Osborne Submarine Construction Yard (SCY) EIS

CCRE2: Greenhouse Gas Emissions

Prepared for:

Australian Naval Infrastructure (ANI) & URPS

November 2024

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Version Control:

Rev.	Date	Description	Doc No./Name	Originator	Reviewed / Approved
A	9 June 2024	DRAFT		CC	
B	15 July 2024	ISSUE		CC	URPS
C	26 Aug 2024	UPDATED		CC	URPS / ANI
D	4 Sep 2024	CONFIDENTIAL FINAL DRAFT		CC	
E	9 Sep 2024	CONFIDENTIAL FINAL DRAFT		CC	
F	11 Nov 2024	FINAL ISSUE		CC	ANI

Distribution List:

URPS
Australian Naval Infrastructure (ANI)

Executive Summary

This report presents information to support the Environmental Impact Statement (EIS) for planning approval of the proposed nuclear powered submarine construction yard (SCY) project at Osborne, Adelaide:

1. It identifies and provides a preliminary inventory and estimate of Greenhouse Gas (GHG) emissions that could be generated by the SCY during its:
    a. Construction phase (for construction of SCY infrastructure at Osborne), and
    b. Operational phase (for construction of submarines at the SCY).
2. It describes how the project could contribute towards South Australia's emissions targets:
    a. 100% renewable energy (in Grid electricity generated) target by 2030,
    b. 50% emissions reduction below 2005 level by 2030, and
    c. Zero net emissions by 2050.
3. It identifies measures that could be undertaken by the SCY to minimise, reduce, and/or ameliorate its future GHG emissions.

Figure E-1 overleaf gives an overview of:

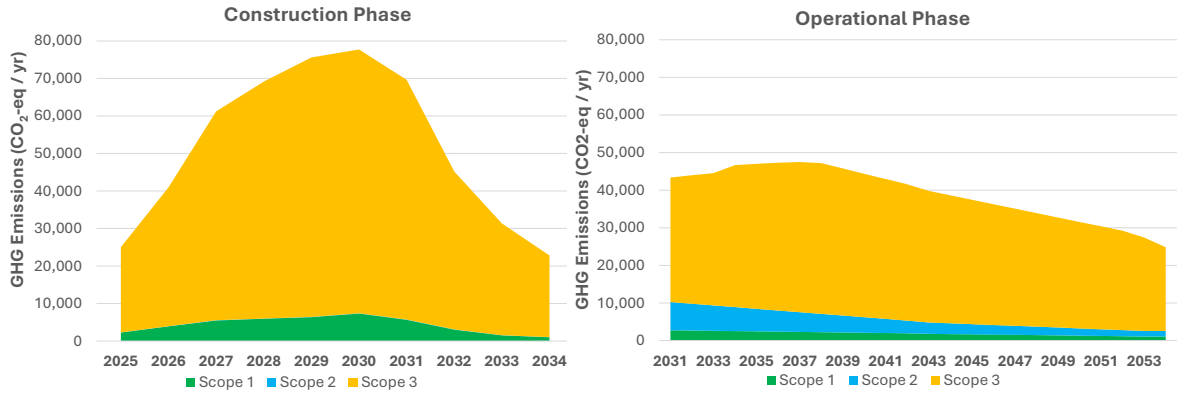
- The Greenhouse Gas (GHG) emissions projections in this report for each phase of the SCY project.
- Key measures or opportunities identified that could be considered by the SCY project to minimise, reduce and/or ameliorate its future GHG emissions and contribute towards South Australia's emissions targets (which align to emission reduction aims and targets in Defence's recently released Net Zero Strategy (Department of Defence, 28 August 2024) too).

Goal

Contribute to South Australia's emissions targets & actions:

- 100% renewable energy (in Grid electricity generated) target by 2030
- 50% emissions reduction below 2005 level by 2030
- Zero net emissions by 2050
- Transition to a low emission Circular Economy to mitigate future climate change impacts
- Support other South Australian and Australian Government Climate Actions
- Design a climate resilient project

Projected performance



Key measures / opportunities *

COMMON TO BOTH CONSTRUCTION & OPERATIONAL PHASES

- *Implement a Green Circular procurement strategy*
- *Buy energy efficienct and low emission plant, equipment, lighting, and vehicles.*
- *Consider diesel substitution with renewable biodiesel*
- *Buy 'greener' / renewable electricity and gas*
- *Encourage digital-first work practices and meeting strategy*
- *NABERS rated (energy, water & waste) Project offices / buildings*
- *Encourage & support public transport options for project workers*
- *Support/ adopt low emission hybrid or EV fleet or project vehicles*
- *Book domestic or international flights that use Sustainable Aviation Fuel (SAF)*
- *Procure carbon offsets towards achieving net zero*

OTHER SPECIFIC CONSTRUCTION INITIATIVES

- *Consider adopting a project sustainability rating, e.g., Green Star*
- *Set up a low emission and Circular Economy design and procurement review committee*
- *Electrify construction plant and equipment where feasible*
- *Work with supply chain partners and local industry to develop and use Green low emission cement, concrete, steel, and other building materials and construction services*
- *Reuse on site or recycle demolition and construction waste and /or source recycled construction materials*

OTHER SPECIFIC OPERATIONAL INITIATIVES

- *On-site renewable energy Solar PV / Battery systems*
- *Minimise waste generation, maximise landfill diversion and reuse and recycling of waste resources*
- *Procure 'green' welding gases or consumables*
- *Replace LPG fuelled forklifts with electric or H2-fueled alternatives*
- *Procure (or mandate supply chain procurement of) low emission submarine construction materials*
- *Use Low Global Warming Potential (GWP) refrigerants*
- *Develop 'cool' microclimate landscaping/infrastructure greening, shading, and cooling, to reduce site cooling demands*

**Note: Not necessarily an exhaustive list, refer to report body for complete list*

Figure E-1 – Results of Greenhouse Gas emissions assessment for SCY project and overview of key measures that could be undertaken to minimise, reduce and/or ameliorate its future GHG emissions.

Contents

1 Introduction

1.1 Context

Australian Naval Infrastructure (ANI) is planning a nuclear-powered submarine construction yard (or SCY) at Osborne, Adelaide, for the Australian Government's SSN-AUKUS submarine construction program.

The Minister for Planning has declared the SCY at Osborne as an impact assessed development under section 108 (1)(c) of the *Planning, Development, and Infrastructure Act 2016* (PDI Act), which requires the preparation of an Environmental Impact Statement (EIS).

To support the EIS, information has been sought on potential Scope 1, 2 and 3 Greenhouse Gas (GHG) emissions that could generated during the project, and opportunities for how these GHG emissions could be managed and/or reduced.

This report provides this information based on the project data available at current time.

1.2 Scope of assessment

Table 1-1 overleaf gives the information requested to support the project EIS. In summary, it seeks:

- An assessment of potential GHG emissions during construction and operational phases of the SCY.
- Information on what the project can or should do to reduce expected GHG emissions to help meet South Australia's future emissions targets, i.e.,
    - 100% renewable energy (in Grid electricity generated[1]) by 2030,
    - 50% emissions reduction below 2005 level by 2030, and
    - Zero net emissions by 2050.

1.3 Presentation

This report is presented as follows.

Section 2 – Project information	Summarises available project information to support this advice.
Section 3 – GHG emissions assessment	Identifies likely and/or potential sources of GHG emissions from the project and estimates of their annual GHG emissions over the project life cycle.
Section 4 – GHG emissions reduction strategy	What the project will or can do or is recommended to reduce these projected GHG emissions.

[1] This target appears to be for renewable energy generated in the Grid electricity supply, see: New target for renewables | Premier of South Australia. The target is attributed to generation, not total supplied (including interstate imports), because it is this specific value regularly reported by the South Australian Government when speaking about this target.

Table 1-1 – Scope of Assessment requested to support the EIS

CCRE2	**Greenhouse Gas emissions**	**Ensure the development minimises greenhouse gas emissions associated with its construction and operation to meet South Australia's goal to reduce greenhouse gas emissions by more than 50% below 2005 levels by 2030 and achieve net zero emissions by 2050.**	Undertake a greenhouse gas assessment that:
			a. Identifies sources GHG emissions generated
			b. Estimates annual GHG emissions from each source
			c. Estimates of net GHG emissions and emissions intensity, including an uncertainty assessment
			d. Provides an inventory of projected annual Scope 1
			Describe how the project will contribute to South Australia's emissions targets, i.e., 100% renewable energy (in Grid electricity generated) target by 2030[1], 50% emissions reduction below 2005 level by 2030 and zero net emissions by 2050.
			Describe measures in the design to minimise, reduce and ameliorate greenhouse gas emissions, including alternative or renewable energy sources and off-sets, energy efficiency and energy conservation measures, and if it incorporates integrated passive design principles and climate-responsive techniques and features and identify barriers to implementation.

2 Available project information

2.1 Project status

Design development for the SCY at its preferred Osborne site has commenced but is still at initial stages.

- At present there does not appear to be bills of quantities for expected materials or energy usage during project construction and operating phases and/or activities.
- This information is normally needed to assess future GHG emissions, by using emission factors that translate these material and energy quantities into Scope 1, 2 & 3 emissions – i.e., see Figure 2-1 below.

