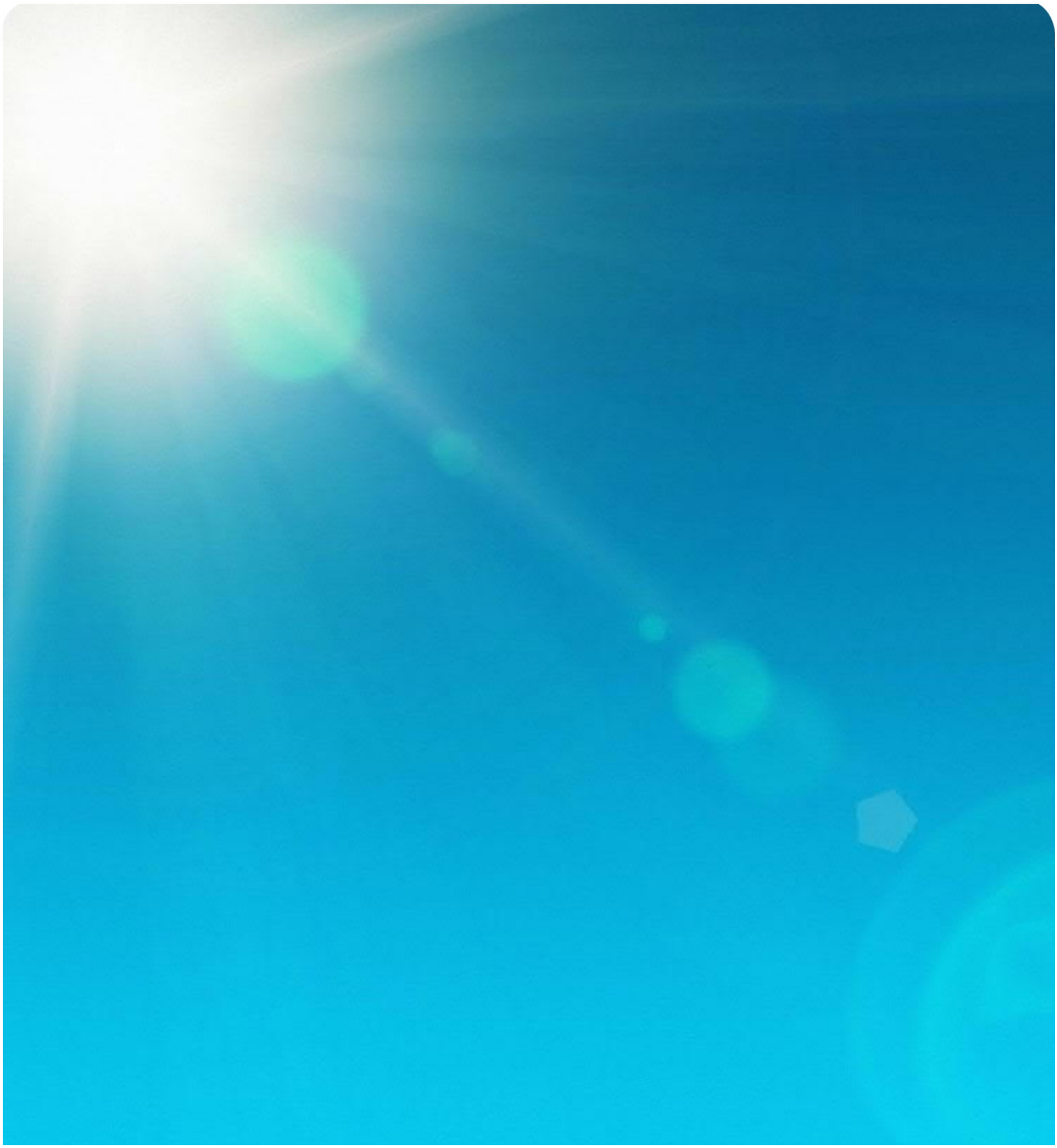
suncable.sg

SUN CABLE

March 2022

Appendix H – Carbon Emissions Study and GHG Abatement Plan

Australia-Asia PowerLink Environmental Impact Statement



Sun Cable Pty Ltd

Carbon Emissions Study

Greenhouse Gas Abatement Plan

ASSIGNMENT P300243-S00
DOCUMENT P-300243-S00-REPT-001

XODUS

Perth

Level 5
1 William Street . Perth
WA 6000 . Australia

T +61 (0)86555 5600
E petrina.raitt@xodusgroup.com

www.xodusgroup.com

REVISIONS & APPROVALS

This document has been prepared by Xodus Green Light Pty Ltd exclusively for the benefit and use of Sun Cable Pty Ltd. Xodus Green Light Pty Ltd expressly disclaims any and all liability to third parties (parties or persons other than Sun Cable Pty Ltd) which may be based on this document.

The authenticity, completeness and accuracy of any information provided to Xodus Green Light Pty Ltd in relation to this document has not been independently verified. No representation or warranty express or implied, is or will be made in relation to, and no responsibility or liability will be accepted by Xodus Green Light Pty Ltd (or any of its respective directors, officers, employees, advisers, agents, representatives and consultants) as to or in relation to, the accuracy or completeness of this document. Xodus Green Light Pty Ltd expressly disclaims any and all liability which may be based on such information, errors therein or omissions there from.

REV	DATE	DESCRIPTION	ISSUED	CHECKED	APPROVED	CLIENT
3	21/3/22	IFU	SH	LS	PR	MB
2	9/3/22	IFU	SH	LS/AT	PR	MB
1	1/3/22	IFU	SH	LS/AT	PR	JS
0	14/12/21	IFU	SH	LS/AT	PR	JS
A	8/11/21	IFR	SH	LS	PR	-

CONTENTS

1 PURPOSE 5
1.1 Structure 6

2 INTRODUCTION 6

3 PROJECT DESCRIPTION 7

4 CONTEXT 8
4.1 Northern Territory Energy Mix 8

5 EMISSIONS ESTIMATE 9
5.1 Methodology 9
5.1.1 Boundary 10
5.1.2 Carbon Assessment Data Collection 12
5.1.3 Inclusions 13
5.1.3.1 Data Collection and Uncertainty 16
5.1.4 GHG Source Exclusions 16
5.2 Emissions Estimate 17
5.2.1 GHG avoided emissions 21
5.2.1.1 Northern Territory Avoided Emissions 21
5.2.1.2 Singapore Emissions Avoided 22
5.2.2 Scope 1 22
5.2.3 Scope 2 23
5.2.4 Scope 3 23
5.2.5 Assumptions 23
5.3 Potential Impacts and Risks 24

6 AVOIDANCE MITIGATION AND MANAGEMENT 26
6.1 Long Term Emissions target 26
6.2 Impact Avoidance and Mitigations 26
6.3 Implementation 29
6.3.1 Monitoring and Reporting 30
6.3.2 NGERs Reporting 30

7 RESIDUAL RISKS/IMPACT & OFFSETS 31

8 REVIEW 33

9 REFERENCES 34

APPENDIX A FULLCAM MODEL INPUTS 36

APPENDIX B GHG CALCULATION RESULTS 37
B.1 Scope 1 37
B.2 Scope 2 38
B.3 Scope 3 39

1 PURPOSE

This document addresses the Sun Cable Pty. Ltd Australia-Asia PowerLink (AAPowerLink) project (the Project) Environmental Impact Statement (EIS) requirements for an atmospheric processes study, combined with the requirements for a Greenhouse Gas (GHG) Abatement Plan, required under Northern Territory (NT) Government's *GHG Emissions Management for New and Expanding Large Emitters Policy* (2021) (the Large Emitters Policy). This document provides the information required to meet the requirements of both, as outlined in Table 1

Table 1 Environmental Impact Statement requirements for processes study and greenhouse Gas Abatement Plan

REQUIREMENT	EIS	LARGE EMITTERS POLICY
Content	**Atmospheric Processes Study Terms of Reference**	**GHG Abatement Plan Requirements**
Project description	✓	✓
Scope 1 and 2 emissions	✓	✓
Scope 3 emissions		✓
Comparison with NT & national emissions	✓	
Long term project GHG goal and targets		✓
Contribution to NT net zero target	✓	
Improvements in supply of renewables and contribution to NT renewables target	✓	
GHG avoidance, mitigation and management	✓	✓
GHG mitigation continuous improvement		✓
Monitoring and reporting	✓	✓
Residual impact	✓	
Offsets	✓	
Review		✓

1.1 Structure

The structure of this document is as follows:

- Section 2: Introduction
- Section 3: Project Description
- Section 4: Context
- Section 5: Emissions Estimate
- Section 6: Avoidance Mitigation and Management
- Section 7: Residual Risks/Impacts and Offsets
- Section 8: Review

2 INTRODUCTION

Under the NT Government's Large Emitters Policy, projects which exceed the triggers outlined below are required to develop a GHG Abatement Plan.

- *Industrial project threshold: Estimated scope 1 emissions of 100 000 T CO_2e in any financial year over the life cycle of a project, not counting emissions generated from land clearing directly associated with the Project.*

- *Land use project threshold: Estimated scope 1 emissions of 500 000 T CO_2e generated from a single land clearing action OR cumulatively from multiple land clearing actions on a 'property' over time.*

The AAPowerLink triggers the Large Emitters Policy thresholds largely due to land clearing and construction emissions.

This document is a GHG Abatement Plan and summarises the GHG emissions inventory for the Project for the purpose of an EIS to address the requirements of the Large Emitters Policy. The inventory is a complete and accurate estimation of the amount of GHG emissions that can be directly attributed to the organisation's operations within the declared boundary and scope.

The inventory has been prepared in accordance with the requirements of the GHG Protocol: A Corporate Accounting and Reporting Standard (2004) and ISO 14064-1:2006 Specification with Guidance at the Organization Level for Quantification and Reporting of GHG Emissions and Removals[1]. The calculation methodology utilised aligns with Australian Commonwealth Government and NT government legislation, regulations and guidelines for the preparation of GHG inventories.

[1] *Throughout this document 'GHG Protocol' means the GHG Protocol Corporate Accounting and Reporting Standard and 'ISO 14064-1:2006' means the international standard Specification with Guidance at the Organizational Level for Quantification and Reporting of Greenhouse Gas Emissions and Removals.*

3 PROJECT DESCRIPTION

Sun Cable Pty. Ltd. is proposing to build the AAPowerLink, a renewable energy a high-voltage direct current (HVDC) energy transmission network that connects NT and Singapore energy markets to a new, large-scale solar farm and energy storage facility located in the Barkly Region of the NT. The AAPowerLink will generate, store and transmit renewable electricity to Australian and overseas markets. The AAPowerLink project proposal comprises six key components:

- Solar Precinct where electricity will be generated, stored, and transmitted, near Elliott in the Barkly Region, NT
- Overhead Transmission Line (OHTL) to transmit electricity from the Solar Precinct to Darwin
- Darwin Converter Site including Voltage Source Converters (VSC), energy storage and network connection to supply electricity to the Darwin region
- Cable Transition Facilities to enable transition of power cables between land and sea
- Subsea Cable System extending between the Cable Transition Facilities and Singapore including the subsea cable
- Singapore Converter Station to receive electricity and supply the Singapore electrical network.

