Health Impact Statement

Project	Paling Yards Wind Farm	Date	23 November 2022
Project No.	220-0052-00-P-04	For	SSD Application and EIS
Revision	01	Client	GPGA and PYD

This Health Impact Statement (HIS) is prepared by Tract Consultants Pty Ltd (Tract) on behalf of Global Power Generation Australia Pty Ltd (GPGA) and Paling Yards Developments Pty Ltd (PYD) in relation to the Paling Yards Wind Farm (PYWF). The HIS is prepared to support the Environmental Impact Statement (EIS) and is structured as follows:

1. Background Information
2. Identification and Assessment of Impacts
3. Recommendations
4. Monitoring
5. Conclusions

1 Background Information

Wind farms are a renewable, sustainable form of energy which are becoming a growing source of energy across NSW and Australia.

1.1 Project Overview

The project will consist of up to 47 wind turbines, each of which allows for a maximum capacity of up to 6.1MW per turbine, providing a total generation capacity of up to 287MW. Each turbine will have a maximum tip height of up to a maximum of 240m, with three blades per turbine. The project site comprises 4,600ha, equating to a turbine density of 1 turbine per 98 ha.

The PYWF will see clean electricity generated and dispatched into the existing 500kV Mt. Piper – Bannaby overhead line, which will result in a reduction of greenhouse gas emissions of approximately 900,000 tonnes of CO^2 equivalent annually.

Ancillary infrastructure will include an on-site collector substation (including control room, maintenance building, switchgear and associated control system) and switching station, with approximately 9km of overhead powerline connecting to the Mount Piper to Bannaby 500kV transmission line.

1.2 Population Profile

While the Project is situated in the Oberon Local Government Area (LGA), it is near the border with the Upper Lachlan LGA. The major regional centre servicing this area is Goulburn which is in the Goulburn-Mulwaree LGA. The region for analysis has therefore been identified as the combine LGAs of Oberon, Upper Lachlan and Goulburn-Mulwaree.

In 2016, the regional economy had a population of 42,605 and a labour force of 19,638, with Goulburn-Mulwaree LGA being the largest. Against this backdrop, it is evident that the population of the region has

grown at an average annual growth rate of 1.16% since 2006, less than the growth rate of NSW. This growth has been strongest in the Goulburn Mulwaree LGA. Oberon LGA had the lowest average annual growth rate of LGAs in the region.

NSW Department of Planning and Environment (DPE) population forecasts for the three LGAs are discussed in more detail in the Socio-economic Impact Assessment prepared by ERM, particularly the section discussing the regional economy. The assessment suggests continued population growth at a rate greater than Regional NSW (but generally less than NSW), predominantly driven by Goulburn Mulwaree LGA. Oberon LGA growth rate is forecast to decline and become negative after 2031.

1.3 Potential Negative Impacts

Over the years it has been established that the main human health concerns relating to wind farms raised by the public during community consultation predominantly relate to:

- Low frequency noise impacts (due to wind turbine operation);
- Shadow flicker;
- The impacts of magnetic fields;
- Increased noise levels (due to traffic during construction and operation);
- Bushfire impacts;
- Blade throw events; and
- Biosecurity assessment and management.

1.4 Potential Positive Impacts

It is also noted that wind farms can have a beneficial impact on human health, including –

- Short and long term employment opportunities;
- Positive impact on the regional NSW economy;
- Reduced greenhouse gas emissions;
- Sustainable source of energy;
- Voluntary Planning Agreement (VPA) with Oberon Council, which can then be directed to a range of community infrastructure needs and programs and a community benefit scheme.

These potential impacts have been discussed within this assessment.

1.5 HIS Limitations

In preparing this health assessment, the NSW *Wind Energy Guidelines for State Significant Wind Energy Development* (December 2016) have been reviewed and considered. The Guidelines state that: *"The NSW Government's position on potential health impacts of wind energy projects continues to be informed by the scientific findings of the NHMRC."*

The following matters will be assessed as part the SSD proposal and subsequent EIS:

- suitability of the site for the proposed project;
- submissions made by the local community, stakeholders and government authorities;
- the likely environmental, social and economic impacts of the construction, operation and decommissioning of the wind energy project in the locality;
- the relevant provisions of any environmental planning instrument, which regulates the permissibility of types of development in certain areas;
- the public interest which includes consideration of the objects of the EP&A Act and, in particular, the principles of ecologically sustainable development;

- the strategic context and alignment with relevant Government policies; and
- the assessment issues outlined in sections 2 and 3.

