AUSTELA

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Energy Security Board
Post 2025 Market design project team
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Dear ESB team,

Post 2025 Market design issues paper

Austela is a non-profit association that advocates on behalf of the Solar Thermal industry. Concentrating Solar Thermal (CST) systems use 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 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. This is a strongly growing global industry which offers Australia many advantages given the wish to add firm capacity and increased competition in the National Electricity Market simultaneously with the wish to reduce greenhouse emissions.

Austela welcomes this investigation of alternative electricity market designs and is keen to remain engaged in this process.

CST systems offer all the characteristics of renewable dispatchable synchronous generation that are identified as being increasingly needed as existing coal plants progressively retire. To date Australia has not built systems because the RET and existing NEM rules have not offered the rewards for its combined values that are needed to cover costs of energy that are higher than variable wind or PV.

CST like wind and PV, is a global industry, Australia, could move quickly to establish large scale systems using competitive tenders or other processes to attract experienced global players who would then establish appropriate supply chains that would incorporate large local content.

We provide commentary on the questions raised in the discussion paper and energy market and policy issues below and background material on CST technology and industry status in an Appendix.

Yours sincerely

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Board members, AUSTELA

Electricity market design for a high RE world

Context

Australia has been pursuing a Renewable Energy Target (RET) with considerable success. This will see around 20% of generation being provided by new renewable energy sources when the current target is reached in 2020. It rewards generators with tradeable certificates for actual MWhs generated and obligates electricity retailers to buy certificates in proportion to their wholesale energy purchases and the current year's target. Post 2020 the target is fixed until 2030 when it ceases. Most analysts predict a rapid drop in certificate value post 2020.

The technology winners in the RET market have been wind and rooftop Photovoltaics, with utility scale photovoltaics systems now increasingly significant. Ie it is variable renewable energy (VRE) that is cheapest when all MWhs are treated as equal. The RET as it stands becomes perverse as the share of generation grows because it rewards generation irrespective of the instantaneous demand or wholesale spot price of electricity. It partially shields the renewable generators (via around 50% of their revenue) from the main supply and demand market signals and so favours the cheapest variable renewable energy over the more costly, but also more valuable (per MWh) dispatchable renewable generators.

The Finkel review clearly identifies the issues on reliability and security associated with over-encouragement of VRE without considering the consequences for the whole electrical system.

Some significant fraction of generating capacity needs to be dispatchable in nature. To date, the added VRE in the system has been balanced largely by dispatchable fossil fuel generation (ie coal and gas). However around 15GW_e of coal plants are expected to retire by 2040.

As the discussion paper correctly identifies:

> *"To maintain reliability and affordability for consumers, it is also essential that market arrangements enable an orderly exit of coal fired generators and incentivise timely replacement by firm, dispatchable generation. The timing of the closure of coal fired generating units is critical to ensuring an orderly transition to a low emission generation mix."*

Further:

> *"Despite the need for flexible and dispatchable capacity to ensure reliable supply under a range of conditions, the market is currently attracting only limited investment of this nature."*

The need for flexible and dispatchable capacity is largely in the future. There is no market signal to invest and build such systems in advance of the closure of coal plants. When closures do happen:

> *"There is a risk that governments may not allow relatively high and volatile wholesale prices (scarcity pricing) for sustained periods of time sufficient to retain and attract plant and support a smooth transition. The lack of policy confidence and market interventions (like price caps and the cumulative price threshold, or the use of the RERT) could work*

against investment in flexible generation that rely on relatively short periods of very high wholesale prices to make their required return."

Examples of all the new technologies that are likely to substantially impact the electricity system over the next 20 years already exist. What is unknown is the mix that will emerge and what an ideal least cost mix should be. Australia should adjust market signals to maximise the probability of achieving a least cost zero emissions electricity generation mix.

Comments against the specific questions in the discussion paper

What scenarios and shocks should be used? How should these be used to test market design?

The scenarios suggested seem reasonable and appropriate. Both the fast change and step change scenarios reference decarbonisation. We would suggest that that be made more explicit to include complete decarbonisation by 2050.

Further consideration in scenarios and shocks might be given to

- The impact of changes in international prices for gas and oil
- The potential growth of international trade in hydrogen or other renewable fuels

How can market and economic modelling best be used to evaluate individual components of market design or the end-to-end market design?

We leave it to others to comment on market modelling. However we do suggest that modelling of least cost generation mixes using suitable capacity expansion models with appropriate assumptions and constraints (eg around GHG emissions) can be used to determine apparent least cost approaches. Any market mechanism needs to be carefully considered for potential perverse outcomes that could lead to non optimal mixes.

