Submission to Senate Select Committee on Fuel and Energy - Public Hearing 25 September
Author- Glen Currie.

I am Glen Currie and am the National Treasurer of the Australian Institute of Energy. I have held the position of General Manager Business at CSIRO Energy Technology and am now starting up a renewable energy company. I will be representing personal views, as the AIE seeks to encourage a broad range of perspectives, and does not lobby for particular solutions.

I subscribe to the idea that we are heading into the third industrial revolution (J. Rivken). The drivers are peak oil and climate change. The changes in this third industrial revolution will be to all aspects of our economy, though energy is central. That is because the problems are both in the area of energy, namely "peak oil" and climate change mainly driven by burning of carbon fuels for energy.)

Australia has an opportunity to take advantage of this rapid change in global economies, and the response will include changing our current sources of energy, and innovating toward new energy technologies for domestic and export use.

Innovation will be required in both research and in business delivery to make this change. I refer to the report of the National Innovation Review chaired by Dr Terry Cutler. He points out that it will not be enough to adjust policy to deliver changes to our energy system. We will also require a strengthening of our ability to innovate. Changing our energy system will be difficult.

1/ Regulation to change our energy system:

- State network regulation is gradually making allowances for small renewables, but the systems and people skills are lacking and make new plant regulatory load quite high
- Renewable energy regulation is complex and really designed for larger generators. This is of particular discouragement to medium renewable plants (5KW to 1MW.)
- One example is ACTEWAGL requires the transformer for a renewable plant to be three times the capacity of the plant (this regulation makes sense in complex grids, but not for a discrete generating point in the grid.)
- Regulation of the energy efficiency of electrical goods especially air-conditioning, (but also fridges) would help moderate the growing summer peak (It is the "5 minute" peak which dictates the infrastructure costs).

2/ Taxation changes to improve our energy system

- Attracting money to the research, commercialisation and demonstration stages is critical to further development of any industry. We have seen many examples of energy technology heading offshore or failing. E.g.: Solar Systems, Suntech Solar, AUSRA, ZBB, and Pacific Solar. Technology companies have high risk, and compete with mining for risk capital in Australia. Mining investment can be risky too, but there is a high familiarity in Australia with mining risks, which attracts the risk capital there.
- Need to be able to attract private capital, and tax incentives are a good way to enhance this.
- Energy technology demonstration often requires huge capital, for which tax incentives are important.
- The high capital nature of most renewable energies (relative to their low operating cost) means that favourable depreciation is very very important to attracting capital.
- Taxing air-conditioning could also reflect its additional cost to deliver the infrastructure required for the summer peak (primarily driven by air-conditioning.)

3/ the role of Alternative Energy

- The costing of centralised power often has a hidden subsidy due to the provision of the network. Renewables tend to be distributed and can sometimes enhance the network by placing the generation at or near the load point. This is recognised in the US as their grid resilience is poor as was seen in the 2003 blackouts. Distributed energy is seen in the US as one method of enhancing their grid resilience
- There is an opportunity for Australia to be at the forefront of a range of energy technologies for which Australia offers some unique advantage.
    - Our current advantage in coal means innovations in this area are important. The value of coal on the world market will influence our domestic coal supplies over time and there will be a long term world supply constraint driving up these prices (just as we are seeing with oil.) This should see the Australian wholesale electricity price rise to make many of the alternative technologies competitive in the medium term (without subsidy.)
    - Carbon capture and storage technologies:
        1. We have finite storage sites and we will soon fill the easily accessible sites with a carbon/nitrogen mix from IGCC plants. The pure carbon from oxyfiring for example has a huge volume advantage.
        2. Even once we move away from 80% coal, we will likely see a continued role for CCS due to use of coal for chemical production, baseload backup, and fluid fuel production.
        3. Gorgon is our first large scale sequestration project and will position Australia well in this area.
        4. Our first CCS coal plant may be 30-40 years away though, so we should pursue other alternative energy formats.
    - Thorium is worth exploring as we hold 1/3 of the worlds reserves
    - Large scale solar thermal is a near term alternative technology. In Australia we have ideal conditions with very high intensity solar areas of which the rest of the developed world has a dearth Solar thermal technologies offer an ideal match to enhance coal power-stations such as the plant at Liddell and can also enhance process heat requirements. It may be 10-15 years before large scale solar thermal electricity is competitive as baseload. This will come when thermal storage is delivered on a large scale. Companies such as Wizard Power and Ausra are actively developing technology, as is the CSIRO.
    - Solar hot water technology is another area of advantage in Australia. We have been the source of much of the innovation in this field.
    - Hot dry rocks is interesting. We are ahead of the game, as most of the world's geothermal is steam driven.