In addition to the guidelines, the National Health and Medical Research Council of Australia (NHMRC) statement: *Evidence on Wind Farms and Human Health* will also be considered. This statement is based on the findings of comprehensive independent assessments of the scientific evidence on wind farms and human health.

2 Identification and Assessment of Impacts

2.1 Noise

Studies indicate that depending on proximity to dwellings, the sounds associated with wind turbines can potentially be loud enough to be a source of disturbance, potentially adversely affecting wakeful activities and / or sleep with resulting irritability, negativity and cognitive disturbance[i].

In order to manage potential noise impacts, guidance and regulation has been established to place an upper limit on the sound generated by wind farms, which effectively limits how close turbines can be located to dwellings and towns.

Specifically, the NSW Government has a wind energy framework to provide greater clarity, consistency and transparency for industry and the community regarding both assessment and decision-making on wind energy projects. The NSW Department of Planning and Environment released the *Wind Energy Noise Assessment Bulletin for State significant wind energy development* in December 2016.

The NSW Government has adopted the South Australian EPA document *Wind farms – environmental noise guidelines* – 2009 which forms the basis of the regulatory noise standard and assessment methodology.

SLR Consulting prepared a detailed Noise Impact Assessment as part of the application.

Within this Noise Impact Assessment, it is noted that the SA EPA Guideline recommends the following noise criteria for new wind farms:

> *The predicted equivalent noise level (LAeq,10min), adjusted for tonality in accordance with these guidelines, should not exceed:*
> - *35 dBA, or*
> - *the background noise level by more than 5 dBA, whichever is the greater, at all relevant receivers for each integer wind speed from cut-in to rated power of the WTG.*

The Noise Impact Assessment sets out that where noise levels at project-involved residences do not comply with the SA EPA Guidelines, the proponent intends to enter into agreements with the owners of those residences to achieve noise criteria in accordance with World Health Organisation (WHO) Guidelines. Effectively this becomes 45 dBA or background + 5 dBA, whichever is the higher.

As part of noise assessment process, the Proponent initially provided specifications for the three alternative indicatively sized WTG models considered. Recent refinements of the turbine layout and agreements with turbine suppliers have confirmed the following:

- **Turbine Model**: General Electric – Cypress 158-6.1MW turbine (50 / 60 Hz) (tubular steel tower)
- **Output**: 6.1MW per turbine, with a total generation capacity estimated at up to 287MW
- **Total Number of Turbines**: 47 turbines with a maximum blade tip height of 240m.

A 'worst case' preliminary noise assessment approach was proposed during the Scoping Phase in which the highest number of WTGs and the largest model WTG size and capacity were considered. This approach

ensured a comprehensive assessment of potential impacts and provided the best information to inform a finalised infrastructure layout that responds to the identified constraints.

Noise modelling of the worst-case layout was completed using SoundPLAN V8.1 software implementing algorithms from ISO9613-2:1996 *Acoustics - Attenuation of sound during propagation outdoors - Part 2: General method of calculation (ISO9613)* at all surrounding residential dwellings within 10km of a turbine.

Furthermore, the model input parameters recommended by the UK Institute of Acoustics - *A Good Practice Guide to the Application of ETSU-R-97 for the Assessment and Rating of Wind Turbine Noise* (IoA Wind turbines) as implemented in SoundPLAN were adopted.

During the detailed Noise Impact Assessment, the following was undertaken as part of the study:

- Baseline noise monitoring at nearby receptors to quantify the existing ambient noise environment. Background noise levels will be statistically regressed with wind speed. The background noise 'curve' is then used to determine the relevant noise criteria for each site across the full operating wind speed range.
- Refinement of the noise model input assumptions e.g. WTG model, WTG sound power level, ground terrain and hardness etc.
- Refinement and consolidation of the wind farm layout.
- Noise optimised operation of WTGs, if required.

The predicted wind turbine noise level assessment carried out by SLR found that:

- the maximum 35 dBA noise criterion is met for all non-involved receptors, with the exception of Locations 3 & 4, which are identified as non-involved receptors.
- the maximum 45 dBA noise criterion is marginally exceeded at project involved receptors at locations 6A, 7, 7A, 8, 8A, 9, 9A and 9B, with the predicted potential exceedance ranging from 1.8 dBA to up to 3.5 dBA.

However, as set out within the Noise Impact Assessment, noise curtailment strategies, such as Noise Management Mode (which enables the reduction of rotor speed), can potentially be used on the candidate turbine. If the Noise Management Mode was utilised, all involved and non-involved receptors would comply with the minimum noise criteria.

