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AUKUS inflection point: Building the ecosystem for workforce development

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Executive summary

Australia stands at an inflection point, where the government's near-term success in preparing its national workforce will determine the future of its defence capability, its alliances and its national economy for decades to come.

Under the AUKUS partnership, Australia will share in some of the most advanced defence technology currently available and will become the only non-nuclear power to operate nuclear-powered, conventionally-armed submarines. However, major challenges persist to acquiring a sovereign submarine capability on the schedule laid out in the March 2023 'optimal pathway.' Mobilising a highly-skilled, specialised industrial workforce at scale to deliver this project is foremost among them.

The federal government has specified that delivering a sovereign fleet of nuclear-powered submarines will depend on the realisation of a 20,000-strong direct workforce to build and sustain the submarines, and a far larger workforce to support the associated supply chain. To meet the near-term needs of both Submarine Rotational Force-West at HMAS *Stirling* in Western Australia and initial construction at Osborne in South Australia, there is a short and shrinking window where this workforce can be identified and prepared. The Australian Submarine Agency, state governments, universities and industry have demonstrated a capacity to coordinate and move at pace. Preliminary workforce training and development initiatives, such as the announcement of a Skills Academy in South Australia, Commonwealth Supported Places at universities in STEM fields, and placements of Australian workers in AUKUS partners' shipyards, are a constructive starting point. However, the challenge is immense, and Australia's national community is, as yet, unprepared to meet it.

Australia has recently experienced its lowest rate of unemployment in 50 years. There is no major manufacturing ecosystem to draw upon, with an industry dominated by SMEs already facing demand that exceeds capacity. Australian industries are facing expansive skills shortages — none more striking than among tradespeople, technicians and labourers. Further, AUKUS is yet to secure the widespread support of the Australian national public. Without

such support, both policy continuity and recruitment efforts are imperilled.

Constructing and sustaining nuclear-powered submarines will ultimately be an Australian sovereign undertaking. The government intends to realise a national workforce; indeed, it has no alternative. Compared to Australia's AUKUS partners, who themselves face major skills shortages in their own submarine industrial bases, Australia has the unique advantage of 'starting from scratch' in some regards in creating its shipyard workforces. It can learn from the experiences that have diminished US and UK submarine programs and civil nuclear sectors, as well as best practice in recruitment and training in adjacent Australian industries.

This report proceeds in four case studies. It begins by evaluating expansion efforts in the US *Virginia*-class submarine workforce, observing that poor early-stage strategic choices and an over-reliance on young recruits had repercussions for workforce productivity. It finds that the implementation of work-integrated learning models, strategic outsourcing of labour to population centres and improvement in public regard for shipbuilding work have improved both recruitment and productivity. A case study analysis of the UK *Astute*-class program reveals the importance of effective project management and oversight to workforce planning, and the impact of local community social license, skills academies and funded apprenticeships on recruitment and retention. Subsequently, an analysis of AUKUS partners' rapid expansion of their civil nuclear workforces reinforces the criticality of policy continuity, a clear value proposition to workers and proactive communication on nuclear safety for successful workforce mobilisation. Finally, an assessment of the Australian minerals and energy sectors conveys the unique constraints of the Australian labour market and reveals the need for dedicated, strategic thinking about the contributions of women and skilled migrants to Australia's AUKUS workforce.



Source: US Navy

The report authors conducted more than 40 engagements with experts and officials across all three AUKUS governments and three Australian states. Informed by these case studies and interviews, this report concludes by proposing a series of policy recommendations to the Australian Government. It does not proclaim to solve the abiding, structural constraints of Australia's submarine workforce needs; instead, it provides a menu of first-order priorities that, if addressed, could significantly improve workforce volume, productivity and ability. As the skills mix and worker conditions are whole-of-country challenges, all recommendations proffered would benefit greatly from alignment and co-

operation between the Commonwealth, state and local governments, industry and unions. Workforce challenges are an iterative problem. The scale of requirements, attendant skills shortages and competition against the AUKUS enterprise will evolve throughout the partnership, and there is therefore no single policy solution. The findings in this report represent the starting point, rather than the conclusion, of a larger national conversation that must occur for AUKUS to deliver the opportunities promised.

Australia stands at an inflection point, where the government's near-term success in preparing its national workforce will determine the future of its defence capability, its alliances and its national economy for decades to come.

Recommendations

1. Increase public and stakeholder engagement and build the social license for the AUKUS partnership needed to attract and retain workers.

- Make and win the case for the AUKUS project at the national level through consistent and high-level public communication that conveys the central role AUKUS plays in the future of Australia's national security.
- Prioritise and publicise nuclear safety training and credentials at all phases of the AUKUS enterprise.
- Make a clear value proposition to potential workers by building an appealing benefits package and emphasise areas of competitive advantage where AUKUS work has greater appeal than employment in adjacent industries.
- Regularly convene meetings between senior officials and stakeholders to address concerns proactively and dispel misinformation.

2. Invest in and continually update a long-term national-level workforce plan to optimise future workforce productivity and account for current and projected demographic and skills problems.

- Create and continually update a comprehensive and integrated workforce plan for the AUKUS Pillar I enterprise that considers the full life cycle for AUKUS workers.
- Facilitate more robust engagement and data-sharing between unions, industry, and state and federal governments for integrated gap analysis on skills.
- Build a rigorous and efficient security clearance process for the local workforce.
- Advocate for opportunities for Australian inputs into the existing supply chains of the US and UK submarine industrial bases so workers can gain necessary experience.

3. Elevate diversity as a strategic imperative across the AUKUS enterprise.

- Set equity targets and promote underrepresented workers into leadership positions in functional and operational areas at the outset of AUKUS work.
- Build a focus on inclusive safety into infrastructure planning and safety management systems, considering psycho-social risks.
- Create a supportive culture, including of accountability and transparency, to attract and retain female workers.
- Invest in training and mentorship initiatives targeted at attracting and retaining workers from underrepresented groups in the industrial workforce.

4. Train and upskill Australian workers through dedicated and creative skills partnerships that seamlessly coordinate government and industry.

- Create scalable undergraduate and vocational apprenticeship programs, including clear funding lines and union/industry partnerships for their placement and training.
- Establish skills academies and models of work-integrated learning that replicate best practice examples from the United States and the United Kingdom.
- Convene consortiums of providers to design training programs.
- Facilitate mid-career transition through short courses, micro-credentials and dedicated training.

5. Attract high-quality migrant workers to fill skills gaps in AUKUS-adjacent industries, increasing the available pool of talent in priority areas.

- Adjust migration policy settings to reflect AUKUS industry skills gaps and encourage their employment in adjacent industries, freeing Australian citizens capable of achieving the required clearance to work in the AUKUS enterprise.
- Improve Recognition of Prior Learning processes for trades with the most significant gaps, or those trades with ample reskilling opportunities, and fund bridging courses to fill critical skills gaps.
- Increase processing speed and take a mature attitude towards risk management for continuous vetting to provide security clearance to skilled migrant workers involved in less sensitive components of the AUKUS enterprise, including supply chain and infrastructure.

6. Make versatility and adaptability intrinsic traits of the AUKUS workforce.

- Install and promote pathways to transition between different components of the project, including transitioning from infrastructure to shipbuilding during all stages of the project.
- Consider creative solutions that could increase workforce productivity, including enabling strategic outsourcing and priming sites for the adoption of advanced technologies to supplement human capital.
- Explore prospects for industrial arrangements that cross-skill workers and consider concurrent projects.
- Expand exchanges and secondments for upskilling with clear incentives to return.

Introduction



Source: Australian Department of Defence

The AUKUS partnership is the most ambitious capability program in Australian defence history. Cooperation between Australia, the United Kingdom and the United States under AUKUS is transforming the character of two of Australia's oldest bilateral partnerships.

Realising an Australian fleet of conventionally-armed nuclear-powered submarines will be a capability leap for the Australian Defence Force (ADF). If successful, AUKUS cooperation will also be transformative for Australia's defence industry, industrial workforce and the economies of South Australia and Western Australia where these submarines will be constructed and sustained.

However, obstacles to the realisation of AUKUS on schedule are daunting. The 'optimal pathway' to achieving an Australian sovereign nuclear-powered submarine capability announced in March

2023 is highly complex. It combines the forward rotation of US and UK submarines at HMAS *Stirling* in Western Australia, the purchase of up to five US *Virginia*-class nuclear-powered attack submarines (SSNs) and the building of a dual UK-Australian-designed SSN-AUKUS in Adelaide, utilising a US combat system, weapons and nuclear reactor technology. The successful implementation of this pathway over decades depends upon ironclad bipartisan political will in three countries and a tremendous effort from Australia's domestic society to prepare its workers and shipyards. It is undoubtedly high risk.¹

The Australian task

A sovereign shipbuilding enterprise for nuclear-powered submarines cannot be achieved without a large, highly skilled industrial workforce. Central to Australia's commitments under this partnership is its promise that the workforce will be capable of safely owning, operating, maintaining and regulating a submarine capability with a nuclear component at its centre.² The optimal pathway explicitly calls for a direct workforce of 20,000 over the next 30 years.³ This includes 4,000 workers to construct infrastructure at Osborne in South Australia; 5,500 workers to build submarines in the South Australian construction yard; and 3,000 workers over the next decade to upgrade infrastructure at HMAS *Stirling* in Western Australia.⁴ This is not including the workforce requirements of the likely sustainment of vessels at Henderson in Western Australia and the operation of an East Coast submarine base, which are yet to be specified.

In the coming months, the Australian Submarine Agency (ASA) will finalise preparations that in less urgent times would have otherwise taken years to complete. The Australian Government, led by ASA, must take measures to ensure the industrial workforce can achieve the requisite scale and specialisation. In the near term, an industrial workforce must be identified to meet the significant infrastructure demands needed to both accommodate nuclear-powered submarine deployments and to house the associated Australian, US and UK workforce. Secondly, workers must be trained to complete long-term preparations for the construction, maintenance and sustainment of Australian-owned SSNs and the concurrent sustainment, maintenance, and life-of-type extension (LOTE) of the existing *Collins*-class fleet.

These requirements will be distinct for the trade and technical workforces, which must be identified and trained simultaneously. Workers are also required beyond construction, maintenance and sustainment. Skills requirements extend into human resources, logistics, administration and project/risk management.

Australia sits at an inflection point where near-term choices about infrastructure and workforce will set the terms for both Australia's economy and its national security for decades to come. At this critical juncture, the Commonwealth, state governments, industry, and unions have each demonstrated their broad understanding of the scale of the challenge ahead and their willingness to 'bend' systems and processes to progress AUKUS arrangements at breakneck speed.⁵ The government's ability to marshal workers for this enterprise swiftly is a test of political will, national capability and public resolve. Its success will determine the AUKUS partners' confidence in Australia to deliver.

The state of play

Major structural impediments stand in the way of Australia's realisation of a sovereign nuclear shipbuilding workforce. Australia has a small population, with no major manufacturing industries to draw upon. Manufacturing employment has consistently declined as a share of the Australian workforce over the past three decades.⁶ Today, Australia ranks last in manufacturing self-sufficiency amongst the world's developed countries.⁷ At this time of need, Australia's available labour force is severely constrained. The national unemployment rate recently fell to the lowest point recorded in almost 50 years.⁸ Labour shortages have intensified rapidly across Australia's industries. The most persistent and acute of these shortages are among the trade workers and technicians needed for shipbuilding.⁹

A sovereign shipbuilding enterprise for nuclear-powered submarines cannot be achieved without a large, highly skilled industrial workforce.

Australia's students and workers are, at present, ill-equipped to deliver orders of magnitude to the submarine workforce. Only nine per cent of Australian final-year high school students take higher maths and the numbers continue to decline.¹⁰ This course of study is a pre-requisite for many Science Technology Engineering Mathematics (STEM) fields. In addition, Australia is struggling in terms of skills development. According to the Coursera 2023 Global Skills Report which assesses the global skills and credentials landscape in 100 countries, Australia ranks 59th in the world, just below Zambia, Oman and New Zealand.¹¹ Almost half of Australian workers under the age of 30 have a bachelor's qualification, with a far smaller proportion enticed to technical and trade apprenticeships relative to Australia's AUKUS partner countries.¹² The completion rate for apprenticeships in Australia sits at only 55 per cent.¹³ Taken in sum, these trends have produced a so-called workforce and skills crisis.¹⁴

These obstacles are compounded by a low baseline of relevant skilled workers. Australia built its last submarine more than 20 years ago, meaning few workers today have meaningful experience to bring to the AUKUS enterprise. Those still working in submarine shipbuilding are preoccupied with the existing demands of the sustainment and LOTE for Australia's fleet of conventional *Collins*-class submarines. Skills shortages also extend to infrastructure projects. As a consequence, in the absence of new training models and international placements, the ASA will face an uphill battle in locating workers with the right experience profile. Both Western Australia and South Australia are planning or have commenced significant infrastructure projects that will only exacerbate already intense competition for construction workers and engineers.¹⁵

These realities notwithstanding, there is some cause for optimism. AUKUS work will not be as remote as many adjacent industries. Both the Osborne shipyard and HMAS *Stirling* are less than an hour from the centre of their respective state capitals. The working age population of Adelaide's metropolitan area exceeds 900,000, and 12.9 per cent of this group work as technicians or trade workers.¹⁶ In Greater Perth, more than 1.3 million workers are participating in the labour force and 14.7 per cent of workers are technicians or trade workers, exceeding the national average.¹⁷ It is not entirely, then, a problem of scale, although the thirst for skilled workers across the economy and in these less populous states continues to grow especially as the AUKUS workforce has to also compete for other directly related jobs in surface ship construction in both Perth and Adelaide through the government's commitment to continuous naval shipbuilding.¹⁸ The greatest challenge will be attracting available workers to the enterprise and incentivising them to undergo specialised training.