- Alternative energies deliver Energy security (detail below)
- CO2 reduction is achieved through most alternative energies
- Lower pollutant generation (heavy metals, radioactivity, ozone, particulates, chemical contamination of water, and hot water released into natural habitats such as Lake Macquarie),
- Lower water usage (relative to coal)
- Home based energy (solar PV) and smart meters increase consumer awareness of electricity consumption, and smart meters also deliver useful information to generators.

4/ Security and reliability of our energy system

- Liquid fuel for transport is a key supply vulnerability in Australia, and likely solutions include biomass, coal liquefaction, gas reforming, expanded gas use, vehicle efficiency and electric vehicles.
- The drop in investment in Coal plant in Australia is creating a reliability risk in our energy system. If mitigating Carbon emissions means brownouts or blackouts then renewables risk losing community support, and we need to ensure base-load is available.
- Most alternative energy sources are far smaller (1KW-200MW) than centralised coal stations (2-3GW), therefore less vulnerable to massive failure, or terrorism.
- New alternative energy sources create diversity of source location, and combined with current developments in the "smart grid" will enhance network stability.
- Renewables offer "infinite" delivery of energy, whereas fossil fuels are running out
- Nuclear is a very reliable alternative, but is not supported by the community and carries terrorism and green activist risk. Thorium offers a benign alternative.
- the intermittency issue of wind and solar can be reduced by:
    - Improved interconnectivity of the grid (e.g.: HVDC).
    - Smart grid development
    - other large scale energy storage methods such as molten salt
- An ideal location of a HVDC line would be the Moonie, SA area to the eastern seaboard interconnect. This might deliver geothermal, wind and solar to the eastern grid.
- Continually improving control of energy industry pollutants and water usage will be required to maintain a "community licence to operate". The fine particle emissions from coal plant and large water use by coal plant are of particular concerns.

5/ Liquid fuels

- As I've noted above liquid fuel supplies remain a core energy vulnerability for Australia. We are blessed with large amounts of most other energy types.
- Options for replacing oil include
    - The liquefaction of brown coal (with carbon storage)
    - Biomass, with bagasse and algae being likely sources
    - Gas reforming to transport fuels could include methanol production using solar thermal transformation
    - Expanding the use of gas in transport (it is currently about 3%)
    - Vehicle efficiency and a move to hybrid and electric vehicles which we are already seeing from the market response to fuel costs

In conclusion,

Short term

- Renewable energy (wind/solar PV), with some gas peaking plant could go to 20% of total load without loss of load probability (Diesendorf).
- Energy efficiency can make a fast and low cost impact on energy requirements. Insulation and solar hot water initiatives are part of this though far more could be done to regulate air-conditioners, and other electrical goods (e.g.: standby power requirement).
- new Green building codes are being rolled out, though more could be done at little cost
- expanded use of natural gas (e.g.: pipelines to PNG or WA)