When applying these mitigation measures to the selected turbines, the predicted wind turbine noise level are expected to be as follow:

- the maximum 35 dBA noise criterion is met for all non-involved receptors, including dwelling locations 3 & 4, which is expected to reach 34.2 dBA and 34.8dBA respectively.
- the maximum 45 dBA noise criterion will not be exceeded at any of the involved dwellings / receptors.

The NHMRC considered noise emitted by a wind farm (including low-frequency noise and infrasound) to be similar to noise from any other natural and human-made source, and at 1.5km from a wind farm, the noise level is usually below 30–35 A-weighted decibels (dBA), which is similar to noise levels in a quiet residential area[ii]. All involved dwellings are located at least 1.0km away from any turbines, and all non-involved dwellings are located at least 1.5km away from any turbines. Noise impacts associated with the operation of the PYWF are not considered likely to present a human health risk.

Impacts associated with operational traffic and substation noise would be compliant with relevant standards at all receptors.

2.2 Shadow Flicker

Due to their height, wind turbines can cast shadows on surrounding areas at a significant distance from the base of the wind turbine tower. Moving blades create moving shadows, and these shadows can appear as

a flicker giving rise to the phenomenon of 'shadow flicker'. When the sun is low in the sky, the length of the shadows increases, increasing the area around the wind turbine that is affected by shadow flicker.

The primary human health concern associated with shadow flicking is the potential to provoke photosensitive seizures.

A Shadow Flicker Assessment has been prepared by DNV to determine and illustrate the potential impact of shadow flicker on the surrounding locations. The report was prepared based on the requirements of the *NSW Wind Energy Visual Assessment Bulletin* (NSW Visual Assessment Bulletin) prepared by the NSW Department of Planning and Infrastructure in December 2016 and the *Draft National Wind Farm Development Guidelines* (Draft National Guidelines).

The NSW Visual Assessment Bulletin does not provide detailed methodologies for assessment but does set out that shadow flicker to dwellings will be limited to 30 hours per year, and may require mitigation measures, such as amended siting, design of turbines and operational measures.

The Draft National Guidelines recommend that the modelled theoretical shadow flicker duration should not exceed 30 hours per year, and that the actual or measured shadow flicker duration should not exceed 10 hours per year. The guidelines also recommend that the shadow flicker duration at a dwelling be assessed by calculating the maximum shadow flicker occurring within 50m of the centre of a dwelling. These limits are assumed to apply to a single dwelling, and it is noted that there is no requirement under either the NSW Visual Assessment Bulletin or the Draft National Guidelines to assess shadow flicker durations at locations other than in the vicinity of dwellings.

The Draft National Guidelines suggest a distance equivalent to 265 times the maximum blade chord, which corresponds to approximately 1000m to 1600m for modern wind turbines (which typically have maximum blade chord lengths of between 4m to 6m). However, the UK wind industry considers that a distance limit of around 10 rotor diameters(10D) from a turbine, or approximately 1200m to 1900m for modern wind turbines (which typically have rotor diameters of 120m to 190m), is appropriate.

DNV's assessment has assumed a distance of 10D for determining the maximum distance from turbines that the shadow flicker is considered to be at least of a moderate level of intensity. DNV considers this approach is more appropriate than a limit of 265 times the maximum blade chord.

A total of 19 dwellings located in the vicinity of the Paling Yards Wind Farm site were assessed by DNV, of which, nine dwellings are understood to be stakeholder dwellings "involved" with the Project.

DNV's assessment found that a total of nine dwellings are predicted to experience some high intensity shadow flicker, meaning generally shadow flicker of at least a moderate level of intensity or above, which is expected to occur up to around 10D from the wind farm. All these dwellings are understood to be involved stakeholder dwellings.

For one of the involved stakeholder dwellings, the theoretical high intensity shadow flicker is predicted to be below the proposed limits, while the actual high intensity shadow flicker within 50 m of the dwelling is predicted to be slightly above the proposed limit.

For eight of these involved stakeholder dwellings, the theoretical and actual high intensity shadow flicker durations within 50 m of the dwelling are predicted to exceed the proposed shadow flicker limits by a significant margin (ranging from approximately 2 to 12 times the limits).

It is important to note that the above prediction of shadow flicker duration does not take into account any reduction due to low wind speed, vegetation or other shielding effects around each receptor.

The effects of shadow flicker may be further reduced through a number of mitigation measures such as the relocation of turbines, the removal of certain identified / problematic turbines, installation of screening

structures or planting of trees, or the use of turbine control strategies, which shuts down turbines when shadow flicker is likely to occur.