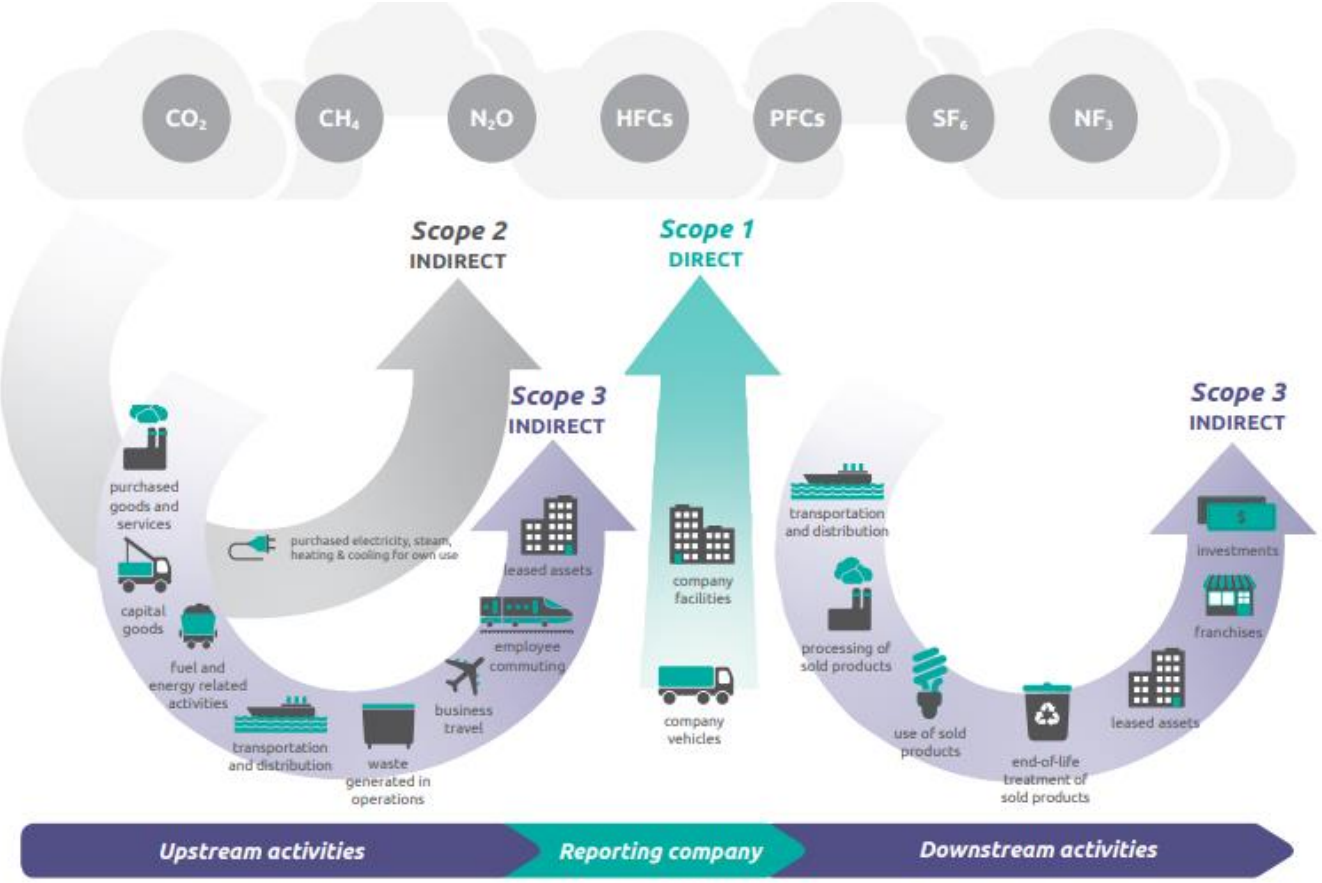


Figure 2-1 – Visualization of different gas emissions that can cause GHG effects, and differences between Scope 1, 2 & 3 emissions and examples of the activities that can generate them. *Image Source: GHG Protocol*

2.2 Project overview

Based on currently available information, the following gives an overview of the SCY project at Osborne.

- The project would cover a substantial site area on the Northeastern corner of the Lefevre Peninsula.
- There would be multiple buildings or structures across this site, not including other proposed road and transport infrastructure.
- At high level, these buildings and structures would be expected to include (but may not be limited to):
    - Single or multi-level office buildings,
    - On-site accommodation facilities (including leisure and catering),
    - Manufacturing buildings,
    - Storage Warehouses,
    - Docks,
    - Covered submarine assembly area including launch area,
    - Car Park areas – External open and/or multi-level covered structures (for personnel parking and fleet vehicles),
    - Utility Buildings – For plant including back-up generators, communication, and data systems.
    - Ancillary facilities (e.g., health)
    - Fuel storage tanks,
    - External yards for storage (including materials and waste),
    - Specialised buildings, yards and storage areas for nuclear related materials and activities,
    - Security fencing and gates,
    - Landscaped and recreational areas for personnel, and
    - Roads and transport infrastructure (including for public transport access).
- There would be tens of thousands of square metres of built area constructed and then operated and maintained after.
- Some of these structures would or could have specialised design needs to meet Defence and submarine construction requirements, which could require substantially more materials (e.g., concrete for shipbuilding structures, reinforcing and structural steel, aggregate for construction fill, electrical cabling, communication systems) than standard (office or industrial) developments.

2.3 Relevant public data

The following publicly available data on the project was identified when preparing this report and provides additional useful information on planned SCY expenditure and timelines. *Note: These publicly reported project details could change in the future as the SCY project and Australian Government SSN-AUKUS submarine construction program develop and evolve. However, they provide a reasonable starting point for this report and its GHG emissions assessment.*

- Up to $2 billion could be invested in South Australian infrastructure for the SCY project[2].
- At its peak, up to 4,000 workers could be employed to design and build the infrastructure for the SCY at Osborne[2].
- A further 4,000-5,500 direct jobs could be expected to be created when the submarine construction program reaches its peak in 20-30 years' time[3].
- The Australian Government intends to start building its first SSN-AUKUS (submarine) at the SCY site by the end of this decade or 2030[4].
- The first SSN-AUKUS submarine built in Australia could be delivered in the early 2040s[5].
- Australia could build up to five SSN-AUKUS submarines at the SCY.
- The SSN-AUKUS class submarines could have a displacement of more than 10,000 tonnes[6].

[2] See: Work to commence on the Submarine Construction Yard, Osborne, South Australia | | Australian Submarine Agency (asa.gov.au)

[3] See: Construction in South Australia | Australian Submarine Agency (asa.gov.au)

[4] See: Osborne Submarine Construction Yard | Australian Submarine Agency (asa.gov.au)

[5] See: Nuclear-powered Submarine Program – Defence SA

[6] See: Submarine agency chief: Australia's SSNs will be bigger, better, faster | The Strategist (aspistrategist.org.au)

3 GHG emissions assessment

3.1 Purpose

This section addresses the requirement to undertake a greenhouse gas (GHG) assessment that:

a. Identifies sources GHG emissions generated.
b. Estimates annual GHG emissions from each source.
c. Estimates of net GHG emissions and emissions intensity, including an uncertainty assessment.
d. Provides an inventory of projected annual Scope 1 GHG emissions.

3.2 Assessment scope (including source identification)

3.2.1 Project phases

The GHG assessment has been prepared for the following project phases and assumed time periods for each (phase).

Construction Phase	*A period between 2025 and 2034 (i.e., 10-year time frame), when it is assumed all construction of the SCY (i.e., buildings, structures, and other facilities) at the proposed Osborne site would be undertaken and completed.*
Operational Phase	*A period starting in 2031 (assuming some on-site operational activities commence before construction phase is complete) and continuing through to 2054 (i.e., 23-year time frame) during which the SCY would build five submarines with the first taking until 2040, and the other four commencing in 2040 and completed by 2054.*

3.2.2 Assessment boundaries

The boundaries (i.e., division between Scope 1 and Scope 3, and between project phases) for the GHG assessment are:

- ***Physical boundary*** – The Osborne SCY site,
- ***Construction phase period*** – Activities at this site (included in the EIS scope) for construction of buildings, structures, and other infrastructure and/or facilities (during this period), and
- ***Operational phase period*** – Activities at this site for submarine construction (which may commence before construction phase is fully completed).

3.2.3 Emissions scope & sources

The scope of GHG emission assessment (for each phase) includes all three scopes: Scope 1, Scope 2 and 3 (as illustrated in Figure 2-1). Table 3-1 overleaf identifies likely main sources of these emissions for the SCY during its construction and operational phases. *[Note: This inventory should be considered a starting point, may not be exhaustive, and should be reviewed and expanded as necessary when more project knowledge comes to hand later.]* In summary:

- ***Scope 1 – Direct GHG emissions***:
    - Would be GHG emissions directly generated on-site from use (for energy) of gaseous and liquid fuels (e.g., heating, mechanical plant, other equipment, etc.) and welding gasses (e.g., acetylene) as well as refrigerant leakages (from HVAC and/or other refrigeration plant).
    - These GHG emissions would happen during both construction and operational phases.

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Table 3-1 – Likely main sources of GHG emissions identified for construction and operational phases of the SCY. *Note: This list may not be exhaustive and should be expanded when more project information becomes available.*

Emissions scope	Potential major sources	Construction phase	Operational phase
Scope 1 (i.e., on-site emissions resulting from)	– Gaseous fuels (e.g., LPG, natural gas)	●	●
	– Liquid fuels (e.g., petrol, diesel)	●	●
	– Welding gasses (e.g., acetylene)	●	●
	– Refrigerant leakages (e.g., HVAC)	●	●
Scope 2 (i.e., imported emissions resulting from)	– Grid electricity	●	●
Scope 3 (i.e., external site embodied emissions caused by)	– Demolition and resource recovery or disposal of waste material	●	
	– Infrastructure construction materials (e.g., concrete, steel, aluminium, aggregate, timber, glass, bitumen, building fit-out, etc.)	●	
	– Submarine construction materials & equipment (e.g., steel, batteries, plastics, communications / guidance / navigation systems, weapon systems, etc.)		●
	– Energy supply - Upstream emissions (e.g., electricity transmission & generation)	●	●
	– Embodied emissions - Other Scope 1 Consumables (e.g., welding gasses, refrigerants)	●	●
	– Water - Supplied & used	●	●
	– Wastewater - Treatment & disposal	●	●
	– Waste management - Collection and resource recovery or landfill disposal	●	●
	– Site maintenance activities		●
	– Other supply chain embodied emissions – For other material & resource use (e.g., paper, food, printer cartridges, other submarine manufacturing and testing equipment or activities, etc.)	●	●
	– Project travel (e.g., vehicular, air)	●	●
	– Workforce (e.g., private and/or public transport to and from work, external site offices, etc.)	●	●

- ***Scope 2 – Indirect GHG emissions***
  - Would be GHG emissions resulting from generation of Grid electricity imported and used at the SCY.
  - Again, these Scope 2 emissions would happen during both construction and operational phases.
- ***Scope 3 – Embodied GHG emissions***
  - Would be the GHG emissions happening outside the Osborne SCY site, in the supply chain, from use of material, energy and resources to support SCY construction and operational phases.
  - In both construction and operational phases, it would include (upstream) emissions from supply of energy (i.e., gaseous, and liquid fuels, electricity) that cause Scope 1 and 2 emissions above.
  - For construction phase, it would include resource recovery and disposal of site demolition materials, supply of raw construction materials (including fit outs) for buildings, structures, and other facilities, plus any plant and equipment supplied and installed for submarine building (during the operational phase).
  - For operational phase, it would include supply of materials and equipment needed to build the submarines which may include raw materials and prefabricated components and equipment from local, other Australian, and global suppliers.
  - For both phases, it would include (among other things) embodied emissions from water supply, wastewater treatment, waste management, project travel, and workforce (private) travel (to and from work).

