Table 13-1 Gross Value Added for the 5 Largest Industries in the Regional Economy (IO Sectors)

Industry	Gross Value Added ($m)	Proportion of Regional Economy (%)	Proportion of Regional Employment (%)
Local Area			
Sheep, Grains, Beef	71	7%	8%
Primary and secondary education services (inc. preschool and special schools	66	7%	10%
Retail Trade	59	6%	13%
Other Agriculture	48	5%	8%
Health Care Services	48	5%	8%
Sub-total		***29%***	***47%***
Region			
Health Care Services	568	6%	11%
Retail Trade	497	5%	12%
Public Administration	482	5%	5%
Primary and secondary education services (incl preschool and special schools	451	5%	8%
Finance	341	4%	1%
Sub-total		***25%***	***36%***
Qld			
Coal mining	32,591	10%	1%
Oil and gas extraction	19,515	6%	0%
Health Care Services	12,728	4%	8%
Construction Service	12,675	4%	6%
Retail Trade	12,321	4%	10%
Sub-total		***27%***	***26%***

In terms of ANZSIC One Digit sectors, the significance of Agriculture, Forest and Fishing in the local area is evident. While for the region Transport, Postal and Warehousing, also become significant sectors. At the Qld level Mining is the most significant sector, as shown in **Table 13-2**.

Table 13-2 Gross Value Added for the 5 Largest Industries in the Regional Economy (ANZSIC One Digit Sectors)

Industry	Gross Value Added ($m)	Proportion of Regional Economy (%)	Proportion of Regional Employment (%)
Local Area			
Rental, Hiring and Real Estate Services	163	16%	2%
Agriculture/Forestry/Fishing	130	13%	17%
Health Care and Social Assistance	92	9%	15%
Education and Training	72	7%	11%
Construction	71	7%	7%
Sub-total		***52%***	***51%***
Region			
Rental, Hiring and Real Estate Services	1,320	14%	2%
Health Care and Social Assistance	874	9%	16%
Public Administration and Safety	830	9%	8%
Transport, Postal and Warehousing	730	8%	6%
Construction	646	7%	7%
Sub-total		***47%***	***39%***
QLD			
Mining	58,058	18%	2%
Rental, Hiring and Real Estate Services	39,398	12%	2%
Construction	24,975	8%	9%
Health Care and Social Assistance	21,520	7%	14%
Financial and Insurance Services	20,097	6%	3%
Sub-total		***50%***	***30%***

The largest exporting industries (IO sectors) by region are listed in **Table 13-3**.

Table 13-3 Five Largest Exporting Industries (Input-Output Sectors)

Local Area	Region	Qld
Other Agriculture	Air and Space Transport	Coal mining
Dairy Product Manufacturing	Accommodation	Oil and gas extraction
Accommodation	Water and Pipeline	Basic Non-Ferrous Metal Manufacturing
Basic Non-Ferrous Metal Manufacturing	Basic Non-Ferrous Metal Manufacturing	Insurance and Superannuation
Sawmill Product Manufacturing	Non Ferrous Metal Ore Mining	Meat and Meat product manufacturing

Exporting sectors are based on a region's endowments and competitive advantages and in regional economic development economics are considered to be the key drivers of the economy (see **Table 13-4**).

Table 13-4 Characteristics of Usual Residents

Demographics	Local Area		Region		QLD	
	No.	%	No.	%	No.	%
Population	24,827		181,728		4,703,193	
Median Age	47		38		47	
In labour force	10,456	42.1%	88,922	48.9%	2,312,118	49.2%
Unemployed	803	7.7%	6,859	7.7%	175,665	7.6%
Median household weekly income	977				1,402	
Unoccupied private dwellings	1,573	14.3%	8,056	11.0%	195,570	10.6%
Median rent	240				330	
Occupations	**No.**	**%**				
Professionals	1,486	15.4%	15,418	19%	423,917	19.8%
Technicians and Trades Workers	1,324	13.7%	12,151	15%	305,441	14.3%
Community and Personal Service Workers	1,148	11.9%	11,100	14%	241,956	11.3%
Clerical and Administrative Workers	1,084	11.2%	10,626	13%	291,317	13.6%
Managers	1,513	15.7%	9,441	12%	258,509	12.1%
Sales Workers	899	9.3%	8,669	11%	207,795	9.7%
Labourers	1,326	13.7%	8,462	10%	225,268	10.5%