Should any exceedances still occur, it is understood that the NSW Wind Energy Guideline allows for negotiated agreements between the wind farm Proponent and involved stakeholders to manage exceedances of the relevant assessment criteria. Consequently, it is recommended that landholders are informed about any predicted shadow flicker durations that may be experienced. It is noted that high shadow flicker durations may not be acceptable to some involved landholders meaning that some mitigation may be required. A copy of the DNV Shadow Flicker Assessment has been provided to all involved landowners.

None of the non-involved dwellings are predicted to experience high intensity shadow flicker due to the proposed wind farm, and therefore the shadow flicker limits are not exceeded at these locations.

The NHMRC Public Statement concludes that the evidence on shadow flicker does not support a health concern[iii]. In particular, the Environment Protection and Heritage Council of Australia estimates that the probability of conventional horizontal-axis wind turbines causing an epileptic seizure for an individual experiencing shadow flicker is <1 in 10 million in the general population, given the low proportion of the population that are subject to epilepsy at any point in time, and further, that only a small proportion of this population with epilepsy is vulnerable to light flashes or shadow flickers[iv]. As such, the risk to human health associated with shadow flicker is considered very low.

2.3 Blade Glint

Blade glint involves the regular reflection of sun off rotating turbine blades. Its occurrence depends on a combination of circumstances arising from the orientation of the nacelle, angle of the blade and the angle of the sun. The reflectiveness of the surface of the blades is also important. Blade glint is not generally a problem for modern wind turbines, provided the blades are coated with a non-reflective paint.

The General Electric – Cypress 158-6.1MW turbine blades are coated with a non-reflective finish, like most modern day turbines and blades. Since a non-reflective finish is proposed, blade glint is not expected to be an issue.

2.4 EMF

Electric and Magnetic Fields (EMF) are a combination of electric and magnetic fields, which occur naturally and as a result of human activity. The electric field is caused by the voltage of the equipment and the magnetic field is caused by the current flowing (amperage). Electric fields and magnetic fields are essentially independent of one another and, in combination, cause energy to be transferred along electric wires. EMFs occur wherever electricity is present and can be found in electrical equipment such as transmission lines, substations and electrical components within the turbines.

Over the past 50 years, concerns have been expressed that the EMFs associated with electrical equipment might have adverse health effects. The EIS is supported by an EMF assessment prepared by ERM, which details, at length, the research conducted about potential human health impacts. The available evidence at large does not find EMF from wind turbines to be a likely causative agent for negative health effects in the community[v].

The Australian Radiation Protection and Nuclear Safety Agency (ARPANSA) is the Australian Government's primary authority on radiation protection and nuclear safety. ARPANSA considers the publications produced by the International Commission on Non-Ionizing Radiation Protection (ICNIRP). ICNIRP has issued Guidelines (2010) which are aimed at preventing the established health effects resulting from exposure to extremely low frequency (ELF) EMF. Exposure to high levels of ELF EMF is extremely rare and does not occur in people during their day-to-day living[vi].

In Australia, EMFs associated with the use of electricity are generated at a frequency of 50 hertz. This frequency falls within the Extremely low frequency (ELF) range. The reference levels (at 50 hertz) for exposure to external magnetic fields is 200 μT (general exposure) and 1,000 μT (occupational exposure), and for exposure to electric fields is 5 kilovolts per metre (kV / m) (general) and 10 kV / m (occupational)[vii].

Dwellings usually have negligible background electric fields, while magnetic fields are usually in the order of 2 MilliG (mG). The EMF Assessment prepared by ERM identifies that the magnetic field measurements associated with overhead power lines and substations (being infrastructure associated with a wind farm) are as follows:

Source	Measurement Location	Microtesla (μT)	Milligauss (mG)
Substation	At substation fence	0.1 – 0.8	1 – 8
Transmission Line (high voltage power lines)	Directly underneath	1 – 20	10 – 200
Transmission Line (high voltage power lines)	At edge of easement	0.2 – 5	2 – 50
Distribution Line (street power lines)	Directly underneath	0.2 – 3	2 – 30
Distribution Line (street power lines)	10m away	0.05 – 1	0.5 – 10

Source: Electric Magnetic Fields Assessment prepared by ERM (22 June 2022)

Based on the available data, the EMF from transmission lines and substations, based on likely exposure scenarios, are well within acceptable levels for magnetic fields.

