Submission by Rick Willoughby

for

Integrated System Plan Consultation AEMO

This submission is in response to the AEMO Integrated System Plan Consultation document released in December 2017.

The author is a retired electrical engineer who gave evidence on behalf of large customers at the Industry Commission hearings on Energy Generation and Distribution in 1991 that led to the formation of the National Grid. During the embryonic stage of the National Grid the author served as the customer representative on the first Electricity Market Systems Committee.

Historical Context

The National Grid evolved through efforts of the Industry Commission under the direction of Treasurer Paul Keating. The primary outcome of the inquiry was removal of monopoly rights held by inefficient State authorities having sole rights to supply electricity across property boundaries from power generation, transmission and distribution assets they owned and operated. It enabled low cost privately owned generators, already connected to the grid, to receive a market price as well as giving consumers choice over suppliers. The State grids already existed and there were already power flows across State borders.

The State grids had evolved from the need to transmit power from centralised generators located on coalfields in each state as well as the Snowy Mountains Scheme to the load centres some distance from the generating sources. Locating power stations on coalfields generally evolved through the 1950s and 1960s in Australia and overcame the comparatively inefficient transport of coal using road, rail or barge to power stations located near load centres.

With growth of new large scale power stations on the coalfields, the States encouraged electricity intensive industry by offering electricity at prices sufficient to recover the marginal cost while dramatically increasing employment opportunities in respective States; construction of aluminium smelters being most notable with the development and expansion through the 1960s, 70s and 80s.

Additional Question

The AEMO document seeks input on any addition questions that may be relevant to the evolution of the National Grid and National Electricity Market as wind and solar generators are added to the grid.

In the 21st century, wind and solar generating sources have been added to the national grid. These generators collect energy from ubiquitous sources available in abundant supply across Australia. The means of collection of this energy offer little to no benefit of scale. PV solar collectors are the same size and have similar solar insolation whether they are located on a residential rooftop in Sydney or on a field in a remote location.

All wind turbines are subject to the Betz limit on their ability to extract energy from a given airflow irrespective of size. There is some benefit of scale with wind generators in terms of the elevation that energy can be extracted with larger turbines. Geographic diversity of these generating resources has shown to offer little benefit. A single weather pattern can affect the whole eastern side of the continent in the same way.

For the majority of consumers in Australia, the cost component of transmitting, distributing and billing electricity is higher than the wholesale price component of electricity. This means that any grid connected wind and solar generation is severely hobbled by the high cost of delivery compared with collecting and generating electricity at the consumer's own premises.

The first and foremost question for the ISP should be-

Will there be a national grid with wind and solar having a high market share?

The answer becomes quite clear using South Australian experience as an example. Despite having heavy reliance on the grid connection for reliable supply from Victoria and the large subsidies from other States through LGC and STC payments, SA still has the highest cost electricity in the developed world. This is with wind and solar only achieving 39% of market share. The high cost of electricity at consumer premises has encouraged them to make an economic choice to generate their own on their premises. Electricity intensive businesses have become uneconomic and have closed down or are receiving some form of government support.

These factors are reflected in the minimum demand in SA of 500MW or so now occurring in the middle of the day on mild days, typically in September. Having divested most of its heavy industry, SA's peak demand is now dominated by air-conditioning demand and can reach 3000MW or some 6 times the minimum demand. SA will soon eliminate base load. Within 3 to 4 years in SA there will be times when the large scale wind and solar generators have zero demand in that State network. All the investment in those assets will have declining return. SA has reached the point where the cost for grid assets such as battery storage and emergency fossil fuelled generators can no longer be recovered from consumers but is being paid for from general revenue and increasing state debt. The SA network is uneconomic and solar/battery technology has given low energy intensive consumers a choice.

To repeat, it is highly improbable to impossible that a national grid can supply high market share from wind and solar generation at a competitive price compared with on-site or local generation given the high cost of transmission, distribution and retailing in Australia. In this regard, mainland Australia is different to most other countries in that solar and wind energy resources are reasonably abundant throughout the year in all regions.

Modelling

It is becoming clear that those charged with guiding the development of the National Grid have lost control of its orderly development. This is of dire concern for what is regarded by most citizens as an essential service. On the other hand, at a constituency level, few people appreciate the constant delicate balance between demand and supply in the National Electricity Market.

It is of great concern that the system modelling featured in the Jacob's Group report that underpinned the Finkel Inquiry is highly flawed. The wind and solar generating profiles on pages 30 and 31 are absurdly optimistic.

