AUSTELA

Australian Solar Thermal Energy Association Ltd

25 May 2017

Rebecca Knights
Director, Energy Policy and Projects
Department of State Development
Adelaide, South Australia 0
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Dear Rebecca,

Re: Submission on the proposed SA Energy Security Target

We write representing Austela, a non-profit association that advocates on behalf of the Solar Thermal industry.

This initiative from the South Australian Government comes at a time when the issues of Climate policy and managing the transition to renewable energy and maintaining electricity system stability are at the forefront of political and public debate.

The proposed Energy Security target represents a significant and constructive contribution to the overall policy and market environment in this country

We note that the consultation paper requests feedback on four specific issues. Questions 1, 2 and 4 address the legal and administrative issues and we leave it to others to comment on these. We restrict our contribution here to the third question:

Are there any changes to the draft Regulations you consider necessary to support the long term interests of South Australian electricity consumers?

We also provide further background material on CST technology and industry status in an Appendix.

We are keen to meet with you and your colleagues to further discuss the ideas we propose here.

Yours sincerely

Keith Lovegrove, Andrew Want, Alan Atchison
Board members, AUSTELA

Summary

- The proposed Energy Security Target is a positive and constructive initiative that could be improved with some key adjustments.
- We note and welcome the fact that Concentrating Solar Thermal plants with their characteristics of steam turbine based generation and built in thermal energy storage are identified as being eligible for generation of certificates under the target. This clearly recognises that such plants do indeed bring all the characteristics needed to meet the goals of the scheme whilst also being emissions free.
- We question the relatively low price cap. This seems too low to significantly influence generator behaviour at times of high wholesale prices in the NEM.
- We suggest that the definitions of fault current and real inertia required need to be technically sound and to be precisely specified.
- We note that it could be anticipated that there will be many submissions seeking to widen eligibility and some of these will have a reasonable case. If this is done then it will be important to adjust other points to avoid perverse outcomes such as electricity storage units that cycle repeatedly on short timescales to artificially maximise Energy Security Certificate income.
- We suggest that there should be a more sophisticated approach to awarding certificates. A further multiplier should be added to the formula for Eligible Energy that favours:
    - Lower emissions intensities
    - Generation when it is most needed for stability
    - Generation that takes place when high NEM wholesale prices might otherwise be expected.

Detailed response

The initiative by the SA government to establish an Energy Security target represents a very constructive step in contributing to re-shaping of the overall market situation in a manner that is conducive to developing an ultimately emissions free but stable and affordable electricity system.

The stated goals of the Energy Security Target are; “to increase competition, put downward pressure on prices and provide more energy system stability.” There is a further implicit goal of reducing Greenhouse Gas Emissions via the explicit targeting of “clean generators”.

We note that the consultation paper requests feedback on four specific issues. Points 1, 2 and 4 address the legal and administrative issues and we leave it to others to comment on these. We restrict our contribution here to the question:

Are there any changes to the draft Regulations you consider necessary to support the long term interests of South Australian electricity consumers?

In this regard the most important issues are the eligibility of technologies / systems to generate certificates and the methodology for creating and awarding certificates.

Inclusion of CST as an eligible technology

We note and welcome the fact that Concentrating Solar Thermal plants with their characteristics of steam turbine based generation and built in thermal energy storage are identified as being eligible for generation of certificates under the target. This clearly recognises that such plants do indeed bring all the characteristics needed to meet the goals of the scheme whilst also being emissions free.

CST power generation in all commercial plants uses steam turbines connected to synchronous generators. These are the same as encountered in fossil fired power stations, however customised for solar operation to give faster start-ups. They can provide, as a matter of course, all the ancillary services (ie the various aspects of frequency control and network stability) that are currently provided in the NEM largely by fossil fired generators and about which there has been so much recent controversy. The CST industry has now adopted as a standard, integrated energy storage using tanks of hot liquid salts. Plants are typically built to provide between 5 and 15 hours of full load operation in a flexible / dispatchable manner.

CST as a global industry has a track record of plants that have operated for over 30 years. Over the last decade it has averaged 30+%/ year growth in deployment. At 4.8GW globally it is far from being experimental and compares to the level of deployment that PV had in 2005 and wind in 1995.

