NUCLEAR ENERGY FOR AUSTRALIA? CONFERENCE REPORT

THE CONFERENCE QUESTION

. The Conference aimed to provide measured and balanced consideration of the question posed by its title: "Nuclear Energy for Australia?"

Some 22 written papers were presented by invited speakers, each an acknowledged topic expert (see Conference Program attached). Together with structured debate, speakers spanned the opportunities and threats offered by nuclear and other proven technology options as Australia seeks to move to a low carbon electricity supply.

POLICY ISSUES

Australia's policy on nuclear power generation. Australia's present policy, as expressed in the 2012 Energy White Paper, is that the Australian Government does not support the use of nuclear energy in Australia. It appeared inconsistent to the majority of delegates that Australia, given its commitment as a reliable supplier of uranium fuel and its proven capability in operating research reactors, remains constrained from considering nuclear energy for domestic electricity generation. Exhaustive discussion found no supportable reason to omit careful consideration of nuclear energy as part of Australia's long term generation portfolio.

ATSE's policy on nuclear power generation. The Academy's policy position is that nuclear energy should be considered as part of Australia's future energy generation portfolio. This policy was noted by delegates who supported the view that, as a responsible global citizen, Australia must significantly reduce its carbon emissions while retaining reliable electricity supplies.

The generation technology portfolio mix. Apart from nuclear energy, other proven low emission technologies such as renewables (primarily hydro, wind and solar) must be part of the long term generation portfolio. Low emission technologies such as carbon capture and storage (CCS), geothermal and others, which remain unproven at commercial scale, should all be considered for the long term generation portfolio if they become viable at large scale. However none of these is believed likely to displace the need for baseload nuclear energy if long term emission reduction targets are to be met economically.

Bi-partisan policy. Australia will need a long term, stable bi-partisan energy policy and associated regulatory environment, covering all viable energy sources and conversion technologies, including nuclear, to meet the combined objectives of reliability, security, minimum cost and emissions abatement.

TECHNOLOGY ISSUES

Australia and the uranium fuel cycle. As the world's third largest supplier of the uranium to fuel nuclear power stations, Australia already plays a substantial role in the international nuclear fuel cycle.

Nuclear technology. Developments in modern nuclear power plant design, both grid scale (1,000 MWe and over) and small modular reactors (300 MWe and below), hold promise for delivery of electricity that, subject to carbon constraints, is cost-competitive with coal when amortised over plant life. The Conference noted that nuclear energy, using today's current build reactors, offers near-zero[1] greenhouse gas and other airborne emissions, high fuel efficiency, minimal and manageable residual waste, built-in proliferation protection and advanced passive safety protection.

Modern large scale reactor development. Today's advanced Generation III and Generation III+ pressurised water (PWR), boiling water (BWR) and heavy water (HWR) reactors offer high levels of safety, improved efficiency and reduced specific costs. System load growth and selected coal plant retirements over the years ahead will call for new base load generation. Plants rated at 1,000 MWe and above could readily be accommodated in Australia's eastern national grid.

Small modular reactors. The advent of small-scale factory assembled packaged nuclear reactors and power plants, generally referred to as SMRs and rated at less than 300 MWe electrical output, could enable new capacity to match growing demand more closely. While applicable to Australia's long eastern national grid and remote area off-grid applications such as mining and processing, SMRs are still under development; international market experience is commended before local commitment to their adoption.

Process heat. Nuclear reactors can deliver high-temperature process heat, for example to dissociate hydrogen directly from water or enable high-temperature electrolysis. Hydrogen can be used to make diesel and jet fuel from Australia's abundant coal or gas.

Water desalination. Nuclear power, especially small modular reactors, could serve remote or regional communities reliably and economically through the provision and delivery of fresh water from saline or brackish water for agricultural development.

ECONOMIC ISSUES

Nuclear investment. There is a surge in investment in new nuclear facilities world wide, predominantly in China, India and Russia. France, Korea and Finland have also made significant new investments. Technology continues to improve; Australia would expect to deploy only well proven reactor technology should it adopt nuclear energy.

Electricity supply system economics. Recent independent modelling by the Bureau of Resource and Energy Economics of the levelised cost of electricity (the Australian Energy Technology Assessment - AETA)[2] suggests that nuclear energy is already competitive with other forms of generation. CSIRO's eFuture model[3] using AETA data suggests there are significant advantages, both economic and to the environment, through including nuclear power in Australia's future generation mix.

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[1] For the sake of shorthand, near-zero refers to generation technologies that produce less than 100kg CO_2–e per MWh across the full life cycle. Nuclear power and renewables hydro, wind and solar fall within that limit.

