DEPARTMENT OF ECONOMIC DEVELOPMENT, JOBS, TRANSPORT AND RESOURCES

QUANTIFYING SMART METER RF EME LEVELS IN VICTORIAN HOMES

VICTORIA

June 2015

Table of Contents

Summary and Conclusion

Introduction

The Department of Economic Development, Jobs, Transport and Resources (DEDJTR) of the Victorian State Government commissioned Total Radiation Solutions Pty Ltd (TRS) to undertake a technical study of smart meters currently being used by electrical distribution business (DB's) in Victoria.

The purpose of this study is to measure the Radiofrequency (RF) Electromagnetic Energy (EME) levels, due to these smart meters, in and around the homes of Victorians.

These levels will then be compared to the general public (GP) regulatory exposure limits specified in Australian Radiation Protection and Nuclear Safety Agency (ARPANSA) Radiation Protection Standard – Maximum Exposure Levels to Radiofrequency Fields – 3 kHz to 300 GHz (RPS 3 GP Limit).

Overview

The study covered the three smart meter communications technologies (Mesh, WiMax and 3G) currently in use in Victoria.

In total, 55 properties with different construction materials - brick and other building cladding material and metal and other roofing material; wooden and metal meter boxes; and ones with both internal (inside the meter) and external (externally mounted) antennas across Victoria were surveyed. This range of properties was included because of the potential attenuation effects upon the EME levels from smart meters and other sources.

RF EME measurements were also conducted at a small number of properties where residents had reported experiencing health problems which they attribute to electromagnetic hypersensitivity (EHS). Measurements of the meter RF EME levels and ambient (Background – BG) RF EME levels at the properties were taken both inside and outside of the properties where practicable.

Internal measurements were taken directly opposite the meter (where possible) so as to determine the maximum RF EME level.

Monitoring each of the meters over their traffic profile (4 or 6 hours) was also undertaken in order to capture the behaviour of the meters under normal operating conditions.

The key results by smart meter technology are shown below in Chart 1, Tables A, B and C.

Results

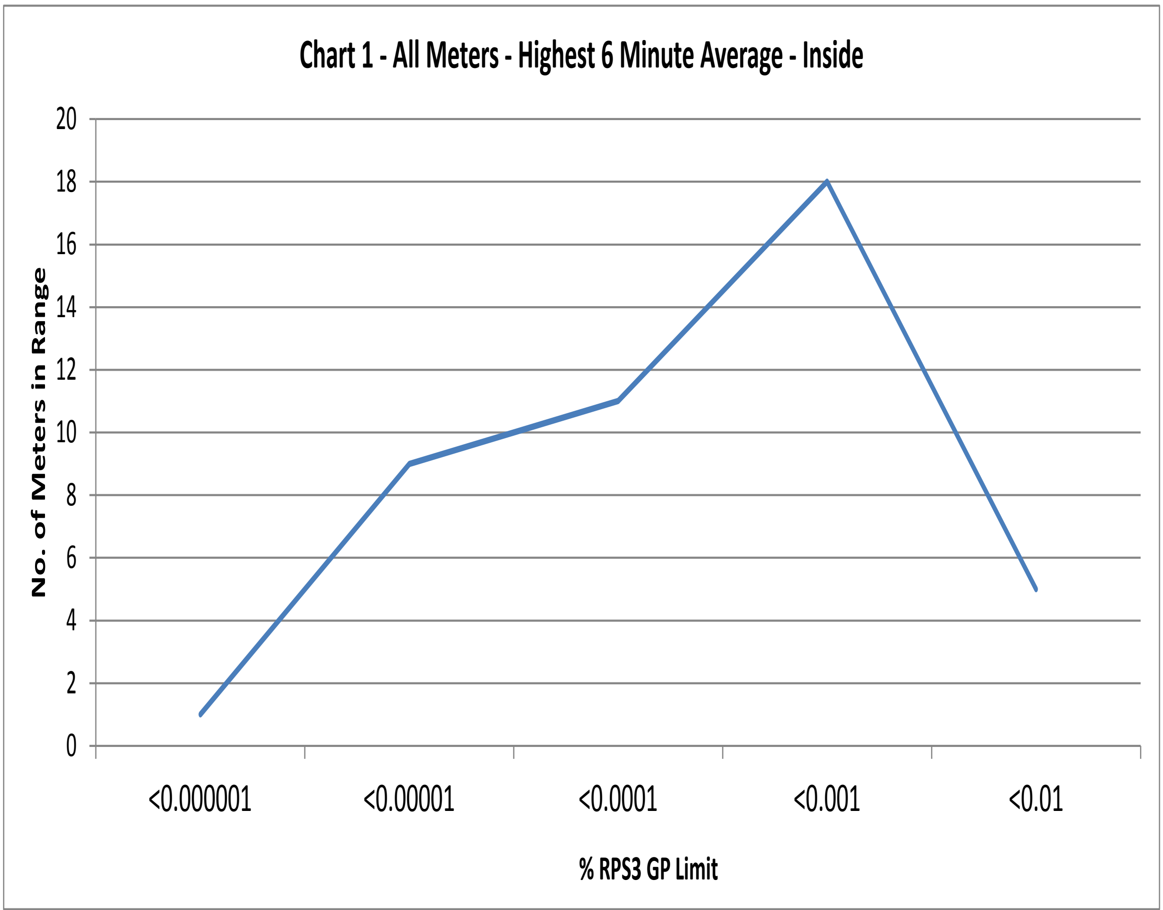


Table A – Highest RF EME Levels - All Mesh Meters

Site Type	RF EME Level											
	Instantaneous						6 Minute Average					
	Inside House			Outside House			Inside House			Outside House		
	mW/m^2	V/m	% RPS3 GP Limit	mW/m^2	V/m	% RPS3 GP Limit	mW/m^2	V/m	% RPS3 GP Limit	mW/m^2	V/m	% RPS3 GP Limit
Single Meter	22	3	0.0005	2287	29	0.1	0.4	0.4	0.009	4.5	1.3	0.1
Group Meter	N/M	N/M	N/M	1253	22	0.03	N/M	N/M	N/M	22	3	0.5
EHS	0.04	0.1	0.0000009	50	4	0.001	0.0001	0.01	0.000002	0.1	0.2	0.003

Table B – Highest RF EME Levels – All WiMax Meters

Site Type	RF EME Level											
	Instantaneous						6 Minute Average					
	Inside House			Outside House			Inside House			Outside House		
	mW/m^2	V/m	% RPS3 GP Limit	mW/m^2	V/m	% RPS3 GP Limit	mW/m^2	V/m	% RPS3 GP Limit	mW/m^2	V/m	% RPS3 GP Limit
Single Meter	139.4	7	0.0014	865.2	18	0.009	0.2	0.3	0.002	3	1	0.03
Group Meter	11.2	2	0.00011	1191.5	21	0.012	0.005	0.04	0.00005	0.9	0.6	0.009
EHS	5.2	1	0.00005	336	11	0.003	0.003	0.03	0.00003	0.1	0.2	0.001

The highest 6 minute average means the 6 minute period (within the polling period) of the smart meter that has the highest averaged RF EME level.

Table C – Highest RF EME Levels – All 3G Meters

Site Type	RF EME Level											
	Instantaneous						6 Minute Average					
	Inside House			Outside House			Inside House			Outside House		
	mW/m^2	V/m	% RPS3 GP Limit	mW/m^2	V/m	% RPS3 GP Limit	mW/m^2	V/m	% RPS3 GP Limit	mW/m^2	V/m	% RPS3 GP Limit
Single Meter	0.1	0.2	0.000003	29	3	0.001	0.04	0.1	0.0009	11	2	0.3

Conclusion

This study determined that the RF EME levels from the smart meters surveyed were significantly below the general public (GP) exposure limits specified by the Australian Radiation Protection and Nuclear Safety Agency (ARPANSA) Radiation Protection Standard – Maximum Exposure Levels to Radiofrequency Fields – 3 kHz to 300 GHz (RPS 3) – Chart 1.

Furthermore, the relative contribution by smart meters to RF EME levels inside the homes surveyed was found to be low in comparison to other sources that Victorians are exposed to in their normal everyday lives.

1 Introduction

The Department of Economic Development, Jobs, Transport and Resources (DEDJTR) of the Victorian State Government commissioned Total Radiation Solutions Pty Ltd (TRS) to undertake a technical study of smart meters currently being used by electrical distribution business (DB's) in Victoria.

The purpose of this study is to measure the Radiofrequency (RF) Electromagnetic Energy (EME) levels in and around the homes of Victorians, due to these smart meters, for comparison with the Australian regulatory RF EME exposure limits.

This report is based on information supplied by the DEDJTR, DB's and field measurements taken during the study as described below.

TRS holds National Association of Testing Authorities (NATA) accreditation - NATA laboratory - Accreditation No. 15096 complying to ISO/IEC 17025 (2005) Standard.

Specifically, the measurement of electromagnetic fields in accordance with Australian Standard AS 2772.2 – 2011 Radiofrequency fields Part 2: Principles and methods of measurement and computation– 3 kHz to 300 GHz.

This accreditation covers the measurement of the smart meter RF EME transmission levels.

2 Project Scope

In total, 55 properties across Victoria were surveyed. The measurement survey included all three different smart meter technologies; it included properties with different construction materials - brick and other building cladding material and metal and other roofing material; wooden and metal meter boxes; and ones with both internal (inside the meter) and external (externally mounted) antennas.

RF EME measurements were also conducted at a small number of properties where one or more of the occupants had reported experiencing symptoms commonly described as "EHS" or Electromagnetic Hypersensitivity (for more information see the World Health Organisation fact sheet: http://www.who.int/peh-emf/publications/facts/fs296/en/.

Measurements of the meter RF EME levels and other sources of RF EME at the properties (other background levels) were taken both inside and outside the properties where possible.

Monitoring of the meters was also undertaken so as to capture the typical or normal operating behaviour of the meters (traffic profile).

It became apparent during the early stages of the study that some smart meters had adaptive power control. Hence, laboratory testing was not carried out as they would not provide realistic measurement results. The site survey results under operational conditions provide the most relevant exposure data in relation to the overall range of operation of the meters.

The main testing equipment used to measure the RF EME levels was the NARDA SRM-3000/6 Spectrum Analyser combined with the appropriate E-field probe (see Appendix I for equipment details). A Spectrum Analyser in effect measures the power of the smart meter signals selectively, compared to other RF EME sources in the environment. Measurement of RF EME levels from the smart meters were recorded in units of Power Density - milliWatts per square meter (mW/m^2).

In this study, measurements were taken to determine the Peak (or maximum) Operational Power Output from the meters – in other words the maximum RF EME emitted by the meters during their normal operation.

Measurements were also taken of the ambient RF EME levels – that is the “background (BG)” RF EME experienced in that place which incorporates all sources of RF EME at the residence. The reported levels of BG do not include the RF EME from the smart meter.

3 Smart Meters in Victoria

The deployment of smart meters to all Victorian electricity customers consuming less than 160 megawatts hours per annum commenced in September 2009. At the time of the survey, some 99% of relevant premises have smart meters installed and 86% of these remotely communicating and hence transmit RF EME.

The rollout has been undertaken by Victoria’s five electricity distribution businesses (United Energy Distribution, Jemena Electricity Networks, CitiPower, Powercor and AusNet Services - previously known as SP AusNet) who own the ‘poles and wires’ infrastructure.

Each of the distribution businesses is responsible for one geographic region across the State. They have employed different technologies to communicate with the smart meters they have installed. United Energy, Jemena, CitiPower and Powercor have chosen Silver Spring Network’s Mesh Radio as their technology.

AusNet has chosen WiMax radio and 3G mobile data communications.

All smart meters deployed in Victoria are marked with the ‘C tick logo’. This compliance mark indicates the meters comply with the relevant Australian Communications and Media Authority (ACMA) regulations and Australian Radiation and Nuclear Safety Agency (ARPANSA) standard for exposure to radiofrequency EMEs.

How Do Smart Meters Work?

Smart Meters that are installed in Victoria are either linked through a Mesh Radio Network, a WiMax or a 3G Network. CitiPower and Powercor together provide electricity to 1.1 million properties with smart meters; with United Energy, Jemena and SP AusNet serving a further 1.6 million customers with smart meters.

These Networks have some similar features to a mobile phone cellular network. Additionally, smart meters include a low power (nominal 50 mW) 2.4 GHz ZigBee transceiver that enables energy management through Home Area Networks (HANs). However, this capability is rarely employed at present.

Mesh Radio Network

The Mesh Radio Network operates in the Industrial Scientific and Medical (ISM) band – 915 to 928 MHz with an output power of one Watt (1W).

Equipment operating in this band is required to employ Frequency Hopping Spread Spectrum (FHSS) techniques – in other words, it switches between different specific frequencies within the band to avoid interference with other nearby equipment operating in the same band.

To retrieve information, the Distribution Businesses (DBs) initiate contact with the smart meters at given periods through the day. These so-called “Polling Periods” occur every 4 hours for Mesh Radio Networks and every 6 hours for the AusNet WiMax and 3G systems.

Each Polling Period generally includes two different types of data acquisition or “packets” of data that are transmitted by the smart meters. The first type includes the property’s consumption data, provided as 30-minute averages. The second type retrieves data about the electrical network performance – in other words on how the electricity distribution network is performing during that period – whether there have been any outages and so on.

Different types of proprietary software or “communication protocols” are employed to retrieve and analyse this available data; some protocols are more complex than others, allowing more or less sophisticated analysis of electricity usage and of the efficiency of the distribution network.

In addition to allowing the DB’s Network Controllers to initiate the Polling Periods, the Mesh Radio networks also “chatter”, that is, the smart meters communicate with each other within the “mesh” to maintain a constant link to the DB. The meters can be linked through a “hub” meter, the identity of which can change depending on where the most effective communication link or signal to the main network access point is operating at any one time. In other words the mesh is a dynamic, self-maintaining system.

One of the main consequences of these characteristics of the Mesh Radio system is that it presents a challenge to determine the maximum operating period of a particular meter. The survey overcame this by taking readings over a lengthy time period, so that monitoring occurred both before and throughout the Polling Period. Actual measurements at each site were taken for at least 4 hours for Mesh Radio and for at least 6 Hours for WiMax and 3G.

During the Polling Periods the data is sent via extremely brief radio signals or pulses and the measurements taken reveal the “Traffic Profile” of signals sent from the meter. This measurement records the band-width or frequency of the signal, the number of pulses, and how long they last – their duration. This clearly varies over the 4 hour or 6 hour Polling Period.

The key advantage of the Mesh Radio is reportedly that a smart meter does not need to be able to communicate directly with an Access Point (similar to a Mobile Phone Radio Base Station or “tower”) so that a meter with a poor connection can relay through its network of neighbouring smart meters to communicate its data back to the DB. This means that the network is dynamic and adaptive, and in addition to the periodic transmission of meter readings, the meter will also transmit randomly at other times during the day.

HAN Radio

All smart meters also have a HAN (Home Area Network) functionality. This is to allow the meter to communicate through a ZigBee protocol (like a wireless mouse for a laptop) with a HAN device such as an In House Display (IHD) unit. An IHD can show information about electricity consumption from various appliances in the home – to allow for better control over costs and improve efficiency. RF EME from HAN radios are not being reported as part of this survey.

WiMax Network

The AusNet WiMax Network Meter uses a WiMax SmartGrid Card operating in the 2.3GHz band with an output power of 1 W.

In normal operation, the WiMax meter transmits for 4 sessions a day. At other times during the day, the meter stays in Idle Mode. However, even then, there will be transmission of very short bursts (less than 10 milliseconds) of time synchronisation signal, which is transmitted every hour. In practice, the meters are transmitting intermittently, perhaps often, throughout the day as well as and not simply just for the 4 main sessions.

Each WiMax Meter is assigned a time slot for its scheduled data transfer. The time slot is based on a random number, so the chance of more than 1 meter transmitting at the same time is very small.

3G Network

The AusNet 3G Network Meter uses an existing mobile phone network operating in the 830 MHz or 2.1 GHz band with an output power of 1.6 W.

In normal operation, the 3G meter transmits for 4 sessions a day. At other times during the day, the meter stays in Idle Mode however, even then, there will be transmission of very short bursts of time synchronisation signal, which is transmitted every hour. In practice, the meters are transmitting intermittently, perhaps often, throughout the day as well as and not simply just for the 4 main sessions.

Each 3G Meter is assigned a time slot for its scheduled data transfer.

4 Health Considerations

Some consumers have expressed concerns about the potential health and safety impacts of their exposure to RF EME from the smart meter at their residence. This survey is not a health impact assessment. It is designed to measure the radiofrequency EMEs emitted from representative smart meters installed in a range of common situations and to compare those results against the Australian Standard and typical background levels of RF EME. The tests are designed to determine levels of exposure to RF EME from smart meters under actual operating conditions in the home.

It is acknowledged that there is an ongoing debate in some quarters regarding reported biological effects from radiofrequency EME at low-intensity exposure. Opponents to smart meters have argued that these effects are not taken into account in the current Safety Guidelines. Victoria, as other States and Territories in Australia, recognises that the relevant Safety Standard is published by the Federal agency, ARPANSA which states that its safety standard considers all available scientific information and provides a high degree of protection against the known health effects of RF EME.

The types of health effects the standard protects against and its margins of safety can be found in the standard which is available at:

http://www.arpansa.gov.au/Publications/codes/rps3.cfm

It is not appropriate for this survey to assess its findings against any standard other than that which applies in Australia. This is the ARPANSA Radiation Protection Standard "RPS 3" ("*Maximum Exposure Levels to Radiofrequency Fields - 3 kHz to 300 GHz*").

The Standard sets limits for human exposure to RF EME and provides the basis for the regulation of telecommunication in Australia by the Australian Communications and Media Authority (ACMA). The Standard applies to smart meters as well as to a wide range of other devices employing RF EME. ARPANSA has written a fact sheet on smart meters which is available on their website:

www.arpansa.gov.au/RadiationProtection/Factsheets/is_smartmeters.cfm.

ARPANSA also conducted measurements on a Mesh meter and provide a link to that report in their Fact Sheet.

5 Sources of RF EME in the Home

Modern householders are typically exposed to a wide range of RF EME. Sources include:

- Mobile phones (predominantly when talking);
- DECT (Cordless) phones (as above);
- Microwave ovens (only when cooking);
- Radio and TV broadcast transmitters (working more or less constantly);

- Cellular base stations / mobile phone towers (as for TV transmitters); and
- Wireless routers (WiFi) (dependent on usage).

A study completed by the Australian Centre for Radiofrequency Bioeffects Research (ACRBR) in 2009, ACRBR EME - In Homes Survey: Final Report, Croft, R., McKenzie, R., and Leung, S., Measured the normal operating peak and average RF EME levels at 20cm directly in-front of a number of devices found within the home. The results of this study are listed in Figure 1.

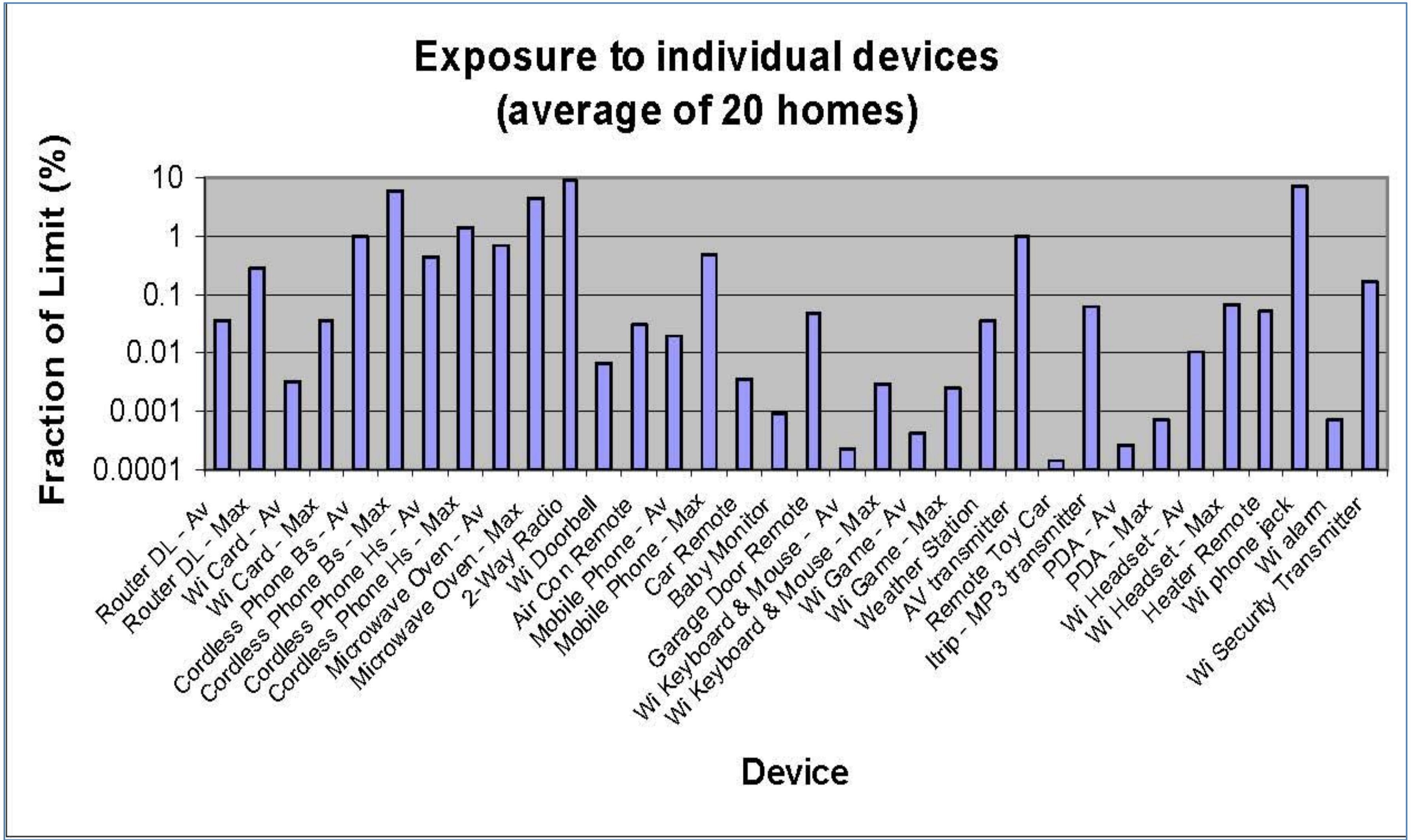


Figure 1 – Results From ACEBR EME In Homes Survey of Individual Devices (Croft, R., McKenzie, R., and Leung, S. 2009)

A study in 2011 found that the RF EME levels from Smart Meters, even when measured just 30 cm away, were lower than the levels from other common household items See Figure 2.

The actual RF EME levels from a smart meter inside the house were very low compared to the levels from such devices as wireless modems, mobile phones and microwave cookers. The mobile phone was the highest RF EME that people experience because they are used in close proximity to the body.

