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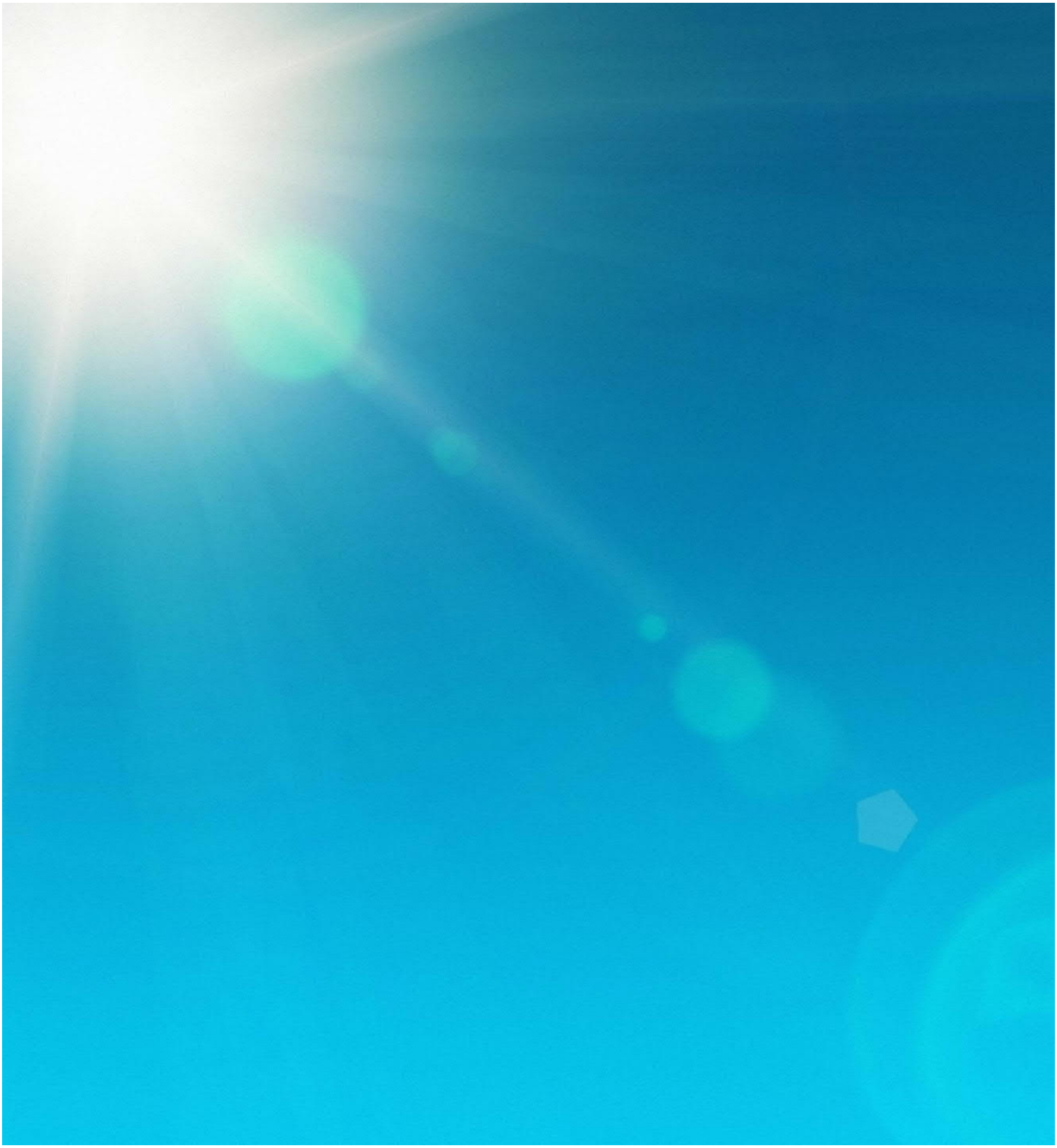
Chapter 12 – Atmospheric Processes

Australia-Asia PowerLink Environmental Impact Statement



Chapter 12 – Atmospheric Processes

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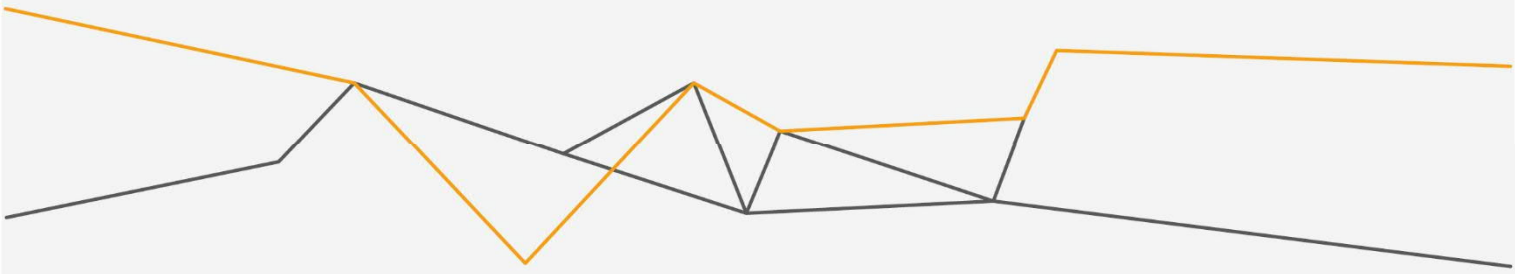
0	18/03/22	Draft EIS Submission	Joe Sheridan	Mark Branson



Contents

Tables

Figures

12 Introduction

This chapter assesses the potential for significant adverse impacts to the environment as a result of greenhouse gas (GHG) emissions and assesses the potential contribution of the Australia-Asia PowerLink (AAPowerLink) project to the Northern Territory (NT) Government's target of achieving net zero GHG emissions by 2050 (NTG, 2020). For the purpose of assessment under the *Environment Protection Act 2019*, GHG emissions are considered under the NT EPA's Atmospheric Processes factor, the objective of which is to:

"Minimise greenhouse gas emissions so as to contribute to the NT Government's aspirational target of achieving net zero greenhouse gas emissions by 2050 and adapt to a changing climate to protect ecological integrity and maintain the welfare and amenity of people."

Other emissions to air associated with the AAPowerLink are particulate matter and exhaust emissions during the construction and operations phase, which are assessed in Chapter 11 Air Quality, and not covered in this chapter.

The GHG emissions inventory prepared for the AAPowerLink by Xodus (2022) indicates the project will be carbon positive within the Australian assessment boundary within four years of being fully commissioned. During construction, GHG emissions are predicted to exceed the *NT Large Emitters Policy* threshold for land use projects. This triggers the requirement for a *Carbon Emissions Study and GHG Abatement Plan (GGAP)* (Appendix H) which provides details on carbon abatement opportunities and how these will be maximized for the AAPowerLink, and how GHG emissions will be avoided and/or minimised during construction and operations. The GGAP indicates that the AAPowerLink will be a net zero infrastructure project and a carbon positive exporter of electricity, and therefore the project is expected to contribute towards the NT EPA's aspirational target for the atmospheric processes factor.

