2], illustrate that CST systems are already cost competitive with remote and off-grid generation in some locations; economic scalability of CST systems will improve further as manufacturing costs fall and supply chains mature.

CST can also play an important role in Australia's international economic development and aid programs in regions such as Africa, Central Asia and South America, where concentrating solar power systems offer the potential for sustainable, low-carbon economic development.

That Australia has world-leading solar resources rivalling or exceeding its blessings of other energy resources is well known. However the potential value of our solar resources is in practice often dismissed or ignored, based on the misapprehension that the cost of realising that value, relative to the cost value of realising other energy resource opportunities, is uneconomic. Treasury modelling reported in the draft Energy White Paper suggesting that large-scale solar power may comprise only 3% of Australia's energy mix by 2050, based on out-dated and inaccurate cost and cost reduction data, is indicative of this narrow, dismissive view.

AUSTELA's Submissions in Response to the draft Energy White Paper

AUSTELA's submission is that the Energy White Paper should reassess the potential role and value of concentrating solar thermal power in Australia's energy strategy to 2050 on the basis of updated cost and cost reduction data now available, having regard to the most recent information available as to deployment of CST technologies internationally, and according greater weight to the unique versatility, complementarity and option value of concentrating solar thermal power.

Specifically, AUSTELA contends:

1. That the value and potential for Australia of concentrating solar thermal power is significantly greater, and the cost of realising that value and potential likely to be significantly less, than Australian analysis to date has recognized,
2. That concentrating solar thermal power is a technology class and an industry that is of vital strategic importance and value for Australia, and one in which Australia's long term interests require that we develop indigenous skills, technologies and industry capability. This is a technology class in which Australia has the right skills to succeed and is not one in which Australia should cede industry capability to others, and
3. That a measured, strategic approach to development of Australian capability and experience in concentrating solar thermal power, designed to leverage private sector participation in demonstration of CST in the Australian market and promote private sector awareness of and confidence in CST technologies, is justified in Australia's long-term interests and will deliver significant economic benefits to Australia.

[2] See for example the 'Review of the Potential for Renewable Energy Projects and Systems in the Mid-West', and 'Review of the Potential for Renewable Energy Projects and Systems in the Pilbarra', Evans & Peck, 2011

16 March 2012

Energy White Paper Secretariat

Resetting Australian Understanding of the Value, Cost and Cost Reduction Potential of Concentrating Solar Thermal Energy Technologies

As noted above, data used by Australian agencies over the past several years have overstated CST costs and understated the achievable rate of cost reduction for CST technologies. This has resulted in the persistent under-estimation in Australia of the potential for and value of concentrating solar thermal energy.

An illustrative example of the wide variance between Australian and international appreciation of CST costs is the difference between the findings of the Power Tower Technology Roadmap and Cost Reduction Plan (April 2011) undertaken by Sandia Laboratories for the US Department of Energy, and those of the Electric Power Research Institute (EPRI, 2009), which has been relied on in a number of Commonwealth and State government assessments of renewable technology cost. The EPRI 2009 study indicated LCOE for central receiver solar thermal power at A$210/MWh at 2020. By comparison, the Sandia Roadmap projects potential LCOE at US$86/MWh at 2020 (refer page 32).

While this example relates to one particular CST technology, the principle holds generally for CST technologies that recent international experience and research, and the resultant cost projections for CST internationally, are typically far more competitive and compelling than is reflected in data historically used by Commonwealth and State agencies in Australia.

Consistent with AUSTELA's remit to provide and facilitate access to the most contemporary information available internationally as to CST, through 2011 and 2012, AUSTELA has contributed to a series of timely and significant reviews of energy technology cost and cost reduction potential.

AUSTELA has engaged with other solar and clean energy bodies, the CSIRO and others in the Australian Solar Institute's 'Review of the Potential for Concentrating Solar Power in Australia'.[3] Drawing on the most contemporary industry experience, research and cost data available globally, this Review is arguably the most thorough yet undertaken of the role and value of concentrating solar power in Australia.

AUSTELA is also engaged with the Bureau of Resource and Energy Economics (BREE) in relation to the preparation of the Australian Energy Technology Assessment (AETA), and with the Australian Energy Market Operator (AEMO) in its 2012 Planning Studies for the National Transmission Network Development Plan (NTNDP).