3.3 Assessment approach & assumptions

Appendix 1 includes more detail on the approach and assumptions made in preparing these GHG emissions estimates for the SCY project. In summary:

- ***Material and energy inventories*** – Were hypothecated across construction and operational phases of the project using the list of likely emission sources in Table 3-1 and based on project information available (as outlined in Section 2) and Colby Phillips Advisory's knowledge of and experience with construction and manufacturing projects and publicly available information on submarine and general shipbuilding construction activities.
- ***Scope 1, 2 and 3 emission factors*** – Were obtained from accepted sources[7], and through standard assessment practices[7], were used to convert these Inventories into estimated GHG emissions.
- ***Uncertainty in estimates*** – Was assessed considering:
  - Likely uncertainty in hypothecated material and energy inventories and/or emission factors,
  - Potential changes to emission factors for materials and energy supplied to the project over its life cycle based on current decarbonisation commitments and possible decarbonisation trajectories over the next 40 years in the economies of South Australia, Australia, and other global trading partners (e.g., US, UK, Japan) that may supply submarine construction materials and components to the SCY.

[7] These standard sources and/or assessment practices include Australian Government NGERS' and National Greenhouse Account (NGA) emission factors for Scope 1 and 2 GHG emissions reporting, and established life cycle databases and inventories for Scope 3 emission factors, e.g., AusLCI, Climate Active, and/or Green Building Council of Australia Life Cycle calculator tool.

- *See Section 4.2 later for more information and examples of South Australia's expected future decarbonisation trajectory during discussion of its current GHG emission reduction targets.*

- Potential uncertainty in the SCY build or submarine construction programs.

At present time with project information available, these estimates provided in this assessment should be considered indicative only, e.g., ± 30-40%.

{Next section commences overleaf}

3.4 Assessment results (including Scope 1 inventory and estimate uncertainty)

3.4.1 Construction phase

3.4.1.1 Project phase (total estimate)

Table 3-2 below gives the estimate of GHG emissions for the construction phase of the SCY (including the inventory of Scope 1 emissions).

- This initial estimate at nearly 560,000 tonnes CO_2-eq assumes 2024 emission factors (i.e., does not yet consider future decarbonisation) and does not allow for potential variability (or uncertainty).
    - GHG emissions for the construction phase of the project would be dominated (>90%) by Scope 3 emissions from embodied emissions in building materials.
    - Major contributors (e.g., >50%) to these building material Scope 3 emissions would be concrete and steel.
    - Other construction materials and components, including for building fitouts and submarine construction plant and equipment, that may involve high embodied energy to manufacture and supply, could contribute significantly too.
- Once uncertainty modelling and potential future decarbonisation was overlaid onto this estimate, a potential range for this initial estimate of total construction phase GHG emissions was 460,000 to 630,000 tonnes CO_2-eq (i.e., ±20%) (see Table 3-2).

Table 3-2 – Summary of Construction phase GHG emissions estimate (over entire construction period) based on 2024 emissions factors. *Note: Indicative only, e.g., ±20-30%. * This is the average from statistical modelling.*

Scope	Resource		Quantity		Estimated emissions (2024 emission factors^)	
			Value	*Units*	*t CO_2-eq*	*%*
1	Liquid fuels		590,000	GJ	42,000	***7.8%***
	Gaseous fuels		19,400	GJ	1,100	
	Other (e.g., welding gasses, refrigerant leaks)				100	
	Sub-total		***609,400***	***GJ***	***43,200***	
2	***Grid Electricity***		***3,200***	***MWh***	***790***	***0.14%***
3	Energy supply: Upstream production & distribution		621,000	GJ	10,900	***92.1%***
	Building materials (BM): Raw &/or prefabricated		710,000	tonnes	306,000	
	Building / area fitouts: Embodied emissions		39.2%	BM emissions	120,000	
	Plant & equipment: Embodied emissions		14.4%	BM emissions	44,000	
	Other (Selected)	*Water Usage*	*510,000*	*kL*	*320*	
		Workforce (e.g., travel, office, etc.)			*14,000*	
		Waste disposal & resource recovery	*74,100*	*tonnes*	*-6,900*	
		Other (consumables, water resource usage &/or other construction activity(ies)			*25,000*	
		Sub-total			32,420	
	Sub-total				***513,320***	
TOTAL: 2024 emission factors					**557,310**	**100%**
Potential range / uncertainty (from statistical modelling) with adjustment for future economy decarbonisation*			*Low (p5%)*		*420,000*	-19%
			Average		***520,000***	**-**
			High (p95%)		*630,000*	+21%

^ Based on 2024 Scope 1, 2 & 3 emission factors, does not consider future decarbonisation during 10-year construction program

* Considers low, mid, and high-level decarbonisation scenarios for future Scope 1, 2 & 3 emission factors.

3.4.1.2 Annual projections

Figure 3-1 below gives potential annual projections for GHG emissions over the expected 10-year construction phase of the SCY including future uncertainty levels (for these annual projections).

- Construction phases GHG emissions could peak between 2028 and 2030 when main civil works for most major buildings and/or other infrastructure (i.e., foundations, structures, facades, services) could be completed.
- The potential uncertainty in future annual GHG emission suggested by Figure 3-1 reflect project uncertainty in:
    - The construction program (or timing for when work might happen and be completed), and
    - Future decarbonisation trajectory for energy used and materials and equipment supplied to the project during this construction period.

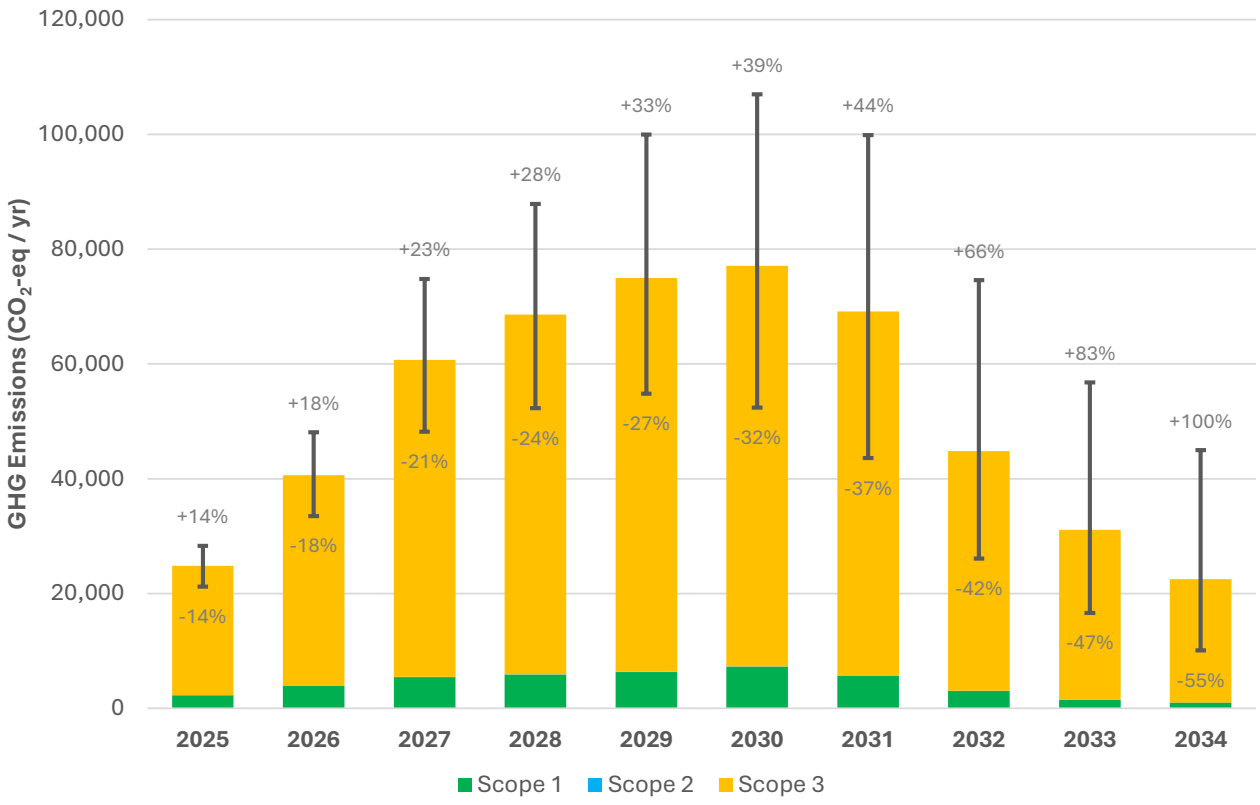

Figure 3-1 – Possible profile of GHG emissions each year during construction phase period including error bars suggesting potential range of uncertainty in annual values

3.4.2 Operational Phase

3.4.2.1 Project phase (annualised average & total estimate)

Table 3-3 overleaf summarises estimated GHG emissions for the operational phase of the SCY (including inventory of Scope 1 emissions).

- The estimate of around 60 ,000 to 70,000 tonnes CO2-eq is an 'average' annualised value, which amortises estimated GHG emissions from construction of five (5) SSN-AUKUS submarines built over 24 years, assuming 2024 emission factors apply.
- Contributors to GHG emissions for the operational phase would be:
    - Scope 1 emissions from on-site diesel and petrol usage, e.g., fleet vehicles, forklifts, plant and equipment, and testing and operation of diesel backup gensets, and gas, e.g., hot water space heating, manufacturing activities, etc (4%).
    - Scope 2 emissions from Grid electricity usage (22%), and
    - Scope 3 emissions from:
        - Submarine construction materials and components (24%),
        - Workforce (17%), e.g., project-related flights and travel, private and public travel to and from work, etc.,
        - Other potential resource usage for operations at the site (17%), e.g., office paper, cardboard from deliveries, plastics in PPE, etc.), and
        - Supply of consumables including refrigerant and welding gasses (5%).
- Table 3-3 includes an estimated total for GHG emissions over a 24-year operational phase period (2031 to 2054) once uncertainty and decarbonisation were considered.
    - Operational phase GHG emissions could total up to 900,000 tonnes CO_2-eq over this period.
    - Uncertainty in this estimate is high (+30% and -45%) as there is large potential variability in future emission factors (especially out to 2050), which depend on how South Australia, Australia and other global economies progress towards their future decarbonisation goals.

3.4.2.2 Annual projections

Figure 3-2 two pages over gives an estimated profile for annual GHG emissions each year during the operational phase of the SCY.

- During the period up to 2040, only a single submarine may be built (as knowledge, capability and experience is built) with submarine construction activity and associated emissions assumed to gradually ramp up over this period.
- Subsequent submarines are expected to be built more quickly with their construction programs likely to overlap, and hence associated emissions would rise.
- Gradual decarbonisation of the economy, however, could instead see annual GHG emissions decline, happening steadily between 2030 and 2040, then perhaps more quickly towards 2050 (when South Australia, Australia and many project global supply chain partners could be aiming to achieve Nett Zero emissions in their economies).