The actual transmit power from the mobile phone was not known since the actual power transmitted varies depending on distance from a base station. The level measured here at 30 cm would be a typical exposure level to the head of the user when using a mobile phone with a hands free kit. (EMC Technologies 2011, Para. 5.3)

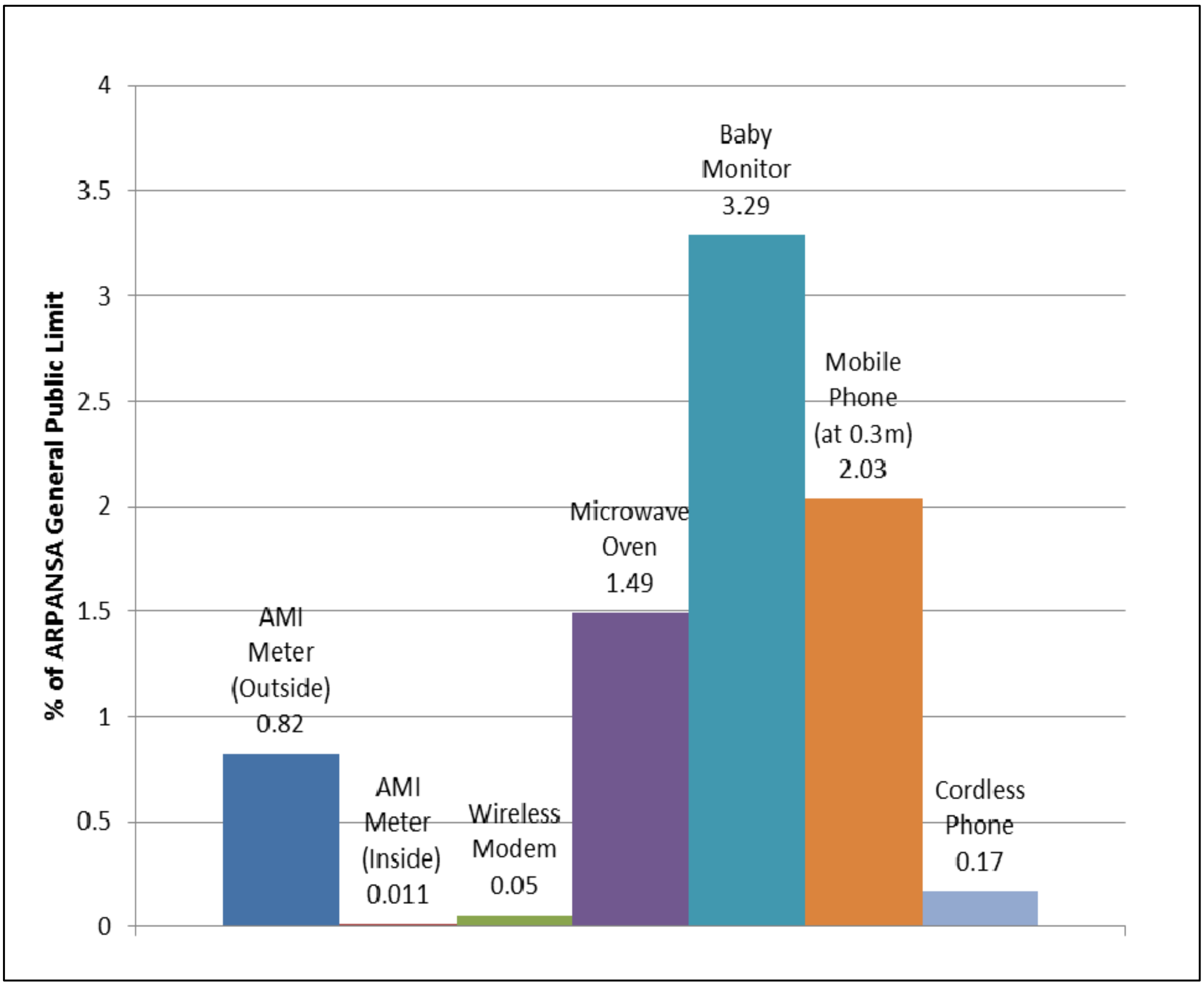


Figure 2 – Comparison of RF EMF Power Density levels: AMI Smart Meters and other Household Appliances (EMC Technologies, 2011)

Similar results were reported in a field study by the College of Engineering, University of Canterbury, Christchurch, New Zealand (EPEC 2012) as shown in Figure 3 below. The measured power density of the smart meter was less than that of the other sources in the home.

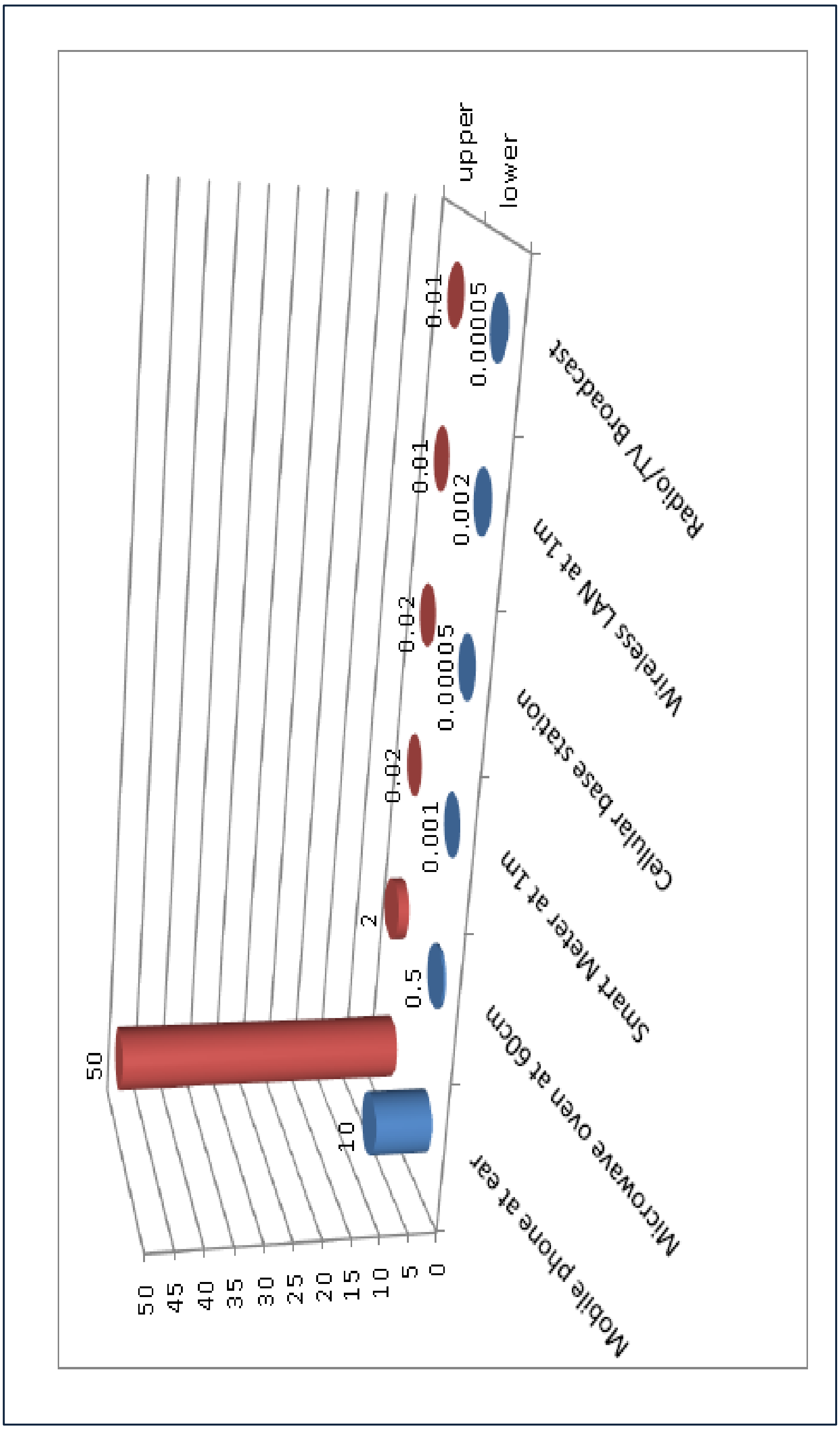


Figure 3. Range of likely exposure levels (in W/m^2) in the home from various sources (EPEC 2012).

Whilst, there may be some differences in the measurement approach, none of the smart meters were above 0.01% of the limit as measured whilst the RF EME from many other sources can be above 0.01%.

6 Measurement Methodology

The measurements were conducted at 55 sites throughout Victoria, between 20 October 2014 and 2 February 2015.

There were three types of communications technologies (mesh, WiMax and 3G) being used by the smart meters at these sites.

RF EME levels due to the smart meters and cumulative background (BG) RF EME levels due to environmental sources were measured inside and outside the house.

Smart Meter RF EME Levels

Using a NARDA SRM-3006 Selective Radiation Meter with an E-Field probe and RF-Cable, only the peak RF EME levels due to the smart meters were measured.

The SRM-3006 meter was used in spectrum analyser mode for the mesh technology and in scope mode for the WiMax and 3G technologies. This was to measure peak power associated with any of the technologies.

The duration of the transmission pulses was measured with a pulse detection circuit and digital storage oscilloscope. This essentially allowed continuous monitoring.

Internal measurements (inside the house) were conducted at the height of the smart meter, at a distance of 30cm from the wall that the smart meter was mounted on. A description of the measurement positions for each of the sites are listed in Appendix H.

External measurements (outside the house) were conducted at the height of the smart meter, at a distance of 30cm from the external antenna/smart meter. A description of the measurement positions for each of these locations are listed in Appendix H.

For smart meters with internal antennas, the inside measurements were conducted with the meter box door closed and outside measurements were conducted with the meter box door open.

For smart meters with external antennas the inside measurements were conducted with the meter box door closed and outside measurements were conducted with the meter box door closed unless otherwise specified.

Once the measurement equipment was in position, repeated transmissions were triggered in co-ordination with the relevant DB.

Background RF EME Levels

Using a NARDA SRM-3000 or 3006 Selective Radiation Meter with an E-Field (27 MHz to 3 GHz) probe and 5m RF-Cable (9 kHz – 6 GHz), the BG RF EME levels due to existing environmental RF EME sources were also measured.

The meter was placed in spectrum analyser mode and set to average (6 min) to measure the cumulative BG RF EME level across the 27 MHz to 3 GHz bandwidth.

The BG RF EME level measurement positions are the same as the internal and external smart meter RF EME level measurement positions.

The measured band includes all radio signals from 27 MHz to 3 GHz. Signals present in this band are FM radio, Wi-Fi, TV signals and other mobile phone base station signals.

These measurements determined the representative RF EME levels present at the time of measurements for each of the services present.

Smart Meter Traffic Profiles

A traffic profile of each smart meter was measured using the traffic profile monitoring system composed of the components listed in Appendix J.

The length of the traffic profile period was equivalent to the length of the polling cycle for the smart meter (4 or 6 hours).

7 Results and Discussion

As the transmissions from the smart meters are pulsed in nature, they are required to meet the instantaneous and time averaged exposure limits set out in Tables F.1 and F. 2 (Appendix F). Both of these will be discussed with respect to the measurement results.

7.1 Instantaneous RF EME Limits

The results of the measured instantaneous maximum RF EME levels, as a percentage of the RPS3 GP limits, from the different smart meters is listed in Tables 3 (Mesh), 4 (WiMax) and 5 (3G) and Charts 2 (Mesh), 3 (WiMax) and 4 (3G).

Mesh - the outside instantaneous maximum RF EME level ranged between 0.001 and 0.05%. While for the inside, the instantaneous maximum RF EME level ranged between 0.0000009 and 0.0005%.

WiMax - the outside instantaneous maximum RF EME level ranged between 0.00002 and 0.012%. While for the inside, the instantaneous maximum RF EME level ranged between 0.0000004 and 0.0014%.

3G - the outside instantaneous maximum RF EME level ranged between 0.0007 and 0.0000001%. While for the inside, the instantaneous maximum RF EME level ranged between 0.0000004 and 0.000003%.

All of these levels are below the RPS3 GP exposure limits.

7.2 Duty Cycles

For pulsing sources the 6 minute average is determined by multiplying the measured RF EME level by the duty cycle. The duty cycle is the ratio of the time that the source is on in comparison to the time that the source is off in a given time period. In this case the time period is 6 minutes.

The higher the duty cycle the higher the level of exposure to RF EME.

In order to determine the 6 min period that has the highest duty cycle, the traffic profile of the smart meter was measured for its respective polling period - 4 or 6 hours.

The highest 6 min period duty cycle, across the smart meters polling period, for each of the surveyed smart meters is listed in the table in Appendix I.

Mesh – The range of the maximum duty cycle for the mesh smart meters was 0.05 to 2.3%.

WiMax - The range of the maximum duty cycle for the WiMax smart meters was 0.03 to 6.5%. The location where the 6.5% duty cycle was determined was at a rural site where the connection back to the access point was quite weak and this resulted in an exaggerated transmission time.

If we consider this duty cycle to be atypical and discount it then the range of the maximum duty cycles is 0.03 to 0.35%.

3G - The range of the maximum duty cycle for the 3G smart meters was 1.4 to 79%. The location where the 79% duty cycle was determined was at a rural site where the mobile phone signal coverage was very poor.

The data transmission process that the smart meter follows is that it sends its data as scheduled and then waits for a confirmation from the DB that the information has been received. If the confirmation is not received then the meter will transmit the data again and then wait for confirmation. This process will continue until the confirmation has been received. Where there is very poor signal strength and the connection between the smart meter and the DB quite poor this process could go on for some time, resulting in a significant duty cycle, as seen in this case.

If we consider this duty cycle to be atypical and discount it, then the range of the maximum duty cycle is 1.4 to 2.1%.

7.3 Time Averaged RF EME Levels

The highest 6 min average RF EME levels, as a percentage of the RPS3 GP limits, for the polling periods of the smart meter communication technologies, for outside and inside the house are listed in Tables 6 (Mesh), 7 (WiMax) and 8 (3G) and Charts 5 (Mesh), 6 (WiMax) and 7 (3G).

Mesh – the highest outside 6 min average level ranged from 0.002 to 0.5%. While for the inside, the highest 6 min average level ranged between 0.000002 and 0.009%.

Whilst the highest RF EME level for the mesh smart meters was 0.5% (outside), it is important to note that this site was a group meter site. This site had a relatively high duty cycle (1.7%) that was not typical of most of the sites. This was also the case for the second highest duty cycle.

WiMax – the highest outside 6 min average level ranged from 0.000005 to 0.03%. While for the inside, the highest 6 minute average level ranged between 0.0000001 and 0.002%.

3G – the highest outside 6 min average level ranged from 0.00005 to 0.3%. While for the inside, the highest 6 min average level ranged between 0.000002 and 0.0009%.

Whilst the highest RF EME level for the 3G smart meters was 0.3% (outside), it is important to note that this site was the site with the atypical duty cycle due to the very poor mobile phone coverage. If we discounted this site then the highest level would be 0.002%.

All of these levels (including the atypical results) are well below the RPS3 GP exposure limits.

7.4 Background (BG) RF EME Levels

When comparing the inside RF EME levels due to smart meters (max of 0.009%), to the levels of other sources in the home (max of 10%) - Figures 3 and 4, it can be seen that the levels from the smart meters are not the most significant.

The measured outside and inside BG RF EME levels are listed in Tables, 5, 6 and 7 and Chart 8.

This represents the cumulative 6 min average RF EME level across the 27 MHz to 3 GHz band. Signals present in this band are FM radio, Wi-Fi, TV signals and other mobile phone base station signals. The smart meter transmissions are not included in this value.

Typically the outside background levels will be greater than the inside background levels due to shielding of the main outside RF EME sources (TV, FM Radio and mobile phone base stations) by the building. However, the level to which this occurs is dependent on the proximity and the number of external sources present. The shielding ability of the different building materials will have an effect on this as well.

In general the internal BG levels were greater than the levels due to the smart meters. However, in locations where the typical main sources of BG i.e. TV, FM Radio and mobile phone base station signals are weak or not present the BG levels can be less than the smart meter levels.

7.5 Group Analyses

Group analyses of the smart meter RF EME exposure data are provided in Appendix B. These analyses explore the influence of smart meter network type (3G, mesh, WiMax), wall building material (brick, metal, timber or Hardiplank), roof building material (tiles, metal), Antenna location with respect to the smart meter enclosure (internal or external) and clustering of the smart meter units (individual or grouped) on the following metrics of the smart meter RF EME exposure:

1. Number of smart meter RF pulses per hour
2. Maximum 6 minute average of RF power flux density levels *inside* the home as a fraction of the allowable ARPANSA RPS3 General Public limit (S_{intlim})
3. Maximum 6 minute average of RF power flux density levels *outside* the home as a fraction of the allowable ARPANSA RPS3 General Public limit (S_{extlim})
4. dB ratio of the maximum RF power flux density levels outside (S_{ext}) and inside (S_{int}) the home, which is calculated as $S_{ratio} = 10.\log_{10}(S_{ext}/S_{int})$

Histogram plots and statistical tests for differences between the *median* values of each group (using Mood's median test) suggest the following conclusions:

1. **Network Type (3G, Mesh, WiMax)**
    1. Has no significant effect on the median estimates for number of RF pulses/hour and $S_{intlim.}$
    2. Highly significant impact on S_{extlim}, with mesh networks giving the highest median (and overall) exposures.
2. **Building Material (brick, metal, timber or Hardiplank)**
    1. Has a significant effect on S_{intlim}, with timber providing the least shielding, as could be expected.
    2. Has a moderate effect on $S_{ratio.}$
    3. Has no substantive effect on S_{extlim} and pulses/hr, again as expected.
3. **Roofing (Tiles, Metal)**
    1. Has no substantive effect on S_{intlim}, S_{extlim}, S_{ratio} and pulses/hr, as expected given the distance of the roof from the smart meters.
4. **Antenna Location**
    1. Has a significant effect on S_{extlim}, with *internal* antennas surprisingly generating the highest external exposures.
    2. Has a moderate effect on $S_{ratio.}$
    3. Has no substantive effect on S_{intlim} and pulses/hr.
5. **Clustering of meters**
    1. The case numbers for the "grouped" group were too low (2) for the S_{intlim} and S_{ratio} metrics to draw any valid conclusions.
    2. Case numbers were higher for S_{extlim} and pulses/hr (6) and no significant differences were found.
6. **EHS Nominated Site**
    1. Case numbers for sites with self-declared EHS residents (3) were too low for statistical analysis. The histogram plots show that the levels for S_{intlim}, S_{extlim} and pulses/hr at the EHS sites were in the low to mid-range of these metrics compared to non-EHS sites.

7.6 General Observations

This study determined that the RF EME levels from the smart meters surveyed were significantly below the general public (GP) exposure limits specified by the Australian Radiation Protection and Nuclear Safety Agency (ARPANSA) Radiation Protection Standard – Maximum Exposure Levels to Radiofrequency Fields – 3 kHz to 300 GHz (RPS 3) – Chart 1.

In general terms, the levels of RF EME from the smart meters found inside the home were typically hundreds if not thousands of times below the Australian standard.

This was also the case at the small number of properties where residents had reported experiencing health problems they attribute to electromagnetic hypersensitivity (EHS). In other words those properties had RF EME characteristics from either smart meters or background levels that were no different from other properties included in the survey.

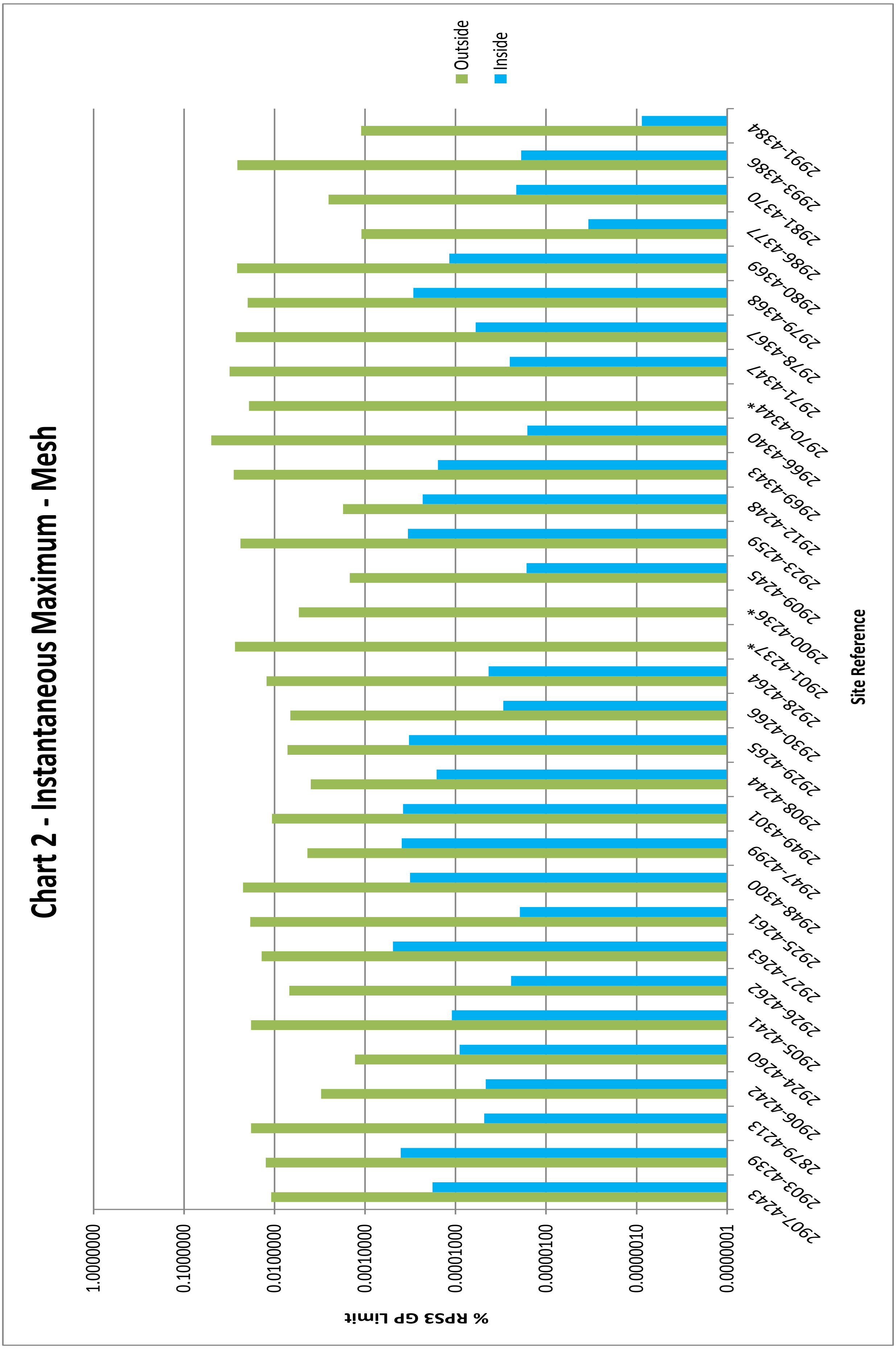
Furthermore, the relative contribution by smart meters to RF EME levels inside the homes surveyed was found to be low in comparison to other sources that Victorians are exposed to in their normal everyday lives.