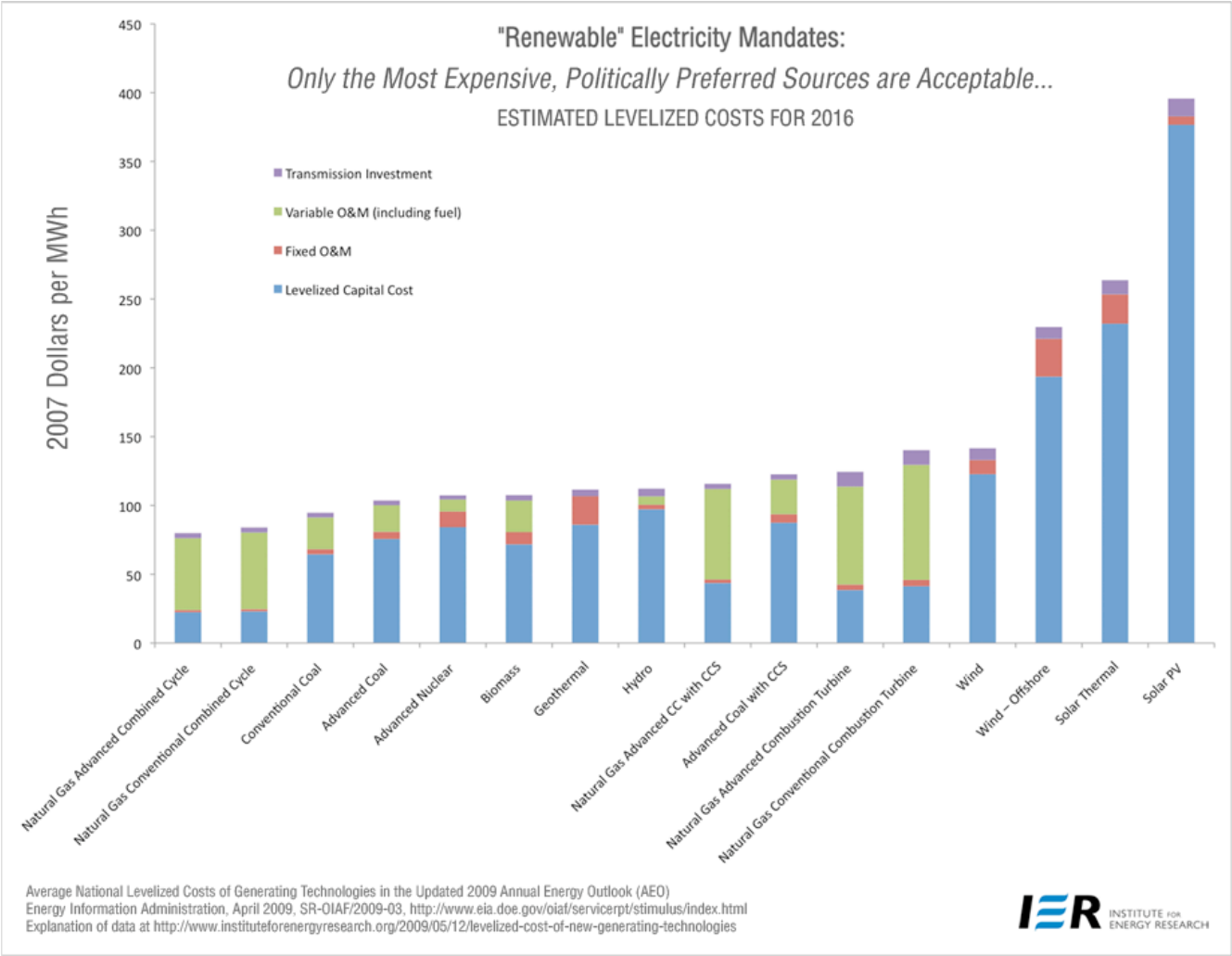
Medium term low emission base-load options include:

- nuclear,
- hot rocks and
- Solar thermal.

CCS from coal is a possible long term option, though it will probably not be the low cost baseload option when it arrives. It might be 40 years before large scale CCS plants are in operation so it is imperative that CCS does not distract us from the other emission reduction options we can implement now. Energy efficiency, intermittent renewables to 20%, perhaps 30%, hot rocks, and solar thermal….and perhaps nuclear.

Thank you.

Levelized Cost of New Generating Technologies



The Energy Information Administration (EIA) produces forecasts of energy supply and demand for the next 20 years using the National Energy Modeling System (NEMS)[1]. These forecasts are updated annually and published in the Annual Energy Outlook (AEO). EIA published a preliminary version of the AEO 2009 in December 2008, and updated the forecasts in April, 2009, to incorporate the energy provisions in the stimulus.[2] All sectors of the energy system are represented in NEMS, including the electric power generation, transmission, and distribution system.

To meet electricity demand, the EIA represents the existing generating plants, retires those that have come to the end of their economic life, and builds additional plants to meet projected demand from the residential, commercial, industrial, and transportation sectors. As a result, EIA must represent a slate of technologies, their capital and operating costs, their availability and capacity factors, the financial structure and subsidies, the time to construct the plant, the utilization of the plant, and expected future cost changes, including fuel input for fossil and nuclear plants. To determine the most economic technology for the type of demand (base,

[1] Energy Information Administration, NEMS documentation, http://tonto.eia.doe.gov/reports/reports_kindD.asp?type=model%20documentation

[2] Energy Information Administration, *Annual Energy Outlook 2009*, http://www.eia.doe.gov/oiaf/aeo/index.html

intermediate, or peaking load) for which new capacity is needed, NEMS competes the technologies based on the economics of their levelized costs. Levelized costs represent the present value of the total cost of building and operating a generating plant over its financial life, converted to equal annual payments and amortized over expected annual generation from an assumed duty cycle.

