12 May 2017

Mr Ben Noone
Project Leader
Australian Energy Market Commission

Submitted online: www.aemc.com.au

Dear Mr Noone

AEMC Ref: ERC0201: 5 Minute Settlement – Directions Paper

Intelligent Energy Systems (IES) welcomes this opportunity to comment in the AEMC Discussion Paper and Public Forum.

IES is an Australian consulting and software company that has supported market reform in Australia since the mid 1980s.

IES staff members have advised and modelled market design options since prior to market start. Specifically, in 1999 IES advised the then market operator, NEMMCO, on the establishment of the current ancillary service arrangements and how they should be paid for. The current causer pays arrangements for regulation emerged from that work (somewhat modified from what was originally recommended).

The IES ancillary services report also identified a violation of sound pricing principles from 5-minute dispatch and 30-minute settlement and proposed a remedy. An alternative remedy was later put forward by NEMMCO for consultation but the proposal failed because of the alleged high cost of implementation. That alternative and its high cost bears a strong resemblance to the proposal in the current AEMC Directions Paper.

CS Energy has recently commissioned a report from IES on "A Package of Improvements for the NEM Auction". The work was motivated by a desire to promote marginal pricing principles in the NEM, to improve NEM operations and to reduce the risk of heavy-handed regulation to achieve secure market outcomes. It includes most of the arguments and concepts contained in this submission and accompanies the submission for reference. IES commends CS Energy for supporting this work.

The AEMC Proposal

The essence of the proposal set out in the AEMC's Directions Paper can be summarised as follows:

- The NEM should move to settlement based on 5 minute measurements rather than 30 minute measurements.
- To do this, all interval maters down to Type 5 customer meters (with the likely exception of meters in Victoria) will need to be upgraded or replaced – running to many hundreds of thousands of meters.
- Disruption to the contract market is expected, especially the cap contract market.

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- Major upgrades to IT systems within AEMO and participants will be required.
- Two phases of transition are envisaged to allow for metering, contracting and IT transitions; the first of 3 years and then a further 2 years. The change will not be in effect, even partially, for 3 years (to which the time for the AEMC decision to be made must be added).

Our summary comment on this Directions Paper and discussion at the public forum is summarised below. More detail on some aspects follows in later sections of this submission.

- Conceptually, a move in the direction of improving marginal pricing within the half hour trading interval is sound.
- However, the proposed "big bang" approach is disruptive of contracting, metering and IT systems and therefore expensive, if not quite as expensive as the round $200 million suggested at the forum presentation by Russ Skelton and Associates.
- In IES's view (based on personal experience of staff member as an industrial energy manager), the potential responses that can emerge over time are likely to be larger than that indicated in the Discussion Paper. In addition to the responses identified in the discussion paper, potentially large sources such as short term interruption of commercial and domestic air conditioning could evolve over time with suitable regulatory support, even to the extent of causing pricing and even system instability at 5-minute price boundaries. Failure to account for large scale responses could require the market design and metering to be revamped again within a relatively short period. The current proposal is incomplete.
- The timetable for implementation is protracted. Stresses on the NEM from plant retirements and gas supply constraints will not be resolved quickly. This leisurely implementation timetable means that commercially-driven load response (as opposed to regulated shutdowns) risk being passed over for next 3 years and more, precisely when the system will need it.
- There is an alternative implementation path that addresses these shortcomings. It is a modest variation and extension of the original Sun Metals proposal. The use of SCADA has been too readily passed over. It can be regarded as a step in the transition to an approach that implements the intent of 5-minute pricing in a more cost effective, comprehensive, robust and timely manner.

Practicality of Using SCADA Metering

The Directions Paper reviews and then dismisses the use of SCADA data for 5-minute settlement, even on an interim basis. It recognises that use of SCADA metering is feasible. The reason for the rejection is that most generators are opposed to it, CS Energy being a notable exception (page 95). Given that most existing generators seem opposed to the whole concept of 5-minute settlement, this reason is hardly rigorous or compelling.

