The Secretary
Senate Select Committee on Fuel and Energy
PO Box 6100
Parliament House
CANBERRA ACT 2600

6 July 2009

Dear Secretary

On 3 July, the Chair of the Committee wrote inviting the Association to make further submissions under the Committee's expanded terms of reference. This letter responds to that invitation.

Recently, the Association received research it had commissioned on electricity-generating technologies from the Centre for Integrated Sustainability Analysis at the University of Sydney, *Current state of electricity-generating technologies – a literature review.* The principal author of the research is Professor Manfred Lenzen.

The research is available on the Association's website www.aua.org.au

The key points to note about the research are as follows:

- The study is a review of, principally, academic literature produced since 2006
- It was commissioned by the Association to clarify the global technology context for Australia's uranium exports; in particular, the relative position of nuclear power technology, which Australia's uranium industry supplies
- The summary of the research findings are found in the tables attached. They show that:
    - The electricity generating technologies currently available to provide electricity to meet base load needs are either fossil fuel-based or nuclear power or, in some cases, hydro
    - Nuclear power and electricity from renewables are the most effective technologies for minimizing greenhouse gas emissions; they have significant greenhouse gas mitigation potential and low energy inputs for the electricity output they produce
    - Fossil fuel, nuclear, hydro and wind technologies are mature technologies
    - Those still in development include coal with carbon capture and storage and solar
    - The fossil fuel-based technologies are the lowest cost technologies per unit of output, followed by nuclear and wind, then hydro and then solar.
    - In 2007, hydro was the least subsidised technology on the basis of subsidy per unit of output; next came nuclear and geothermal, then wind, coal and biomass. Solar was the most heavily subsidised for the amount of electricity it produced.
- The summary above illustrates the strengths of the technologies. Yet all the technologies also face barriers to their development and deployment
    - Nuclear power faces public acceptance barriers
    - The cost of solar energy is very high
    - The intermittency of wind power creates stability problems for an electricity grid

GPO Box 1649, Melbourne, 3001
T: +61 3 8616 0440 F: +61 3 8616 0441 W: www.aua.org.au ABN: 30 005 503 828

- Geothermal energy has uncertain field capacity
- The scale of biomass is constrained by its potential to compromise food and biodiversity objectives
- Carbon capture and storage has an energy penalty.

- These findings reinforce the need for a full global portfolio of technologies.

Professor Lenzen notes the limitations of the research as a decision-making tool: the research does not resolve the argument in favour of any technology, or mix of technologies, for any particular country, including Australia.

It does, however, reinforce the case for expanding Australia's uranium exports to service the growing needs of a technology that is the only low-carbon technology available now to supply base load electricity at a reasonable price.

If the Committee wished, the Association could elaborate on the research in a public hearing.

Yours sincerely

Michael Angwin
Executive Director

GPO Box 1649, Melbourne, 3001
T: +61 3 8616 0440 F: +61 3 8616 0441 W: www.aua.org.au ABN: 30 005 503 828

Current state of development of electricity generating technologies

Technology	Annual generation (TWh_{el}/y)	Capacity factor (%)	Mitigation potential ($GtCO_2$)	Energy requirements (kWh_{th}/kWh_{el})	CO_2 emissions (g/kWh_{el})	Generating cost (USc/kWh)	Barriers
Coal	7755	70-90		2.6-3.5	900	3-6	GHG
Oil	1096	60-90		2.6-3.5	700	3-6	Resource constraint
Gas	3807	≈60		2-3	450	4-6	Fuel price
CCS		n.a.	150-250	2-2.5+0.3-1	170-280	3-6+0-4	Energy penalty etc
Nuclear	2793	86	>180	0.12	65	3-7	Public acceptance
Large hydro	3121	41	200-300	0.1	45-200	4-10	Resource potential
Small hydro	≈250	≈50	≈100	n.a.	45	4-20	Resource potential
Wind	260	24.5	≈450-500	0.05	≈65	3-7	Variability, grid integration
Solar PV	12	15	25-200?	0.4/1-0.8/1	40/150-100/200	10-20	Cost
Concentrating solar	≈1	20-40	25-200?	0.3	50-90	15-25	Cost
Geothermal	60	70-90	25-500?	n.a.	20-140	6-8	Uncertain field capacity
Biomass	240	60	≈100	2.3-4.2	35-85	3-9	Efficiency etc

Source: *Current state of electricity-generating technologies – a literature review,* Centre for Integrated Sustainability Analysis, The University of Sydney, June 2009

Subsidisation of electricity-generating technologies 2007

Technology	Subsidy (c/kWh.y)
Coal-fired power	3.1-24.6
Nuclear power	0.72-1.5
Wind	2.1-2.4
Solar PV	26
Concentrated solar	30.5
Geothermal	1.5
Biomass	2.6-5.9
Hydro-power	0.013

Source: *Current state of electricity-generating technologies – a literature review,* Centre for Integrated Sustainability Analysis, The University of Sydney, June 2009