Electromagnetic Compatibility (EMC)

Analysis and Management Plan for the HCPV North West Victoria Project

Purpose

The purpose of this document is to:

- Define electromagnetic fields and electromagnetic compatibility (EMC)
- Discuss potential EMC issues associated with Solar Systems' north-west Victoria Heliostat Concentrator Photovoltaic (HCPV) Project
- Assess the impact of the potential EMC issues with regard to people, animals and the environment
- Set out the EMC mitigation and management strategies

Overview

Risk levels associated with electromagnetic fields from an operating HCPV power station are expected to be very low. They will be comparable to those in everyday domestic and industrial environments.

This document identifies and describes the potential EMC issues for Solar Systems' north-west Victoria HCPV Project and its interaction with the local environment including residents, businesses / farming activities and flora and fauna.

Solar Systems has undertaken an assessment of the EMC risks in connection with the HCPV power station. There is no expectation that EMC issues will arise from the establishment or operation of the HCPV power station. This is because the design - based on established standards - is expected to control all impacts to acceptable and safe levels.

Should any compatibility issues arise, specific technical and procedural mitigation and management strategies shall be applied to achieve safe levels. These strategies are described later in this document and also form part of Solar Systems' Site Management Plan (SMP).

Electromagnetic Fields and Electromagnetic Compatibility

Where ever there is natural or man-made electricity, there are also electric and magnetic fields. Natural electrical fields are produced by, for example, static from your clothes or carpet; while natural magnetic fields are created deep within the earth's core or by lightning. Electric and magnetic fields are created wherever electricity is used, distributed, transmitted or generated.

All animals depend upon electrical signaling within their nervous systems – even humans. Carrier pigeons detect magnetic fields and use them to navigate. Sharks and other fish sense and use minute electric and magnetic fields to find their way and locate prey.

Electric Fields - The electric charge or voltage of an object creates an electric field. As you move away from the charged object the strength of the field decreases.

Outside the home, the common electric field sources are overhead high-voltage powerlines and certain electrical equipment. Electric fields are generally blocked by trees, fences or walls, therefore, outdoor electric fields make an insignificant contribution to electric field levels inside houses. Electrical wiring, lighting and some appliances, such as electric blankets and televisions, create smaller electric fields indoors.

Magnetic Fields – Whenever electric charges move, such as when an electric current flows through a wire, a surrounding magnetic field is created. The strength of the magnetic fields depends on the current. Magnetic fields also decrease as you move away from the current but unlike electric fields, magnetic fields are not blocked at adjacent objects such as trees, fences or walls.

Magnetic fields are present in the home due to electrical wiring, appliances and outdoor powerlines.

Electromagnetic Fields - Involve the interaction of electric and magnetic fields. Magnetic fields are generated by electrical currents or magnets. Electrical fields are associated with the voltages on conductors such as on power lines. Electromagnetic energy is generated when there are changing electric and magnetic fields. The nature of the phenomena observed depends on the rate of change of the field strength, usually expressed as a magnitude and a frequency in Hertz (Hz).

Electromagnetic compatibility (EMC) refers to the compatibility of various pieces of equipment which unintentionally generate, transmit or receive electromagnetic fields. The goal of EMC is the correct operation of different equipment in close proximity and thus the avoidance of any unwanted interference effects.

Electromagnetic compatibility is achieved by reducing both the emission of interference and the susceptibility to interference.

Regulation & Control

There are an established and proven set of methods to achieve electromagnetic compatibility. Application of these methods ensures compliance with legislative requirements; international and national standards; directives; and regulations.

In the case of an HCPV plant electromagnetic compatibility requirements and testing methods are set out in the documents listed in Appendix A. These are used to specify the electromagnetic characteristics required of the plant items.

Electromagnetic field levels associated with appliances, electrical equipment and plant can be calculated and measured to determine compliance with the relevant standards.

Analysis of Solar Systems' HCPV Technology and the Electromagnetic Environment

The components that make up Solar Systems' high concentration photovoltaic (HCPV) power system are all based on existing and proven technology. Some components have been developed and used in other applications over recent decades and many rely on mature engineering technology as developed over the last several hundred years. Solar Systems has used these components in its existing power stations for several years.

All of this equipment has been used in other environments and applications performing similar functions such as pumping fluids, converting power, transporting power via cables and moving objects. The characteristics of such equipment are therefore well known and - where required – are regulated and subject to established standards and procedures.

So although the appearance and configuration of an HCPV power station is different to other power stations in Australia it uses many of the same components.

The table below classifies and gives examples of electromagnetic fields arising in the context of our everyday lives. It also identifies areas of electromagnetic field generation from Solar Systems' HCPV technology.

Table One: Classification and Examples of Electromagnetic Fields

Type or Class	Presence in Solar Systems' HCPV Technology	Notes
Constant or slowly varying electric and magnetic fields	Yes, associated with cables carrying the power from the solar receiver to the power converter	Levels are similar to that associated tram and train DC power systems
Electric power network (50Hz in Australia)	Yes, associated with power cables and standard power conversion equipment such as motors, transformers, variable speed drives and power converters	Associated with current and voltages in power lines, transformers and household appliances Levels similar to that present in industrial plants
Audio frequency fields (20Hz to 20kHz)	Yes, generated in power conversion systems such as power converters and variable speed drives	Associated with currents and voltages used to feed speakers in Hi-Fi systems Significantly reduced by standard equipment enclosures Low level acoustic noise may be present near equipment
Low frequency radio fields (20kHz to 2MHz)	Yes, generated in power conversion systems such as power converters and variable speed drives	As used by AM radio stations Controlled to low levels by design to prevent interference between equipment and with domestic AM radio reception
Short Wave radio 2MHz to 50MHz	Yes, low levels generated in power conversion systems and other electronic equipment such as computers	Used for some aircraft communications, ship to shore communications and long distance mobile communications Controlled to low levels by design to prevent interference between equipment and with radio services
VHF & UHF 50MHz to 700MHz	Yes, very low levels generated in power conversion systems and other electronic equipment such as computers	Used for TV, FM radio, radio communications and aircraft Controlled to low levels by design to prevent interference between equipment and with radio services
UHF & Microwave 700MHz to 10,000MHz	No	Only generated on site by standard items such as mobile phones and microwave ovens which are regulated by appropriate product standards
Infra red, visible and ultraviolet light	Yes, high intensity light concentrated on photo voltaic array	Sunlight Not an electromagnetic compatibility issue

