Submission on National Transmission Network Development Plan

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1. Introduction

This submission to the consultation on the National Transmission Network Development Plan (NTNDP) addresses concisely the need for additions and enhancements to the high-voltage transmission backbone for the rapid development of renewable sources of electricity (RElec) over the period 2010–2030. The author of this submission has been and is currently engaged in research on RElec scenarios for Australia (Saddler, Diesendorf & Denniss 2004 & 2007; Diesendorf 2007a).

To achieve Australia's RElec target, of 20% RElec by 2020, will entail a major expansion and upgrade of the backbone transmission lines feeding the transmission grid of the National Electricity Market over the next 20 years. Some of the proposed major changes will have to be commenced almost immediately and completed well before 2020.

At present the only very low-carbon supply-side technologies that are commercially available, or nearly so, and could be implemented rapidly in Australia, are renewable energy technologies, namely hydro-electricity, wind power, bio-electricity from crop and plantation forestry residues, photovoltaics (PV) and solar thermal power with thermal storage (CSTP). Gas, both natural gas and coal seam methane, could also play a valuable role until it becomes scarce and expensive.

Hence, this submission focuses on generation scenarios based on a mix of RElec and gas. These scenarios also have a large component of demand reduction, but this aspect is not examined in the present submission. Since most of the generation technologies are of smaller scales than large-coal-fired power stations and all are more geographically decentralised, their implementation will require significant changes to the transmission network. The submission recommends additions and enhancements to the existing backbone of high-voltage transmission lines to facilitate the growth of RElec generation. But first it examines the status, in terms of technological development, of supply-side technologies.

2. Supply-side technologies

There is growing expert opinion that coal power with carbon capture and storage is unlikely to be commercially available on a significant scale before 2030. Even if it is, the current view is that it retrofitting existing coal power stations with CCS will be even more difficult, energy-intensive and expensive than building new types of coal power stations, such as integrated gasification combined cycle, which allow CO2 to be separated more readily. Therefore, a likely part of any scenario based on taking greenhouse gas emission reductions seriously, would have to involve a phase-down of existing coal power stations. If CCS is not commercially available before 2025, then many existing coal stations would have to be retired before 2030 and replaced with a combination of demand-side measures (energy efficiency, energy conservation and solar hot water) and much cleaner supply-side technologies (gas and renewable energy).

Nuclear power is excluded from this submission on the grounds that:

- There is still widespread public opposition to it, based on concerns about proliferation of nuclear weapons, rare but devastating accidents and the unsolved problems of long-term nuclear waste management.
- Labor is opposed to it and the Coalition has stated that it would only implement it with bipartisan support.
- It is a very slow technology to implement. It is widely recognised the first nuclear station and associated infrastructure could take 15 years to be commissioned in Australia, assuming no public opposition.

Some brief comments are now made on the available RElec technologies.

- The potential for large-scale, environmentally-acceptable hydro is exhausted in Australia. However, there may be sufficient small-scale potential to offset the decline in rainfall resulting from climate change in south-east Australia.

- While some innovation analysts would still classify CSTP in the pre-commercial (limited mass-production) stage of technological development, it is being rolled out at such a high rate in Spain that there is little doubt that it will be widely accepted as a commercially available within a just few years.

- PV is a commercial technology that is growing rapidly on a global scale. However, economics at present favour residential and commercial-scale PV systems that compete with the retail prices of electricity, rather than larger PV power stations that compete with wholesale electricity prices. Therefore, in this submission, PV plays the principal indirect role of reducing demand on the grid. However, we don't rule out the possibility of larger PV power stations contributing to intermediate-load in the 2020s.

- Although hot rock geothermal power is not yet quite ready for the demonstration scale (eg 50 MWe), the Australian resource is huge and it is being proven rapidly by many companies. Geothermal power could possibly reach commercial availability before 2020, and so merits consideration in RElec scenarios running out to 2030.

- Wave and ocean current power, currently at the demonstration stage, are expected to make much smaller contributions than the above RElec sources before 2030. Therefore, they do not feature in this submission.

3. Generation scenarios

Leading climate scientists propose that the most effective means of cutting greenhouse gas emissions is to phase out all emissions from coal combustion by 2030 and to ensure that oil is not replaced by more greenhouse-intensive fuels, such as oil from coal, shale and tar sands (Hansen et al 2008).

Figure 1 shows a hypothetical electricity generation scenario for Australia in 2010–2030, that meets Hansen's requirement. It is a preliminary result of research that extends earlier published work by the present author (Saddler, Diesendorf & Denniss 2004 & 2007; Diesendorf 2007a). In this scenario, CCS is not commercially available and coal power is phased out by 2030. It is replaced by a mix of demand reduction, renewable energy and gas.