12.1 Information sources

Xodus' 2022 Carbon Emissions Study and Greenhouse Gas Abatement Plan (GGAP) (Appendix H) addresses the requirements for an atmospheric processes study under the AAPowerLink EIS Terms of Reference (ToR), as well as a GGAP under the NT Governments *GHG Emissions Management for New and Expanding Large Emitters' policy* (2021) (the Large Emitters Policy). The GHG inventory prepared for the AAPowerLink is a conservative estimation of the amount of GHG emissions that can be directly attributed to the project's construction and operations activities within the assessment scope and boundary described in Chapter 2.

A Carbon Assessment Definition (CAD) workshop was held with the AAPowerLink project team to identify and agree on data requirements and sources of information for the emissions estimate. The emissions sources included in the inventory, sources utilised for data input and specific items excluded are detailed in Appendix H Section 5.0. Given the complexity of the project, conceptual engineering, and limited detail available for selected construction work methods, residual uncertainty in the assessment remains. As such, and in line with best practices outlined in the *Climate Active Carbon Neutral Standard*, an uplift of 20% has been applied to the emissions to account for uncertainties.

The following assumptions were made in preparing the GHG emissions inventory:

- GHG emissions calculation input data was agreed with the AAPowerLink project team
- Power export profiles were provided by the AAPowerLink project team

  Given the complexity of the Project, including the level of engineering and detail available regarding construction and execution, a level of residual uncertainty exists in the definition of GHG emissions estimate. As such, in line with best practice an uplift of 20% has been applied to GHG emissions estimates.

- An approximately 70-year project life was assumed, including construction, operations, repowering and decommissioning
- Embodied emissions were not included (these emissions are defined in a separate AAPowerLink life cycle GHG assessment study)
- Emissions for the scope of the project outside of Australia are not included as they are not addressed in the Draft GHG Offsets Policy and Technical Guidelines (NT Government, 2021)
- Avoided emissions are estimated using AAPowerLink export profile assumptions
- The evaluated supply scenario assumes that 100MW of electricity would be made available for customers on the DKES, with 700 MW made available for new and existing industrial customers
- Connection to DKES is assumed from day 1 of operation
- NT grid GHG intensity utilised 2020 GHG intensity as a constant assumption
- Singapore grid GHG intensity utilised 2020 GHG intensity and 2019 overall emissions
- Singapore electricity usage calculations are based on 2020 usage statistics and 2032 forecast usage (Energy Market Authority. 2021a)
- NT industrial (LNG and other) generation GHG intensities assume 0.42 Tonnes CO2e/GWh aligned with Hardisty et al, (2012)
- All Singapore avoided emissions are assumed to be at GHG intensity of 0.41 Tonnes CO2e/MWh. This is representative of the 2020 actual GHG intensity of the Singapore gird intensity of 0.408 Tonnes CO2e/MWh (Energy Market Authority. 2021).
- The DKES, which utilises open cycle gas turbines (96%) with diesel backup systems (4%) has a location based GHG intensity of 0.54 T CO2e/MWh under the DKES National Greenhouse Accounts factors for 2020 (DISER, 2021a)
- Decommissioning emissions have been estimated as a proportion of construction emissions due to uncertainty of scope and methodology. AAPowerLink will continue to seek reductions to GHG emissions associated with decommissioning throughout the life of the facility. Decommissioning emissions estimates will be revised prior to decommissioning of project facilities.
- Upstream Scope 3 emissions from the supply and transport of gaseous fuel were not included in the stated intensity or avoided emissions calculated. Scope 3 emissions from the supply of gas typically contribute a further ~25% GHG emissions per MWh (Hardisty et al, 2012).

12.2 Relevant policies and guidelines

The AAPowerLink GHG inventory has been prepared in accordance with the requirements of the:

- GHG Protocol: A Corporate Accounting and Reporting Standard (World Resources Institute and World Business Council for Sustainable Development 2004)
- ISO 14064-1:2006 Specification with Guidance at the Organization Level for Quantification and Reporting of GHG Emissions and Removals (International Organization for Standardization 2006)

The emissions calculation methodology utilised aligns with Australian Commonwealth Government and NT government legislation, regulations, and guidelines for the preparation of GHG inventories as listed below:

- *National Greenhouse and Energy Reporting Act 2007* (NGER Act)
- *National Greenhouse and Energy Reporting Regulations 2008*
- *National Greenhouse and Energy Reporting (Measurement) Determination 2008* (Australian Government 2021)
- *Greenhouse Gas Emissions Management for New and Expanding Large Emitters' Policy* (Department of Environment, Parks and Water Security 2021)
- Delivering the Climate Change Response: Towards 2050 (Office of Climate Change 2020)
- GHG Accounting for Grid Connected Renewable Energy Projects (International Financial Institutions Technical Working Group on Greenhouse Gas Accounting 2019)
- Full Carbon Accounting Model (FullCAM).

The GGAP is aligned with the following guidance relating to offsets:

- *Draft GHG Offsets Policy and Technical Guidelines* (NT Government, 2021)
- *Climate Active Carbon Neutral Standard for Organisations* (Commonwealth of Australia, 2020)

12.3 Environmental values

A desktop review of the current NT energy mix, including proportion of renewables in use, and sources of GHG emissions was conducted by Xodus (2022) to characterize the baseline condition. Key findings are summarised below.

A total of 41,083 gigawatt hours (GWh) was used in NT in 2019. Less than 1% of that energy was generated by renewable sources, while 65.6% of the energy was generated by gas-fuelled generation, and 33.6% generated by oil-fuelled generation (Figure 12-2). The two largest energy users were the electricity sector (supply to the electricity grid) and the mining and industry sectors, using 44.8% and 51.8% of the energy generated, respectively (DISER 2021b cited in Xodus 2022).

Approximately 20.7 million tonnes (MT) of carbon dioxide equivalent (CO_2e) were reported as NT emissions in 2019. Of this, 1.4MT of CO_2e was associated with public electricity generation in the NT, representing approximately 6.7% of the NT's emissions, and 0.7% of Australia's national GHG emissions (DISER 2021 cited in Xodus 2022) (Figure 12-2).