Table 3-3 – Summary of annualised average operating phase GHG emissions estimate based on 2024 emissions factors plus projected 21-year operational phase totals. *Note: Indicative only, e.g., ±20-30%.*

Scope	Resource		Quantity		Estimated annualised (average) emissions (2024 emission factors)	
			Value	Units	t CO_2-eq / yr.	%
1	Liquid fuels		24,000	GJ	1,650	***4.8%***
	Gaseous fuels		24,000	GJ	1,250	
	Welding gasses		240	GJ	16	
	Refrigerant leakage(s)		170	kg	240	
	Sub-total		***48,000***	***GJ***	***3,200***	
2	***Grid Electricity***		***60,000***	***MWh***	***15,000***	***22.3%***
3	Energy supply - Upstream production & distribution		264,000	GJ	5,500	***72.9%***
	Other Scope 1 consumables				3,510	
	SSN-AUKUS submarine construction materials – Annualised (average value) for 5 submarines over 24 Years		2,500	tonnes	16,300	
	Other (selected)	*Water usage*	380,000	kL	240	
		Wastewater disposal / treatment	200,000	kL	370	
		Workforce (e.g., travel, office, etc.)			11,600	
		Waste disposal & resource recovery	1,900	tonnes	-100	
		Other (office resource usage &/or other activities)			11,630	
		Sub-total			23,740	
	Sub-total				***49,050***	
TOTAL					**67,250**	**100%**
Total (21-year) operational phase estimated including potential future economy decarbonisation effects			*Low (p5%)*		510,000	-45%
			Average		***920,000***	-
			High (p95%)		1,200,000	26%

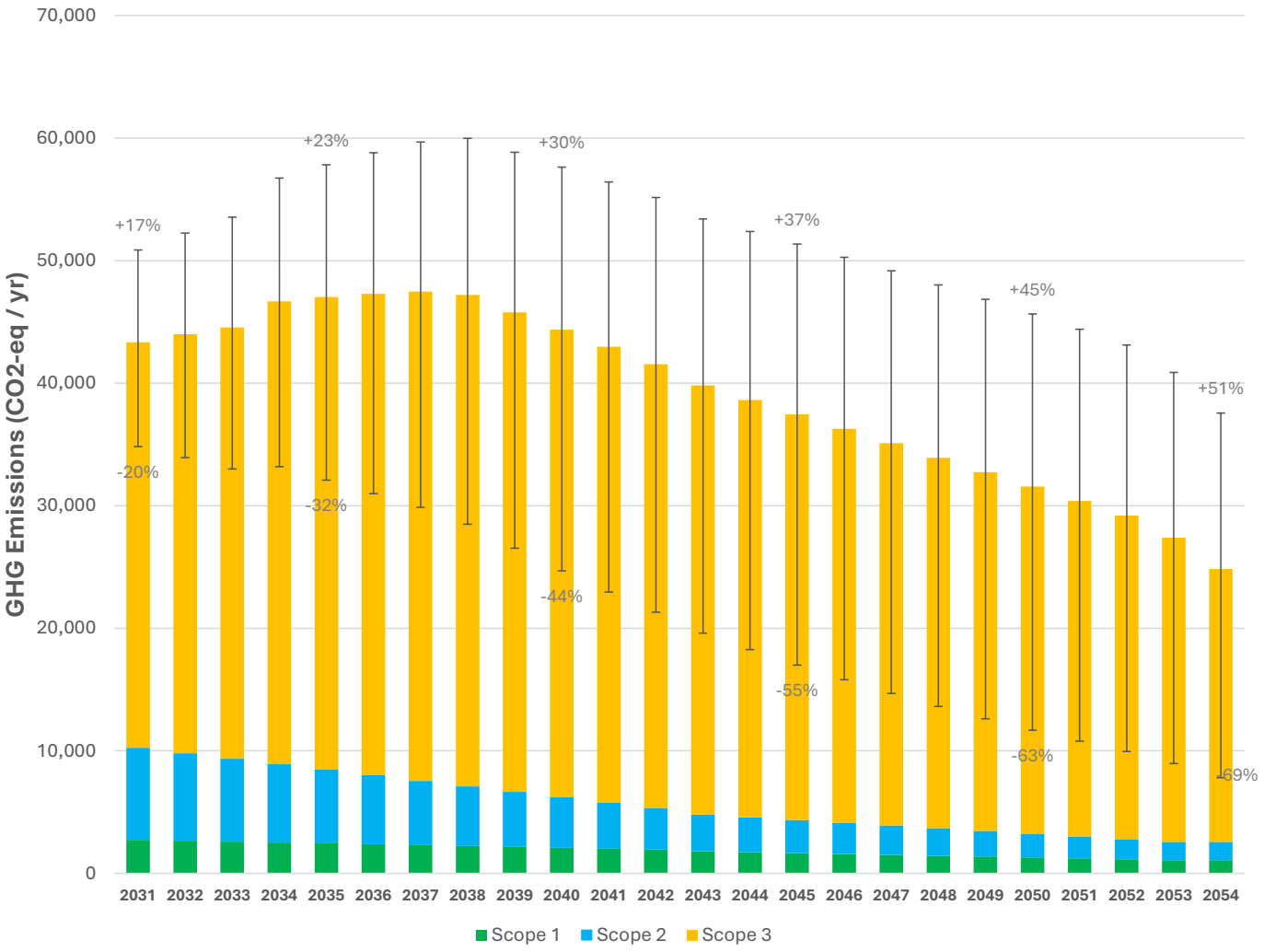

Figure 3-2 – Possible profile of GHG emissions each year during operational phase period including error bars suggesting potential range of uncertainty in annual values

4 Project GHG emissions reduction strategy

4.1 Introduction

This section of the report addresses the following questions.

- **Describe how project will contribute to South Australia's emissions targets,** i.e., 100% renewable energy (in Grid electricity supply) target by 2030, 50% emissions reduction below 2005 level by 2030 and zero net emissions by 2050.
- **Describe measures in the design to minimise, reduce and ameliorate greenhouse gas emissions**, including alternative or renewable energy sources and off-sets, energy efficiency and energy conservation measures, and if it incorporates integrated passive design principles and climate-responsive techniques and features and identify barriers to implementation.

4.2 Contributing to South Australia's GHG emissions targets

4.2.1 What are these targets

4.2.1.1 Context

To frame how the SCY project can contribute to South Australia's emissions targets, it is helpful to review what these targets are and see how South Australia is already progressing towards them.

4.2.1.2 100% Renewable Energy (generated by SA in its electricity supply)

This target aims to achieve 100% Renewable Energy in electricity generated in South Australia and supplied to the State's Grid electricity supply by 2030[8].

- Using Australian Energy Market Operator (AEMO)[9] data, Figure 4-1 overleaf shows South Australia's performance in using renewable energy to generate and supply electricity to its Grid since 2015.
    - Last year (calendar year 2023) the State achieved 76% renewable energy in electricity generated (in South Australia) and supplied into the Grid.
    - Once Imports (across existing Heywood and Murray link interconnectors) are considered, this renewable energy content in the State's Grid (total) supply was about 71%.
    - These interstate electricity Imports have lower renewable energy content, about 35 to 40%.
    - In recent years they have contributed about 10 to 12% of the State's Grid electricity supply and are drawn on when insufficient local generation is available in SA to meet demands.
- Figure 4-1 projects out this situation as the State heads towards its 100% target by 2030.
    - This projection assumes that once the 100% target is achieved (with fossil fuel sources of generation in SA eliminated), there would still be electricity imports from interstate, whose contribution to the Grid supply may grow (e.g., to up to 20%) to maintain a stable Grid supply (even with future battery storage expansion and a new electricity interconnector to NSW).

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[8] This target is for renewable energy generated in South Australia for Grid electricity supply, see: New target for renewables | Premier of South Australia. Renewable electricity generated for is not the same as renewable electricity in South Australia's Grid supply. South Australia's Grid supply includes electricity generated and imported from interstate that has a lower renewable generation contribution. This target does not consider purchase of Renewable Energy Certificates used for offsetting purposes, which may affect the renewable energy mix in a Grid supply able to be claimed.

[9] This data can be accessed at: AEMO | Australian Energy Market Operator

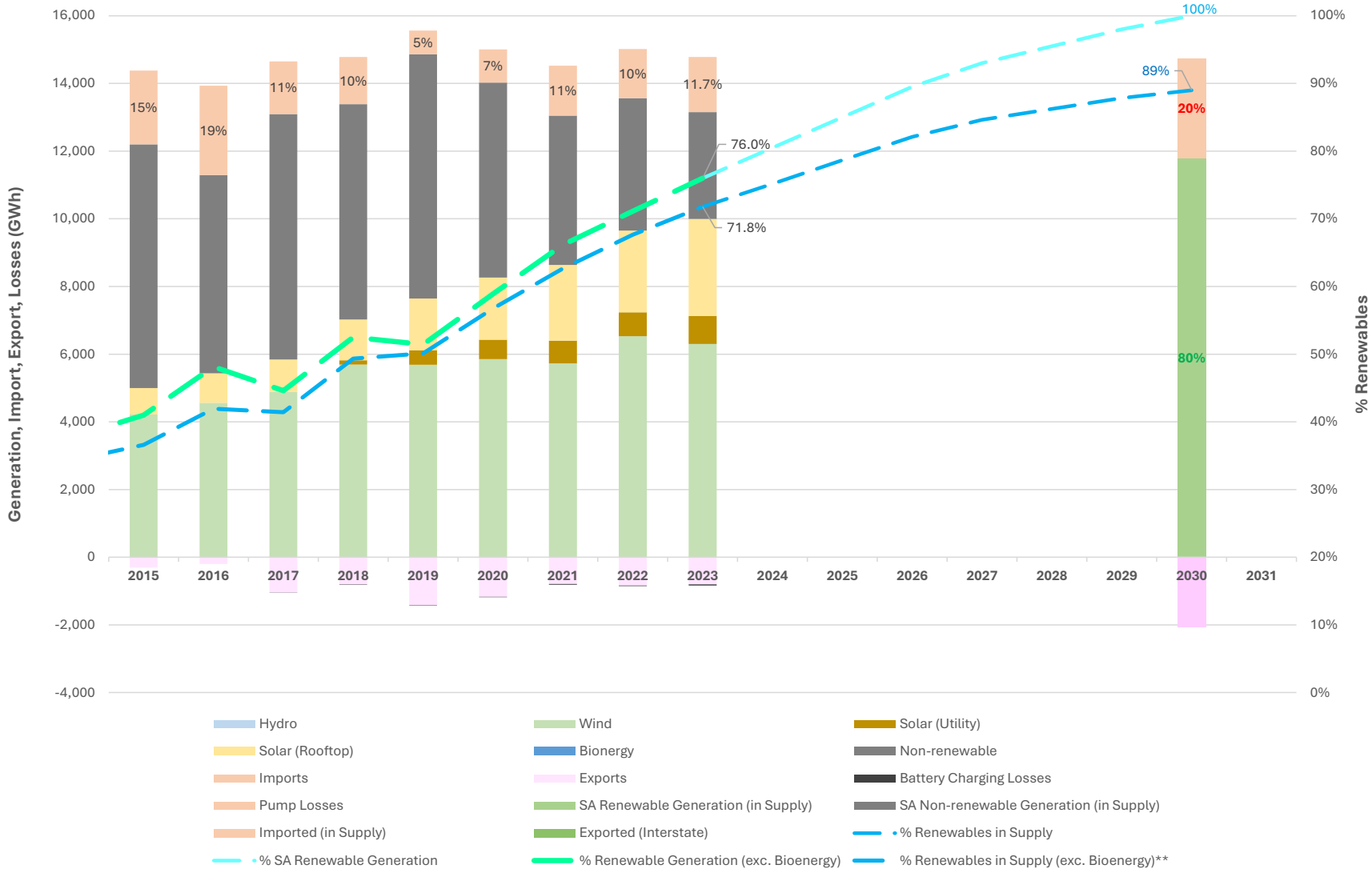

Figure 4-1 – Past uptake in SA of renewable energy in electricity generated and supplied to the State electricity Grid supply, total renewable content in Grid supply once (electricity) imports (i.e., less renewable supply from other States) considered, and projection of future trajectory towards a future 2030 100% target.