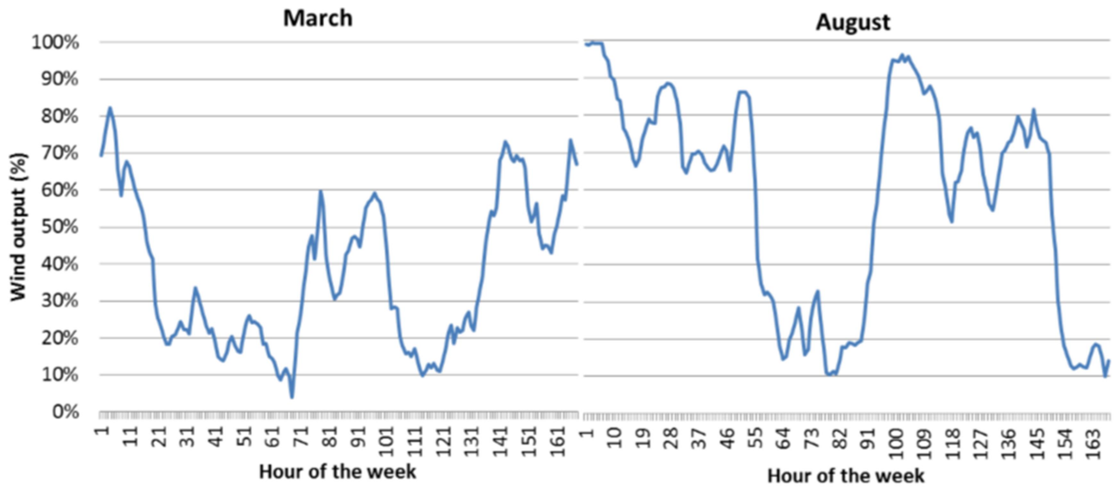

Figure 1: Wind Generating Profiles from page 30 Jacob's Group Report

The wind profile for SA shows one brief period below 10% and the average capacity factor is taken as the model input. The worst case should be catered for and that is ZERO for at least hours at a time as the AEMO actual data demonstrates.

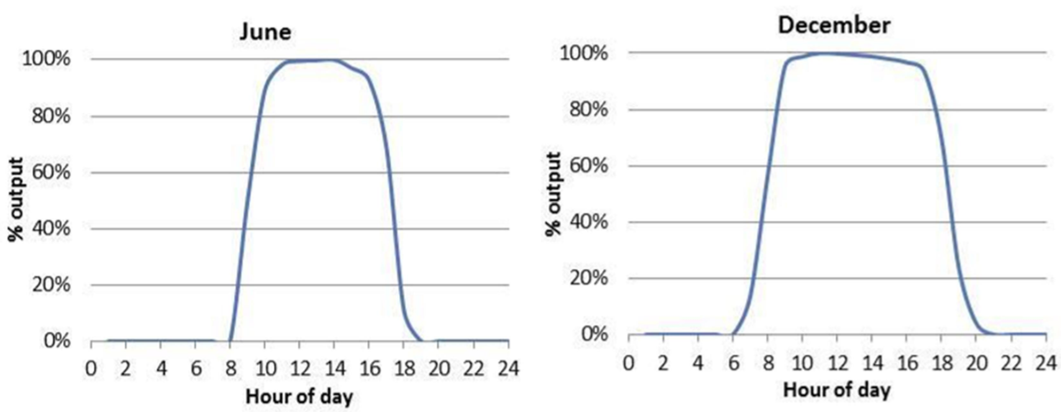

Figure 2:Solar Generating Profiles from page 31 Jacobs Group Report

The solar profile shows the output to be at 100% from 10am to 4pm IN JUNE – simply absurd. It is stated in a footnote that this data comes from AEMO assumptions although the link is no longer active. Using capacity factors for intermittent generators supplying into an on-demand system is naive and produces meaningless results.

The only valid means of modelling intermittent generation is using 30-minute scheduling intervals or smaller time intervals to match generation to demand based on actual recorded data.

AEMO now has historical wind and solar generating data to input to a system model that is based on actual time intervals rather than averages.

In 2015 wind generation in Australia provided 41.3PJ out of a total of 1666.9PJ supplied or 1/40th of the energy required. Wind generating installed capacity is 4360MW. The capacity factor works out at 30%. This is essentially the unconstrained capacity factor. In 2017 wind generators in South Australia are already being demand constrained. Endeavouring to increase the market share of wind will result in more frequent demand constrained situations. So a 40 fold increase in wind (or combination of wind and solar) will NOT be sufficient to meet demand as the demand constrained capacity factor is much lower than the unconstrained situation and decreases geometrically as the market share is increased.

In fact, time interval modelling based on actual generating data for wind will show overbuild of the order of 2 to 3 times depending on the storage available and its cost. Overbuild for solar is of the order of 4 to 5 times. Anyone operating an off-grid solar/battery system has a clear appreciation of the required overbuild. For example in Melbourne where the average solar insolation is 3.5 hours per year, a buffered system for reliable supply needs to be based on no more than 2 hours full sunlight equivalent over 48 hours or capacity factor of just 4%.