The highest levels of RF EME were found outside the house, where local conditions meant that poor communication links between the property and the DB.

Instantaneous RMS RF EME Fields (Unperturbed Fields)

Table 3 –Mesh Technology - Instantaneous

Site Reference No.	Inside			Outside		
	Maximum (mW/m^2)	E-field (V/m)	% RPS3 GP Limit	Maximum (mW/m^2)	E-field (V/m)	% RPS3 GP Limit
2907-4243	8	1.8	0.0002	499	14	0.01
2903-4239	18	2.6	0.0004	572	15	0.01
2879-4213	2	0.9	0.00005	831	18	0.02
2906-4242	2	0.9	0.00005	140	7	0.003
2924-4260	4	1.2	0.00009	59	5	0.001
2905-4241	5	1.4	0.0001	831	18	0.02
2926-4262	1	0.6	0.00002	314	11	0.01
2927-4263	22	2.9	0.0005	633	15	0.01
2925-4261	1	0.6	0.00002	851	18	0.02
2948-4300	15	2.3	0.0003	1019	20	0.02
2947-4299	18	2.6	0.0004	198	9	0.004
2949-4301	17	2.6	0.0004	490	14	0.01
2908-4244	7	1.7	0.0002	182	8	0.004
2929-4265	15	2.4	0.0003	329	11	0.01
2930-4266	1	0.7	0.00003	307	11	0.01
2928-4264	2	0.9	0.00004	561	15	0.01
2901-4237[1, 2]	NM	NM	N/M	1253	22	0.03
2900-4236[1, 2]	NM	NM	N/M	246	10	0.01
2909-4245	1	0.5	0.00002	68	5	0.001
2923-4259	15	2.4	0.0003	1092	20	0.02
2912-4248	11	2.0	0.0002	80	5	0.00
2969-4343	7	1.6	0.0002	1295	22	0.03
2966-4340	1	0.5	0.00002	2287	29	0.05
2970-4344[1,2]	N/M	N/M	N/M	875	18	0.02
2971-4347	1	0.7	0.00003	1439	23	0.03
2978-4367	3	1.0	0.00006	1225	21	0.03
2979-4368	13	2.2	0.0003	906	18	0.02
2980-4369	5	1.4	0.0001	1186	21	0.03
2986-4377	0.2	0.2	0.000003	50	4	0.001
2981-4370	1	0.6	0.00002	116	7	0.003
2993-4386	1	0.6	0.00002	1179	21	0.03
2991-4384[3]	0.04	0.1	0.0000009	50	4	0.001



* Measurement not taken due to practical considerations

Table 4 –- WiMax Technology - Instantaneous

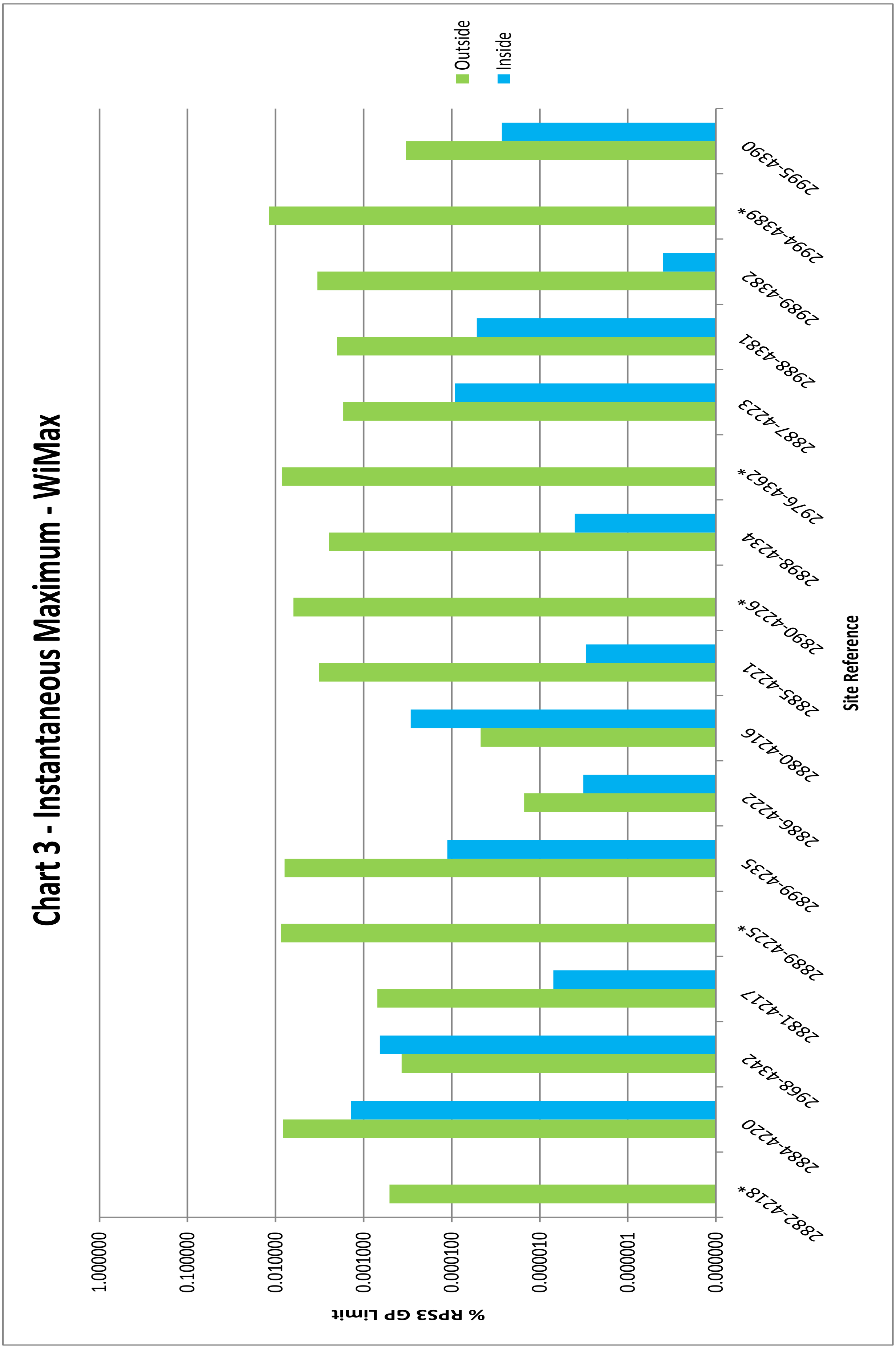
Site Reference No.	Inside			Outside		
	Maximum (mW/m²)	E-field (V/m)	% RPS3 GP Limit	Maximum (mW/m²)	E-field (V/m)	% RPS3 GP Limit
2882-4218[1]	N/M	N/M	N/M	50.7	4	0.0005
2884-4220	139.4	7	0.0014	826.4	18	0.008
2968-4342	65.6	5	0.0007	37	4	0.0004
2881-4217	0.7	1	0.00001	70	5	0.0007
2889-4225[1]	N/M	N/M	N/M	865.2	18	0.009
2899-4235[2]	11.2	2	0.0001	792.1	17	0.008
2886-4222	0.32	0.3	0.0000032	1.5	1	0.00002
2880-4216	29.1	3	0.00029	4.7	1	0.00005
2885-4221	0.3	0.3	0.000003	320.4	11	0.003
2890-4226[1]	N/M	N/M	N/M	629.3	15	0.006
2898-4234[2]	0.4	0.4	0.000004	248.4	10	0.002
2976-4362[1]	N/M	N/M	N/M	849.6	18	0.008
2887-4223	9.2	2	0.00009	169.9	8	0.002
2988-4381[3]	5.2	1	0.00005	201.4	9	0.002
2989-4382[3]	0.04	0.1	0.0000004	336	11	0.003
2994-4389[1, 2]	N/M	N/M	N/M	1191.5	21	0.012
2995-4390	2.7	1	0.00003	33.1	4	0.0003

Table 5 – 3G Technology - Instantaneous

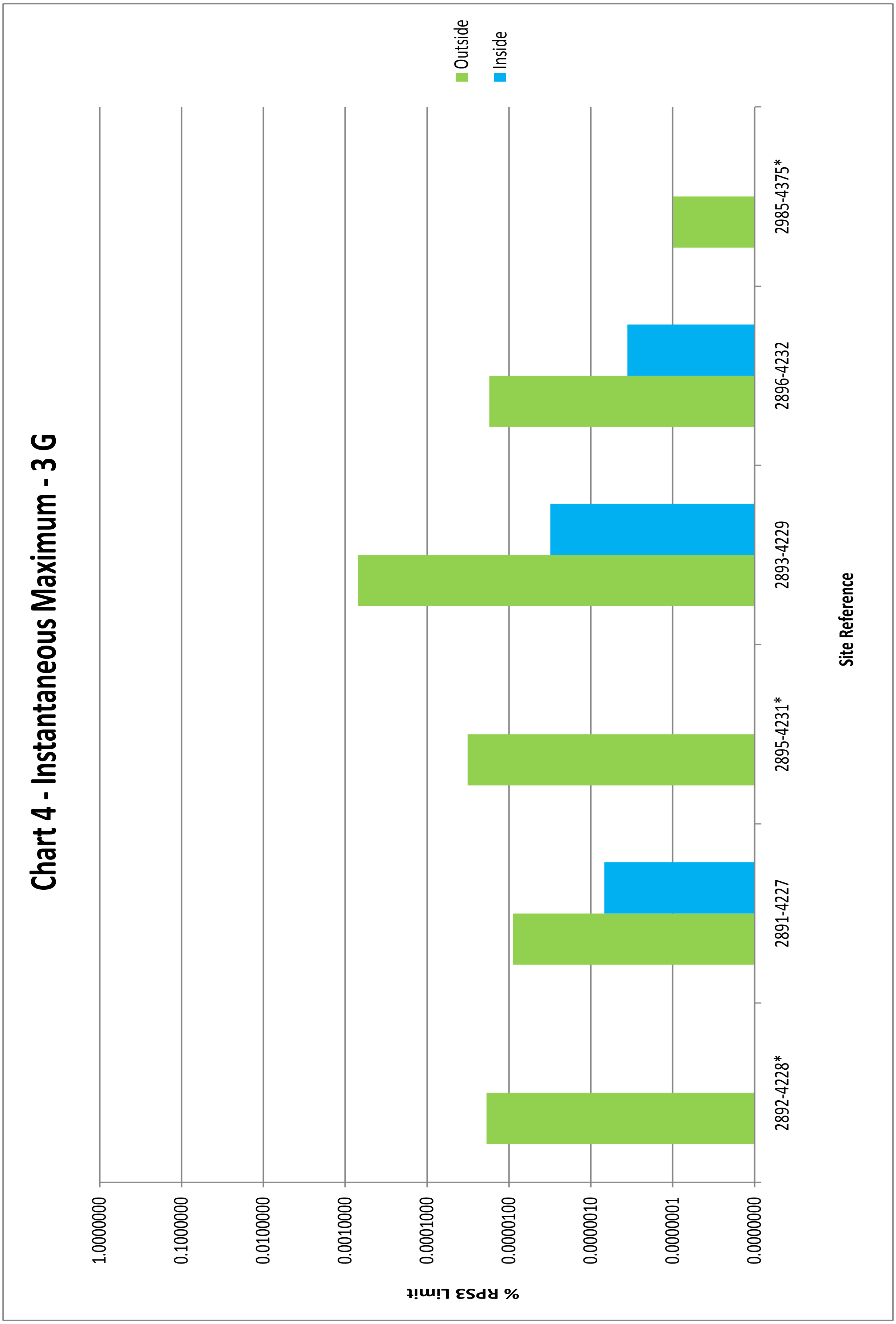
Site Reference No.	Inside			Outside		
	Maximum (mW/m²)	E-field (V/m)	% RPS3 GP Limit	Maximum (mW/m²)	E-field (V/m)	% RPS3 GP Limit
2892-4228[1]	N/M	N/M	N/M	0.8	0.5	0.00002
2891-4227	0.03	0.1	0.0000007	0.4	0.4	0.00001
2895-4231[1]	N/M	N/M	N/M	1.3	0.7	0.00003
2893-4229	0.1	0.2	0.000003	29.1	3.3	0.0007
2896-4232	0.01	0.07	0.0000004	0.7	0.5	0.00002
2985-4375[1]	N/M	N/M	N/M	0.004	0.04	0.0000001

Notes:

1. The smart meter recorded measurements were taken from the SRM-3006 using the 27 MHz – 3 GHz or 420 MHz to 6 GHz E-field probes.
2. The BG recorded measurements were taken from the SRM-3006 or 3000 using the 27 MHz – 3 GHz E-field probes.
3. The measurements were conducted as per Australian Standard AS 2772.2 – 2011 Radiofrequency fields Part 2: Principles and methods of measurement and computation– 3 kHz to 300 GHz.
4. The measurements conducted with the SRM-3006 and 3000 instrument with tripod mounted probes and 1.5 / 5m cable have an expanded uncertainty of ± 4.4 dB.
5. The coverage factor (k) value used to give an expanded uncertainty with a 95% confidence interval was 1.96.
6. The recorded measurements taken from the SRM-3006 and 3000 were power density (mW/m^2) and frequency (MHz).
7. % RPS3 GP Limit – Percentage of the Australian Regulatory General Public Exposure Limit.
8. The % RPS3 GP Limit was calculated using the power flux density values (mW/m^2) and not the field strengths. (V/m).
9. The frequencies used for the determination of the % RPS3 GP Limit (time averaged) was 915 MHz (4.575 W/m^2) for Mesh, 2373 MHz (10 W/m^2) for WiMax and 830 MHz (4.150 W/m^2) for 3G.
10. N/M – Not measured.
11. [1] – Inside measurement not made for practical considerations.
12. [2] – Smart meter group sites.
13. [3] – Sites where residents reported EHS.
14. BG levels do not include smart meter transmissions.



* Measurement not taken due to practical considerations

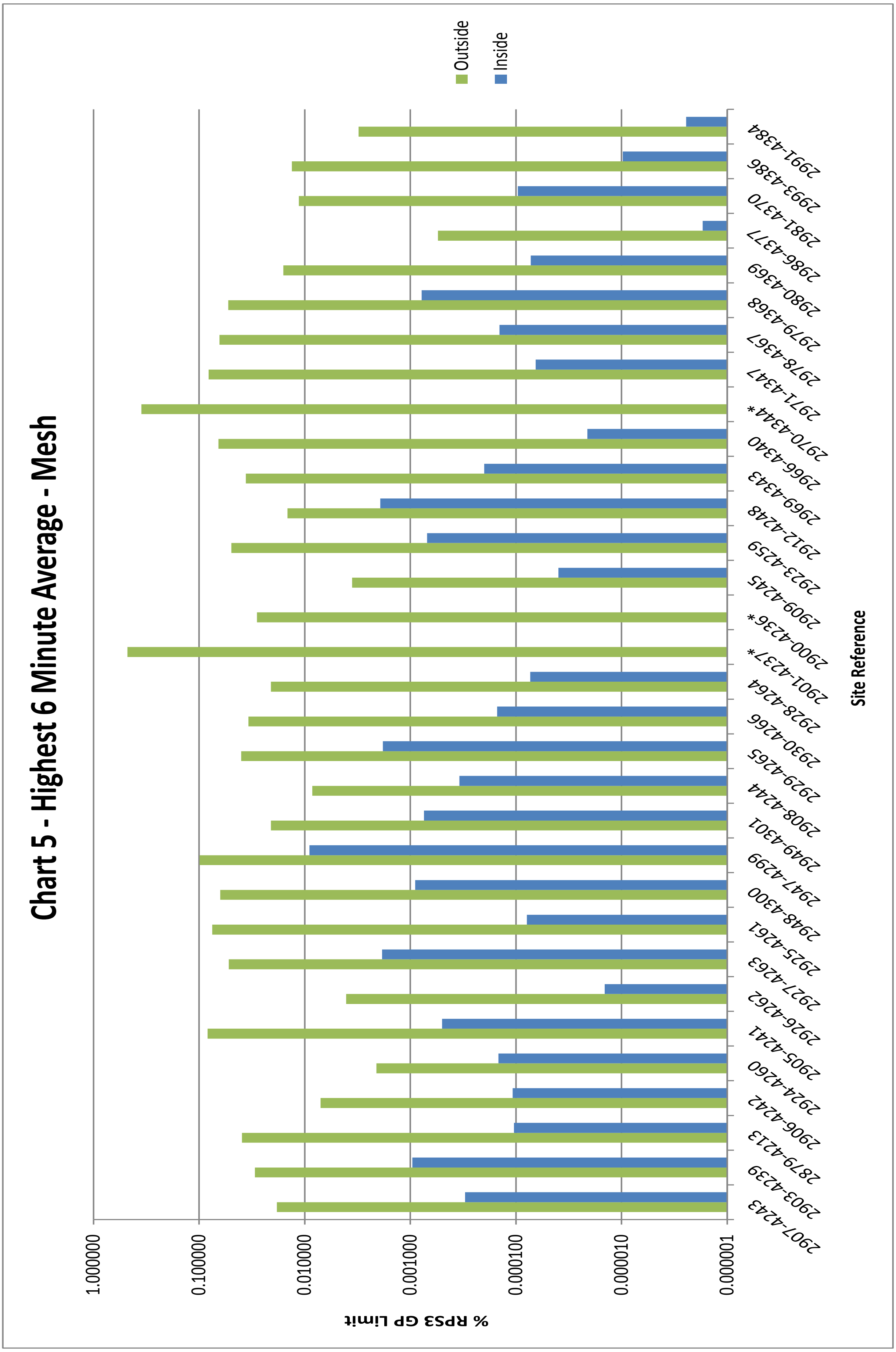


* Measurement not taken due to practical considerations

Time Averaged Exposure to RMS RF EME Fields (Unperturbed Fields)

Table 6 - Mesh Technology - Time Averaged

Site Reference No.	Measurement Location							
	Inside House (Highest 6-min Average)				Outside House (Highest 6-min Average)			
	Power Density (mW/m^2)	Electric Field Strength (V/m)	% of RPS3 GP Limit	BG RF EME Levels (mW/m^2)	Power Density (mW/m^2)	Electric Field Strength (V/m)	% of RPS3 GP Limit	BG RF EME Levels (mW/m^2)
2907-4243	0.01	0.1	0.0003	0.16	0.8	0.6	0.02	0.16
2903-4239	0.04	0.1	0.001	0.18	1.4	0.7	0.03	0.22
2879-4213	0.005	0.04	0.0001	0.16	2	0.8	0.04	0.18
2906-4242	0.005	0.04	0.0001	0.16	0.3	0.3	0.01	0.18
2924-4260	0.007	0.1	0.0001	0.17	0.1	0.2	0.002	0.16
2905-4241	0.02	0.1	0.0005	0.21	4	1.2	0.08	0.96
2926-4262	0.001	0.02	0.00001	0.33	0.2	0.3	0.004	0.21
2927-4263	0.08	0.2	0.002	0.16	2	0.9	0.05	0.25
2925-4261	0.004	0.04	0.0001	0.16	3	1.1	0.08	0.17
2948-4300	0.04	0.1	0.0009	0.17	3	1	0.06	0.17
2947-4299	0.4	0.4	0.009	0.18	5	1.3	0.1	0.18
2949-4301	0.03	0.1	0.0007	0.27	1	0.6	0.02	0.31
2908-4244	0.02	0.1	0.0003	0.29	0.4	0.4	0.01	0.25
2929-4265	0.08	0.2	0.0018	0.18	2	0.8	0.04	0.19
2930-4266	0.007	0.1	0.0002	0.22	2	0.8	0.03	0.86
2928-4264	0.003	0.04	0.0001	0.5	1	0.6	0.02	0.16
2901-4237[1, 2]	N/M	N/M	N/M	NM	22	3	0.5	0.20
2900-4236[1, 2]	N/M	N/M	N/M	NM	1	0.7	0.03	0.76
2909-4245	0.002	0.03	0.00004	0.17	0.2	0.2	0.004	0.17
2923-4259	0.03	0.1	0.0007	0.16	2	0.9	0.05	0.38
2912-4248	0.09	0.2	0.002	0.17	0.7	0.5	0.01	0.26
2969-4343	0.009	0.1	0.0002	0.42	1.7	0.8	0.04	0.18
2966-4340	0.001	0.02	0.00002	0.26	3	1.1	0.07	0.17
2970-4344[1, 2]	N/M	N/M	N/M	N/M	16	2	0.4	0.75
2971-4347	0.003	0.03	0.0001	0.08	4	1.2	0.08	0.10
2978-4367	0.007	0.05	0.0001	0.05	3	1.1	0.06	0.06
2979-4368	0.04	0.1	0.0008	0.41	2	1.0	0.05	0.12
2980-4369	0.003	0.04	0.0001	0.11	0.7	0.5	0.02	0.06
2986-4377	0.0001	0.01	0.000002	0.08	0.03	0.1	0.001	0.08
2981-4370	0.004	0.04	0.0001	0.10	0.5	0.4	0.01	0.19
2993-4386	0.0004	0.01	0.00001	0.06	0.6	0.5	0.01	0.07
2991-4384[3]	0.0001	0.01	0.000002	0.05	0.1	0.2	0.003	0.06