Demographics	Local Area		Region		QLD	
	No.	%	No.	%	No.	%
Machinery Operators and Drivers	727	7.5%	4,812	6%	147,636	6.9%

Source: ABS (2016b)

The main industry sectors in which usual residents were employed in 2016 is provided in **Table 13-5**. Hospitals (except Psychiatric Hospitals) is the main sector of employment for usual residents across all geographical locations. Primary Education and Supermarkets and Grocery Stores are also major sectors of employment for usual residents across the three geographical locations. In the region, Accommodation, and Cafes and Restaurants are also major sectors of employment for usual residents, reflecting the tourism nature of the region, driven by the influence of the Cairns LGA. Across the three geographic areas, service-based sectors dominate apart from in the local area where Beef Farming (Specialised) is a major sector.

Table 13-5 Top 5 Industry Sectors of Employment for Usual Residents

Local Area			Region			QLD		
Sector	**No.**	**%**	**Sector**	**No.**	**%**	**Sector**	**No.**	**%**
Hospitals (except Psychiatric Hospitals)	372	3.9	Hospitals (except Psychiatric Hospitals)	4,484	5.5	Hospitals (except Psychiatric Hospitals)	91,756	4.3
Primary Education	326	3.4	Accommodation	2,643	3.2	Primary Education	54,394	2.5
Secondary Education	317	3.3	Supermarket and Grocery Stores	2,144	2.6	Supermarket and Grocery Stores	52,291	2.4
Supermarket and Grocery Stores	313	3.3	Primary Education	2,032	2.5	Cafes and Restaurants	49,488	2.3
Beef Cattle Farming (Specialised)	308	3.2	Cafes and Restaurants	2,020	2.5	Takeaway Food Services	41,958	2.0

Source: ABS (2016b)

An indication of the health of an economy can be gained from population changes. This theory of regional economic growth suggests that places that are able to attract population immigration create increased demand for goods and services and thus more jobs. This growth leads to increasing local multiplier effects, scale economies and an increase in the rate of innovation and capital availability (Sorensen, 1990). Conversely, population losses can contribute to a 'vicious cycle' of decline whereby reduced populations results in closure of services, which in turn makes it difficult to attract new populations (Sorensen, 1990).

Trends in regional economies as a result of globalisation and associated structural adjustment include:

- loss of significant industries such as abattoirs and timber mills from many rural areas;
- increased mechanisation of agriculture and aggregation of properties, resulting in loss of employment opportunities in this industry;

- growth of regional centres, at the expense of smaller towns;
- preference of Australians for coastal living, particularly for retirement; and
- preference of many of today's fastest growing industries for locating in large cities.

The result is that there has been declining population in many rural LGAs, though this is not the case for the Tablelands Regional Council LGA.

Against this backdrop, it is evident that the population growth of the local area has been less than half that of the region and Qld. Population growth of the region has been generally in line with growth in the Queensland population, until 2016 when growth has fallen behind that of Qld. Population growth in the region has been mainly driven by growth in the Cairns Regional LGA (see **Table 13-6**).

Table 13-6 Population Growth

	Population					**Population Growth**			
Area	**2001**	**2006**	**2011**	**2016**	**2021**	**2001-2006**	**2006-2011**	**2011-2016**	**2016-2021**
Tablelands Regional	21,894	23,228	24,372	25,217	26,244	6%	5%	3%	4%
Cairns Regional	115,373	131,843	150,992	161,573	166,943	14%	15%	7%	3%
Total Region	**137,267**	**155,071**	**175,364**	**186,790**	**193,187**	**13%**	**13%**	**7%**	**3%**
QLD	**3,571,469**	**4,007,992**	**4,476,778**	**4,845,152**	**5,156,138**	**12%**	**12%**	**8%**	**6%**

Source: ABS (2016c), (2022).