Is the assessment framework appropriate to evaluate the effectiveness of future market designs? What else should be considered for inclusion in the assessment framework?

The assessment criteria listed in 3.5 seem reasonable and appropriate, however a notable omission is any consideration of climate and other environmental impacts. This should be explicitly included.

Have we identified all of the potential challenges and risks to the current market? If not, what would you add?

The potential challenges are identified quite well.

The overall level of policy uncertainty around climate and energy. The lack of a coordinated approach between state and federal governments and that lack of bipartisanship on future directions is a very major challenge. It is to be hoped that this market design process will help in part to address this overarching challenge.

The discussion paper, does not consider if challenges might arise from international shifts in for example gas and oil prices, this might deserve further consideration.

Which of these challenges and risks will be most material when considering future market designs and why?

We consider that the challenges identified in section 4.2 ''Investment signals to ensure reliability'' is by far to most material to future market designs'. If this can be addressed in an appropriate manner that also recognises the imperative to decarbonise, then other challenges are likely to be addressed also as a consequence. For example, the available dispatchable technologies that provide reliability by generating to meet demand, have all the characteristics to deal with system security issues as a matter of course.

As the discussion paper highlights, dispatchable (and ideally renewable) generation needs to be built in advance of coal plant closures in an orderly manner. It needs to be recognised also that different dispatchable technologies have different lead times for project development and construction. For example, CST and pumped hydro systems take longer to develop and build than diesel engine systems or batteries. A market that leads to rushed installation of the quickest build options when problems arise, will not deliver the most cost optimal mix of energy generation in the long run.

Which (if any) overseas electricity markets offer useful examples of how to, or how not to, respond to the challenges outlined in this paper?

Many of the challenges identified hold in other countries around the world that do not have centrally planned electricity systems. So far, no overseas market to our knowledge has developed an exemplary solution to the. Others are better position to offer detailed commentary on this.

There are aspects of time of day pricing in renewable energy tariffs in California that may offer some useful insights.

Mechanisms to encourage investment in new zero emissions dispatchable generation

Capacity payments for example could be workable, but challenges include; how will capacity be determined? Should flexible dispatchable capacity be valued more than traditional baseload? Should other measures be included to ensure new plant built with capacity payments actually operates at the times it is needed to ensure reliability and increased competition.

We argue that a modified Clean Energy Target (CET) or Renewable Energy Target (RET) could be a good mechanism to consider.

- The RET (or a CET) could be modified for a growing target post 2020 but with certificates allocated to renewable generation with a **Market Value Multiplier** applied that is proportional to the wholesale pool price at the time of generation. Ie
  Certificates earned = C x (Generation in half hour NEM settlement period) x (Pool price in NEM settlement period) / (Average pool price in previous month)
  where C is a factor to be determined from time to time that sets the relative incentive for

generation at high pool price times vs low and so can adjust the actual total levels of RE generation to match the target for each year.

- Using this methodology, certificates earned would be higher for generation at times when the pool prices was high and those earned would be lower than generation when the pool price was low. They would be negative if the pool price is negative, thus incentivising no further generation at such times.
- The RET has in the past had a mechanism of multipliers, where small solar systems in particular were for a time awarded certificates that were a multiple of their actual deemed generation. The administrative methods for this clearly exist. Even though the 'currency' of the market is MWh, the volume of certificates earned does not have to equal actual generation.
- This incentive would encourage dispatchable renewable generators to generate in high price periods and thus have the further effect of increasing competition and lowering the pool price at such times.
- As the fraction of RE increases towards 100%, the pool price will increasingly be determined by renewable generators and the certificate price will progressively trend to zero such that the two markets become one in a smooth fashion.
- At very high levels of RE in the NEM questions remain as to how an energy only market will function when all the generators have very low (or zero) marginal costs of generation, some form of capacity mechanism may also need to be considered. Indeed the CET / RET acts in many ways like a capacity payment that is generation linked.

Barriers to investment in the electricity sector

The most significant barrier to investment is quite simply policy uncertainty. The portfolio of new energy technologies, including CST with storage, needed for the future energy mix is already well proven and technically bankable. Whenever the market settings are both sufficient and reasonably certain to justify investment, the capital required has proven to be readily available. The success of Australia's RET in regards Wind and PV technologies in past years is testament to that.

Policy certainty requires that it be logically compatible with global expectations around future energy technologies and greenhouse response and that it be largely bipartisan in approach. At the present time in Australia, the opposite is the case and investment in any energy generation technology be it new and emissions free or traditional and fossil based, is being curtailed.

Underlying the policy uncertainty is a range of vested interests. A contributor also is a lack of familiarity with flexible renewable generation like CST on the part of some policy makers and the community. In this regard early support of first large scale projects by agencies such as ARENA will help to build familiarity and confidence.