[2] The 2012 *Australian Energy Technology Assessment* (AETA) prepared by the Australian Government Bureau of Resources and Energy Economics (www.bree.gov.au) provides the currently best available and up-to-date cost estimates for 40 electricity generation technologies under Australian conditions. The full BREE report can be found at (www.bree.gov.au) together with and access to the accompanying model.

[3] CSIRO's Energy Flagship model *eFuture* is a web-based modeling tool that allows users to explore Australia's energy future using a number of scenarios based on technology costs, electricity demand and fuel prices. The nuclear power option can be included or excluded by user choice.

Capital requirements for system expansion and renewal. If Australia is to attract the necessary massive capital investment for electricity system expansion and large scale baseload plant replacement, regardless of technology, it will need to address:

- total electricity system costs rather than simply the levelised costs of electricity (LCOE)[4] for candidate technologies – these additional costs can be substantial;
- technology neutral electricity pricing mechanisms that accommodate not only expanded distributed generation but also the need to service future long lived high capacity capital investments, probably sourced in international markets, needed to provide secure, reliable and economic low emission electricity supplies for Australia;
- those elements of the current liberalised electricity market that are currently deterring the required investment in new generation, notably the inadequate recognition of the value of system capacity[5] (MWe) added as well as energy delivered (MWh); and
- the location of power stations, their social acceptability and their integration with the existing grid.

REGULATORY ISSUES

Regulatory arrangements. If Australia is to adopt nuclear energy for power generation it will need an enhanced and expanded regulatory regime. This will take time. Nevertheless Australia's established nuclear regulators provide the basis for developing the appropriate regulatory arrangements for nuclear power generation.

ENVIRONMENTAL ISSUES

Climate change. The Conference accepted that there is little doubt that human activities are primarily responsible for the rapidly changing chemical composition of the atmosphere, with the real risk of long term adverse consequences for the climate and ocean oxygen supply upon which mankind depends. While uncertainties remain, it is a risk to future generations that cannot justifiably be ignored.

Australia's response. While Australia espouses the need to reduce greenhouse gas and other emissions it has so far declined to consider nuclear power, choosing instead to promote more expensive renewable energy options which are unlikely to achieve economically its policy objectives and emission reduction targets. Such policies are believed short-sighted.

Greenhouse gas emission reduction. Compared with the gradual migration to renewables assumed in the 2012 Energy White Paper, the introduction of nuclear power to Australia by 2030 would lead to very large savings to the economy through greenhouse gas emission abatement, more competitive electricity costs, improved health outcomes and reduced health costs over the decades following.

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[4] The levelised cost of electricity (LCOE) for any technology is a calculation of the cost of generating electricity at the point of connection to a load or electricity grid. It includes the initial capital and discount rate as well as the costs of continuous operation including fuel and maintenance. LCOE is used by policy makers, researchers and others as a guide in discussions and decision making.

[5] Generating plant capacity is the maximum electric power output, typically measured in megawatts electrical (MWe), that a generator can produce under specific conditions. A 1 MWe generator that operates continuously for one hour will produce 1 megawatt hour (MWh) of electrical energy, typically referred to as baseload generation. If it operates at any lesser capacity, for example due to intermittency of its energy source, it will produce proportionally less electrical energy. The ratio of annual electrical energy produced to rated capacity is known as the capacity factor.

HEALTH, SAFETY, RISK AND WASTE DISPOSAL ISSUES

Personal health and safety. The Conference was advised of evidence showing that personal health and safety outcomes related to the full nuclear fuel cycle are superior to those of other full cycle energy technologies.

Nuclear safety. Despite three significant and well documented accidents the industry has demonstrated it can operate safely. Its safety record is better than most other power and manufacturing industries worldwide. Nevertheless concerns remain that must be openly addressed if nuclear energy is to be adopted in Australia.

Nuclear waste disposal. A process of broad community consultation, sound engineering practice and careful construction with rigorous regulatory support has been shown as the best way to manage the challenge of safe permanent nuclear waste disposal in other countries. One well developed model of sound political and technological practice, from which Australia could take guidance, is that of Finland.

Waste disposal and plant decommissioning costs. The Conference respected the proposition, adopted by other nuclear nations, that the long term costs of high level nuclear waste disposal and eventual plant de-commissioning be provided for by a levy on the wholesale price of nuclear generated electricity, accumulated over the plant life.

