Renewable energy consultants

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Coopers Gap CCC Meeting

Electromagnetic Interference (EMI)

Overview

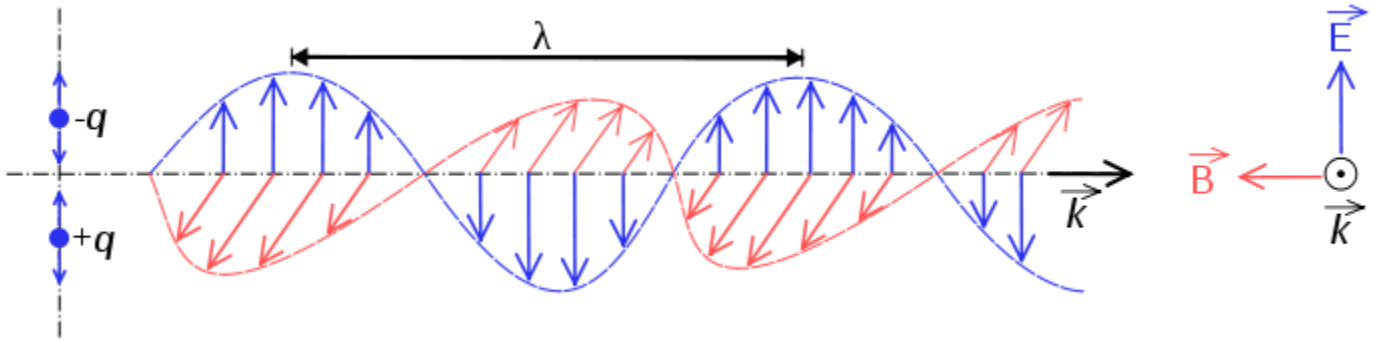
- What is electromagnetic interference (EMI)?
- How can wind turbines cause EMI?
- What services can be affected by EMI from wind turbines?
- How is EMI assessed?
- EMI at Coopers Gap
- Mitigation of EMI

GL Garrad Hassan are international technical consultants who have been engaged by AECOM to give an overview of the issues relating to the shadow flicker and EMI impacts of the proposed Coopers Gap wind farm. The information contained in the following presentation is based on current project information provided by AGL, AECOM and other entities.

What is electromagnetic interference (EMI)?

- Wireless radiocommunications involve transmission of signals via electromagnetic waves.