It is convenient to divide mentally the 20-year period of interest into two decades. Given effective government policies, the principal contribution to the growth in RElec in 2010–2020 will come from those technologies that are already commercial, namely wind and solid biomass, in that order. At the same time, demand growth could be reduced greatly and possibly stabilised with energy efficiency and conservation, solar hot water and small-scale residential and commercial PV. Also during this period, the pre-commercial technology CSTP will become commercial and could grow so rapidly that it could become a substantial contributor during the second decade, catching up with biomass and then wind around 2030 or shortly afterwards. These trends are illustrated in Figure 1. In the period 2025–30, it is possible that the use of gas for electricity supply could be already on a declining path as the result of the peak in global gas production being reached and the associated rapid escalation gas prices.

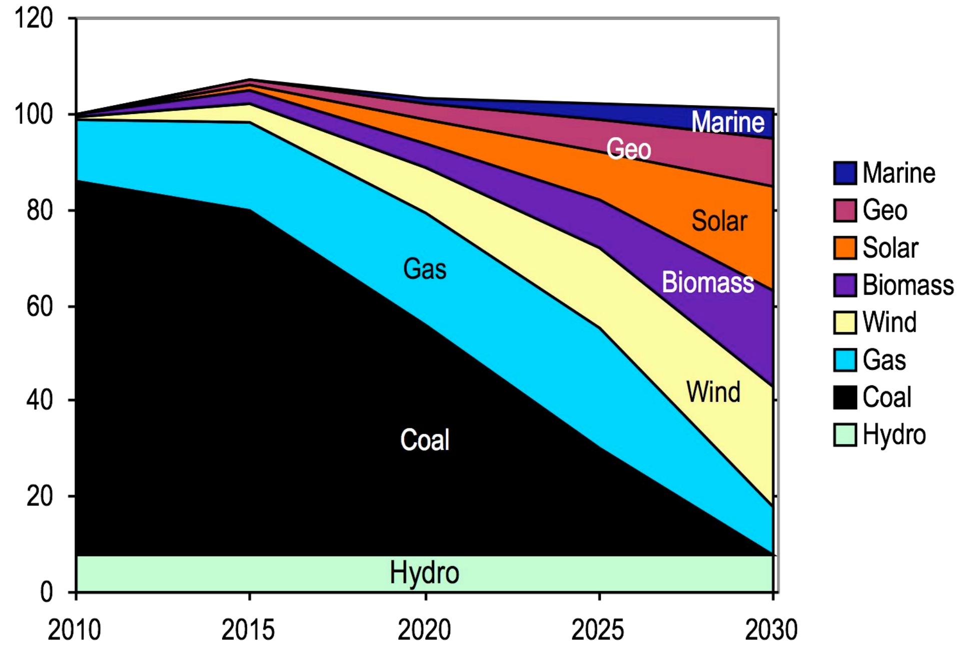

Figure 1: Electricity scenario to phase out coal, Australia, 2010–2030
Source: Diesendorf (to be published)

4. Potential contribution from RElec

The most urgent task for the coming decade is to integrate the huge wind energy potential of South Australia into the NEM. In the above scenario, wind power is the largest RElec contributor through to 2030, when it could contribute 25% of Australia's grid-connected electricity. This penetration may be possible provided wide geographic distribution of wind farms be achieved and some dedicated peak-load back-up is assigned to cover rare periods when there is little wind over the whole region of the grid.

In Denmark, where wind power has provided about 20% of electricity since 2001, back-up is provided by interconnection to Norway, Sweden and Germany. Norwegian hydro-power, in particular, provides a fast response to fluctuations in Danish wind power, and an expansion of the transmission link between the two countries is being planned together with a huge increase of Denmark's wind capacity to 50% of electricity by 2025.

In the US, a study by the Energy Efficiency and Renewable Energy division of the Department of Energy finds that it is feasible to generate 20% of US electricity from wind by 2030 (EERE 2008). The US result does not rely on international transmission links to achieve this wind penetration, but rather geographic distribution of wind farms facilitated by an expanded internal transmission grid and increased use of gas turbines for balancing the remaining fluctuations in wind power.

Australia is in a similar situation to the USA, with no prospect of major international transmission links in the medium term. Outhred (2003) has shown that it is possible to achieve a wind energy penetration of about 8000 MW (about 8% of current energy generation) with the existing transmission system. However, with upgrading of transmission links and some feeder lines, the present author has estimated that at least 20% of Australia's electricity could be supplied by wind (Diesendorf 2007b).

