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Implications of AUKUS for the Australian Energy Transition

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Key Points

- The AUKUS agreement is well under way for Australia to acquire nuclear-powered submarines.
- This requires Australia to demonstrate competence in nuclear safety, security and environmental protection.
- Nuclear suitably qualified and experienced personnel will form a significant part of the workforce to be established for AUKUS submarines.
- AUKUS provides a strong case for introduction of nuclear power for electric power generation in Australia.

Executive Summary

This paper addresses the relevance and implications for the Australian national energy transition leading to a greenhouse emissions-free future, of the tri-partite AUKUS agreement for Australian acquisition of a fleet of nuclear-powered submarines starting a decade hence.

The paper describes the implications of the three-phase AUKUS pillar one program to engage the Australian community in the education, training, construction, operation, sustainment and the ultimate retirement of at least eight nuclear attack submarines (generally abbreviated to SSN ship submersible nuclear) to US and UK designs. This will inevitably require a specialised workforce and infrastructure and new legislative and regulatory oversight.

At the same time the SSN program will result in a greater awareness of the benefits, costs and risks associated with nuclear energy beyond what has been previously acquired through the work of ANSTO and other agencies.

The nuclear propulsion workforce that is being developed and the common areas of interest for other energy sources, are discussed for Australia’s overall energy transition in the domains of the electrical power grid and transportation.

The paper summarises the Strengths, Weaknesses, Opportunities and Challenges for the Australian energy transition that are presented by the AUKUS SSN program.

Introduction

The tripartite AUKUS agreement comprises pillar one providing for Australia to acquire a nuclear-powered submarine capability from the UK and USA, and pillar two covering eight areas of advanced technology collaboration among the three partners. None of this relates directly to the challenge of transition to a future national energy portfolio free of carbon emissions. Nevertheless, AUKUS is relevant due to its introduction of nuclear industrial capacity to Australia in support of sustaining US and UK SSNs in Western Australia, and then acquiring and operating nuclear submarines from Australian base infrastructure. This paper discusses the implications of this significant development as it affects Australia's energy transition over the next three or more decades.

The Energy Transition Challenge for Australia

The Australian commitment to zero-greenhouse gas emissions by 2050 presents a significant challenge as has been discussed widely and most clearly by former Australian Chief Scientist, Dr Alan Finkel, in his recent book 'Powering Up'[i]

Government policy has been framed for a progressive reduction in carbon emissions, mainly carbon dioxide and methane, over the period until 2050 when zero net emissions are planned. This is mainly to be achieved with electric power generation by renewable sources, solar panels and wind-turbines, supported by electrical energy storage in battery banks and in some cases also by hydroelectric pumped storage. The difficulties envisaged with this approach are two-fold: the need for rapid response to fluctuating supply and/or demand; and the need for extensive additional distribution links to connect the large-scale generation facilities with the main areas of demand in cities and large-scale smelting and other industry.

The AUKUS Tri-Partite Agreement for Technology Collaboration

The AUKUS agreement between the United Kingdom (UK), the United States of America (USA) and Australia for collaboration on technology development and application to national security has presented a number of challenges and also opportunities that are relevant for the energy transition.

The most significant of these is the so-called pillar 1 program for Australia to acquire nuclear-powered attack submarine capability, abbreviated to SSN (ship submersible nuclear), in three phases:

1. The setting up of the Submarine Rotational Force – West (SRF-W) to be based in the Australian Defence Force (ADF) Fleet Base West (FBW) south of Fremantle, Western Australia.
2. The sale of three and possibly five United States Navy (USN) Virginia-class SSN submarines to Australia. These boats are currently in production in USA at two shipyards: General Dynamics Electric Boat (GDEB) at Groton, Connecticut, and Huntington Ingalls Industries (HII) at their shipyard at Newport News, Virginia.
3. The construction in Osborne, South Australia of the SSN AUKUS to a design based on the UK Royal Navy replacement program for their current Astute class SSN still in production at Barrow in Furness, Cumbria.

Challenges presented by the AUKUS SSN Program

There are several significant challenges presented by the AUKUS SSN program but also opportunities relevant to Australia's energy transition, including the following:

- The use of highly enriched uranium (HEU) nuclear reactor fuel by both UK and USA in their current submarine classes is proposed for SSN AUKUS. This requires the diligent compliance with all aspects of the international Nuclear Non-proliferation Treaty (NPT) of which Australia was an initial signatory.
- The extensive build up of the workforce of nuclear suitably qualified and experienced personnel (NSQEP) for both naval operations and sustainment, and civilian workforces for the design, construction, sustainment and ultimate decommissioning of the submarine reactors and disposal of radioactive materials.
- The establishment of the infrastructure for both the submarine reactors, their integration with the other submarine hull sections, the support for reactor initiation especially fail-safe cooling, the provision of safety preparations and emergency planning zones, security for materials, personnel and information and communications technology (ICT).
- The legislative and regulatory framework essential for the lawful and effective creation and execution of AUKUS within the pre-existing nuclear power bans and restrictions at both federal and state and territory levels. This will include the development and approval of Safety Cases which explore the risks inherent in the several aspects of AUKUS pillar 1 and the essential steps needed to mitigate those risks to acceptably low level.