Stakeholder engagements conducted in the preparation of this report underscored that achieving social license for the partnership and meeting workforce requirements are intertwined. In the United Kingdom, the building of the *Astute*-class of SSNs demonstrated that sustainable local-level worker recruitment is underpinned by community confidence in nuclear safety and pride in the shipbuilding enterprise.¹⁹

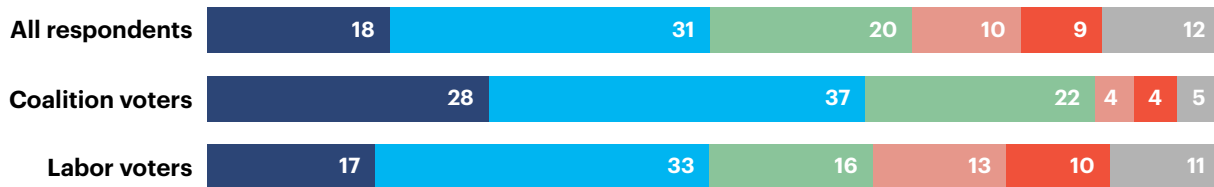
In this endeavour, Australia is currently falling short. These concerns are multifaceted. At the local level, concerns about job security based on Australia's inability to implement continuous shipbuilding, including the cancellation of the *Attack*-class submarines and questions over the future of the *Hunter*-class frigate program, has produced scepticism among many South Australian workers that the opportunities that AUKUS presents will materialise.²⁰ At the national level, polling from the United States Studies Centre indicates national-level support for AUKUS has weakened since the optimal pathway announcement, and has now fallen below a majority.²¹

Do you agree or disagree with the following statements about AUKUS?

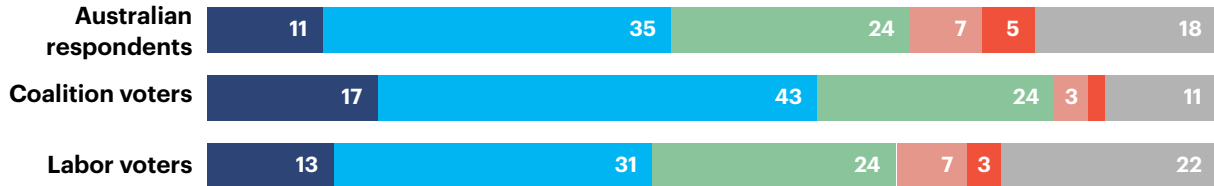
■ Strongly agree
 ■ Agree
 ■ Neither agree nor disagree
 ■ Disagree
■ Strongly disagree
 ■ Don't know

It is a good idea for Australia to have nuclear-powered submarines

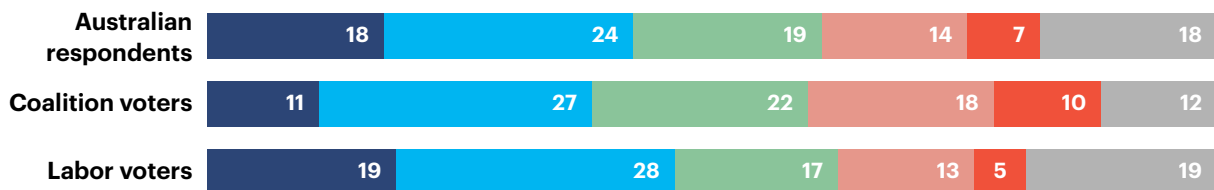
Australian respondents



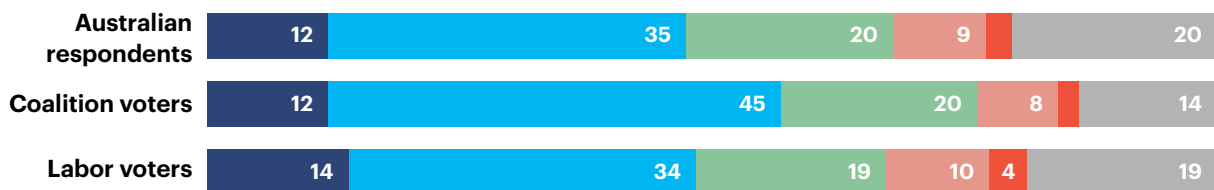
AUKUS is good for creating jobs in Australia



AUKUS submarines are not worth the cost for Australian taxpayers



AUKUS locks Australia into supporting the United States in an armed conflict



Source: United States Studies Centre

The lack of strong national-level popular support, along with local scepticism and the absence of certainty and incentives, impedes the ASA, industry, and state and federal governments from encouraging workers to pursue specialised training and to go through the arduous and lengthy security clearance processes. Minister for Defence Industry and the Pacific Pat Conroy's November 2023 address to the National Press Club is the first major speech by a senior official to make the strategic case for AUKUS in detail.²² It is a sign that the government increasingly understands that a lack of clear social license and community understanding makes the realisation of AUKUS Pillar I more challenging. Such efforts must continue if the submarine enterprise is to attract the Australian workers required.

Unlike its AUKUS partners, Australia cannot rely on a sense of 'heritage' around nuclear submarine shipbuilding to drive skills training and worker attraction. Nevertheless, this presents Australia with a unique opportunity: the ability to build an industrial workforce from the ground up, to generate a new approach to this national endeavour, circumventing the problems that have plagued the nuclear-powered submarine shipbuilding industries of the United States and the United Kingdom.

Workforce initiatives to date

Since the announcement of AUKUS in September 2021, a host of trilateral and national programs to prepare the future Australian industrial workforce have been launched with impressive expeditiousness. At the same time as the first two cohorts of Australian submariners to be educated in US programs have graduated, Australian construction workers have begun entering US shipyards.²³ Two thousand Australian workers are poised to be trained in the next five years through rotations at three US and UK submarine construction facilities.²⁴ Though such efforts are useful in building skills and experience, they do not constitute a comprehensive AUKUS Pillar I national strategy and are challenging to scale.

One of the first key initiatives by the Commonwealth and South Australian governments was the announcement of a South Australian state-level joint initiative for the construction, establishment and operation of a Skills and Training Academy.²⁵ The 2023-24 Australian Budget dedicated \$128.5 million over four years to fund an additional 4,000 university places, on top of the existing 20,000 Commonwealth Supported Places (CSPs), in areas of priority for AUKUS implementation.²⁶ The Malinauskas government in South Australia has introduced a first-of-its-type paid undergraduate program for apprentices in software engineering, modelled on UK examples, that is set to broaden to other skills areas.²⁷ Both state governments are crafting initiatives to grow relevant expertise and underwrite future recruitment targeted at every age level. This starts as early as primary school through the School Pathways Program and industry projects in schools and extends to mid-career transition options, including a Defence Force to Industry transition program.²⁸ These programs will make headway into alleviating critical skills shortages. Yet, these efforts are only a start; many Australian businesses and union leaders remain unconvinced that these initiatives are sufficient to deliver the volume of trained workers required in the near term. In their view, the cumulative nature of various existing initiatives does not provide the answer for how Australia will realise the industrial workforce for AUKUS Pillar I.

Since the announcement of AUKUS in September 2021, a host of trilateral and national programs to prepare the future Australian industrial workforce have been launched with impressive expeditiousness.



Source: Australian Department of Defence

At the outset, it must be accepted that there is no obvious workforce solution to be achieved at the trilateral level. Australia's AUKUS partners — the United States and the United Kingdom — are facing their own severe labour shortages that jeopardise the efficacy of their submarine industrial bases. Australia's AUKUS partners are not in a position to transplant their workers to assist Australia in achieving scale. However, the Australian Government stands to learn from the experiences of their submarine industrial bases in developing its approach to workforce mobilisation.

At present, Electric Boat, one of the prime manufacturers of US SSNs, has only realised 4,000 new workers out of a total of 7,000 new workers needed within the decade. Workers will also be required to fill gaps arising from worker retirement.²⁹ Due to critical workforce shortages, the United States has missed its production target of 2.3-2.5 SSNs per year — constructing only 1.2 boats per year.

Workforce shortages have exaggerated the US Navy's burden of maintenance and sustainment, limiting the number of SSNs in service. The availability of the US Navy's SSN fleet fell to 60 per cent due to maintenance challenges driven by worker shortages. As a recent US Congressional Report highlighted, "the number of boats in the SSN force is projected to experience a valley or trough from the mid-2020s through the early 2030s...[falling to] a minimum of 46 boats in FY2030, return[ing] to 50 boats in

FY2032, and then grow to more than 50 boats starting in FY2036."³⁰ This dip will occur just as the sale of the first *Virginia*-class submarine to Australia is due to occur. This poor rate of production, driven by workforce shortages in US submarine shipyards looms as one of the biggest hurdles to the sale of *Virginia*-class SSNs to Australia.

In its start-up phase, the ASA has diligently learned from the expertise of its AUKUS partners. This report aims principally to survey those experiences of those partners with relevance to Australia in detail. Accordingly, this report's assessment of workforce development challenges and opportunities in Australia considers four cases of rapid skilled industrial workforce development: the UK *Astute*-class, the US *Virginia*-class, civil nuclear energy projects in the United Kingdom and the United States, and the experience of the mining and gas sectors in Australia. It draws upon meetings with more than 40 Australian Government, industry and union personnel in Canberra, Perth and Adelaide, as well as outreach to officials and experts in the United States and the United Kingdom. The report concludes by posing a series of recommendations for the federal government, in partnership with the ecosystem of stakeholders at the national and state level.

The US *Virginia*-class submarine industrial workforce



Source: US Navy

This case study examines how the US Government has managed the competing workforce demands of its array of continuous shipbuilding programs across multiple shipyards.

The United States Navy has more than a century of experience in submarine construction.³¹ Its submarine force is composed of 67 submarines, including 53 fast attack submarines (SSGN and SSN) and 14 ballistic missile submarines (SSBN).³² In FY1998, the US Navy ordered a total of 38 *Virginia*-class submarines at a rate of one boat per year, which was then accelerated to two per year by FY2011. By 2019, production had fallen behind; today, 17 submarines are still outstanding.³³ General Dynamics Electric Boat and Huntington Ingalls Industries (HII) construct *Virginia*-class submarines for the US Navy. Electric Boat employs 14,000 workers between its shipyard in Connecticut and its automated hull-fabrication and outfitting facility in Rhode Island. HII employs 23,000 workers across its shipyards, supporting the

Virginia program as well as the *Ford*-class aircraft carriers and the refuelling and complex overhaul of *Nimitz*-class aircraft carriers.³⁴ The US Navy largely assumes responsibility for maintenance at its four public shipyards, employing 39,156 people.³⁵

Production and maintenance of the *Virginia*-class fleet have suffered concerning delays since 2019. The industrial base began to struggle to keep pace with the Navy's delivery schedule following the inclusion of the *Virginia* Payload Module.³⁶ Delays have worsened since as a result of the US Navy's prioritisation of the *Columbia*-class SSBN program, given its status as one 'leg' of the US nuclear triad.³⁷ This decision led Electric Boat to shut down its production of *Virginia*-class submarines at the peak of COVID-19.³⁸ The US Navy now aims for a '2+1 sched-

ule' for the programs, producing two *Virginias* and one *Columbia* submarine per year from the middle of this decade to the mid-2030s.³⁹ Yet, at present, Navy officials estimate that the two major contractors averaged only 1.2 *Virginia*-class boats annually from 2018-2023. This rate is not expected to lift to two boats annually until 2028.⁴⁰

Experience of workforce challenges

Labour shortages have contributed to delays in the *Virginia*-class program. The construction workforce has been experiencing a 25 per cent shortage of required workers since September 2022.⁴¹ Impediments to the recruitment and retention of skilled workers include demographic challenges, wage cost blow-outs, and attrition due to both the pandemic and competition across submarine programs and between sectors.⁴² These trends compound and accentuate underlying problems in the program related to poor strategic investment choices, a limited supply chain and low productivity.