The table below provides the average national levelized costs for the generating technologies represented in the updated AEO2009 reference case.[3] The values shown in the table do not include financial incentives such as state or federal tax credits, which impact the cost and the competitiveness of the technology. These incentives, however, are incorporated in the evaluation of the technologies in NEMS based on current laws and regulations in effect at the time of the modeling exercise, as well as regional differences in the cost and performance of the technology, such as labor rates and availability of wind or sun resources.

In the AEO2009 reference case, a 3-percentage point increase in the cost of capital is added when evaluating investments in greenhouse gas intensive technologies such as coal-fired power plants without carbon capture and sequestration (CCS) technology and coal-to-liquids plants. The 3-percentage point adjustment is similar to a $15 per ton carbon dioxide emissions fee when investing in a new coal plant without CCS technology. This adjustment represents the implicit hurdle being added to greenhouse gas intensive projects to account for the possibility that they may need to purchase allowances or invest in other greenhouse gas emission-reducing projects that offset their emissions in the future. Thus, the levelized capital costs of coal-fired plants without CCS are likely higher than most current coal project costs.

The levelized cost for each technology is evaluated based on the capacity factor indicated, which generally corresponds to the maximum availability of each technology. However, some technologies, such as a conventional combined cycle turbine, that may look relatively expensive at its maximum capacity factor may be the most economic option when evaluated at a lower capacity factor associated with an intermediate load rather than base load facility.[4]

Simple combustion turbines (conventional or advanced technology) are typically used for peak load, and are thus evaluated at a 30 percent capacity factor. Intermittent renewable resources, e.g. wind and solar, are not operator controlled, but dependent on the weather or the sun shining. Since the availability of wind or solar is dependent of forces outside of the operator's control, their levelized costs are not directly comparable to those for other technologies although the average annual capacity factor may be similar. Because intermittent technologies do not provide the same contribution to system reliability as technologies that are operator controlled and dispatched, they may require additional system investment as back-up power that are not included in the levelized costs shown below.

[3] Energy Information Administation, *Assumptions to the Annual Energy Outlook*, http://www.eia.doe.gov/oiaf/aeo/assumption/index.html

[4] Base load plants are facilities that operate almost continuously, generally at annual utilization rates of 70 percent or higher. Intermediate load plants are facilities that operate less frequently than base load plants, generally at annual utilization rates between 25 and 70 percent. Peaking plants are facilities that only run when the demand for electricity is very high, generally at annual utilization rates less than 25 percent.

Levelized Cost of New Generating Technologies, 2016
Revised AEO 2009 Reference Case

Plant Type	Capacity Factor (%)	U.S. Average Levelized Costs (2007 $/megawatt hour) for Plants Entering Service in 2016				
		Levelized Capital Cost	Fixed O&M	Variable O&M (including fuel)	Transmission Investment	Total System Levelized Cost
Conventional Coal	85	64.5	3.7	23.0	3.5	94.6
Advanced Coal	85	75.6	5.2	19.3	3.5	103.5
Advanced Coal with CCS	85	87.4	6.2	25.2	3.8	122.6
Natural Gas-fired						
Conventional Combined Cycle	87	23.0	1.6	55.7	3.7	83.9
Advanced Combined Cycle	87	22.4	1.5	52.3	3.7	79.9
Advanced CC with CCS	87	43.6	2.6	65.8	3.7	115.7
Conventional Combustion Turbine	30	41.3	4.6	83.6	10.7	140.2
Advanced Combustion Turbine	30	38.5	4.0	71.2	10.7	124.3
Advanced Nuclear	90	84.2	11.4	8.7	3.0	107.3
Wind	35.1	122.7	10.3	0.0	8.5	141.5
Wind – Offshore	33.4	193.6	27.5	0.0	8.6	229.6
Solar PV	21.7	376.6	6.2	0.0	12.9	395.7
Solar Thermal	31.2	232.1	21.3	0.0	10.3	263.7
Geothermal	90	86.0	20.7	0.0	4.8	111.5
Biomass	83	71.7	8.9	23.0	3.9	107.4
Hydro	52	97.2	3.3	6.1	5.6	114.1

Source: Energy Information Administration, Annual Energy Outlook 2009 (revised), April 2009, SR-OIAF/2009-03, http://www.eia.doe.gov/oiaf/servicerpt/stimulus/index.html