Population in the region is forecast to continue to be similar to that of Qld, with a lower population growth rate for the local area (Qld Government, 2018) – **Table 13-7.**

Table 13-7 Population Projections

	Population Projections					**Population Growth**			
Area	**2021 (Actual)**	**2026**	**2031**	**2036**	**2041**	**2021-2026**	**2026-2031**	**2031-2036**	**2036-2041**
Tablelands (R)	26,244	27,153	28,230	29,233	30,127	4%	4%	4%	3%
Cairns (R)	166,943	189,436	205,468	221,242	236,593	9%	8%	8%	7%
Total Region	**193,187**	**216,589**	**233,698**	**250,475**	**266,719**	**8%**	**8%**	**7%**	**6%**
Qld	**5,156,138**	**5,722,780**	**6,206,566**	**6,686,604**	**7,161,661**	**9%**	**8%**	**8%**	**7%**

Source: Qld Government (2018)

13.1.2 Potential Impacts

The proposed Action would provide economic activity to the local, regional and Queensland economy during both the construction and operation phase. These regional economic impacts were assessed using IO analysis involving two steps:

- Construction of appropriate IO tables (for the local, regional and Qld economies) that can be used to identify the economic structure of each geographic area and multipliers for each existing sector of the local, regional and Qld economies; and
- Identification of the impact or stimulus of the Project (construction/operation of the Project) in a form that is compatible with the IO equations so that the IO multipliers and flow-on effects for the impacts or stimulus of the Project can then be estimated (West, 1993).

IO analysis identifies the economic activity of a Project on the economy in terms of four main indicators:

- Gross regional output – the gross value of business turnover;
- Value-added – the difference between the gross value of business turnover and the costs of the inputs of raw materials, components and services bought in to produce the gross regional output. These costs exclude income costs;
- Income – the wages paid to employees including imputed wages for self-employed and business owners; and
- Employment – the number of people employed (including self-employed, full-time and part-time).

13.1.2.1 Construction Phase

Construction is estimated to occur over a two-year period. WTGs and other component costs are estimated to comprise 43% of construction costs and imported from overseas. The remainder (57%) is associated with civil works and associated salaries. Civil works and associated salary costs are assumed to be spread across construction expenditure categories and industry sectors as per **Table 13-8**.

Table 13-8 Expenditure Breakdown of Construction (Excluding Turbines and Salaries)

% Construction Expenditure (excluding turbines and salaries)	Construction Exp Categories	Relevant Industry	Proportion
32%	Contract Administration and Site Design	Heavy and Civil Engineering Construction	50%
		Construction Services	50%
32%	Site Construction Works	Heavy and Civil Engineering Construction	50%
		Construction Services	50%
36%	Site Electrical Works	Electrical Transmission	100%

Source: Derived from SKM (2012).

Accordingly, nonlabour construction expenditure occurring in Australia is spread across the following three sectors:

- the Heavy and Civil Engineering Construction sector which includes businesses involved in engineering construction and Project management services for a diverse range of infrastructure projects for public and private sector clients, including wind farms;
- the Construction Services sector which includes businesses involved in site preparation services, concreting services, structural steel erection services, electrical services, hire of construction machinery with operator, etc.; and
- the Electricity Transmission, Distribution, On Selling and Electricity Market Operation sector.

Construction is estimated to be associated with a peak workforce of 250 to 300 and an average annual full-time equivalent workforce of 200. Based on the IO coefficients of the Heavy and Civil Engineering Construction sector; Construction Services sector and Electricity Transmission, Distribution, On Selling and Electricity Market Operation sector in the regional economy IO transactions table, $112M of expenditure would be required in these sectors to generate an average annual onsite workforce of 250.

The direct and indirect regional economic impact of this level of expenditure in the local, regional and Qld economy is reported in **Table 13-9**, **Table 13-10** and **Table 13-11.**

Table 13-9 Annual Economic Impacts of the Construction Workforce on the Local Economy

	Direct	Production induced	Consumption induced	Total Flow on*	TOTAL EFFECT*	ADJUSTED TOTAL EFFECT
OUTPUT ($M)	112	69	24	93	206	194
Type 11A Ratio	*1.00*	*0.62*	*0.21*	*0.83*	*1.83*	*1.72*
VALUE ADDED ($M)	59	13	15	27	86	79
Type 11A Ratio	*1.00*	*0.22*	*0.25*	*0.46*	*1.46*	*1.34*
INCOME ($M)	22	7	5	11	33	31
Type 11A Ratio	*1.00*	*0.30*	*0.22*	*0.52*	*1.52*	*1.41*
EMPL. (No.)	250	112	114	225	475	418
Type 11A Ratio	*1.00*	*0.45*	*0.45*	*0.90*	*1.90*	*1.67*

Note: Totals may have minor discrepancies due to rounding.