Building on overseas progress, estimated costs of energy from CST with storage done at mature scale in Australia have dropped from $250/MWh in 2012 to approximately $150/ MWh in 2016. The extra value that CST with storage provides via its flexible generation and network and system support features more than justify the premium over Variable Renewable Energy (VRE).

Significance of the price cap

It is indicated that the price of Energy Security Certificates (ESCs) will be capped at $50 per MWh certificate. We question why such a relatively low price cap is planned. Clearly it does allow for an upper bound estimate of the overall cost that must be borne by consumers, however one of the main goals is to put downward pressure on prices in the wholesale market and the measure of success will be the extent to which customers end up seeing lower overall average prices than they otherwise would. This depends on the behaviour of eligible generators in the market and not the price cap that is used.

As a certificate value, a $50/MWh average value would have a considerable impact on the business case for the generators targeted. However the downward pressure on prices that is desired is needed at times when due to various market circumstances, wholesale prices can be very high and indeed occasionally reach the $14,000 / MWh NEM cap. We would suggest that an upper limit to ESC income of $50/ MWh will mean that at times of very high or leading into very high wholesale prices, the potential for ESC income will be outweighed by the potential for wholesale market income and so the generators present will have little incentive to modify their behaviour.

On the other hand, if a certificate value of $50/MWh were to be routinely added to the average cost of power at times when the wholesale price is low and if substantial amounts of generation were to occur at such times, then this would be a considerable impost on consumers and would indicate a failure of the target to encourage competition in the market at peak times.

The downward pressure on prices is expected to flow from an increase in competition from more active generators in the SA system. This is a very reasonable proposition. However it should be noted that with the target to become operational from July of 2017, it is only existing generating units that can realistically be expected to generate in the first 2 – 3 years of operation of the scheme. There appears to be a risk that in the early years of the scheme, if it is implemented as proposed, it could just become a route to windfall profits for existing generators at no gain to consumers.

These considerations together lead us to suggest that the number of certificates awarded for an actual MWh of sent out generation, should be varied by the need and circumstances at the time of generation as discussed further below.

Elligible Generators

Section 44EC deals with Accreditation of electricity generating plant.

We suggest that the meaning intended in the draft is clear; what is sought is generating plant that is dispatchable and has sufficient energy reserves available to deliver nameplate power output for extended periods, offers in built frequency support due to rotating machinery with inertia and is low in emissions. However the wording and definitions may need to be more precise to achieve the outcome intended.

We would also predict that there will be many submissions from proponents of technologies that appear not to be eligible, asking for a wider range of eligible systems. In this regard we consider that the government needs to consider the arguments very carefully and not accept all at face value as there is a danger of loosing the potential benefits from accepting too wide an eligibility. If widening the scope is considered, to for example pure electricity storage technologies, then careful attention would need to be paid to the earning of certificates. Perverse outcomes such as energy storage units repeatedly charging and discharging on short cycles to accumulate maximum ESC income with no benefit to the electricity system would need to be anticipated and avoided.

Regarding the specific clauses we offer the following comments.

44EC part (1) defines the eligibility. We suggest that:

In regards to 44EC part (1) (a), being a scheduled generator in the NEM, this seems a reasonable requirement as it means generators can be dispatched up or down by the market operator when they are available which is a clear benefit to system adequacy. It does however mean that generators need to be of 30MW or greater. This does coincide with what is effectively a minimum viable size for a commercially operated CST plant. It does however mean that smaller plants such as pilot stage CST plants with storage would not be eligible and indeed smaller bioenergy or other such generators would also not be eligible. Maybe thought should be given to allowing aggregation of smaller systems such that they could also contribute.

In regards to 44EC part (1) (b), this establishes a requirement for “fault current” and “real inertia”. Whilst the meaning is clear, this is a highly technical requirement and we suggest it should be defined more precisely. In 44EB, Fault current is defined as “current that results from a fault”. This is not a useful definition. We suggest the definition should be something like “an ability to sustain a current in excess of nominal specifications in the event of a sudden fault in the electricity system”. Further the requirement in 44EC (1) (b) (i) should be tightened to “sustain a fault current of X% greater than design point current for a period of Y seconds“. The value of X and Y need to be determined in consultation with the industry.