KNOWLEDGE AND SKILLS FORMATION ISSUES

Education and training. The necessary skills and knowledge formation base will take time to build, not only in reactor engineering but to meet the future needs for regulators, licensing and environmental approval. To this end the Conference noted the advanced planning in place for the new Nuclear Science and Engineering degree course at the University of New South Wales in association with established international providers. The contributory role of the Australian Nuclear Science and Technology Organisation (ANSTO) was also noted by the Conference.

Careers and jobs. The Conference accepted that nuclear engineering education will provide challenging careers for young Australians in future high-technology industries. Worldwide nuclear R&D is focussed on reducing wastes, lowering costs and reinforcing inherent safety. Australia's best young minds need to have the opportunity to apply such knowledge in advancing clean energy technologies in their own country, as well as developing into respected regional partners.

Educational export potential. The Conference noted that, with the planned establishment of an internationally recognised education and training course in nuclear power engineering in Australia, it can be confidently expected that graduates will be in demand in both home and international markets.

Engineering capability. Although at still a relatively modest level, the Conference noted that major Australian engineering organisations are already developing valuable engineering capabilities and project management experience in international nuclear power markets.

Nuclear medicine. The Conference noted that Australia offers significant skills and capabilities in the field of radiomedicines and therapies. ANSTO's new Open Pool Australian Light Water Reactor (OPAL) contributes significantly to this capability.

Research and development. ANSTO's nuclear research and development capabilities are world class but will need broadening if Australia is to adopt nuclear power and to engage more comprehensively in advanced nuclear technologies.

SOCIAL ISSUES

Public acceptance. Concerns that the nuclear industry is unsafe, expensive, risks weapons proliferation and has intractable waste disposal problems are not supported by the evidence. Although unsupported, such concerns cannot be ignored; public trust in industry transparency and government oversight is fundamental to public acceptance. The Conference trusts that its deliberations and findings can be the beginning of a progressive transformation of the nuclear symbol from one that instils fear of the unknown to one that creates hope for a sustainable future through the use of nuclear technology, alongside other low carbon options.

Public debate is essential. Accepting the option of nuclear energy for Australia will require transparent communication and open public debate over an extended period at all levels. The carefully planned approach of Finland to community consultation on public risks and benefits was again noted as a model of best practice that Australia could do well to adopt if it is to build social acceptance for nuclear energy.

SUMMARY OF CONCLUSIONS

The majority of delegates noted that nuclear energy is a viable technology for Australia. Nuclear energy already generates some 11-12 per cent of the world's electricity, much of it using Australian uranium, with massive reduction of emissions compared to fossil fuel alternatives. Nuclear is also a viable option for a near-zero emissions technology to replace ageing coal power stations in Australia, despite recognised challenges.

Exhaustive discussion found no supportable reason to omit consideration of nuclear from the generation mix for Australia. The predominant Conference finding was that open informed public debate and consultation, especially involving younger community members, is of paramount importance. The Conference considered that a more relevant and up to date study of the economic and environmental potential of nuclear energy for Australia may now be warranted. Several suggestions were made as to possible ways ahead for such a study.

The majority of Conference delegates concluded that current policies that negate the consideration of nuclear energy should be reviewed; moreover Australia must be better prepared for the possible adoption of nuclear energy if the need arises. Thus action is needed now to plan and put in place the necessary legal and regulatory instruments as well as adequate educational and training facilities.

ACKNOWLEDGEMENTS

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RESPONSIBILITY FOR OPINIONS EXPRESSED

ATSE accepts responsibility for the opinions expressed in this report which it believes reflect the considered views of the majority of delegates.

NUCLEAR ENERGY FOR AUSTRALIA?

CONFERENCE PROGRAM - DAY 1

Session 1 – Opening and keynote addresses
Chair: Mr Martin Thomas AM FTSE, Chair, ATSE Energy Forum
Putting nuclear in the debate – Dr Alan Finkel AM FTSE, President, Australian Academy of Technological Sciences and Engineering (ATSE)
The global challenge of sustainability – Professor Peter Guthrie, Professor of Sustainability, Cambridge University, UK

Session 2 – Why nuclear power?
Chair: Dr John Söderbaum FTSE, Deputy Chair ATSE Energy Forum
Australia and the world nuclear energy situation – Dr Ron Cameron FTSE, Head, Nuclear Development Division, OECD Nuclear Energy Agency, France
Korea's nuclear role – Mr Seong-key Cho, General Manager of Overseas Nuclear Project Development Department, KEPCO, Korea
Liberalised markets and long-term capacity – Professor Tony Owen, Professor of Energy Economics, UCL International Energy Policy Institute, Australia (Video introduced by Professor Stefaan Simons)