Table 13-10 Annual Economic Impacts of the Construction Workforce on the Regional Economy

	Direct	Production induced	Consumption induced	Total Flow on*	TOTAL EFFECT*	ADJUSTED TOTAL EFFECT
OUTPUT ($M)	112	84	44	127	240	235
Type 11A Ratio	*1.00*	*0.74*	*0.39*	*1.13*	*2.13*	*2.09*
VALUE ADDED ($M)	59	19	25	45	103	101
Type 11A Ratio	*1.00*	*0.32*	*0.43*	*0.76*	*1.76*	*1.71*

	Direct	Production induced	Consumption induced	Total Flow on*	TOTAL EFFECT*	ADJUSTED TOTAL EFFECT
INCOME ($M)	22	17	12	29	50	49
Type 11A Ratio	*1.00*	*0.77*	*0.53*	*1.30*	*2.30*	*2.25*
EMPL. (No.)	250	168	215	384	634	612
Type 11A Ratio	*1.00*	*0.67*	*0.86*	*1.54*	*2.54*	*2.45*

Note: Totals may have minor discrepancies due to rounding.

Table 13-11 Annual Economic Impacts of the Construction Workforce on the Queensland Economy

	Direct	Production induced	Consumption induced	Total Flow on*	TOTAL EFFECT*
OUTPUT ($M)	112	118	86	204	317
Type 11A Ratio	*1.00*	*1.05*	*0.77*	*1.82*	*2.82*
VALUE ADDED ($M)	59	34	47	81	140
Type 11A Ratio	*1.00*	*0.57*	*0.80*	*1.37*	*2.37*
INCOME ($M)	22	28	23	51	73
Type 11A Ratio	*1.00*	*1.29*	*1.05*	*2.34*	*3.34*
EMPL. (No.)	250	272	369	641	891
Type 11A Ratio	*1.00*	*1.09*	*1.48*	*2.56*	*3.56*

Note: Totals may have minor discrepancies due to rounding.

In estimating the total regional impacts, it is important to separate the flow-on effects that are associated with firms buying goods and services from each other (production-induced effects) and the flow-on effects that are associated with employing people who subsequently buy goods and services as households (consumption-induced effects). This is because these two effects operate in different ways and have different spatial impacts.

Production-induced effects occur in a near-proportional way within a region, whereas the consumption-induced flow-on effects only occur in a proportional way if workers and their families are located in the region or migrate into the region. Where workers commute from outside the region, some of the consumption-induced flow-on effects leak from the region. CWF advises that 50% of the construction workforce are expected to be from the local area, 90% are expected to be from the region and 100% expected to be from Queensland. Consequently, the final column in **Table 13-10** and **Table 13-11** adjusts consumption-induced flow-ons to only include the appropriate percentage of consumption-induced flow-ons. At the Queensland level all the construction workforce is expected to come from Queensland and hence no adjustment to consumption induced flow-ons is made.

The annual construction impact of the Project on the local economy is estimated at up to:

- $194M in annual direct and indirect output;
- $79M in annual direct and indirect value-added;

	Direct Effect	Production Induced	Consumption Induced	Total Flow-on	TOTAL EFFECT
VALUE ADDED ($M)	88	5	3	8	96
Type 11A Ratio	1.00	0.06	0.03	0.09	1.09
INCOME ($M)	2	3	1	4	6
Type 11A Ratio	1.00	1.99	0.90	2.89	3.89
EMPL. (No.)	18	30	23	53	71
OUTPUT ($M)	1.00	1.65	1.27	2.92	3.92

Note: Totals may have minor discrepancies due to rounding.

The Project is estimated to make up to the following total annual contribution to the local economy:

- $111M in annual direct and indirect regional output or business turnover;
- $93M in annual direct and indirect regional value-added;
- $4M in annual direct and indirect household income; and
- 49 direct and indirect jobs.