* Measurement not taken due to practical considerations

Table 7 - WiMax Technology - Time Averaged

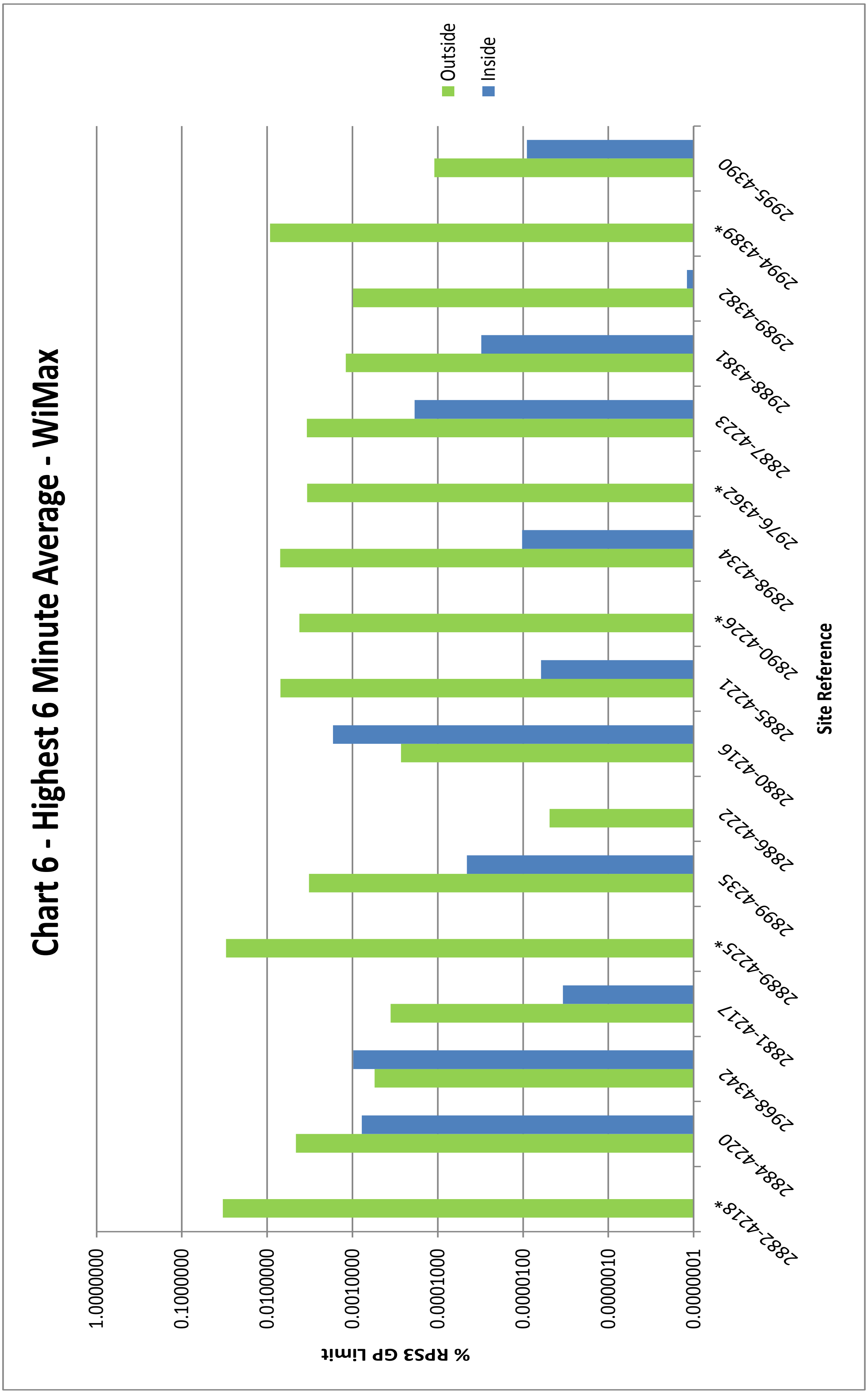
Site Reference No.	Measurement Location							
	Inside House (Highest 6-min Average)				Outside House (Highest 6-min Average)			
	Power Density (mW/m²)	Electric Field Strength (V/m)	% of RPS3 GP Limit	BG RF EME Levels (mW/m²)	Power Density (mW/m²)	Electric Field Strength (V/m)	% of RPS3 GP Limit	BG RF EME Levels (mW/m²)
2882-4218[1]	N/M	N/M	N/M	N/M	3	1.1	0.03	0.07
2884-4220	0.08	0.2	0.0008	0.05	0.5	0.4	0.005	0.05
2968-4342	0.1	0.2	0.0010	0.06	0.1	0.1	0.001	0.26
2881-4217	0.0003	0.01	0.000003	0.06	0.04	0.1	0.0004	0.06
2889-4225[1]	N/M	N/M	N/M	N/M	3	1.1	0.03	0.53
2899-4235[2]	0.005	0.04	0.00005	0.53	0.3	0.3	0.003	0.32
2886-4222	0.00001	0.002	0.0000001	0.07	0.0005	0.01	0.000005	0.20
2880-4216	0.2	0.3	0.002	0.17	0.03	0.1	0.0003	0.37
2885-4221	0.001	0.02	0.00001	0.05	0.7	0.5	0.01	0.39
2890-4226[1]	N/M	N/M	N/M	N/M	0.4	0.4	0.004	0.06
2898-4234[2]	0.001	0.02	0.00001	0.09	0.7	0.5	0.01	0.33
2976-4362[1]	N/M	N/M	N/M	N/M	0.3	0.4	0.003	0.06
2887-4223	0.02	0.1	0.0002	0.09	0.3	0.4	0.003	0.08
2988-4381[3]	0.003	0.03	0.00003	0.03	0.1	0.2	0.001	0.09
2989-4382[3]	0.00001	0.002	0.0000001	0.06	0.1	0.2	0.001	0.06
2994-4389[1, 2]	N/M	N/M	N/M	N/M	0.9	0.6	0.01	0.06
2995-4390	0.001	0.02	0.00001	0.06	0.01	0.1	0.0001	0.13

Table 8 – 3G Technology - Time Averaged

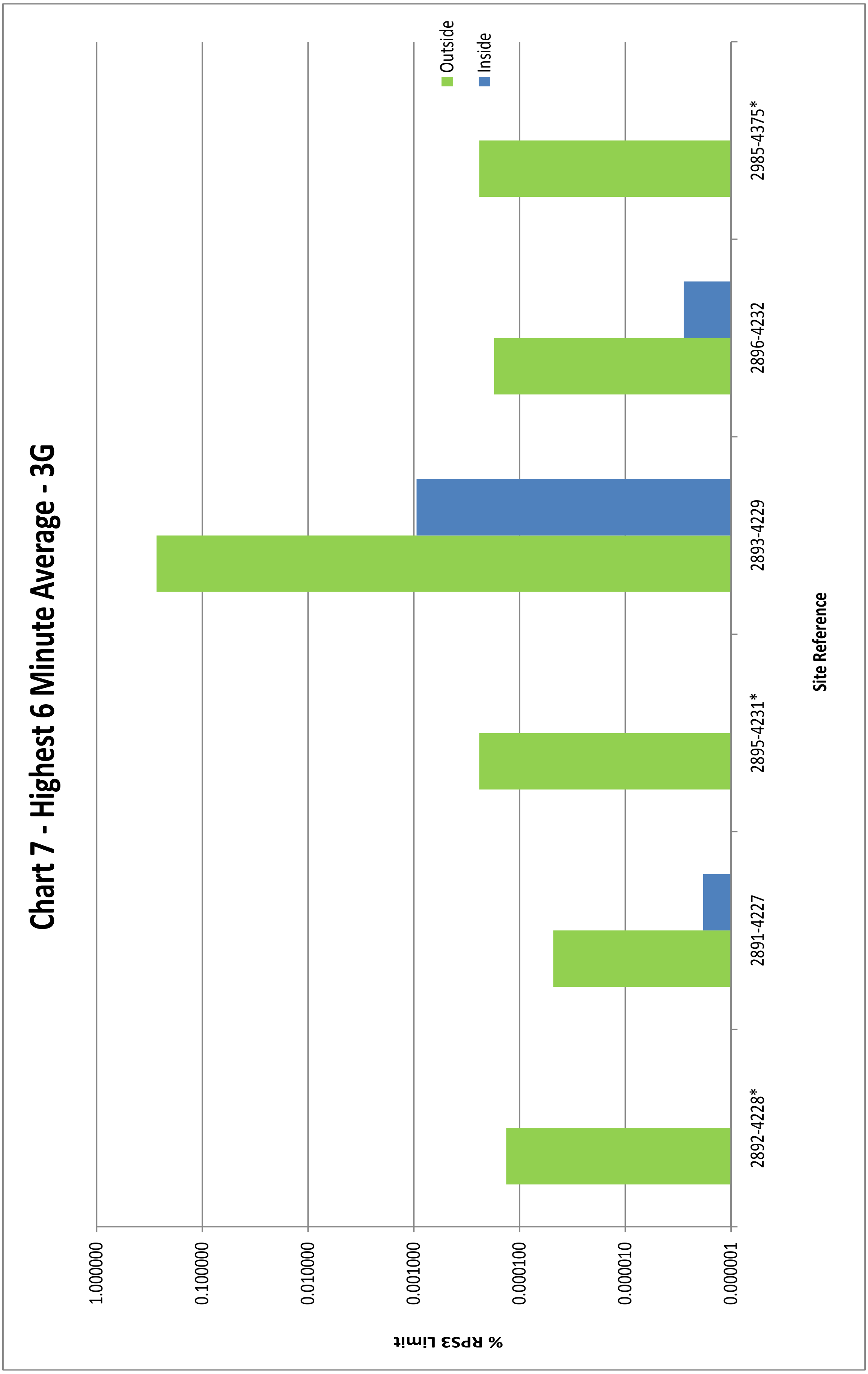
Site Reference No.	Measurement Location							
	Inside House (6-min Avg)				Outside House (6-min Avg)			
	Power Density (mW/m²)	Electric Field Strength (V/m)	% of RPS3 GP Limit	BG RF EME Levels (mW/m²)	Power Density (mW/m²)	Electric Field Strength (V/m)	% of RPS3 GP Limit	BG RF EME Levels (mW/m²)
2892-4228[1]	N/M	N/M	N/M	N/M	0.01	0.05	0.0001	0.1
2891-4227	0.0001	0.01	0.000002	0.1	0.002	0.03	0.00005	0.06
2895-4231[1]	N/M	N/M	N/M	N/M	0.01	0.1	0.0002	0.05
2893-4229	0.04	0.1	0.0009	0.05	11	2.1	0.3	0.15
2896-4232	0.0001	0.01	0.000003	0.06	0.01	0.1	0.0002	0.06
2985-4375[1]	N/M	N/M	N/M	N/M	0.01	0.1	0.0002	0.16

Notes:

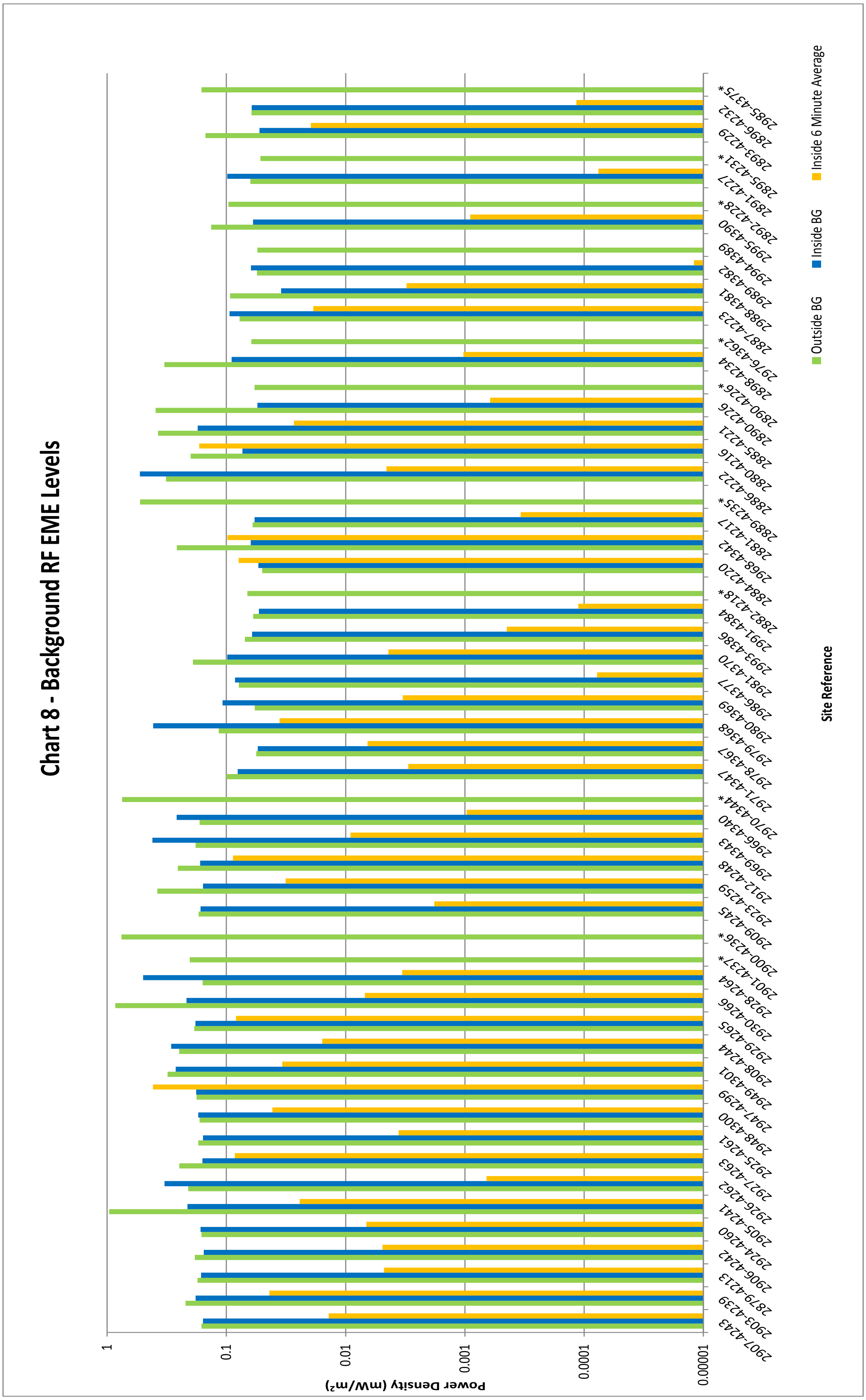
1. The smart meter recorded measurements were taken from the SRM-3006 using the 27 MHz – 3 GHz or 420 MHz to 6 GHz E-field probes.
2. The BG recorded measurements were taken from the SRM-3006 or 3000 using the 27 MHz – 3 GHz E-field probes.
3. The measurements were conducted as per Australian Standard AS 2772.2 – 2011 Radiofrequency fields Part 2: Principles and methods of measurement and computation– 3 kHz to 300 GHz.
4. The measurements conducted with the SRM-3006 and 3000 instrument with tripod mounted probes and 1.5 / 5m cable have an expanded uncertainty of ± 4.4 dB.
5. The coverage factor (k) value used to give an expanded uncertainty with a 95% confidence interval was 1.96.
6. The recorded measurements taken from the SRM-3006 and 3000 were power density (mW/m^2) and frequency (MHz).
7. % RPS3 GP Limit – Percentage of the Australian Regulatory General Public Exposure Limit.
8. The % RPS3 GP Limit was calculated using the power flux density values (mW/m^2) and not the field strengths. (V/m).
9. The frequencies used for the determination of the % RPS3 GP Limit (time averaged) was 915 MHz (4.575 W/m^2) for Mesh, 2373 MHz (10 W/m^2) for WiMax and 830 MHz (4.150 W/m^2) for 3G.
10. N/M – Not measured.
11. [1] – Inside measurement not made for practical considerations.
12. [2] – Smart meter group sites.
13. [3] – Sites where residents reported EHS.
14. BG levels do not include smart meter transmissions.



* Measurement not taken due to practical considerations



* Measurement not taken due to practical considerations



* Measurement not taken due to practical considerations

Appendix A– Detailed Smart Meter Measurement Results

Table A.1 Mesh Technology

Site Reference	Inside Power Density (mW/m^2)				Outside Power Density (mW/m^2)			
	x	y	z	Total	x	y	z	Total
2907-4243	1.278	5.557	1.417	8	247	221	30.54	499
2903-4239	4.854	8.65	4.934	18	328.5	182.1	61.36	572
2879-4213	1.101	0.122	0.989	2	292.1	383.3	155.6	831
2906-4242	0.513	0.589	1.02	2	5.499	64.83	70.02	140
2924-4260	0.42	1.148	2.563	4	37.36	17.8	3.995	59
2905-4241	2.162	2.02	0.834	5	382.2	198.1	250.3	831
2926-4262	0.71	0.069	0.339	1	79.29	1.153	233.1	314
2927-4263	9.952	6.101	6.416	23	382.9	183.4	67.07	633
2925-4261	0.379	0.417	0.095	1	400.9	377	73.02	851
2948-4300	4.279	8.034	2.244	15	284.2	285.4	449.6	1019
2947-4299	2.91	4.21	10.89	18	56.99	117	24.06	198
2949-4301	5.397	3.1173	8.9	17	277.4	150.7	61.6	490
2908-4244	1.619	2.469	3.297	7	67.02	73	42.13	182
2929-4265	13.43	1.28	0.249	15	53.91	182.7	92.59	329
2930-4266	0.092	0.697	0.569	1	165.6	129.2	12.24	307
2928-4264	0.898	1.014	0.064	2	475.5	73.85	12.03	561
2901-4237[1, 2]	NM	NM	NM	NM	546.3	340.6	366.1	1253
2900-4236[1, 2]	NM	NM	NM	NM	61.02	84.27	100.8	246

2909-4245	0.2176	0.3014	0.234	1	19.2	15.16	33.22	68
2923-4259	4.547	9.115	1.716	15	145.9	646.4	299.5	1092
2912-4248	5.283	2.79	2.488	11	55.91	7.129	16.8	80
2969-4343	0.2893	2.494	4.365	7	688	554.9	51.77	1295
2966-4340	0.4385	0.2535	0.0422	1	839	938.4	509.6	2287
2970-4344[1, 2]	N/M	N/M	N/M	N/M	296.1	419.5	159.8	875
2971-4347	0.3674	0.6136	0.1698	1	132.8	324.6	981.2	1439
2978-4367	1.472	1.153	0.11	3	448.7	519.9	255.9	1225
2979-4368	0.279	12.14	0.972	13	10.43	508.6	386.8	906
2980-4369	0.402	3.719	1.253	5	783.9	135.1	266.5	1186
2986-4377	0.1196	0.0336	0.002574	0.2	9.903	9.128	31.23	50
2981-4370	0.3639	0.509	0.1024	1	71.99	35.1	8.61	116
2993-4386	0.247	0.246	0.372	1	756.9	219.8	202.4	1179
2991-4384	0.01796	0.004783	0.01731	0.04	17.65	2.998	29.83	50

Table A.2 WiMax Technology

Site Reference	Internal Power Density (mW/m^2)				External Power Density (mW/m^2)			
	x	y	z	Total	x	y	z	Total
2882-4218 (Max)[1]	N/M	N/M	N/M	N/M	65.53	55.84	70.55	192
2882-4218 (Avg)[1]	N/M	N/M	N/M	N/M	15.24	19.15	16.34	51
2884-4220 (Max)	83.81	165.8	207.9	458	989.9	128.9	1267	2386
2884-4220 (Avg)	18.79	42.11	78.46	139	363.1	32.82	430.5	826
2968-4342 (Max)	267.2	4.077	6.716	278	54.14	39.85	39.36	133
2968-4342 (Avg)	62.69	1.395	1.536	66	13.73	10.71	12.56	37
2881-4217 (Max)	1.607	0.007065	0.6215	2	88.41	72.73	24.99	186
2881-4217 (Avg)	0.4667	0.0016	0.2069	1	34.18	26.14	10.44	71
2889-4225 (Max)[1]	N/M	N/M	N/M	N/M	1781	654.3	507.8	2943
2889-4225 (Avg)[1]	N/M	N/M	N/M	N/M	547.7	183	134.5	865
2899-4235 (Max)[2]	0.6068	14.9	23.32	39	905.8	917.7	1001	2825
2899-4235 (Avg)[2]	0.1581	4.492	6.5	11	218.6	226.4	347.1	792
2886-4222 (Max)	0.1193	0.005492	0.01285	0.1	4.166	0.6726	0.8695	6
2886-4222 (Avg)	0.0271	0.00106	0.003385	0.03	1.127	0.1798	0.2413	2
2880-4216 (Max)	13.73	79.03	45.66	138	13.68	1.916	2.577	18
2880-4216 (Avg)	3.44	15.42	10.28	29	3.408	0.2458	1.028	5
2885-4221 (Max)	0.5382	0.06564	0.4647	1	345.4	706.1	318.7	1370
2885-4221 (Avg)	0.1493	0.01682	0.1151	0.3	105.7	133.3	81.35	320
2890-4226 (Max)[1]	N/M	N/M	N/M	N/M	938.5	784.1	478.1	2201
2890-4226 (Avg)[1]	N/M	N/M	N/M	N/M	224.6	301.2	103.5	629
2898-4234 (Max)	0.6297	0.8542	0.1532	2	471.5	217.3	598.7	1288
2898-4234 (Avg)	0.127	0.2073	0.02844	0.4	85.37	46.76	116.3	248
2976-4362 (Max)[1]	N/M	N/M	N/M	N/M	1267	861.9	1048	3177
2976-4362 (Avg)[1]	N/M	N/M	N/M	N/M	339.3	245	265.3	850
2887-4223 (Max)	8.314	11.33	18.1	38	384.7	115.2	224.1	724
2887-4223 (Avg)	2.48	2.371	4.369	9	82.21	28.68	58.97	170
2988-4381 (Max)	13.55	0.749	6.675	21	888.9	41.44	92.66	1023
2988-4381 (Avg)	2.98	0.18	2.012	5	165.2	12.37	23.78	201
2989-4382 (Max)	0.004068	0.04773	0.08135	0.1	314.4	565.2	350.8	1230
2989-4382 (Avg)	0.001585	0.01508	0.02496	0.3	91.62	148.9	95.5	336
2994-4389 (Max)[1, 2]	N/M	N/M	N/M	N/M	3107	602.3	542.4	4252
2994-4389 (Avg)[1, 2]	N/M	N/M	N/M	N/M	886.3	152	153.2	1192
2995-4390 (Max)	3.216	6.866	1.923	12	87.92	7.261	29.12	124
2995-4390 (Avg)	0.7115	1.504	0.4558	3	24.69	1.961	6.433	33

Table A.3 3G Technology

Site Reference	Inside Power Density (mW/m^2)				Outside Power Density (mW/m^2)			
	x	y	z	Total	x	y	z	Total
2892-4228 (Max)[1]	N/M	N/M	N/M	N/M	0.2174	0.324	0.2424	0.8
2892-4228 (Avg)[1]	N/M	N/M	N/M	N/M	0.1149	0.1056	0.1306	0.4
2891-4227 (Max)	0.01667	0.005442	0.006217	0.03	0.202	0.004647	0.1648	0.4
2891-4227 (Avg)	0.003577	0.000776	0.001005	0.01	0.08235	0.000851	0.05591	0.1
2895-4231 (Max)[1]	N/M	N/M	N/M	N/M	0.09825	0.02268	1.205	1.3
2895-4231 (Avg)[1]	N/M	N/M	N/M	N/M	0.05108	0.009248	0.5357	0.6
2893-4229 (Max)	0.049	0.07479	0.0052	0.1	20.94	4.387	3.726	29
2893-4229 (Avg)	0.0141	0.03326	0.00204	0.05	9.91	2.092	2.184	14
2896-4232 (Max)	0.0049	0.00521	0.004787	0.01	0.164	0.241	0.3165	0.7
2896-4232 (Avg)	0.001	0.00269	0.00186	0.01	0.07569	0.1146	0.1558	0.3
2985-4375 (Max)[1]	N/M	N/M	N/M	0.0	0.00113	0.00129	0.00165	0.004
2985-4375 (Avg)[1]	N/M	N/M	N/M	0.0	0.00003	0.000451	0.00055	0.001

Notes:

1. [1] – Inside measurement not made for practical considerations.
2. [2] – Smart meter group sites.
3. The SRM-3006 was set to single axis mode and then the smart meter was triggered for each of the X, Y and Z axes, measuring the peak RF EME level for each of these.