Government intervention for particular projects

In the current debate there is a risk of 'knee jerk reaction' technical interventions in the electricity system. We would argue that this is not necessary if overall market settings are adjusted to adequately reward desired attributes and avoid perverse incentives.

Australia should move immediately to ensure that the market settings in place are designed to encourage the progressive deployment of new energy technologies that together offer the characteristics needed to provide grid security and reliability. These include rewarding zero emissions generation in proportion to the instantaneous price in the wholesale market and further preferentially rewarding zero emissions system and network support (ancillary services).

The available technologies can easily be deployed at a rate needed to ensure that the overall security of the NEM is not compromised as we progressively move to decarbonise it.

CST systems with storage and the ability to provide all the ancillary services associated with coal or gas plants, can be built in as little as 18months once the first few projects in a country have established supply chains.

The role of gas for electricity generation to contribute to reliability and security

A major topic of discussion in recent years is the impact of the onset of large scale LNG exports from Queensland on the level of demand for and price of gas in the East Coast of Australia. The increase in demand and increase of price to export ‘net back’ levels was widely anticipated. It is the natural consequence of building a major new export industry that has lifted LNG to the level of number 4 biggest source of export earnings for the country.

It naturally makes gas fired power generation more expensive and less competitive. We argue that it is a mistake to intervene and take steps to force a greater use of gas for power generation. Whilst gas has significantly lower GHG emissions than coal, OCGT systems in particular still have high emissions. Moves that were to create new generating capacity from gas, would lock in a technology that is not compatible with long term climate goals. At the same time they would slow the deployment of zero emissions flexible generation systems.

CST with storage can deliver the same dispatchability and ancillary services benefits of gas fired systems. Where ramp rate response times faster than CST steam turbine limits allow are needed, more expensive battery or other electrical storage systems can complement them.

A new build OCGT system running at low capacity factor and with gas input prices of say $10/GJ, would have a LRMC of electricity of around $150/MWh, a CST system with 10hours of storage and zero emissions can deliver energy cheaper than this.

We strongly suggest that the government should not intervene to divert gas to power generation at the expense of both export income and delays in the deployment of available zero emissions flexible generation like CST.

Future costs of electricity generation

Innovation that responds to the correct market signals can help to give the least cost solution to simultaneously providing secure supply and lowering emissions.

Electricity prices have risen faster than CPI in recent years. This can be attributed in large part to major investments in electricity networks. It is also the case that much electricity generation in the last two decades has been provided by large coal fired plants whose capital costs were covered when utilities were vertically integrated and state owned. Australia has had extended periods of average wholesale prices that are lower than would be needed to cover the LRMC of any form of new generation capacity. It is the presence of excess generating capacity at times that forces this outcome. We are moving into a period where those legacy systems are reaching the end of their economic life and must be replaced by something.

Some commentary naively suggests the clock can be wound back and lower historical prices be reinstated. Whilst there may be some scope for reducing retailer margins, we suggest the reality is that this is not possible.

We argue that the lowest possible costs will be delivered by an optimal mix of variable and dispatchable renewable energy technologies. This mix now offers cheaper reliable generation than a hypothetical mix of new build coal and gas.

Innovation, appropriately directed, will give us the best services at the lowest possible costs, but it is unlikely to reduce generation costs much below their present levels. It is important that governments at all levels realistically communicate these realities to the community.

The key elements of an emissions reduction policy to support investor confidence and a transition to a low emissions system

Investor confidence will be supported by an emissions reduction and electricity market policy that is:

- Largely bipartisan
- In line with international commitments Australia has made
- In line with global community expectations
- In line with Australian community expectations.
- Covers all sectors in a balanced way

The role for new coal technologies

Ultra-supercritical coal plants have higher emissions than Open Cycle gas and much higher than Combined Cycle gas. It is a misnomer to refer to them as ‘low emissions’. We would argue they have no role to play in Australia’s future generation mix. Aside from the emissions issue, they are plants that only really suit old style baseload generation whereas the growing need is for flexible dispatchable generation. Thus new build coal will need to be balanced by new build gas plants and the combination will give an average cost of energy higher than an optimal mix of variable plus dispatchable renewable energy generation.

There appears no reason for nor any investor appetite for any new build coal based power plants in Australia.

Appendix – Background information on CST

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.

Increased attention to the future security in the NEM 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 15 years, averaging greater than 20% p/a. Deployed capacity is now around 6 GW_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 China. China is well progressed 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. There are now completed examples at 100+MW scale in the USA, Morocco and China. 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, Jemalong 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 following 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.