An imbalanced reliance on new recruits has resulted in workforce inefficiency in the *Virginia* program. Contemporary demographic challenges in the US submarine industrial base date back to the reduction of its workforce by approximately 70 per cent in the aftermath of the Cold War.⁴³ Since then, its industrial workforce has aged considerably. There is no cohort with sufficient experience poised to easily replace senior workers as they retire or change industries.⁴⁴ Consequently, tens of thousands of new recruits were introduced to US shipyards from 2013-2018 and offered costly incentives to alleviate worker shortages. This approach meant that, by 2018, 56 per cent of the production workforce had less than five years of experience.⁴⁵ A June 2023 US Government Accountability Report confirmed major work efficiency setbacks and salary cost blowouts with the *Virginia* program.⁴⁶ This experience highlights the need for greater investments in training and upskilling across the submarine workforce to mitigate the risks associated with inexperienced recruits.⁴⁷ As the ASA endeavours to construct a workforce from the ground up, it is likely to face similar challenges.

Shortages in critical skills, sharpened by fierce competition for workers across industries and subdued recruitment, continue to frustrate *Virginia*-class production. The *Virginia*-class workforce has suffered from intense competition for both white-collar and trades talent between public and private shipyards, as well as from other sectors.⁴⁸ Public perceptions that shipbuilding is an undesirable career have obstructed recruitment efforts. As a result, the available shipbuilding workforce has been overwhelmed and is currently unable to meet the simultaneous demands of upscaling the *Virginia*-class program, *Columbia*-class construction and the overhaul of *Los Angeles*-class submarines.⁴⁹ These challenges were accentuated by the COVID-19 pandemic, where many shipbuilding workers left the workforce and did not return.⁵⁰ The pandemic had a bruising effect across the supply chain, with contractors falling behind due to resulting worker shortages.

Attempted solutions

The US Navy has partnered with industry to develop and implement workforce solutions for the *Virginia*-class program and the broader submarine industrial base. Of note is the Navy's Talent Pipeline Program,⁵¹ funded through the Pentagon's Program Executive Office Submarines and designed to improve workforce retention and training outcomes.⁵² This work-integrated learning program cultivates relationships with small and medium-sized defence enterprises. These companies are paired with Career and Technical Education (CTE) suppliers who in turn train workers. Training involves a one-year CTE training program. According to the US Navy, this unusual customer-supplier-product dynamic results in a more productive business model, with improved retention outcomes and better-trained employees.⁵³ Introduced in 2021, the Talent Pipeline Program aims to improve collaboration between government, small-to-medium industrial suppliers, the Department of Defense (DoD), not-for-profits, technical training and other education providers, as well as students across the submarine industrial base to incubate a talent pipeline.⁵⁴ While it is likely too early to assess the impact the program has had on the strength of the *Virginia*-class workforce

specifically, the model holds promise for bolstering the broader submarine industrial workforce in the medium to long term.

There are two notable examples of shorter, accelerated training programs, which have been held up by Navy officials as successful models: the South-eastern New England Defence Industry Alliance's (SNEDIA) training partnership with Electric Boat, and the Accelerated Training in Defence Manufacturing program in Danville, Virginia.⁵⁵

SNEDIA has partnered with Electric Boat and other submarine industrial base stakeholders on a 'Next Gen Submarine Shipbuilding Supply Chain Partnership.' The partnership delivers accelerated training programs in collaboration with the Department of Defense Industrial Base Analysis and Sustainment office and their National Imperative for Industrial Skills Initiative (NIISI).⁵⁶ More than 1,400 shipyard and manufacturing workers have been trained through the program in the past few years.⁵⁷ The program was awarded US\$6.8 million by the NIISI in August 2020 and has created 93 courses in maritime trades including electrical, pipefitting, ship fitting, machining, sheet metal, and welding.⁵⁸

The Accelerated Training in Defence Manufacturing program in Danville, Virginia is a four-month training program, involving over 600 hours of lessons, that produces a variety of skilled trades workers. The program is supported by a public-private consortium that includes the Department of Defense, the Institute for Advanced Learning and Research, Danville Community College, Phillips Corporation and the SPECTRUM Group. The program required an initial US\$7 million investment from the NIISI and will enable 800-1,000 graduates to become qualified at pace in a variety of skilled trades each year by 2025.⁵⁹ The graduates will fill existing vacancies in the defence industrial workforce.⁶⁰

Simultaneously, the US Navy has sought to shift public perceptions of careers in shipbuilding by promoting work in the submarine industrial base as a life-long career rather than a job. Admiral Galinis best summarised this initiative by stating that compensation packages must be overhauled, and workers presented with the opportunity to "build a career — build a skill — and advance

throughout that career."⁶¹ In FY2023, the Navy allocated money to the creation of a pay scale structure for trades with increased remuneration, as well as pay increases for the white-collar shipyard workforce.⁶² In recent years, the US Navy has improved facilities at shipyards to make them more attractive and inclusive, including by increasing childcare and parking availability and improving housing for workers.⁶³

Virginia-class prime contractors have increased the productivity of available workers through strategic outsourcing. Both Electric Boat and HII suffer from workforce shortages despite millions of dollars of government investment and efforts to spur manufacturing training opportunities.⁶⁴ As of 2023, Electric Boat outsources more than one million hours of work per year and HII's subsidiary Newport News Shipbuilding outsources 900,000 hours to Northeastern states, where there are greater numbers of skilled workers available. Projections indicate strategic outsourcing will grow to a combined 5,000,000 hours of work by 2025, or half of the hours required to build one submarine.⁶⁵ To that end, the use of additional manufacturing capacity to produce component parts of submarines is an effective method of supplementing the local workforce. Additional solutions to workforce challenges proposed by senior US Navy officials include accepting greater numbers of skilled migrants and replacing human capital with advanced manufacturing such as 3D printing where possible.⁶⁶

Lessons for AUKUS Pillar I

The ASA should be cautioned against repeating the mistakes that have slowed production in the US *Virginia*-class program. This case highlights that attempts to rush program decision-making have long-term detrimental effects on workforce planning. Poor strategic choices in the early phases of the *Virginia* program around capability production and supply chains ultimately increased workforce requirements and slowed productivity. Significant maintenance backlogs on new boats and near new boats have preoccupied workers, limiting those available for new construction.

A second lesson from the *Virginia*-class program is that high levels of maintenance proficiency are critical for operational capability. At a 2023 US Senate hearing, Acting Under Secretary of Defense for Policy Dr Mara Karlin emphasised the interdependency between maintenance and sustainment workforce size and the availability of submarines at sea.⁶⁷ For the AUKUS enterprise, the ASA must consider the differentiated needs of both the construction and maintenance as it develops workforce plans and project requirements. Projected future sustainment work must be carefully reconciled with the size and skill set of the industrial build workforce, a lesson well understood by the Royal Australian Navy in its experience operating *Collins*-class submarines.

The US case is also evidence that training a largely inexperienced workforce from a very limited base has implications for workforce efficiency. Experience profile is just as important to workforce capability as scale. New hires integrated from outside industries require extensive training to be sufficiently capable of staffing a nuclear-powered shipbuilding project. Introducing programs for training at pace requires initial trade-offs in efficiency and investments but has proven essential for ongoing productivity and workforce safety. While delivering dedicated training to new recruits is one part of the puzzle, identifying workers with transferrable experience at the medium and higher levels will be critical for a 'fully productive' AUKUS program. The ASA and its industry partners must consider how skilled labourers from adjacent industries can be brought into the project and upskilled. Where the United States was able to enter into contracts with the private sector to entice specialists and industry leaders into the industry, Australia's political context makes this approach more challenging to implement.

COVID-19 was an unavoidable exogenous factor affecting retention in the *Virginia*-class workforce. Though a catastrophic shutdown due to another global pandemic is unlikely (although not unfeasible), AUKUS Pillar I efforts will face periodic worker attrition due to the competitiveness of other industries. In the Australian context, this trend is certain to ensue from 'boom' periods in the mining sector,

The program required an initial US\$7 million investment from the NIISI and will enable 800-1,000 graduates to become qualified at pace in a variety of skilled trades each year by 2025.

where increased demand for traditional energy sources and critical minerals will periodically intensify workforce requirements. Government and industry partners must think determinedly about incentive packages to retain workers and prepare for potential talent drain.

The solutions implemented to address *Virginia*-class workforce issues may prove useful in the Australian setting. Firstly, the work-integrated learning model exemplified by the Talent Pipeline Program offers a blueprint for Australia for building a reliable and competent workforce and connecting stakeholders across the talent pipeline in one network. This model manifestly improved the training, retention and efficiency of the *Virginia*-class workforce.⁶⁸

Such a program could be employed during the design and operation of the federal and South Australian Government's co-badged Skills and Training Academy.⁶⁹ Likewise, the Next Gen Submarine Shipbuilding Supply Chain Partnership and Accelerated Training in Defence Manufacturing program illustrates how consortiums of training providers can pool expertise and capacity to bolster the workforce at speed and scale.

Secondly, the *Virginia*-class workforce has benefitted from strategic outsourcing. Half of the hours required for the construction of a US *Virginia*-class submarine are expected to be outsourced to densely populated manufacturing regions with available industrial capacity by 2025.⁷⁰ Australia suffers from comparable challenges with workforce distribution and concentration. Failing to attract sufficient volumes of workers to the cities where construction and maintenance work on Australia's SSNs will occur, Australia's submarine programs could similarly benefit from strategic outsourcing to more populous regions. This option warrants consideration, despite potential opposition from local SMEs.

Thirdly, efforts to improve the perception and accessibility of submarine industrial base jobs have had some success.⁷¹ Australia does not share the same level of cultural reverence for military service and defence industry as the United States. Therefore, casting submarine industrial base careers in a more attractive, accessible and long-term career-friendly light will be an even greater challenge for Australia's AUKUS industrial workforce. As a starting point, the ASA should heed lessons from the US industrial base about general working conditions and employment terms for submarine workers.

Finally, proposed solutions to US workforce shortages such as advanced manufacturing — like 3D printing — have the potential to be exceptionally beneficial for AUKUS Pillar I. As the Osborne construction site is a greenfield location, Australia has an opportunity to build advanced infrastructure and manufacturing processes at an early stage, or to plan to do so iteratively in future to create manufacturing efficiencies. This has the potential, especially if the technology and cost nexus provide positive returns over the long term, to significantly reduce workforce needs and speed up production time and capacity. Starting from scratch, Australia has the opportunity to build the most advanced submarine construction facility in the world at Osborne by taking into account future technological disruption and cutting-edge manufacturing methods. For its part, the ASA should be on the front foot of considering technological solutions for their worksites and starting the process of innovation, trialling, training and adoption.

Half of the hours required for the construction of a US *Virginia*-class submarine are expected to be outsourced to densely populated manufacturing regions with available industrial capacity by 2025.

The UK experience training its *Astute*-class workforce



Source: Getty Images

This case study focuses on how the UK Government and its industry partners have grown and sustained an *Astute*-class workforce at industrial centres.

The *Astute*-class is the most advanced class of nuclear-powered attack submarines operated by the United Kingdom's Royal Navy in its long history.⁷² Five *Astute* boats are currently in operation with a further two boats under construction and slated for delivery by 2026. All British nuclear submarines are constructed in the Barrow-in-Furness shipyard in Cumbria. The shipyard at Barrow is operated by BAE Systems, which has been the prime contractor for the *Astute*-class program since it acquired the original contractor, GEC Marconi, in November 1999.⁷³ As of October 2023, BAE is also the prime contractor for the future SSN AUKUS.

The workforce at Barrow has fluctuated significantly over time. Today, the Barrow workforce numbers almost 10,000.⁷⁴ In the next five to seven years, that

workforce is poised to grow to 17,000 to support the construction of the SSN AUKUS.⁷⁵ Historically, 70 per cent of that workforce was recruited locally from the north of England.⁷⁶

The program's first issues were evident by 1998. By August 2002, the program was running three years behind schedule and hundreds of millions of pounds over budget.⁷⁷ By 2004, the delay on the first three boats was estimated at 43 months, exacerbated by an inexperienced and understaffed industrial workforce.⁷⁸ In more recent years, *Astute* has continually faced criticism from senior officials for over-inflated costs, delays and a loss of skills in the UK submarine workforce.⁷⁹ These extensive delays to *Astute*-class program delivery were primarily the result of significant workforce issues.

Government Major Projects Portfolio data from March 2023 reported a Senior Responsible Owner Delivery Confidence Assessment of ‘amber’ for the *Astute* program on a colour scale (red, amber and green), indicating that successful delivery was feasible but that major issues required addressing.⁸⁰ This includes “significant schedule risk for the remaining boats because of workload demands and the limited number of Suitably Qualified and Experienced Personnel available,” who are also working on other initiatives including the upcoming *Dreadnought* program of ballistic missile submarines.