Appendix B - Group Analyses of Smart Meter Data

This Appendix presents group analyses of the smart meter data, making statistical comparisons of various RF EME exposure metrics for different groupings of the data.

The RF EME exposure metrics that were analysed are:

1. Number of smart meter RF pulses per hour
2. Maximum 6 minute average of RF power flux density levels *inside* the home as a fraction of the allowable ARPANSA RPS3 General Public limit (S_{intlim})
3. Maximum 6 minute average of RF power flux density levels *outside* the home as a fraction of the allowable ARPANSA RPS3 General Public limit (S_{extlim})
4. dB ratio of the maximum RF power flux density levels outside (S_{ext}) and inside (S_{int}) the home, which is calculated as $S_{ratio} = 10.\log_{10}(S_{ext}/S_{int})$

The criteria used for grouping the data for these exposure metrics are:

1. Smart meter network type (3G, mesh or WiMax)
2. Building material of the home walls (brick, metal or timber/Hardiplank)
3. Roof building material (metal or tiles)
4. Location of antenna relative to the smart meter box (internal or external)
5. Clustering of meters (individual or grouped)
6. Self-declared EHS status of resident (EHS or non-EHS)

The grouping analyses did not include data from sites where the relevant group descriptor was not collected.

The grouping analyses comprise:

- Histogram plots by group. For histogram plots of 'pulses per hour', the data point for one extreme outlier is not shown as it would have obscured the shape of the remaining distribution.
- Comparison of *medians* (not means) of groups, using Mood's median test to calculate the p-values for equality in medians of grouped data. Mood's test is a non-parametric (i.e. distribution-free) test which does not assume normality or equal variances of the group distributions, and copes well with outliers.
- Percentile values (quartiles) of the grouped data
- No. of data points in each group (n)
- A bootstrapped 95% confidence interval. Bootstrapping was used due to non normal variations in the data distributions

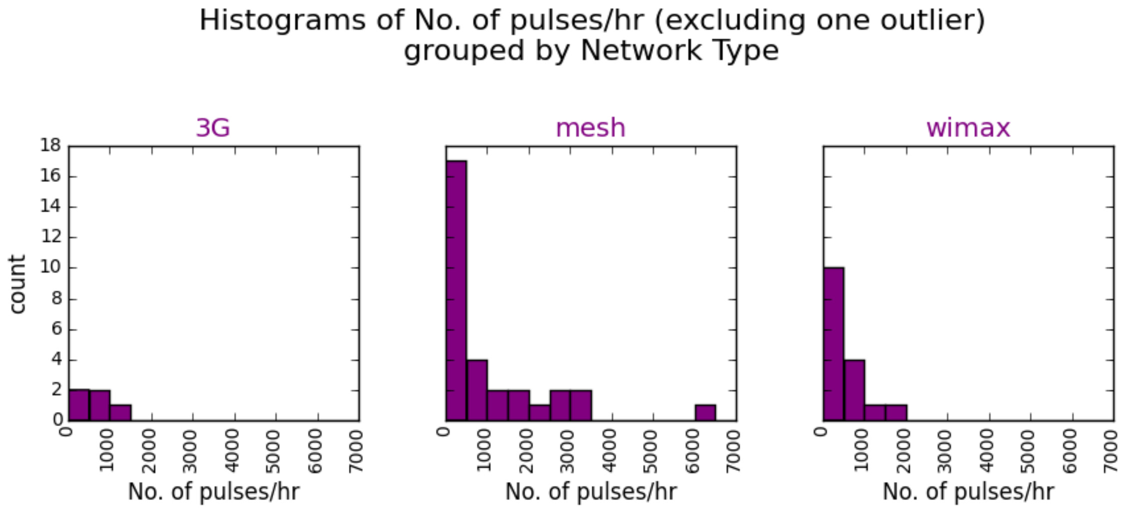
Significant (<0.05) and highly significant (<0.01) p-values for Mood's median test are highlighted with a '*" and '**" respectively, and coloured in red font in the tabulated results.

The tabulated p-values for 'ALL' vs each grouping are a test for significant difference in median values between the group values and all of the remaining values. The tabulated p-values for 'ALL' vs 'ALL' are a test for any significant differences in medians between all groups.

No p-values were calculated for the EHS grouping as the group size for the EHS sites was too small (3) for meaningful analysis.

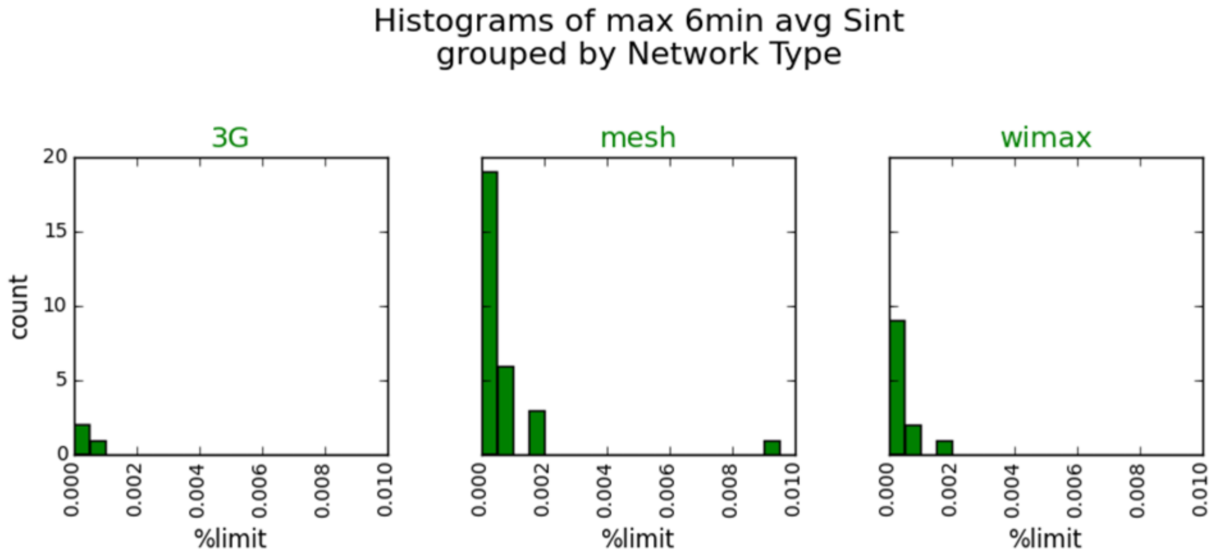
Group analysis by smart meter *network type*

1) Pulses per hour



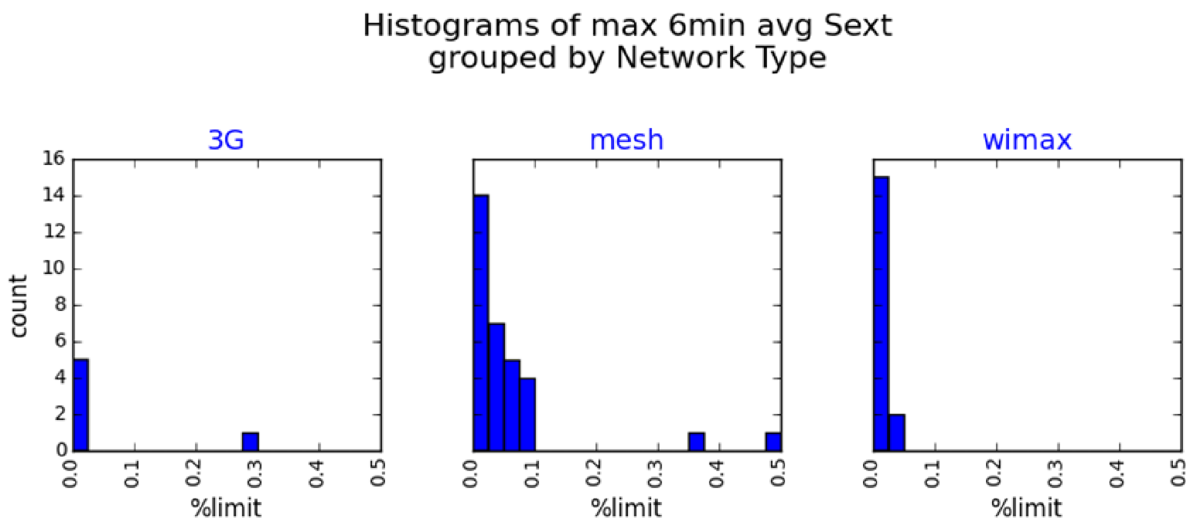
Smart Meter Type	p-values for difference in medians for Pulses Per Hour				Percentile Values					Bootstrapped 95% CI		
	3G	**Mesh**	**WiMax**	**ALL**	**0**	**25**	**50**	**75**	**100**	**n**	**CI (low)**	**CI (high)**
3G	1.0000	0.6564	0.5490	0.6314	129.4	387.4	844.3	994.9	389628.9	6	502.3	260034.0
Mesh	0.6564	1.0000	0.9171	0.9090	98.5	302.6	481.8	1752.5	15389.2	32	905.1	3271.9
WiMax	0.5490	0.9171	1.0000	0.6217	52.3	257.2	457.5	749.0	66076.1	17	481.7	19935.0
ALL	0.6314	0.9090	0.6217	0.5548	52.3	271.4	473.1	1099.7	389628.9	55	156.2	44023.4

2) Maximum S_{int} 6 min average as percentage of the ARPANSA RPS3 GP limit (Sintlim)



Smart Meter Type	p-values for difference in medians for Sintlim				Percentile values					Bootstrapped 95% CI		
	3G	Mesh	WiMax	ALL	0	25	50	75	100	n	CI (low)	CI (high)
3G	1.0000	1.0000	0.8971	1.0000	1.80E-06	2.26E-06	2.73E-06	4.94E-04	9.85E-04	3	0.000%	0.066%
Mesh	1.0000	1.0000	0.3526	0.2033	1.70E-06	7.24E-05	1.46E-04	7.43E-04	9.01E-03	29	0.036%	0.196%
WiMax	0.8971	0.3526	1.0000	0.3099	9.95E-08	5.46E-06	2.05E-05	3.34E-04	1.69E-03	12	0.009%	0.074%
ALL	1.0000	0.2033	0.3099	0.2824	9.95E-08	1.34E-05	1.06E-04	7.51E-04	9.01E-03	44	0.033%	0.140%

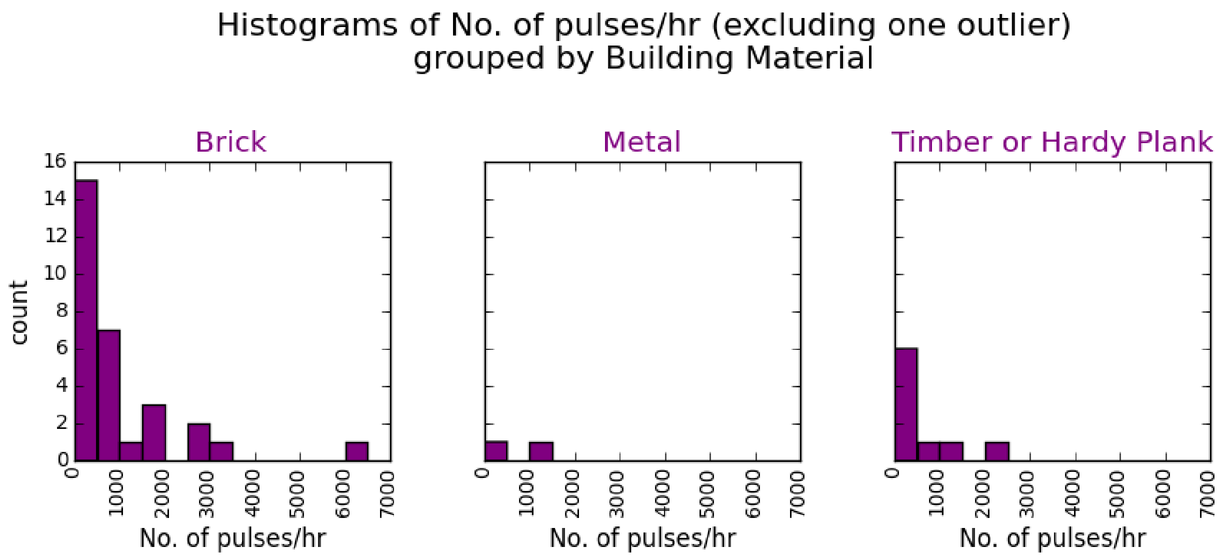
3) Maximum S_{ext} 6 min average as percentage of ARPANSA RPS3 GP limit (Sextlim)



Smart Meter Type	p-values for difference in medians for Sextlim				Percentile values					Bootstrapped 95% CI		
	3G	Mesh	WiMax	ALL	0	25	50	75	100	n	CI (low)	CI (high)
3G	1.0000	0.1820	0.1929	0.2111	4.45E-07	6.76E-05	1.50E-04	2.19E-04	2.83E-01	6	0.009%	18.864%
mesh	0.1820	1.0000	0.0005**	0.0000**	5.48E-04	1.28E-02	3.19E-02	6.32E-02	4.78E-01	32	3.478%	11.223%
wimax	0.1929	0.0005**	1.0000	0.0006**	4.88E-06	5.53E-04	3.40E-03	6.99E-03	3.31E-02	17	0.305%	1.325%
ALL	0.2111	0.0000**	0.0006**	0.0000**	4.45E-07	2.59E-03	1.14E-02	3.96E-02	4.78E-01	55	2.491%	7.593%

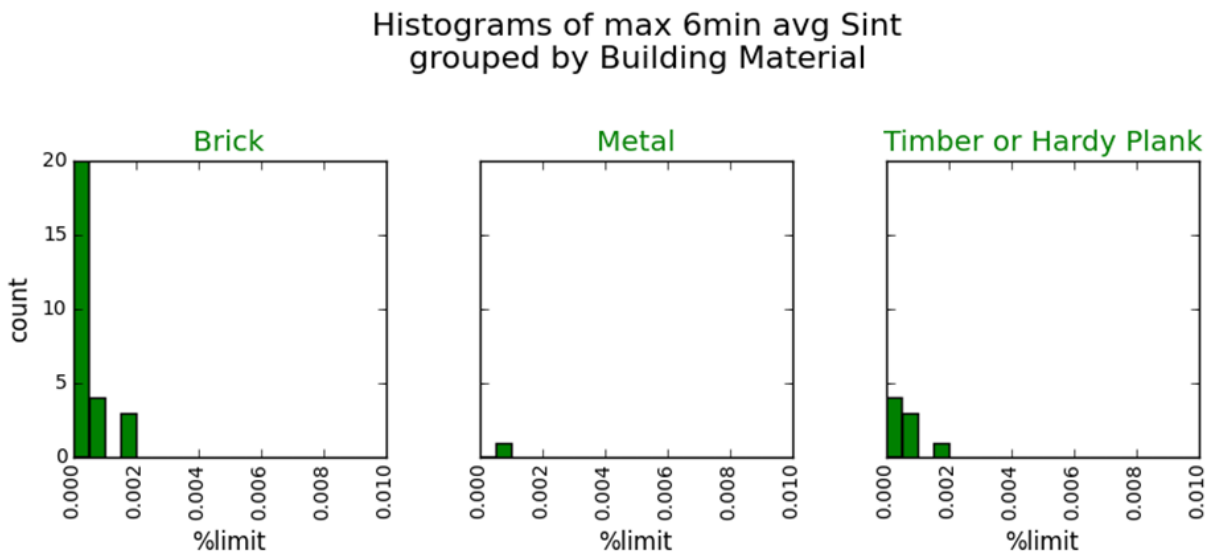
Group analysis by smart meter *building material of home wall*

1) Pulses per hour



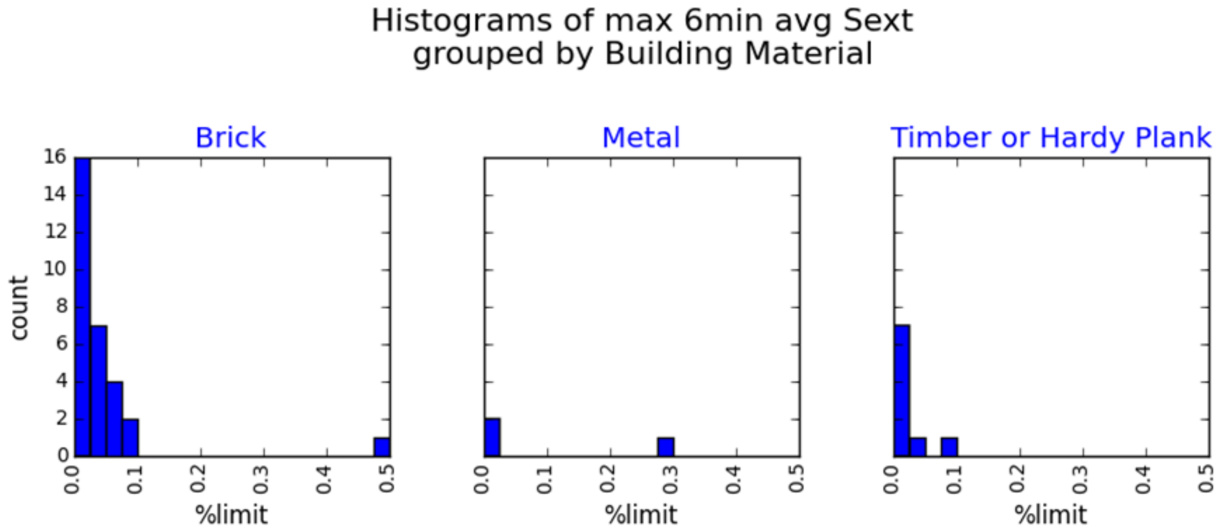
Building material of wall	p-values for difference in medians for Pulses Per Hour				Percentile Values					Bootstrapped 95% CI		
	Brick	Metal	Timber or Hardy Plank	ALL	0	25	50	75	100	n	CI (low)	CI (high)
Brick	1.000	0.956	0.501	0.733	52.3	311.9	508.6	1056.9	6302.8	30	711.7	1713.1
Metal	0.956	1.000	1.000	1.000	129.4	578.8	1028.1	195328.5	389628.9	3	129.4	260095.3
Timber or Hardy Plank	0.501	1.000	1.000	0.452	98.5	187.3	307.2	503.7	2426.0	9	273.6	1369.9
ALL	0.733	1.000	0.452	0.480	52.3	260.4	481.8	1082.8	389628.9	42	820.7	56413.9

2) Maximum S_{int} 6 min average as percentage of ARPANSA RPS3 GP limit (Sintlim)



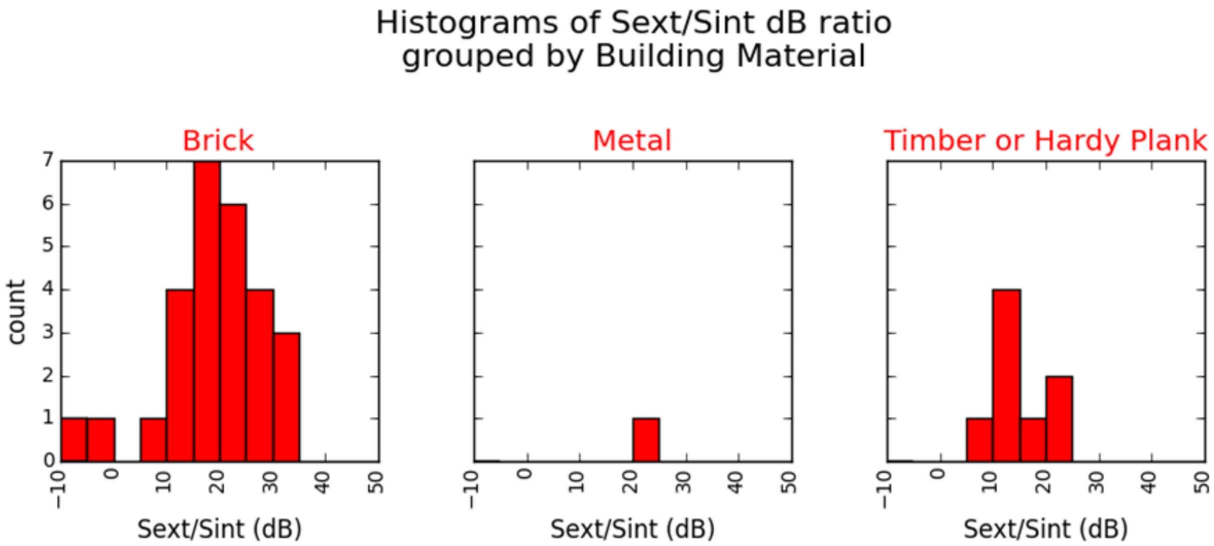
Building material of wall	p-values for difference in medians for Sintlim				Percentile values					Bootstrapped 95% CI		
	Brick	Metal	Timber or Hardy Plank	ALL	0	25	50	75	100	n	CI (low)	CI (high)
Brick	1.0000	1.0000	0.0352*	0.0209*	9.95E-08	1.77E-05	9.59E-05	4.47E-04	1.85E-03	27	1.97E-04	6.46E-04
Metal	1.0000		0.9056	1.0000	9.85E-04	9.85E-04	9.85E-04	9.85E-04	9.85E-04	1		
Timber or Hardy Plank	0.0352*	0.9056	1.0000	0.0450*	7.33E-05	2.64E-04	4.22E-04	7.96E-04	1.93E-03	8	3.36E-04	1.18E-03
ALL	0.0209*	1.0000	0.0450*	0.0258*	9.95E-08	4.40E-05	1.45E-04	7.51E-04	1.93E-03	36	2.80E-04	6.67E-04

3) Maximum S_{ext} 6 min average as percentage of ARPANSA RPS3 GP limit (Sextlim)



Building material of wall	p-values for difference in medians for Sextlim				Percentile Values					Bootstrapped 95% CI		
	Brick	**Metal**	**Timber or Hardy Plank**	**ALL**	**0**	**25**	**50**	**75**	**100**	**n**	**CI (low)**	**CI (high)**
Brick	1.000	0.956	0.930	1.000	4.88E-06	3.46E-03	1.37E-02	4.70E-02	4.78E-01	30	2.16E-02	1.02E-01
Metal	0.956	1.000	1.000	1.000	1.30E-04	1.83E-04	2.35E-04	1.42E-01	2.83E-01	3	1.30E-04	1.89E-01
Timber or Hardy Plank	0.930	1.000	1.000	1.000	2.10E-03	8.47E-03	1.84E-02	2.09E-02	8.30E-02	9	1.25E-02	4.68E-02
ALL	1.000	1.000	1.000	0.801	4.88E-06	3.46E-03	1.53E-02	3.98E-02	4.78E-01	42	2.32E-02	8.36E-02