The Project is estimated to make up to the following total annual contribution to the regional economy:

- $114M in annual direct and indirect regional output or business turnover;
- $94M in annual direct and indirect regional value-added;
- $5M in annual direct and indirect household income; and
- 60 direct and indirect jobs.

The Project is estimated to make up to the following total annual contribution to the Queensland economy:

- $118M in annual direct and indirect regional output or business turnover;
- $96M in annual direct and indirect regional value-added;
- $6M in annual direct and indirect household income; and
- 71 direct and indirect jobs.

The impacts are larger for the Queensland economy because there is less leakage of direct and indirect expenditure out of the Queensland economy compared to the regional economy.

13.1.3 Mitigation Measures

It is evident from **Section 13.1.2** that construction and operation of the Project will have positive impacts on the level of economic activity in the local, regional and Queensland economies.

The CWF Project proposes to work in partnership with Tablelands Regional Council and the local and regional community to help maximise the projected economic local and regional benefits whist minimising potential impacts. In this respect, a range of general economic impact mitigation and management measures are proposed and will include:

- Employment of local and regional residents preferentially, including traditional owners and gender diversity, where they have the required skills and experience.
- Participating, as appropriate, in business group meetings, events or programs in the local and regional community.
- Locally source non-labour inputs to production where local and regional producers can be cost and quality competitive.

In February 2022, the CWF announced a Community Benefit Fund (CBF) for the life of the project (commencing during construction) to provide enduring value to the Ravenshoe and associated Tablelands LGA communities from the proposed Action. The CBF is intended to share an industry-leading allocation of funds approximating $500,000 per annum towards initiatives the community cares about under a hybrid model as illustrated in **Figure 13-2**. Initial feedback from stakeholders indicates the community could benefit from the CBF by allocations towards a shortage of affordable housing and in response to emergencies and natural disasters and further informed by the Community Advisory Group.

Figure 13-2 Community Benefit Fund Hybrid Model

13.2 Greenhouse Gas

The GHG emissions of a wind energy development occur predominantly through the following processes:

- Energy expended in the production of materials (i.e. embodied energy);
- Fuel consumed through the transportation of materials to site; and
- Loss of carbon sequestration potential through the clearing of vegetation.

These are discussed and quantified in **Section 13.2.1**.

The GHG reductions from a wind energy project is in the form of production of electricity without generating GHG emissions through replacement of bituminous coal as a fuel source. The GHG savings of a wind energy project are represented by the emissions that would occur if the equivalent energy output was achieved using fossil fuels and further discussed and quantified in **Section 13.2.2**.

13.2.1 GHG Emissions

The GHG emissions from a wind farm predominantly occur during construction from materials production, transportation and vegetation clearing. Emissions during the operational phase will be limited to light vehicle movements within the site (for inspections and maintenance) and occasional deliveries of replacement parts to the site. The quantity and distance of these vehicle movements is negligible compared to the construction phase and will not materially contribute to the GHG emissions of the Project.

The embodied energy of turbine parts was adopted from Crawford (2009), who explains that:

"The embodied energy of a wind turbine includes the energy required in the manufacturing, construction, installation and ongoing maintenance stages".

The fact that the embodied energy values include energy from "ongoing maintenance stages" suggest that operational impacts are accounted for in the energy expenditure during production of materials.

13.2.1.1 Materials

The dominant construction materials required for the Project are steel, concrete and composite materials.

The tower, hub and nacelle components of a WTG are manufactured from steel. Crawford (2009) suggests an energy intensity of 85.3 GJ/t for steel turbine components. This value is higher than typical energy intensity values for steel, which in the order of 30-40 GJ/t. However, the higher energy intensity for steel turbine parts is attributed to the complex fabrication processes required for these components.

Steel is also used for the construction of powerline towers and reinforcement bars (in reinforced concrete). Lee et al (2010) suggest an energy intensity of 33.7 GJ/t for steel frames. This value has been adopted for the steel used in powerlines and reinforced concrete.