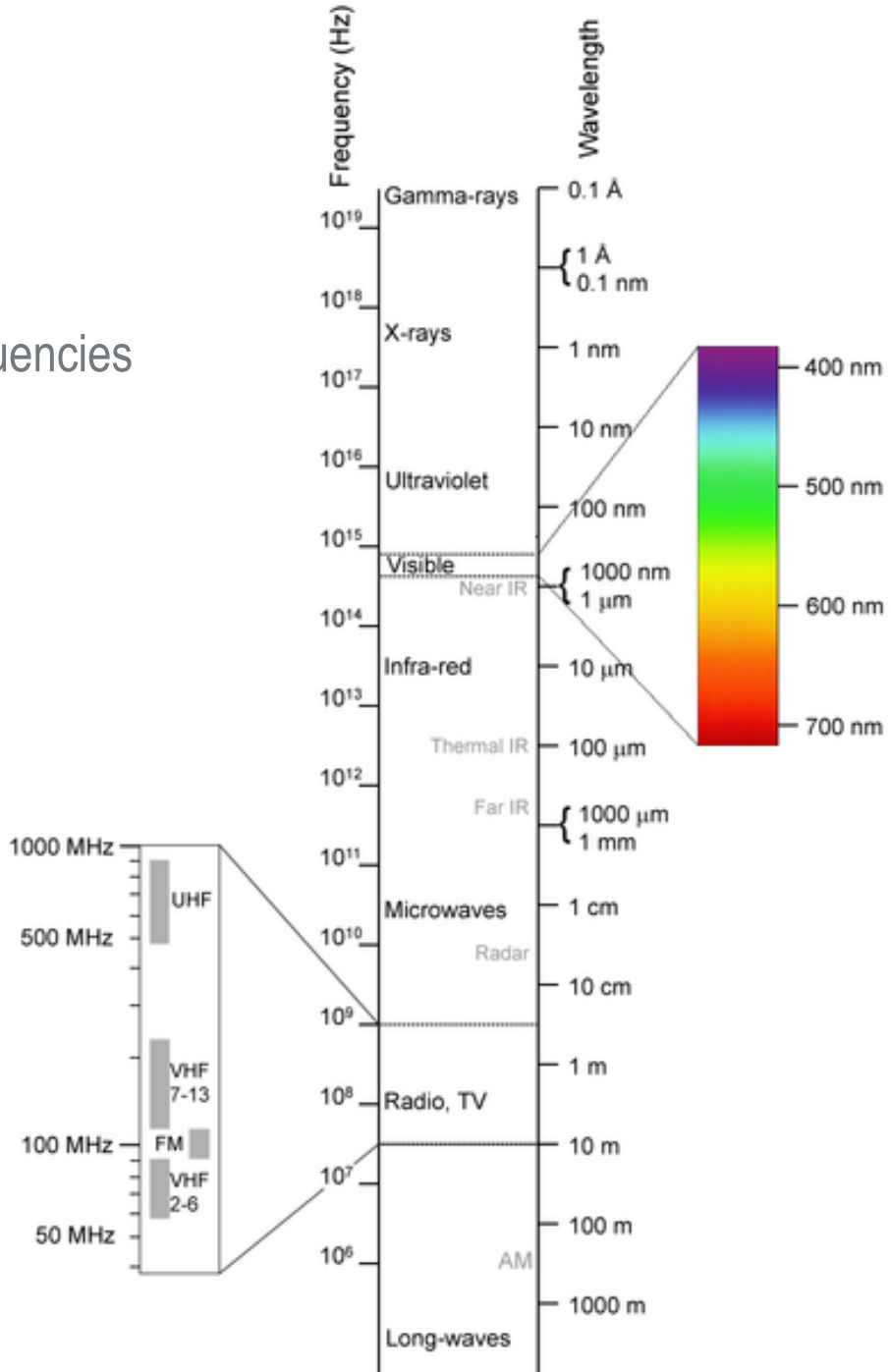
- Electromagnetic interference involves disturbance or degradation of a signal transmitted via an electromagnetic wave.



http://en.wikipedia.org/w/index.php?title=File:Onde_electromagnetique.svg&page=1

Electromagnetic spectrum

- Electromagnetic waves at different frequencies used for different purposes



http://en.wikipedia.org/wiki/File:Electromagnetic-Spectrum.png

Some examples of EMI…

- Lawn mower interfering with analogue television signals
- Interference to AM radio signals when driving under power lines
- Buildings causing poor mobile phone reception

How can wind turbines cause EMI?

- Wind turbines can *theoretically* cause EMI through two mechanisms:

- **Active interference**
  - Caused by emissions of electromagnetic radiation from a wind turbine or electromagnetic fields

- **Passive interference**
  - Caused by the physical structure of a wind turbine

How can wind turbines cause EMI?

- **Active interference (electromagnetic emissions)**

- The strength of electromagnetic emissions from wind turbines is generally very low.

- Turbine components (such as the tower) shield emissions.

- Wind turbines are required to comply with various international standards that place limits on allowable electromagnetic emissions.

- *Generally emissions can not be detected a small distance (100 m) from the base of a turbine.*

How can wind turbines cause EMI?