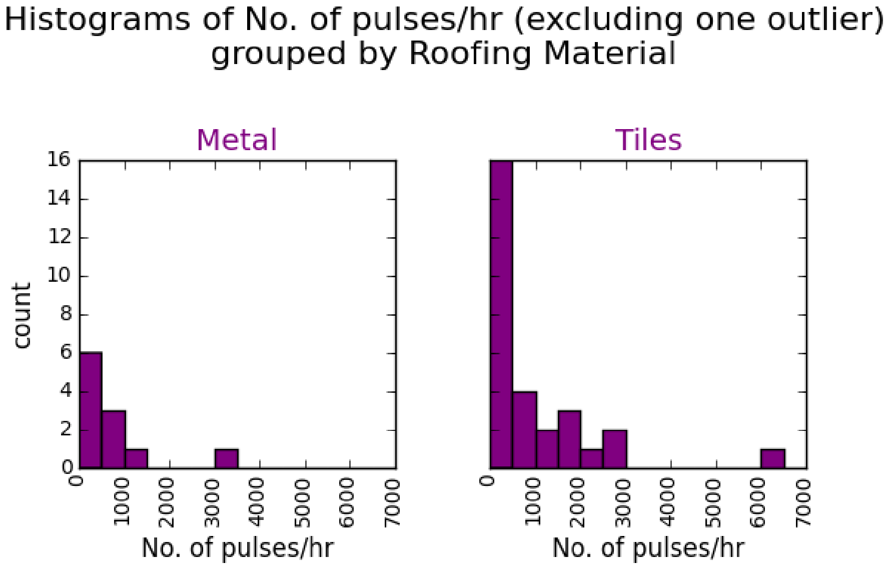
4) dB ratio of S_{ext}/S_{int} (Sratio)



Building material of wall	p-values for difference in medians for Sratio				Percentile Values					Bootstrapped 95% CI		
	Brick	Metal	Timber or Hardy Plank	ALL	0	25	50	75	100	n	CI (low)	CI (high)
Brick	1.000	1.000	0.264	0.441	-7.9	15.7	19.5	25.1	34.9	27	15.2	22.4
Metal	1.000	-	0.906	1.000	24.6	24.6	24.6	24.6	24.6	1		
Timber or Hardy Plank	0.264	0.906	1.000	0.229	8.8	13.3	14.7	18.9	24.5	8	12.9	19.7
ALL	0.441	1.000	0.229	0.189	-7.9	14.4	18.5	24.5	34.9	36	15.6	21.2

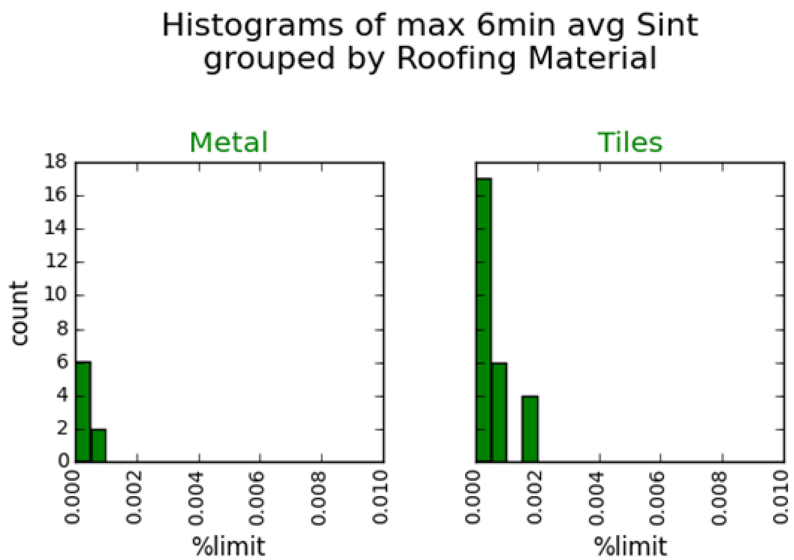
Group analysis by smart meter *building material of home roof*

1) Pulses per hour



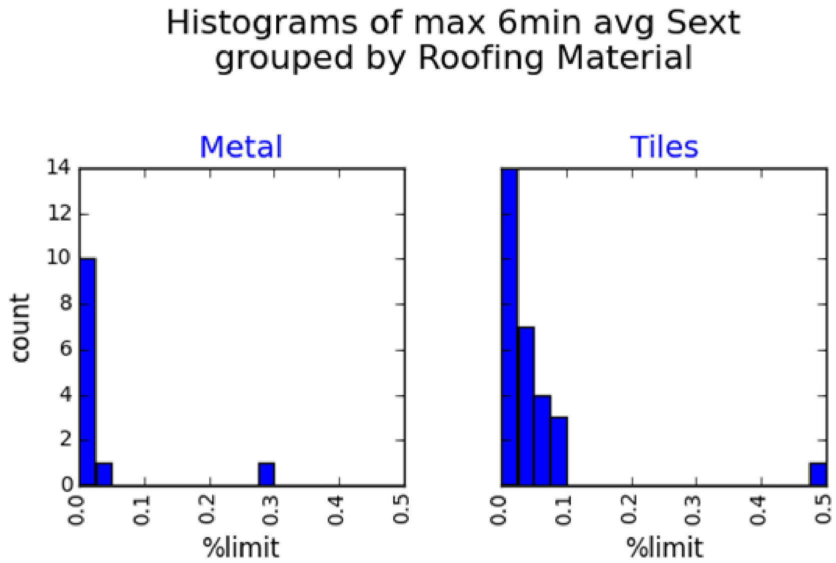
Roofing	p-values for difference in medians for pulses/hour			Percentile Values					Bootstrapped 95% CI		
	Metal	**Tiles**	**ALL**	**0**	**25**	**50**	**75**	**100**	**n**	**CI (low)**	**CI (high)**
Metal	1.000	0.808	0.808	1.29E+02	2.50E+02	4.87E+02	9.28E+02	3.90E+05	12	5.43E+02	1.63E+05
Tiles	0.808	1.000	0.808	5.23E+01	2.86E+02	4.58E+02	1.45E+03	6.30E+03	29	6.97E+02	1.72E+03
ALL	0.808	0.808	0.808	5.23E+01	2.52E+02	4.70E+02	1.10E+03	3.90E+05	41	8.26E+02	4.89E+04

2) Maximum S_{int} 6 min average as percentage of ARPANSA RPS3 GP limit (Sintlim)



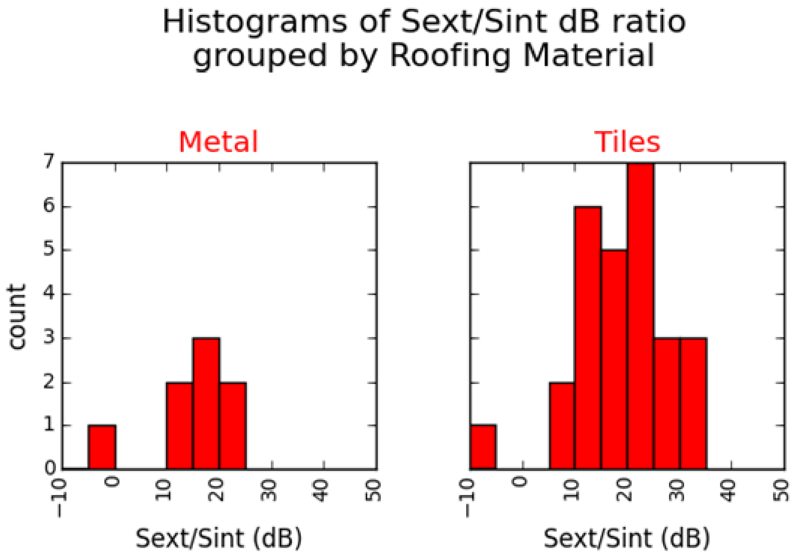
Roofing	p-values for difference in medians for Sintlim			Percentile Values					Bootstrapped 95% CI		
	Metal	**Tiles**	**ALL**	**0**	**25**	**50**	**75**	**100**	**n**	**CI (low)**	**CI (high)**
Metal	1.000	0.756	0.756	9.95E-08	2.50E-06	5.64E-05	5.03E-04	9.85E-04	8	7.16E-05	6.67E-04
Tiles	0.756	1.000	0.756	3.41E-06	7.55E-05	1.51E-04	7.60E-04	1.93E-03	27	3.03E-04	7.77E-04
ALL	0.756	0.756	0.756	9.95E-08	5.53E-05	1.46E-04	7.60E-04	1.93E-03	35	2.91E-04	6.87E-04

3) Maximum S_{ext} 6 min average as percentage of ARPANSA RPS3 GP limit (Sextlim)



Roofing	p-values for difference in medians for Sextlim			Percentile values					Bootstrapped 95% CI		
	Metal	Tiles	ALL	0	25	50	75	100	n	CI (low)	CI (high)
Metal	1.000	0.106	0.106	4.88E-06	1.60E-04	2.05E-03	1.16E-02	2.83E-01	12	4.23E-03	1.22E-01
Tiles	0.106	1.000	0.106	2.71E-04	6.99E-03	2.96E-02	5.23E-02	4.78E-01	29	2.71E-02	1.10E-01
ALL	0.106	0.106	0.106	4.88E-06	3.43E-03	1.60E-02	4.00E-02	4.78E-01	41	2.34E-02	8.49E-02

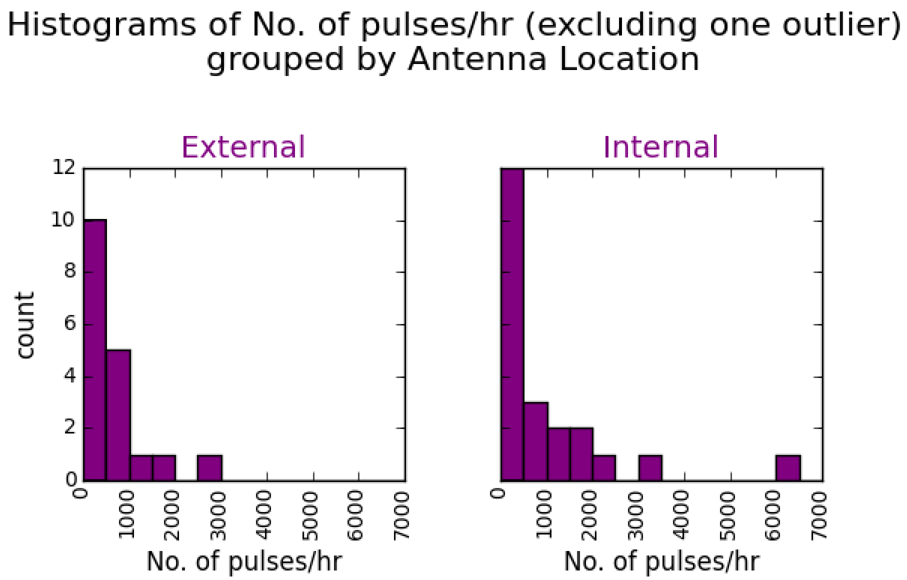
4) dB ratio of S_{ext}/S_{int} (Sratio)



Roofing	p-values for difference in medians for Sratio			Percentile Values					Bootstrapped 95% CI		
	Metal	Tiles	ALL	0	25	50	75	100	n	CI (low)	CI (high)
Metal	1.000	0.756	0.756	-2.49E+00	1.41E+01	1.74E+01	2.08E+01	2.46E+01	8	8.28E+00	2.02E+01
Tiles	0.756	1.000	0.756	-7.94E+00	1.45E+01	1.85E+01	2.40E+01	3.49E+01	27	1.55E+01	2.21E+01
ALL	0.756	0.756	0.756	-7.94E+00	1.43E+01	1.85E+01	2.40E+01	3.49E+01	35	1.53E+01	2.10E+01

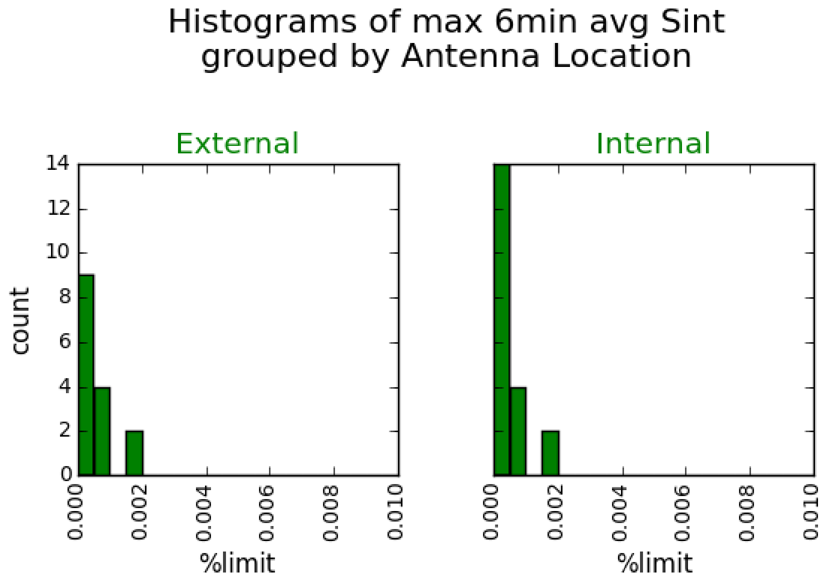
Group analysis by smart meter *antenna location with respect to smart meter box*

1) Pulses per hour



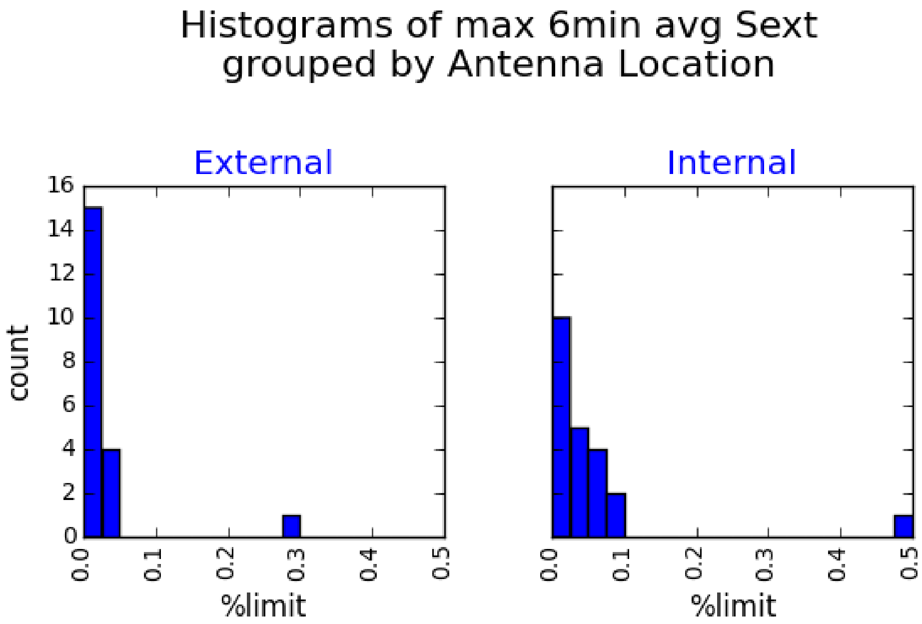
Antenna location	p-values for difference in medians for pulses/hour			Percentile Values					Bootstrapped 95% CI		
	External	**Internal**	**ALL**	**0**	**25**	**50**	**75**	**100**	**n**	**CI (low)**	**CI (high)**
External	1.000	1.000	1.000	5.23E+01	2.50E+02	4.91E+02	9.50E+02	3.90E+05	20	8.52E+02	1.04E+05
Internal	1.000	1.000	1.000	9.85E+01	2.91E+02	4.82E+02	1.37E+03	6.30E+03	22	6.67E+02	1.98E+03
ALL	1.000	1.000	1.000	5.23E+01	2.60E+02	4.82E+02	1.08E+03	3.90E+05	42	1.08E+03	5.63E+04

2) Maximum S_{int} 6 min average as percentage of ARPANSA RPS3 GP limit (Sintlim)



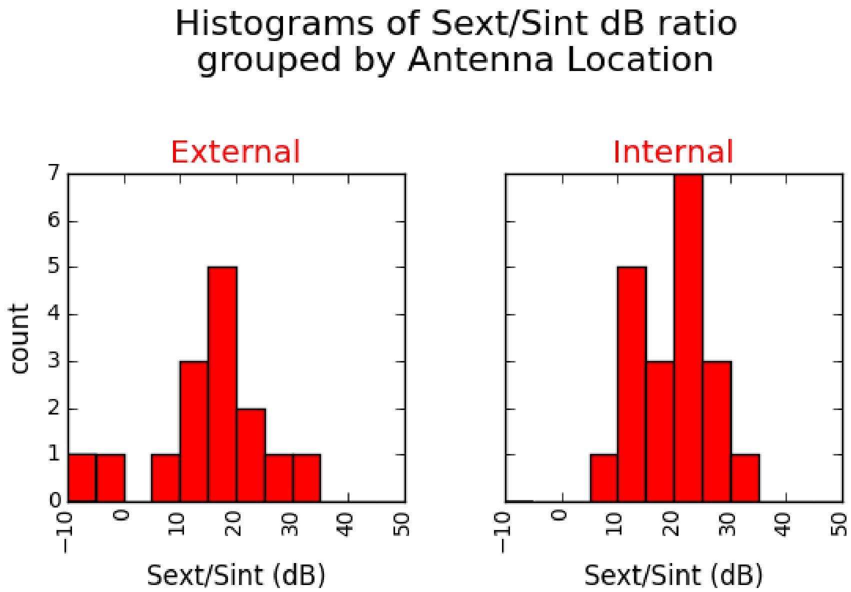
Antenna location	p-values for difference in medians for Sintlim			Percentile Values					Bootstrapped 95% CI		
	External	Internal	ALL	0	25	50	75	100	n	CI (low)	CI (high)
External	1.000	0.884	0.884	9.95E-08	4.77E-06	1.07E-04	8.79E-04	1.82E-03	15	2.29E-04	8.69E-04
Internal	0.884	1.000	0.884	1.44E-05	7.73E-05	1.49E-04	5.61E-04	1.93E-03	20	2.41E-04	7.64E-04
ALL	0.884	0.884	0.884	9.95E-08	4.25E-05	1.46E-04	7.60E-04	1.93E-03	35	2.89E-04	6.86E-04

3) Maximum S_{ext} 6 min average as percentage of ARPANSA RPS3 GP limit (Sextlim)



Antenna location	p-values for difference in medians for Sextlim			Percentile Values					Bootstrapped 95% CI		
	External	Internal	ALL	0	25	50	75	100	n	CI (low)	CI (high)
External	1.0000	0.0054**	0.0054**	4.88E-06	2.62E-04	3.81E-03	1.29E-02	2.83E-01	20	7.76E-03	8.06E-02
Internal	0.0054**	1.0000	0.0054**	2.10E-03	1.49E-02	2.90E-02	5.27E-02	4.78E-01	22	2.88E-02	1.36E-01
ALL	0.0054**	0.0054**	0.0054**	4.88E-06	3.46E-03	1.53E-02	3.84E-02	4.78E-01	42	2.22E-02	8.24E-02

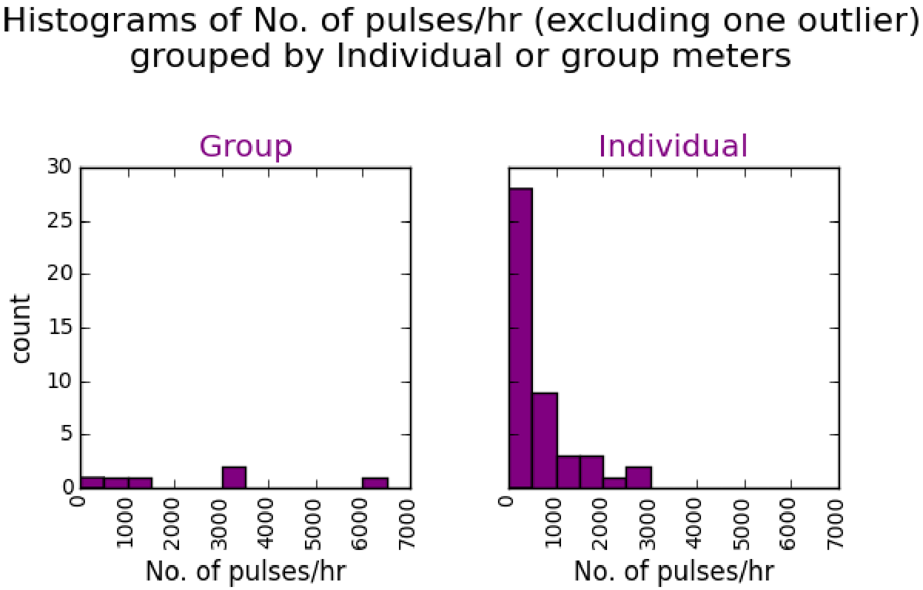
4) dB ratio of S_{ext}/S_{int} (Sratio)



Antenna location	p-values for difference in medians for Sratio			Percentile Values					Bootstrapped 95% CI		
	External	Internal	ALL	0	25	50	75	100	n	CI (low)	CI (high)
External	1.000	0.222	0.222	-7.94E+00	1.30E+01	1.79E+01	1.94E+01	3.06E+01	15	9.50E+00	1.97E+01
Internal	0.222	1.000	0.222	8.79E+00	1.48E+01	2.15E+01	2.45E+01	3.49E+01	20	1.79E+01	2.35E+01
ALL	0.222	0.222	0.222	-7.94E+00	1.43E+01	1.85E+01	2.40E+01	3.49E+01	35	1.52E+01	2.09E+01

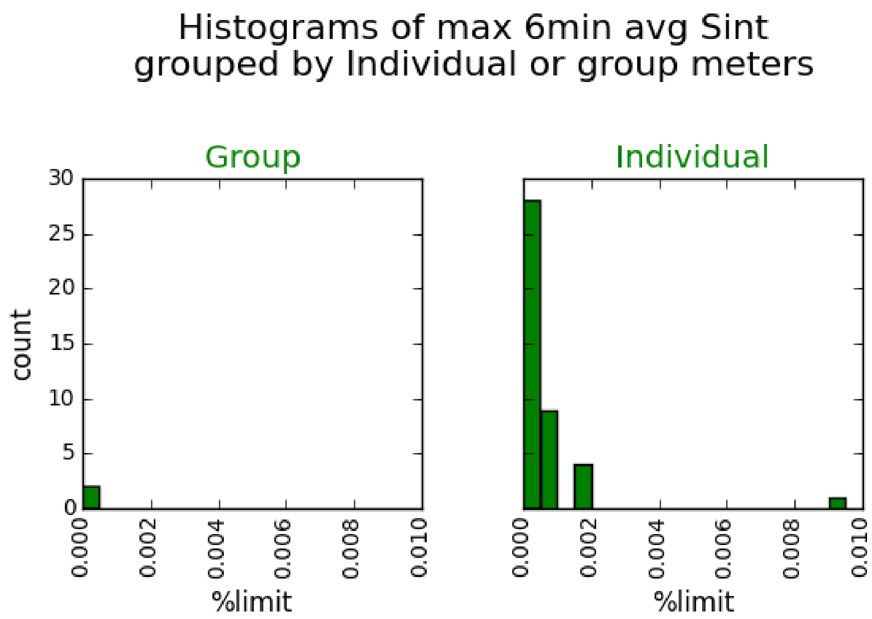
Group analysis by *clustering of smart meters (individual or grouped)*