Experience of workforce challenges

Workforce issues at Barrow throughout the 2000s emanated from the 17-year-long ‘valley of death’ that occurred between the commissioning of the *Astute*-class program and its predecessor, the *Vanguard* submarines.⁸¹ Previously, shorter intervals between submarine classes had provided overlap between design programs, providing workers with a constant tempo of new work. The long delay between the *Vanguard* and *Astute* classes led many skilled design and construction personnel to retire. The Barrow shipyard workforce fell from 13,000 workers to 3,000.⁸² Attrition was most significant among craftsmen, along with designers and engineers, who were predominantly older and reaching retirement age.⁸³ As described by a senior official, the result of Barrow’s workforce attrition was that “BAE had to learn how to design and build submarines again.”⁸⁴

Policy and leadership changes led to the concurrent attrition and removal of senior personnel at Barrow. The takeover of GEC Marconi by BAE Systems, and three ownership changes at Barrow in the five years before 2000, led to substantial loss of SQEP at Barrow.⁸⁵ The ‘small government’ philosophy of the UK Government at the time increased officials’ desire to transfer risk in defence procurement from government to industry.⁸⁶ Ministry of Defence staff at Barrow were reduced from 50 during the *Vanguard* program to a low of just four staff in the wake of the end of the Cold War and the *Options for Change* defence review in 1990.⁸⁷ This approach,

and the associated reduction in staff, limited governmental oversight workforce access and project coordination.⁸⁸ The outsourcing of design outlines for *Astute* to commercial contractors, for example, left experienced designers and shipbuilders within the Ministry of Defence underutilised.⁸⁹

Skills shortages, due to a reliance on new staff and problems with technological adoption, exaggerated workforce challenges. Nuclear-powered submarine construction and maintenance demands a large workforce with high levels of expertise. The formerly low priority placed on investing in a wide pool of young talent meant there was no ‘mid-level’ tier of workers when the attrition of senior personnel was most acute. The lack of skilled and experienced personnel led to adoption issues with CADD5-3 three-dimensional design software, that had been intended to increase workforce efficiency. Ineffective and limited training meant that the software was ultimately poorly understood by workers.⁹⁰ The imposition of an untried software on an under-trained workforce caused program delays.⁹¹

Like in the US case, skilled workers in the United Kingdom were stretched between work on other defence programs, including the Royal Fleet Auxiliary vessel *Wave Knight*, the *Albion*-class landing platform dock vessels and the work required for the transfer of the *Upholder*-class SSK submarines to Canada.⁹² For example, the late delivery of electrical components to HMS *Audacious* in 2017 and, later, faulty components, delayed sea trials while repairs were carried out, reducing the capacity of the Barrow workforce to work on the next boat in class, HMS *Anson*.⁹³

Attempted solutions

After extensive efforts by the UK Government and industry to improve recruitment at Barrow in the last decade, the workforce has recently been successfully rebuilt. Gender representation has improved onsite, as well as the attraction of recruits from areas outside of northeast England. Safety accidents have been reduced by 75 per cent.⁹⁴ Accordingly, the *Astute*-class program is an instructive example for Australia in driving broad-based recruitment and improving workforce productivity.



Source: Getty Images

The 2018 establishment of the £25 million (A\$45,243,900) Academy for Skills & Knowledge in Barrow provided the foundation for ongoing workforce resilience. The academy has provided skills training to almost 9,000 employees and 800 apprentices to date.⁹⁵ A focus on recruitment at young ages boosted retention rates, which declined precipitously at the university graduate level. Through the Academy for Skills & Knowledge, BAE planned to train 600 new apprentices in 2023.⁹⁶ The Barrow workforce now numbers over 9,000 for the first time in 30 years, and BAE expects to recruit a further 200 graduates and 1,500 apprentices over 2021-26.⁹⁷ The Barrow workforce is expected to eventually grow to 17,000 to support both the AUKUS and *Dreadnought* programs.⁹⁸ Integration of trainees into the workforce further helps to address issues with the high levels of expertise required at more senior levels by providing on-the-job experience as fast as possible.

The recruitment of young people has been crucial to growing the Barrow workforce. As emphasised by the managing director of BAE Systems Maritime Tony Johns in 2015: “Innovation is also coming from the high calibre of the young engineers we are getting. They are not as constrained by the history and approach the design with a fresh pair of eyes. They’ve learnt quickly and have added substantial value.”⁹⁹ To mitigate the challenges of relying

on early-career talent, as evinced by the US *Virginia*-class program, BAE have drawn heavily on well-documented records of problems experienced and lessons learnt, and have continually updated their training models accordingly.

Continuous training on systems has proved just as important to workforce productivity as initial training. As early as 2004, the UK National Audit Office reported that “the Department [of Defence] and BAE Systems recognised that experienced individuals were needed to provide leadership in using the computer-aided design tool on the *Astute*-class.”¹⁰⁰ External workforce expertise was sought through the secondment to Barrow of 13 US submarine designers from General Dynamics Electric Boat, and almost 100 additional designers and managers working remotely from the United States.¹⁰¹ These actions helped to transfer skills, production knowledge, design tools and lessons from the US experience of producing *Ohio* and *Virginia*-class submarines.¹⁰² An Electric Boat employee later became the *Astute* Project Director in a successful example of cross-national cooperation and exchange of workforce skills.¹⁰³

Government oversight and stakeholder communication has improved workforce planning around future workforce requirements. A Key Suppliers Forum, established in 2006, convenes quarterly to assess defence industry suppliers' output and help them plan future workforce requirements with an overview of future projects.¹⁰⁴ This process has resulted in project management restructuring, improved information sharing, and effective risk management through the co-location of Defence and BAE staff.¹⁰⁵ By 2011, 30 Ministry of Defence staff were employed on-site at Barrow, bolstering government to *Vanguard* program levels.¹⁰⁶

Policy and governance changes at Barrow in efforts to improve workforce management are ongoing. BAE underwent an organisational restructure in 2015 to improve project management processes and create an integrated master schedule to better link and monitor project stakeholders and their contributions, improving workforce planning as a result.¹⁰⁷ In September 2019, Government Major Project Portfolio data highlighted that, "through continued close engagement and collaboration with industry, further schedule improvement has been made."¹⁰⁸ In 2023, a Nuclear Skills Taskforce was unveiled to address contemporary workforce challenges and innovate skills development programs in the defence and civil nuclear workforce.¹⁰⁹

Like in the US case, investment in Barrow's physical infrastructure has also been essential to support the submarine construction workforce. While *Astute* benefited from pre-existing infrastructure in Barrow, £300 million in additional government investment was announced in 2014 to increase infrastructure development.¹¹⁰ More than two dozen projects over the following decade were intended to extend the Dock Hall, construct a Central Yard Facility and the Ramsden Dock Facility which will house a production hall as well as workshops, offices, stores, and welfare facilities to support workers.¹¹¹ In January 2023, BAE purchased retail units in Barrow to regenerate the Barrow town centre and create a multi-use facility that offers workforce training.¹¹² Such solutions show an appreciation of the need for well-funded facilities to support the existing workforce, deliver multi-faceted project requirements and attract future workers.

Lessons for AUKUS Pillar I

Project management and a short-term mindset have significant implications for workforce scale and productivity in the *Astute*-class program. The design and construction risks of the *Astute*-class submarines were underestimated by both industry and the Ministry of Defence.¹¹³ Governmental assumptions around design and build processes were misguided and the private sector was unprepared to deal with the resultant issues. The key lesson for Australia is that SQEP are needed in government and leadership, as well as within the industrial workforce itself, for successful operation. The high-level recognition of existing workforce challenges already voiced by Australian officials, the establishment of the ASA and increasingly comprehensive state-level workforce planning convey the Australian Government's appreciation of the complexities involved and the need for sustained and substantial government oversight of the workforce.

The ASA should be cautioned against the total separation of the design, build and operational planning teams that characterised the early stages of the *Astute* program. This approach resulted in poor coordination, unwieldy workforce management and a failure to pre-empt problems.¹¹⁴ The associated delays prior to and during this period were directly responsible for the workforce challenges

Government oversight and stakeholder communication has improved workforce planning around future workforce requirements.

faced by the *Astute* program. Successful implementation of AUKUS Pillar I depends on an organised and efficient project management process, not only to ensure design and construction proceed smoothly, but to guarantee that the workforce required to support those processes does not degrade. An effective workforce requires open communication channels between different components, and between the government and the private sector, to harness the specialised skills and abilities of workers.

The UK example demonstrates that training academies are effective at attracting, training and retaining skilled apprentices and integrating young trainees at an early stage through placements with project teams. The Academy for Skills & Knowledge at Barrow has underwritten both effective initial training and later-stage transitions between trade, construction and engineering positions at different phases of the submarine project. That said, the UK model of vocational skills training and apprenticeships will not be easily replicated in Australia. UK training institutions have benefited from close integration with employers, such as BAE, creating a demand-oriented model; Australia's tertiary education ecosystem faces structural hurdles to the models harnessed in the United Kingdom, such as lacklustre integration between industry, technical colleges and universities which limits the opportunities and numbers of students who transition between the vocational and tertiary education sectors.¹¹⁵

The UK experience of a 'valley of death' in construction underscores that avenues to employ and train workers in advance of the procurement of US *Virginia*-class SSNs and construction of AUKUS SSNs must be explored. Some Australian industry leaders have already voiced their concerns about a 'valley of death' arising prior to AUKUS submarine construction.¹¹⁶ Planning must consider the knock-on implications of delays given the long lead times required not only for the physical production of the components required for SSNs, but also for the development of the workforce expertise required to produce them. Prior to and concurrently with the establishment of such skills academies, the ASA must consider alternate means for workers to develop experience with the requirements of the nuclear-powered submarine enterprise. This may involve building component parts for US and UK nuclear-powered submarines that meet their robust quality standards, for example, to achieve and demonstrate SQEP personnel.

Such risks must be considered at the outset. Acquiescing to short-term cost considerations at the expense of workforce sustainment and development is counterproductive. Delays to the commencement of the *Astute* program, which led to the loss of critical skilled personnel continue to affect the final delivery of the program almost three decades later. Implementation of AUKUS Pillar I must provide clarity, certainty and continuity in funding and workforce arrangements to avoid the feast or famine cycle which fundamentally damaged the *Astute*-class rollout.

Greater efforts in workforce recruitment stand to be made at Barrow. As of 2023, just 22 per cent of BAE's global workforce are women, a gender shortfall that, if properly addressed, could contribute to significant growth in workforce size.¹¹⁷ BAE continues to face challenges encouraging workers to relocate to Barrow, due to housing, transport and lifestyle among other factors. These ongoing impediments will be similarly challenging for Australia's AUKUS enterprise.

Solutions to *Astute* challenges instituted at Barrow provide a useful roadmap for AUKUS Pillar I. The secondment of American Electric Boat employees to Barrow successfully shared skills and lessons gained from the US *Virginia* and *Ohio* programs in an example of the forms of allied cooperation that will be necessary to support the AUKUS Pillar I workforce. Importantly, this has been supplemented by the cultivation and support of local talent through the Academy for Skills & Knowledge and the integration of young workers through apprenticeship programs. Effective implementation of AUKUS Pillar I would greatly benefit from similar models of workforce cultivation and sustainment.

Meeting civil nuclear workforce demands

This case study considers how Australia’s partners have delivered workforce capacity and capability in short time frames while accounting for the unique social license, safety and skills imperatives associated with a nuclear industry.