AUSTELA's members seek, through their participation via AUSTELA in these studies, to bring up to date Australian understanding of the cost, value and economic potential of concentrating solar thermal power in Australia.

A copy of AUSTELA's recent submission to the AEMO 2012 Planning Consultation is attached to this submission as an Appendix. We draw the attention of the Energy White Paper to AUSTELA's comments in this submission in relation to the following issues in particular:

– The Australian Solar Institute's 'Review of the Potential for Concentrating Solar Power (CSP) in Australia' will represent arguably the most thorough and contemporary analysis of CSP cost, value and market

[3] The 'Review of the Potential for Concentrating Solar Power in Australia' has been commissioned by the Australian Solar Institute and is being undertaken by IT Power Australia. It is due to report in April 2012.

potential yet undertaken in Australia, and its findings should be accorded significant weight by Australian policy-makers in considerations of current and future costs and market potential of CST in Australia

- The value of large-scale thermal energy storage available today with concentrating solar thermal energy systems must be measured and factored more effectively into electricity system planning
- The value, flexibility and versatility available today with hybrid applications of concentrating solar thermal energy technology must also be measured and factored more effectively into electricity system planning
- Concentrating solar thermal power is unique in its complementarity with other generation technologies that will underpin Australia's future energy system:
    - CST is unique among renewable generation technologies, having the ability to integrate with the operation of other thermal generation types through hybrid configurations (CST/gas, CST/coal, CST/biomass, CST/oil), lowering fuel and emissions costs of gas, coal or diesel generation technologies, and
    - CST is able by virtue of inherent thermal inertia to provide load-firming zero-carbon generation to support more variable renewable generation types such as wind and PV, enabling significantly higher penetration of renewable energy sources in a network (Denholm and Mehos, 2011). These benefits are enhanced using thermal energy storage, where cost-effective.

Concentrating Solar Thermal Power as a Complement to Australia's Broader Energy Strategy

The draft Energy White Paper identifies gas and coal as continuing to be at the heart of Australia's energy strategy – in terms both of export earnings and domestic power needs - for decades to come; the export value of our gas and coal resources is pivotal to Australian national wealth over the period to 2050.

The development of Australian gas resources is both an export market development opportunity in its own right and a hedge against risks associated with the carbon intensity of coal exports. Should international concern about carbon intensity of electricity production and industrial processes accelerate, demand for coal could reduce and demand for gas as a transitional fuel could accelerate more quickly than currently anticipated.

Although gas provides a natural hedge against coal in this sense, it could be also argued that Australia's reliance on gas and coal together exposes Australia to potential economic risks associated with the pace of international action to reduce carbon intensity of economic activity. Much depends on the rate at which the global economy seeks to decarbonise in the period to 2050.

It is also important to note than, as observed in the draft Energy White Paper, risks associated with non-traditional gas resources are still to be fully understood, and that community concern over issues such as water table impacts have potential to derail gas industry development. AUSTELA would add that the carbon intensity of some gas production processes is also of significant potential concern.

AUSTELA submits that there is compelling logic for Australia to invest in the development of concentrating solar thermal power technology and industry capability against this background.

As noted earlier, concentrating solar thermal power is uniquely complementary to Australia's broader energy strategy. Development of Australian capability and expertise in concentrating solar power technology, project development and investment will provide Australia with 'option value' that AUSTELA would argue no other energy technology can provide.

Concentrating Solar Thermal Power should be considered on its own merits, and not bundled with pre-demonstration CCS and geothermal

The draft Energy White Paper notes the need for the development of large-scale zero-carbon power capacity to complement Australia's energy strategy to 2050, and in passing touches on large-scale solar in this context:

> 'If large-scale technologies such as carbon capture and storage, geothermal or large-scale solar fail to emerge, future Australian governments may need to consider other clean energy alternatives to minimise the risk of significantly higher adjustment costs.' (Energy White Paper Ch 7, at 197. AUSTELA emphasis)

It is notable that in doing so the Energy White Paper places concentrating solar thermal power at the same point in technological maturity as carbon capture and storage and deep hot rocks geothermal power. This is erroneous and misleading.