Furthermore, in line with the Energy Network's Association's 'prudent avoidance' approach, dwellings and publicly accessible locations have been setback from project infrastructure (e.g. substations, switching station, transmission line). The nearest dwellings (which are all involved dwellings) to electrical infrastructure are as follow:

- The nearest dwelling to Substation Option 1 is 1.1km away
- The nearest dwelling to Substation Option 2 is 1.4km away
- The nearest dwelling to the Collector Substation is 1.1km away.
- The nearest dwelling to the transmission line is 0.4km away.

Given these setbacks, potential EMF exposure from project infrastructure to nearby dwellings will be negligible.

Consideration has been given to the potential EMF and EMR fields in the vicinity of the turbines. ERM has deemed that the EMF strengths and EMR levels are likely to be within the limits imposed by the relevant and applicable guidelines and will cause no adverse impacts on any services or on public health.

The broadly accepted guideline in both Australia and overseas is to implement a prudent avoidance approach which has been adopted in the Project design through the provision of setbacks and easements. The Project has also been designed in accordance with relevant standards and guidelines, and dwellings and publicly accessible areas would be well within acceptable levels for magnetic fields. Due to the low

exposure likely to be generated from the proposed activity and the findings of the scientific community, no adverse health impacts are expected due to EMFs from the Project.

The EMF assessment concludes that the available evidence at large does not find EMF from wind turbines to be a likely causative agent for negative health effects in the community.

2.5 Bushfire

ERM was commissioned by the proponent to consider bushfire risk in the vicinity of the proposed PYWF. A Bushfire Risk Assessment (BRA) was undertaken to identify potential hazards and risks associated with the project and use of bushfire prone land. The report contains management and mitigation measures designed to address the obligations, which are to be consistent with the NSW Rural Fire Service (RFS) guidelines Planning for Bushfire Prone Protection 2019.

Bushfire presents a threat to human life and assets. The BRA aims to identify potential hazards and risks associated with bushfires and demonstrate that the proposed wind farm can be constructed and operated in a safe manner.

A key bushfire risk factor identified in the assessment is the potential for loss of life. Residential dwellings on rural properties are scattered throughout the landscape and may be at risk from bushfire. The BRA lists potential mitigation measures to reduce the impact:

- The PYWF will be controlled by a remote supervisor and the system will allow the remote operation and shut-down of individual or all turbines (if required).
- NSW RFS will review all access roads to enable safe access and egress to residents.
- Key assets are to be located outside of the flame zone.
- A Bushfire Emergency Management and Operations Plan must be prepared in conjunction with relevant stakeholders.

In addition to the above, improved access, additional recommended water source and Asset Protection Zones (APZ) around turbines (10m around each turbine and 20m around substation, switching station and operations & management building) and infrastructure, will be of advantage to both the RFS and the NPWS.

Despite the bushfire mitigation measures and treatments that are put in place, bushfire risk will always remain. It is very important that ongoing consultation with the NSW RFS and NOPWS during the detailed design and the preparation of the Emergency Management and Operations Plan.

2.6 Blade Throw

Blade throw describes an incident in which a structural failure occurring in the blade of a wind turbine during operation results in parts of the blade detaching and being thrown into the surrounding area.

Modern wind turbines and turbine components are generally designed and certified in accordance with recognised international standards to ensure structural integrity and safe operation over the lifetime of the turbine. In addition, modern turbines also incorporate sophisticated control systems designed to shut the turbine down during high wind speed conditions, and in response to the detection of a range of faults or abnormalities. As such, blade throw incidents are relatively rare events for modern turbines.

Regardless of the rarity of events, given the potential for significant consequences to human health arising from a blade throw incident, either in terms of either personal injury or death, the EIS is supported by an assessment prepared by DNV which recognises and evaluates the risks.

The DNV methodology has undertaken a conservative approach, both in terms of methodology and assumptions (i.e. that any impact would be fatal), and reviews the risk at nearby dwellings, nearby properties, and to users of nearby roads.

The Blade Throw Assessment finds that no nearby dwellings or sensitive locations are located 240m of any proposed turbine locations within the Project Site. All dwellings are more than 490m from the nearest proposed turbine location, and therefore the frequency at which a person who remains at any fixed location on a neighbouring property for a whole year would be hit and killed by a blade or blade fragment thrown from the Project is less than 1 in 1,000,000 (1-in-1 million) and considered "extremely remote" or "improbable".

The Blade Throw Assessment finds that no neighbouring properties are located within half a turbine rotor diameter of any proposed turbine locations. The frequency at which a person who remains at any fixed location on a neighbouring property for a whole year would be hit and killed by a blade or blade fragment thrown from the Project is less than 1 in 100,000.