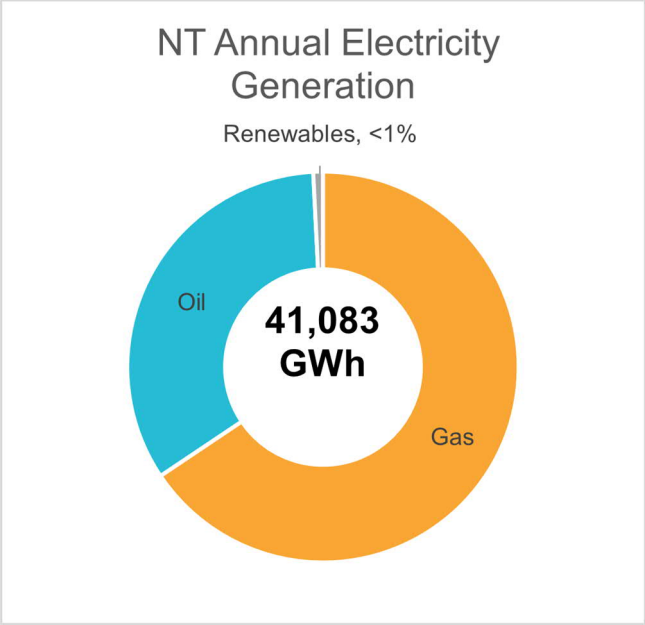


Figure 12-2. NT Annual Electricity Generation

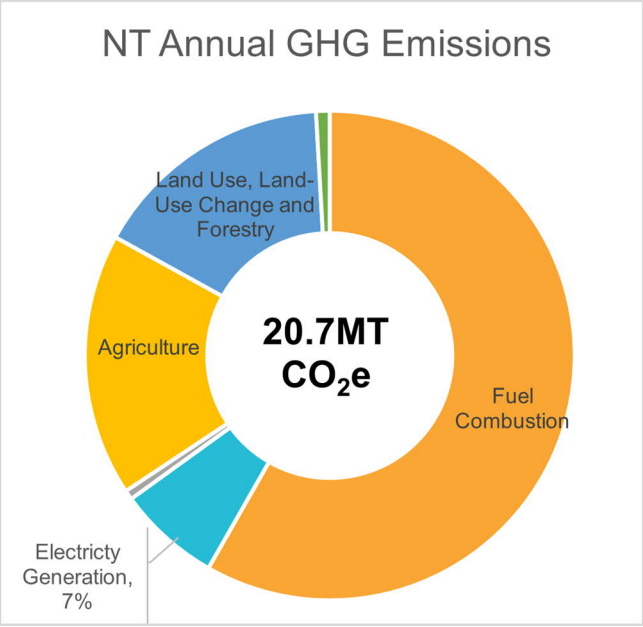


Figure 12-1. NT Annual GHG Emissions

The electricity industry in the NT, like elsewhere in Australia, is experiencing a rapid transformation, primarily driven by large growth in distributed solar Photo Voltaic (PV) systems on residential and commercial premises. The Utilities Commission of the NT (2021) reports that in the Darwin-Katherine Electricity System (DKES), renewable energy generation as a percentage of underlying consumption (total consumption at consumers' power points) was 6 % in 2019-2020. Solar PV generation is forecast to increase over time to meet 23 % of underlying consumption by 2028-29 in DKES based on existing uptake rates of residential and commercial solar PV installations and committed large-scale solar PV projects (excluding AAPowerLink). The DKES Plan (NT Government 2021) identifies investment in large scale solar as the pathway to achieve the NT Government's 50% Renewable Energy Target by 2030 (NTG, 2020).

The AAPowerLink proposes to supply electricity to users in the Darwin-Katherine region, and although activities to support this are currently out of scope for the project, this could potentially include customers on the DKES as well as industrial customers, who typically utilise behind the meter power generation from non-renewables sources. The carbon abatement opportunities available by avoiding emissions are discussed below.

12.4 Potential Impacts

12.4.1 Assessment scope and boundaries

The scope and boundary of the GHG emissions estimate prepared for the AAPowerLink meets the requirements of both the ToR, as well as the *GHG Emissions Management for New and Expanding Large Emitters Policy* (NT Government, 2021), and is illustrated in Figure 12-3 and summarised below.

The boundary of the GHG emissions estimate includes Scope 1 and 2 emissions associated with the project, within Australian and NT jurisdiction, as well as Scope 3 emissions from travel, waste, and wastewater associated with construction and operations. GHG emissions avoided by the provision of solar power replacing fossil fuel combustion are also included within the scope of this estimate.

GHG emissions outside of the scope of this estimate are those generated from activities outside of Australia, such as those embodied in imported goods, construction, and operation activities outside of Australia, and specifically, emissions avoided in Singapore[1]. It is noted AAPowerLink intends to develop a full project life cycle assessment for corporate purposes, however this is not a requirement under the NT or national legislative requirements and is out of the scope of this assessment.

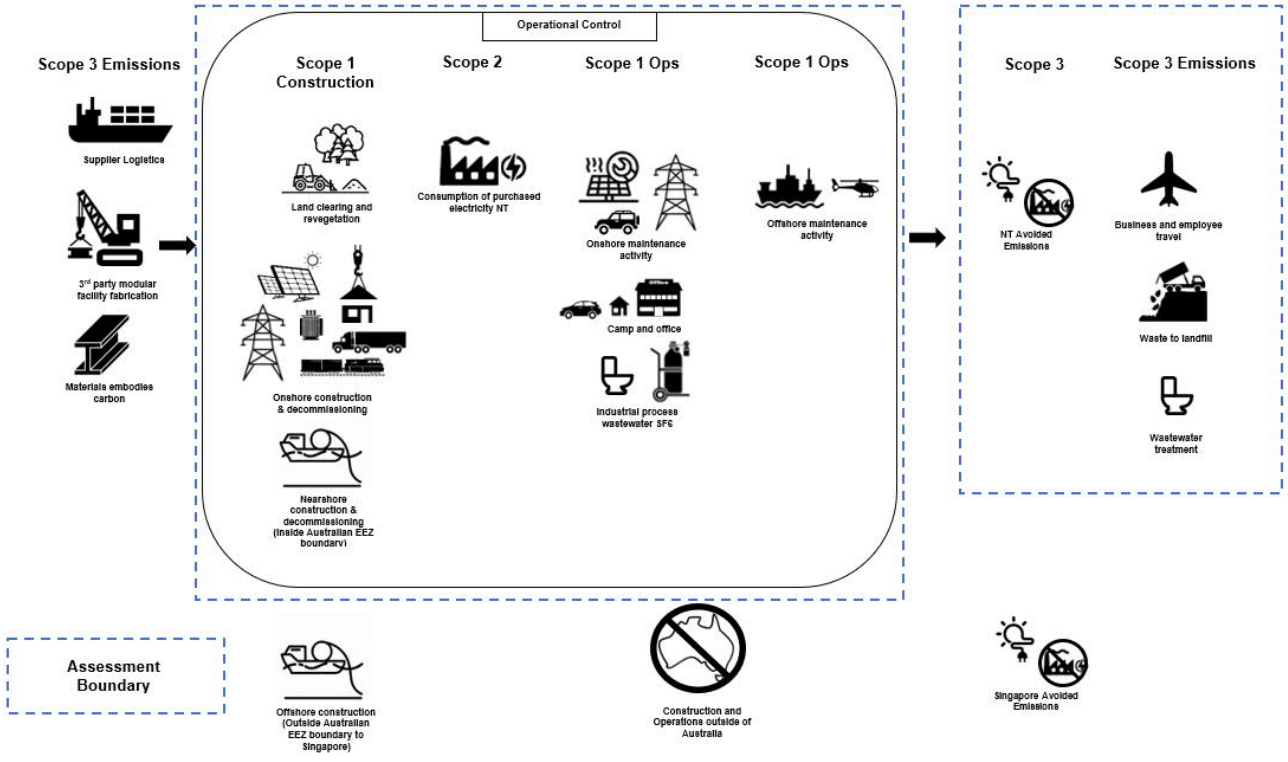


Figure 12-3. GHG emissions estimate scope and boundary

[1] The displacement of emissions from fossil fuel combustion, and the subsequent avoidance of GHG emissions from fossil fuel power generation in Singapore, are referred to as 'Singapore avoided emissions' throughout the document.