Large-scale solar thermal power is already a rapidly maturing, utility-scale technology that has demonstrated technical reliability at scale in major electrical and industrial systems since the mid 1980s.

If the Energy White Paper is to be consistent with its urging that, 'Australia as a society must have a mature debate about our future energy directions', it is most unhelpful for a technology already in utility-scale operation internationally, with over 2GW of installed capacity and significantly more in construction and planning, to be equated with technologies yet to be demonstrated sustainably.

AUSTELA offers no criticism of the continuing investment made by Australian governments in CCS technology, despite the significant questions that remain over the viability of CCS technologies at scale and the cost, investment and time required to develop the storage and transport infrastructure that CCS at scale will require. Nor does AUSTELA level any criticism at the ongoing investment in geothermal technology.

AUSTELA does however point to the fact that CST is at a significantly more advanced stage of commercialisation than neither CCS nor deep hot rocks geothermal technologies. The challenges to large-scale development of CST technology in Australia are fundamentally about market awareness and confidence and cost reduction - quite different to the significant technical challenges (as well as cost challenges) facing CCS and geothermal.

Energy Market Reform – Incentivising a Long-term View and Appropriate Technology Risk-sharing in Energy Financial Markets

Australia has benefited from the application of competitive market reforms in its energy sector including and since the establishment of the NEM in 1996. Competitive market philosophy is at the core of Australia's energy reform program.

After 15 years of productive energy market liberalization, Governments are understandably reluctant to intervene in the choices made by electricity market participants in the transition to a low-carbon electricity sector. However markets are rarely perfect and Australia's energy markets – world-leading in terms of the adoption of competitive market philosophy – are no exception. Without diminishing the economic achievements of energy market reform in Australia since the 1990's, energy markets are failing to keep pace with the need for renewable energy technology innovation and development.

AUSTELA notes and agrees with the Government's view that energy market reform requires revitalisation in Australia, and that certain trends (including the trend towards vertical integration) have created challenges to the pace of change required in order for Australia to achieve least cost transition to a low-carbon economy consistent with Australia's carbon reduction targets.

Electricity generation assets are relatively capital-intensive investments with long operating lives. This is particularly true of renewable energy assets and of large-scale solar thermal power assets, which have low marginal operating costs and higher capital costs relative to traditional generation assets. In effect, renewable energy assets internalise (as capital costs) fuel costs and the cost of avoiding carbon emissions wastes that, in traditional generation assets, reflect as operating costs.

Long-term security and stability of revenue is therefore essential for large-scale renewable energy assets to be financed.

AUSTELA wishes to highlight the significant challenge presented by the short-term focus of Australian energy financial markets, and particularly the absence in Australia of market practice for long-term power purchase agreements.

In effect, development of large-scale renewable energy assets requires that one of the three major gentailers will provide a long-term offtake agreement for energy output and/or renewable energy certificates. Combined with the virtual absence from Australian market practice of long-term PPAs, this concentration of power amounts to a structural deficiency in Australia's energy financial markets which demonstrably has retarded and is continuing to thwart large-scale renewable energy development in Australia.

Where Australia lacks specific local experience in particular renewable generation technologies such as CST, this short-term focus and market concentration is compounded by the lack of mechanisms to share technology risks.

The structure of Australia's energy market system is such that Government cannot and should not provide the very significant levels of capital required to deliver the investment required in Australia's electricity and gas networks. Private sector capital must be mobilised.

However Australian capital markets currently have little interest or incentive to invest in forms of renewable energy development, and even less where technology risks are perceived because the technologies concerned are not familiar to Australian investors. There is a lack of energy financial market innovation to address these market gaps.

During the interregnum until perceived technology risks have been mitigated through deployment and demonstration at scale, there is a role for Government to play in implementing measures so that those risks are shared appropriately between the public and private sectors and so that long-term revenue streams can be secured (or created synthetically through energy financial market product innovation).

AUSTELA submits that there is no compelling evidence at present that existing commercial or regulatory incentives will deliver the changes or innovation needed to address these market gaps in a time frame consistent with Australia's carbon emissions reduction targets to 2050. To the contrary, AUSTELA submits that the evidence available strongly suggests that market failure will continue to thwart the uptake of large-scale renewable energy technologies such as solar thermal power generation.