Unlike Australia, both the United Kingdom and the United States have longstanding civil nuclear enterprises — and, accordingly, a wealth of experience training a workforce with nuclear expertise. Australia is not pursuing civil nuclear power as it implements the AUKUS partnership. Regardless, Australia will have to develop the knowledge and public understanding needed to operate a capability with nuclear reactors at its centre and dispose of the resultant nuclear waste. As the ASA attempts to mobilise a workforce with a “nuclear mindset,” the US and UK civil nuclear industries are useful models to examine.¹¹⁸

The United Kingdom was the location of the world’s first commercial-scale nuclear reactor. Today, nuclear energy provides 15 per cent of the country’s electricity.¹¹⁹ The relative contribution of nuclear to the UK energy mix has declined dramatically since the 1990s, primarily due to the ageing of reactors and cost considerations.¹²⁰ Almost half of the United Kingdom’s current civil nuclear projects are due to be decommissioned by 2024. However, the UK Government increasingly views nuclear power as strategically essential to both decarbonisation and energy security. Consequently, by the end of the current parliament, UK leaders intend to bring at least one large-scale nuclear



Source: US Department of Energy

project to the point of Final Investment Decision.¹²¹ By 2050, the government intends for nuclear to constitute 25 per cent of the national energy mix. The government's plan to install 24GW of nuclear capacity would double the greatest installed capacity ever achieved in the country.¹²²

To support these ambitions, the United Kingdom has rapidly expanded its civil nuclear workforce. As of 2023, 77,413 workers are employed in the civil nuclear sector.¹²³ This is a 20 per cent increase from 2022, driven primarily by the demands of the new Hinkley Point C nuclear project. This rapid uptick is the greatest in 20 years and has been lauded as a “nuclear revival.”¹²⁴ Nonetheless, serious questions remain about the United Kingdom's ability to continue to grow its workforce proportionately to its strategic ambitions. The plan to build another large-scale nuclear plant could support an additional 10,000 jobs during construction.¹²⁵ The latest modelling suggests a 300 per cent increase in personnel will be needed by 2050 to meet the requirements of new projects.¹²⁶

The United States is the world's largest producer of nuclear energy. Before 2015, the last nuclear plant to come online in the United States was Watts Bar 1 in 1996. The two AP1000 reactors constructed in Georgia in the past decade were the first to be built since the Three Mile Island accident in 1979: the most serious nuclear malfunction in the history of US commercial nuclear operations.¹²⁷ Like its United Kingdom counterpart, the Biden administration has elevated nuclear power as strategically essential to the national climate response.¹²⁸ The nuclear power industry directly employs 100,000 workers, including 4,200 nuclear engineers.¹²⁹ Each US nuclear power plant employs up to 700 workers with salaries that are 30 per cent higher than the local average.¹³⁰

The construction process also demands a host of workers; at the peak of construction of the Plant Vogtle Units 3 and 4 in Georgia, more than 9,000 workers were needed onsite.¹³¹ The International Atomic Energy Agency stresses that appropriate infrastructure is essential for the efficient, safe, reliable and sustainable use of nuclear power.¹³² A highly specialised, well-trained workforce is needed, then, for both the initial construction phase and the operation of nuclear power. Accordingly, US and UK experiences of workforce development on infrastructure construction, as well as on maintenance and sustainment, are distinctly relevant for the AUKUS project.

Experience of workforce challenges

Both the United Kingdom and the United States are attempting rapid workforce expansion to meet resurgent nuclear requirements. The overarching issue facing both countries' civil nuclear industries, familiar to the Australian shipbuilding community, has been a lack of policy continuity.¹³³ As the enthusiasm for nuclear power has waxed and waned, gaps have arisen in both countries' workforces around key competencies. Today, British expertise is primarily concentrated in the sustainment and decommissioning of existing plants, rather than in construction.¹³⁴ In the United States, there was a considerable period where workers with nuclear expertise were under-utilised, and skills were lost between 1986, when Watts Bar Unit 2 construction halted, and 2015, when it recommenced.

Given the long lull in large-scale nuclear construction in the United States, there was a shortage of construction professionals with the requisite understanding of a nuclear culture, quality requirements, and nuclear-related safety codes.¹³⁵ Construction-side requirements will be more manageable in Australia for the AUKUS project, where there is a strong baseline of experience in shipbuilding, but the absence of familiarity with nuclear projects will pose a challenge.

The United Kingdom's rapid uptick in workers is the greatest in 20 years and has been lauded as a 'nuclear revival.'

Both the US and UK workforces are currently at risk of talent drain; both nuclear sectors are ageing, and attrition rates are high and increasing.

Skills shortages impair recruitment efforts at civil nuclear projects in both the United States and the United Kingdom. Given the specialised nature of the work, it takes between five and 20 years for workers to develop the requisite skills to staff these projects.¹³⁶ In the US case, the greatest challenge faced at the construction stage of nuclear projects in Georgia was a persistent shortage of general craft workers, particularly those with nuclear experience. Local labour markets were insufficient to meet the demands of nuclear sites like Vogtle.¹³⁷ Both the US and UK workforces are currently at risk of talent drain; both nuclear sectors are ageing, and attrition rates are high and increasing.¹³⁸ A failure to replace those experts will result in project delays, reduced productivity, and increased operational costs.¹³⁹ Further, as components of UK reactors are manufactured overseas, there are vacuums of domestic technical knowledge and skills engineering that will lead to long-term domestic skills gaps.¹⁴⁰

Though recent initiatives have been successful, the United Kingdom is still struggling to attract workers on the timeline forecast as necessary. The remote locations of many nuclear sites are an impediment to attracting workers. The civil nuclear industry is geographically concentrated in England's north-west and a third of nuclear jobs in England are in the 25 per cent most income-deprived local areas in the country.¹⁴¹ School leavers lack familiarity with the nuclear sector, and less than half report receiving information about apprenticeships before departing school.¹⁴² Work in the industry is reportedly perceived as being undesirable, only requiring

rudimentary skills, being unsafe and insecure.¹⁴³ *NEI Magazine* finds that job satisfaction in the UK nuclear sector is only 62 per cent, and the US sector reports similar worker dissatisfaction.¹⁴⁴ For its part, the United States civil nuclear workforce has suffered from demographic trends, recruitment and retention challenges, and intense competition for skilled workers in science and engineering.¹⁴⁵ In the US case, Vogtle was the largest jobs-producing site in Georgia, and its demands strained the local labour market.

British workers will be constructing up to five or more civil nuclear plants by 2030, while still decommissioning old facilities. Accordingly, its skills academies must ensure workers are sufficiently trained across the expanse of skills demanded by these concurrent projects. This bears some resemblance to how the AUKUS enterprise must consider the transferability of skills needed to simultaneously conduct maintenance and sustainment for both *Collins* and *Virginia*-class boats while constructing the SSN-AUKUS.

Attempted solutions

The UK and US governments, through partnership with their respective local industries, have introduced an array of measures to increase the volume and skillset of their workforce. Comprehensive workforce planning and tailored initiatives have led to the recruitment of a higher volume of workers and the upskilling of the existing workforce to prepare for unprecedented or reinvigorated nuclear projects.

To build the UK nuclear workforce to its current size, the full ecosystem of educational institutions, industry groups and officials in the United Kingdom have collaborated to grow public understanding and acceptance of nuclear.¹⁴⁶ To that end, industry groups have created educational programs and undertaken public outreach. 'The Pod', an online educational program created by gas and electricity provider EDF Energy for primary and secondary school students, is one such example. Since its launch in 2008, it has engaged over 22,000 schools and 10 million pupils in educational programming on low-carbon energy, like nuclear, and encouraged them to enrol in graduate and post-graduate training.¹⁴⁷



Source: Georgia Power Company via Bechtel

To alleviate recruitment challenges in its civil nuclear sector at Vogtle, Bechtel took a multifaceted approach. Stakeholder engagement with workers unions, as well as labour market surveys, proved integral to comprehensive workforce planning. Consequently, a wage adjustment plan was developed in coordination with the unions to create sufficient incentives to attract and retain craft labour. Job fairs and blitzes were rolled out locally and in target states. Recruitment efforts also looked beyond local communities into metropolitan areas to achieve greater volume.¹⁴⁸ A plan was developed to engage a migrant workforce from Canada to fill labour shortages of electricians and pipefitters. This involved industry coordinating with the US federal government on outlining visa requirements and assisting migrants in obtaining H2B visas to support the project.¹⁴⁹ However, though similar initiatives had proven successful on other projects, in this instance this plan failed to deliver labour to site.

In recent months, the UK Government has instituted a range of measures to facilitate skills training and apprenticeships for civil nuclear workers. MPs on the Science, Innovation and Technology Committee requested that the government turn its top-line visions for nuclear projects into “specific commitments” that are time-bound and clearly allocated.¹⁵⁰ To provide certainty and the necessary demand signals to industry, Great British Nuclear was established in July 2023 to deliver the government’s nuclear program and administer the competition process for small modular reactor (SMR)

technologies. The government has pledged to publish a nuclear roadmap and consult on alternative routes to market by the end of 2023.¹⁵¹

The UK Government has also established a Nuclear Skills Taskforce to “turbo-charge skills activity in the nuclear sector.”¹⁵² The taskforce’s primary function will be developing a skills strategy for the jobs driving the nuclear sector. The Minister for Defence Procurement James Cartlidge stated that the taskforce will “support industry to build a long-term and sustainable pipeline of skills to meet our nuclear ambition.”¹⁵³ It is built on the acknowledgement that skills mapping is a key function that must precede rapid workforce development.

As discussed previously, Skills Academies provide critical input into both the nuclear-powered submarine industrial base and the civil nuclear sector. The University of Sheffield, the University of Manchester, and CATAPULT High Value Manufacturing have partnered on a specialist Nuclear Scientist and Nuclear Engineer Degree Apprenticeship that accepted its first intake in September 2023.¹⁵⁴ It is specifically designed to produce professionals with “the skills, knowledge and behavioural requirements of the role, for the current and future UK civil nuclear programmes.”¹⁵⁵ Notably, this program involves industry partners including the UK Atomic Energy Authority (UKAEA), Westinghouse, Rolls-Royce, Sellafield and Jacobs. With their support, apprentices will be employed by a company working in the nuclear supply chain throughout their training.¹⁵⁶ As most of these programs have

only arisen in the past year, their efficacy is by and large untested. To date, they have faced some criticism for constituting more of a ‘wish list’ than the much-needed comprehensive strategy for workforce capacity building.¹⁵⁷

Comprehensive training programs surrounding nuclear culture and safety and continued upskilling were also attempted in the United States. At Vogtle, a rigorous on-job training program introduced by Bechtel was the most impactful means to ensure suitably qualified craftspeople worked onsite — rather than refusing to hire labour without established nuclear expertise.¹⁵⁸ For electrical craftspeople, where unions were only able to fill half the number required, the project had to recruit other energy sector workers with no experience on a nuclear project. A comprehensive training matrix was developed for general foremen, foremen, and craftspeople to ensure a baseline competency for the whole project workforce, including in nuclear safety and quality.

The US case also underscores the need for preparations that underwrite workforce productivity and minimise errors. Bechtel developed tailored training programs for installations with historically low inspection pass rates to upskill workers and minimise the rework that arises from failed inspections. To pre-empt mistakes, training programs emphasised the importance of stopping activities when unsure despite schedule pressure.¹⁵⁹

Lessons for AUKUS Pillar I

The US and UK civil nuclear cases are a useful analogue for a rapid workforce build-up driven by clear strategic imperatives, problematised by policy inconsistency and the need for specialist knowledge. The most significant takeaways include the importance of necessary preparations and workforce studies, creativity in workforce attraction and the creation of useful pathways to compensate for shortages in nuclear expertise.

Efforts to attract workers to the UK and US civil nuclear workforces required a clear value proposition to the public. Employer branding across industries is a key influence over worker attraction. Polling data attests that, in recent years, public opposition to nuclear energy generation has declined and support has grown.¹⁶⁰ It is important to acknowledge that the United States and the United Kingdom have had decades to build support for nuclear power among their domestic constituencies. Australia, undoubtedly, is in a different position, given its lack of a civil nuclear sector and the rapid progression demanded by the AUKUS partnership. Consequently, building public understanding and support in Australia will be more challenging.

Vocalising nuclear energy’s role in the clean energy transition has been foundational to US and UK education programs and major policy initiatives. Industry groups recognise that providing students at the secondary level information and career opportunities as early as possible is highly beneficial to the attraction of workers.¹⁶¹ This has especially been the case in the nuclear-powered submarine workforce, where Rolls-Royce found that four years after graduation, 80 per cent of their degree apprentices recruited directly out of high school were retained whilst only 50 per cent of their graduate recruits were retained.¹⁶² A comprehensive attraction strategy geared towards high school students as well as graduates will be necessary for the AUKUS workforce to achieve sufficient scale.

Local recruitment efforts depend on direct, transparent communication about nuclear safety. The UK Government has progressively taken a more transparent, deliberative approach to public engagement in relation to its nuclear sector. Initiating public discussions and entering a two-way conversation throughout processes have been key elements of understanding public views and strengthening local support.¹⁶³ At Barrow-in-Furness, Cumbria County Council and BAE issue extensive public information about managing nuclear risks.¹⁶⁴ That said, a mature attitude towards nuclear risk is not on its own sufficient; public pushback to civil nuclear power at Barrow-in-Furness underscored that the perception of clear economic benefit to the wider local area is also essential.¹⁶⁵

Thoughtful planning for workforce training and the early engagement of key stakeholders is invaluable in developing a sustainable workforce model. In the United States, relationships between industry and unions proved essential to identifying craft shortages and developing responses. For government's part, establishing baseline standards for nuclear safety and quality in construction was a first-order priority. In the UK example, a cornerstone of the government's approach to filling skills gaps and sustaining a flexible, advanced workforce has been limiting gaps between projects and reconciling gaps in expertise to enable the delivery of successive civil nuclear projects, as the workforce transitions from the decommissioning of plants to the construction and operation of new projects. An immediate near-term priority for the ASA should be developing a comprehensive workforce plan. Like in the US case, Australian shipyards will have to accept workers without a wealth of technical or nuclear-specific expertise. Pathways to entry from adjacent sectors, including from infrastructure construction, must be considered. Versatility and transferability between different projects should be front of mind in the design of training academies and apprenticeships.