The proposal is being assessed at the level of an EIS under the NT *Environment Protection Act 2019* (EP Act) and Commonwealth *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act) under an accredited assessment process. Offshore project components within the NT Coastal Waters limit are subject to the EP Act and the Australia Exclusive Economic Zone (EEZ) sets the extent of the EPBC Act assessment. The Terms of Reference (TOR) for preparation of an EIS were issued by the NT EPA on 21st January 2021 and an amendment was issued on 5th October 2021 to incorporate a variation to the location of the Darwin facilities and Subsea Cable System components). The TOR require that the EIS assesses potential impacts to the NT EPA's objective for Atmospheric Processes, which is to: Minimise GHG emissions and thereby contribute to the NT Government's aspirational target of achieving net zero emissions by 2050.

4 CONTEXT

4.1 Northern Territory Energy Mix

The NT used 41083 gigawatt hour (GWh) of energy in 2019-2020. During this period 33.6% of energy was from oil fuelled generation, 65.6% was from gas fuelled generation with 0.8% from renewable sources. 44.8% of the energy generated in the NT was utilised in the electricity sector with 51.8% was used in mining and industry (DISER, 2021b).

NT total GHG emissions for 2019-2020 was approximately 20.7 million tonnes (MT) of CO2e, with approximately 5.8 MT of CO2e for stationary energy purposes (including energy industries (inclusive of mining, oil and gas and public electricity generation), manufacturing industries and construction). Approximately 1.4 MT CO2e per year is emitted from public electricity generation in the Territory contributing approximately 0.7% to the Australian national greenhouse inventory (DISER, 2021, DISER, 2021[d] & Clean Energy Regulator 2022).

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 (2020) provided a recent review of electricity usage and forecasts including renewables uptake (excluding AAPowerLink), the review is bounded by the NT's regulated power systems, namely Darwin-Katherine, Alice Springs and Tennant Creek and states the following:

> *Based on existing uptake rates of residential and commercial solar PV installations and committed large-scale solar PV projects only (excluding AAPowerLink), solar PV generation is forecast to increase over time to meet 19 per cent of underlying consumption (total consumption at consumers' power points) by 2028-29 in Darwin Katherine, 12 per cent in Alice Springs and 2 per cent in Tennant Creek. Overall, across the three regulated power systems, this equates to a forecast increase from 5 per cent of underlying consumption from renewable energy in 2018-19 to 18 per cent in 2028-29.*

It is noted that AAPowerLink will supply approximately 800 MW of electricity to users in the Darwin-Katherine region, potentially including customers on the Darwin Katherine Interconnected System (DKIS) as well as industrial customers who typically utilise behind the meter power generation. The average GHG intensity of NT public electricity in 2020 was 0.62 kg CO_2e/kWh with the average GHG intensity of the DKIS was 0.54kg CO_2e/kWh, this DKIS GHG intensity figure (0.54kg CO2e/kWh) is used in the estimates provided in this plan (DISER, 2021[a]).

There is a large behind the meter power generation capacity supporting industry in the NT from both the INPEX and Darwin LNG facilities. This power generation capacity is comprised of gas fired generation with waste heat recovery bottoming cycle. These facilities do not currently integrate any renewables into their power generation systems. The GHG intensity of the power generation capacity at the LNG facilities is in the order of 0.42kg CO_2e/kWh (Hardisty et al, 2012), this figure is used in the estimations provided in this plan for both new and existing potential industrial customers of AAPowerLink.

For the purposes of this assessment, a supply scenario was developed with the assumption that 100MW of electricity would be made available for customers on the DKIS, with 700 MW made available for new and existing industrial customers. This division of supply is theoretical and does not necessarily represent the final allocation of power supply to NT customers.

5 EMISSIONS ESTIMATE

5.1 Methodology

The calculation methodology used in this Plan aligns with the following legislation, regulations, standards and guidelines:

- ISO 14064 Greenhouse gases – Part 1: Specification with guidance at the organisation level for quantification and reporting of greenhouse gas GHG emissions and removals.
- GHG Protocol a Corporate Accounting and Reporting Standard
- National and Territory GHG Legislation, regulations & policy:
- *National Greenhouse and Energy Reporting Act 2007* (NGER Act)
- *National Greenhouse and Energy Reporting Regulations 2008*
- *National Greenhouse and Energy Reporting (Measurement) Determination 2008*
- *Greenhouse Gas Emissions Management for New and Expanding Large Emitters Policy*
- Climate Active Carbon Neutral Standard
- Delivering the Climate Change Response: Towards 2050 A Three Year Action Plan for the NT Government - Action Plan
- 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
- Full Carbon Accounting Model (FullCAM) see Appendix A for model inputs

The Plan is also aligned with the following guidance relating to offsets:

- NT Draft GHG Offsets Policy and Technical Guidelines
- Commonwealth Government Climate Active Carbon Neutral Standard

The inventory calculations use emissions factors from National Greenhouse and Energy Reporting (Measurement) Determination 2008, or if not available, alternative national or international factors are applied.

The method for calculating emission followed the following steps:

1. Established a boundary for the GHG estimate;
2. Conducted a carbon assessment definition (CAD) workshop to define sources within the boundaries of the estimate:
    a. defined the activities contributing to GHG emissions occurring within each aspect of the Project
    b. define the required input data to calculate an estimate of GHG emissions from each activity or aspect
    c. identify the source of the input data;
3. Source the input data and determine appropriate assumptions where data gaps or a lack of definition existed;
4. Construct a calculation based on the inputs and assumptions sourced.

5.1.1 Boundary

The boundary of the GHG estimate for the EIS and GHG Abatement Plan is defined in Figure 1. The aim of the Project is to maximise carbon abatement opportunity to avoid GHG emissions, to be net zero and be a carbon positive exporter of electricity. Therefore, the avoided emissions within the NT are include within the GHG assessment boundary. Avoided emissions overseas are discussed for context but are excluded from the scope of the GGAP.

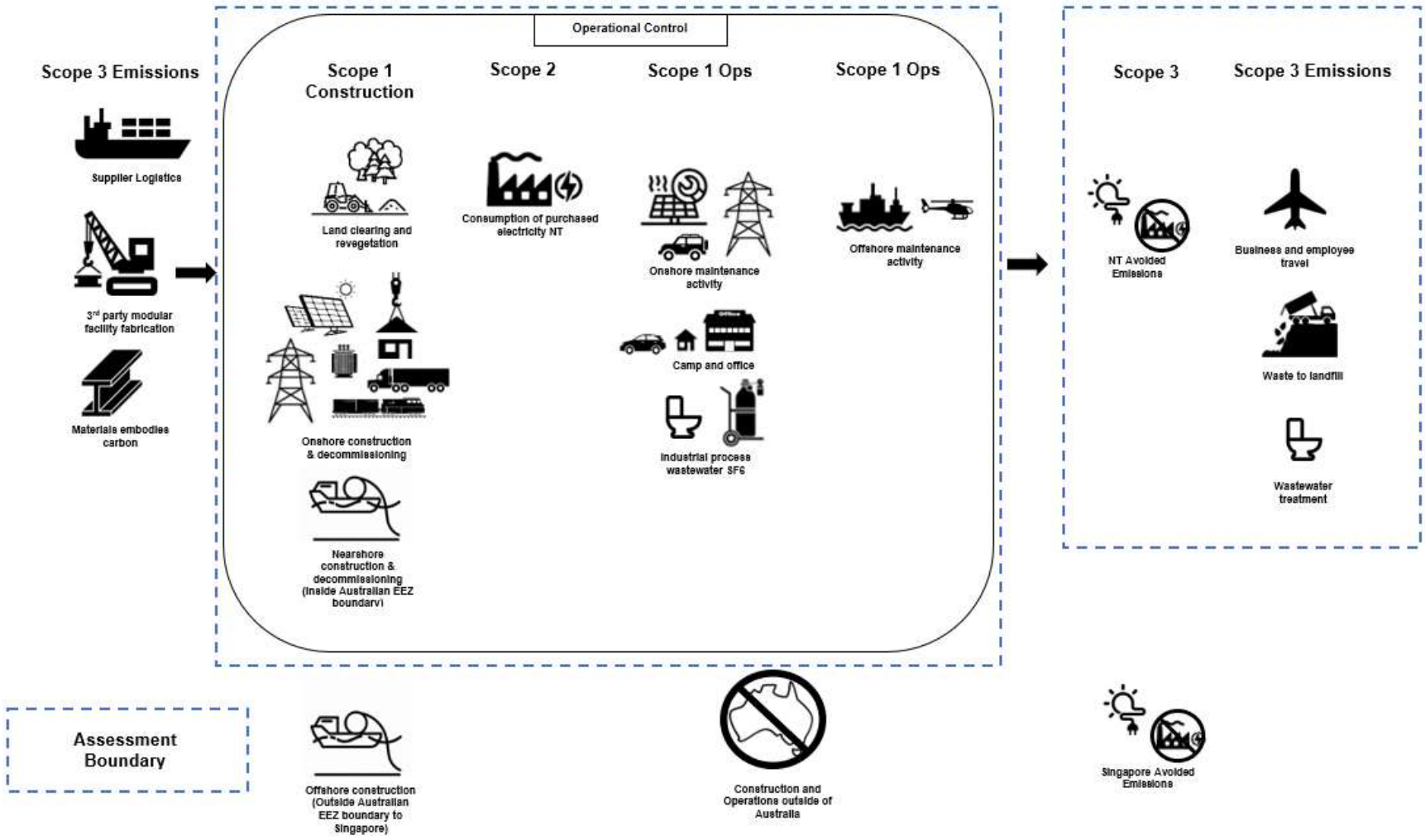


Figure 1: GHG Estimate Boundary

The estimate includes scope 1 and 2 emissions from AAPowerLink and its main subcontractors within the Australian and NT jurisdiction (included within the scope 1 boundary). It includes relevant scope 3 emissions from travel, waste and wastewater associated with the construction and operations of the Project. The provision of solar power, which would otherwise be met by fossil fuel combustion, and the subsequent NT avoided emissions[2], is included within the scope of the estimate.

Emissions outside of the NT and Australia are excluded from this estimate. Similarly embodied emissions in manufactured good (such as solar panels and electrical components), activities outside Australia (such as the infrastructure in international waters and Singapore), Singapore avoided emissions[3] are also excluded from the GGAP. It is noted AAPowerLink will develop a full project life cycle assessment however this is not a requirement under the NT or national legislative requirements and is out of the scope of this document.

5.1.2 Carbon Assessment Data Collection

Xodus and AAPowerLink held a CAD workshop to identify and agree data requirements and sources of information with the AAPowerLink project team. The scope of the CAD workshop included the Australian components both onshore and offshore within the Australian EEZ described in Table 2.