16 March 2012

Energy White Paper Secretariat

The Energy White Paper should consider in more detail the structural changes, changes in incentive structures, and innovations in energy financial markets, needed promote broad participation of long-term investors in the development of large-scale renewable and clean energy assets.

Summary

Concentrating solar thermal power is a strategically important technology class for Australia, highly complementary to Australia's energy export strategy and to Australia's medium and long-term domestic energy strategy. CST is an industry in which strategic considerations warrant Australia having strong indigenous expertise and capability.

AUSTELA submits that there is a compelling rationale to significantly increase Australian research, development and demonstration of CST through a measured and sustained program, designed to leverage private sector investment and promote private sector awareness of and confidence in CST technologies.

CST is a rapidly maturing technology class that has already reached a stage of large-scale deployment that will deliver accelerating cost reduction. CST should not be considered in the same category as pre-demonstration technologies such as CCS and deep hot rocks geothermal.

CST should be considered on its own merits and from a strategic perspective that takes into account the broad option value only CST can deliver for Australia.

Prior analyses of cost and cost reduction trajectories used by Government in consideration of CST's potential in Australia have significantly overstated current costs and understated cost reduction potential, distorting Australian views of the viability and value of CST; new data and analysis drawing on the most contemporary experience and research globally should be preferred and afforded significant weight in the Energy White Paper.

AUSTELA appreciates the opportunity to present these views. AUSTELA may present additional views as new information and analysis becomes available.

AUSTELA and our members stand ready to support the work of the Energy White Paper and to assist the Government's considerations of the optimal approaches to Australia's energy future.

Best regards

Andrew Want
Chair, AUSTELA

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Energy White Paper Secretariat

Appendix
AUSTELA Submission to the AEMO 2012 NTNDP Planning Studies

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Planning Studies 2012 Consultation

AUSTELA is pleased to provide the following submissions for consideration by AEMO in the course of the 2012 Planning Studies for the National Transmission Network Development Plan (NTNDP). We appreciate the opportunity to contribute to AEMO's Scenarios Stakeholder Reference Group and renew our invitation to AEMO to seek AUSTELA's assistance with any information that may be useful to support the consideration of concentrating solar thermal power (CST) in the 2012 and future NTNDP (and GSOO) processes.

About AUSTELA

AUSTELA is the industry body solely dedicated to concentrating solar thermal power generation (CSP) in Australia. Composed of some of leading national and international solar thermal industry participants, AUSTELA's membership is open to organisations involved in the development of solar thermal power systems on a large scale to supplement or replace existing power requirements in Australia, whether in the electricity sector or in other industry sectors.

Companies involved in large-scale solar thermal energy observe significant misconceptions among policy makers and investment decision-makers in Australia about the cost of solar thermal power, and a lack of understanding of the rapidly improving cost dynamics of large-scale solar thermal energy production emerging from research and deployment at scale in other markets.

AUSTELA's goal is to significantly improve the investment environment for solar thermal power generation in Australia by providing information, analysis and data to assist policy and investment decision-makers to better understand the value, cost and potential importance of solar thermal power in Australia's electricity system.

Background

AUSTELA agrees with and strongly endorses the view expressed by AEMO that the NTNDP 2010 Scenarios are out-dated and require thorough review, and endorses AEMO's intention, in the 2012 NTNDP, to deliver a new set of generation results based on substantially updated evaluations of technology cost.

AUSTELA would add that it is vital that the 2012 Planning Studies should undertake a thorough review of the potential cost reduction trajectory for CST generation over the NTNDP's 20 year forward planning period.

AUSTELA notes that the 2012 NTNDP also aims to:

- Ensure the transparency of transmission development, to facilitate optimal coordination between generation and transmission developments
- Develop transmission plans that show greater interaction between electricity generation and transmission as well as gas transmission, which requires improvements to the modelling methodology
- Provide a long-term national focus on efficient generation and transmission investments, rather than shorter-term regional modelling

and that network support and control ancillary service (NSCAS) will be addressed in separate studies.

We note AEMO's intention to work with stakeholders to understand how the 2012 NTNDP can usefully address issues that are emerging in the energy market.