Turbine blades are constructed from a composite material consisting of glass fibre and epoxy. Crawford (2009) suggests energy intensity values of 163 and 168 GJ/t for epoxy and glass fibre, respectively. The value of 168 GJ/t has been adopted for turbine blades.

Each of the WTGs, substations and other infrastructure compounds will require a concrete hardstand and foundation. The energy intensity of concrete was estimated at 3.5 GJ/m^3 by the University of Melbourne (2019). This equates to a value of 1.45 GJ/t, assuming the typical concrete density of 2.4 t/m^3.

If constructed, the BESS will utilise lithium-ion batteries for storage of generated electricity. The embodied energy of lithium-ion batteries is related to the storage capacity (rather than the mass) of the batteries. The energy intensity of lithium-ion batteries has been estimated at 990 MJ/kWh (Kim et al, 2016).

Table 13-17 presents the estimated embodied energy for the infrastructure proposed by the Project. In total, the production of materials required for the Project will consume an estimated 9,318,412 GJ of energy, with the WTGs accounting for the majority of energy requirements. Assuming that this entire energy requirement is provided by bituminous coal, the production of the required materials required would generate approximately 838,643 t CO_{2-e} of GHG emissions. This represents a worst-case scenario, as energy required for material production would (at least partly) be supplied by renewable sources.

Full details of the embodied energy and GHG calculations are presented in **Appendix L**.

The Project will include some structures that are complex and/or comprised of several materials, such as switchyards, control rooms and other occupied buildings. It is difficult to accurately quantify the embodied energy in these structures. However, as indicated in **Table 13-17**, the embodied energy within ancillary structures is substantially outweighed by that within the wind turbines (which have been fully quantified). The omission of some minor ancillary structures from the calculations in **Table 13-17** will not affect the conclusions of this assessment.

Table 13-17 Embodied Energy of Project Infrastructure

Project Component	Material	Total Embodied Energy (GJ)	GHG Emissions (t CO_{2-e})
Wind Turbine Generator	Steel	5,941,998	534,780
	Composite	939,120	84,521
Turbine Footing	Concrete	239,424	21,548
	Steel	289,820	26,084
Turbine Hardstand	Concrete	966,425	86,978
	Steel	211,569	19,041
Substation (hardstand)	Concrete	83,520	7,517
	Steel	12,604	1,134
Construction compound (hardstand)	Concrete	52,200	4,698
O&M Facility	Concrete	41,760	3,758
Battery Energy Storage System	Concrete	83,520	7,517
	Lithium-ion Batteries	396,000	35,640
Wind monitoring mast	Steel	5,898	531
Transmission Line (275 kV) towers	Steel	29,973	2,698
	Concrete	5,306	483
Overhead Powerline (33 kV) towers	Steel	19,276	1,716
Turbine Subtotal		***8,588,356***	772,952
Ancillary Infrastructure Subtotal		***730,057***	65,691
TOTAL		**9,318,412**	838,643

13.2.1.2 Transportation

It has been assumed that turbine components will be sourced from Tianjin (China), whilst lithium-ion batteries will be sourced from Newcastle (NSW). These represent the nearest facilities that manufacture the required components. Turbine components and lithium-ion batteries are the only materials that will require shipping. All other construction materials will be sourced locally and therefore require only road transportation.

As shown in **Table 13-18**, transportation of materials to the Project site will generate in the order of 16,414 t CO_{2-e} of GHG emissions. The calculations for transportation emissions are presented in **Appendix L**.

Table 13-18 Emissions due to Transportation of Materials

Material / Component	Place of Origin	Mode of Transport	GHG Emissions (t CO_{2-e})
Turbine components	Tianjin (China)	Cargo ship	4,980
		Heavy vehicle	2,874
Concreting materials	Ravenshoe (Qld)	Heavy vehicle	7,809
Steel reinforcement bars	Cairns (Qld)	Heavy vehicle	632
Steel bars / frames	Cairns (Qld)	Heavy vehicle	80
Lithium-ion batteries	Newcastle (NSW)	Cargo ship	12
		Heavy vehicle	26
Total			**16,414**

The transportation of materials within the Project site (i.e. construction movements) has been disregarded as these distances are negligible compared to the distance from the producer to the Project site.