1) Pulses per hour



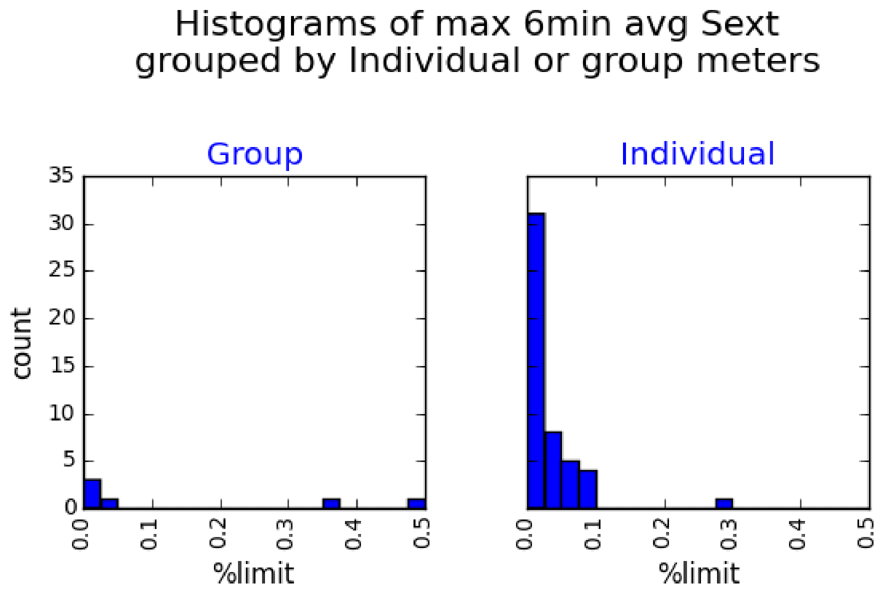
Clustering	p-values for difference in medians for pulses/hour			Percentile Values					Bootstrapped 95% CI		
	Grouped	Individual	ALL	0	25	50	75	100	n	CI (low)	CI (high)
Grouped	1.000	0.179	0.179	2.19E+02	7.75E+02	2.07E+03	3.32E+03	6.30E+03	6	1.06E+03	4.42E+03
Individual	0.179	1.000	0.179	5.23E+01	2.57E+02	4.58E+02	9.24E+02	3.90E+05	49	1.41E+03	4.88E+04
ALL	0.179	0.179	0.179	5.23E+01	2.71E+02	4.73E+02	1.10E+03	3.90E+05	55	1.52E+03	4.33E+04

2) Maximum S_{int} 6 min average as percentage of ARPANSA RPS3 GP limit (Sintlim)



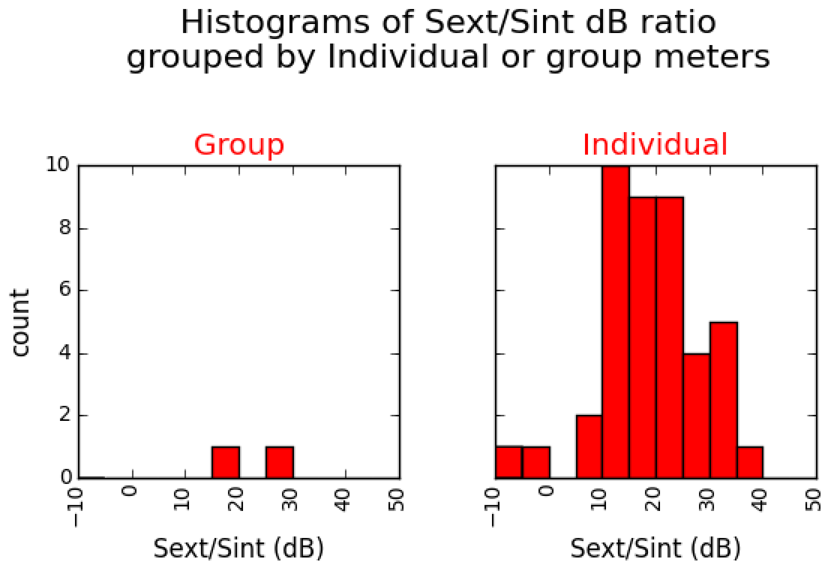
Clustering	p-values for difference in medians for Sintlim			Percentile Values					Bootstrapped 95% CI		
	Grouped	Individual	ALL	0	25	50	75	100	n	CI (low)	CI (high)
Grouped	1.000	0.469	0.469	1.03E-05	1.91E-05	2.79E-05	3.67E-05	4.55E-05	2	1.03E-05	2.79E-05
Individual	0.469	1.000	0.469	9.95E-08	1.61E-05	1.25E-04	7.68E-04	9.01E-03	42	3.46E-04	1.47E-03
ALL	0.469	0.469	0.469	9.95E-08	1.34E-05	1.06E-04	7.51E-04	9.01E-03	44	3.33E-04	1.39E-03

3) Maximum S_{ext} 6 min average as percentage of ARPANSA RPS3 GP limit (Sextlim)



Clustering	p-values for difference in medians for Sextlim			Percentile Values					Bootstrapped 95% CI		
	Grouped	Individual	ALL	0	25	50	75	100	n	CI (low)	CI (high)
Grouped	1.000	0.700	0.700	3.23E-03	7.59E-03	1.88E-02	2.71E-01	4.78E-01	6	1.14E-02	3.37E-01
Individual	0.700	1.000	0.700	4.45E-07	1.20E-03	1.14E-02	3.92E-02	2.83E-01	49	1.92E-02	4.82E-02
ALL	0.700	0.700	0.700	4.45E-07	2.59E-03	1.14E-02	3.96E-02	4.78E-01	55	2.48E-02	7.53E-02

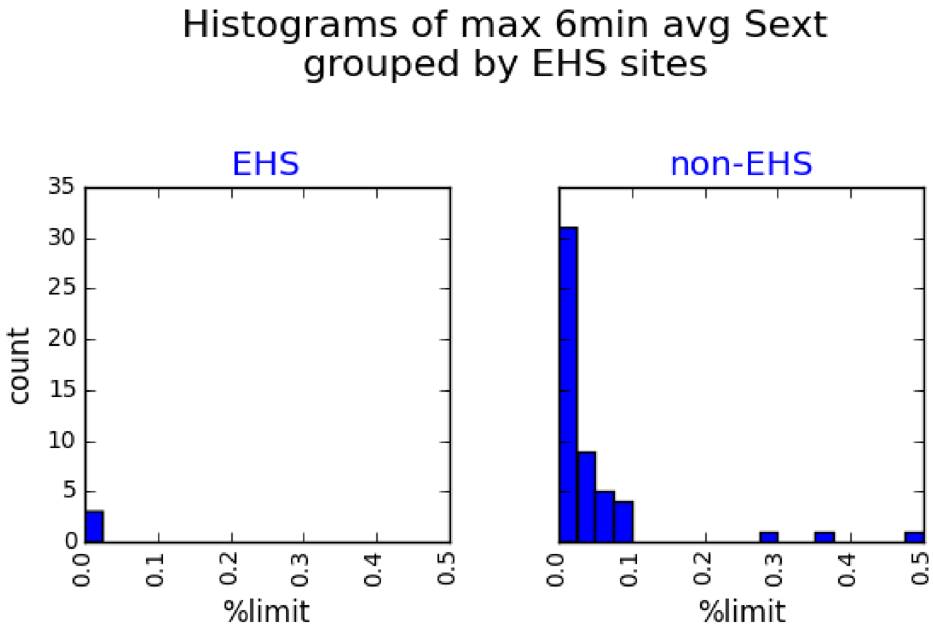
4) dB ratio of S_{ext}/S_{int} (Sratio)



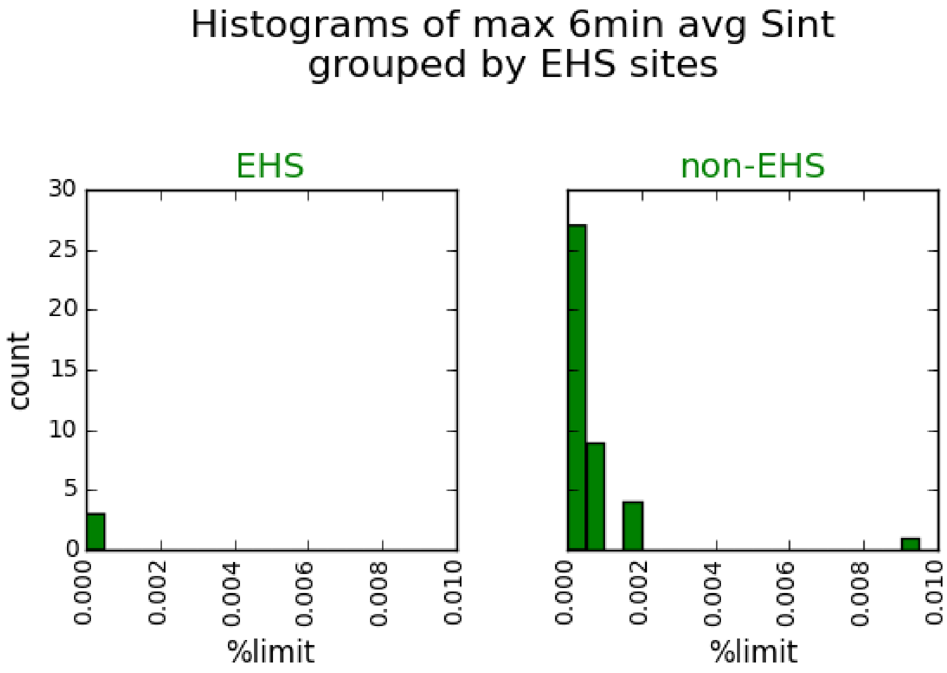
Clustering	p-values for difference in medians for Sratio			Percentile Values					Bootstrapped 95% CI		
	Grouped	Individual	ALL	0	25	50	75	100	n	CI (low)	CI (high)
Grouped	1.000	0.469	0.469	1.85E+01	2.10E+01	2.34E+01	2.59E+01	2.84E+01	2	1.85E+01	2.34E+01
Individual	0.469	1.000	0.469	-7.94E+00	1.42E+01	1.85E+01	2.46E+01	3.91E+01	42	1.64E+01	2.19E+01
ALL	0.469	0.469	0.469	-7.94E+00	1.44E+01	1.85E+01	2.47E+01	3.91E+01	44	1.66E+01	2.20E+01

Group analysis by smart meter *EHS classification*

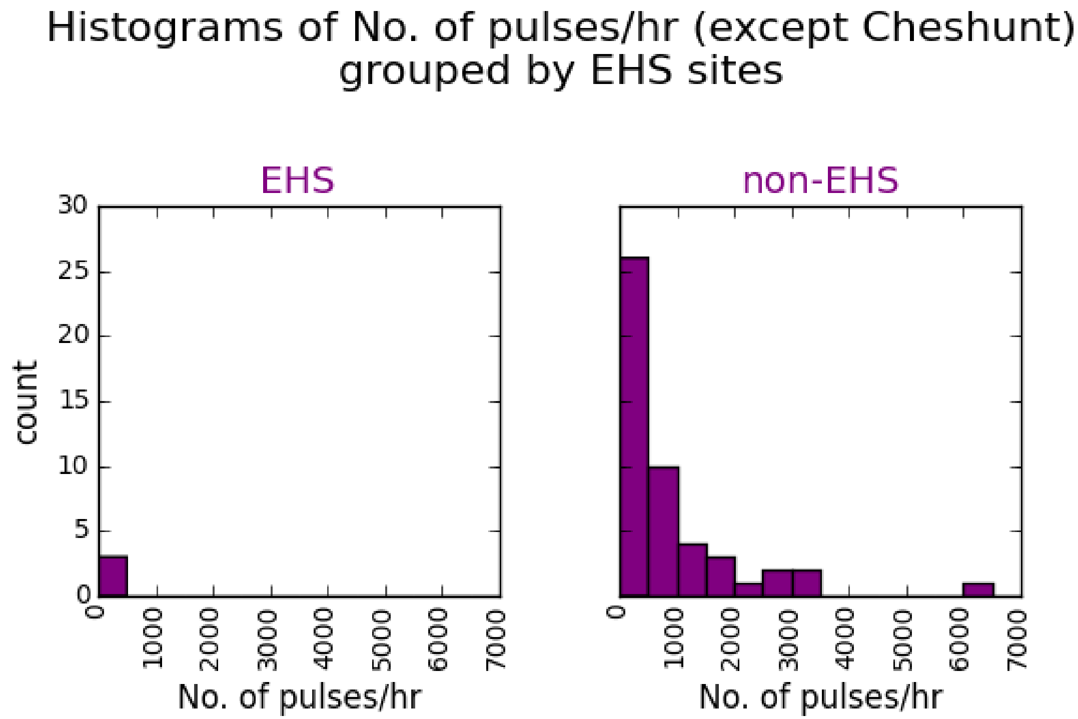
1) Maximum S_{ext} 6 min average as percentage of ARPANSA RPS3 GP limit (Sintlim)



2) Maximum S_{int} 6 min average as percentage of ARPANSA RPS3 GP limit (Sintlim)



3) Number of pulses per hour



Appendix C – Smart Meter Photos

Photo B.1 Mesh – Individual Meter Site – Internal Antenna

Photo B.2 Mesh – Group Meter Site – Internal Antenna

Photo B.3 Mesh – Individual Meter Site – External Antenna

Photo B4 WiMax – Individual Meter Site – Externally Mounted Antenna

Photo B.5 WiMax – Individual Meter Site – Internally Mounted Antenna

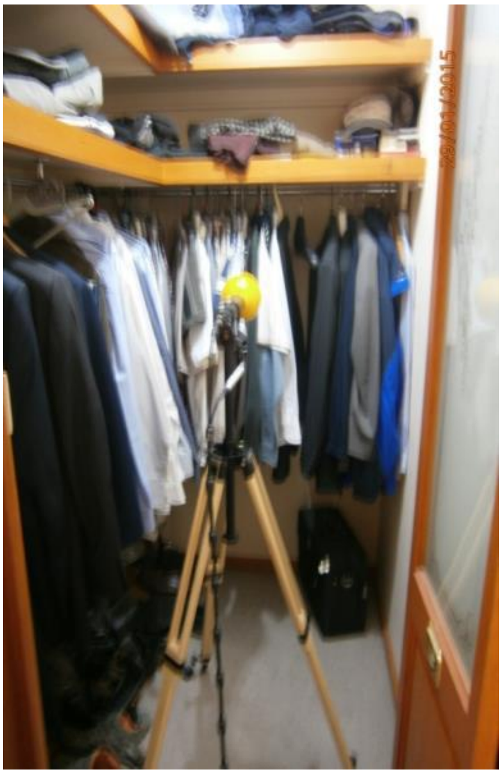
Photo B.6 WiMax – Group Meter Site - External Mounted Antennas

Photo B.7 3G – Individual Meter Site – Externally Mounted Antenna

Photo B.8 3G – Individual Meter Site – Internally Mounted Antenna

Appendix D – Sample Measurement Position Photos

Photos D.1 Mesh - Individual Meter Site– Inside Measurements



Photos D.2 Mesh - Individual Meter Site – Outside Measurements

Photo D.3 Mesh - Group Meter Site – Outside Measurements

Photo D.4 Mesh - Individual Meter Site– External Antenna Measurements

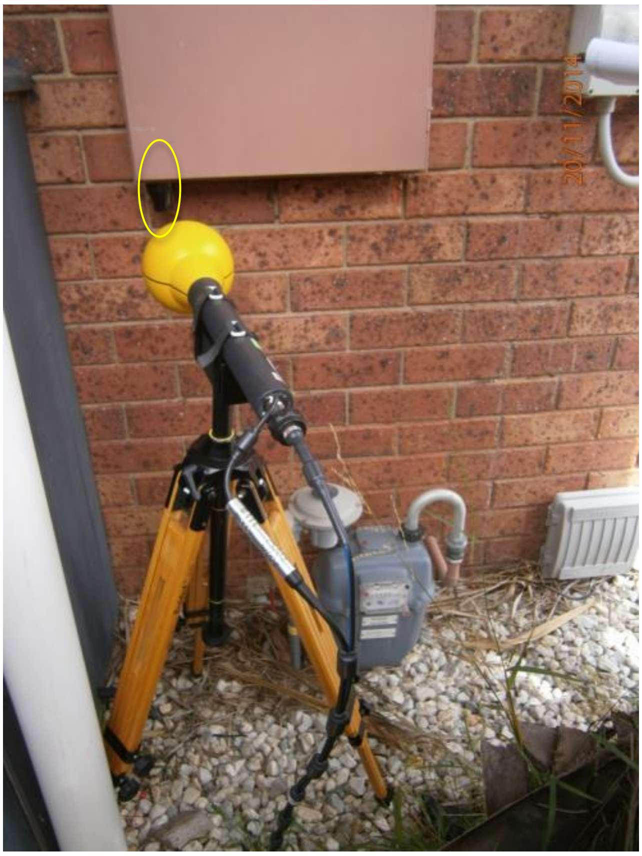


Photo D.5 WiMax - Individual Meter Site–Inside Measurements




Photo D.6 WiMax - Individual Meter Site– Outside Measurements

Photo D.7 WiMax - Group Meter Site – Outside Measurements

Photos D.8 WiMax - Individual Meter Site– Inside Measurements

Photos D.9 WiMax - Individual Meter Site– Outside Measurements

Appendix E – Site Structure Details

Site Reference	Technology	Meter Type	Distribution Business	Antenna Location	Meter Box Material	Building Cladding Material	Rooftop Material
2880-4216	Wi-Max	Individual	AusNet	External	Wood with cement sheet front	Brick veneer	Concrete Tiles
2881-4217	Wi-Max	Individual	AusNet	External	Metal	Brick	Concrete Tiles
2882-4218	Wi-Max	Individual	AusNet	External	Tin	N/A	N/A
2884-4220	Wi-Max	Individual	AusNet	External	Metal	Brick	Cement tiles
2885-4221	Wi-Max	Individual	AusNet	External	Metal	Brick	Tiles
2886-4222	Wi-Max	Individual	AusNet	External	Metal	Brick	cliplock metal.
2887-4223	Wi-Max	Individual	AusNet	External	Metal	Brick	Cement tiles
2889-4225	Wi-Max	Individual	AusNet	External	Metal	Brick	Cement tiles
2890-4226	Wi-Max	Individual	AusNet	External	Steel	Partly plank weatherboard	Zinc corrugated Iron
2891-4227	3G	Individual	AusNet	External	Wood, lined with fibrous sheet	Brick	Iron
2892-4228	3G	Individual	AusNet	External	Wood	Corrugated Iron	Corrugated Iron
2893-4229	3G	Individual	AusNet	External	Steel	Colourbond steel	Ripple iron
2895-4231	3G	Individual	AusNet	External	Metal	Corrugated sheeting	Corrugated sheeting
2896-4232	3G	Individual	AusNet	External	Metal	Brick	Colourbond
2898-4234	Wi-Max	Group	AusNet	External	Metal	Brick	Tile
2899-4235	Wi-Max	Group	AusNet	External	Metal	Brick	Cement tiles
2900-4236	Mesh	Group	CitiPower	Internal	Timber	Brick	Metal
2901-4237	Mesh	Group	Powercor	Internal	Timber	Brick	Tiles
2879-4213	Mesh	Individual	Jemena	Internal	Metal	Brick	Ceramic Tiles
2903-4239	Mesh	Individual	Jemena	Internal	Wood	Weatherboard	Ceramic Tiles
2905-4241	Mesh	Individual	Jemena	Internal	Wood	Weatherboard	Ceramic Tiles
2906-4242	Mesh	Individual	Jemena	External	Metal	Brick	Ceramic Tiles
2907-4243	Mesh	Individual	Jemena	Internal	Wood	Weatherboard	Ceramic Tiles
2908-4244	Mesh	Individual	CitiPower	Internal	Timber	Timber	Metal
2909-4245	Mesh	Individual	CitiPower	Internal	Metal	Brick	Metal
2912-4248	Mesh	Individual	CitiPower	Internal	None	Timber	Tile
2923-4259	Mesh	Individual	Powercor	External	Metal	Brick	Tile
2924-4260	Mesh	Individual	United Energy	Internal	Metal	Weatherboard	Tiled Roof
2966-4340	Mesh	Individual	United Energy	Internal	Metal	Brick Veneer	Concrete Tiles
2925-4261	Mesh	Individual	United Energy	Internal	Metal with Solar Panel	Brick Veneer	Terra Cota Tiles
2926-4262	Mesh	Individual	United Energy	Internal	Metal	Brick Veneer	Concrete Tiles
2927-4263	Mesh	Individual	United Energy	Internal	Wooden meter box	Brick veneer	Tiles Roof
2928-4264	Mesh	Individual	United Energy	Internal	Metal	Hardy Plank	Corrugated Iron Roof
2929-4265	Mesh	Individual	United Energy	External	Metal	Brick Veneer	Tiled Roof
2930-4266	Mesh	Individual	United Energy	Internal	Metal	Brick Veneer	Tiled Roof
2949-4301	Mesh	Individual	United Energy	Internal	No Meter Box	Weatherboard	Tiled Roof

2969-4343	Mesh	Individual	United Energy	Internal	Metal	Brick Veneer	Tiled Roof
2970-4344	Mesh	Group	Jemena	Internal	Metal	N/A	N/A
2968-4342	WiMax	Individual	AusNet	External	Wood	Brick veneer	Colourbond steel
2948-4300	Mesh	Individual	United Energy	Internal	Wood	Weatherboard	Tiles
2947-4299	Mesh	Individual	United Energy	Internal	Wood	Weatherboard	Tiles
2971-4347	Mesh	Individual	United Energy	Internal	Metal	Brick	Tiles
2976-4362	Wi-Max	Individual	AusNet	External	Wood	Brick	Steel Decking
2978-4367	Mesh	Individual	Powercor	Internal	Metal	Brick	Tile
2979-4368	Mesh	Individual	Powercor	Internal	Metal	Brick	Tile
2980-4369	Mesh	Individual	Powercor	Internal	Metal	Brick	Tile
2981-4370	Mesh	Individual	CitiPower	Internal	Metal	Brick	Tile
2985-4375	3G	Individual	AusNet	External	Metal	Brick	Colourbond
2986-4377	Mesh	Individual	Jemena	Internal	Metal	Brick	Tile
2993-4386	Mesh	Individual	Powercor	Internal	Metal	Brick	Tile
2994-4389	Wi-Max	Group	AusNet	External	Metal	N/A	N/A
2995-4390	Wi-Max	Individual	AusNet	External	Wood	Brick Veneer	Tile
2988-4381	Wi-Max	Individual	AusNet	External	Wood	Brick	Tile
2989-4382	Wi-Max	Individual	AusNet	External	Metal	Weatherboard	Ripple iron
2991-4384	Mesh	Individual	United Energy	Internal	Metal	Brick	Tile

Appendix F – Regulatory Exposure Limits

The Australian Radiation Protection and Nuclear Safety Agency (ARPANSA), an agency of the Commonwealth Department of Health has established a Radiation Protection Standard – Maximum Exposure Levels to Radiofrequency Fields – 3 kHz to 300 GHz (RPS3) specifying limits for continuous exposure to RF EME transmissions (Table 1). Further information can be gained from the ARPANSA web site at http://www.arpansa.gov.au .