UK challenges with retaining workers in their nuclear sector are a cautionary tale for Australia. NEI finds that 83 per cent of nuclear sector employees were headhunted in the past year and that the industry's workers are twice as likely as colleagues in the oil and gas sectors to be approached for jobs in an outside industry.¹⁶⁶ Commentators on the UK civil nuclear workforce have stressed that low-skilled workers should be invested in and upskilled continuously, and pathways for career progression should be clearly publicised and encouraged.¹⁶⁷ In its long-term planning, Australia should also closely follow how the United Kingdom advances its workplace health and safety measures in light of its ageing population, so Australia can underwrite the longevity of its own workforce.

Thoughtful planning for workforce training and the early engagement of key stakeholders is invaluable in developing a sustainable workforce model.

Attraction and retention in Australia's energy sector



Source: Bechtel

This analysis reviews how Australia has responded to similar periods of rapid workforce demand in adjacent industries that reflect the unique constraints of the Australian population and economy.

Recruitment for Australia's AUKUS workforce is set to face fierce competition from adjacent industries over the lifetime of the project — most significantly, mining, renewable energy and liquid natural gas (LNG) industries. Equally, workforce development efforts in these sectors offer useful insight into achieving a skilled workforce at volume in an Australian context. Bechtel's experience growing a workforce for its LNG project at Curtis Island is one such example, with applicability for infrastructure construction, workforce recruitment and skill development.

The mining sector is Australia's largest industry by share of national GDP.¹⁶⁸ In 2021-22, Australian mineral and energy exports accounted for 69 per cent of total export revenue, despite only occupying

two per cent of Australia's workforce.¹⁶⁹ The total direct workforce in Australian coal mining is 49,616 people in 2023, and the resources sector writ large exceeds 274,000.¹⁷⁰ This workforce has grown in size by nearly 30 per cent, rather than contracted, since the COVID-19 pandemic began.¹⁷¹ Eighty-three committed projects are in the investment pipeline as of December 2022, and each requires agile, well-trained workers.¹⁷² Consequently, the mining workforce is projected to grow by 15,900 (or 5.9 per cent) from November 2021 to November 2026.¹⁷³

Work in the mining sector is distinctive in its skill requirements, location and lifestyle. Mining employment varies from preparation work, underground or open-cut mining, dredging, quarrying

and well-operations.¹⁷⁴ Seventy-five per cent of the total mining employment is split between Western Australia (45 per cent) and Queensland (30 per cent).¹⁷⁵ Eighty-five per cent of mining employment resides in non-metropolitan areas, and a majority is in remote areas.¹⁷⁶ Mining jobs are notoriously well-paid, with average full-time total earnings in mining surpassing \$144,000 in 2021, compared to a national standard of \$94,000.¹⁷⁷ Ninety-nine per cent of mining workers earn above-award wages. Post-school qualifications are often, though not always, required for work in the sector; a third of mining workers do not have post-school qualifications, but almost half have a Vocational Education and Training (VET) qualification.¹⁷⁸

The mining sector is expected to face dramatic labour shortages in the coming years. A shortage of 36,500 workers is forecast for 2025.¹⁷⁹ The end of the pandemic has catalysed an exodus from the mining industry, in part due to changing life priorities and a preference for remote work.¹⁸⁰ It remains a vastly male-dominated industry, though female participation is incrementally increasing.¹⁸¹ Rapid adjustments will need to be made, particularly to retain workers in this industry, as demands grow and cultural expectations around ways of work change. At the same time, the renewable energy transition will require an addition of 59,000 workers, on top of its existing 26,000, for solar, wind, and storage projects in Australia by 2030.¹⁸² The clean energy sector is far more effective at recruiting women, with 39 per cent female representation compared with mining's 21 per cent.¹⁸³

The energy sector has long faced similar periods of rapidly expanding demand for workers in remote areas. In 2009, Bechtel was engaged to simultaneously deliver three LNG plants on Curtis Island. Trade-qualified craft professionals, especially special-class welders, electricians, and instrumentation trades, were required in exceptionally high numbers across the projects. The workforce requirements for these three simultaneous Bechtel projects exceeded 14,000 workers in 2015 at the peak of execution.¹⁸⁴ Curtis Island had a local population of only 323 people; the closest population centre, Gladstone, had a population of just 60,000.¹⁸⁵ At the outset of the project, it was established that a comprehensive trade training and upskilling program would be necessary to alleviate labour shortages and satisfy community and union expectations.

Key problems from a workforce perspective

Sector-wide trends have jeopardised the energy sector's ability to recruit and retain workers in the volume necessary to staff upcoming projects. The sector is suffering from the skills shortages plaguing all Australian industries. The minerals industry is experiencing severe shortages in a range of occupations, including drillers, drivers, mining engineers, geologists and metallurgists.¹⁸⁶ Seventy-one per cent of mining leaders report that talent shortage is holding them back from delivering on production targets.¹⁸⁷ Heightened expectations for competencies in advanced mathematics and robotics make it increasingly difficult to recruit sufficiently to fill skills gaps. Consequently, there has been around a 63 per cent drop in mining engineering enrolment in Australia since 2014.¹⁸⁸

There are serious impediments to filling those gaps. The skills demand of the mining sector has grown as the industry has adapted to trends of digitisation and automation. Energy sector projects, like Bechtel's Curtis Island plants, typically do not have a sufficiently drawn-out construction phase to train new apprentices from start to finish.¹⁸⁹ Subsequently, the skills training programs introduced to train workers on schedule faced scrutiny from the government and unions due to their accelerated timeframe.¹⁹⁰ New kinds of energy projects, including in the renewables sector and for LNG plants, must build skills from a very low base, given Australia's inexperience in this area. The sheer size of such projects exacerbates recruitment challenges.

Changing expectations about ways of working, particularly among young people, have proven testing for recruitment efforts in both mining and LNG projects. Stronger environmental, social and governance (ESG) expectations among young people have hampered enthusiasm for working in an extractive industry notorious for detrimental environmental effects. LNG has also faced criticism for its environmental impact.¹⁹¹ Establishing projects in remote areas entails their own challenges. Dealing with community local employment expectations and ensuring not to inflict unintended negative consequences on the local community by poaching workers from local industries was a major challenge for Bechtel's projects at Curtis Island.¹⁹² Moreover, 54 per cent of mining projects are locat-

ed on or near Indigenous land, and high-profile disputes have negatively impacted mining's public profile.¹⁹³ These characteristics have brought into question the industry's social license.¹⁹⁴

The mining sector is also facing continuous challenges in retaining workers. A 2022 MPI survey found that 25 per cent of mining employees plan to leave their current place of work within the next five years, and a large portion planned to leave the sector altogether.¹⁹⁵ Though the fly-in-fly-out (FIFO) model revolutionised the mining workforce, turnover among non-resident workers is high.¹⁹⁶ Inflexible FIFO rosters result in extended time away from home. While resident workers would provide continuity, the cost of infrastructure reduces the viability of that model. Currently, the appeal of more prolonged work in remote mining communities is reduced by a lack of sophisticated infrastructure and low family friendliness. A failure to improve the culture and lifestyle of work in the mining sector will be an opportunity for recruitment within the AUKUS enterprise.

Women globally experience disproportionate attrition from the mining workforce — a trend attributed in part to a feeling that the work is not intellectually challenging and the perception that there are few advancement opportunities.¹⁹⁷ The same research demonstrated that mining companies have failed to promote women. A 2022 report into sexual harassment in Western Australia's mining industry among FIFO workers starkly illustrated the frequent incidents of sexual harassment and assault occurring within the industry and female workers' lack of trust in management.¹⁹⁸ The Australian Human Rights Commission's 2022 national survey found that 62 per cent of women in mining experienced workplace sexual harassment and it is among the industries where people surveyed were least likely to make a formal complaint to their superiors.¹⁹⁹ Frequent incidences of workplace bullying and racism have also been reported across Australian energy sector companies.²⁰⁰

Attempted solutions

Industry leaders have repeatedly called for Australia to lift its cap on immigrants to staff critical vacancies in the mining sector.²⁰¹ Mining companies rely on immigrant labour across the gamut of roles in the industry. In the aftermath of the pandemic, an industry association lobbied for changes to visa requirements to bring tens of thousands of foreign workers to Western Australia.²⁰² In 2021, the Australian Government added mining occupations to the Priority Migration Skilled Occupation List (PMSOL) to address the local skills shortages.²⁰³ Australia has a healthy pool of migrant engineers it could draw upon to help stymie shortages in manufacturing — with this group constituting 58 per cent of Australia's migrant workforce.²⁰⁴ However, migrant workers face numerous legal, cultural and security barriers to career entry in Australia. Such restrictions include challenges in obtaining visas and sponsorship, lack of local qualifications, and having insufficient financial resources to achieve local skills recognition.

The Australian Government has partnered with industry groups to invest in apprenticeships and education programs in the energy and mining sectors. The Minerals Council of Australia has invested over \$65 million into minerals higher education since 2000 and partnered variously with universities to design skills programs. The Mining Skills Organisation Pilot, announced in June 2020 in partnership with the MCA, was designed to accelerate 1,000 new apprenticeships and fill skills gaps in the sector.²⁰⁵ The initiative paired apprentices with mining employers upfront and facilitated accelerated training. To meet immediate needs after the pandemic, the government announced the Boosting Apprenticeship Commencements and Completing Apprenticeship Commencements program, which offered a 50 per cent wage subsidy to businesses employing apprentices in the mining supply chain and was effective at reducing shortages in the short term.²⁰⁶

Apprenticeship programs have proven effective on alternative energy projects. Bechtel's apprenticeship program at Curtis Island, developed over 12 months and operating from 2012 until 2016, trained over 400

apprentices who then staffed the three LNG projects. This was enabled by a partnership with the federal government's National Apprenticeship Program, which allowed for the recognition of prior learning of previously experienced but non-trade qualified workers. Bechtel also partnered with Registered Training Organisations, Group Training Organisations and TAFEs to develop combined programs, benefiting from these organisations' experience with funding and competency requirements. It must be acknowledged, however, the administration required for that program was extensive and time-intensive.²⁰⁷ It should also be noted that among the greatest difficulties with establishing apprenticeship programs is sustaining investment; Bechtel's program was supported by a co-investment of \$2.7 million from Construction Skills Queensland.²⁰⁸

Tailored state government policies have also been useful in ensuring state workers satisfy the skill requirements for mining sector positions. In January 2023, the Queensland Government launched a Gateway to Industry Schools program, a key industry engagement strategy wherein it facilitates school and industry partnerships to expose participating students to professional experiences aligned with workforce priorities, including in the minerals and energy sector.²⁰⁹ In Western Australia, the \$195 million Reconnect WA package, commencing in January 2023, cut TAFE fees and provided free short courses for critical mining sector roles — for example, in the drilling profession.²¹⁰

In the Curtis Island example, industry's investments were also a key enabling factor for workforce recruitment and retention. Bechtel invested directly in on-site training facilities (e.g., welding bays, WAH platforms and confined space training modules), transport and accommodation costs for apprentices who were required to travel to Brisbane to conduct their training blocks and the direct wages and on-costs of employment.

Corporations across the energy sector are reviewing their approach to encouraging female participation. Mining companies have set gender inclusivity targets and have seen a spike in the number of women studying or undertaking apprenticeships in recent years.²¹¹ Women now represent a record 22 per cent of the mining workforce in Queensland.²¹² Mentoring programs, including by QRC and Women in Mining and Resources Queensland (WIMARQ), and by Indigenous Women in Mining and Resources Australia, are gaining greater visibility and empower women currently employed in the mining sector.²¹³ In 2021, 450 women had graduated from WIMARQ's program, and a further 140 had signed up for mentoring.²¹⁴ Though these moves are positive, none are effective in the absence of protections for safety in the workplace. State and federal governments have, in recent years, taken stronger public steps to criticise and combat the industry's record for sexual harassment in the workplace.²¹⁵ Some companies have introduced 'banner systems', wherein all staff are notified promptly when incidents occur and are informed of the company's response to reinforce a culture of accountability.²¹⁶ However, systemic cultural change across the construction and operation phases of energy sector projects is still required.

Lessons for AUKUS Pillar I

The labour shortages that plague Australia's energy sector are here to stay. Competition for the few available technicians and trade workers will be an ongoing obstacle to staffing the AUKUS industrial workforce. The creation of a highly skilled and regionally concentrated Australian workforce during a skills crisis in both the contemporary Australian coal mining sector and the historic Curtis Island LNG projects is instructive for AUKUS manufacturing.

Tailored state government policies have also been useful in ensuring state workers satisfy the skill requirements for mining sector positions.