The Assessment also finds that no roads are located within half a turbine rotor diameter (or 79m) of any proposed turbine locations within the Project Site. Therefore, the frequency at which a person who remains at any fixed location on a nearby road for a whole year would be hit and killed by a blade or blade fragment thrown from the Project is less than 1 in 100,000, which is less than the annual frequency of death on Australian roads and varies from 1 in 8264 to 1 in 23,256. Furthermore, this frequency (1 in 100,000) does not consider the probability that a person and vehicle would be present on the road in the exact location at risk of being hit by a blade throw exactly when the incident occurred. In fact, a more detailed analysis of risk to road users provided within the DNV assessment, considered that the individual risk of death caused by Blade Throw by road users along Abercrombie Road would be closer to 1 in 71,000,000 (1-in-71 million).

When considering traffic volume and assuming an average of two people travelling in each vehicle, DNV evaluates that the potential societal risk of death caused by Blade Throw on Abercrombie Road would be one death every 71,000 years.

Given the conservative assessment methodology and assumptions used by DNV, the results show that the potential risks of death or injury due to blade throw are considerably lower than existing risks associated with the current use of the land and / or use of nearby roads. Therefore, based on the proposed turbine layout and site parameters, the risk to human health (injury or death) associated with blade throw is considered very low.

2.7 Biosecurity Management

ERM prepared a Biosecurity Risk Management Plan to identify and assess existing and potential biosecurity risks as well as to determine and recommend measures to prevent, minimise and / or eliminate these risks. While these risks are not considered to be directly associated with human health, it is important to highlight the key biosecurity risks identified with the management plan. In summary, they include:

- Weeds of national, state and regional priority species
- Pest animal species within the project area.

The following activities have been identified as those that could contribute to the potential introduction or spreading of weeds and facilitate pest animal incursions or biosecurity risks:

- Movement of vehicles
- Ground disturbance
- Vegetation clearance
- Delivery of materials
- Ongoing site management.

The following criteria for success will be assessed throughout the project:

- No pest animals or plans species population will increase through the project

- No introduction of significant / priority biosecurity matter; and
- Weed species populations will reduce within the project area.

It is emphasised that the use of pesticide in relation to any pests in the project area must be done in accordance with the *Pesticides Act 1999*, to mitigate any potential human health impacts via exposure to pesticide.

2.8 Employment Opportunities

The project is anticipated to generate up to 152 full-time equivalent jobs during construction, and approximately four ongoing full-time jobs, in addition to about 10 maintenance-related jobs, during the operation of the wind farm. This will result in the up-skilling of the local workforce, within a growing energy market. It is anticipated that the project will stimulate the local and regional economy, including greater income generation and subsequent expenditure in the region, which in turn will facilitate additional employment and commercial opportunities from the economic investment.

Studies suggest that higher income is commonly linked with better health, including a reduced overall risk of mortality and decreased rates of chronic diseases such as diabetes, heart disease, and stroke[viii]. Mortality rates are often lower among those who are employed compared to the unemployed[ix]. Employment can also improve general mental health, and, over time, is linked to a positive trend in perceived health and physical functioning in both women and men[x].

2.9 Renewable Energy

The project will generate up to 287MW of clean, renewable energy, and will contribute towards reducing the dangerous impacts of climate change through the displacement of up to 900,000 tonnes of greenhouse gases per year.

In Australia, it is estimated that negative health impacts linked to pollutants produced via coal fired electricity generation cost circa A$2.6 billion annually. Air pollution results in 3000 premature deaths each year in Australia and costs the nation up to $24.3 billion in health expenses every year[xi].

Studies indicate that creating electricity from clean energy sources like wind and solar, and reducing the need for fossil fuel power generation, lowers emissions of harmful gases like nitrogen oxides, sulphur dioxide, and carbon dioxide, which in turn helps reduce premature deaths, heart attacks, asthma exacerbations, and hospitalisation for cardiovascular or respiratory issues[xii].

3 Recommendations

Having assessed the potential impacts on human health, recommendations have been made to either mitigate potential adverse effects, or otherwise ensure positive impacts are achieved.

With respect to **shadow flicker** and **blade glint**, the following recommendations are made:

- Installation of screening structures or planting of trees to block shadows cast by the turbines.
- Using turbine control strategies to shut down turbines when shadow flicker is likely to occur.
- Relocation (or micro-siting) of turbines.
- Commitment to ensuring that turbine suppliers confirm they coat blades with non-reflective paint to address blade glint.