Panel Discussion – Session 2 speakers plus Professor Stefaan Simons, International Energy Policy Institute, UCL Australia, University College London; Mr Tony Wood, Director Energy, Grattan Institute; and Mr Ian Hore-Lacy, Senior Research Analyst, World Nuclear Association, UK

Session 3 – Environmental, social and political challenges
Chair: Ms Erica Smyth FTSE, Chair, Toro Energy Ltd, Independent Director ANSTO
Climate change - status of the science – Professor Andrew Pitman, ARC Centre of Excellence for Climate System Science, University of NSW
Social attitudes and concerns – Emeritus Professor Ian Lowe AO FTSE, Professor of Science, Technology and Society, Griffith University
Achieving community support – Mr Ben Heard, Director, ThinkClimate Consulting, Australia

Panel Discussion – Session 3 speakers plus Dr Simon Longstaff AO, Executive Director, St James Ethics Centre, Australia

Session 4 – Australian capabilities and roles
Chair: Mr Keith Orchison AM, Managing Director, Coolibah Pty Ltd
What is the Australian uranium industry capable of? – Mr Michael Angwin, CEO Australian Uranium Association
Health impacts of nuclear accidents – Dr Carl-Magnus Larsson, CEO Australian Radiation Protection and Nuclear Safety Agency
Why nuclear safeguards and security matter – Dr Robert Floyd, Director General, Australian Safeguards and Non-Proliferation Office
Achievements in nuclear-related technologies – Professor Dale Bailey, Royal North Shore Hospital and Sydney University

Panel Discussion – Session 4 speakers

Session 5 – Rapporteur Review of Day 1
Chair: Mr Peter Laver AM FTSE
Open discussion with Rapporteurs – Dr Susan Pond AM FTSE, US Studies Centre, Sydney University and Vice President, ATSE; Ms Jasmin Craufurd-Hill, Women in Nuclear; Dr John Wright FTSE, Wright Energy Consulting and Director, ATSE.

Cocktail Reception hosted by NSW Government
Welcome – Professor Mary O'Kane FTSE, NSW Chief Scientist and Engineer
Vote of Thanks – Dr David Cook FTSE, Chairman, ATSE NSW Division

CONFERENCE PROGRAM - DAY 2

Session 6 – Technological Perspectives
Chair: Professor John Boldeman FTSE, Distinguished Laboratory Fellow, ANSTO
Nuclear technology options – Dr Massimo Salvatores, Senior Scientific Advisor, CEA, France and INL, USA
Waste disposal technologies and community acceptance – Dr Timo Äikäs - Executive Vice President, Posiva Oy, Finland

Session 7 – Technological Perspectives
Chair: Professor John Boldeman
Renewable and low-emission technologies – Professor Ken Baldwin, Director, Energy Change Institute, Australian National University
Managing the addition of nuclear and renewables – Dr John Sligar FTSE, Director, Sligar and Associates

Panel Discussion – Session 6 and 7 speakers plus Professor John O'Connor FTSE, Head of School of Mathematical and Physical Sciences, Newcastle University

Session 8 – Economic Perspectives
Chair: Mr Paul Hyslop – CEO, ACIL Allen Consulting
Comparative costs and scenarios – Mr Bruce Wilson, Acting Executive Director, Bureau of Resources and energy Economics (BREE)
Potential Impact on the Australian Economy – Mr Martin Nicholson, Director MN Information Technology Group

Panel Discussion – Session 8 speakers plus Mr Barry Murphy, Past Chair and CEO, Caltex Australia; and Mr Tony Irwin, Chairman, Engineers Australia Nuclear Engineering Panel

Session 9 – Keeping Australia's options open
Chair: Mr Richard Kell AM FTSE, Secretary ATSE NSW Division
Nuclear Regulator for Australia – Dr Ian Duncan FTSE, Consultant
Meeting our human resource needs – Professor Graham Davies, Dean of Engineering, University of NSW
ANSTO's role in protecting Australia's interest and options in global nuclear science and technology – Professor Paul Greenfield AO FTSE, Chair, ANSTO
Engineering and construction opportunities – Mr Djurica Tankosic, President, Global Nuclear, WorleyParsons

Panel Discussion – Session 9 speakers plus Mr Sandy Longworth AM, The Warren Centre, Sydney University, and Dr Alex Wonhas, Director, Energy Flagship, CSIRO

Session 10 – Communiqué and Close
Communiqué Presentation – Mr Peter Laver and Rapporteurs
Thanks and Close – Professor Susan Pond AM FTSE, Vice President, ATSE

Conference Presentations

Presentations received can be found at:
http://www.atse.org.au/AustralianNuclearConference