12.4.2 Impact assessment

The potential impacts to atmospheric processes associated with construction and operation of the AAPowerLink have been assessed using the EIA methodology described in Chapter 3 – Impact Assessment. The EIA identified and assessed the following impacts that could occur during construction and/or operations:

- Greenhouse gas emissions from the combustion of fuel from vessels, plant and equipment for earthworks, air and land travel, logistics and power generation
- GHG emissions from land clearing and land use change
- GHG emissions from the decomposition of organic debris and loss of soil carbon during operation
- Positive impact – Overall reduction in GHG emissions from generation of renewable energy

The EIA considered the impact avoidance and mitigation measures detailed in Section 12.5 below and assessed the residual impacts to atmospheric processes assuming these measures are effectively implemented. A residual impact rating was then assigned taking into consideration the scale, magnitude and duration of the impacts, the presence/absence of environmental values and/or sensitive receptors and the level of certainty with respect to the intensity of the impact and the effectiveness of the mitigation measures. The residual impact ratings adopted in the assessment are provided in Table 12-1

The outcomes of the EIA are summarised in Table 12-2 and Table 12-3 from the Impact Assessment Register provided at Appendix E and discussed in the following sections.

Table 12-1. Residual impact ratings adopted for the AAPowerLink EIA

Ratings and Description
Minor: A minor residual impact is unlikely to be significant.
A minor impact generally has two or more of the following characteristics: Scale: Limited/Localised Magnitude: Negligible/Minor Duration: Short-term/ Medium-term/Reversible. **OR** There are no sensitive receptors or land uses present, and the environment does not contain any aspects that are valuable or otherwise important or unique (i.e., Very Low/Low rating), and there is moderate to high degree of certainty about the likelihood and intensity of the impact, and the effectiveness of proposed mitigation measures.
Moderate: A moderate residual impact has potential to be significant. The significance depends on the acceptability of the impacts and the effectiveness of mitigation measures.
A moderate impact generally has two or more of the following characteristics: Scale: Localised/Regional Magnitude: Moderate Duration: Medium-term/Long-term **AND/OR** There are sensitive receptors or land uses present, or environmental aspects that are valuable or otherwise important or unique (i.e., Medium-High value rating), and there is a low degree of certainty about the impact, and the effectiveness of proposed mitigation measures.
Major: A major residual impact is likely to be significant. The level of acceptability will depend on offsets or benefits compensating for the impact.
Impact generally has two or more of the following characteristics: Scale: Regional/ Widespread Magnitude: Moderate/Major Duration: Long-term/Permanent **AND** There are sensitive receptor land uses present, or environmental aspects that are valuable or otherwise important or unique (i.e., Medium-High value rating).

Table 12-2. Summary of EIA results - Atmospheric processes factor - Construction

Impact	Likelihood	Scale	Duration	Magnitude	Value rating	Certainty	Residual impact
GHG emissions from combustion of fuel from vessels, plant and equipment for earthworks, air and land travel, logistics and power generation	**Likely** Equipment requiring fuel combustion will be used where self-generated or renewable energy is not practicable, mainly during construction phase.	**Widespread** Fuel generated GHG from logistics and earthworks from a combined area ~12,900ha	**Medium-term** Impact occurs only during the construction phase	**Minor** Relevant criteria for environmental protection are met	**Low** Most of the footprint is in remote areas. Sensitive receptors are not locally impacted by GHG emissions; project has a net positive GHG impact.	**High** Acceptable level of certainty pertaining to values and receptors	**Minor**
GHG emissions from land clearing and land use change	**Likely** Land clearing and land use change is to take place	**Widespread** Land clearing on a combined area ~12,900ha	**Medium-term** Impact occurs only during the construction phase	**Minor** Relevant criteria for environmental protection are met	**Low** Most of the footprint is in remote areas. Sensitive receptors are not locally impacted by GHG emissions; project has a net positive GHG impact.	**High** Acceptable level of certainty pertaining to values and receptors	**Minor**

Table 12-3. Summary of EIA results - Atmospheric processes factor - Operations

Impact	Likelihood	Scale	Duration	Magnitude	Value rating	Certainty	Residual impact
GHG emissions from the decomposition of organic debris and loss of soil carbon during operation	**Likely** Organic matter from land clearing will decompose	**Widespread** Organic matter and debris from a combined area of ~12,900ha	**Long-term** Impacts will occur over the operational phase.	**Minor** Relevant criteria for environmental protection are met	**Low** Local sensitive receptors are not impacted by GHG emissions; project has a net positive GHG impact.	**High** Acceptable level of certainty pertaining to values and receptors	**Minor**
Positive Impact **Overall reduction in GHG emissions from generation of renewable energy**	**Likely** This is the intent of the Project	**Widespread** Intended benefits are regional and global	**Long-term** Impact will occur over the construction and operational phase.	**Major** The degree of the change will contribute to the protection of environmental values, ecological function, and sensitive receptors	**High** Important at regional, national, and international scale	**High** Overall project objective	**Major**

12.4.3 Emissions Inventory

The AAPowerLink will have a positive impact on reducing the NT's GHG emissions by increasing the supply of renewable energy to the DKES and to existing and new industrial users in NT. The potential abatement opportunities and emissions associated with construction and operation of the AAPowerLink have been assessed using the methods and guidance discussed in Appendix H, Section 5.

12.4.3.1 Emissions sources

The breakdown of GHG emission sources from the AAPowerLink over the life of the project, inclusive of construction, operations, and decommissioning, is presented in Figure 12-4. Most emissions (69%) are associated with the combustion of fuel from vessels, plant and equipment for earthworks, air and land travel, logistics and power generation. Almost one-third of emissions (28%) come from the decomposition of organic debris and loss of soil carbon over the 70-year life of the infrastructure, prior to decommissioning. Emissions from land clearing and land use change accounts for 3% of total GHG emissions.