- By 2030, it suggests that SA could have up to 89% renewable energy in its supply.
- This high renewable energy content will effectively decarbonize the State's electricity supply.
- The State's current Scope 2 emission factor of 0.25 kg CO_2-eq/kWh[10] should decrease, e.g., to perhaps < 0.1 kg CO_2-eq/kWh, depending on non-renewable content in electricity Imports.
- All users of the State's Grid electricity supply will benefit from this decarbonization outcome, including the SCY during both its construction and operational phases.

4.2.1.3 50% emissions reduction below 2005 levels by 2030

This target aims to reduce South Australia's emissions below 2005 levels by 2030.

– Nationally reported data[11] for the State's Emission Inventory in 2005 and the most recent (data available) five years from 2017 to 2020 are given in Figure 4-2 overleaf.
  - The State's Nett emissions in 2022 were 46% less than 2005 levels, which is nearly at the 50% target.
  - This downward trend is expected to continue as decarbonization of the State economy continues (e.g., through improved energy efficiency, industrial transitioning to renewable energy, improved transport fuel efficiency and electric vehicle adoption, etc.).
– Figure 4-2 also projects the State's Emission Inventory out to 2030 assuming similar (average) decarbonization rates seen between 2017 and 2018.
  - It suggests that South Australia should already on track to achieve its 2030 target of a 50% emissions reduction (below 2005 levels).

4.2.1.4 Nett Zero emissions by 2050

The Australian Government and all State and Territory Governments have committed to this target[12].

– To achieve this target, even though South Australia has already nearly halved its Nett emissions since 2005 (per Figure 4-2), there will likely need to be the following actions taken.
  (1) An economy wide transformation of energy use to maximize energy efficiency and eliminate fossil fuel use wherever possible.
    - South Australia like many other States and Territories still substantially relies on non-renewable energy from fossil fuels – see Figure 4-3 overleaf – especially across its industrial (e.g., natural gas use) and transport sectors (e.g., diesel, petrol, LPG).
  (2) Mitigation of other non-energy related emissions (e.g., agriculture, waste disposal), and
  (3) Creation of offsets (e.g., carbon credits) for any residual carbon emissions.
– Progress towards this target would be achieved through:
  - Australian and State Government policy actions to further encourage and incentivize more renewable energy generation and uptake (and to discourage fossil fuel use), especially across industrial and transport sectors.

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[10] Per the *National Greenhouse and Energy Reporting (Measurement) Determination 2008*, see: National Greenhouse and Energy Reporting Scheme - DCCEEW.

[11] See South Australia's reported Emissions Inventory at: State and Territory Greenhouse Gas Inventories - DCCEEW

[12] See National review prepared for AgriFutures in: 21-149.pdf (agrifutures.com.au)

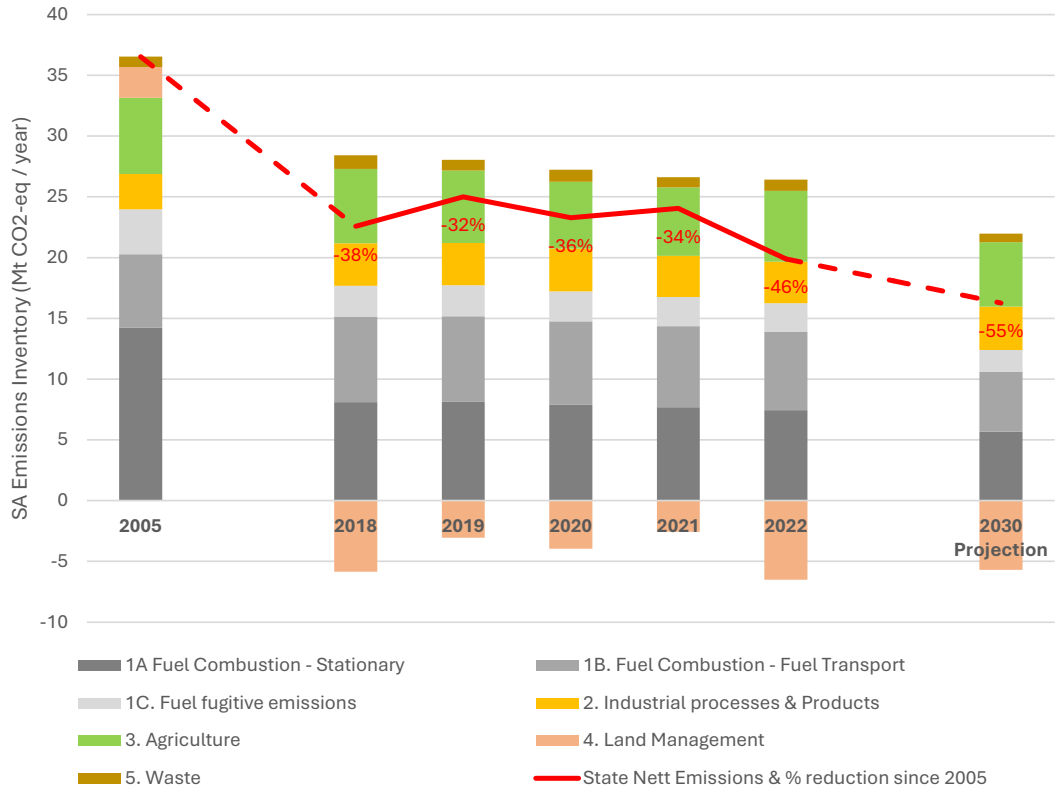

Figure 4-2 – South Australia's reported Emissions Inventory in 2005, for the five years, 2019 to 2022, and projection if current decarbonisation trends continue

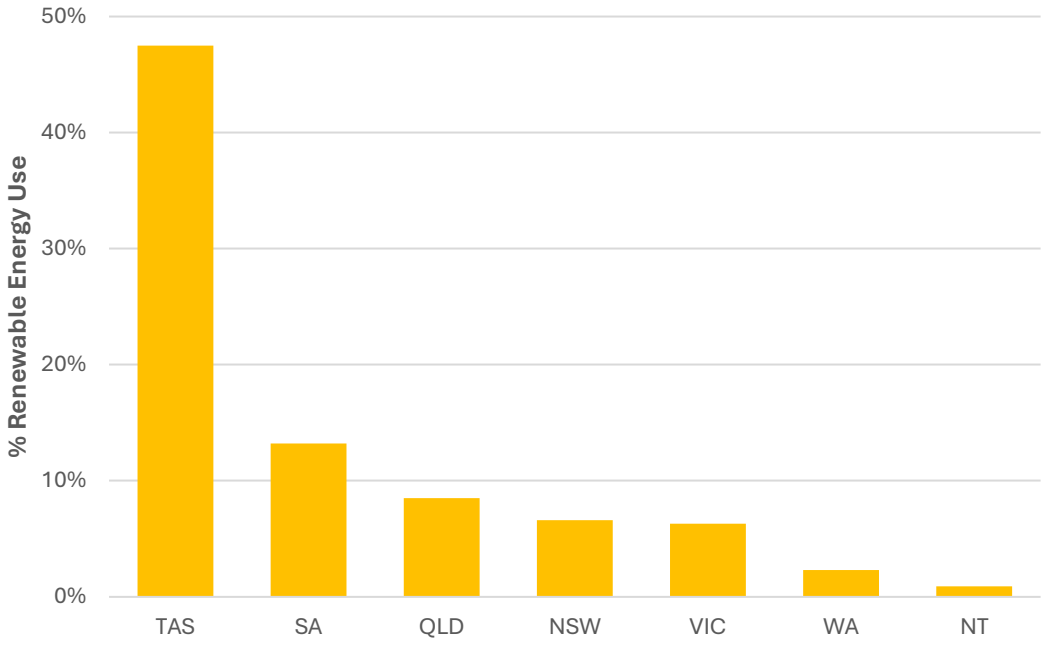

Figure 4-3 – Percentage (%) renewable energy use by State or Territory in 2021-22 as reported by the Australian Government's Energy Statistics. *Data Source: Australian energy mix by state and territory 2021-22 | energy.gov.au*

- Acceleration of existing economy wide transitions towards:
  - Improving energy efficiency, e.g., LED lighting, more efficient industrial gas burners, improved vehicle efficiency,
  - On-going replacement of fossil fuels with renewable energy sources, e.g., heat pumps for hot water heating, electric vehicles, use of biofuels and hydrogen, and
  - Mitigation of non-energy related emissions including creation of offsets from these projects.

– Many of these changes will happen organically outside the SCY, and automatically benefit it through lower Scope 1 (direct), Scope 2 (indirect) and Scope 3 (embodied) emission factors for its activities.
– Others can be influenced by the SCY's own actions, which can help it contribute towards this target.

4.2.1.5 Climate Change Actions

To support its above emissions reduction and nett zero emissions target, the South Australian Government released in 2022 its Climate Change Actions statement (2022).

- This Statement includes sustainable resource use actions it intends to undertake to help tackle climate change.
- A number of these relevant actions are listed in Table 4-1 overleaf.

4.2.2 Impact on GHG emissions estimates for the SCY

The GHG emissions estimates for the construction and operational phases of the SCY were presented earlier – in Figure 3-1 (page 15) and Figure 3-2 (page 18), respectively.