- Active interference (electromagnetic fields)

Table 2: Typical values of magnetic fields measured near power lines and substations		
Source	Location of measurement	Range of measurements (mG)*
Distribution Line	directly underneath	2 - 30
Distribution Line	10m away	0.5 - 10
Substation	at substation fence	1 - 8
Transmission line	directly underneath	10 - 200
Transmission line	at edge of easement	2 - 50

Table 1: Typical values of magnetic fields measured at normal user distance	
Appliance	Range of measurements (mG)*
Electric stove	2 - 30
Refrigerator	2 - 5
Electric kettle	2 - 10
Toaster	2 - 10
Television	0.2 - 2
Personal computer	2 - 20
Electric blanket	5 - 30
Hair dryer	10 - 70
Pedestal fan	0.2 - 2

http://www.arpansa.gov.au/pubs/factsheets/021is_magfields.pdf

http://www.windrush-energy.com/update%20Jul%2024/Appendix%20D%20-%20Magnetic%20Field%20Survey/Magnetic%20Field%20Report.pdf

How can wind turbines cause EMI?

- Active interference (electromagnetic fields)

http://www.windrush-energy.com/update%20Jul%2024/Appendix%20D%20-%20Magnetic%20Field%20Survey/Magnetic%20Field%20Report.pdf

How can wind turbines cause EMI?

- **Passive interference (structure)**
- Caused by physical structure of turbine – hub, blades & tower.
- Affects electromagnetic waves passing in the vicinity of a wind farm.
- Turbines can obstruct, diffract, reflect, or scatter electromagnetic waves.
- *Main mechanism by which wind turbines can cause EMI.*

Factors affecting interference

- Placement of the wind turbine in relation to the signal path
- Signal frequency
- Characteristics of the wind turbines rotor blades
- Characteristics of the transmitter and receiver
- Local atmospheric conditions

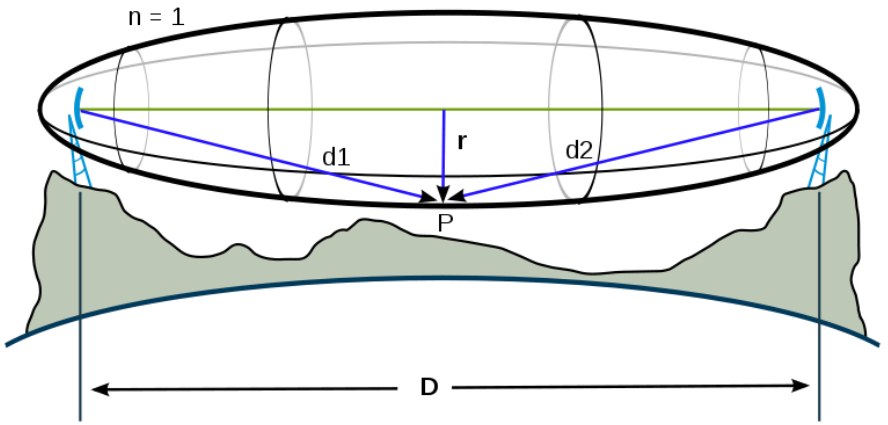
What services could *theoretically* be affected by EMI?

- Radiocommunications links (microwave, UHF)
- Aviation and meteorological radar
- Voice-based communications
    - e.g.,citizens band radio, mobile phones,
- Wireless internet
- Emergency services
- Satellite services (television and internet)
- Terrestrial radio broadcasts (AM, FM)
- Terrestrial television broadcasts (analogue, digital)

- *Impact to some services can be quantified by analysis*
- *Impact to other services must be determined by consultation with operators*

Radiocommunications links
(microwave, UHF)

- Used for data transmission
  - mobile phone towers, utility control systems, etc.
- Frequencies typically in UHF or microwave range
- Exclusion zone established around link path based on Fresnel zone
- *No links crossing Coopers Gap site*