Firstly, the ASA and its industry partners should seek to replicate the components of the mining sector's value proposition that have reliably attracted workers — namely, in its high remuneration — and work to create a positive workplace culture and lifestyle.²¹⁷ Australia's mining industry is equally evidence that compensation alone is not enough to counterbalance other major challenges to worker attraction and retention. Pecuniary incentives need to be complemented by facilities and work arrangements that appeal to workers. The depths of bonds formed at work sites are consistently emphasised by energy sector companies as a key component of their advertisement to workers and will be comparable to the tight-knit communities formed around Australia's submarine bases. Where FIFO models are not seen as unattractive, the ASA must build both on-site and community facilities around its shipyards that meet worker expectations about lifestyle.

Beyond tangible incentives, energy sector projects attest to the importance of broader social license to operate to workforce productivity and recruitment efforts. Females and workers from other underrepresented groups must be promoted across all functional and operational areas within the industry. Doing so will not only improve program design but also have a strong demonstration effect for prospective

employees and make a holistic value proposition to the local community. Clear pathways to promotion and community infrastructure must be prepared and advertised from the outset of operations to prevent attrition. This includes maintaining a social license to operate, with respect to Indigenous and local communities' interests. To do so, the AUKUS enterprise must consider the dignity of female and racially diverse employees across the project, from the design of safety systems to infrastructure. Bechtel's recruitment efforts at Curtis Island also underscore that satisfying community expectations regarding local employment contributes to community-wide social license. The opportunity to combine trade training with community projects, for example, skill building through the construction of local community facilities as was conducted at Curtis Island, could satisfy multiple imperatives in this regard. AUKUS projects at Stirling and Osborne must realise a 'sweet spot' between hiring local labour and inadvertently producing overemployment that detracts from other local industries.

Comprehensive, long-term workforce planning should underpin AUKUS efforts. The Curtis Island project showcased the benefits of understanding gaps in critical skills early to the outcomes of mitigation plans. The long lead time of trade training and upskilling must be factored into such planning. A failure to take a comprehensive strategic approach to skills and training has been detrimental to the mining sector. Consultancies have consistently recommended that the mining sector shift from short-term to long-term mine planning, that pre-empt changes caused by technology transformations, new assets and large capital projects.²¹⁸ Workforce planning should also accept that, even in its highest priority industries, Australia cannot fill its workforce requirement with its national population alone; migrant workers make essential inputs into Australia's manufacturing industries upon which corporations depend. Even though the AUKUS enterprise will have uniquely restrictive security requirements, migrant workers will make critical contributions across the supply chain and in filling broader national workforce needs allowing for the AUKUS program to target workers who meet the required security clearances

The labour shortages that plague Australia's energy sector are here to stay. Competition for the few available technicians and trade workers will be an ongoing obstacle to staffing the AUKUS industrial workforce.

Challenges and opportunities for the Australian AUKUS workforce

Australian federal and state government officials and industry and union leaders agree as to the scale of the challenge and the first-order priorities. These priorities are several-fold: upgrading the infrastructure at Stirling to host US and UK rotational deployment, demonstrating that Australia is capable of ‘nuclear stewardship,’ and making immediate preparations for a major shipbuilding workforce in South Australia. The short lead times to deliver SRF-W and the construction of Osborne means that stakeholders are demanding certainty from the federal government as soon as possible as to the future of AUKUS work.

Recruitment challenges and skills shortages are not unique to the AUKUS enterprise or to Australia. Workforce problems are adaptive challenges, with no single technical or policy fix; they are beyond the government’s capacity to address alone. Ongoing dialogue across sectors and between countries, that extend beyond a narrow focus on shipbuilding construction, is a pathway to creative solutions. The following recommendations, implemented by the federal government in partnership with other stakeholders, provide a starting point to pre-empt some challenges faced by our AUKUS partners and prepare Australia to realise the needed sovereign industrial workforce:

1. Increase public and stakeholder engagement and build the social license for the AUKUS partnership needed to attract and retain workers.

Australian workers retain concerns about components of AUKUS cooperation. Foremost among these concerns are fears of another cancelled contract and apprehensions about nuclear components of the venture that contravene long-established principles of Australian unions. A deeply engrained scepticism endures among Australian workers that the promises of AUKUS may not be realised, especially in South Australia. Such concerns will not forestall union and industry participation in the AUKUS enterprise, but they will subdue recruitment. Concerns must be addressed at both the local and national levels simultaneously. Sustained engagement must be led from the top and continue throughout the partnership as workforce plans are developed and implemented.

- ***Make and win the case for the AUKUS project at the national level through consistent and high-level public communication that conveys the central role AUKUS plays in the future of Australia’s national security.***

There is a need for a national conversation on the purpose of AUKUS. The work of the ASA to date has necessarily focused on outreach to local communities and among members of parliament. However, local social license depends on a rigorous assertion of AUKUS’s importance for Australia’s national security to the broader public. The government’s focus to date on the economic benefits of the partnership has not proven sufficient to persuade the national public, and it does not insulate AUKUS from criticism or undoing as economic pressures change and will not be equally felt across states. A comprehensive cultural shift around the AUKUS enterprise is only possible if a compelling, frank justification for the AUKUS project — beyond its workforce and industry benefits — is made. This must be made on a clear-eyed assessment of Australia’s strategic circumstances and the criticality of this major defence capability to Australia’s security circumstances and national strategy. Minister Conroy’s Press Club address from November 2023 is a useful starting point for making a concerted statement of the national security rationale. This emphasis should appear in all public communications about AUKUS and rise to the level of the prime minister. This message will require continued reinforcement, so the Commonwealth and their state-level counterparts should prepare for frequent, if not regularised, future senior communications to sustain public understanding.

- ***Prioritise and publicise nuclear safety training and credentials at all phases of the AUKUS enterprise.***

Building public literacy in nuclear issues has been foundational to continued local community support for the *Astute*-class program at Barrow-in-Furness. As a country with no nuclear industry, establishing nuclear safety standards will be front of mind for the Australian government, industry and workers in the AUKUS enterprise. Nuclear skills and safety should be emphasised as part of social license efforts. Conveying a strong commitment to nuclear safety will assist in recruitment efforts among workers unions and local communities historically hostile to nuclear power in all its forms. It is worth noting that the United Kingdom's experience with its civil and military nuclear programs has underscored that it is far easier to convince the public of the importance of nuclear if there is a real economic benefit to the local community.²¹⁹

- ***Make a clear value proposition to potential workers by building an appealing benefits package and emphasise areas of competitive advantage where AUKUS work has greater appeal than employment adjacent industries.***

Competition for workers from adjacent industries in Australia is fierce and poised to intensify. A significant volume of major projects in both Western Australia and South Australia will mature on the same timeline as AUKUS, including the Hydrogen Hub in South Australia.²²⁰ From initial worker attraction to training to long-term retention, government and industry organisations must think strategically about their value proposition to Australian workers and the incentives they provide throughout the employment lifecycle to shift hardened perceptions of employment in the shipbuilding industry as being transient and insecure. Despite the efforts of senior officials to date, state bodies report that the economic opportunities for their communities are still poorly understood and require clarification.

Like in adjacent industries, taking an 'attract the worker, retain the family' mindset is necessary to prevent attrition in the AUKUS workforce, where families will reside in communities around shipbuilding facilities. In the establishment of such communities, ensuring social infrastructure is in place, including affordable housing, schooling and transportation, will prevent worker attrition. Renumeration will also have to be cost-competitive to prevent poaching. Equally, clear promotion pathways and upward mobility in the shipbuilding industry must be evident from the outset to attract and retain highly skilled workers. Strategic marketing of these jobs should prioritise but not be limited to local communities, as recruitment efforts would benefit from a larger talent pool. Indeed, AUKUS work may require, in some instances, outsourcing components to metropolitan areas elsewhere to achieve scale in the future.²²¹

As a country with no nuclear industry, establishing nuclear safety standards will be front of mind for the Australian government, industry and workers in the AUKUS enterprise.

- ***Regularly convene meetings between senior officials and stakeholders to address concerns proactively and dispel misinformation.***

Since the optimal pathway announcement, cabinet-level and ASA officials have created dialogue opportunities with union and industry leaders. Such engagements have proven effective at increasing public confidence in the initiative, even if officials' ability to provide details on workforce requirements and planning has been heavily constrained. However, this degree of high-level engagement has not been replicated across the enterprise. For example, stakeholders exhibited no awareness of any outreach undertaken to date by the South Australian Office for AUKUS, established in June 2023.

Consistent, high-level engagement will drive recruitment and limit misinformation. For instance, workers in the United States and the United Kingdom remain concerned about the poaching of their workers by Australia. There is no awareness of non-poaching arrangements, to the extent that they exist.²²² A public document cementing rules about non-poaching and company behaviour should be released to reassure unions and workers from the three countries about the future of their national industries. Australian workers also remain sceptical that a sovereign shipbuilding enterprise will materialise, noting the likelihood for Australia to purchase submarines outright from AUKUS partners. Discussions by Deputy Prime Minister Richard Marles and Minister for Defence Industry Pat Conroy with union officials in the lead-up to the Labor National Conference in 2023 were very positive, but they should be seen as a starting point for engagement rather than an endpoint. Australian senior officials should further communicate frankly about AUKUS partners' capacity constraints and constantly emphasise the bipartisan national strategic commitment to a sovereign shipbuilding capability.

2. Invest in and continually update a long-term national-level workforce plan to optimise future workforce productivity and account for current and projected demographic and skills problems.

If forward-thinking workforce plans are not released soon or not continually updated, the risk emerges that an enthusiastic university and training sector will train graduates in the wrong volume or skills profile, with no priority career paths for them to enter. Accordingly, leaning on AUKUS partner countries' industries to gain fidelity on requirements for every activity involved in the near term must be a first-order priority — a reality that the ASA is alert to.

Hurry up and wait — a common phrase in military parlance — is the order of the day for state and local governments and industry. At this inflection point, patience is required as the ASA liaises with the United States and the United Kingdom to get fidelity on infrastructure and workforce requirements. Foundation planning for infrastructure based on broad-based needs assessments must be undertaken. Only once trilateral demand requirements are set can arrangements proceed at pace.

Case study analysis in this report highlights that long-term detailed planning is the only way to ensure future work can proceed at pace. Workforce quality and experience need to be considered as well as skills alone. That experience is especially valuable in work related to nuclear, which is highly technical and has no margin for error. Emphasising experience is, of course, a delicate balancing act, as time is the major 'enemy' of AUKUS Pillar I's success.

- **Create and update a comprehensive and integrated, data-driven workforce plan for the AUKUS enterprise that considers the full life cycle of potential AUKUS workers.**

As the United Kingdom's experiences with its *Astute* program and civil nuclear sector have borne out, comprehensive planning and effective project management in the start-up phase are foundational to long-term workforce sustainment in the submarine enterprise. State governments, industry and unions independently undertake rigorous data collection on their relevant workforces. For integrated industrial development, data-sharing between state and federal governments on graduates, migration, and between the interagency, needs to be eased (in a way that respects data security and privacy concerns). There is a role for Jobs and Skills Australia in acting as the centralised point of direction on requirements and signalling to the federal government. The function of Osborne's Naval Shipbuilding College, which anticipated shipbuilding work demands and maintains a register of skilled personnel until its closure in 2023, should be assessed in the process of determining a suitable alternative model.²²³

Under the logic that the AUKUS enterprise will give Australians 'careers', rather than jobs, thought must be given to the pathway for workers from recruitment to retirement. This should be with a view of both making an appealing proposition to workers, and for optimising SQEP contribution to different components of AUKUS work as their relative demands increase.

- **Facilitate more robust engagement between unions, industry, and state and federal governments for integrated gap analysis on skills.**

A robust definition phase, informed by closer cooperation between stakeholders, founded in collective understanding and political will, can provide greater fidelity on skills gaps and potential solutions. The Curtis Island case study demonstrated the significant insight unions can bring to bear in identifying skills shortages and recruitment and training barriers. Unions from Australia, the United Kingdom and the United States have demonstrated their willingness to be involved in generating solutions to the challenges faced by the AUKUS partnership. Indeed, the union movements emphasise their position as generating the first formalised trilateral agreement of the AUKUS partnership.²²⁴ Under a Labor government, there is an opportunity to embed unions into the partnership as arrangements firm.

- **Build a rigorous but efficient security clearance process for the local workforce.**

Many commentators have observed that Australia's security clearance system is not currently fit for purpose with the Defence Strategic Review (DSR), calling for an acceleration of the transfer of Defence's Positive Vetting (PV) authorities to the Top Secret Privileged Access (TSPA) Authority.²²⁵ The growth in demand for security clearances at all levels has resulted in dramatic backlogs. AUKUS will only intensify this demand, given the high level of clearance required to work on or around a capability with a nuclear component. The awarding of clearances to Australian nationals through the Australian Government Security Vetting Agency must be accelerated. This prerogative must be balanced with the safety of Defence and the broader AUKUS and national security enterprise. Ensuring this process is match fit, risk-balanced and strategic is a precondition for AUKUS workforce recruitment at scale.

