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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.[1] This has resulted in projections for generation mix which, with one minor exception, did not include any solar energy generation.[2]

   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

   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

[1] 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

[2] 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.

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.[3] Similar analysis and research is being undertaken in Europe (Sanchez, 2011).[4]

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

> ‘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.

[3] 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

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

- 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[5], 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.

[5] EPRI, 2009

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:

- 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 CO_2 injection wells, pipelines to deliver the CO_2 from the power plant to the storage facility and all administration supervision and control costs for the facility' [are excluded from capital costs][6]

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.

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.'[7]

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[8] cost review in relation to the rate of technology cost reduction for CST technologies are carried across into the 2012 and future NTNDPs.

[6] Worley Parsons, Costs of Generation at 15

[7] Ibid at 18

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

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.'[9]

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.[10] It 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:

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[9] Worley Parsons, Costs of Generation at 52

[10] 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

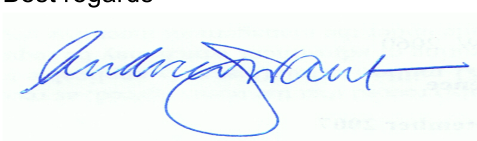
- Ensure the transparency of transmission development, to facilitate optimal coordination between generation and transmission developments
- Develop transmission plans that show greater interaction between electricity generation and transmission as well as gas transmission, which requires improvements 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



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