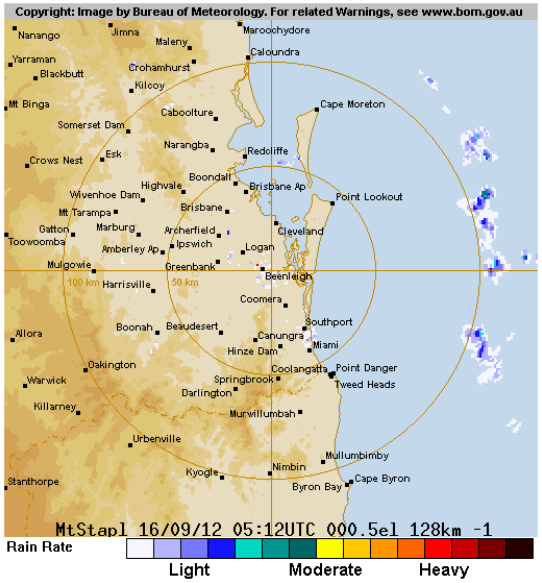


http://en.wikipedia.org/wiki/File:FresnelSVG.svg

Radar
(aviation and meteorological)

- Aviation radar used to track aircraft
- Meteorological radar used to observe weather and wind speeds
- Network of stations across Australia
- Interference possible when turbines in range of radar stations

- Bureau of Meteorology and aviation authorities consulted
  - *No interference expected*



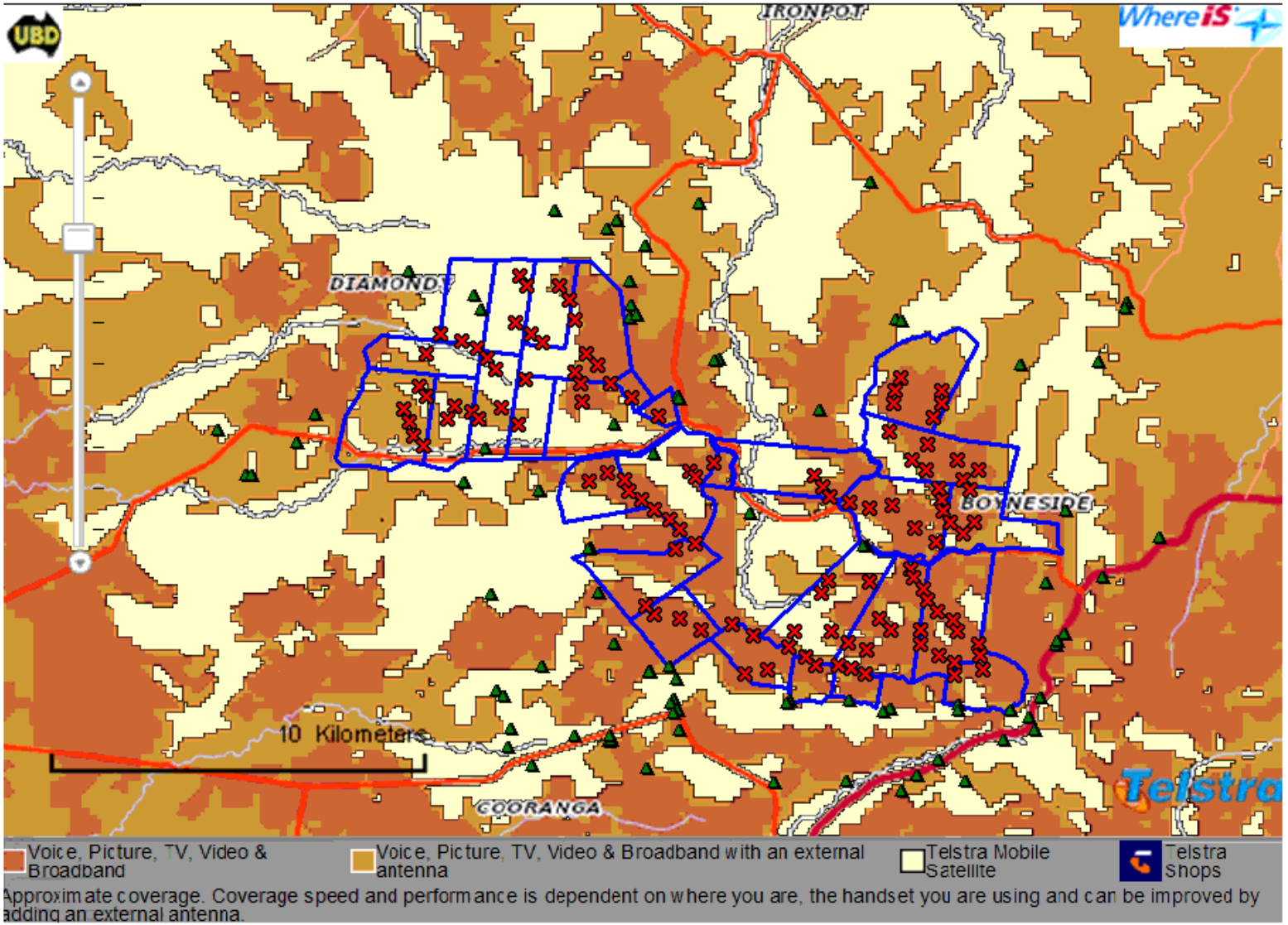
http://www.bom.gov.au/products/IDR663.shtml

