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The Secretary of the Committee
Inquiry into the Development of the Non-Fossil Fuel Energy In Australia
House Standing Committee on Industry and Resources
House of Representatives
Parliament of Australia
Canberra

Feasibility of a Renewable Energy Economy for Australia

Dear Committee Members,

Attached is a peer reviewed paper on the development of a renewable energy economy for Australia over the next 50 years. While its topic is a little broader than your terms of reference, I would like you to focus on ten key points that are relevant to your enquiry as follows:

1. 80% Renewable Electricity by 2050
The integrated scenario (Section 3.4) develops an 80% renewable electricity supply that is essentially in place by 2040, with a 20% contribution each from wind turbines, solar photovoltaics, biomass electricity and solar thermal. The average GDP growth rate for the 45 year scenario period is 1.8% for the renewable scenario, compared with 2.2% for a high greenhouse base case. By 2040, Australia has a fully distributed and regionalised energy provision system that provides regional economic stimulus and employment, and is relatively secure in the face of terror threats and natural disasters.

2. Gas Turbines and Advanced Coal
Gas turbines and advanced coal make up the remaining 20% of the electricity provision by 2051. In 2051, fossil fuel sources generate about 50% of the electricity volume of the total amount demanded today. However the electricity requirement in 2051 is larger because of economic growth. The 'black electrons' then have a much lower carbon content because of advanced technology.

3. Deep focus on each technology
In the report proper (see below), each technology is comprehensively analysed and critiqued. The 80% renewable electricity scenario is based on robust and conservative assumptions. The use of 20% provision for each technology, draws on a wide range of work showing that wind and solar can be spatially and temporarily averaged and so meet variable demand requirements provided that the electricity grid is suitably developed over the next 45 years.

4. Base load power
Given that switching, storage and distribution capabilities will comprehensively change out to 2051, it should be emphasised that both biomass electricity and solar thermal electricity are base load providers. When the 40% from these sources is added to the 20% from gas turbine and advanced coal, then fully 60% of 'double the amount of electricity that we demand today' will be baseload compliant. Behavioural adaptation and storage technology will make giant strides over the next 45 years and render the current 'baseload argument' a marginal issue.

5. The process of transition
The process of this renewable energy transition is a bumpy one where the pressure of investment over the next 25 years is substantial and halves economic growth rates for one human generation. Relaxing some analytical assumptions could improve this message, but totally re-formatting Australia's energy metabolism is a difficult task. Over the full 45 year scenario total dollar production and measures of wealth 'stocks' are similar between the 'renewable energy' and 'base case' scenarios. Many current economic analyses report a 'have your cake and eat it too' situation. Physical realities for major infrastructure transitions are difficult as perhaps the process of German reunification showed.

6. Liquid transport fuels
This renewable energy transition also develops a near neutrality in carbon terms for the liquid transport fuels cycle. It deals comprehensively with the 'peak oil' issue, a topic examined by a Senate Rural and Regional Affairs and Transport Committee in a report released on the 7th February of this year. The fuels of choice are wood alcohol (or methanol-CH_3OH) as a replacement for petrol (or a Hydrogen carrier for fuel celled vehicles), and Di-Methyl-Ether (DME) as a replacement for diesel. There is a commercial synergy between biomass electricity and methanol/DME production as all of the wood production, handling and gasification processes are similar, and then the 'synthesis gas' routes to either a gas turbine for electricity, or a catalytic processor for methanol/DME production. In your Committee's context, methanol could be viewed as an energy storage mechanism to run gas turbines or fuel cells.

7. Biomass plantings to refurbish rural Australia
The 80% renewable electricity scenario requires 48 million hectares of dedicated wood biomass (or woodscape) by 2051 to supply both bioelectricity and fuel transport requirements. This constitutes a powerful refurbishment force for rural and regional Australia giving a climate-resilient perennial crop and cash flow, high-tech employment, and a sophisticated industrial base. Narrow consumer measures of cents per kilowatt hour electricity or cents per litre for transport fuel, cannot adequately represent the step-change in opportunity and resilience for regional Australia that the transition represents.

8. Investments are immense
These investments are immense and almost beyond comprehension the view today of a renewable energy economy. By 2051 for example, the 20% wind turbine component of the scenario requires 35,000 MW of installed capacity, or 7,000 large 5 MW turbines. Currently there is only 65,000 MW of wind capacity installed worldwide. The analysis assumes that more than 90% of the design and fabrication is done by Australian industry. Thus the value adding, employment, intellectual acumen and profits accrue firstly to Australian interests, notwithstanding that ownership is open to international capital. It is worth noting that geothermal electricity is not included in the analysis, not because it lacks potential, but because we currently do not have a systemic description of its infrastructure costs and performance. Solar thermal electricity may be roughly equivalent.

9. Greenhouse outcomes
The whole-economy outcome for greenhouse emissions is notable. The accumulated or summed carbon dioxide emissions for the base case are **28.7 billion tonnes** for the 45 year scenario period 2006-2051. The 80% renewable scenario reduces this to **11.6 billion tonnes**, a 60% reduction. There are still improvements to be gleaned in the analytical process and we are working towards an 80% reduction, but 60% is reasonably assured under this well

developed plan. The analytical process (see next point) is comprehensive with all sectors of the economy interacting i.e. the full system of swings, roundabouts and disappointments. Thus it is much more robust than many single sector technology audits, or the 'sustainability wedge' analyses that are commonly quoted in energy and sustainability literature.

10. Methodologies used in analysis
The approach used here is 'physical economy' analysis that brings together the physical realities which underpin all economic and social functions. The physical-economy structure is derived from input-output tables from the National Accounts, and then turned 'physical' by integrating a wide range of energy, greenhouse, water and land accounts. The function of the analytical framework must conform to the physical laws of thermodynamics and mass balance in particular. This allows us to say they are 'physically real' or have 'physical reality'. Such analysis provides different insights from the economic models commonly used in national policy formulation. Thus these results are derived from 'physical models with economic implications', rather than 'economic models with physical implications'. Insights from physical and economic approaches vary. The 'physical models' come up short in aspects of consumer and market behaviour, while 'economic models' display only rudimentary physical reality.

This work is a short extract from research commissioned by the Federal R&D agency Land and Water Australia with a specific focus on a biomass-based economy. This work was commenced under a CSIRO contract when I was employed there, and should be completed by the end of 2007. This submission is made by myself as a private individual and does not represent the views of CSIRO or Land and Water Australia in any way.

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