With regards to **bushfire** and as mentioned above:

- Ensure the wind farm is controlled by a remote supervisor and the system allows the remote operation and shut-down of individual or all turbines, when required in an emergency.

- Cooperate with NSW RFS to review all access roads to enable safe access and egress to residents.
- Locate key assets outside of the flame zones.
- Prepare a Bushfire Emergency Management and Operations Plan in conjunction with relevant stakeholders.
- Ensure APZs around turbines (10m around each turbine and 20m around substation, switching station and operations & management building) and infrastructure.
- Provide for a minimum combined storage of 50,000 litres of water on the site.

In relation to **noise** mitigation, it is noted that:

- That Noise Management Mode may be used for the 16 WTG's, closest to those receptors where exceedances were predicted, to reduce noise impacts, and achieve compliance with the relevant noise criteria.
- A construction noise management plan should be prepared to ensure that all reasonable steps are taken to reduce noise from construction sources.

In terms of ensuring that potential positive **human health impacts** are felt within the local community as a result of the project, the following recommendations area made:

- Where possible, ensure local workforces and supplies are used to maximise benefits to the local community.
- Prior to construction, ensure that all reasonable and feasible mitigation measures have been considered, and the consent authority is satisfied that the economic, social and environmental benefit of the project outweigh its adverse impacts.

Should consent be granted by the NSW DPE, the following conditions will apply to the Project:

- obligations to meet a performance outcome or objective;
- obligations to implement specific mitigation measures as identified in the supporting documents and specialist studies;
- obligations to monitor actual versus predicted impacts;
- obligations to monitor the effectiveness and outcomes of any mitigation strategies in accordance with agreed performance indicators and implement adaptive management strategies where required; and
- reporting and auditing requirements, including by requiring reporting of data.

As prescribed in the guidelines, adaptive management frameworks can be implemented through conditions so as to require proponents to report to the Department, and publicly, against outcomes.

4 Monitoring

Prior to construction, GPGA will prepare management plans or arrange monitoring programs to address the below potential environmental considerations. These management plans will include scheduled monitoring activities to ensure compliance with health and safety objectives.

Noise

- A Noise Management Plan will be prepared to manage noise emissions from the operation of the development, and would include:
    (a) compliance monitoring within 3 months of operations, or the commencement of operation of a cluster of turbines if the development is to be staged, in accordance with the Department's Wind Energy: Noise Assessment Bulletin (2016) (or its latest version);
    (b) description of the parameters and meteorological conditions which trigger the use of noise management mode and sector management;

(c) an auditable process that compliance can be independently confirmed for the use of noise management mode and sector management;
(d) procedures and corrective actions to be undertaken if non-compliance is detected;
(e) provision of a copy of the compliance monitoring results to the Secretary and the EPA.

- A Construction Noise Management Plan will be prepared closer to the time at which works are due to commence on site, in order to mitigate potential noise impacts associated with the construction stage of the project.

Bushfire

- A comprehensive Emergency Plan will be prepared detailing emergency procedures for the development. GPGA would:
  (a) Ensure that the development
    - provides for asset protection in accordance with the RFS's *Planning for Bushfire Protection 2019* (or equivalent); and
    - is suitably equipped to respond to any fires on site;
  (b) develop procedures to manage potential fires on site, in consultation with the RFS; and
  (c) assist the RFS and emergency services as much as possible if there is a fire in the vicinity of the site.
- The emergency plan would:
  (a) be consistent with the RFS's *Planning for Bushfire Protection 2019* (or equivalent);
  (b) identify the fire risks and hazards and detailed measures for the development to prevent or mitigate fires igniting;
  (c) list works that should not be carried out during a total fire ban
  (d) include availability of fire suppression equipment, access and water;
  (e) include procedures for the storage and maintenance of any flammable materials;
  (f) detail access provisions for emergency vehicles and contact details for both a primary and alternative site contact who may be reached 24 / 7 in the event of an emergency;
  (g) include a figure showing site infrastructure, Asset Protection Zone and the on-site water supply tank
  (h) include location of hazards (physical, chemical and electrical) that may impact on fire-fighting operations and procedures to manage identified hazards during fire-fighting operations;
  (i) include details of the location, management and maintenance of the Asset Protection Zone and who is responsible for the maintenance and management of the Asset Protection Zone;
  (j) include bushfire emergency management planning; and
  (k) include details of the how RFS would be notified, and procedures that would be implemented, in the event that:
    - there is a fire on-site or in the vicinity of the site;
    - there are any activities on site that would have the potential to ignite surrounding vegetation; or
  (l) there are any proposed activities to be carried out during a bushfire danger period.