Voice-based communications
(e.g., CB radio, mobile phones)

- Systems designed for a changing environment
  - Buildings, trees, terrain can vary significantly throughout coverage area
  - Generally robust to interference from objects such as wind turbines

- Citizens Band (CB) radio
  - Interference unlikely

- Mobile phones
  - Designed to operate effectively in and around obstructions
  - Marginal coverage around site
  - Mobile signals could theoretically experience interference



Legend:

- Site boundary
- House location
- Turbine location

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http://www.telstra.com.au/mobile-phones/coverage-networks/our-coverage/coverage-search/

Voice-based communications
(e.g., CB radio, mobile phones)

- Few examples of interference to these services from wind turbines

- **Mitigation:** any interference issues should be improved by:
  - Relocating a short distance
  - Use of external antennas

- Wireless internet services rely on the mobile network

Emergency services

- Emergency services use a range of telecommunications systems
  - Telecommunications links (microwave, UHF)
  - Land-mobile radio systems

- All emergency services with licensed radiocommunications assets in vicinity of site contacted:
  - Queensland Police Service
  - Queensland Ambulance Service (Department of Community Safety)
  - Queensland Fire and Rescue Service (Department of Community Safety)
  - St John Ambulance Australia
  - Moore Linville Bush Fire Brigade (Department of Community Safety)

- *No significant concerns raised*

Satellite internet and television

- Provides services for regions where terrestrial services are not available
- Relies on high-frequency, line-of-sight signal between satellite and recipient
- The majority of satellite services in Australia rely on a small number of satellites
  - Optus C1, Thaicom-4
- *Satellite elevation angles high enough that interference from wind turbines unlikely*

Broadcast radio

- Broadcast radio includes AM, FM and DAB (digital) services
    - Interference unlikely

- AM radio
    - Low frequency, long wavelength signal
    - Can readily propagate around physical obstructions

- FM radio
    - Short range broadcasting
    - Can be susceptible to interference from buildings and structures
    - Interference only likely to be encountered in vicinity of wind turbines