The main argument against the use of SCADA is its alleged inadequate accuracy for dealing with large sums of money. This is incoherent, because SCADA itself is used to control the plant and therefore directly affects the money earned by plant. Irrespective of this, as the Directions Paper points out, SCADA would not be used to settle the whole market – only to "profile" a weighted price for settlement of generator or load patterns. However, no quantitative error analysis is offered to support that proposition.

IES has undertaken an error analysis of the profiling option, as well as an alternative logic that delivers the same result with improved error properties. These results are summarised below. If requested, IES will provide a copy to AEMC of a spreadsheet that demonstrates this analysis.

We assume that the revenue meter is accurate (operating within specified tolerances) and that associated SCADA metering can vary from this, either because of inherent inaccuracy or because some auxiliary load is (or is not) not measured by the SCADA relative to the revenue meter. We allow for two type of SCADA meter inaccuracy:

- An offset error proportional to the rating of the meter/installation. As an example, if the installation was 500 MW and the offset error was 1%, the measurement error would be 5MW over the whole range of load. The error could be positive or negative and it may not be accurately known.
- A scaling error proportional to the load. Again, this could be of the order of a percent or two of the metered load and may not be accurately known.

Using this error model, we can express the SCADA reading as function of the "true" revenue meter reading as:

$$MW(SCADA) = a*CAP + b*MW(REV)$$

where:

MW(SCADA) and MW(REV)   are SCADA and revenue meter MW values respectively

CAP   is the capacity of the installation in MW

a   is the fractional offset error as defined above

b   is the fractional scaling error as defined above

Of course, we cannot extract revenue meter readings at the same time interval (4 seconds) as we can with SCADA; for settlement we only have the accumulated energy value over 30 minutes.

There are also other potential sources of error, including delay between measurement and delivery of the data to AEMO which can be of the order of seconds, as well as random errors within each half hour. However, we consider offset and scaling errors to be the main ones. Using this error model, we can evaluate the settlement error over a half hour trading interval for different settlement methodologies and also express that error in relative terms.

The first approach is the "profiling" approach proposed in the Discussion Paper. An alternative approach is the Ramping Ancillary Service (RAS) approach proposed in the IES report prepared for CS Energy, which is mathematically equivalent to 5-minute settlement using profiling if the metering is fully accurate.

The RAS settlement over a trading interval is defined as:

RAS settlement = (5-minute settlement as measured by SCADA)

– (Time averaged price settlement as measured by SCADA)

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To this we add the current time averaged price settlement as measured by revenue metering to get the effective 5-minute settlement for the trading interval. Note that under this approach the:

- current half hour settlement logic is untouched; and
- RAS settlement is based on differences between SCADA readings, so offset error is cancelled out. Note that this is the way SCADA is used in the dispatch process; a SCADA target is set based on current SCADA readings. Any relatively stable load included in the measurement is cancelled out.

For both profiled and RAS-based settlement logics, the settlement error using SCADA measurement have similar forms:

Fractional Settlement Error = Factor * (1 – Time_Weighted_Price/Dispatch_Weighted_Price)

The term in brackets is common to both logics and is in fact the ratio of the difference between dispatch weighted and time weighted settlement (which we define as the RAS settlement) relative to the dispatch weighted settlement.

However, the "Factor" term is different in each case:

Factor (dispatch weighted)   = -a*CAP/Average_Trading_Interval_MW = - a/Capacity_Factor

Factor (RAS)   = b

While the RAS factor is a simple constant (which we may not know precisely), the dispatch weighted factor increases as the average MW over the trading interval (capacity factor) drops, such as when a facility is ramping from a low base or operates for only one or a few trading intervals.

From these results we observe the following:

- In both cases, there is no error in settlement if the dispatch profile or load is flat, even though SCADA readings are used in settlement.
- With modest variation of load or generation and even if there are large price variations, dispatch and time weighted prices are relatively close and the error from the use of SCADA is attenuated, with little increase in error from the use of SCADA metering in settlement.
- However, in the dispatch weighted case, the error is amplified if the capacity factor over the trading interval is low, as the offset error becomes more significant.
- When the capacity factor is very low and when dispatch weighted and time weighted prices vary greatly, such as when a fast start unit is coming on line, the relative settlement error in the RAS case approached the SCADA scaling error but never exceeds it. This contrasts with the dispatch weighted case where the offset relative settlement error becomes amplified.