Against this background, AUSTELA makes the following observations and submissions:

1. **Updating cost data and cost reduction projections in relation to concentrating solar thermal power generation – the Australian Solar Institute's 'Review of the Potential for Concentrating Solar Power in Australia'**

   We reiterate our observations in previous submissions that past assumptions as to CST costs, and in particular cost reduction forecasts used in AEMO scenarios development in the 2010 and 2011 NTNDPs, were significantly at odds with international research, data and experience.[4] This has resulted in projections for generation mix which, with one minor exception, did not include any solar energy generation.[5]

   While we note and broadly support AEMO's intention to adopt consistent modelling methodologies and assumptions for different generation technologies in relation to 2012 NTNDP preparation, we also note (and agree with) the following statement by Worley Parsons highlighting the challenges with and limitation of this approach:

   > *The objective [of the deliverables from the Report] is to ensure that the capital cost estimates are derived consistently for the electricity generation technologies.*
   >
   > *This is achieved for fossil technologies by utilizing a consistent software and cost data base. For other technologies where there is no consistent pricing basis, only a subjective analysis is possible. This was based on the available information and considered / adjusted based on Worley Parsons' experience with these technologies.* [Worley Parsons, Cost of Construction of New Generation Technology, February 2012, ('Cost of Generation Report') at 4] - AUSTELA emphasis

[4] Kutscher C, Mehos M, Turchi C, Glatzmaier G, Moss T, 2010, Line-Focus Solar Power Plant Cost Reduction Plan , NREL/TP-5500-48175 December 2010. http://www.nrel.gov/docs/fy11osti/48175.pdf; IEA, 2010, Technology Roadmap - Concentrating Solar Power, OECD International Energy Agency; Kolb G, Ho C, Mancini T, and Gary J, 2011, Power Tower Technology Roadmap and Cost Reduction Plan, SANDIA REPORT SAND2011-2419 April 2011 Prepared by Sandia National Laboratories Albuquerque, New Mexico

[5] In the context of emerging issues in energy markets, we note that cost assumptions used in analysis for the draft Energy White Paper of generation costs are based is the same as the source of the 2010 NTNDP, with the result that the Energy White Paper similarly (in effect) dismisses solar power as a meaningful proportion of Australia's energy mix at 2030.

As previously advised, the Australian Solar Institute has commissioned IT Power to undertake a 'Review of the Potential for Concentrating Solar Power in Australia'. This Review, due for publication in April 2012, has been developed in close consultation with AUSTELA, CSIRO, the Australian Solar Energy Society, the Clean Energy Council and Boston Consulting Group, and has directly engaged the leading developers of concentrating solar thermal power (CST) facilities operating in the world today, such as Abengoa, ACS Cobra, Areva, Ferrostaal, BrightSource Energy and others. The Review will provide an up-to-date and thorough re-assessment of capital costs (and levelised cost of energy) for CST in Australia.

The extensive research, analysis of actual project experience, and industry consultation undertaken for the ASI Review represents the nearest possible approximation of empirical data in Australia relating to CST technology and provides a sound basis for consideration of the cost of CST generation over the 20 year forecast period to be covered in the 2012 NTNDP. Our submission is that this Review should be given significant weight in NTNDP Planning Studies.

AUSTELA reiterates our earlier submissions and contributions as a member of the Scenarios Stakeholder Reference Group that AEMO should ensure that any assessments of CST technology cost utilised in 2012 and future NTNDPs – and in particular estimates as to the rate of future cost reduction flowing from learning and deployment of CST technologies – should be compared and tested against the findings and observations of the ASI Review and the international research, data and experience reported in it, including those reports referenced above.

AUSTELA also reiterates that assumptions used in relation to renewable source generation, which as Worley Parsons notes are inherently subjective, must be transparent in the body of their report. In particular, it is imperative that where cost premia are applied or assumed based on subjective assessments of CST project, technology or financing risks, these are highlighted and compared with comparable assumptions in relation to other technologies, to enable readers to readily assess the logic and veracity of these assumptions and to weigh the merits or otherwise of them.

2. The impact of large-scale energy storage in development of transmission network scenarios

AUSTELA notes that, just as the 2012 NTNDP is intended to address the increasing interaction of gas and electricity markets and infrastructure, the 2012 and future NTNDPs must develop more sophisticated modelling capability that allows the impact and value of large-scale energy storage to be incorporated into future network development scenarios.