– These estimates already factor in the above-mentioned future anticipated decarbonization trends happening in South Australia.
– For the construction phase:
  - The project would automatically benefit from South Australia's decreasing electricity emission factor between now and 2030, for its Scope 2 emissions, and in Scope 3 emissions of locally manufactured construction materials (concrete, steel, timber, etc.) for building and infrastructure.
  - It may also benefit from other decarbonization plans to soon introduce up to 20% renewable Hydrogen (H_2) into Metropolitan Adelaide natural gas supply[13], which should act to help lower (embodied) emissions of manufactured materials across the industrial sector.
  - For SSN-AUKUS submarine construction plant and equipment that may be supplied from overseas by Australia's global or other trading partners (e.g., US, UK, Japan), these developed countries are decarbonizing too (by similar means), which would further reduce Scope 3 emissions.
– For the operational phase:
  - The project should benefit even more (across Scope 1, 2 & 3) as the South Australian, Australian and many global economies decarbonize on their way to the widely adopted Nett Zero emissions target by 2050.
  - For example, as shown in Figure 3-2, the operating phase average annual emissions by 2054 could be nearly one third (or 33%) of the initial estimate (by using 2024 emission factors).

If decarbonization happens more rapidly, it could even be half of this value.

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[13] This project is called HyP Adelaide, for more information, see: Hydrogen Park Adelaide | AGIG

Table 4-1 – Examples of actions in South Australian Government Climate Change Actions statement (South Australian Government, 2022) that are relevant to sustainable resource usage

Action	Description
1.4. Implement energy demand management and productivity programs	The government will implement a range of policies and projects to manage electricity demand and improve energy efficiency.
2.8 Support business and communities to adopt circular economy practices	Encourage businesses to implement circular economy opportunities and boost sustainable growth and address resource security.
2.9 Implement South Australia's Waste Strategy 2020–2025	South Australia's Waste Strategy 2020–2025 outlines a range of actions that will help reduce emissions by increasing recycling and resource reuse and reducing methane from landfills.
2.11 Deliver a stronger regulatory framework to reduce waste and encourage greater reuse of materials to support a circular economy	Encourage business and industries to reduce waste, improve resource recovery and keep materials in use longer.
3.8 Develop a framework to deliver integrated urban water management and inform investment decisions	Consider urban greening needs, and stormwater management to minimise flood risk.
4.1 Drive the transition to electric vehicles	The government is supporting initiatives to increase the uptake of hydrogen and battery electric vehicles by motorists in South Australia.
4.2 Plan to transition the public transport system aligned with net zero emissions targets	The government will plan for a staged transition of the public transport fleet and operations to align with the government's net zero emissions targets.
4.5 Align transport planning with net zero emissions outcomes	State and government emission reduction goals will be embedded in transport and infrastructure planning and investment frameworks.
4.6 Drive increased patronage of public transport through delivery of services that are more efficient, integrated and customer-focused	The government will deliver a modern and customer focused public transport network to encourage greater uptake and thereby reduce private car use and associated greenhouse gas emissions.
5.3 Support development and implementation of stronger climate smart standards in the National Construction Code	The South Australian government will contribute to improvements in standards in energy efficiency, emissions and climate resilience in the National Construction Code and relevant South Australian standards.
5.4 Encourage the private and public sector to go 'beyond compliance' in climate smart design	Encourage consumers, designers, developers, builders, and assessors to understand and apply climate smart design that goes 'beyond compliance' with relevant standards.
5.6 Deliver low-emission infrastructure and operations	Encourage the use of low and zero emissions technology and materials, and support recycling and reuse as part of a more circular economy.

4.2.3 Recommended project approach for contributing to these targets

The approach in Table 4-3 overleaf is recommended for the SCY to contribute towards South Australian GHG emission targets – during both construction and operational phases.

- It includes preparing a more fully developed baseline GHG emissions assessment (once more project information becomes available), comparing it with these State Targets (including future trajectories), and identifying and implementing design and operational interventions to align the project with these targets.
    - As noted above, South Australia is already on track to meet its future emissions targets to 2030 and future gaps between these targets and the SCY's GHG baseline emissions trajectories may not be large.
    - Section 4.3 gives examples of design and operational measures and offset strategies that can enable the project to contribute towards these State emission reduction targets.
- This recommended approach should be commenced immediately and embedded as part of:
    - Future project management and design development process, as decisions made here often dictate what is possible to achieve later.
    - Current or future project construction and operational phase sustainability strategy(ies) and ISO 14000 certified Environmental Management System(s), including to support future Australian Government's future mandatory climate reporting (disclosure) requirements[14] (which will commence in 2027 and will likely capture the SCY project and /or its supply chain partners).

4.2.4 Relationship to Defence Nett Zero Strategy targets

During preparation of this report, Department of Defence released its Nett Zero Strategy (Department of Defence, 28 August 2024).

- The strategic aims and targets in this Defence Net Zero Strategy align with South Australia's GHG Emission Targets as summarised in Table 4-2 below.

Table 4-2 – Comparison between SA's GHG Emission Targets and aims and targets in Defence's recently released Nett Zero Strategy

SA's GHG Emission Targets	Defence Nett Zero Strategy strategic aim alignment
• 100% Renewable Energy (generated by SA in its electricity supply)	*"1. Accelerate emissions reductions with renewable electricity"*, by *"prioritise sourcing [of] 100% renewable power"*
• 50% emissions reduction below 2005 levels by 2030	*"4. Embed a unified and integrated approach to achieving net zero"* by aligning Defence emission reduction actions and/or targets with Australian Government national targets: • *"Interim target of a 43% reduction on 2005 emission levels by 2030"*, and • *"Net zero by 2050"*
• Nett Zero emissions by 2050	

[14] For more information on the Australian Government's future mandatory climate reporting (disclosure) scheme, see: Mandatory climate-related financial disclosures - Policy position statement (treasury.gov.au)

Table 4-3 – Recommended / proposed approach for the SCY to contribute towards South Australian GHG emission targets

(1) Define Baseline GHG emissions for project	– Using the early assessment / framework developed by this report, prepare a fully developed project baseline GHG emissions assessment once more project information is available. – This baseline assessment may potentially require product / material (Scope 3) emission disclosure statements from expected material and/or equipment suppliers and may evolve over the design process as greater clarity on the final SCY design and future operation is attained.
(2) Identify GHG emission reduction contribution gap to support State Targets	– Compare the trajectory of the baseline emissions assessment with State GHG emissions targets and identify any contribution gap (between baseline and State targets). – It may be important to differentiate between what decarbonization outcomes will happen organically (in the economy and supply chain and automatically benefit the project) and where the SCY can separately act to materially reduce its GHG emissions to help close a Gap.
(3) Identify & select GHG reduction measures to align with State Targets	– Identify, assess, and select design and operational intervention measures that can help SCY close these gaps and/or align its future GHG emissions trajectory with State targets. – These measures may include adopting design and operational sustainability ratings for the project, e.g., Green Star, NABERS, etc., to support accelerated decarbonization outcomes. – *Note: Selection of measures may need to be balanced against Defence requirements for SCY built infrastructure and future submarine construction, project budget and maximizing GHG emissions reductions (but lowering GHG emissions through design and/or materials selection decision can often act to reduce cost too).*
(4) Set targets & Implement selected GHG reduction measures	– Set (GHG emission reduction) targets and incorporate selected design and operational intervention measures and/or purchase of offsets into a project decarbonization strategy for both construction and operational phases of the SCY. – This project decarbonization strategy can be part of SCY's larger sustainability strategy(ies), and (client, contractors, and major suppliers) Environmental Management System(s) to ensure on-going monitoring, review and improvement will happen.
(5) Monitor & report performance	– Regularly measure, monitor, and report performance of the SCY's GHG emissions and compare against reduction targets. – This measurement and reporting should be supported by including these requirements in SCY's Environmental Management System(s). – It should comply with requirements of the Australian Government's future mandatory climate reporting (disclosure) scheme[14].
(6) Adjust approach if needed (i.e., feedback control loop)	– If needed, refine the SCY project decarbonization strategy and adjust performance to re-align project with these State targets. – This review and adjustment mechanism can be supported by recommended implementation of ISO 14000 certified Environmental Management System(s) by the SCY.

4.3 Proposed design and operational measures to reduce GHG emissions

4.3.1 Construction phase

Table 4-4 overleaf gives design (and operational) measures that could be considered to minimise (Scope 1, 2 & 3) GHG emissions during the project's construction phase and help the SCY contribute towards meeting South Australia's emission targets. These potential measures include (but are not limited to) the following.

- ***Consider adopting a project sustainability rating (or elements of)***, e.g., Green Star[15] – Which automatically integrate and support low emission design frameworks & tools for buildings & other infrastructure including passive design principles and climate-responsive techniques.
- ***Electrification of construction plant and equipment*** – To use renewable electricity instead of fossil fuels (if practical and feasible).
- ***Procurement by construction contractors of high energy efficiency and low emission plant, equipment, lighting, and vehicles.***
- ***Diesel substitution*** (e.g., up to 20% to start with) ***with renewable biodiesel*** – Made available at site or local service stations for plant and equipment and project vehicles.
- ***Buying 'greener' electricity and gas*** (e.g., H_2/bio-CH_4/E or synthetic Green-CH_4), or even generating H_2 on-site with 'Green' electricity to replace natural gas and LPG.
- ***Implementing a Green Circular procurement strategy*** – and working with relevant Government agencies and local suppliers to source low emission materials or components to overcome procurement barriers.
- ***Using low emission cement or recycled substitutes for concrete, 'Green' or low emission steel***, and other low emission building materials or infrastructure.
- ***Recycling of demolition and construction waste materials and sourcing recycled materials for construction***, e.g., soil, aggregate, from local construction & demolition (C&D) waste reprocessors.
- ***Digital-first work practices and meeting strategy*** (to minimize domestic and international travel and maximize working from home for office / design workers).
- ***Project offices*** (at site and/or external project service providers) ***that are NABERS rated*** (for energy, water, and/or waste) to at least 5 stars[16].
- ***Encourage public transport*** and partner with local transport departments to facilitate convenient public transport options for site project and construction workers.
- ***Explore fleet or private vehicle subsidies*** for workforce ***to buy fuel efficient vehicles, hybrids, or electric vehicles*** (to travel to and from site and/or work).
- ***Book all project domestic or international flights with airlines that use Sustainable Aviation Fuel (SAF).***

These measures can be reviewed, expanded, and assessed by SCY project designers as part of Step (4) in the recommended / proposed approach outlined in Section 4.2.3.

- As noted earlier, the selection of measures may need to be balanced against Defence standards for SCY project-built infrastructure and future submarine construction and the project budget.
- But often lowering GHG emissions through design and/or materials selection decisions can act to reduce upfront cost too, as well as future operating costs.