Similarly 44EB defines Real Inertia as “the provision of an inertial response”. Again this is not a useful definition. Noting that the intention has been clearly expressed that “real inertia” is required and not “synthetic inertia” we would suggest a suitable definition is “The presence of kinetic energy within the rotating machinery of the generator that works to resist a change in frequency in the event of a disturbance in the electricity system” Further 44EC (1) (b) (ii) should be tightened to; “contain rotational kinetic energy in normal operation that is equal or greater than the design point power output sustained for Z seconds” Again the value of Z needs to be established in consultation with industry. In regards inertia, we would predict that there will be many submissions arguing that ‘synthetic inertia’ should be equally eligible. In some regards this is not an unreasonable proposition, however we would note that real inertia, as we have defined it above, does have the advantage of being automatically present and adding its benefits to the electrical system without the need for any electronic control system. It is therefore not subject to the range of possible failure scenarios that an electronic based response must consider.

Awarding certificates based on value to the system

Section 44ED deals with the creation of certificates. We comment specifically on 44ED (2) in which the amount of eligible electricity is determined.

A logical formula is presented that specifies that ‘Elligible Electricity’ is equal to the product of the ‘Sent out Generation’ and the % that is based on ‘Eligible Fuel’ and the ‘Marginal Loss Factor’.

Ie

EE=SOGen x %EF x MLF

Referring back to the definitions, 44EB (3) defines the Marginal Loss Factor implicitly in the same way that the term is used within the NEM. However 44EB (6) then allows the Commission the power for ..”fixing a marginal loss factor of 1 or more than 1 in relation to an accredited electricity generating plant”. This apparently simple clause thus allows the Commission to provide certificates an any basis whatsoever.

We suggest that it is very misleading to use MLF in this manner, particularly when the variable is in common usage within the NEM. We suggest that 44EB (6) be removed. However we agree that there should be the ability to differentiate on the level of certificates created. We suggest that a further variable be added to the equation in 44ED (2), called for the sake of argument the “System Utility Factor” SUF. This variable could then be set in advance by the Commission according to assessed desirable attributes.

Ie the equation would instead appear as:

EE=SOGen x %EF x MLF x SUF

Recalling that the goals of the Energy Security Target are to put downward pressure on prices, increase system stability and implicitly contribute to lowering emissions, it seems that if eligible generators can earn certificates on an equal basis irrespective of when and how they generate that much of the potential advantage of the scheme is being missed.

We suggest that there are three aspects that should be recognised in the creation of certificates:

- The emissions intensity of the generator.
- The extent to which generation from eligible generators correlates with an instantaneous need to increase system security
- The extent to which generation correlates with times when high price events might be expected

Thus we are suggesting a multivariable and systematic approach to determining the System Utility Factor SUF on a continuous basis, varying every half hour, that could be as follows:

- A baseline value, less than one, that applies at all times.
- An additional value of 1 or more that is added whenever:
    - AEMO has signalled a creditable contingency event (or a similar determination that system security would benefit from support).
    - Wholesale prices have risen to a level that is more than a certain multiple (eg twice) the previous days average value.
- A further multiplier that is inversely proportional to the emissions intensity of the generator.

If the basis for determination of the SUF is fixed in advance this would be no more difficult for the Commission to determine and for generators to plan for than the wholesale price itself.

Appendix – Background information on CST

The material in this appendix has also been included in other recent submissions including:

- Independent Review into the Future Security of the National Electricity Market http://www.environment.gov.au/energy/national-electricity-market-review/submissions
- Senate select committee Select Committee into the Resilience of Electricity Infrastructure in a Warming World http://www.aph.gov.au/Parliamentary_Business/Committees/Senate/Resilience_of_Electricity_Infrastructure_in_a_Warming_World/ElectricityInfrastructure/Submissions (submission 43)
- House of Representatives Standing Committee on the Environment and Energy http://www.aph.gov.au/Parliamentary_Business/Committees/House/Environment_and_Energy/modernelectricitygrid/Submissions (submission 34)

The characteristics of Concentrating Solar Thermal

Concentrating Solar Thermal (CST) systems use mirror based solar concentrators to produce high temperatures in heat transfer fluids which ultimately transfer heat to superheated steam for use in steam turbines in the same way that heat from fossil fired boilers currently does. Most new systems and more than half of the existing CST systems incorporate intermediate storage of the collected heat using 'two tank molten salt' thermal energy storage.