We point to a recent study published by the National Renewable Energy Laboratories in the United States (Denholm and Mehos 2011) in which the potential value of CST generation in terms of avoided network augmentation costs, particularly in scenarios of high penetration of variable renewable energy sources (such as wind and PV), is investigated.[6] Similar analysis and research is being undertaken in Europe (Sanchez, 2011).[7]

In their report referred to above, Denholm and Mehos note as follows:

[6] Paul Denholm and Mark Mehos, Enabling Greater Penetration of Solar Power via the Use of CSP with Thermal Energy Storage, http://www.nrel.gov/docs/fy12osti/52978.pdf

[7] M Sanchez, RED Electrica Espana, CSP Plants Dispatchability, September 2011

> ‘The ability of the aggregated set of generators to rapidly change output at a high rate and over a large range can be described as a grid’s overall flexibility. Flexibility depends on many factors, including:
>
> - Generator mix – Hydro and gas-fired generators are generally more flexible than coal or nuclear.
> - Grid size – Larger grids are typically more flexible because they share a larger mix of generators and can share operating reserves and a potentially more spatially diverse set of renewable resources.
> - Use of forecasting in unit commitment – Accurate forecasts of [sic] the wind and solar resources and load reduces the need for operating reserves.
> - Market structure – Some grids allow more rapid exchange of energy and can more efficiently balance supply from variable generators and demand.
> - Other sources of grid flexibility – Some locations have access to demand response, which can provide an alternative to partially-loaded thermal generators for provision of operating reserves. Other locations may have storage assets such as pumped hydro.
>
> A comprehensive analysis of each flexibility option is needed to evaluate the cost-optimal approach of enhancing the use of variable generation…
>
> [Thermal energy storage] TES provides some potential advantages for bulk energy storage. First, TES offers a significant efficiency advantage [as compared with electricity storage], with an estimated round trip efficiency in excess of 95% (Medrano et al. 2010). TES has the potential for low cost, with one estimate for the cost associated with TES added to a CSP power tower design at about [US]$72/kWh-e (after considering the thermal efficiency of the power block).’

AUSTELA submits that the benefits of large-scale energy storage now available by utilising CST technologies in the transmission system must be addressed in NTNDP modelling, and that current cost comparison methodologies constrain assessment of potential benefits relative to other generation options.

It is noted for example that the Cost of Construction report addresses costs of generation at the ‘boundary’ of a generation facility, so that transmission and, in the case of Carbon Capture and Storage (CCS) technology, storage infrastructure, is not taken into account in generation capital costs. AUSTELA submits that this approach results in a capital cost bias against CST technologies.

In CST technologies, unlike gas and CCS technologies, the capital cost attributable to providing flexible dispatch is internalised into the plant capital cost. In relation to gas and CCS technologies, incremental costs of providing immediate (peak) or load-following dispatch reflect as fuel or waste costs or both (as an aside, we note that in the case of CCS, waste costs are speculative until such time as costs of waste and storage infrastructure are known), reflecting in LCOE. In the case of CST, the cost of providing capacity for flexible dispatch is internalised in the form of incremental capital cost attributable to scale in the solar array and in the heat transfer and storage system.

The bias is exacerbated if, as in some previous cost and LCOE assessments of generation technologies[8], amortisation periods adopted for CST generation plant are shortened to reflect subjective assessments of plant operational life.

3. **Appropriate sizing (influencing capital costs) of thermal energy storage capacity**

It is also noted that for the CST technologies with energy storage considered in the Cost of Generation study, 6 hours storage has been assumed. Optimisation of thermal energy storage in CST plants is specific to regional market and network constraint conditions; while it is possible that in some locations 6 hours may be optimal, it is likely that this is an excessive amount of storage in most locations in the NEM, and thus that capital costs for CST with storage in the Cost of Generation study will have been overstated.

It is submitted that NTNDP modelling must be enhanced to enable the assessment and comparison of costs of CST generation with thermal energy storage to reflect optimised storage capacity based on forecast load and constraint data by region.