For the case of wind generation meeting current NEM demand, it follows that the wind generating capacity will be of the order of 500,000MW or ONE HUNDRED times the existing wind capacity. Then there still needs to be massive storage capacity to buffer the high variation in output. The astronomic cost of such a system can never be met. Long before that stage, all heavy industrial users that were attracted by low cost electricity will have shut down and any current consumer with a roof or spare sun exposed space will have solar panels.

With regard to power system modelling the author commends the attached paper titled "Buffering volatility: A study of limits of Germany's energy revolution" where modelling is based on actual recorded time interval data rather than averages. Germany has achieved a 26% market share for wind, solar, hydro and bio-fuels and is beginning to experience demand constraint on wind generators similar to the experience in South Australia. Wind generation demand constraints have occurred in Germany at a lower level than SA because they do not have neighbouring States as obliging as Victoria able to sink or source a large proportion of the output or demand. The German electrical system has some similarities to Australia in terms of access to perched and pumped hydroelectric but that is predominantly through interconnectors to Norway rather than in Germany.

Permitting large scale wind and solar into the NEM has guaranteed its eventual demise. The NEM evolved by the need to transfer electrical energy from coalfields to population centres. There is ample wind and solar in any location in Australia to meet local needs. Already the lowest cost option for domestic and commercial electricity consumers in South Australia is solar panels with a battery. There is nothing that can be added to the grid that will alter that situation now. Any additional hardware means higher cost and higher cost means lower demand resulting in accelerating unit cost. The grid in South Australia is in terminal demise. That is despite the reliance on other States as on-demand sources and sinks of power and income from excess LGCs and STCs produced in the SA region.

Levelised Cost of Energy – Meaningless Number

The ISP Consultation document makes reference to the Levelised Cost of Energy. These often stated comparative numbers have NO significance when comparing intermittent generation with on-demand generation where the system operates predominantly on demand. In fact there are times in Australia when no wind or solar generators are producing. That means the entire demand has to be met with on-demand generation from fossil fuel, hydroelectric and battery. In terms of the NEM at the present time, the only benefit of wind and solar is a slight reduction in fuel burnt or conservation of perched water. The on-demand generators still need to be available at short notice. The wind and solar generators can only provide an economic benefit if their LCOE is lower than the marginal cost of fossil fuel saved or perched water retained providing these on-demand generating assets already exist; are paid for and have no maintenance cost.

As the market share of wind and solar rises, the LCOE has to be increased by the same factor as the degree of overbuild plus the cost of associated storage to be able to produce 8760 hours a year. The degree of overbuild increases as a function of market share. Ultimately the overbuild required to achieve the lowest overall generating cost depends on the cost of storage to buffer the intermittency. Referencing LCOE for comparisons of intermittent and on-demand generators shows little understanding of on-demand systems. To put it bluntly it is worse than naïve.

Clearly if there was some relevance to these numbers there would be no need for wind and solar generation to enjoy such large subsidies to make them appear economically viable. The current subsidies for wind and solar are twice the wholesale price of electricity from coal fired generation just a decade ago before wind generators achieved the current destabilising level of output. Without subsidies all existing grid scale wind and solar generators would be uneconomic. There will be no point where grid scale wind and solar achieves an economic return without subsidy because generating power locally or on premises using the same technology will always be lower cost due to the high cost of electric power delivery in Australia.

Attachment

Buffering volatility: A study on the limits of Germany's energy revolution.

Abstract

Based on the 2014 German hourly feed-in and consumption data for electric power, this paper studies the storage and buffering needs resulting from the volatility of wind and solar energy, focusing on a "double-structure-cum-storage strategy". While buffering wind and solar energy jointly requires less storage capacity than buffering them separately, joint buffering requires a storage capacity of over 6,000 pumped-storage plants, which is 183 times Germany's current capacity. Taking the volatility of demand into account would not reduce storage needs, and managing demand by way of peak-load pricing would only marginally do so, given that storage is primarily needed for seasonal fluctuations. Thus, only a buffering strategy based on double structures, i.e. conventional energy filling the gaps left in windless and dark periods, seems feasible. With this strategy, green and fossil plants would be complements rather than substitutes, contrary to widespread assumptions. Unfortunately, however, a buffering strategy based on double structures loses its effectiveness when wind and solar production overshoots electricity demand. This is shown to happen when average wind and solar power production exceeds about one third of aggregate electricity production. Voluminous, costly and inefficient storage devices will then be unavoidable to avoid progressively increasing efficiency losses. Buffering the overshooting production spikes associated with a market share of wind and solar of 50% would require an ideal, frictionless storage volume of 2.5 TWh or a storage capacity of 2.1 TWh in ordinary pumped-storage plants. This is about seven times the entire pumpedstorage capacity currently available in western Europe, including Norway and Switzerland; and 81% of the volume that the EU's ESTORAGE project considers as "realisable" in western Europe. This will make it difficult for Germany to pursue its energy revolution towards green autarchy, as intended.

Full Text Link

http://www.hanswernersinn.de/dcs/2017%20Buffering%20Volatility%20EER%2099%202017_0.pdf