There is no sharp barrier to a NEM wind energy penetration of 20%. Currently there are several mini-grids in Australia achieving wind energy penetrations of over 40%, namely the wind-diesel systems at Denham, Bremer Bay, Coral Bay and Hopetoun in Western Australia (Verve Energy website). The two wind turbines at the Australian Antarctic Base at Mawson achieved an average wind energy penetration of 34% over the first four years of operation (Australian Antarctic Division website). Some of these mini-grids run at above 70% wind contribution during periods of high wind speed. Provided there is sufficient transmission capacity, the barriers to increasing wind penetration in both mini-grids and the NEM are not primarily technological, but rather are economic. In remote areas, the high price of diesel fuel justifies very high wind energy penetrations. In the NEM, wind farms have value both in saving capacity and fuel, but the fuel saved is generally coal. So, in the NEM the principal barriers are the increased fuel costs of the back-up from gas turbines operated intermittently, followed by the capital cost of additional peak-load capacity that would be dedicated to wind. To some extent, the barriers can be raised by advanced wind forecasting techniques.

At present, the wind power capacity in the eastern states of the NEM is too small to require back-up additional to that provided for balancing the existing system.

However, South Australia, with huge wind power potential, is already reaching the limits of its ability to use that potential within the state. There is an urgent need to strengthen the weak transmission links between South Australia and Victoria and between SA and NSW, and in addition to construct a new major link SA and the eastern states. It would make sense to plan the major transmission developments for the coming decade to facilitate the rapid growth in wind power, while taking into account the likelihood that large precincts of solar thermal power with thermal storage and geothermal power may have to be connected to this strengthened backbone before 2020.

5. Recommendations for transmission enhancements for RElec

Only the broad features are suggested here. The details would have to be worked out by transmission experts.

To enhance the transfer of wind power and later geothermal power from SA to Victoria and NSW, and to enhance the transfer of large-scale solar power within NSW, the following transmission enhancements are recommended for the period 2010–2020.

5.1 Supplement Murraylink SA-NSW

As a first and urgent step, supplement Murraylink by upgrading the connection between SA & NSW via Buronga (near Mildura). The TransGrid contingent project, to upgrade the Darlington Point to Buronga 220 kV line for 275 kV operation, should be supplemented by a 275 kV line between Buronga NSW and Robertstown SA. In addition, construct a Yass to Wagga 330 kV line to strengthen the NSW-Vic connection as well as the SA-NSW. Then existing 132 kV lines between Yass and Wagga can be used to connect new wind generation in that area. This series of developments would assist the connection of wind generation from Silverton (near Broken Hill) and solar precincts.

5.2 Upgrade Heywood link SA-Vic

Upgrade the Heywood (ie, coastal) SA-Vic link from the existing 275 kV double-circuit link to a 500 kV double-circuit. This would connect South Australia to the existing 500 kV line between Heywood (near Portland Vic) and the La Trobe Valley via Melbourne, and would increase the Heywood SA-Vic transfer capacity from about 300 MW to at least 2000 MW.

5.3 Construct new SA-NSW link

Build the NTS 2009 ‘big concept’ DC link from SA to NSW through the Broken Hill area, with 500 kV AC double-circuit extensions, as follows.
(i) The portion from Port Augusta SA to Broken Hill would be 500 kV AC double-circuit and would serve to receive generation from new geothermal sources as well as forming a necessary connection for large wind developments in SA.
(ii) The DC link would join the Broken Hill converter station to a converter station near Dubbo in NSW. It is not realistic to locate a converter station at Innamincka.

(iii) From Dubbo a 500 kV double circuit AC line would connect to the TransGrid 500 kV ring at Wollar.
The 500kV lines would have a capacity of about 2000 MW per circuit and the DC link perhaps 3500MW. The long AC sections will be able to collect new major generation from wind, solar and geothermal sources.

5.4 Construct Port Lincoln to Port Augusta within SA

Construct a new 275 kV double-circuit line from Port Lincoln to Port Augusta. This would then act as a more effective feeder line for the high-wind region of the Eyre Peninsula in SA.

Together these enhancements 5.1–5.4 would lift the *secure* electricity transfer capability from SA to the eastern states from 520 to at least 4500 MW and also provide feeders for wind power, then geothermal and large-scale solar thermal power into the strengthened backbone.

In addition, large-scale solar thermal power station precincts could be established west of the Great Dividing Range in south-west, central-west NSW and possibly the north-west. To facilitate this, some upgrading of feeder lines would be required.

In Queensland, there is also potential for large-scale solar thermal power station precincts in regions west of the Great Divide and south of the Wet Tropics, eg, near Roma and Barcaldine. There may be possibilities of linking the potential geothermal region in south-west Queensland with solar thermal precincts. More detailed investigations are recommended.

For the long-term, a study is recommended of the feasibility, costs and potential benefits of a high-voltage DC transmission link between WA and SA, taking into account the high RElec potential of WA (wind, solar, wave and tidal) and the time differences between the two states.

6. Conclusion

Transmission system enhancement is essential for Australia's future reductions in greenhouse gas emissions by means of large-scale renewable electricity precincts. The most urgent projects are to increase greatly the transmission capacities between South Australia and the east coast grid in NSW and Victoria.

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