The steam turbine driven generators used are 'synchronous' in the same way that those in coal fired power plants are. They offer all the features of inertia, spinning reserve and frequency and voltage control that fossil fired systems can. The turbines used, typically in the range 50 – 100MW are smaller than the units in coal fired stations (around 600MW) and are optimised to be able to start quicker and ramp faster.

Steam turbines tend to be higher efficiency at larger sizes. At 50MW good efficiency is achieved, this increases somewhat out to 100MW and 200MW, with minor increases beyond that. Below 50MW, efficiency progressively drops and is quite poor for units below 5MW. A consequence is that the CST industry recognises that systems need to be built in the size range 50 – 250MW for best economic performance. There can be cases where systems in the 10s of MW are justified by high energy costs in situations with limited demand and smaller systems are also needed to demonstrate new technology variations and innovations.

A feature of integrated thermal energy storage (via molten salts or any newer more advanced approaches) is that the addition of such energy storage actually lowers the cost of delivered energy. This arises because annual system output increases as there is no longer a need to spill energy from oversized solar fields during times of peak solar input, plus the ability to operate the power block at higher capacity factor means that the investment in that subsystem is amortised more effectively and offsets the extra investment in storage components.

This is in distinction to electricity only storage systems applied to electricity generated by wind or PV. In such cases, the storage system reduces output through its own efficiency limitation and adds very considerably to the investment cost and hence overall cost of delivered energy.

CST annual performance will be maximised when constructed in areas with the best annual levels of solar radiation. These characteristics together indicate that CST plants are best built in a distributed manner around the inland extremes of both the distribution and transmission electricity networks, depending on size.

The motivation to examine the future modernisation of the grid no doubt flows in part from the situation experienced by South Australia during its September 2016 blackout. That event was the result of the direct destruction of transmission towers by a storm. The concern that arises is as much around the duration of the loss of supply as the initial loss of supply itself, particularly to customers in the mid North West of the state. Future CST plants in a region like that would greatly increase resilience by for example:

- Being able to trip to house-load in the event of a system black, remaining as spinning reserve ready to reconnect at short notice.
- Incorporate a black start capacity via an onsite black start diesel generator if desired.
- Facilitate the operation of a section of the network in an islanded manner in the event of an extended loss of transmission connection to the rest of the NEM.
- Switch to an energy storage management strategy that maximised the benefit to the local region by; holding stored energy in reserve, adding stored energy via electric heaters from other variable sources of generation such as wind, as needed.
- Operating at part-load so as to maximise the potential for ramping up and down on call to balance an islanded section of the electrical system.

A rapid and consistent rollout of CST systems with thermal energy storage would add greatly to the resilience of the electrical system whilst creating a large number of jobs in installation and manufacture. The nature of the technology is such that rather that it relies on traditional skills of civil engineering, steel fabrication, glass installation and infield pipework and electrical and control system installation. This is in contrast to technologies where much of the value chain is derived in high tech factory environments which tend to be in countries like China. Consequently with CST systems, more of the value is generated in the regional area of installation and overall within the country.

CST systems with storage are utility scale, and hence not suitable for the small commercial or household scale. They are however of smaller size than traditional GW scale coal fired power stations. They are an option for large businesses in high solar areas. In particular there are opportunities for building CST systems that provide both process heat and electric power generation for businesses that have demands of that nature.

Transmission or distribution connected CST systems with 6 – 10 hours of energy storage are also a very good complement to localised storage systems able to meet loads for smaller time periods that are located ‘behind the meter’ in households or businesses.

As with all new energy technologies, a strong pipeline of projects within Australia, will lead to cost reductions as supply chains and installation approaches become more efficient and implement new innovations.