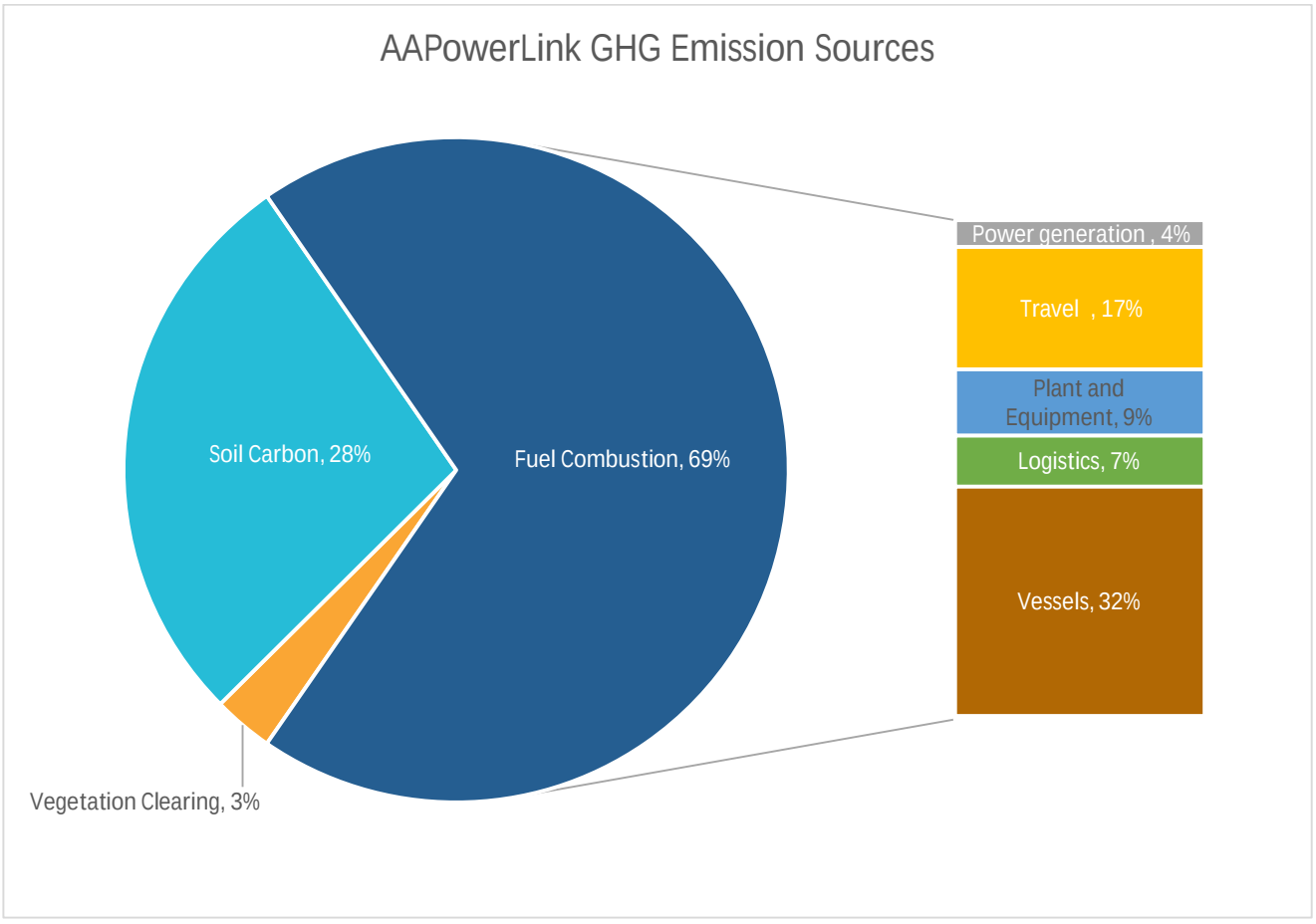


Figure 12-4. AAPowerLink GHG emissions by source for the Project life (Xodus 2022)

12.4.3.2 Direct and indirect emissions from project activities

Scope 1, 2 and 3 emissions within the boundary of assessment during construction, operations, and decommissioning phases of the AAPowerLink project are presented in Table 12-4 The construction phase of the project is the most GHG-intensive, with an estimated total production of ~3 MT CO_2e over the four-year construction schedule. During operations, low levels of GHG emissions (~0.01 MT CO_2e/year) are associated with energy consumption and maintenance/repair activities. Decommissioning will take approximately three years and is estimated to emit 0.5 MT CO_2e/year.

Table 12-4. Australia scope 1, 2 and 3 emissions associated of the AAPowerLink (Xodus 2022)

PROJECT PHASE	SCOPE 1 EMISSIONS (T)	SCOPE 2 EMISSIONS (T)	SCOPE 3 EMISSIONS (T)	TOTAL (CO_2E) (T)
Design and operations office	10,000	-	1,000	11,000
Construction	2,500,000	4000	100,000	2,604,000
Operations	500,000	-	5,000	505,000
Decommissioning	500,000	-	20,000	520,000
Uplift (20%)	700,000	1000	25,000	725,000
Total (emitted CO_2e)	**4.2 million**	5000	0.2 million	**4.4 million**
NT avoided emissions (Operations)			-115 million	-115 million
Total (net CO2e)				**-110 million**

12.4.3.3 Avoided GHG emissions

The AAPowerLink project is a carbon positive supplier of low-emissions, renewable solar electricity, and as such, presents carbon abatement opportunities to assist the NT and Singapore in reducing power generation emissions and ultimately achieve their net zero GHG targets. Each GWh of electricity generated by the AAPowerLink project will avoid between 410 and 540 T CO_2e emissions from fossil fuel generated power in NT or Singapore. These emissions avoided are considered as a carbon abatement or negative emissions in line with the accounting methodology outlined in *Carbon Credits (Carbon Farming) Act 2011* and the United Nations Framework Convention on Climate Change *International Financial Institutions Technical Working Group on Greenhouse Gas Accounting: GHG Accounting for Grid Connected Renewable Energy Projects* 2019.

The project will export approximately 1.2 million GWh, avoiding a total of 485 MT CO_2e from fossil fuel power generation including:

- Within the NT: 1.8 MT CO_2e/y or 115MT CO_2e over the Project life.
- Within Singapore: 5.7 MT CO_2e/y or 370 MT CO_2e over the Project life

12.4.3.4 Emissions profile

The net annual GHG emissions profile (Figure 12-5) indicates that avoided emissions during the operation phase dominate the emissions over the life of the project, resulting in net emissions of -110 million CO_2e. These operational avoided emissions significantly offset the construction emissions in years 0-4, maintenance emission in years 5-69, and decommissioning emissions in years 70-72.

An analysis of the total emissions (Figure 12-6) indicates the project will be carbon neutral (net zero) after four years of operation, at which time the project significantly becomes carbon positive for the remaining lifetime of the project.