[15] See Green Star ratings available at: Home | Green Building Council of Australia (gbca.org.au)

[16] See NABERS ratings available: Home | NABERS

Table 4-4 – Construction-phase design and operating opportunities that could reduce, minimise, or ameliorate the SCY's GHG emissions. *Note: This list is not necessarily exhaustive*

Emissions scope	Design or operational Measure
1	– Electrification of diesel construction plant & equipment (excavators, bulldozers, loaders, graders, where possible (to leverage of State's high renewable energy in Grid supply)
	– Select / procure / mandate highest efficiency and 'clean emission' construction plant & equipment diesel engines
	– Select / procure / mandate Hybrid or EV vehicle mandate for site vehicles (where appropriate)
	– Select / procure / mandate Biodiesel substitution option (e.g., 20% Biodiesel to be used) for diesel plant, equipment, and site vehicles
	– For HVAC and other refrigeration, specify high COP systems with low GWP refrigerants and low leakage rates (e.g., <5% pa or even less).
	– Use Green Gas (e.g., H_2/b-CH_4/E-CH_4) instead of natural gas and LPG
	– Consider on-site H_2 generation from renewable electricity to replace on-site fossil fuel gas usage
2	– Select / procure / mandate highest electrical efficiency construction plant (screens, equipment (e.g., drills, water heating) & lighting (e.g., LED)
	– Buy 100% renewable electricity for (part or all) site supply (to reduce Scope 2 emission factor)
	– Where opportunity permits, consider on-site Solar PV or wind (which can continue into operational phase) to boost renewables percentage (above Grid electricity supply).
3	– Consider sustainability ratings, e.g., Green Star, for SCY project or elements of, including relevant low emission design frameworks & tools for buildings & other infrastructure that automatically incorporate / embed low energy / emission integrated passive design principles, climate-responsive techniques, and energy efficiency through select high efficiency HVAC and lighting systems.
	– Design team institute a low emission review process into the design process to identify and assess opportunities for decarbonization and regularly report on review outcomes
	– Implement a Green Circular procurement strategy (for all project materials and equipment) including: o Joint committee with ANI / ASA / Defence, design team, relevant government agencies (e.g., DCCEEW, GISA, DTI, DIT), and standard setting bodies to 'pro-actively' review and overcome potential blockages caused by procurement requirements, specifications, and standards. o Development of 'smart' and flexible supply chain pull through procurement strategies and work with suppliers to minimise cost increments from sourcing low emission materials or components. o Partner with Australian and South Australian Government agencies to support suppliers and develop complementary programs to unlock separate support for them to partner / collaborate on 'green' or 'lower' emission manufacturing &/or supply strategies or processes for the project.
	– Buy low emission cement for concrete (e.g., energy efficient cement manufacturers that use renewable energy sources) and consider use of recycled fly ash or other materials to reduce cement usage
	– Procure 'Green' or low emission steel (e.g., manufacturers that use Hydrogen instead of carbon)
	– Procure (or mandate supply chain procurement of) low emission glass and aluminum and other prefabricated materials
	– Recycle soil and aggregate recovered from site demolition or procure recycled soil and aggregate from construction and demolition (C&D) re-processors
	– Set up on-site recycling systems to maximize diversion from landfill and recycling or resource recovery (e.g., alternative fuels) of C&D waste generated at the site (including engaging with GISA for advice)
	– Digital-first work practices and meeting strategy (to minimise domestic and international travel and maximize working from home for office / design workers).
	– Encourage public transport and engage with local transport departments to facilitate convenient public transport options for site construction workers.
	– Fleet or private vehicle subsidies for the workforce to buy fuel efficient vehicles, hybrids, or even electric vehicles.
	– Book domestic or international flights with airlines that use Sustainable Aviation Fuel.
	– Require major project offices to meet National Built Environment Rating System (NABER) energy rating of at least 5 stars.
	– Supply Chain Renewable Gas or Electricity Procurement (i.e., buy renewable energy for supply chain partners so they can directly reduce their Scope 1 and 2 emission factors).
All	– Consider sustainability ratings, e.g., Green Star, NABERS, for SCY project or elements of, where it can help reduce energy use and emissions during the construction and future operational phase.
	– Develop GHG emissions reduction strategy for construction phase.
	– Implement ISO 14000 Environmental Management System to embed processes to review and drive down GHG emissions during design and construction activities (and for future operational phase)

4.3.2 Operational phase

Table 4-4 overleaf lists recommended management and operating measures that can be considered and/or implemented to further reduce (Scope 1, 2 & 3) GHG emissions during the SCY's operational phase and help contribute towards meeting South Australia's emission targets.

- Many of these are similar in nature to those identified for the construction phase, so they are not all repeated here.
- But some vary due to the different nature of operational phase activities, e.g.,
    - ***Working with suppliers to procure 'green' welding gases or consumables*.**
    - ***Hybrid or EV vehicle mandate for SCY fleet vehicles*** (where appropriate).
    - ***Replace LPG fueled forklifts with electric or H_2-fueled alternatives.***
    - ***Procure*** (or mandate supply chain procurement of) ***low emission submarine construction materials*** (where this is feasible).
    - ***Use Low Global Warming Potential (GWP) refrigerants*** in HVAC systems and perform regular maintenance to ensure low leakage rates (of these refrigerants from these systems).
- Again, selection of these measures may need to be balanced against Defence standards for SCY submarine construction and future operating or expenditure budgets.

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Table 4-5 – Potential operational phase measures that could be considered to reduce or offset the SCY's GHG emissions. *Note: This list is not necessarily exhaustive*

Emissions scope	Design or operational measure
1	– Select / procure / mandate highest efficiency office and submarine manufacturing plant and equipment
	– Select / procure / mandate Hybrid or EV vehicles for SCY fleet vehicles (where appropriate)
	– Replace LPG fueled forklifts with electric or H_2-fueled alternatives.
	– Electrify other equipment that otherwise use diesel or fossil fuels, e.g., heat pumps for water heating, electrical space heating, electrical steam production (if small generation capacity, e.g., < 50kW)
	– Where not possible (to electrify), procure highest efficiency or lowest emission diesel and gas plant, equipment, and site vehicles.
	– Replace or reduce residual natural gas usage wherever possible, e.g., H_2/b-CH_4/E-CH_4/Natural Gas blends for space heating, industrial burners, or boilers, etc.
	– For HVAC and other refrigeration, use low GWP refrigerants and maintain regularly to ensure low leakage rates (e.g., <2% pa or even less).
	– Consider Biodiesel substitution / mandate option (e.g., 20% Biodiesel to be used) for all diesel engines and site vehicles, including on-site storage or partnering with nearby fuel stations.
	– Consider on-site H_2 generation from renewable electricity to replace on-site fossil fuel gas usage
	– For welding activities, work with suppliers to procuring 'green' welding gases or consumables.
2	– Select / procure / mandate highest electrical efficiency operating plant, equipment, and lighting (HVAC, refrigeration plant, cranes, lathes, CNC machines, water heaters, lighting, kitchen, etc.)
	– Develop 'cool' microclimate landscaping/infrastructure greening, shading, and cooling, to reduce site cooling demands during summer
	– Buy 100% renewable electricity for (part or all) site supply (to further reduce Scope 2 emission factor)
	– Install on-site Solar PV or wind with batteries to boost renewables percentage (above Grid supply).
3	– Consider operational sustainability rating, e.g., NABERS, or elements of, for energy, water and/or waste and apply same operational / management principles to other buildings & infrastructure
	– SSN-AUKUS submarine design team institutes a low emission review process into the design process to identify and assess opportunities for decarbonization and regularly report on review outcomes
	– Implement a Green Circular procurement strategy for the SCY operational activities including SSN-AUKUS submarine construction procurement: o Joint committee with ANI / ASA / Defence, management team and submarine designers, relevant government agencies (e.g., DCCEEW, GISA, DTI, DIT), and standard setting bodies to 'pro-actively' review and overcome potential blockages caused by procurement requirements, specifications, and standards. o Develop 'smart' and flexible supply chain pull through procurement strategies and work with suppliers to minimise cost increments from sourcing low emission resources, goods &/or services. o Partner with Australian and South Australian Government agencies to support suppliers and develop complementary programs to unlock separate support for them to partner / collaborate on 'green' or 'lower' emission manufacturing &/or supply strategies or processes for the operational resources needed.
	– Procure 'Green' or low emission steel for the SSN-AUKUS submarine construction (e.g., manufacturers that use Hydrogen instead of carbon) if possible
	– Procure (or mandate supply chain procurement of) low emission resources, other submarine construction materials or components and other site operational resources.
	– Manage and operate on-site recycling systems to maximize diversion of waste from landfill and recycling or resource recovery (e.g., alternative fuels) – for both Submarine constriction and office and other operational ancillary activities (including engaging with Green Industries SA for advice)
	– Digital-first work practices and meeting strategy (to minimise domestic and international travel and maximize working from home for office / design workers)
	– Encourage public transport and engage with local transport departments to facilitate convenient public transport options for site staff and workers
	– Fleet or private vehicle subsidies for workforce to buy fuel efficient vehicles, hybrids, or even electric vehicles.
	– Book domestic or international flights with airlines that use Sustainable Aviation Fuel
All	– Consider operational sustainability ratings, e.g., NABERS, or elements thereof, where this can minimise energy, water use, waste generation and /or emissions of assets during the operational phase.
	– Develop GHG emissions reduction strategy for operational phase.
	– Implement certified ISO 14000 Environmental Management system to review and drive down GHG emissions during operational activities.

4.3.3 Offsets

Previously identified measures for construction and operational phases of the SCY can reduce and minimise future GHG emissions of the SCY project.

- To further contribute towards meeting South Australia's emission targets, the SCY can consider offsets that reduce the actual or Nett GHG emissions left over (or residual).
- Table 4-6 below summarises offsets that are presently or may be available to the SCY in the future for this purpose, e.g.,
    - ***Scope 1*** – The SCY could offset natural gas use by buying voluntary Renewable Green Gas Offsets (RGGOs) [17] or future Australian Government Guarantee of Origin (GO) certificates[18].
    - ***Scope 2*** – Non-renewable Grid electricity use can be offset through Renewable Energy Certificates (RECs)[19] to 2030 or future Guarantee of Origin (GO) certificates afterwards[18].
    - ***Scope 3*** – The above Scope 1 and 2 offsets can be bought by the SCY and provided to supply chain partners to help them offset their Scope 1 and 2 emissions that become embodied Scope 3 emissions for the SCY project.
    - ***All*** – The SCY could buy or create their own carbon credits through the Australian Government Carbon Farming Initiative[21] or international voluntary schemes, to offset against their (or supply chain partner) residual GHG emissions.
- The number and type of offsets can be assessed and decided during Step (4) in the recommended / proposed approach outlined in Section 4.2.3.

Table 4-6 – Potential offset mechanisms or measures

Scope	Offset measure (to reduce actual or Nett emissions)
All Scopes (1, 2 & 3)	– Buy carbon credits, e.g., Australian Carbon Credit Unit(s), Voluntary Emission Reduction (VER) Units, e.g., Gold Standard[20], Verified Carbon Standard. – Create own carbon credits through on-site or off-site projects, e.g., ACCUs through Carbon Farming Initiative (CFI)[21], VERs through international voluntary schemes (e.g., Gold Standard, Verified Carbon Standard).
1	– Renewable Green Gas Offsets (RGGOs) (through voluntary GreenPower scheme[17]).
	– Future Australian Government Guarantee of Origin (GO) Scheme certificate offsets[18]
2	– Buy MRET Renewable Energy Certificates (LGCs) or future GO renewable electricity certificates.
	– Buy Certified 100% Renewable Power from GreenPower (with embedded REC offsets)[22].
3	– Buy renewable gas or electricity offsets for supply chain partners to they can offset their Scope 1 and 2 emission factors in products and services supplied to the SCY.