This approach would enable a more accurate comparison of costs and network benefits of CST generation with energy storage with those of other flexible generation types. This capability is essential for transmission system planning to appropriately consider the role of CST in scenarios of high penetration of renewable generation sources beyond 2020.

Thermal energy storage has potential to displace the need for gas generation and gas supply infrastructure and to reduce the need for electricity transmission infrastructure.

Just as the modelling for the NTNDP and GSOO is being developed in parallel to enable the relative benefits of electricity versus gas infrastructure augmentation to be considered, modelling capability is needed to facilitate assessment of the value and potential of large scale thermal energy storage. We are not aware of methodology currently available to AEMO that allows this value potential to be measured so that CST with thermal energy storage can be appropriately compared with other generation options.

We submit that the development and application of such methodologies is essential if the 2012 NTNDP is to address AEMO's stated areas of focus:

- Developing transmission plans that show greater interaction between electricity generation and transmission as well as gas transmission.
- Providing a long-term focus on efficient generation and transmission investments, rather than shorter-term modelling based on regional, reliability-driven investments …
- … [U]pdating the scenarios and assumptions in light of current events, and the creation of new generation and transmission development results.

4. **Development of cost models for CST hybrid and solar boost configurations**

Concentrating solar thermal power is complementary with a broad range of other generation types:

8 EPRI, 2009

- CST is unique among renewable generation technologies, having the ability to integrate with the operation of other thermal generation types through hybrid configurations (CST/gas, CST/coal, CST/biomass, CST/oil), lowering fuel and emissions costs of gas, coal or diesel generation technologies, and
- CST is able by virtue of inherent thermal inertia to provide load-firming zero-carbon generation to support more variable renewable generation types such as wind and PV, enabling significantly higher penetration of renewable energy sources in a network (Denholm and Mehos, 2011). These benefits are enhanced using thermal energy storage, where cost-effective.

While CCS and geothermal technologies may provide zero-carbon generation capacity at some point in the period to 2050, it is the case that neither technology is operating at scale today. In the case of CCS, an entire class of major infrastructure associated with CCS would need to be developed and constructed, and at this stage the costs associated with this infrastructure must be regarded as speculative, despite being assumed in capital costs of CCS generation:

> 'For CCS cases, the cost associated for CO2 injection wells, pipelines to deliver the CO2 from the power plant to the storage facility and all administration supervision and control costs for the facility' [are excluded from capital costs][9]

By comparison, utility scale CST plants with gas backup are already operating in many international locations. CST/gas integrated combined cycle and gas/CST co-fired generation technologies are available today from major international energy companies (GE, Abengoa and ACS Cobra are examples of major companies offering solutions in this technology class).

A 40MW CST plant to provide integrated solar boost into the operation of an existing coal-fired generator is under construction in Australia today (Kogan Creek, CS Energy/Areva); a smaller example in operation at the Liddel power station for several years has been expanded and is currently being commissioned (Macquarie Generation/Novatec Solar).

Over the time horizon of the NTNDP to 2050, Australia's carbon emissions are, under current government policy, to reduce by 80%. Achievement of this policy objective will require greater penetration of zero-carbon emissions generation technologies, and a significant proportion of this must be low-carbon load-firming generation. Of the technologies potentially able to perform this role, only CST in hybrid configurations is currently available for deployment in Australia at utility scale.

Planning Studies consider other hybrid plant configurations - CCS plant configurations are, as indicated in the Cost of Generation Report combinations of a number of technologies (although unlike CST hybrids, the CCS combinations noted are not to our knowledge currently operating at utility scale anywhere in the world).

CST in hybrid configurations, with existing (retrofit) and greenfields (integrated combined cycle) traditional generation plant is a proven, existing class of generation technology that should be included in NTNDP modelling.

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[9] Worley Parsons, Costs of Generation at 15

5. Technology development and cost reduction forecasts applicable to CST generation

AUSTELA notes and agrees with Worley Parsons observation that the 'The impact for technological improvement has probably the most influence over pricing trends for the different generating technologies during the period 2012 to 2032.'[10]

For this reason, it is vital that AEMO pauses to consider and review elements of the logic applied in previous cost analyses carried over into the Cost of Generation report prepared by Worley Parsons. AEMO's conclusion (with which AUSTELA concurs), is that data used in the 2010 NTNDP are, at best, out-dated. AUSTELA submits that this is nowhere more evident that in the EPRI 2010 assumptions as to cost reduction for CST technologies.