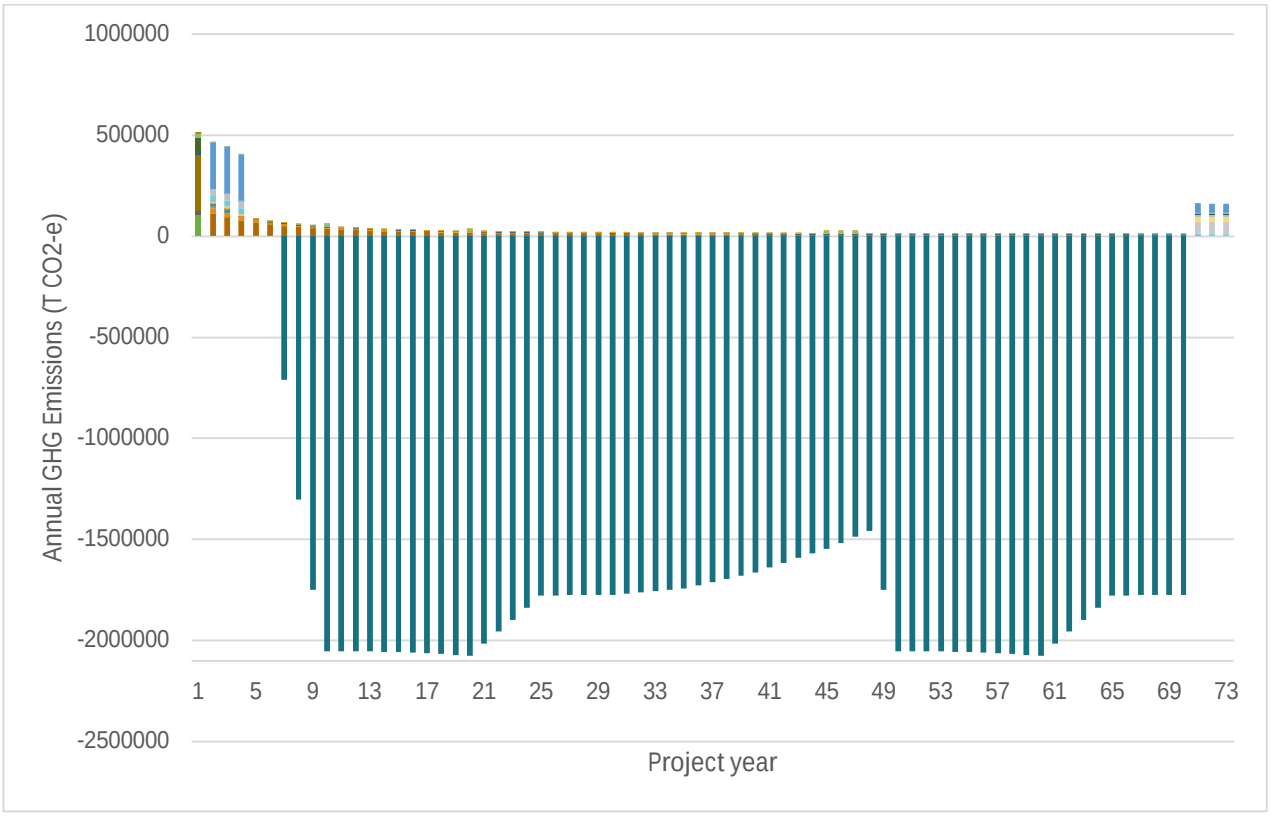


Figure 12-5. AAPowerLink GHG emissions profile within Australia (Xodus 2022)

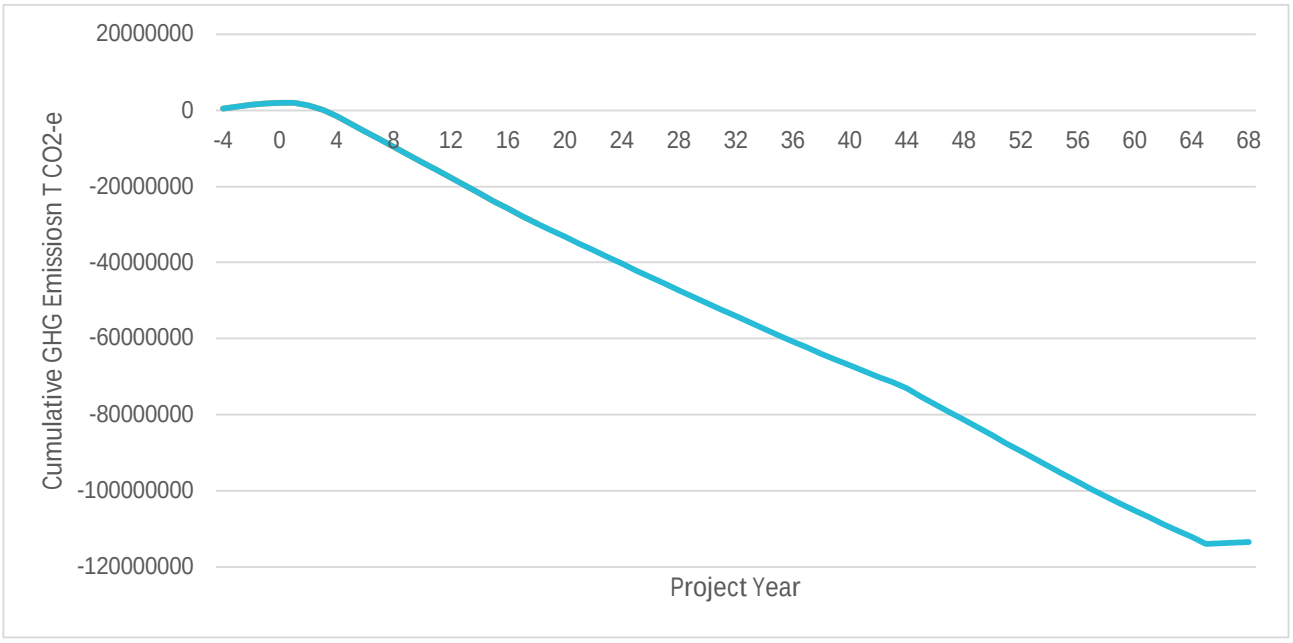


Figure 12-6. AAPowerLink cumulative GHG emissions within Australia (Xodus 2022)

12.4.3.5 Alignment with NT and Australian emission and renewables targets

AAPowerLink aligns with the NT and Australian net-zero emissions targets, as it is a carbon positive project within both the NT and Australian assessment boundaries. Approximately 485 MT of CO_2e will be avoided over the life of the project globally, including net 110 MT CO_2e avoided in NT, with the remainder avoided in Singapore. This positive impact significantly contributes to the decarbonization of both the NT's public electricity generation and industry sectors in line with the NT and Australian net zero GHG targets.

For context, AAPowerLink will increase the solar generation capacity of the NT by ~70 times the currently installed solar generation capacity and will produce almost half (45%) as much power as all of the current rooftop solar installations in Australia (DISER, 2021[c]). This electricity generation will supply the NT with the equivalent of 2.8 times the DKES electricity demand annually[2] or approximately 10% of the NT's total energy needs (DISER, 2021[b]), equivalent to the electricity used by over half a million Australian homes.

The lifetime GHG emissions avoided anticipated to be achieved by the AAPowerLink in NT will have the same impact as removing 1.1 million Australian cars, or 10% of the total carbon credits generated by every emissions reduction project in Australia, registered under the Carbon Credit (Carbon Farming) Act 2011 in 2020-21.

Further, based on the evaluated scenario, it is projected that AAPowerLink will supply ~30% of the DKES electricity requirements, avoiding emissions of approximately 0.3 MT of CO_2e per year and ~19 MT of CO_2e over the project life in the NT. These avoided emissions represent the potential for:

- A 30% reduction in GHG emissions from the DKES
- A 30% reduction in GHG intensity of the DKES from 0.54 kg CO_2e/kWh prior to project start-up to 0.4 kg CO_2e/kWh.
- A 20% reduction in total GHG emissions from public electricity generation in the NT
- An overall reduction in the NT's total annual GHG emissions of ~10%
- A reduction of ~0.3% in Australia's national GHG inventory (DISER, 2021[a&b])

While outside of the scope of this document, it is noted that climate change is a global issue and the project has an impact on reducing global GHG emissions, estimated at 4.2 times the impact in the NT. The AAPowerLink is projected to supply ~27% of Singapore's 2020 electricity needs (Energy Market Authority, 2022), or ~15% of Singapore's electricity needs[3], over the life of the project, based on the market predictions from 2028 onwards (Energy Market Authority, 2021), with low carbon electricity facilitating a reduction in GHG emissions of 5.7 MT CO_2e/yr. or 370MT CO_2e over the Project life. This represents the potential for:

- A 27% reduction in Singapore's GHG emissions from electricity generation
- A reduction in Singapore's GHG intensity from 0.41 kg CO_2e/kWh to 0.3 kg CO_2e/kWh
- A 10% reduction in Singapore's total annual GHG emissions, equivalent to the emissions from 3.8 million Australian cars, or equivalent to the electricity used by over 2 million Australian homes. (National Climate Change Secretariat, 2021)

[2] Based on the 2019-2020 DKES electricity demand

[3] AAPowerLink aims to supply ~27% of Singapore's 2020 electricity needs (Energy Market Authority, 2021). Based on The Energy Market Authority projections for total electricity demand in 2032, AAPowerLink aims to supply ~17% of the projected 2032 total electricity use (Energy Market Authority, 2021a). It is noted that the Energy Market Authority published forecast does not extend beyond 2032 and thus does not cover the duration of the project. A conservative assumption of supplying ~15% of Singapore's electricity needs has been used for the purpose of this report.