Table 2: AAPowerLink Project aspects relevant to the GHG estimation

ACTIVITY	LOCATION	PROJECT ASPECT
Design and Engineering		
	All	Engineering
	Offshore	Subsea survey
	Onshore - Australia	Site surveys
		Geotech surveys
Construction		
	Onshore	Personnel camps/ accommodation
	Onshore	Office - Monitoring Australia
	Onshore	Personnel travel (land)
	Offshore	Personnel travel
	Onshore	Solar Farm and utilities
	Onshore	Converter site - Darwin
	Onshore	Overhead transmission line- NT
	Onshore	Solar System Manufacturing Facility
	Offshore	Subsea cable transportation and laying

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

[3] *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.*

ACTIVITY	LOCATION	PROJECT ASPECT
	Onshore	Overhead transmission line transportation and laying
	Offshore	Shore crossing
Operation		
	All	Energy Consumption during operation
	All	Onshore Maintenance
	Onshore	inspection maintenance and repair
	All	Operation Maverick Facility
	All	Management
	All	Offices
	All	Offices
Decommissioning		
	Onshore	Revegetation
	All	Energy Consumption during decom
	Onshore - Elliott	
	Onshore - Darwin	
	Onshore - Solar Farm	
	Onshore	Personnel camps/accommodation
	Offshore	Subsea cable retrieval
	Onshore	Panels retrieval
	Offshore	Equipment recycling and disposal
	Onshore	Equipment removal
Darwin and Singapore displacement of existing electricity supply		
	Onshore Australia	Avoided CO_2 emissions electricity generation
	Onshore Singapore	Avoided CO_2 emissions electricity generation

5.1.3 Inclusions

The emissions sources in Table 3 have been included in the GHG emissions inventory covering design, construction, operations and decommissioning.

Table 3: GHG Emissions Source Inclusions

Inclusions					
Activity	Aspect Emissions Source	GHG Emission Scope	Data Source	Data Collection Unit	Uncertainty
AAPL Project Offices	Electricity Use	2	Sun Cable assumptions	MWh and source	Moderate
AAPL Project Offices	Vehicle Travel	1	Sun Cable assumptions	Vehicle km and type	Moderate
AAPL Project Offices	Air travel	3	Sun Cable assumptions	Passenger numbers and destination	Moderate
Site surveys	Vehicle/aircraft travel	1	Survey plan	Vehicle/aircraft type and km	Low
Seabed surveys	Vessel	1	Survey data	Fuel use data	Low
Wastewater disposal - Darwin facilities	Sewage	3	Personnel profiles	People days, treatment plant type	Low
Wastewater disposal - AAPowerLink facilities	Sewage	1	Personnel profiles	People days, treatment plant type	Low
Vegetation clearing	Vegetation clearing and soil carbon. (Land Use, Land-Use Change and Forestry)	1	FullCAM model and area cleared	Area of land cleared Ha	Low
Displacement of cattle farming and avoidance of associated GHG emissions	Cattle digestion	3	Station herd composition	Herd numbers, age and weight	Low
Earthworks	Plant and machinery	1	Project execution strategy	Machine type and hours	Moderate
FIFO and DIDO workforce	Vehicle and aircraft travel	1	Personnel profiles	Vehicle and aircraft type and distance travelled	Low

Inclusions					
Activity	Aspect Emissions Source	GHG Emission Scope	Data Source	Data Collection Unit	Uncertainty
FIFO workforce mobilisation	Aircraft travel	3	Personnel profiles	Passenger km	Moderate
Workforce Movements	Vehicle travel	1	Personnel profiles and execution strategy	Vehicle type and km	Low
Logistics	Vehicle travel	1	Project execution strategy	Vehicle type and km	Moderate
Logistics	Plant and equipment	1	Project execution strategy	Vehicle type, hours and utilisation	Moderate
Electricity supply during construction, operations and decommissioning	Electricity supply	2	Sun Cable power use calculations	MWh and source	Low
MAV Factory Waste disposal	Waste	3	Materials quantity estimate	Waste type and weight	Moderate
Subsea cable construction activities – Cable lay vessel	Vessels and aircraft	1	Marine execution program	Vessel/aircraft type, number, duration and activity	Moderate
Electrical switch gear	Sulphur Hexafluoride emissions	1	Electrical system design	Sulphur Hexafluoride volume in equipment	Low
Operations maintenance	Plant and machinery	1	Operations plan	Machine type and hours	Moderate
Supply of renewable solar energy to Darwin – Katherine grid	NT Avoided emissions	3	NGERs, Gas Turbine GHG intensity calculation, Sun cable business plan	MWh, CO_2e per MWh	Low
Supply of renewable solar energy to Singapore – Singapore country (For information only - Out	Singapore avoided emissions	3	Singapore government electricity generation statistics, Sun	MWh, CO_2e per MWh	Low

Inclusions					
Activity	Aspect Emissions Source	GHG Emission Scope	Data Source	Data Collection Unit	Uncertainty
of scope of EIS approval)			cable business plan		

5.1.3.1 Data Collection and Uncertainty

The sources utilised for data input to the GHG inventory are noted in Table 3. Further details including auditable references are noted in the detailed calculation worksheet and CAD response worksheets.

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 outlined in the Climate Active Carbon Neutral Standard, an uplift of 20% has been applied to the emissions presented in Table 5.

5.1.4 GHG Source Exclusions

The purpose of this emission inventory is to inform the NT and Commonwealth Government Environmental Impact Assessment process. As such the scope excludes all business units and activities outside the EEZ of Australia. Further specific exclusions are noted in Table 4.

Items were excluded where they were not material and the effort to gather the input data is high or the data is not present or deficient.

Table 4: GHG Emissions Source Exclusions

Exclusions				
Business Unit/ Location	Aspect Emissions Source	Activity	GHG Emission Scope	Reason for Exclusion
All	Staff travel	Taxi travel and hotel accommodation	3	Lack of data and lack of materiality
All	Office waste	Waste disposed to landfill	3	Lack of data and lack of materiality
All	HVAC and refrigeration	HVAC and refrigeration emissions	3	Lack of materiality

Exclusions				
Business Unit/ Location	Aspect Emissions Source	Activity	GHG Emission Scope	Reason for Exclusion
All	Vessel emissions (international)	Logistics (for cable, and solar farm materials), vessel mobilisation and demobilisation in international waters	1,3	These emissions occur outside of the Australian and NT jurisdiction. Note: subsea cable lay activities within Australian waters are included.
All	Embodied emissions	Manufacture and supply of goods and services to build and operate the Project.	3	Embodied emissions are not required to be reported under NT or Commonwealth requirements.
All	Goods and Services	Emissions associated with the supply of purchased goods and services to AAPowerLink are not included	3	Goods and services scope 3 emissions are not required to be reported under the NT or Commonwealth requirements.
All	Soil and vegetation carbon	Revegetation and rehabilitation (Land Use, Land-Use Change and Forestry) at end of project life	1	Uncertainty on timing of revegetation. The uncertainty on duration of revegetation maturation and soil carbon recovery timeframes. Timeframes are likely to span ~200+ years for recovery of soil carbon. Due to the significant negative emissions associated with revegetation this is a conservative exclusion.
All	Construction waste	Construction	3	There is a very high level of uncertainty around downstream scope 3 construction waste GHG emissions.
All	Decommissioning waste	Decomsissioning	3	There is a very high level of uncertainty around downstream scope 3 decommissioning waste GHG emissions. Sun cable will plan to recycle project components where practicable.

5.2 Emissions Estimate

The AAPowerLink Project is a carbon positive project within the Australian assessment boundary, with net NT avoided emissions of approximately 110 MT of CO_2e over the Project life including construction, operation and decommissioning emissions. Emissions profiles are presented in Table 5, Figure 2 and Figure 3. The Project emits a total of ~4.4 MT of CO_2e over the project life and avoids ~115 MT of CO_2e from the electricity and power generation systems in the NT.

The GHG construction emissions are ~3 MT CO_2e over the four year construction period, with annual emissions contributing approximately 3.5% to the total annual NT GHG emission during the construction period.

Once operational and exporting to the DKIS grid and industrial customers the Project emits ~0.01 MT of CO_2e per year and results in 1.8 MT CO_2e of NT avoided emissions each year.

Over its life, approximately 1.2 million GWh will be exported, with a project total of 485MT CO_2e emissions avoided. This comprises 115 MT CO_2e of NT avoided emissions and 370MT CO_2e of Singapore avoided emissions.

During operations a small amount of GHG is emitted from fuel burning activities contributing less than 0.04% of the total annual NT GHG emission.

Decommissioning of the Australian scope of the Project emits approximately 0.5 MT of CO_2e over the three year decommissioning period. With annual emissions contributing approximately 1% to the total NT annual emissions during the decommissioning period.

The construction, operations and commissioning emissions estimate within the defined Australian scope of the Project can be broken down into the following scope 1, 2 and 3 emissions (Table 5). Annual scope 1, 2 and 3 GHG emissions are presented in Appendix B.

Table 5: AAPowerLink Australian Scope 1, 2 and 3 emissions summary

	SCOPE 1	SCOPE 2	SCOPE 3	TOTAL (CO2e)
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%)[4]	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 CO_2e)				**-110 million**

[4] 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 outlined in the Climate Active Carbon Neutral Standard, an uplift of 20% has been applied to the emissions.

The avoided emissions are described in Section 5.2.1. Further details on scope 1, 2 and 3 emissions are described in Sections 5.2.2 to 5.2.4.

The net annual GHG emissions are pictured in the GHG emissions profile of Figure 2. The main features of the GHG emissions profile are the initial GHG emissions associated with constructing the facility, two small humps of GHG emission during maintenance campaigns (panel and battery replacement) during the project life and decommissioning emissions at the end of the Project life. Avoided emission dominate the profile when AAPowerLink is operational.