The Australian Communications and Media Authority (ACMA) mandates exposure limits for continuous exposure of the general public to RF EME from telecommunications sources. Further information can be found at the ACMA website at http://www.acma.gov.au.

Table F.1 Reference Levels for Time Averaged Exposure to RMS Electric and Magnetic Fields (Unperturbed Fields) (ARPANSA)

Exposure Category	Frequency Range	E-Field Strength (V/m rms)	H-Field Strength (A/m rms)	Power Flux Density (W/m^2)
Non-Occupational (General Public)	100 kHz – 150 kHz	86.8	4.86	N/A
	150 kHz – 1 MHz	86.8	0.729/f	N/A
	1 MHz – 10 MHz	86.8 / $f^{0.5}$	0.729/f	N/A
	10MHz – 400 MHz	27.4	0.0729	2
	400 MHz – 2 GHz	1.37 x $f^{0.5}$	0.00364 x $f^{0.5}$	f / 200
	2 GHz – 300 GHz	61.4	0.163	10

Table F.2 Reference Levels for Exposure to Instantaneous RMS Electric and Magnetic Fields (Unperturbed Fields) (ARPANSA)

Exposure Category	Frequency Range	E-Field Strength (V/m rms)	H-Field Strength (A/m rms)	Power Flux Density (W/m^2)
Non-Occupational (General Public)	3 kHz – 100 kHz	86.8	4.86	-
	100 kHz – 150 kHz	488 / $f^{0.75}$	4.86	-
	150 kHz – 1 MHz	488 / $f^{0.75}$	3.47 x $f^{0.178}$	-
	1 MHz – 10 MHz	488 / $f^{0.25}$	3.47 x $f^{0.178}$	-
	10 MHz – 400 MHz	868	2.30	2 000
	400 MHz – 2 GHz	43.4 x $f^{0.5}$	0.00364 x $f^{0.5}$	5 x f
	2 GHz – 300 GHz	1941	0.163	10 000

NOTES:

1. f is frequency in MHz
2. For frequencies between 100 kHz and 10 GHz, S_{eq}, E^2, and H^2, must be averaged over any six minute period

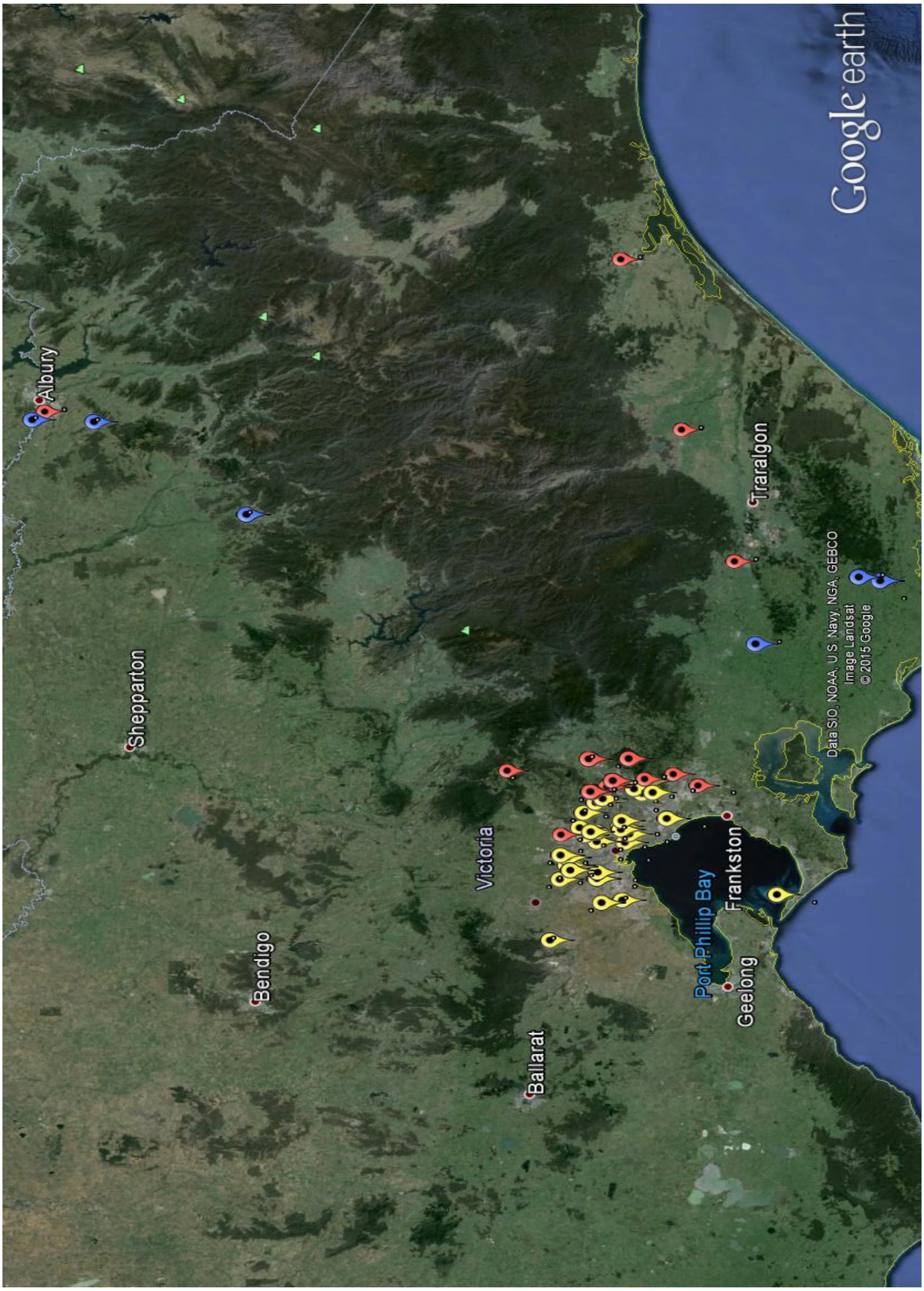
A recent review of the of the research completed since the establishment of this standard "Radiofrequency Health Effects Research – Scientific Literature 2000 – 2012" – Technical Report 164 , ARPANSA, March 2014 found that:

" since the preparation of RPS3 there have been significant advances in the science. Based on the assessment of the scientific evidence from January 2000 till August 2012, the Expert Panel find that the underlying basis of the ARPANSA RF exposure Standard remains sound and that the exposure limits in the Standard continue to provide a high degree of protection against the known health effects of RF electromagnetic fields."

http://www.arpansa.gov.au/pubs/technicalreports/tr164.doc.

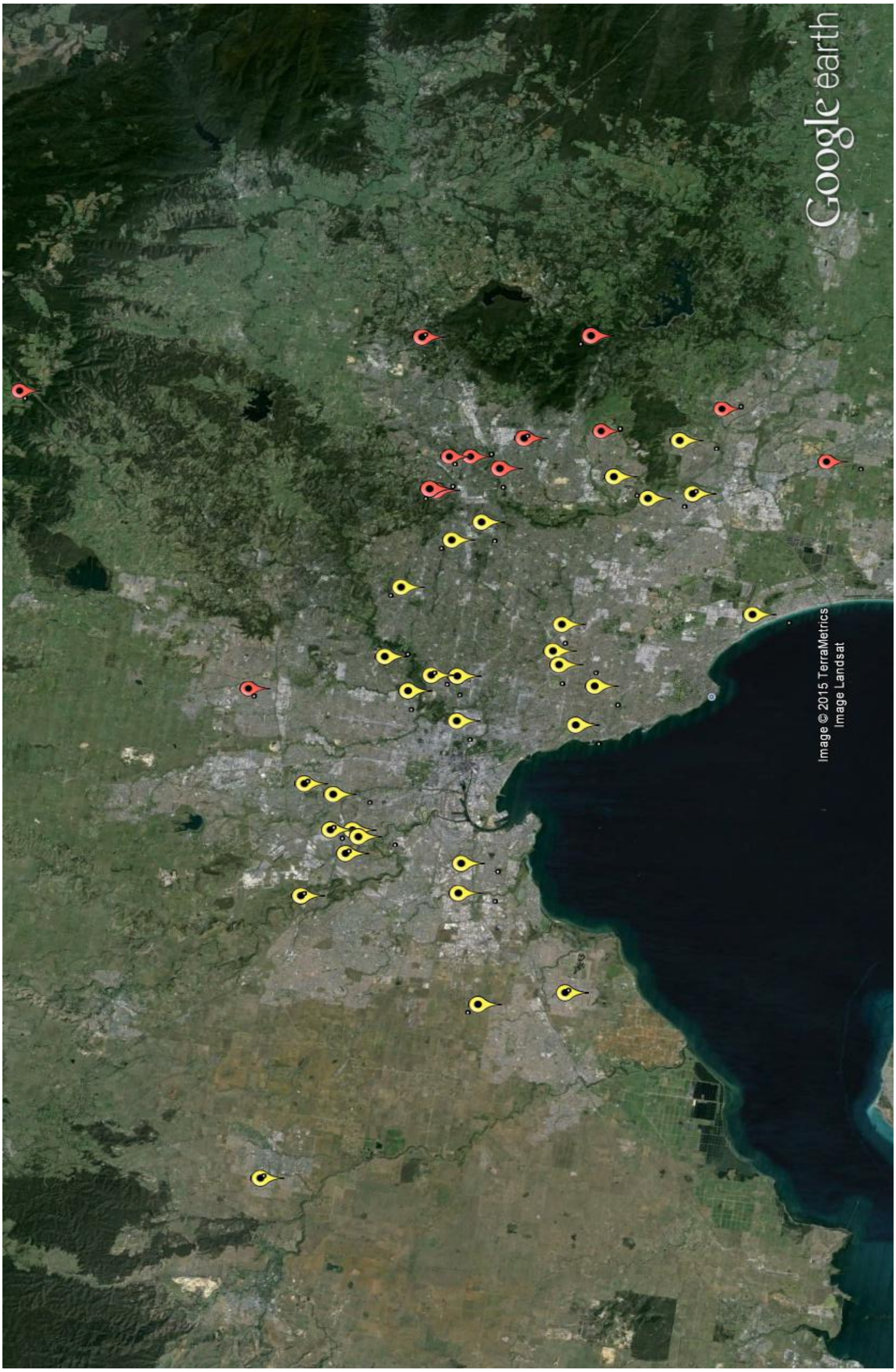
Appendix G – Coverage Maps of Study

Map G.1 – State Overview



Map Legend - Yellow – Mesh Red – WiMax Blue - 3G

Map G.2 – Melbourne Overview



Map Legend - Yellow – Mesh Red – WiMax

Appendix H – Probe Measurement Position Details

Site Reference	Inside Measurements		Outside Measurements	
	Distance from Wall (cm)	Probe Alignment	Distance from Meter/Antenna (cm)	Probe Alignment
2880-4216	30	Behind	30	In Front
2881-4217	45	Above Bed	54	In Front
2882-4218	N/M	N/M	30	Off Centre
2884-4220	30	Behind	30	Off Centre
2885-4221	103	Beyond TV	30	Off Centre
2886-4222	72	Behind	30	In Front
2887-4223	40 cm from Bookcase	Beyond Bookcase	30	Off Centre
2889-4225	N/M	N/M	30	Off Centre
2890-4226	N/M	N/M	35	Off Centre
2891-4227	55	Above Bed	30	In Front
2892-4228	N/M	N/M	30	Off Centre
2893-4229	30	Behind	30	In Front
2895-4231	N/M	N/M	30	Off Centre
2896-4232	30	Behind	30	Off Centre
2898-4234	30	Behind	30	Off Centre
2899-4235	30	Behind	30	Off Centre
2900-4236	N/M	N/M	30	In Front of One Meter
2901-4237	N/M	N/M	30	In Front of One Meter
2879-4213	30	Behind	30	In Front
2903-4239	65	Behind	30	In Front
2905-4241	30	Behind	30	In Front
2906-4242	30	Behind	30	In Front
2907-4243	30	Behind	30	In Front
2908-4244	30	Behind	30	In Front
2909-4245	30	Behind	30	In Front
2912-4248	30	Behind	30	In Front
2923-4259	30	Behind	30	In Front
2924-4260	30	Behind	30	In Front
2966-4340	30	Behind	30	In Front
2925-4261	30	Behind	30	In Front

2926-4262	30	Behind	30	In Front
2927-4263	102.5	Beyond Cupboard	30	In Front
2928-4264	30	Behind	30	In Front
2929-4265	30	Behind	30	In Front
2930-4266	30	Behind	30	In Front
2949-4301	30	Behind	30	In Front
2969-4343	30	Behind	30	In Front
2970-4344	N/M	N/M	30	In Front of One Meter
2968-4342	30	Behind	65	Off Centre
2948-4300	30	Behind	30	In Front
2947-4299	30	Behind	30	In Front
2971-4347	30	Behind	30	In Front
2976-4362	N/M	N/M	30	Off Centre
2978-4367	30	Behind	30	Off Centre
2979-4368	30	Above Bed	30	In Front
2980-4369	30	Behind	30	In Front
2981-4370	30	Behind	30	In Front
2985-4375	N/M	N/M	30	In Front
2986-4377	30	Behind	30	In Front
2993-4386	82	Beyond Clothes	30	In Front
2994-4389	N/M	N/M	30	In Front
2995-4390	30	Behind	30	In Front
2988-4381	70	Behind	30	In Front
2989-4382	30	Behind	30	In Front
2991-4384	40 cm from Cupboard	Beyond Cupboard	30	In Front

Notes:

1. N/M – RF EME Levels not measured due to practical reasons – i.e. No location to measure at or measurement location inaccessible.
2. In front – probe is directly in front of the meter (Mesh) or antenna (WiMax or 3G).
3. Behind – probe is directly behind meter/antenna location on other side of wall.
4. Off centre – probe is located off to one side of antenna.
5. Above bed – probe is placed above the bed at the position most likely to be occupied by the head.
6. For smart meters with internal antennas, the inside measurements were conducted with the meter box door closed and outside measurements were conducted with the meter box door open.
7. For smart meters with external antennas the inside measurements were conducted with the meter box door closed and outside measurements were conducted with the meter box door closed unless otherwise specified.
8. No corrections were made when the measurement was not 30cm from the wall.

Appendix I – Traffic Profile Monitoring Detailed Results

Site Reference	Technology	Polling Period (Hours)	Pulses per hour (Average)	Highest 6 minute Duty Cycle (%)
2891-4227	3G	6	252	1.4%
2892-4228	3G	6	1030	1.6%
2893-4229	3G	6	176,201	79%
2895-4231	3G	6	129	1.7%
2896-4232	3G	6	896	2.1%
2985-4375	3G	6	794	1.8%
2879-4213	mesh	4	225	0.22%
2900-4236	mesh	4	3043	0.53%
2901-4237	mesh	4	6324	1.7%
2903-4239	mesh	4	239	0.24%
2905-4241	mesh	4	1942	0.46%
2906-4242	mesh	4	323	0.23%
2907-4243	mesh	4	98	0.17%
2908-4244	mesh	4	504	0.21%
2909-4245	mesh	4	470	0.24%
2912-4248	mesh	4	2431	0.83%
2923-4259	mesh	4	168	0.21%
2924-4260	mesh	4	187	0.16%
2925-4261	mesh	4	748	0.40%
2926-4262	mesh	4	286	0.06%
2927-4263	mesh	4	885	0.38%
2928-4264	mesh	4	173	0.17%
2929-4265	mesh	4	2599	0.56%
2930-4266	mesh	4	495	0.51%
2947-4299	mesh	4	15,396	2.3%
2948-4300	mesh	4	587	0.28%
2949-4301	mesh	4	331	0.20%
2966-4340	mesh	4	1801	0.13%
2969-4343	mesh	4	7298	0.13%
2970-4344	mesh	4	3421	1.8%
2971-4347	mesh	4	2728	0.26%
2978-4367	mesh	4	3706	0.24%
2979-4368	mesh	4	309	0.27%
2980-4369	mesh	4	397	0.06%
2981-4370	mesh	4	1104	0.45%
2986-4377	mesh	4	122	0.05%
2991-4384	mesh	4	321	0.28%
2993-4386	mesh	4	424	0.05%
2880-4216	wimax	6	926	0.58%

2881-4217	wimax	6	458	0.05%
2882-4218	wimax	6	66092	6.5%
2884-4220	wimax	6	439	0.06%
2885-4221	wimax	6	52	0.22%
2886-4222	wimax	6	243	0.03%
2887-4223	wimax	6	1942	0.2%
2889-4225	wimax	6	750	0.35%
2890-4226	wimax	6	307	0.07%
2898-4234	wimax	6	688	0.28%
2899-4235	wimax	6	218	0.04%
2968-4342	wimax	6	619	0.15%
2976-4362	wimax	6	215	0.04%
2988-4381	wimax	6	501	0.06%
2989-4382	wimax	6	288	0.03%
2994-4389	wimax	6	1100	0.08%
2995-4390	wimax	6	310	0.03%

Notes:

1. Maximum 6 minute Duty Cycle – The duty cycle for the 6 minute period with the highest smart meter transmission time across the duration of the monitored polling period (4 or 6 hours).
2. The value of the duty cycle is dependent on the length and number of pulses in the nominated time period.
3. The traffic profile monitoring system was verified using signals generated by a pulse generator.

Appendix J – Measurement Equipment Details

RF EME Levels

Measurement Equipment (Set 1 and 3) - NARDA SRM-3006 Selective Radiation Meter with an E-field (27 MHz to 3 GHz) probe and 5m RF-Cable (9 kHz – 6 GHz) – Smart meter and BGE RF EME.

Measurement Equipment(Set 2) - NARDA SRM-3006 Selective Radiation Meter with an E-field (420 MHz to 6 GHz) probe and 1.5m RF-Cable (9 kHz – 6 GHz) – Smart meter RF EME and NARDA SRM-3000 Selective Radiation Meter with an E-field (27 MHz to 3 GHz) probe and 1.5m RF-Cable (9 kHz – 6 GHz) – BGE RF EME.

- NARDA SRM-3006 Selective Radiation Meter (Set 1 and Set 3)
  Frequency Range 100 kHz – 6 GHz
  Model Number 3006/01
  Serial Number C-0003
  Calibration Verified – 14-10-2014
- NARDA 3-Axis, E-field Antenna (Set 1)
  Frequency Range 420 MHz – 6 GHz
  Model Number 3502/01
  Serial Number AE-0070
  Calibration Verified – 14-10-2014

- NARDA RF-Cable SRM, Length 1.5m, 50 Ohms (Set 1)
  Frequency Range 9 kHz – 6 GHz
  Model Number 3602/01
  Serial Number AA-0057
  Calibration Verified – 14-10-2014

- NARDA SRM-3000 Selective Radiation Meter (Set 1)
  Frequency Range 100 kHz – 3 GHz
  Model Number 3000/01
  Serial Number J-0039
  Calibration Verified – 13-10-2014

- NARDA 3-Axis, E-field Antenna (Set 1)
  Frequency Range 27 MHz – 3 GHz
  Model Number 3501/01
  Serial Number H-0009
  Calibration Verified – 13-10-2014

- NARDA RF-Cable SRM, Length 5m, 50 Ohms (Set 1)
  Frequency Range 9 kHz – 6 GHz
  Model Number 3602/02

Serial Number AB-0018
Calibration Verified – 13-10-2014

- NARDA SRM-3006 Selective Radiation Meter (Set 2)
  Frequency Range 9 kHz – 6 GHz
  Model Number 3006/107
  Serial Number K-0092
  Calibration – 5-11-2014

- NARDA 3-Axis, E-field Antenna (Set 2 and 3)
  Frequency Range 24 MHz – 3 GHz
  Model Number 3501/03
  Serial Number K-1128
  Calibration – 28-10-2014

- NARDA RF-Cable SRM, Length 5m, 50 Ohms (Set 2 and 3)
  Frequency Range 9 kHz – 6 GHz
  Model Number 3602/02
  Serial Number AC-0135
  Calibration – 03-11-2014

Traffic Profile Monitoring System

Antenna

Co-axial Cable

Co-axial Diode Detector

Signal Amplifier

Digital Storage Oscilloscope

ACER Linx Chromebook

Appendix K - Information Sources

ARPANSA. EME Series Facts Sheets and supporting information.
http://www.arpansa.gov.au/eme/index.cfm

ARPANSA RPS 3. Radiation Protection Standard for Maximum Exposure Levels to Radiofrequency Fields - 3 kHz to 300 GHz (2002).
http://www.arpansa.gov.au/Publications/Codes/rps3.cfm

Department of Primary Industries, Victoria.
http://www.dpi.vic.gov.au/smart-meters/about-smart-meters

EMC Technologies (2012) "AMI Meter Electromagnetic Field Survey. Final Report.". Prepared for Department of Primary Industries by EMC Technologies Pty Ltd. Melbourne. Document Number: M110736 (October 2011)]

EMF Explained Series. (Information about Wireless Technologies)
http://www.emfexplained.info/?ID=25216

EPECentre, "Health and Safety Aspects of Electricity Smart Meters",
http://www.epecentre.ac.nz/docs/media/Arc_Full_Final_01.pdf
http://en.wikipedia.org/wiki/Non-ionizing_radiation

EPRI, "Characterization of Radio Frequency Emissions From Two Models of Wireless Smart Meters", Report no. 1021829, December 2011,
http://my.epri.com/portal/server.pt?Abstract_id=000000000001021829

EPRI, "Radio-Frequency Exposure Levels from Smart Meters: A Case Study of One Model", Report no.1022270, February 2011,
http://my.epri.com/portal/server.pt?Abstract_id=000000000001022270

Health Protection Agency (UK). Information on Smart Meters.
http://www.hpa.org.uk/Topics/Radiation/UnderstandingRadiation/UnderstandingRadiationTopics/ElectromagneticFields/SmartMeters/

Sense about Science 2008 Making Sense of Radiation. A Guide to Radiation and its Health Effects. London, Sense about Science.
http://www.senseaboutscience.org/resources.php/8/making-sense-of-radiation

World Health Organisation, Geneva. International EMF Project.
http://www.who.int/peh-emf/publications/en/