12.5 Avoidance, mitigation, and monitoring

Sun Cable is aligned with the NT government objective of achieving net zero emissions by 2050 and has set the following long-term targets for the AAPowerLink:

- Maximise the carbon abatement opportunity from AAPowerLink
- Be a net zero infrastructure project
- Be a carbon positive exporter of electricity

As a component of achieving these objectives, Sun Cable is actively pursuing the identification of opportunities for avoiding and minimising GHG emissions from the construction, operation and decommissioning of the AAPowerLink through innovation and adoption of low carbon technologies. Consistent with section 26 of the *EP Act*, the identification of opportunities focusses on applying the environmental decision-making hierarchy as follows:

1. Avoid - Ensure that actions are designed to avoid adverse impacts on the environment.
2. Mitigate - Identify management options to mitigate adverse impacts on the environment to the greatest extent practicable.
3. Offset - If appropriate, provide for environmental offsets for residual adverse impacts on the environment that cannot be avoided or mitigated.

To commence this process, a design GHG mitigation workshop was held on 28th October 2021. The workshop identified several opportunities to avoid and mitigate GHG emissions that have been adopted and incorporated into the AAPowerLink design, and several opportunities that Sun Cable is committed to further assessing the feasibility of prior to commencement of construction[4]. Sun Cable has also set a target to conduct a life cycle assessment during the design phase to quantify GHG emissions including embodied, direct, and indirect emissions and demonstrate that the AAPowerLink is a carbon positive project. These commitments are captured in Table 12-5.

To manage and continually improve GHG performance, Sun Cable will develop a GHG Abatement and Management Plan, based on the GGAP provided in Appendix H. The plan will be aligned with *ISO 14001 Environmental Management Systems* and will identify and adopt GHG reduction opportunities. The plan will incorporate GHG mitigation workshops every 2 years during the design and construction phase and reviews during operations every 5 years. The plan will allow flexibility to review mitigation actions and abatement plans so they can be improved and updated to enable further emissions reductions throughout the life of the project.

[4] It is noted that due to the level of maturity of some of the technology options considered in the workshop to reduce emissions during operations it is likely that some will not yet be commercially available in the NT. As such a commitment is made to review GHG mitigation options every 5 years to allow for consideration of evolving technology and GHG reduction opportunities.

Table 12-5. GHG emissions – Avoidance, mitigation, monitoring and reporting commitments

Impact	Avoidance	Mitigation	Monitoring	Reporting
Greenhouse gas emissions	Continue to identify and engage in opportunities to maximise commercially viable carbon abatement from the AAPowerLink, including: • Pursuing power purchase agreements with large fossil fuel power generators in the NT. • Conduct a life-cycle assessment during the design phase to quantify GHG emissions including embodied, direct, and indirect emissions and demonstrate that the AAPowerLink is a carbon positive project • Supply AAPowerLink construction and operational power needs via self-generated solar energy where practicable. • Where the use of self-generated solar energy is not possible, source renewable energy via market mechanisms (if available). • Identify and (where practicable) adopt practical zero carbon technology solutions such as electric vehicles, plant and equipment and remote solar energy systems.	Develop and implement a GHG Abatement and Management Plan that aligns with ISO 140001 Environmental Management Systems Conduct GHG mitigation workshops every 2 years during design and construction and every five years during operations to assess performance and identify new opportunities for leveraging best practice and emerging technology. Procurement strategies to consider adoption of carbon reduction and energy efficient technologies (where practicable), including but not limited to: • Electrification options for civil plant, machinery, and equipment. • Energy efficiency in aircraft services selection. • Electrification and alternative fuel options for transportation (e.g., marine vessels, rail) Develop vegetation management strategies that aim to retain vegetation and soil carbon Conduct studies to identify and select clearing, fire management,	Monitor GHG emissions from activities, as well as energy produced and exported in line with the requirements of NT and Commonwealth law. Data required to calculate GHG emissions will be collected in line with the methods outlined in the *National Greenhouse and Energy reporting (Measurement) Determination 2008* Monitor performance against targets set in the GHG Abatement and Management Plan.	Reporting of GHG emissions in line with the requirements of the *NGER Act*. AAPowerLink will trigger emissions thresholds for reporting during construction and reporting thresholds for energy production during operations. External reporting in accordance with environmental approval conditions under the *EP Act*.

Impact	Avoidance	Mitigation	Monitoring	Reporting
	• Explore practicable opportunities with NT Carbon Capture Utilisation and Storage Project	vegetation disposal practices and vegetation species to plant or retain. Develop and implement Rehabilitation Plans that aims to reinstate vegetation post-construction and post-decommissioning		

12.6 Residual impacts

As stated at the start of this chapter, the NT EPA's objective for the Atmospheric processes factor is to:

"Minimise greenhouse gas emissions so as to contribute to the NT Government's aspirational target of achieving net zero greenhouse gas emissions by 2050 and adapt to a changing climate to protect ecological integrity and maintain the welfare and amenity of people."

The residual impact of the AAPowerLink to atmospheric processes is summarised below, assuming the adoption of the impact avoidance, mitigation and monitoring measures described in this chapter.

Each impact to atmospheric processes was assigned a residual impact rating taking into consideration the scale, magnitude and duration of the impacts, the presence/absence of environmental values and/or sensitive receptors and the level of certainty with respect to the intensity of the impact and the effectiveness of the mitigation measures. The residual impact ratings adopted in the assessment were provided earlier in Table 12-1. The combined residual impact to atmospheric processes from all components of the AAPowerLink construction and operations is summarised in Table 12-6.

Table 12-6. Residual impact ratings for impacts to Atmospheric processes

Impacts	Residual Impact Rating
Construction	
GHG emissions from combustion of fuel from vessels, plant and equipment for earthworks, air and land travel, logistics and power generation	**Minor**
GHG emissions from land clearing and land use change	**Minor**
GHG emissions from the decomposition of organic debris and loss of soil carbon during operation	**Minor**
Operations	
GHG emissions from the decomposition of organic debris and loss of soil carbon during operation	**Minor**
Positive Impact Overall reduction in GHG emissions from generation of renewable energy	**Major (positive)**

As presented in the GGAP, the residual impacts of AAPowerLink will be predominantly positive locally, domestically, and internationally, supporting the NT in achieving its target of net zero by 2050 (by avoiding GHG emissions from fossil fuel power generation). The positive impact of overall reduction in greenhouse gas emissions is considered a Major residual impact.