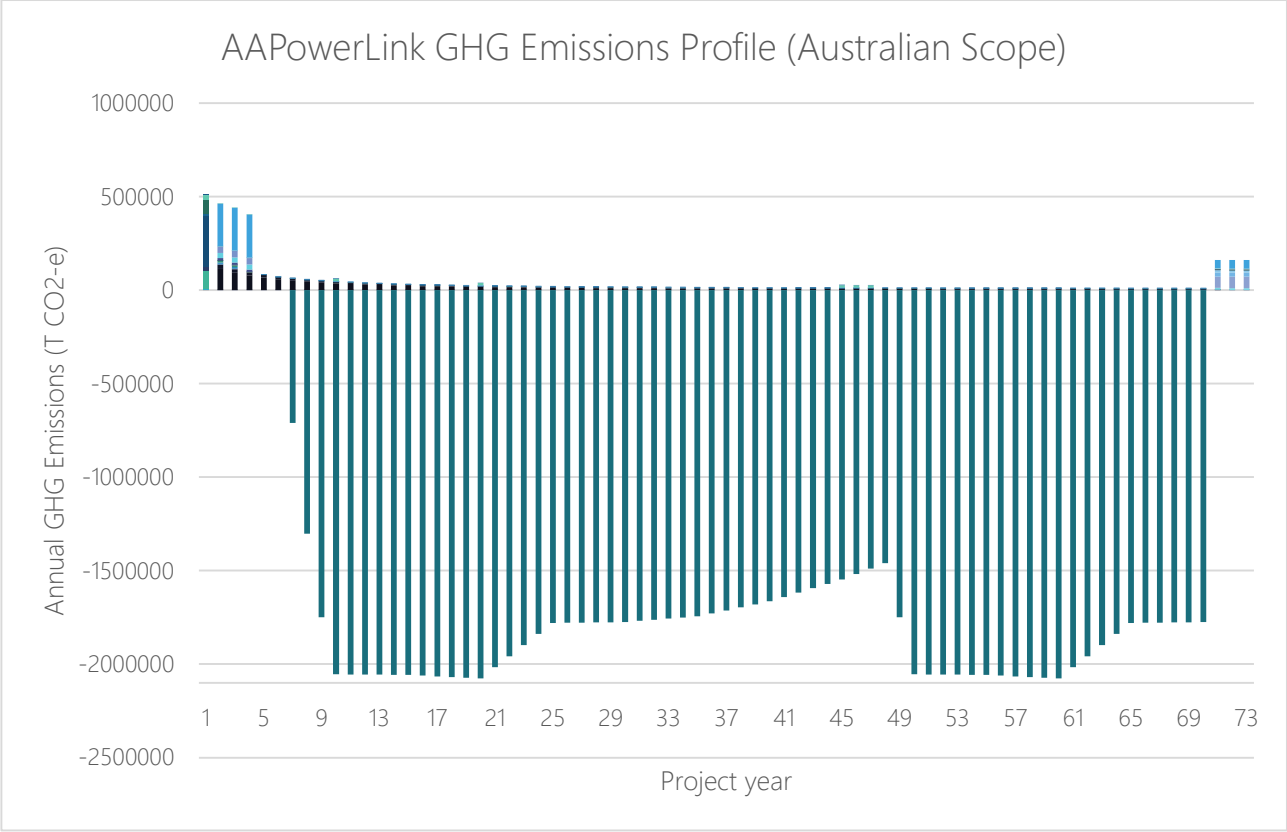


Figure 2: AAPowerLink construction, operation and decommissioning GHG emissions within the Australian scope of the project and the assessment boundary[5]

The cumulative emissions are pictured in in Figure 3. It is noted that following construction, once the Project is operational for four years it becomes carbon neutral within the GHG estimate boundary and remains significantly carbon positive for the remainder of the operational life.

[5] *AAPL electricity produciton varies due to solar panel efficiency degradation and panel replacement programs*

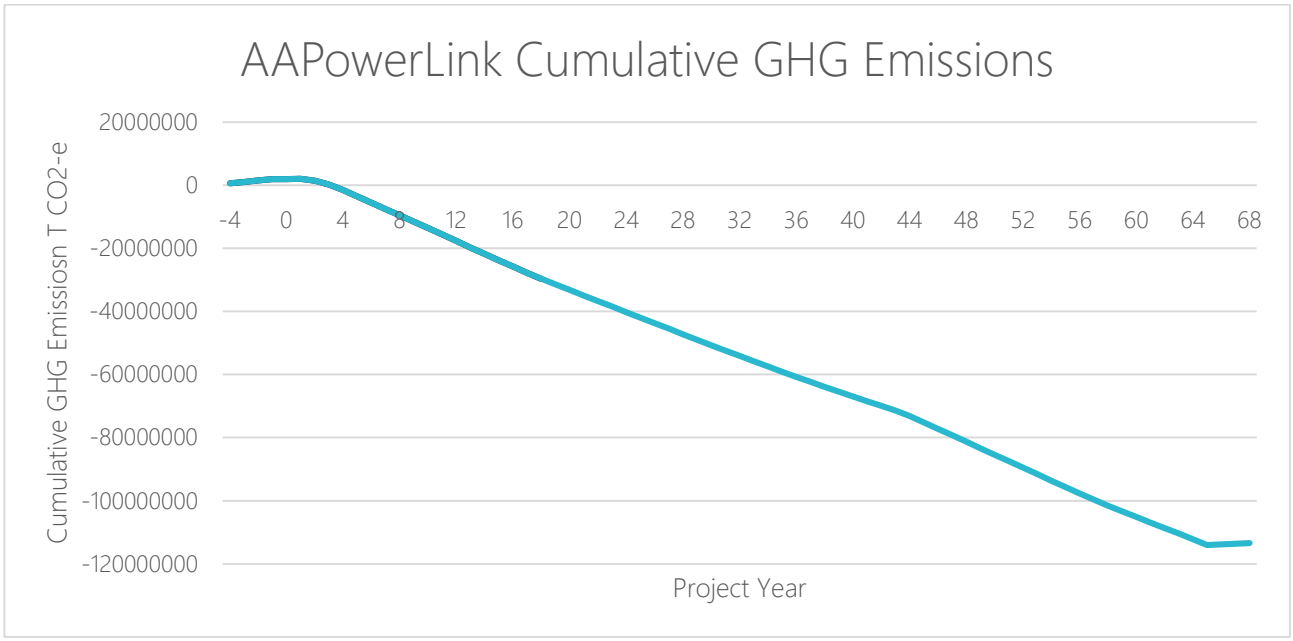


Figure 3: AAPowerLink cumulative GHG emissions within the Australian Scope of the Project and assessment boundary

AAPowerLink GHG emissions are dominated by emissions from the combustion of fuel (Figure 4). Emissions comprise of 32% from vessels, 9% from plant and equipment for earth works, construction and maintenance, 17% from air and land travel, 7% from logistics, 4% from power generation. The emissions from land use change and land clearing contribute 3% from vegetation clearing, as well as 28% from the decomposition of organic debris and loss of soil carbon over 70 years due to land use change. Emissions from electrical switch gear (Sulphur hexafluoride), wastewater treatment and waste disposal account for less than 1% of project emissions.

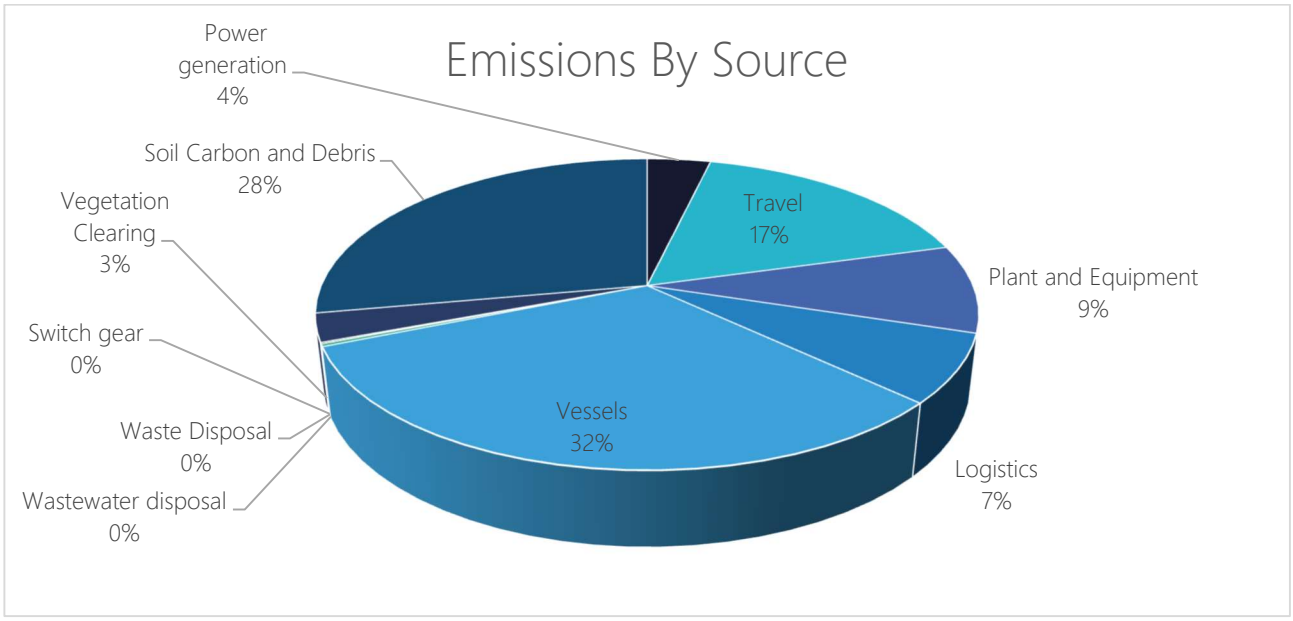


Figure 4: AAPowerLink Emissions by source for the Project life including construction operations and decommissioning

Scope 1, 2 and 3 emissions are summarised in Table 5. Details of each are discussed below in section 5.2.2 to 5.2.4. An annual profile of scope 1, 2 and 3 emissions are provided in Appendix B.

5.2.1 GHG avoided emissions

The aim of the AAPowerLink project is to maximise the carbon abatement opportunities of the Project by supplying low emissions renewable electricity from solar power to assist the NT and Singapore to reduce power generation emissions and achieve their respective net zero GHG emissions goals. AAPowerLink aims to be a carbon positive exporter of electricity. Each GWh of electricity exported from the AAPowerLink project to either the NT or overseas will avoid between 410 and 540 T CO_2e emissions from fossil fuel generated power. These emissions 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 over the Project life 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 or Singapore country: 5.7 MT CO_2e/yr or 370 MT CO_2e over the Project life

The total avoided emissions including Singapore/Singapore and NT combined is 485 MT CO_2e.

5.2.1.1 Northern Territory Avoided Emissions

For the purposes of this assessment, the supply scenario assumes that 100MW of electricity would be made available for customers on the DKIS, with 700 MW made available for new and existing industrial customers. This division of supply is theoretical and does not necessarily represent the final allocation of power supply to NT customers. However it does allow for the calculation of avoided emissions in this scenario, given the different GHG intensity values of these two markets.

It is estimated that the Project will supply approximately 10% of the NT's total energy needs (DISER, 2021[b]) when fully operational and represents an opportunity for a 10% reduction in the Territory's emissions. This includes supplying approximately ~30% (35,000 GWh over the life of the facility) of the DKIS electricity requirements from renewable sources and supplying seven times that amount of energy (250,000 GWh over the life of the facility) to industrial customers in the NT once fully operational.

The avoided emissions from DKIS assuming the energy exported from the Project is avoiding the GHG emissions associated with an average unit of electricity in the DKIS with a GHG intensity of 0.54 kg CO_2e/kWh (at 2019 GHG intensity) is approximately 0.28 MT of CO_2e per year or 19 MT of CO_2e over the Project life. The integration of the AAPowerLink project into the DKIS, will allow for a significant decarbonisation of the largely fossil-fuel powered grid and reduce the GHG intensity of the average unit of electricity in DKIS by 30% from 0.54 kg CO_2e/kWh to 0.4 kg CO_2e/kWh.

It is estimated AAPowerLink will avoid 115 MT CO_2e over the Project life or 1.8 MT CO_2e per year from NT LNG and other industrial facilities providing low carbon intensity electricity. This estimate assumes an average existing power generation GHG intensity of 0.41 kg CO_2e/kWh.

5.2.1.2 Singapore Emissions Avoided

While outside of the scope of the GGAP and the EIS a key element of the AAPowerLink project is its role in reducing global emissions through the provision of clean renewable energy to Singapore to allow the country to avoided GHG emissions associated with fossil fuel powered electricity generation, with the country currently reliant on LNG and pipeline natural gas.