From this analysis, results of which we can observe in the IES spreadsheet and by examining the error formulae, we conclude the following:

- The RAS settlement formula is demonstrably more robust than the dispatch weighted formula in terms of containing the propagation of SCADA error into settlement.

- Participants that are little affected by 5-minute price variations are little affected by the use of SCADA measurements in settlement.
- In the case of fast start units coming on line when the settlement error is likely to be greatest (but still less than the SCADA scaling error if RAS settlement is used), the current settlement approach is so distorted that the error from the use of SCADA metering is inconsequential, at least for an interim solution.

The RAS formulae may be seen as applying over a trading interval. However, the RAS component can also be expressed for each 5-minute interval as:

Settlement increment in dispatch interval = $(p - pbar)*(x - xbar)$

where p is the dispatch interval price and $pbar$ is the time average price over the trading interval, while x is 5 minute SCADA energy and $xbar$ the average 5-minute energy over the trading interval as measure by SCADA.

The sum of these dispatch interval values over the trading interval looks like a correlation, which in fact is what it is.

Other important things to note about the RAS approach in contrast to the dispatch weighted or profiled approach are:

- The calculation delivers the same outcome as 5-minute settlement, but with greater robustness if SCADA data are used.
- The existing half hour settlement logic is untouched and, arguably, so are the dependent contractual arrangements and the need for an immediate major revamp of settlement systems, although some supplementary contracting may be desirable for some but not all participants.
- The RAS approach could be implemented in stages simply by applying different fractions of the calculated RAS settlement amount, say 0%. 20%, 40% 60% 80%, 100%, to allow participants time and some experience to adjust operations.

Optionality and the Residue

The Directions Paper examines the Sun Metals proposal for optionality for non-scheduled participants and rejects it, largely on the argument that many of the benefits of 5-minute settlement would not then be realised. The implication that many hundreds of thousands of interval meters will then need to be adjusted or replaced within a 3 or 5-year window appears unnecessary, as only a tiny fraction of these customers, will be active load managers at the 5-minute level in any immediate time frame, even taking an optimistic view.

Further, the 5-minute settlement approach as proposed in the Directions Paper may well be overtaken by new realities that emerge in the coming few years (such as destabilising load responses), requiring yet another round of meter upgrades. The original Sun Metals optionality proposal is a perfectly reasonable interim stage to aim for, using the following approach:

- All scheduled generators to be placed on RAS-based 5-minute settlement, probably phased in over a period as suggested in the previous section.

- Non-scheduled loads and generators to be treated as a residual (after allowing for loss factors) and the residual RAS settlement amount is allocated to them pro-rated by energy, or absorbed into the settlement residue if that is deemed acceptable as an interim solution.
- If some participants wish to pay for metering to be included in the RAS-based 5-minute settlement, they may do so, with the residual adjusted accordingly.
- After gaining some experience and confirming the long term market deign, proceed to full 5-minute settlement with universal 5-minute revenue metering, built over a much longer transition period that prioritises parties that volunteer to respond to 5-minute pricing.

We see no reason why incremental 5 minute settlement costs cannot be allocated pro-rata based on energy, as it is with many other NEM costs such as contingency FCAS. Indeed, we see the RAS/5-minute settlement as being treated along the same lines as other FCAS. While necessarily approximate and only an interim measure, allocation of the residual on the basis of energy would match the load profiles of most retailers quite well and would form a reasonable basis for short term contracting.

As noted above, parties who feel they could do better in the short term could opt in at their own expense. This was essentially the Sun Metals original proposal as we understand it.