Upon approval, GPGA will implement the Emergency Plan.

Biosecurity

GPGA would initiative an ongoing monitoring plan to mitigate potential biosecurity risk. This would include:

- Monitoring for signs of, and reporting sightings of pest animals and habitats.

- Monitoring fencing for damage (that may facilitate pest access), repairing and / or reporting any damage.
- Monitoring for signs of weeds, and undertaking weed surveys (every 3 months during construction and annually during operation)

If a suspected pest or biosecurity incident occurs, GPGA will report this immediately.

5 Conclusion

The National Health and Medical Research Council (NHMRC) conducted a review of the evidence relating to the adverse health impacts caused by the wind turbines and concluded that:

*"In the most recent Statement "Evidence on Wind Farms and Human Health" (Febr**uary 2015), the NHMRC concludes that there is currently no consistent evidence supporting a link between wind energy** projects and adverse health outcomes in humans relating to infrasound."*

Current evidence gathered, assessment of the supporting documents, and compliance with the recommendations outlined above, indicates that potential impacts from noise, EMF, shadow flicker and blade glint associated with the proposed wind farm would not give rise to any adverse human health impacts. Furthermore, the level of risk to human life posed by blade throw and biosecurity associated with the project is considered to be very low. With respect to bushfire risk, it is noted that the project is located in a bushfire prone landscape. Therefore, ongoing monitoring and management will be required. However, the mitigation measures proposed (including improved access and additional water sources) will be advantageous in a bushfire situation.

Subject to upholding the recommendations set out in Section 3 of this report, and to subsequent monitoring and ongoing management set out in Section 4, it is not considered that the project would give rise to any unacceptable human health impacts.

References

[i] Davy, J.L., Burgemeister, K., Hillman, D. et al (2020). A Review of the Potential Impacts of Wind Turbine Noise in the Australian Context. Acoust Aust 48, 181–197. Accessed online: https://doi.org/10.1007/s40857-020-00192-4

[ii] National Health and Medical Research Council (2015). NHRMC Statement: Evidence on wind farms and human health, online: https://www.nhmrc.gov.au/about-us/publications/nhmrc-statement-evidence-wind-farms-and-human-health

[iii] Chatham-Kent Public Health Unit (2008). The Health Impact of Wind Turbines: A Review of the Current White, Grey, and Published Literature. ChathamKent Municipal Council, Chatham Ottawa.

[iv] EPHC 2010, National Wind Farm Development Guidelines – draft, Department of the Environment, Water, Heritage and the Arts, Environment Protection and Heritage Council, Adelaide.

[v] Knopper, L., Ollson, C., McCallum, L., Whitfield Aslund, M., Berger, R., Souweine, K., & McDaniel, M. (2014). Wind turbines and human health. Frontiers in Public Health, 2(63), 1-20.

[vi] ARPANSA. (2020, July 16). Extremely low frequency electric and magnetic fields. Retrieved July16, 2020, from Australian Radiation Protection and Nuclear Safety Agency: https://www.arpansa.gov.au/understanding-radiation/what-is-radiation/non-ionising-radiation/low-frequency-electric-magnetic-fields

[vii] ICNIRP. (2010). Guidelines for limiting exposure to time varying electric and magnetic fields (1Hz to 100 kHz).Health Physics

[viii] Steven H. Woolf, Laudan Y. Aron, Lisa Dubay, Sarah M Simon, Emily Zimmerman, Kim Luk (2015). How Are Income and Wealth Linked to Health and Longevity? Urban Institute and Virginia Commonwealth University, USA.

[ix] Waddell, G. Burton, A. K. (2006). IS work good for your health and well-being? Department for Work and Pensions, UK.

[x] Maaike van der Noordt, Helma IJzelenberg, Mariël Droomers, Karin I Proper. (2014) Health effects of employment: a systematic review of prospective studies. Accessed online: https://pubmed.ncbi.nlm.nih.gov/24556535/

[xi] Climate and Health Alliance (2015). The Health Implications of Energy Choices in Australian, online: https://www.caha.org.au/the_health_implications_of_energy_choices_in_australia_vhaz5b8qjcnx8exq4y8hca

[xii] Harvard School of Public Health (2015). Health Benefits of Renewable Energy, online: https://www.hsph.harvard.edu/c-change/news/health-benefits-of-renewable-energy/