Compared to 2020 actual electricity usage AAPowerLink aim to supply ~27% of Singapore's electricity needs (Energy Market Authority, 2021), however electricity usage in Singapore is forecast to increase in the future. The Energy Market Authority have release projections for total electricity demand for Singapore extending to 2032. At the 2032 electricity demand level AAPowerLink aim 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 does not cover the duration of the project, as such AAPowerLink have adopted a figure of suppling ~15% of Singapore's electricity needs, this value has been used for the purpose of this report.

The avoided emissions from Singapore assuming the solar energy supplied by AAPowerLink is avoiding an average unit of electricity in the Singapore grid from 2020 with a GHG intensity of 0.41 kg CO2e/kWh (Energy Market Authority, 2021), represents the avoidance of approximately 5.7 MT of CO2e per year or 370 MT of CO2e over the Project life. This represents an opportunity for a ~10% reduction in Singapore's total annual GHG emissions based on 2019 actual emissions (National Climate Change Secretariat. 2021).

The integration of the AAPowerLink project into the Singapore electricity system is a significant decarbonisation of the largely fossil fuel powered grid and could reduce the GHG intensity of the average unit of electricity in Singapore by ~27% from 0.41 kg CO_2e/kWh to ~0.3kg CO_2e/kWh early in the life of AAPowerLink based on 2020 GHG intensity (Energy Market Authority, 2021). Given the forecast increase in total electricity demand of Singapore over the life of AAPowerLink it is expected that on average over the whole project life AAPowerLink will be reduce Singapore's electricity supply GHG intensity by ~15% (Energy Market Authority. 2021[a]).

5.2.2 Scope 1

The project will contribute a total of ~4 MT CO2e of scope 1 emissions to the NT emissions over the life of the Project.

The main sources of scope 1 emissions are the construction phase where the majority of emissions are generated from the combustion of fuel for power generation, plant and equipment, logistics and vehicle movement. A significant amount of emissions is also generated from land clearing and change in land use.

Construction contributes ~3 MT CO2e over the four year period or approximately 0.7 MT per year representing ~3.5% of the NT's annual emissions during this period. Operations of the Project contributes a total of 0.5 MT CO2e over the life of the Project or approximately 0.01 MT per year representing less than 0.04% of the annual NT GHG emissions. Decommissioning contributes 0.5 MT CO2e scope 1 emissions over the three year decommissioning period or approximately 0.17 MT CO2e per year representing 0.85% of the annual NT GHG emissions.

5.2.3 Scope 2

AAPowerLink will supply the majority of the Project's behind the meter electricity needs via renewables (except for some diesel driven generation during the construction and decommissioning period of the Project). The Project sources renewable energy were practicable to do so. As such, for the purpose of the EIS and the GHG abatement plan, only a market based GHG estimation approach has been included in this estimate. All electricity generated using renewable energy and used onsite behind the meter is omitted. All electricity generated using onsite diesel generation is included as scope 1 emissions.

The Project does not utilise a significant amount of fossil fuel generated electricity during construction, operations or decommissioning.

5.2.4 Scope 3

For scope 3 emissions included within the boundary of assessment the Project will contribute ~0.1 MT CO2e of scope 3 emissions to the NT emissions over the life of the Project. Construction contributes 0.07 MT CO2e. Operations is approximately 500 T per year with a total of 0.02 MT CO2e over the life of the Project. Decommissioning contributes 0.01 MT CO2e scope 3 emissions.

The main source of scope 3 emissions is emissions from commercial air travel and centralised sewage treatment facilities.

The project can avoid other NT entity scope 1 and scope 2 emissions quantifying approximately 1.8 MT of CO2e per year or 115 MT of CO2e over the Project life, these are discussed above in Section 5.2.1.

5.2.5 Assumptions

The following assumptions have been made regarding the GHG estimate presented in this document:

- GHG emissions calculation input data as agreed with the AAPowerLink project team.
- Power export profiles provided by 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.
- Approximately 70 year project life assumed including construction, operations and decommissioning.

- Embodied emissions not included (These emissions are defined in a separate AAPowerLink lifecycle GHG assessment study).
- Emissions for the scope of the Project outside Australia are not included (These emissions are defined in a separate AAPowerLink lifecycle GHG assessment study).
- Avoided emissions are estimated using AAPowerLink export profile assumptions.
- The supply scenario assumes that 100MW of electricity would be made available for customers on the DKIS, with 700 MW made available for new and existing industrial customers.
- NT grid GHG intensity utilised 2020 GHG intensity.
- Connection to DKIS is assumed from day 1 of operation.
- Singapore grid GHG intensity utilised 2020 GHG intensity and 2019 overall emissions.
- Singapore electricity usage calculations are based of 2020 actual usage statistics and 2032 forecast usage (Energy Market Authority, 2021[a]).
- Territory industrial (LNG and other) generation GHG intensities assume 0.42 Tonnes CO_2e/GWh in line with best available technology gas power generation aligned with Hardisty et al, (2012).
- All Singapore avoided emissions are assumed to be at GHG intensity of 0.41 Tonnes CO_2e/MWh. This is representative of the 2020 actual GHG intensity of the Singapore gird intensity of 0.408 Tonnes CO_2e/MWh (Energy Market Authority, 2021) rounded to two significant figure.
- The DKIS which utilises open cycle gas turbines (96%) with diesel backup systems (4%) and has a location based GHG intensity of 0.54 T CO_2e/MWh under the DKIS National Greenhouse Accounts factors for 2020 (DISER, 2021[a]).
- 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 the facility.
- Upstream Scope 3 emissions from the supply, transport of gaseous fuel is not included in the stated intensity or avoided emissions calculated in this plan. Scope 3 emissions from supply of gas typically contribute a further ~25% GHG emissions per MWh (Hardisty et al, 2012).

5.3 Potential Impacts and Risks

The AAPowerLink project is a carbon positive project within the Australian assessment boundary, avoiding approximately 110 MT of CO_2e net in the NT over the Project life including construction, operation and decommissioning (Figure 3). AAPowerLink contributes significantly to decarbonising both the NT's public electricity generation system as well as industry sector in line with the NT net zero target.

Under the evaluated supply scenario, AAPowerLink will supply the equivalent of 2.8 times the DKIS electricity demand to the NT annually[6] or approximately 10% of the NT's total energy needs (DISER, 2021[b]), this is

[6] *Based on the 2019-2020 DKIS electricity demand*

equivalent to the electricity used by over half a million Australian homes[7] or the emissions from 1.1 million Australian cars[8]. This is equivalent to 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.

It is projected that AAPowerLink will supply ~30% of the DKIS electricity requirements. DKIS avoided emissions will be 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:

- An 30% reduction in GHG emissions from the DKIS
- An 30% reduction in GHG intensity of DKIS 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 territory
- An overall reduction in the Territory's total annual GHG emissions of ~10%
- A reduction of ~0.3% in the national GHG inventory

(DISER, 2021[a&b])

The AAPowerLink will increase the solar generation capacity of the Northern Territory by ~70 times the currently installed solar generation capacity. AAPowerLink will produce almost half (45%) as much power as all of the current rooftop solar installations in Australia (DISER, 2021[c]).

While outside of the scope of this document it is noted that GHG is a global issue and that the Project has a global impact on reducing GHG emissions. AAPowerLink is projected to supply approximately 15% of Singapore's electricity needs[9] with low carbon electricity facilitating a reduction in GHG emissions of 5.7 MT CO2e/yr or 370MT CO_2e over the Project life. This represents the potential for:

- Approximately a 15% reduction in Singapore's GHG emissions from electricity generation[10]
- A reduction in Singapore's GHG intensity from 0.41 kg CO_2e/kWh to 0.3 kg CO_2e/kWh[11]
- A 10% reduction in Singapore's total annual GHG emissions[12] 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)

[7] Based on an average electrical consumption of 19kWh/day

[8] Based on Department of Industry Science Energy and Resources data on fuel efficient cars

[9] Compared to 2020 actual electricity usage AAPowerLink aim to supply ~27% of Singapore's electricity needs (Energy Market Authority, 2021), however electricity usage in Singapore is forecast to increase in the future. The Energy Market Authority have release projections for total electricity demand for Singapore extending to 2032. At the 2032 electricity demand level AAPowerLink aim 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 does not cover the duration of the project, as such AAPowerLink have adopted a figure of suppling ~15% of Singapore's electricity needs, this value has been used for the purpose of this report.

[10] Based on 2032 predicted electricity demand data (Energy Market Authority, 2021[a])

[11] Based on 2020 data (Energy Market Authority, 2021) assuming AAPowerLink displaces existing gas fired electricity generation

[12] Based on 2019 actual emissions (National Climate Change Secretariat. 2021)

6 AVOIDANCE MITIGATION AND MANAGEMENT

6.1 Long Term Emissions target

The NT government has a long term objective to progressively reduce net GHG emissions, with the goal of achieving net zero emissions by 2050 (Office of Climate Change, 2020).

Sun Cable are aligned with the NT government long term net zero goal and have set the following long term targets for AAPowerLink:

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

AAPowerLink have set the following interim targets:

- Develop and implement a GHG Management Plan aligning with the NT long term net zero goal
- Develop and implement a GHG Offsets Strategy which addresses the requirements of the *NT GHG Emissions Offsets Policy* and the *National Greenhouse and Energy Reporting (Safeguard Mechanism) Rule 2015*
- Integrate an energy and GHG reduction program into the construction and operations of AAPowerLink to minimise GHG emissions through innovation and the adoption of low carbon technology;
    - 2 yearly GHG mitigation workshops and review during design and construction to select and implement ALARP GHG mitigations into the Project; and
    - 5 yearly GHG mitigation workshop and review during project operations to select and implement ALARP GHG mitigations.
- Conduct a life cycle assessment during the design phase to quantify GHG emissions including embodied, direct and indirect emissions and demonstrate that the Project is a carbon positive project.

These targets have been selected to ensure that the Project is carbon positive and will comply with all legislations.

6.2 Impact Avoidance and Mitigations

Sun Cable's goal is to maximise the positive impact of the Project by minimising the design, construction, operation and decommission GHG emission by incorporating a few avoidance and mitigation actions. AAPowerLink will include GHG as an aspect to manage under its environmental management system (EMS) with elements of energy management integrated into the EMS which are aligned with ISO50001 Energy Management Systems including:

- 2 yearly GHG mitigation workshops in design and construction and 5 year reviews during operations
- Identifying, screening and adopting ALARP GHG mitigation opportunities.

The workshops adopt the following methodology:

- Identify a list of opportunities leveraging best practice references, emerging technology review and an equipment based brainstorming session outlining the activity, equipment involved, description,

challenges and possible clarifications needed. The identification of opportunities focuses on applying the hierarchy of control (Figure 5).

- During the workshop opportunities are identified and screened to define the overall savings/benefits of each item as well as cost and effort to implement.
- A priority ranking is then made to select the best opportunities and define actions required to reduce GHG emissions and implement the opportunity.