Risks of the Direction Paper's Proposed "Big Bang" Implementation

While the Directions Paper outlines a phased implementation, the implementation strategy will be set in stone up front and a practical launch is 3 or 4 years away. This approach carried the following risks:

- The costs are claimed by participants to be very high (several hundred million dollars) while the benefits are unproven and certainly not immediate, so the rule change risks failure on that ground alone.
- There is a significant risk that issues that the Discussion Paper has not addressed such inefficient responses to large price steps at the 5 minute boundary and the need for a more efficient real time regulation market) will come to the fore within a short period, requiring a rethink of implementation details or unnecessary scheduling and compliance obligations.
- There will be no load response outcome within 3 or 4 years, when the NEM is clearly in need of all the load flexibility available, even if that is only from larger participants who are discouraged by the confused pricing that exists at present. System reliability and even security are put at risk from such a delayed implementation.

An Alternative Pathway to Full 5 Minute Pricing

As a general comment, we think it more productive to think of the 5-minute settlement concept in terms of an incremental Ramping Ancillary Service (RAS) rather than as a complete revamp of the market design and associated contracting and systems. IES proposes an alternative pathway to implementation that deals with the risks identified above:

1. Develop and implement *before next summer* a SCADA–based RAS, to apply to scheduled and other SCADA metered participants.

- Allocate the residual to non-scheduled or non SCADA metered parties pro-rated by energy.
- Allow and support voluntary participation.
- Phase it in at gradually increasing levels to allow parties to adjust.
- Note the implementation complexity is of the same order as causer pays, with no major upgrades of existing systems required in the short term.

2. Review the outcomes to determine adjustments to the full implementation strategy may be required, such as:
   - ramping dispatch prices to discourage "piling in "at 5 minute boundaries;
   - providing an integrated regulation price to further stabilise responses;
   - building into the meter logic the ability measure and reward inertial and fast frequency response
   - accounting for new metering and communications technology.

3. Proceed to full implementation driven by the demand for participation using specially programmed 5-minute metering.

The essence of this strategy is the interim step based on SCADA metering, from which a long term strategy can be properly evaluated and developed. The end point is essentially the same as proposed in the Discussion Paper, but with other important issues in the NEM that affect operations within the trading interval recognised and dealt with cost effectively. These issues include current and future requirements for FCAS, the need to avoid potential instability from artificial price transition shocks, and to improve the interactions with non-scheduled parties. The IES report prepared for CS Energy emphasises that 5 minute pricing is not an end goal in itself; rather, real time pricing adjusted for system frequency is the goal.

Impact on Fast Start Units and Associated Contracting

The Directions Paper is correct in identifying incumbent fast start (non-hydro) units and their contracting as likely to be most affected by 5-minute pricing. Looking ahead, and setting aside the current stresses in the gas market, fast start gas plant will clearly play an important ongoing role in supporting the system. However, most such plant cannot support the increasing physical need for 0-15-minute response.

With a staged move to full 5-minute pricing under a RAS model, fast start options can develop over time and offer fast start contract options to support the traditional caps offered by incumbent fast start plant. Indeed, if 5-minute pricing is implemented as a RAS, there may be less disruption to the existing contract market, depending on legal advice as to whether this voids existing contracts. For most participants, the RAS would be mostly quite small and could be regarded as an element of basis risk, just as current FCAS costs are treated now. Any unacceptable additional risks from fast moving market situations could be dealt with by supplementary contracting, rather than by forcing the re-contracting of the whole market. These could develop as RAS settlement is phased in at gradually increasing levels.

It should be noted that withdrawal of gas plant from the contract market can be driven by factors other than 5-minute pricing. Constrained gas supply is a current problem that may

persist for some years. Less obvious is the impact of increasing horizontal and vertical integration in the market, where contracting behaviour can diverge markedly from what would be expected under more competitive conditions.

Conclusion

The intent of the Sun Metals rule change proposal is sound but the proposed implementation strategy in the AEMC Directions Paper is:

- too limited in scope;
- too disruptive;
- too costly; and
- too risky.

This submission and accompanying report prepared for CS Energy proposes an alternative strategy, whereby 5-minute pricing is defined as a Ramping Ancillary Service, or RAS. This approach could be implemented progressively starting relatively quickly, with scope for removing artificial price shocks, smoothly integrating FCAS regulation and existing contingency FCAS and, over time, supporting fast frequency response and inertia.

IES commends this approach to the AEMC and to all current and future market participants.

Yours sincerely

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