[17] See information on the RGGO scheme at: Renewable Gas Certification | GreenPower

[18] See future GO certificate scheme at: Guarantee of Origin scheme - DCCEEW

[19] See information on Australian Government MRET at: Renewable Energy Target | Clean Energy Regulator (cer.gov.au)

[20] See VER scheme example at: Gold Standard

[21] See CER for more information on ACCUs: Australian carbon credit units | Clean Energy Regulator (cer.gov.au)

[22] See GreenPower for information on this scheme: How GreenPower works | GreenPower

4.4 Climate resilience

There are two areas identified that the SCY project already appears to be incorporating climate change resilience into the design (either explicitly for that purpose or indirectly):

Future Sea Level Rise	*The early design concept seen to date have already considered this issue, recommending site and Ground Floor levels to meet Council's requirements for a 1-in-100-year flood event at this location and has also tested these against 1-in-500-year flood events.*
Future Extreme Weather	*The early design concepts seen to date have already considered that the project will be built to Nuclear Qualified Facilities (NQF) standards, which include protection against extreme weather events.*

In addition, the potential design and operational GHG emission reduction opportunities identified in this report can be considered to support the SCY in adapting to and contributing towards a future low emission economy to help mitigate climate change impacts.

4.5 Barriers to implementation

The following are identified as the main barriers to successful implementation of potential GHG emission reduction measures identified for the SCY in this report, along with ways to overcome these barriers.

– Potential strategies and opportunities for overcoming these barriers have already been identified in construction and operational GHG reduction measures outlined earlier to help the SCY contribute towards achieving South Australia's emission reduction targets.

Project build and procurement requirements, specifications, and standards	Many built infrastructure or Defence equipment design standards may not allow for recycled materials or resources or alternative energy supplies. This barrier can be addressed by: – The design and operational phase proposal suggested in this report for SCY to set up joint committee with ANI / ASA / Defence, design or management team, relevant government agencies, key suppliers, and standard setting bodies to 'pro-actively' review and where blockages may occur and find solutions around them. – Considering established Sustainability ratings, e.g., Green Star, NABERS, which bring with them industry accepted (and adaptable) low emission design frameworks and access to supply chains for design and operation of built infrastructure.
Budget & affordability	'Green' or 'low emission' energy and material procurement costs can be higher (but not always). This barrier can be overcome by: – Embedding processes and a project culture that encourages design flexibility and innovation to reduce GHG emissions – including by having a well-articulated sustainability strategy and GHG emission reduction targets, supported by Environmental Management Systems to ensure regular performance review and continuous improvement. – Leveraging existing Government agency partnerships and programs to work with, and support and encourage local suppliers to develop low emission project materials and components. – 'Smart' and flexible supply chain pull through procurement strategies that enable suppliers to minimise cost increments for low emission materials and components supplied to the SCY.
Design team & local industry / supplier capability & knowledge	– Recruit SCY management and staff with practical experience and knowledge in sustainability and how to reduce GHG emissions in built infrastructure and industrial manufacturing operations. – Embed these people in the construction phase design and operational phase management teams. – Appoint a dedicated sustainability manager with a direct reporting line to the SCY CEO, Director and/or Board. – Ensure the sustainability team is well resourced to perform its important function. – Develop and deliver training for construction and operational phase staff, suppliers and contractors in sustainability including GHG emission reduction goals, practices, and opportunities. – Leverage existing government agency partnerships and programs to raise awareness and provide knowledge and training to supply chain partners (if this is needed too), as well as support to help them build their own capability to contribute. – Establish formal and ISO 14000 certified Environmental Management Systems that provide the framework for measurement, review, reporting and improvement in performance towards reducing SCY's GHG emissions. – Regularly report to SCY management, staff, and supply chain partners on GHG emission reduction performance or successes to make them aware their efforts are making a difference and inspire them to contribute further towards SCY achieving this goal.

5 Key references

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Appendix 1 – GHG emissions assessment methodology & assumptions

A1.1 Assumed material & energy inventories

At this early project stage there does not yet appear to be detailed design plans and/or quantities for expected materials or energy usage during the project construction and operational phases and/or activities – which are normally needed to undertake a GHG assessment.

- Consequently, Material and Energy Inventories were hypothecated across both phases of the project using the 5% Concept Plans and list of likely emission sources in Table 3-1.
- These Material and Energy Inventories were based on Colby Phillips Advisory's experience and knowledge of construction and manufacturing projects and from additional desktop research (of publicly available information) on submarine construction including for the Virginia-class submarines.
- For Scope 1 and 2 emissions during the construction phase, reference was made to the Australian Bureau of Statistics integrated Environmental-Economic Accounts to estimate likely energy usage for these activities (based on construction expenditures).
- For simplicity, operational phase material and energy usage assumed that a relatively constant workforce would be maintained over the entire period from 2031 to 2054.
- *Note:*
    - *These hypothecated Material and Energy Inventories for the project are and should be considered indicative only.*
    - *They were used to develop the GHG emissions estimates presented in this report, but themselves are not presented in detail by this report.*

A1.2 Emission factors

Emission factors used to convert material and energy quantities to GHG emissions are summarised as follows. They were selected following standard and best Australian and international practices in assessment and reporting of GHG emissions and are drawn from the same sources that would be widely used by Australian and State or Territory Governments and major Australian companies for corporate reporting and/or emissions disclosure.

- Scope 1 & 2 emission factors – Per the Australian Government's National Greenhouse Accounts (NGA) Factors[23] and/or *National Greenhouse and Energy Reporting (Measurement) Determination 2008*[24].
- Scope 3 emission factors –
    - Where available, from existing and widely used Australian Life Cycle or other Scope 3 emission factor inventories or databases, including (but not limited to):
        - AusLCI Scope 3 emissions factors from The Australian Life Cycle Inventory Database[25].
        - Green Building Council Australia (GCBA) (publicly) reported Scope 3 emission factors for assessing embodied carbon in building materials[26].

[23] See these Scope 1, 2 and 3 emission factors at: National Greenhouse Accounts Factors - DCCEEW

[24] See these Scope 1 and 2 emission factors at: National Greenhouse and Energy Reporting Scheme - DCCEEW

[25] See this site for information on this Inventory: AusLCI Carbon Emissions Factors

[26] For examples of Green Star emission factors for building materials, see: Embodied Carbon & Embodied Energy in Australia's Buildings (thinkstep-anz.com)

        - Climate Active Carbon Scope 3 emission factor inventory[27]
    - Where not available in the above inventories or databases:
        - From desktop research of published literature to find the most relevant emission factor estimate for this project's circumstances, and/or
        - High-level desktop-based Life Cycle Analysis (LCA) to develop an estimated emission factor.
    - For recycling of waste materials, (nett environmental benefit) emission factors from South Australia's Circular Economy Resource Recovery Report 2021-22 were used[28].
    - *Note: Scope 3 emission factors in existing inventories or databases may themselves only be estimates or sourced from other published data that may not necessarily reliably model Scope 3 emissions for SCY's situation.*

A1.3 Impact of future economy decarbonisation

The above emission factors (usually) reflect emissions caused by energy or material usage in the present (i.e., current year: 2024). In the future, especially for a project that will take up to 5 years to construct and have a 30+ year operational period, these emission factors could change. These changes in emission factors are likely to happen as South Australia decarbonises its economy by switching from fossil fuels to renewable energy to meet its renewable energy and emissions targets (as mentioned in Table 1-1):

- ***100% renewable energy (in Grid electricity supply) target by 2030***[29] –
    - Which could see current Grid electricity emission factor (of 0.25 kg CO_2-eq / kWh) reduce to an even lower value by 2030.
    - Future decreased emissions in Grid electricity would flow through the supply chain and reduce the Scope 3 embodied emissions of locally made materials that could be used in the project too.
- ***50% emissions reduction below 2005 level by 2030 –***
    - Outside of electricity, emission reductions would need to happen across the State economy to achieve this target, from how liquid and gaseous fossil fuels are used or produced and from other emissions from agricultural, industrial, and waste management activities.
    - These changes are already being seen across the South Australia, with both improvements in energy efficiency and transitions from fossil fuels to electricity, Green Gas (e.g., Hydrogen, Biomethane and /or E-Methane) and biofuels, and projects to mitigate of other direct emissions (e.g., capping of landfills and capture of landfill gas for flaring and/or electricity generation).
    - It should result in year-on-year on-going reductions in Scope 3 embodied emissions in local materials supplied to the project for the construction phase, and throughout the later 30+ year operating phase.

[27] See information on this Inventory: Tools and resources | Climate Active

[28] See the recycling benefit emission factors in: gisa-cerrr-2021-22.pdf (greenindustries.sa.gov.au)

[29] This South Australian target is for renewable energy in the Grid electricity supply, see: New target for renewables | Premier of South Australia

  - Likewise, similar actions are happening across the Australian economy as the Nation strives to achieve its Paris Agreement commitment of 43 % reduction on 2005 levels by 2030[30].

- ***Zero net emissions by 2050 –***
  - Not just South Australia has committed to this future Nett Zero target, but the Australian Government and every other State or Territory Government too[31].
  - Globally, many of Australia's trading partners (e.g., US, UK, Japan) that may supply materials and components to the SSN-AUKUS submarine construction program are making similar commitments as well.
  - The expected future decarbonization of South Australia's, the Nation's, and home economies of SSN-AUKUS submarine construction global supply chain partners, will transform and significantly reduce emission factors for material used during the SCY's operational period.

Consequently, a potential decarbonisation trajectory for material and energy usage hypothecated was overlaid on emission factors for the project (at Scope 1, 2 & 3 levels).

Note: This future decarbonisation trajectory would happen ordinarily and is distinct to any initiatives or actions the project could take to further accelerate and reduce its GHG emissions.

A1.3 Uncertainty in estimates

Uncertainty in the GHG emissions estimates was assessed as follows.

- Assigning likely range (low and high value) to point emissions estimates, considering both potential material and/or energy usage uncertainty in each.
- Using Monte Carlo (or statistical) simulation to develop a likely probability distribution for total construction and operating phase GHG emission estimates.
- Overlaying on these results a potential low and high-level decarbonisation trajectory too (at Scope 1, 2 and 3 assessment levels).

[30] See further information on the Paris Agreement National targets: International climate action - DCCEEW

[31] See National review in this report: 21-149.pdf (agrifutures.com.au)