This methodology has been applied to the first design GHG mitigation workshop which was held on the 28th of October 2021 and identified several opportunities to pursue.

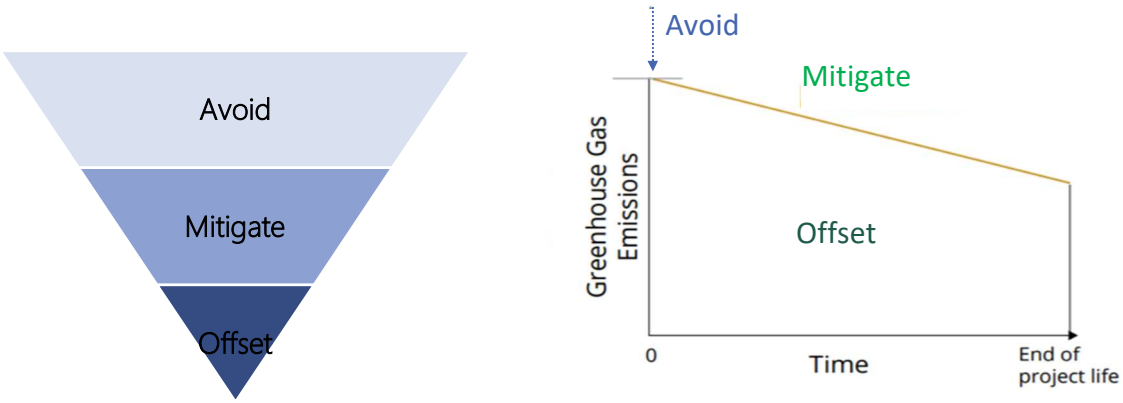


Figure 5 - Hierarchy of control

Adopting an approach aligned with the hierarchy of control (Figure 5), the following opportunities have been adopted and incorporated into the AAPowerLink design:

- Avoid
    - Supply the power needs of AAPowerLink project through the use self-generated solar energy where practicable
        - Supply of electricity needs of the solar farm construction camp (as early as practicable) and solar farm operations camp with solar energy.
    - Where self-generation solar is not practicable AAPowerLink will source renewable energy through market mechanisms where practical.
    - Review practical zero carbon technology solutions for construction operations and decommissioning such as electric vehicles and remote solar energy systems during engineering design and include these where ALARP.
    - Review and include practicable carbon reduction technology solutions for construction operations and decommissioning such as battery energy storage solutions for marine vessels, electric and hybrid vehicles, plant and equipment.
    - Substitute higher GHG intensity power generation with low emissions renewables:

        - Pursue power purchase agreements with electricity users who utilise fossil fuel power generation in the NT and Singapore countries.
        - Continue to review, assess and engage in practicable opportunities which align with the AAPowerLink project drivers (Review of commercial opportunities to offset hydrocarbon electricity generation within the NT), NT net zero target, Australian net zero target and global GHG emission reduction targets within the bounds of this approval including:
            - Including CSIRO proposed NT Carbon Capture Utilisation and Storage Project
            - Supply to NT industrial power generators and electricity users

- Mitigate
    - Vegetation management
        - Conduct vegetation and landscaping studies during the design phase of the Project to identify and select clearing, fire management, vegetation disposal practices and vegetation species to plant or retain. Goal is to maximise vegetation cover that can coexist with the development to reduce soil carbon loss over the Project life.
        - Review construction methods to reduce clearing requirements to ALARP within the Project footprint.
        - Develop and implement a revegetation plan for the Project to rehabilitate the land at the end of the Project life.

Sun Cable is committing to reviewing the following opportunities further prior to construction commencing:

- To define power supply strategy for the camps which will consider including power supply from early solar modules to maximise the amount of renewable energy used by all phases of personnel camps.
- Scope up vegetation management plan, include retention of vegetation and soil carbon as a topic in the plan
- Include electrification options for machinery in the procurement process for civil contractor and machinery suppliers
- Consider energy efficiency in aircraft services selection and procurement
- Include electrification options (including BESS) and consider efficiency in vessel selection and vessel services procurement

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 during project operations to implement ALARP GHG mitigations.

6.3 Implementation

AAPowerLink will develop a GHG Management Plan, based on this document, aligned with ISO 14001 including the 'plan – do – check - act' framework to manage and continually improve GHG performance. The plan will include elements aligned with ISO50001 Energy Management Systems for the identification and adoption of GHG reduction opportunities. 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.

A GHG Management Plan aligned with ISO140001 includes the following elements:

Plan: Develop the GHG inventory, complete a GHG review, benchmarking and establish the baseline, GHG performance indicators, objectives, targets, and action plans necessary to deliver results in accordance with opportunities to improve GHG performance and the organisation's GHG policy.

Do: implement the GHG management action plans.

Check: monitor and measure processes and the key characteristics of operations that determine GHG performance against the GHG policy and objectives and report the results.

Act: take actions to continually improve GHG performance and the GHG management plan.

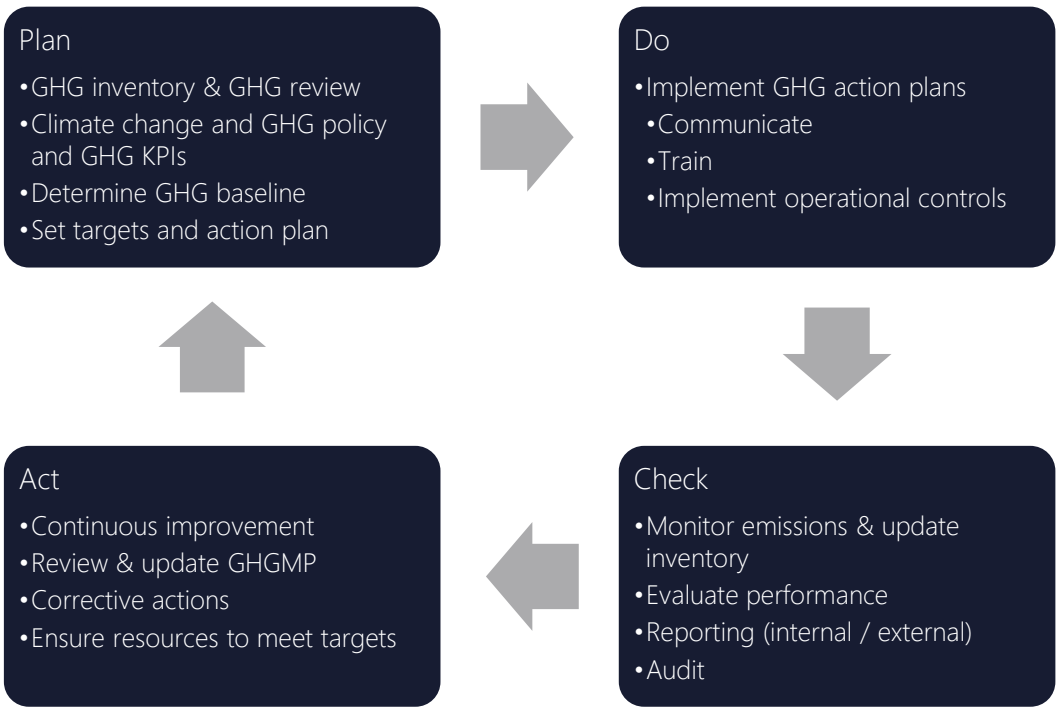


Figure 6 – GHG Management Plan enabling continuous improvement

6.3.1 Monitoring and Reporting

AAPowerLink will monitor and report on both GHG emissions from its facilities as well as energy produced and exported in line with the requirements of Territory and Commonwealth law including the National Greenhouse and Energy Reporting Act 2007 throughout construction, operations and decommissioning phases of the Project. Monitoring will ensure that data required to calculate GHG emissions is collected in line with the methods outlined in the National Greenhouse and Energy Reporting (Measurement) Determination 2008.

AAPowerLink through Sun Cable will voluntarily publicly report GHG emissions throughout construction, operations and decommissioning of the Project. Reporting will be in line with standards outlined in the Greenhouse Gas Protocol Corporate Reporting Standard.

AAPowerLink will monitor and report GHG emissions as per the requirements of any relevant environmental approval under the Northern Territory Environmental Protection Act 2019 such as reporting on actual emissions against targets and estimates included to support the EIS process and identify and address any adjustments required against the NT Offsets Policies.

6.3.2 NGERs Reporting

The project will trigger the relevant reporting requirement under the Australian Government's National Greenhouse and Energy Reporting Act 2007 (the NGER Act), during the construction period, due to GHG emissions from combustion of fuel in plant and equipment utilised on site. Following completion of construction and commencement of operation AAPowerLink will trigger the reporting thresholds for energy production.

As required by the NGER Act AAPowerLink will register and report in line with the requirements of the act.

During operations, emissions from the Project are expected to be an order of magnitude below the emissions trigger level for the safeguard mechanism under the NGER Act and Safeguard Mechanism. As such it is not expected that AAPowerLink will be required to develop an emissions baseline under the Safeguard Mechanism.

7 RESIDUAL RISKS/IMPACT & OFFSETS

The residual impact of AAPowerLink will be positive. AAPowerLink will assist the NT in achieving its target of net zero by 2050 by avoiding GHG emissions from fossil fuel power generation.

The net impact of the Project to the NT is the avoidance of 110 MT of CO2e emissions from the NT while also having a significant global co-benefit of a further reduction in global GHG emissions of ~370MT of CO2e (in Singapore) (Figure 7).

There is a short-to-medium term impact associated with GHG emissions during the construction of the Project. During this period, the Project will contribute to NT annual emissions with an increase of up to 3.5% for the four year construction period. During operations, a small amount of GHG is emitted, representing an addition of less than 0.04% to the NT annual GHG emissions.

Due to the nature of the Project, these emissions will be offset by the provision of solar power to the NT. NT avoided emissions from fossil fuel power generation will result in net zero by year four, with net carbon positive emissions increasing throughout the Project's life to ~110 MT CO2e carbon positive at the end of the facility life (Figure 7). The Project will reduce the NT annual emissions by ~10% in total.

While there are some GHG emissions associated with the Project relating to single events (i.e. construction and land clearing) the Project includes GHG mitigations to avoid and reduce GHG emissions to ALARP (Section 6.2) and the GHG emission profile over the Project life is significantly carbon positive. The overall impact on the Territory's emissions profile and trajectory towards the Territory's target of net zero emissions by 2050 is positive, supporting the NT achieve its stated goals. Furthermore, it is noted the Project assists other nations in achieving their stated GHG reduction goals and facilitates alignment of both Australia and Singapore/Singapore countries in achieving their stated global under international treaties on climate change.

As such there are no residual negative impacts relating to GHG from the AAPowerLink project and no offsets are proposed or required under the draft *NT GHG Emissions Offsets Policy*.