In all cases the strength of electromagnetic fields decay rapidly with increased distance from the source, following an inverse square law. For example, the intensity at 1km (1000m) from a source is only one millionth of that at 1m. This means that plant and equipment that is safe for personnel, at working distances of 1m or less, presents negligible risk for people and animals at any significant distance.

Discussion

Solar Systems' HCPV technology generates electric power, in both 50 Hz and DC forms. Therefore it generates electromagnetic fields similar to other power infrastructure.

There are limits for exposure levels as established by Australian and international authorities. These include:

- Australian Radiation Protection and Nuclear Safety Agency (ARPANSA), *Maximum Exposure Levels to Radiofrequency Fields — 3 kHz to 300 GHz*

- European Union Directive 2004/40/EC and Recommendation 1999/519/EC on electromagnetic field exposure

In general, electrical and electronic equipment generate electromagnetic fields in the audio, radio frequency, VHF, and into the lower microwave spectrum. This creates a potential to interfere with other equipment, and for radio and television reception to be degraded. The management and mitigation strategies set out below are being used to avoid and resolve any such issues.

Limits are prescribed to manage exposure of workers, interference between equipment and interference with radio and television reception. International and national standards (refer Appendix A) set these limits and describe methods of testing equipment to ensure conformance. Solar Systems' HCPV plants are designed in accordance with these limits.

Considering the HCPV plant specifically:

- HCPV generates low level radio frequency fields as a by-product of operation. There is no high power generation of radio frequency energy, which means there will be no significant interference
- Standard commercial equipment that generates electromagnetic fields may be used on site (e.g. mobile and portable phones and microwave ovens). These are certified by regulatory agencies and comply with relevant international and national standards for safety and interference
- Solar cells convert sunlight into electricity by absorbing electromagnetic radiation in the 'visible light' and 'near visible' spectrum. The risks associated with these high intensity light sources are dealt with separately in the Reflectivity and Ultraviolet Light Management Plans

Management & Mitigation

Solar Systems has employed proven methods to analyse EMC issues in its HCPV technology and plant. Areas where electromagnetic field strengths could exceed the limits in relevant standards have been identified. Management and mitigation measures to reduce any potential impact are set out below and in the Project's Site Management Plan.

Management and mitigation includes:

- Appropriately specifying plant components
- Direct measurements in areas where electromagnetic field may occur – such as close to high current cables, power converters, or inside electrical enclosures
- Appropriate installation and shielding of items of plant where required
- Developing standards for working in the HCPV plant environment – including procedures to be followed by staff, contractors and visitors (e.g. access restrictions and operational protocols)

Conclusions

This document describes the potential compatibility issues for the HCPV plant and the local environment. Design based on established and proven methods is expected to control all impacts to acceptable levels. Should any issues arise specific technical and procedural mitigation and management strategies will be applied.

Any EMC issues associated with Solar Systems' HCPV technology are similar to those in many public, domestic and industrial environments. Thus, existing standards provide relevant safe exposure levels; and established test procedures verify compliance.

Risk levels to people, animals and the environment due to electromagnetic fields from an operating HCPV power station are expected to be very low. They will be comparable to those in everyday domestic and industrial environments.

Appendix A

Key International Directives, National Standards & Regulations used by Solar Systems related to Electromagnetic Issues

- Australian Radiation Protection and Nuclear Safety Agency (ARPANSA), *Maximum Exposure Levels to Radiofrequency Fields — 3 kHz to 300 GHz*

  This document reflects internationally accepted human exposure levels which are enforced by relevant Australian agencies

- European Union Directive 2004/40/EC and Recommendation 1999/519/EC on electromagnetic field exposure

  The EU Directive and Recommendation set limits on magnetic, electric and electromagnetic (radio frequency exposure) considered safe for humans.

- AS/NZS CISPR 11:2004 (2nd Edition) Industrial scientific and medical (ISM) radio-frequency equipment - Electromagnetic disturbance characteristics - Limits and methods of measurement

  CISPR 11 sets limits for radiated and conducted electromagnetic energy for most types of electrical equipment.

- AS/NZS/IEC 61000 series standards relating to EMC

  The AS/NZS 61000 and IEC 61000 series is a set of Australian and international standards documenting limits and test procedures for all electrical equipment.

Appendix B

Current References to Health impacts of Electromagnetic Fields

- ARPANSA/TR142, October 2005 - Electromagnetic Fields and Possible Adverse Health Effects

  http://www.arpansa.gov.au/radiationprotection/factsheets/is_emf.cfm This document summarises some of the issues related to low frequency magnetic fields and provides links to comments on epidemiological data.

- Pilot Study of Residential Power Frequency Magnetic Fields in Melbourne - 580/28 pages Ken K. Karipidis and Lindsay J. Martin

  Measurements in a small sample of Melbourne homes showing slightly higher than expected exposure magnetic fields in a domestic environment.