- ***Advocate for opportunities for Australian inputs into the existing supply chains of the US and UK submarine industrial bases so workers can gain the necessary experience.***

Australian shipbuilders and other technicians need to gain skills through experience in advance of the transfer of the first *Virginia*-class submarine. This fact has been accepted by both unions and senior leadership.²²⁶ Fortunately, stakeholder engagements have underscored US and UK willingness to accept Australian inputs into existing supply chains as a means of relieving capacity constraints. Such opportunities should be explored as soon as possible, to provide certainty to workers, facilitate skills development and prepare experienced Australian personnel capable of supporting workforce training in the future.

3. Elevate diversity as a strategic imperative across the AUKUS enterprise.

Ensuring that the AUKUS workforce is diverse is integral not only for social license reasons, but also for capability and achieving scale. A workforce that is heavily skewed towards one demographic artificially constrains its potential labour supply. For instance, Australia's National Skills Commission has found that, for more than half of the occupations in shortage, women make up less than 20 per cent of their total workforce.²²⁷ Many of these occupations input into infrastructure and submarine construction and maintenance, including metal fitters and machinists (one per cent female workforce); electricians (two per cent female workforce) and construction managers (14 per cent female workforce).²²⁸ To achieve scale, barriers must be removed to the participation of female and culturally and linguistically diverse workers, to the extent possible.

- ***Set equity targets and promote underrepresented workers into leadership positions in functional and operational areas at the outset of AUKUS work.***

Diversity and inclusion targets should be set at the outset of AUKUS work, including in senior positions. Explicit gender equity targets have proved demonstrably effective in other Australian industries; best practice is setting a target of 40 per cent women across work areas.²²⁹ UK industry leaders find that the presence of senior female workers in their shipyards is one of the greatest drivers of female recruitment at every level across the enterprise. Ensuring women and other underrepresented groups make visible, important contributions to the enterprise and that they are not concentrated in functional areas helps make a value proposition to prospective workers and to the local communities. Workforce gender balance, available promotion pathways and prospects for mentorship should be emphasised in community outreach.

- ***Build into infrastructure planning and safety management systems a focus on inclusive safety, considering psycho-social risks.***

Gender equity is rarely considered in the design processes of industries and workplaces. Women and other underrepresented groups should be involved from the outset of planning processes for the design of infrastructure and safety processes. Prioritising inclusive safety in infrastructure will include ensuring facilities are fit for purpose for workers and design out potential harm; for example, ensuring shipyards are well-lit to limit the potential for safety incidents on-site. From the outset, the AUKUS enterprise should install mature safety systems at each of its sites that consider the psycho-social risk of workplace harassment and assault. Discrimination and harassment should be treated as systemic challenges rather than isolated workplace grievances.

- ***Create a supportive culture, including of accountability and transparency, to attract and retain female workers.***

Construction, shipbuilding and maintenance must contend with public perceptions that the work is isolated, dirty and physically strenuous in a way that precludes the participation of women and other underrepresented groups. Crafting an industry narrative, reinforced by workplace culture, that emphasises the potential for women to make a valuable contribution is critical. Creating a culture that respects the varied needs of workers involves accommodating caregiving arrangements and otherwise providing flexibility as much as possible. Councils should be established with diverse membership at shipbuilding and maintenance sites. Identity-based incidents should be escalated to the purview of the leadership team, rather than isolated to human resources. In the interests of transparency, major incidents and the organisational response could be communicated to all staff.²³⁰

- ***Invest in training and mentorship initiatives targeted at attracting and retaining workers from underrepresented groups in the industrial workforce.***

Recruitment efforts for AUKUS should be harmonised with the ecosystem of existing initiatives for Women in STEM at the high school and university levels. Mentoring and peer support programs, as implemented in the Australian mining sector, should be encouraged and funded. These initiatives should be supported while remaining cognisant of the risk of ‘othering’ female employees and encouraging additional professional development in gender-balanced environments. The ASA should engage with Australian trade unions to learn from existing best practice examples in trades. Part of this work should leverage existing STEM initiatives to encourage further interests from underrepresented groups.

4. Train and upskill Australian workers through dedicated and creative skills partnerships that seamlessly coordinate government and industry.

Existing proposals and fledgling initiatives in South Australia and Western Australia will make headway into filling skills gaps. As established, skills shortages in critical areas may impede AUKUS work long into the future. Though there are large communities in metropolitan Perth and Adelaide that may join a future AUKUS workforce, their involvement will be conditional on rapid, effective training programs.

- ***Create scalable undergraduate and vocational apprenticeship programs, including clear funding lines and union/industry partnerships on their placement and training.***

In all cases considered in this study, the funding of apprenticeships made an exponential difference in the volume of skilled workers on a given project. The ASA must develop a clear division of responsibilities between the federal government, state governments and industry for the funding and placing of apprentices as a first-order priority. Partnerships between government and relevant industry groups and state-level bodies, informed by the model used by Bechtel at Curtis Island could be developed to best design and implement those apprentices around the most critical skills shortages.

- ***Establish skills academies and models of work-integrated learning that replicate best practice examples from the United States and the United Kingdom.***

British skills academies have proven effective at providing a stable stream of workers and offering them experience from the outset onsite. Such academies require both significant investment and thoughtful strategies for the smooth integration of trainees with the active workforce. Australia’s structural and cultural issues with the integration of vocational and university education programs require reassessment and adaptation if this model is to be adopted.

US models of work-integrated learning and the development of talent pipelines hold promise for increasing retention and continuously lifting work standards in the AUKUS enterprise. State governments should work with industry to develop collaborative training models for prospective and existing workers which prioritise learning on site and treat employers as customers, training providers as suppliers, and the trained worker as the product. Committing to collaborate with industry from start to finish in worker training could equip workers to best meet skills requirements.

- ***Convene consortiums of providers to better design training programs.***

In the United States, consortiums of training providers have collaborated on the development of rapid training programs. The groups are typically cross-sectoral, melding government, industry, and education sector (universities and colleges) expertise and capital to rapidly train a wide variety of skilled workers. Provided policy and regulatory infrastructure is developed to enable collaboration between these groups in Australia, this model could prove an effective means to scale the submarine workforce at pace by sharing the burden of program design, funding, and execution. Typically, Australian education and training has remained siloed. Subsequently, overcoming cross-sector reticence may require policy, regulation and structural reform to encourage collaboration.²³¹

- ***Facilitate mid-career transition through short courses, micro-credentials and dedicated training.***

The *Astute*-class and *Virginia*-class programs provide a cautionary tale for over-relying on an ageing workforce supplemented by a large cohort of young talent. A gap in mid-level workers is a major disadvantage in any industry. Accordingly, enabling career transition and upskilling retired military personnel or workers with related experience. Accelerated training, short courses and micro-credentials in nuclear safety could assist in increasing the available pool of talent at multiple levels.

5. Attract high-quality migrant workers to fill skills gaps in AUKUS-adjacent industries, increasing the available pool of talent in priority areas.

The US law, the *International Traffic in Arms Regulation* (ITAR), imposes restrictions on not only the birth country but also the citizenship and ties of personnel working on any project involving ITAR-controlled technology.²³² If the Australian Government accepts US security requirements, migrant workers' involvement in all phases of the AUKUS project will be scrutinised and limited. In Australia, migrant workers are a significant national resource. At present, 27 per cent of Australian university graduates come from overseas, compared with five per cent in the United States. Their contribution to Australian industries over the lifetime of AUKUS should be considered during ASA workforce planning. The most significant contribution of migrant workers to the success of AUKUS will be filling labour shortages in adjacent industries. Further, where security requirements allow, their involvement in the direct AUKUS workforce could lend further expertise and scale to the enterprise in key areas of infrastructure and supply chain.

- ***Adjust migration policy settings to reflect AUKUS industry skills gaps and encourage their employment in adjacent industries, freeing Australian citizens capable of achieving the required clearance to work in the AUKUS enterprise.***

Industry bodies have been candid that migrants with specialist expertise will likely be required to achieve scale in the AUKUS workforce.²³³ The COVID-19 pandemic has underscored the essential contribution migrant workers make across Australian industries. Certainly, the national, and in some cases tripartite, security clearances required for AUKUS projects will make recruiting migrant workers to the direct workforce more challenging.

The federal government has already sought to alleviate recruitment challenges in STEM fields through dedicated migration policies, such as the introduction of a new temporary work visa under the Migration and Mobility Partnership Arrangement with India. Such efforts should continue and similar arrangements could be introduced with other partners that are already major sources of foreign-born engineers in Australia.²³⁴ This should include modifying university international student post-degree citizenship pathways in critical skills areas. National and information security and worker safety should be front of mind in setting migration policies.

- ***Improve Recognition of Prior Learning processes for trades with the most significant gaps, or those trades with ample reskilling opportunities, and fund bridging courses to fill critical skills gaps.***

Delays and obstructions to employment arising through failures to recognise credentials earned abroad need to be shortened and removed, to the extent possible. Pathways to official recognition of previous credentials, especially from countries from which Australia attracts particularly large volumes of engineers and tradespeople, should be designed. This could improve employment outcomes through a formalised credit transfer process and would also shorten the financial and time burden required by any additional on-the-ground learning. Bridging courses could be provided and subsidised to ease migrant workers' transition to the Australian workforce and increase confidence in their capability.

A component of this will be incentivising and co-developing International Accreditation Pathways for international tertiary education students to facilitate their employment. Assessments of migrant workers should not be limited to their degree of local experience. Increasing the recognition of accreditations received and experience gained overseas will ease the migration and employment of sufficiently skilled migrant workers.

- ***Increase processing speed and take a mature attitude towards risk management for continuous vetting to provide security clearance to skilled migrant workers involved in less sensitive components of the AUKUS enterprise, including supply chain and infrastructure.***

To incorporate greater numbers of migrant workers into adjacent industries, Australia's clearance process requires reform. A new approach towards risk will be necessary for the AUKUS enterprise. While sustaining its robust standards for security clearance, accelerating the issuing of clearance to the maximum extent possible and facilitating the movement of security clearances across borders in AUKUS countries should be considered for eligible migrant workers. Certainly, these considerations will also have to be balanced with US and UK clearance requirements and set out through ongoing consultation with AUKUS partners.

6. Make versatility and adaptability intrinsic traits of the AUKUS workforce.

- ***Install and promote pathways at the outset for workers to transition between different components of the project, including transitioning from infrastructure to shipbuilding.***

The infrastructure workforce must be considered as separate to but inputting into the requirements of subsequent shipbuilding. Job training efforts that feed the infrastructure phase of the project should enable a smooth transition into the building and sustaining of SSNs. This not only provides greater job security to workers but is a means to continuously benefit from preliminary investments in infrastructure workers' baseline nuclear safety and familiarity with the sites.

- **Consider creative solutions that could increase workforce productivity, including enabling strategic outsourcing and priming sites for the adoption of advanced technologies to supplement human capital.**

Planners should consider the localisation and specialisation of workers. Concentrating specific tasks and skills in certain areas where available talent might be highest could increase productivity and limit competition between various sites. This could potentially include outsourcing some component parts of construction to metropolitan areas, to take advantage of a larger pool of workers.

Digitisation and automation should be front of mind for industry, to both supplement human capital shortages and modernise the manufacturing process. Expanded adoption of digital is rightly identified among the key forces shaping the Australian workforce in the coming decades by the Treasurer's White Paper.²³⁵ In building greenfield shipyards Australia has an opportunity to incorporate, or at least plan for the incorporation, of advanced digital technologies such as 3D printing. If integrated effectively, advanced technologies will not only supplement human capital, thereby easing workforce pressures, but also likely increase worker productivity.²³⁶ Accordingly, workers on submarine bases must be continuously upskilled in light of new technologies. Pilot programs should be designed to ensure new training programs meet the needs of workers and that workers can collaborate seamlessly with advanced technologies. Cutting edge manufacturing methods being innovated today will take many years to be trialled, qualified and adopted at shipyards. The work must start today if technological solutions are to meaningfully contribute to answering workforce challenges.

- **Explore prospects for industrial arrangements that cross-skill workers and consider concurrent projects.**

Skills academies should ensure that transferability between different components of the AUKUS enterprise is a key consideration in program design to ensure Australia does not lose capacity between different phases of the project. Arrangements for cross-skilling should be explored, in coordination with relevant unions.

- **Expand exchanges and secondments for upskilling with clear incentives to return.**

Mobility is both an attractive component of work in the AUKUS enterprise and a key means of training Australian workers. With the requisite trilateral coordination, stints for Australian workers in US and UK shipyards need to be enabled on a larger scale and for longer durations to fill key shortages in the United Kingdom and the United States, incentivise the transferring of technologies and best train Australian workers across the different phases of the partnership. Clear incentives to return should be offered, including time-limited work visas and promotion pathways, to ensure that expertise returns readily to Australia.

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