13.2.1.3 Vegetation Clearing

Vegetation has the ability to capture carbon from the atmosphere. The clearing of vegetation (during construction) will reduce the available carbon uptake potential (carbon sequestration) and therefore constitute a GHG impact.

The Australian Chief Scientist (2009) estimates that each hectare of woodland can capture 0.5-2.0 t of GHGs. For conservatism, the upper bound of 2.0 t/ha has been adopted to calculate the loss of carbon uptake due to the Project.

For the purposes of this assessment, a very conservative estimate of 25% of the disturbance footprint is assumed to be rehabilitated following the construction phase (it is noted the Project commits to 70% rehabilitation in accordance with the Preliminary Rehabilitation Plan in **Appendix K**). It has been assumed that rehabilitated areas will capture carbon at the lower rate of 0.5 t/ha. That is, the loss of carbon uptake in rehabilitated areas will be reduced to 1.5 t/ha.

Given that the Project may disturb up to 1,071.1 ha of land (predominantly comprising woodland), the annual loss of carbon uptake capacity is estimated at 2,142 t CO_{2-e}/year. Upon rehabilitation of temporary disturbance areas after the construction phase, this loss will reduce to 2,008 t CO_{2-e}/year.

Over the Project life, the removal of vegetation is predicted to reduce the available carbon sequestration potential by 65,605 t CO_{2-e}. The calculations for impacts associated with vegetation disturbance are presented in **Appendix L**.

13.2.2 Reductions

By generating electricity from renewable sources, the Project will reduce reliance on electricity generated from fossil fuels. The GHG emissions that would have resulted from combustion of the displaced fossil fuels are therefore considered to be a benefit of the Project.

The Project has a total nameplate capacity of 602 MW. Data from the Clean Energy Council (2021) indicates that in 2020, Australia had 7,376 MW of installed wind farm capacity and generated 22,605 GWh of electricity through wind energy. This implies that WTGs in Australia operated at 34.9% of nameplate capacity. Assuming the Project's WTGs operate at the national average efficiency, the effective generating capacity of the Project is 210.1 MW. **Table 13-19** presents that projected electricity and energy output of the Project.

On an annual basis, the energy output of the Project will be equivalent to that produced 245,394 t of bituminous coal[27]. By displacing this quantity of bituminous coal, the Project will reduce Australia's GHG emissions by 596,309 t CO_{2-e}/year or 17,889,256 t CO_{2-e} over the 30-year operational phase.

Table 13-19 Benefits of the Project

Measure	Estimated Value
Annual Electricity Output (using a conservative capacity factor of 35 %)	1,840 GWh/year
Annual Energy Output	6,625,651 GJ/year
Quantity of coal required to produce equivalent energy	245,394 t
Reduction in GHG emissions – Annual	596,309 t CO_{2-e}/year
Reduction in GHG emissions – Operational Phase	17,889,256 t CO_{2-e}

Table 13-20 compares the GHG costs and savings facilitated by the Project. The total GHG cost of the Project is estimated at 920,662 t CO_{2-e} and will occur primarily during the construction phase. Once operational, the WTGs are predicted to reduce Australia's GHG emissions by 596,309 t CO_{2-e}/year. At this rate, the Project will offset its GHG costs within 1.5 years of commencing operations. Over the full operational life of the WTGs, the GHG savings facilitated by the Project are expected to be 20 times greater than the emissions associated with its construction. Therefore, the Project is justifiable from a GHG perspective.

Table 13-20 Summary of GHG Costs and Savings

Aspect	GHG Emissions (t CO2-e)
GHG Costs	
Production of materials	838,643
Transportation of materials	16,414
Loss of carbon sequestration due to vegetation clearing	65,605
Total Costs	920,662
GHG Savings	
Reduction in emissions due to reduced reliance on fossil fuels	17,889,256
Total Savings	17,889,256
Net Benefit of Project	**16,968,595**

[27] In the year to 21 February 2022 the majority (72%) of electricity generated in Queensland was sourced from black (bituminous) coal (44,674 GWh). For this reason, the electricity generated from this project is considered most likely to displace electricity generated from black coal. See https://opennem.org.au/energy/qld1/?range=1y&interval=1w

Ratio of Savings to Costs	**20**