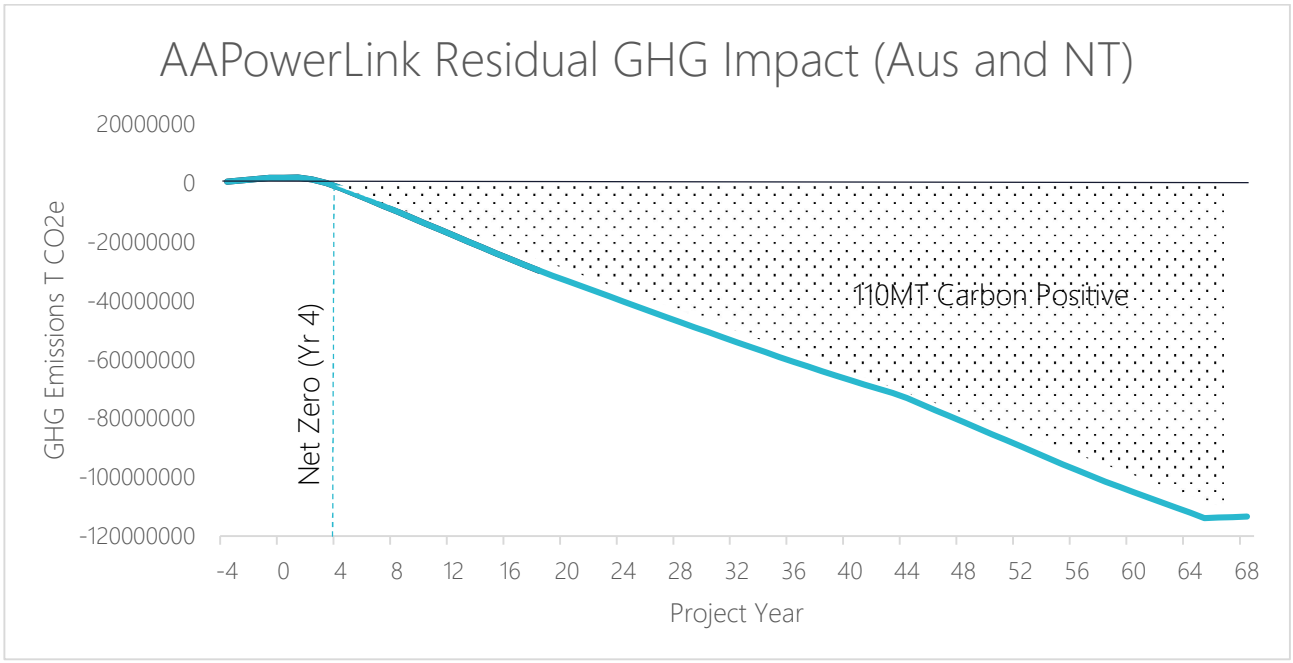


Figure 7 – AAPowerLink Residual GHG Impact within the Australian Scope of the Project and assessment boundary

8 REVIEW

The GGAP will be reviewed every two years during engineering and construction, every 5 years during operations and two years prior to decommissioning or during the design of the decommissioning phase. The GAPP will be reviewed against the interim goals, NT net zero goals and requirements of the NT EPA Environmental approvals.

PHASE	REVIEW PERIOD
Design and Construction	2 yearly
Operations	5 yearly
Decommissioning	2 year prior to decommissioning

9 REFERENCES

Clean Energy Regulator. 2022. *Electricity sector emissions and generation data 2020-21.* Commonwealth of Australia, Canberra, Australia. Accessed on 9th March 2022 at http://www.cleanenergyregulator.gov.au/NGER/National%20greenhouse%20and%20energy%20reporting%20data/electricity-sector-emissions-and-generation-data/electricity-sector-emissions-and-generation-data-2020-21

Department of Environment, Parks and Water Security. 2021. *Greenhouse Gas Emissions Management for New and Expanding Large Emitters'.* Northern Territory Government Darwin Australia.

Department of Environment and Natural Resources, Flora and Fauna Division (DENR). 2020. *Northern Territory Offsets Principles.* NTEPA2020/0034-002~0001. https://depws.nt.gov.au/__data/assets/pdf_file/0005/901877/nt-offsets-framework-principles.pdf

Department of Environment, Parks and Water Security. 2021. *DRAFT Greenhouse Gas Emissions Offsets Policy and Technical Guidelines Northern Territory Offsets Framework*. Northern Territory Government. Darwin. Accessed on 8/11/21 at https://depws.nt.gov.au/__data/assets/pdf_file/0007/1042000/DRAFT-Greenhouse-Gas-Emissions-Offsets-Policy-and-Technical-Guidelines.pdf

Department of Industry Science, Energy and Resources (DISER). 2021. *Quarterly Update of Australia's National Greenhouse Gas Inventory: March 2021. Incorporating emissions from the NEM up to June 2021. Australia's National Greenhouse Accounts.* Commonwealth of Australia, Canberra, Australia. Accessed on 19 October 2021 at https://www.industry.gov.au/sites/default/files/August%202021/document/quarterly_update_of_australias_national_greenhouse_gas_inventory_-_march_2021.pdf

Department of Industry Science, Energy and Resources (DISER). 2021[a]. *National Greenhouse Accounts Factors Australian National Greenhouse Accounts August 2021.* Commonwealth of Australia, Canberra, Australia. Accessed on 19 October 2021 at https://www.industry.gov.au/sites/default/files/August%202021/document/national-greenhouse-accounts-factors-2021.pdf

Department of Industry Science, Energy and Resources (DISER). 2021[b]. *Australian Energy Statistics (2019-2020).* Commonwealth of Australia, Canberra, Australia. Accessed on 27 October 2021 at https://www.energy.gov.au/data/states-and-territories

Department of Industry Science, Energy and Resources (DISER). 2021[c]. *Media Release: Record 3 million rooftop solar energy installations.* Commonwealth of Australia, Canberra, Australia. Accessed on 27 October 2021 at https://www.minister.industry.gov.au/ministers/taylor/media-releases/record-3-million-rooftop-solar-energy-installations

Department of Industry Science, Energy and Resources (DISER). 2021[d]. *State and territory greenhouse gas inventories: data tables and methodology.* Commonwealth of Australia, Canberra, Australia. Accessed on 9th March 2022 at https://www.industry.gov.au/data-and-publications/national-greenhouse-accounts-2019/state-and-territory-greenhouse-gas-inventories-data-tables-and-methodology#download-the-data-tables

Energy Market Authority. 2021. *Singapore Energy Statistics 2020.* Government of Singapore, Energy Market Authority, Singapore. Accessed on 19 October 2021 at https://www.ema.gov.sg/singapore-energy-statistics/

Energy Market Authority. 2021[a]. *Singapore Electricity Market Outlook (SEMO) 2021.* Government of Singapore, Energy Market Authority, Singapore. Accessed on 19 October 2021 at https://www.ema.gov.sg/cmsmedia/PPD/Singapore-Electricity-Market-Outlook-2021.pdf

Hardisty, P., Clark, T., and Hynes, R. 2012. *Life Cycle Greenhouse Gas Emissions from Electricity Generation: A Comparative Analysis of Australian Energy Sources.* Energies 2012, 5, 872-897; doi:10.3390/en5040872 Accesses online on 27 October 2021 at https://www.mdpi.com/1996-1073/5/4/872/pdf

International Organization for Standardization. 2006. *ISO14064-1:2006. Greenhouse gases – Part 1: Specification with guidance at the organisation level for quantification and reporting of greenhouse gas GHG emissions and removals*. ISO, Geneva, Switzerland.

United Nations Framework Convention on Climate Change (UNFCCC) 2019. *International Financial Institutions Technical Working Group on Greenhouse Gas Accounting: GHG Accounting for Grid Connected Renewable Energy Projects*. United Nations Framework Convention on Climate Change. Accessed on 8 November 2021 at https://unfccc.int/sites/default/files/resource/Renewable%20Energy_GHG%20accounting%20approach.pdf

National Climate Change Secretariat. 2021. *Singapore's Emissions Profile*. Strategy Group Prime Minister's Office, Government of Singapore, Singapore. Accessed on 20 October 2021 at https://www.nccs.gov.sg/singapores-climate-action/singapore-emissions-profile/

Australian Government, 2021. *National Greenhouse and Energy Reporting (Measurement) Determination 2008,* Compilation 13. Australian Government. Canberra. Accessed on 8 November 2021 at https://www.legislation.gov.au/Details/F2021C00740

Office of Climate Change. 2020. *Northern Territory Climate Change Response: Towards 2050.* Department of Industry Science, Energy and Resources, Northern Territory Government, Darwin, Australia. Accessed on 7 November 2021 at https://depws.nt.gov.au/__data/assets/pdf_file/0005/904775/northern-territory-climate-change-response-towards-2050.pdf

Utilities Commission of the Northern Territory. 2020. *Northern Territory Electricity Outlook Report 2018-19.* Northern Territory Government, Darwin, Australia. Accessed on 19 October 2021 at https://utilicom.nt.gov.au/__data/assets/pdf_file/0010/895357/2018-19-NT-Electricity-Outlook-Report.pdf)

World Resources Institute and World Business Council for Sustainable Development. 2004. *The Greenhouse Gas Protocol: A Corporate Accounting and Reporting Standard (revised)*. WBCSD. Geneva, Switzerland.

APPENDIX A FULLCAM MODEL INPUTS

The following model inputs were utilised in FullCAM. Inputs were shared with Department of Industry Science Environment and Resources FullCAM group (25/10/21):

Configuration

- Forest System including minerals
- tree yield formula

Timing

- Simulation timing: Step
- Start simulation 7/1020
- End simulation 6/2300
- Simulation steps: Monthly with recording of output every 12 simulation steps (i.e. annual)

Data Builder

- Lat Long: -16.260 00; 133.360 00, Apply downloaded data
    - Plot file developed for main solar precinct. All other clearing scaled from this by area
- Spatial data averaged over 2500ha
- Native Species Regeneration>-500mm rainfall

Site

- Water, temperature and Productivity Cycle table data across all time
- Area: 12,000 ha, max aboveground biomass 19.3194 tdm.ha Trees

Trees & Soil

- Native Species Regeneration>-500mm rainfall
- 31.2561% clay in soil by weight

Initial conditions

- Trees / Standing Dead / Debris and Soil– Standard values utilised

Events

- 1 Jan 2023 Initial clearing: no product recovery – solar precinct clearing 100% site affected
    - Standard values
    - Proxy for mulching. - No windrow and burn included
- 1 May 2099 Plant trees: Native Species Regeneration>-500mm rainfall – site revegetation
    - Standard value

APPENDIX B GHG CALCULATION RESULTS

The annual scope 1, 2 and 3 emissions are presented below in Appendix sections B.1, B.2 and B.3 respectively. All figures are presented without the 20% uplift noted in section 5.