Despite AEMO's intentions to update cost data for the 2012 Planning Studies, there is a risk that erroneous assumptions made in the 2010 EPRI[11] cost review in relation to the rate of technology cost reduction for CST technologies are carried across into the 2012 and future NTNDPs.

For example, AUSTELA points to the relative maturities of 'Central Receiver STE' and 'Geothermal' as shown in Figure 3 in the Cost of General Report in the Australian context. AUSTELA would submit that it does not make sense to characterise Central Receiver STE technology, of which well over 500MW is currently operating or in advanced stages of construction, as less mature than deep hot rocks geothermal technology, which has not yet been proven as sustainable at demonstration scale.

We note that in Section 5 of the Cost of Generation Report Worley Parsons comments that:

> 'It is expected that development and/or further refining of these [CST] systems for power generation will continue well into the 2025-2030 timeline.'[12]

This statement, while probably correct, could equally be made about coal-fired or gas-fired generation technology; it is a reality that all technologies continue to evolve and refine over time. However in context, the statement could be read as suggesting that CST technologies (and, in the context of the statement, Central Receiver CST in particular) may not achieve full commercialization until 2025-30. AUSTELA does not accept this implication.

Central Receiver STE has reached a more advanced stage of development than is indicated in the Cost of Generation Report and has already entered a phase of large-scale deployment. This will have the effect of significantly accelerating the cost reduction curve for Central Receiver STE generation.

AUSTELA submits that the projections for capital cost reduction indicated in Appendix 1 (figures 8, 9 and 10) of the Cost of Generation Report do not accord with either general experience in technology cost improvement, nor with international experience and research of CST capital cost specifically.[13] It

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[10] Ibid at 18

[11] Australian Electricity Generation Technology Costs – Reference Case 2010, February 2010, EPRI

[12] Worley Parsons, Costs of Generation at 52

[13] For example, see Kutscher C, Mehos M, Turchi C, Glatzmaier G, Moss T, 2010, Line-Focus Solar Power Plant Cost Reduction Plan ,NREL/TP-5500-48175 December 2010. http://www.nrel.gov/docs/fy11osti/48175.pdf; IEA, 2010, Technology Roadmap - Concentrating Solar Power, OECD International Energy Agency; Kolb G, Ho C, Mancini T, and Gary J, 2011, Power Tower Technology Roadmap and Cost Reduction Plan, SANDIA REPORT SAND2011-2419 April 2011 Prepared by Sandia National Laboratories Albuquerque, New Mexico

makes little sense to observe as the Report does that CST technologies are at early stages of commercial deployment and will continue to be refined and improved over time, and then to find that capital costs reductions will essentially cease from 2020.

AUSTELA suggests that the forecast rates of capital cost reduction in the Cost of Generation Report should be reconsidered against best available international experience.

We again draw AEMO's attention to the impending ASI Review of the Potential for CSP in Australia as a resource for the 2012 Planning Studies, particularly in relation to forward projections of cost improvement. We submit that the assumptions made in the 2010 EPRI cost review as to CST generation should not be carried forward into the 2012 and future AEMO Planning Studies.

In this submission, AUSTELA has focused on a number of specific issues we believe are of critical importance in order for Australian transmission network planning to begin to properly assess the value and potential of concentrating solar thermal generation technologies relative to other generation options, in order to meet AEMO's objectives for the 2012 NTNDP to:

- Ensure the transparency of transmission development, to facilitate optimal coordination between generation and transmission developments
- Develop transmission plans that show greater interaction between electricity generation and transmission as well as gas transmission, which requires improvements to the modelling methodology
- Provide a long-term national focus on efficient generation and transmission investments, rather than shorter-term regional modelling

AUSTELA will wish in due course to make submissions in relation to other issues relating to CST's role in the NEM and in the transmission system, including submissions in relation to the value and potential of CST technologies with respect to ancillary services.

AUSTELA is pleased to be able to contribute to the 2012 NTNDP. This submission may be supplemented as further data becomes available.

We look forward to continuing to assist AEMO in its work.

Best regards

Andrew Want
Chair, AUSTELA