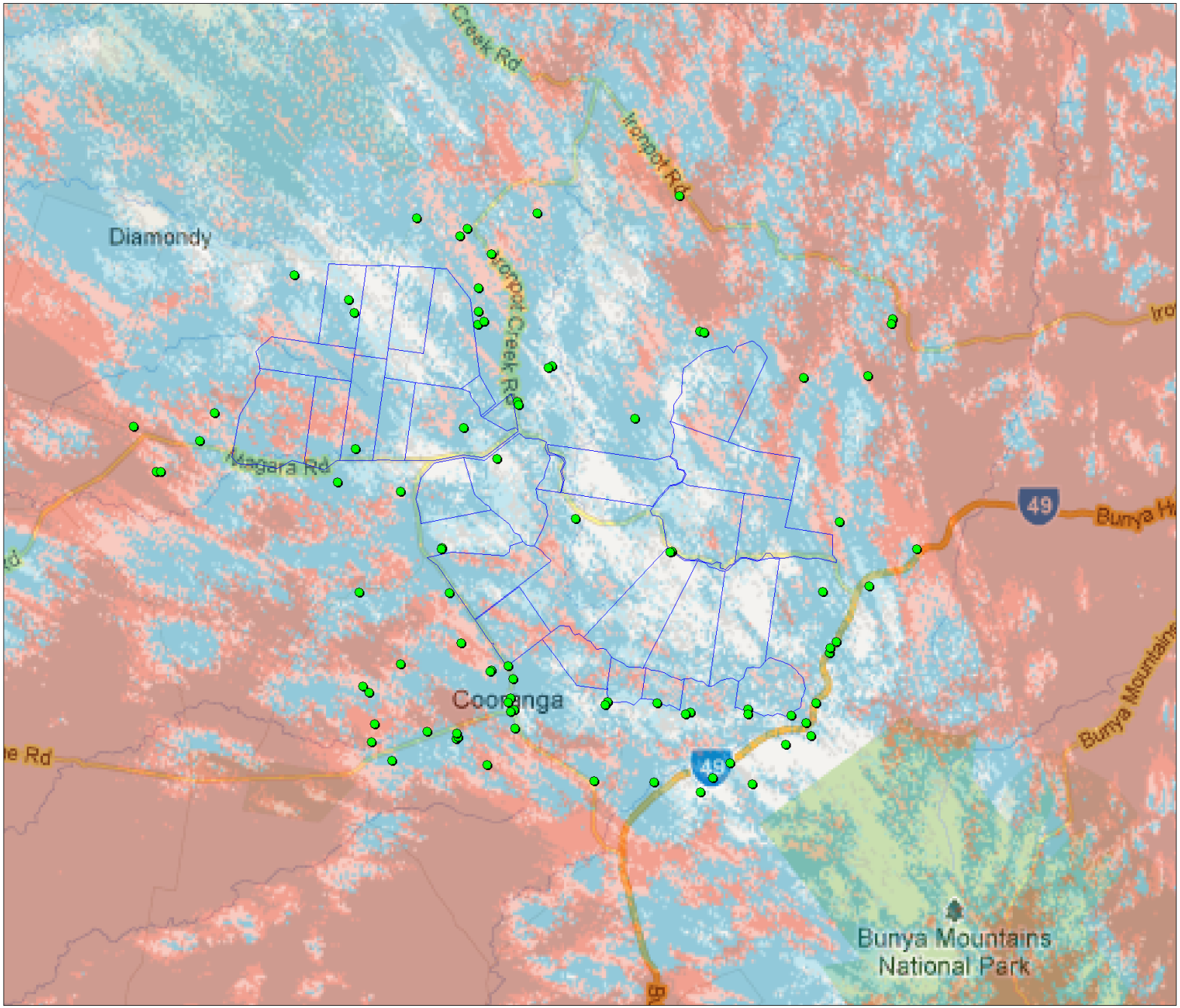
Broadcast radio

- DAB
  - Not yet available outside metropolitan areas

- **Mitigation:** any interference issues should be improved by:
  - Use of external antennas

Terrestrial television broadcasts

- Consist of analogue and digital broadcasts
- Analogue television signals gradually being phased out
  - Switchover for Darling Downs transmitter occurred in December 2011
- Marginal digital reception in areas around the Coopers Gap site



45350 Coopers Gap Wind Farm
EMI Assessment

Legend:

- Site boundary
- House location

Digital TV Coverage

- Good
- Variable
- None

N
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Scale:

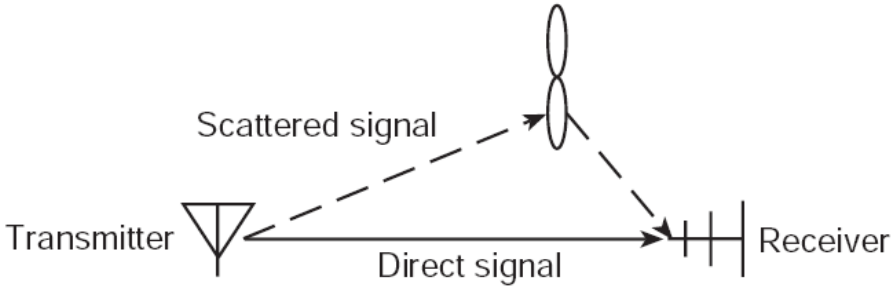
0 3 6
kilometers

http://myswitch.digitalready.gov.au/

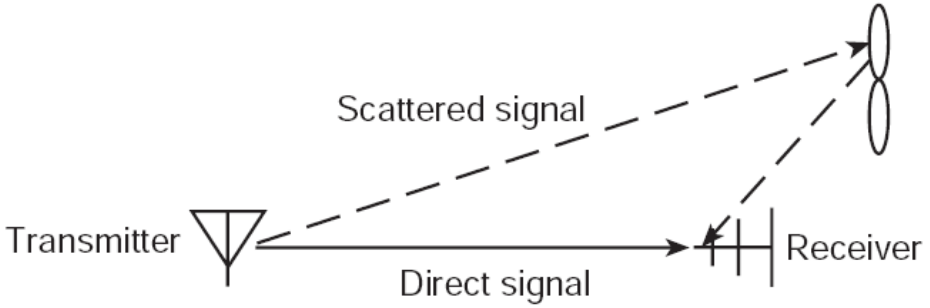
Terrestrial television broadcasts

- Wind turbines can cause interference to television signals through multipath interference:

- Forward scatter

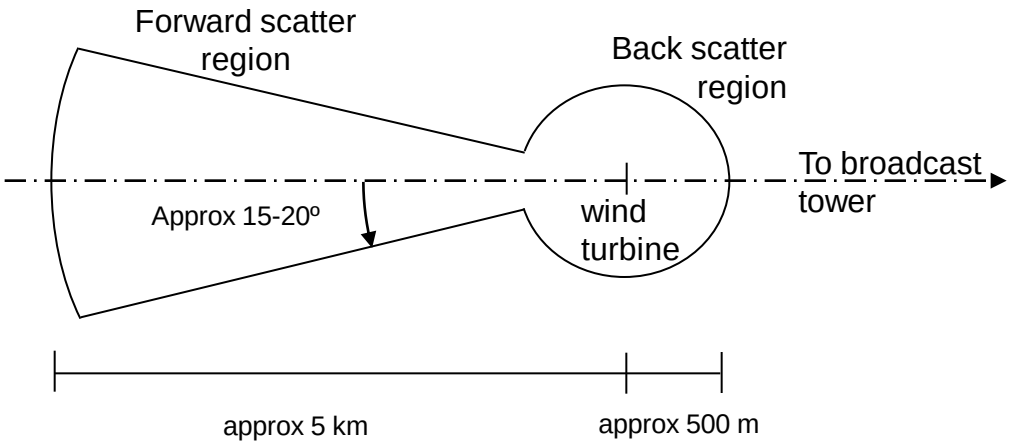


- Back scatter



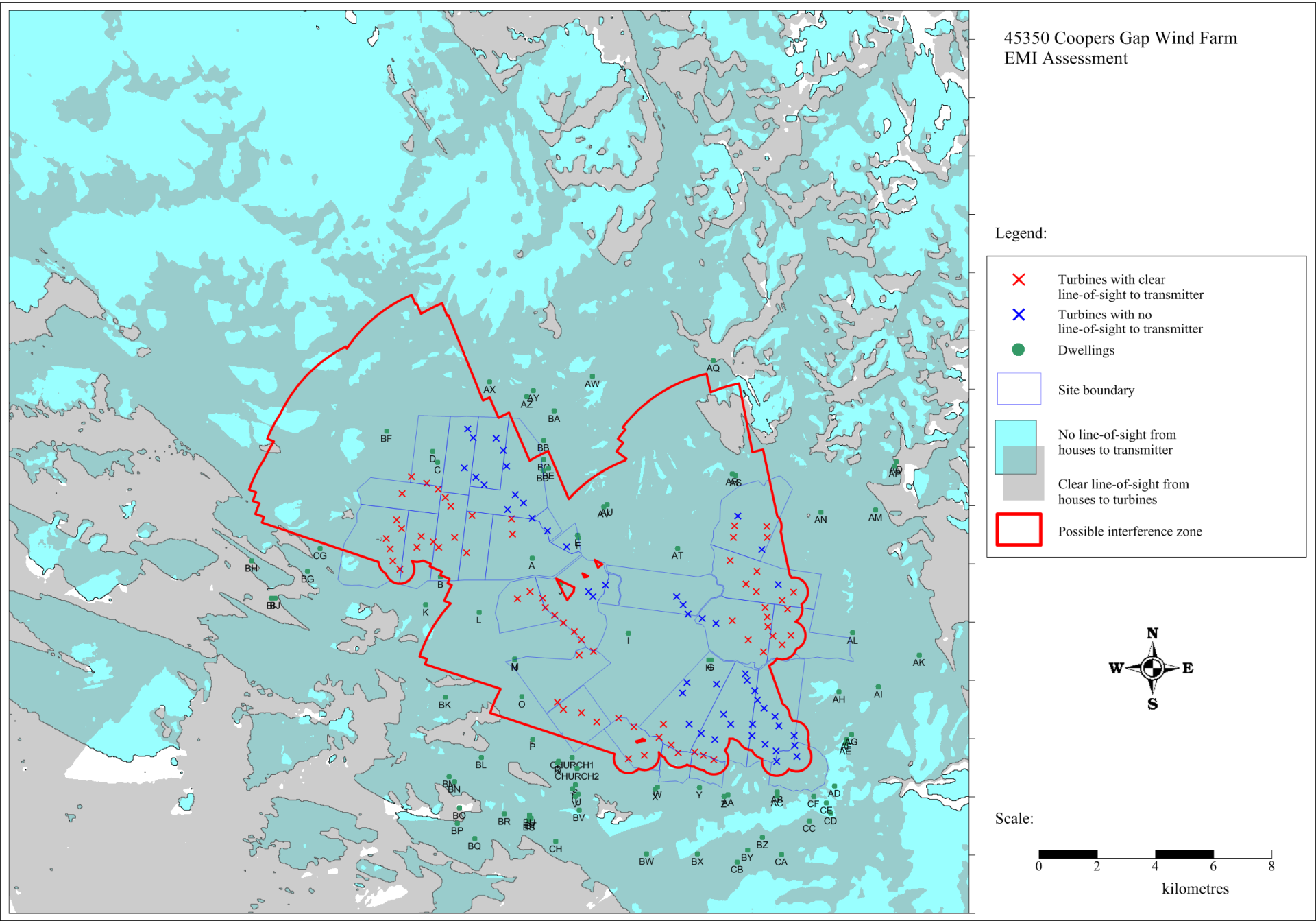
Terrestrial television broadcasts

- Region typically affected by interference from forward and backscatter:



- However, affected area can be larger if houses do not have direct line of sight to a transmitter

http://licensing.ofcom.org.uk/radiocommunication-licences/fixed-terrestrial-links/guidance-for-licensees/wind-farms/tall_structures/


45350 Coopers Gap Wind Farm
EMI Assessment
Legend:
Turbines with clear line-of-sight to transmitter
Turbines with no line-of-sight to transmitter
Dwellings
Site boundary
No line-of-sight from houses to transmitter
Clear line-of-sight from houses to turbines
Possible interference zone
N
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Scale:
0
2
4
6
8
kilometres

Terrestrial television broadcasts

- **Mitigation**

- If reception difficulties are encountered, a number of mitigation options are available:
  - Realigning TV antenna more directly towards existing transmitter
  - Tuning antenna into alternative sources of the same or suitable TV signal
  - Installation of more directional and/or higher gain antenna
  - Relocating the antenna to a less affected position
  - Installation of satellite TV
  - Installation of a TV relay station

  - Many areas in the vicinity of the wind farm are expected to have variable or no coverage, and may be able to access the Viewer Access Satellite Television (VAST) service

Questions?