Australian Experience with Nuclear Energy

Australia established the Australian Atomic Energy Commission (AAEC) in 1953 and participated in a number of research and development activities until its replacement in 1987 by the Australian Nuclear Science and Technology Organisation (ANSTO)[ii] which continues today at two facilities: Lucas Heights in NSW, site of the OPAL nuclear reactor which replaced the former HIFAR reactor; and Clayton in Victoria, site of the Australian Synchrotron.

In 1999 as part of a federal political deal that partly reflected the nuclear accident in Chernobyl, Ukraine in 1986[iii], the Australian Radiation Protection and Nuclear Safety Act 1998 (the ARPANS Act) and the Environment Protection and Biodiversity Conservation Act 1999 (the EPBC Act) were passed by the Federal Parliament which expressly prohibited the following activities in Australia:

(a) a nuclear fuel fabrication plant;
(b) a nuclear power plant;
(c) an enrichment plant;
(d) a reprocessing facility.[iv]

These and other similar bans and restrictions all stand in stark contrast to the extensive reserves of uranium ore in Australia and our continuing export for other countries to process into fuel for nuclear reactors.

Benefits, Costs and Risks of Nuclear Energy

There are a number of generally acknowledged benefits, costs and risks associated with nuclear energy for any purposes including submarines and including its possible contribution to the energy transition. They generally fall into several main categories:

- the nuclear fuel cycle;
- the regulatory framework for safety, security and efficiency;
- the workforce development and sustainment;
- preparation for and contingency planning for possible nuclear accidents or failures;
- the cost-of-ownership of nuclear reactors and their supporting infrastructures; and
- the longer term provisions for reprocessing of radioactive materials and disposal of residual radioactive waste.

Benefits

Nuclear energy is well understood and in widespread international use, providing Australia with immense experience to draw upon. The potential installation of small modular nuclear reactors (SMRs) on existing coal-powered electric generating stations would enable continuing use of existing switchgear and distribution networks. This is further supported by the expectation that Emergency Planning Zones for SMRs would not extend beyond the perimeters of existing coal-fired power stations.

Costs

Nuclear energy is cost-effective when considered over the full life of a typical Generation 3+ nuclear power plant with expected life-spans of some sixty years.

Risks

There is always the small possibility of a nuclear accident such as took place in Fukushima, Japan, in 2011 but the actual death toll there due to nuclear aspects was zero compared with thousands killed by the tsunami. What was demonstrated was that the design of nuclear power stations must consider worst-case scenarios over very long periods, with detailed safety cases to be developed and emergency response plans of all kinds must be prepared, approved and practiced.

Strengths, Weaknesses, Opportunities and Challenges of Nuclear

Strengths

Nuclear power is emissions free, affordable and well understood. Small modular nuclear power stations are of a similar technology and scale to the reactors in SSNs. The land areas needed for SMRs is much less than for solar or wind farms of the same capacity. Acquisition of nuclear-powered submarines will at the same time develop the workforce, infrastructure and regulatory framework that will support SMR nuclear power stations in the future.

Weaknesses

The long-term effects of radioactive waste are not yet fully understood but are assessed as low-risk compared with other threats such as global warming. The disposal of radioactive waste in deep, geologically stable underground repositories is assessed as acceptable but should continue to be monitored for the foreseeable future.

Opportunities

The current international development of small modular nuclear reactors (SMR) is timed well to be introduced by Australia in time to support the 2050 zero-emissions goal.

The confirmed introduction of nuclear-powered submarines is already providing a significant impetus to build up the knowledge and experience essential for the safe and secure adoption of nuclear propulsion and this will provide much of the necessary qualified and experienced workforce to support introduction of nuclear power for general uses.

Nuclear reactors are essentially sources of thermal energy which can also be used for such applications as hydrolysis to produce hydrogen or ammonia for vehicular fuels.

Challenges

The federal and some state and territory bans on nuclear power are preventing the sensible consideration of nuclear energy as part of the energy transition. Public fears of nuclear proliferation, nuclear accidents and the long-term effects if radioactive waste need to be addressed. Progress will only be made with bipartisan support as was already achieved for AUKUS.

Conclusions

AUKUS pillar one nuclear-powered submarines will require an expanded workforce of suitably qualified and experienced people to be built up over the next decade. This provides a strong case for introduction of nuclear power for more general applications, especially electric power generation and distribution.

About the Author

Christopher Skinner served thirty years in the Australian Navy as a weapons and electrical engineer in six surface warships. He has maintained active memberships in Engineers Australia, IET and is a life member of IEEE. He has become involved in nuclear engineering since retiring and is a member of the American Nuclear Society, the Australian Nuclear Association and the EA Nuclear Engineering Panel. He chaired the technical program committee for the 7th Submarine Science, Technology and Engineering Conference that was held in Adelaide in September 2023.

[i] FINKEL, Alan (2023). Powering Up. Black Inc., Collingwood ISBN: 9781760644598
[ii] HARDY, Clarence (2008). Enriching Experiences. Uranium Enrichment in Australia 1963-2008. Glen Haven Publishing, Peakhurst ISBN: 9781740184373
[iii] HIGGINBOTHAM, Adam. Midnight in Chernobyl. Corgi Books, London ISBN: 9780552172899
[iv] ENVIRONMENT PROTECTION AND BIODIVERSITY CONSERVATION ACT 1999 - SECT 140A. Australian Parliament