B.1 Scope 1

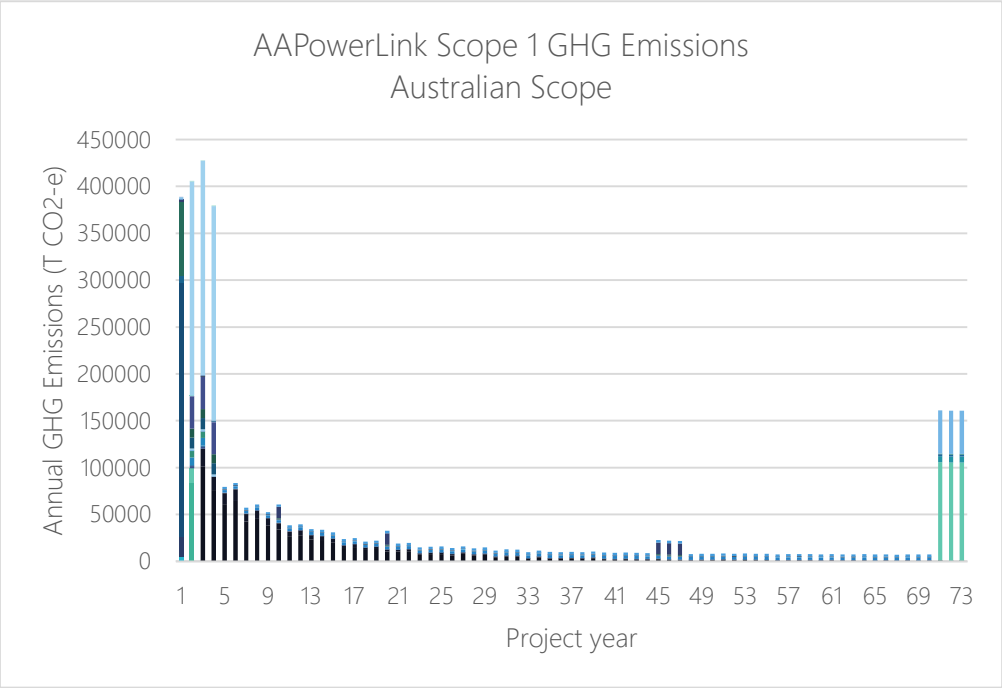


Figure 8: AAPowerLink Scope 1 GHG emissions within the Australian assessment boundary

B.2 Scope 2

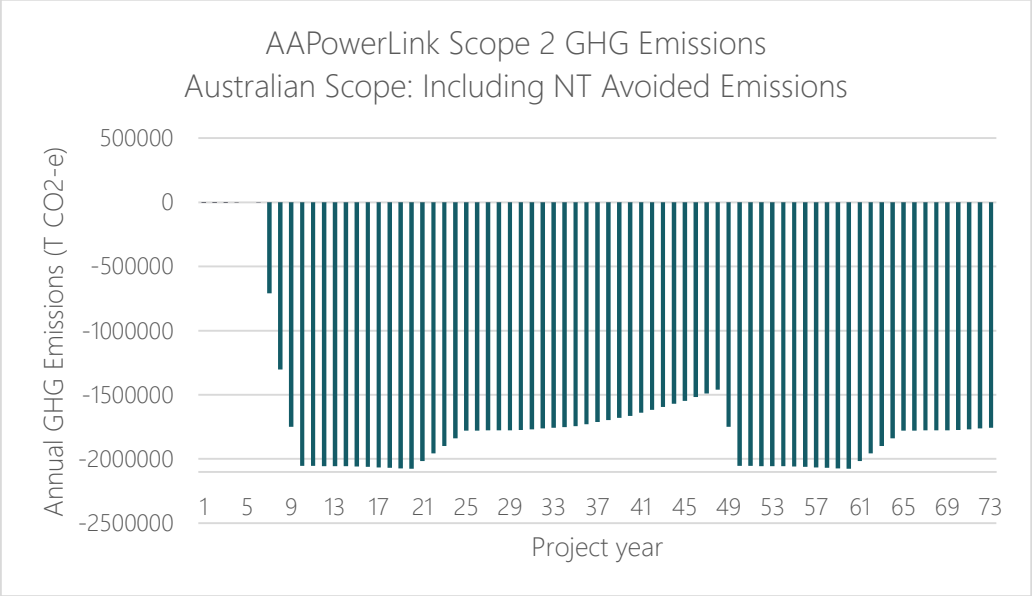


Figure 9: AAPowerLink Scope 2 GHG emissions within the Australian assessment boundary including avoided emissions

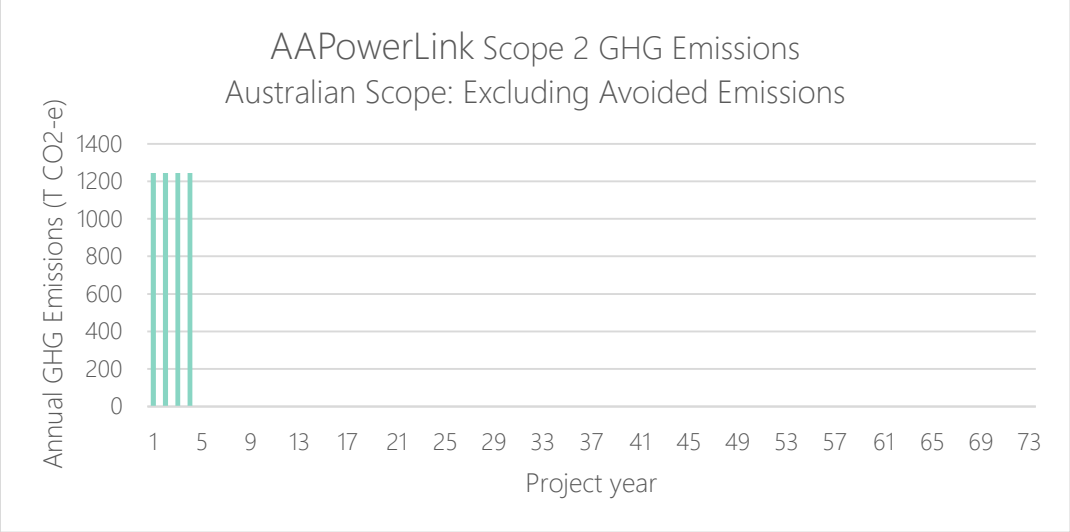


Figure 10: AAPowerLink Scope 2 GHG emissions within the Australian assessment boundary including avoided emissions[13]

[13] *Scope 2 emissions reduced where practicable through the purchase and use of renewable electricity*

B.3 Scope 3

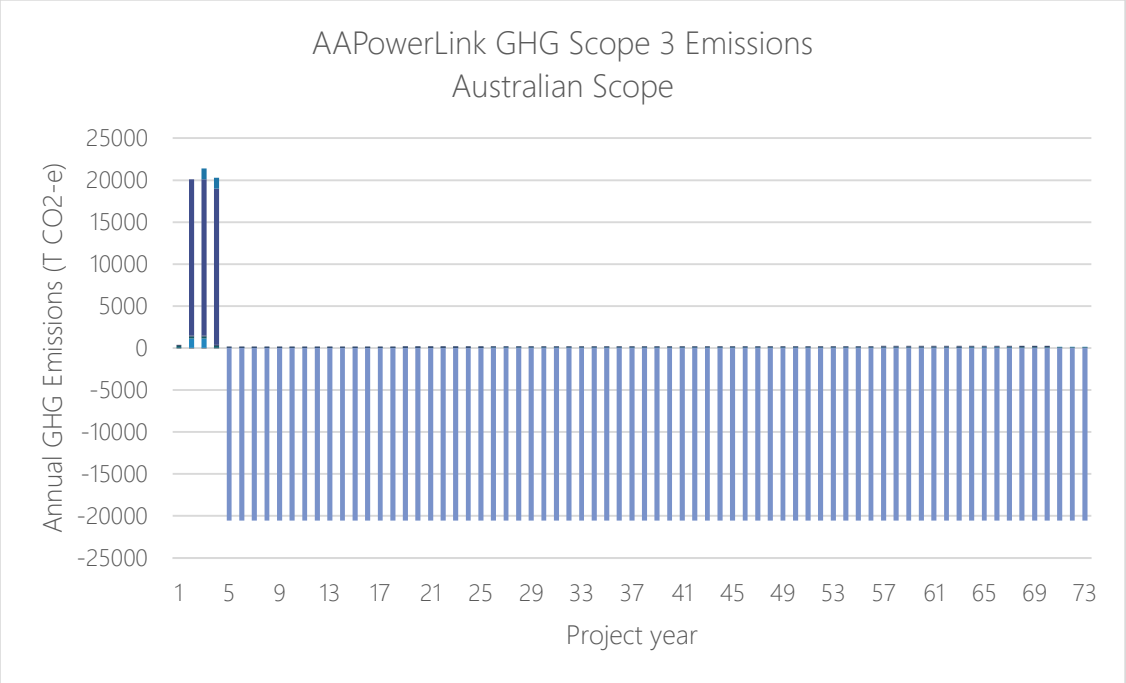


Figure 11: AAPowerLink Scope 3 GHG emissions within the Australian assessment boundary including cattle displacement[14].

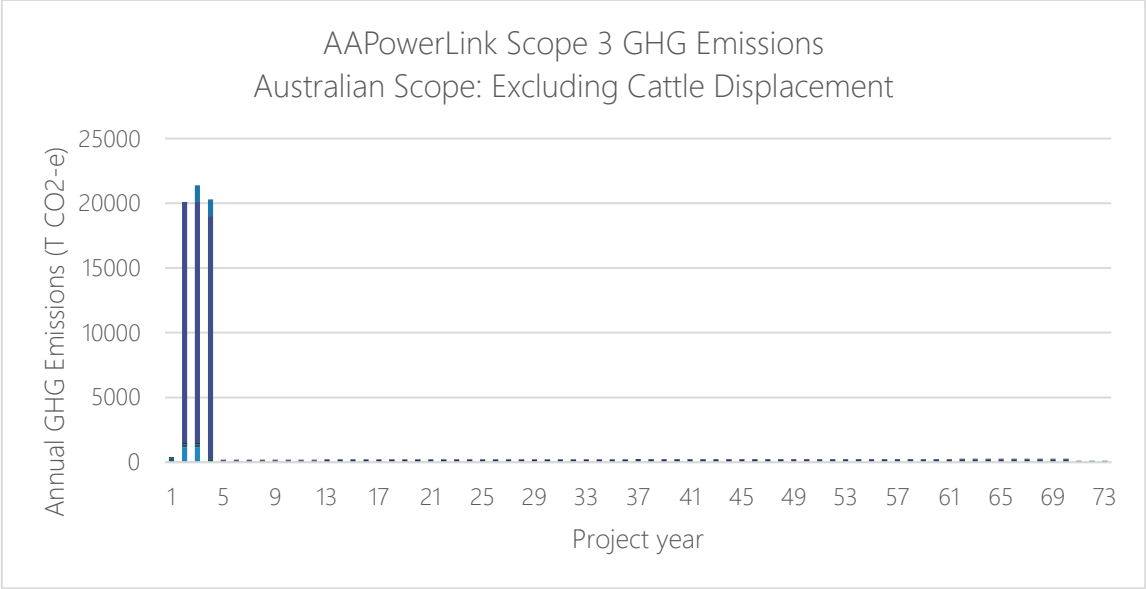


Figure 12: AAPowerLink Scope 3 GHG emissions within the Australian assessment boundary excluding cattle displacement

[14] *Note: Displacement of cattle from pastoral lease results in a negative scope 3 emissions for the land areas where cattle are excluded.*