The status of Concentrating Solar Thermal

Globally the CST industry has experienced very strong growth over the last decade, averaging greater than 30% p/a. Deployed capacity now exceeds 4.8GW_e made up of nearly 100 separate utility scale power stations with capacities that are typically between 50 and 250MW. Whilst this deployment level is only about 2% of PV, this is a mature global industry at a phase that is highly analogous to that of PV a decade earlier. Continued development is assured due to the very cost effective nature of integrated energy storage that it offers.

Spain and USA currently dominate installed capacity, however other countries have become increasingly significant. Notable amongst these are South Africa, Chile, Morocco and India. China has recently embarked on a 'pilot' program that could see as many as 20 separate plants totalling 1.3GW in installed capacity built in the next few years.

In countries where the industry has matured with multiple plants, construction times can be down to 18 months from ground breaking to on grid generation.

The majority of installed CST capacity is in the form of trough concentrator systems. Systems of this nature have been generating continuously for over 30 years in California. Consequently this approach is technically lowest risk and the easiest to secure debt finance for. In recent years, Tower systems with direct heating of molten salt are increasingly favoured for their more cost effective use of the energy storage system. The first such commercially operated plant of this nature (the Gemasolar 19MW plant in Spain) has been operating well for over five years, such that the perception of technical risk is dropping rapidly. Linear Fresnel systems have been implemented in 2 utility scale plants and are a promising approach for lowering cost. Dish systems, although offering very high efficiencies, are still the least commercially mature approach and have yet to be implemented at utility scale.

Australia has so far not built a first utility scale CST system. There are small CST arrays at Sundrop farms in SA, Liddell Power station, Jemalong and Lake Cargelligo in NSW, plus a range of experimental facilities. There is a significant sized Linear Fresnel array (130MWth) at Kogan Creek power station in Queensland, however that project has been stalled for several years coincident with the exit of AREVA Solar from the business and a decision by CS Energy not to complete the system themselves.

The global CST industry is still at a sufficiently early stage, that Australia could develop a global leadership role if it establishes a strong pipeline of project deployment. Australia already has a strong position in CST R&D via research groups at CSIRO and universities and support from ARENA. Deployment of commercial utility scale projects should begin with replication of designs and technology already proven in overseas markets. From such a starting position, the potential for increasingly adopting Australian improvements and innovations is high.

The CST value proposition

The cost of energy from a mature utility scale CST system in Australia would be around 50% higher than a utility scale PV system. Both technologies can expect continued cost reductions, however cost reduction is contingent on continued deployment.

Whilst being 50% more expensive CST plants offer a range of features in addition to providing emissions free electricity, that are valued either implicitly or explicitly in the market place. These include:

- **Moving energy sales to high demand periods:** CST system can preferentially dispatch in the highest demand periods of the day. Early evening periods are the key point of attention in this regard. In the wholesale market, energy sold in such periods can be 100% more valuable than the 24 hour average NEM price.
- **Ancillary services (spinning and non-spinning reserves, frequency and voltage control, blackstart capability etc):** These have traditionally been provided by gas and coal fired generators. As the level of penetration of variable wind and PV increases and coal use declines, these will become increasingly valuable. CST systems offer such services as a matter of course and in a balance low emissions system that value could be considerable.
- **Whole electrical network avoided cost:** CST systems with storage have 'equivalent firm capacities' that can be as high as a gas turbine system. This means they can be relied on to support the system with very high probability in high demand periods. When built at strategic locations in the transmission system they can offer the potential to substitute for expensive transmission upgrades when constraints are emerging. The value of that saving can be as much as 100% of the CST system investment.
- **Community / society benefits:** the most obvious being that the nature of CST technology, involving largely conventional fabrication using steel, glass, concrete etc leads naturally to greater levels of value in the local region and the state of deployment. Other technologies more amenable to containerised transport tend to favour overseas manufacture by contrast.

Overall the 'value' that is apparent is > 100% more than variable renewable generation and compared to a 50% higher cost, a very attractive proposition. A future net zero emissions generation mix will benefit from a significant contribution from CST with energy storage.