The project will notably contribute to decarbonising the NT's electricity generation system by increasing the territory's solar generation capacity seventy-fold, producing almost half (45%) as much power as all current rooftop solar installations in Australia, and therefore providing ~10% of the NT's total energy needs via solar renewable energy. In total, within the Australian EIS boundary, an avoidance of 115 MT CO_2e emissions is anticipated over the project life, with a 110 CO_2e net avoidance adjusted for initial project stages. This avoidance further solidifies a path to the EPA's objective and NT's aspirational target of *net zero GHG emissions by the year 2050,* as this project will singularly reduce (by ~10%) annual GHG emissions in the NT, and a ~0.3%

reduction in the national GHG emissions inventory. This is equivalent to the electricity used by over half a million Australian homes[5] or the emissions from 1.1 million Australian cars[6].

Furthermore, although not within scope of the Australian EIS, AAPowerLink's global benefit of reduction in global GHG emissions is significant by providing a projected supply of ~15% of Singapore's electricity needs over the life of the project, based on the market predictions from 2028 onwards (Energy Market Authority, 2021), equivalent to ~370MT of CO_2e avoided in Singapore over the project life. This is an approximate 10% reduction in Singapore's total annual GHG emissions, equivalent to the emissions from 3.8 million Australian cars or equivalent to the electricity used by over 2 million Australian homes. This would signify a total avoided emissions of 485 MT CO_2e globally between NT and Singapore.

The residual impact of land clearing, greenhouse gas emissions from combustion of fuel (vessels, equipment, transport etc) and decomposition of organic matter and loss of soil carbon all have a residual impact of Minor. While there are some short to medium term impacts of GHG emissions associated with the project relating to events (land clearing and construction), the project includes GHG mitigations to avoid and reduce GHG emissions to as low as reasonably practicable (ALARP).

The mitigation components for the initial Project phase include alternate use of renewable energy when self-generated energy is not practicable as well as vegetation management measures amongst others discussed in Table 12-5. As discussed in Section 12.5, the Project offsets its initial footprint within four years of operations, achieving net zero and becoming increasingly carbon positive throughout its life cycle. GHG emissions associated with the operations and decommission phases will be offset by the project's lifetime GHG emission avoidance profile.

12.7 Cumulative impacts

Cumulative impacts were considered by assessing potential residual GHG impacts of AAPowerLink together with residual impacts from other past, present, and reasonably foreseeable future projects. The framework used to assess cumulative impacts of the project is described in Chapter 3.

AAPowerlink aims to provide dispatchable electricity at a lower wholesale price than the current average cost of gas-based electricity in the NT. With the establishment of a competitive, low-emissions, renewable energy source, local existing and future developments can substitute their power consumption with AAPowerLink's carbon positive energy versus the current and commonly used fossil fuel derived power. The type and scale of development that could occur is difficult to predict, but it is reasonably foreseeable that the project will stimulate economic activity as development is encouraged based on industry access to this lower cost resource without the added GHG emissions footprint from power demands in the NT.

Reasonably foreseeable future development activities which could contribute to potential cumulative impacts are anticipated in Barkly Region where the Solar Precinct is located, Darwin Region where the OHTL corridor and Darwin Converter Site are located and near the marine area of outer Darwin Harbour and Timor Sea where the Subsea Cable System will be located.

[5] Based on average household consumption of 19kW/day
[6] Based on Department of Industry Science Energy and Resources data on fuel efficient cars

The potential for cumulative impacts arises mainly in the construction phase of the AAPowerLink and its potential to coincide with the construction phases of any of the projects mentioned below. The potential for an increase in traffic volume, industrial machinery use and construction activity simultaneous to the AAPowerLink Project could yield higher GHG emissions for the NT in a particular time period.

- The Barkly region is anticipated to experience increased development as a result of the Barkly Region deal to stimulate economic growth via infrastructure development and upgrades in the region. Similarly, Beetaloo Sub Basin onshore gas developments and exploration have been identified as a high priority initiative by the NT for purposes of domestic and international gas use and provisioning, thus projects regarding the concept are anticipated. Lastly, as mining exploration is already a practice in the Barkly Region, it is reasonable to foresee future mining developments.
- The Darwin region's Gunn Point Peninsula has been deemed a Priority Development Zone with a goal of being a rural centre tourist destination and ability to use its deep-water port with associated industrial facilities. Per Chapter 3, this area is also identified as a "Future Renewable Energy Hub" which anticipates an investment in large scale solar projects close to existing transmission lines. In a similar fashion, industry, the NT, and Australian governments are anticipated to make Middle Arm a sustainable precinct with focus on low emission petrochemicals, renewable hydrogen, carbon capture storage and mineral processing. Proximal to the Darwin Converter site, a prawn hatchery has been proposed and a development permit has been issued although the construction schedule is not currently known.
- The Santos Darwin Pipeline Duplication project located in the Shoal and Timor Sea area will facilitate movement of gas from the Barossa Field to the Darwin LNG facility. This project has a planned construction date of 2023 and would cross the AAPowerLink subsea Cable System route.

While cumulative residual impacts as a result of GHG emissions are possible, the previously determined residual impact ratings (scale, severity, value, certainty, and likelihood) are not expected to change.

12.8 Offsets

Offsets pertaining to atmospheric processes are not required as there are no overall residual negative impacts relating to GHG emissions from the AAPowerLink project when emissions over the Project's life cycle are contemplated. The total avoided emissions will result in the AAPowerLink being net zero by year four of operations, with net carbon positive emissions increasing to ~110 MT CO2e carbon positive at the end of its life. Sun Cable has committed to monitoring and reporting to verify that the project is carbon positive as discussed in Table 12-5.

12.9 References

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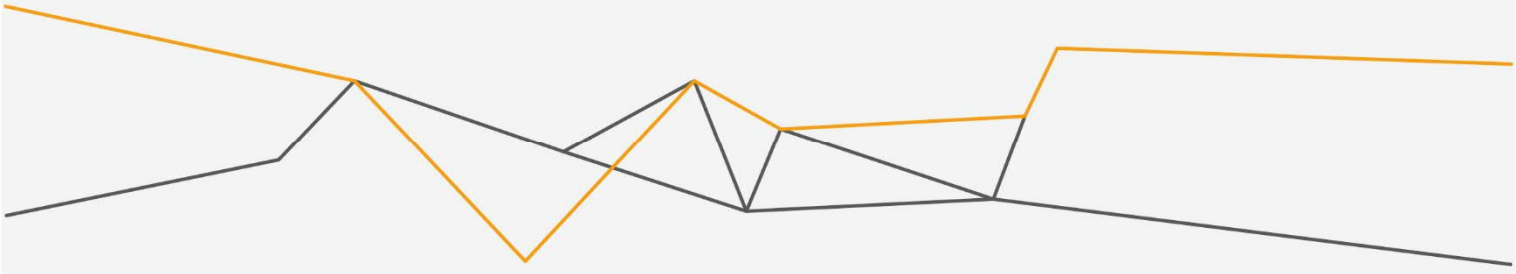

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