24 February 2014

Measurement and verification of energy savings within the Energy Efficiency for Small Business Program

energetics

In the business of climate change

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Prepared by Energetics for the Office of Environment and Heritage.

Published by:

Office of Environment and Heritage

59 Goulburn Street, Sydney NSW 2000

PO Box A290, Sydney South NSW 1232

Phone: (02) 9995 5000 (switchboard)

Phone: 131 555 (environment information and publications requests)

Phone: 1300 361 967 (national parks, general environmental enquiries, and publications requests)

Fax: (02) 9995 5999

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ISBN 978 1 74359 397 4

OEH 2014/0079

February 2014

Table of Contents

Introduction

1. Energy Efficiency for Small Business Program

The $15million Energy Efficiency for Small Business Program (EESBP) was developed for businesses that have an energy use of up to about $20,000 (up to160MWh per annum) or have the equivalent of up to around 10 full time staff.

The EESBP was launched in February 2009 and to date over 16,500 businesses have registered to the program. The EESBP provides a participating business with a customised energy assessment that identifies where electricity is being used, and a tailored action plan with electricity and cost saving recommendations.

Businesses that implement energy saving recommendations with greater than a 2 year payback period have access to financial assistance that covers half the cost of implementing measures that improve the energy efficiency of:

- lighting, including skylights
- heating, ventilation and air-conditioning, including insulation
- motors
- air compressors
- commercial refrigeration
- boilers
- hot water systems
- insulation

The maximum financial assistance available for each business is:

- $2,000 for businesses that use up to $5,000 on electricity per annum. This is considered a “small business” for the purposes of the program, OR
- $5,000 for businesses that use between $5,000 and $20,000 on electricity per annum. This is considered a “medium sized business” for the purposes of the program.

Businesses also receive up to 4 hours free support to coordinate the installation of energy efficient technologies and equipment. This includes obtaining quotes, managing the installation and completing the necessary paperwork to apply for the subsidised payment.

2. Background to this evaluation

In early 2009, as part of the ongoing monitoring and evaluation of the EESBP, an Evaluation Framework was developed to measure the short and long term outcomes of the program. Among a range or outcomes to be measured (e.g. market transformation) is the actual energy savings.

A general approach to confirming energy savings is envisaged as follows:

1. Using billing data to confirm that:
    a. DEP is working with Energy Providers (e.g. Ausgrid, Essential Energy) in extracting billing data, with a customer list provided by EESBP.
    b. DEP was provided with first batch of hairdressers downlight retrofit data and are keen to monitor the progress and outcomes of this project
2. Measurement & Verification:
    a. DEP is exploring the feasibility of using Measurement & Verification (M&V) to confirm energy savings from EESBP, as an alternative to the billing data.

3. Project scope

The Business Partnerships and Climate Change Air and Noise sections of the NSW Office of Environment and Heritage (OEH) has engaged Energetics to:

1. Conduct a preliminary billing data analysis using meter information obtained from Energy Providers (Ausgrid and Essential Energy) to confirm energy and bill savings achieved by the Energy Efficiency for Small Business Program (EESBP). In the process develop an approach to future data collection and verification for Small businesses which is cost-effective, operable and robust enough to ensure the long term viability of energy savings verification for this sector.
2. Analyse the abovementioned information in conjunction with existing OEH Small Business Data sets to develop a methodology/s that meet the Independent Pricing & Regulator Tribunals (IPART) requirements to claim Energy Savings Certificates (ESC's) under the Energy Savings Scheme (ESS).

Energetics' engagement with OEH relates to item 1 above which is the subject of this report.

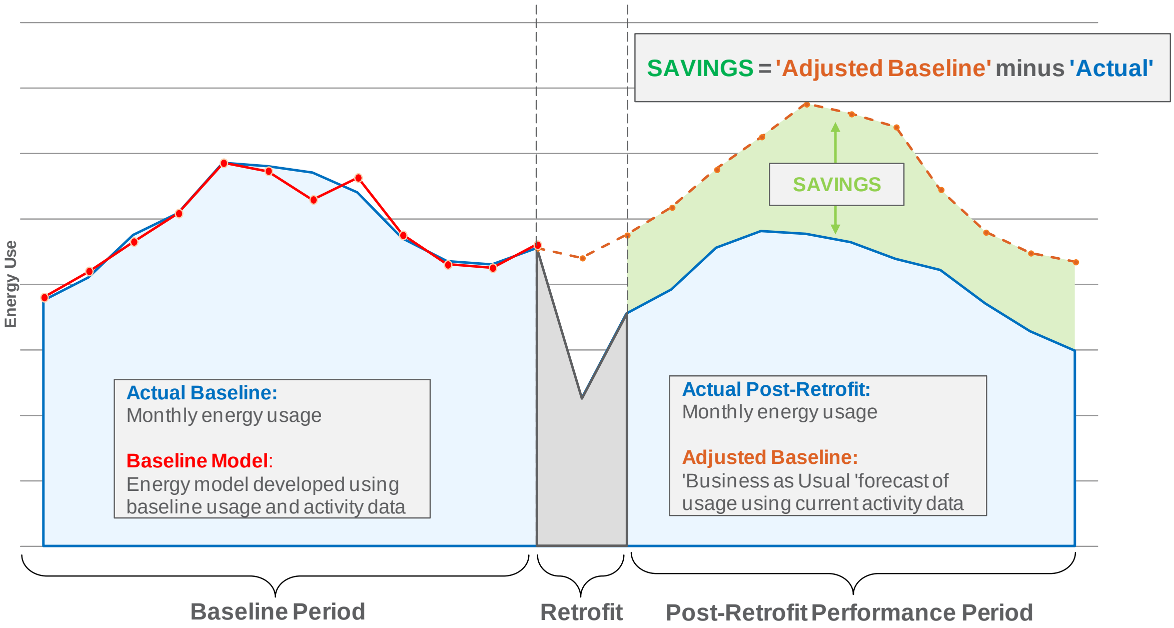
Proposed methodology and tasks

4. Overall approach

Energetics has applied the formal techniques described within the International Performance Measurement and Verification Protocol (IPMVP) to conduct energy and peak load savings analysis for the EESBP population. Broadly, the methodology is described by a savings calculation whereby:

$$\textit{Savings} \quad = \quad \textit{Baseline Usage} \pm \textit{Adjustments} - \textit{Actual Usage}$$

The intended approach involves two periods of activity as shown in the chart below.



Prior to project implementation:

1. A period of time prior to the project implementation is selected and measured – this is called the 'baseline period'.
2. During the baseline period, data is also collected for 'independent variables', which are parameters that change on a regular basis, and have a direct effect on baseline energy usage patterns. Examples of such variables include changes in weather.
3. A model is developed to describe the relationship between energy use, and the independent variables affecting energy use.

Once the project has been implemented:

4. A suitable period of data is once again selected and measured. This is called the 'post-retrofit' performance period.
5. Data is also collected for the same independent variables for the post-retrofit period.

6. Like-for-like energy use is then determined by using the developed baseline energy model with the post-retrofit data for independent variables to forecast the 'business as usual' energy usage. This is called the 'adjusted baseline'.

7. Finally, savings are determined by subtracting the measured actual usage from the adjusted baseline.

The ability to create an 'Adjusted Baseline' is a critical step in which an energy model is developed to describe energy use in relation to the variables that influence usage. The model is then used to forecast energy use over the same time period as the Actual usage. This process is described in the diagram below:

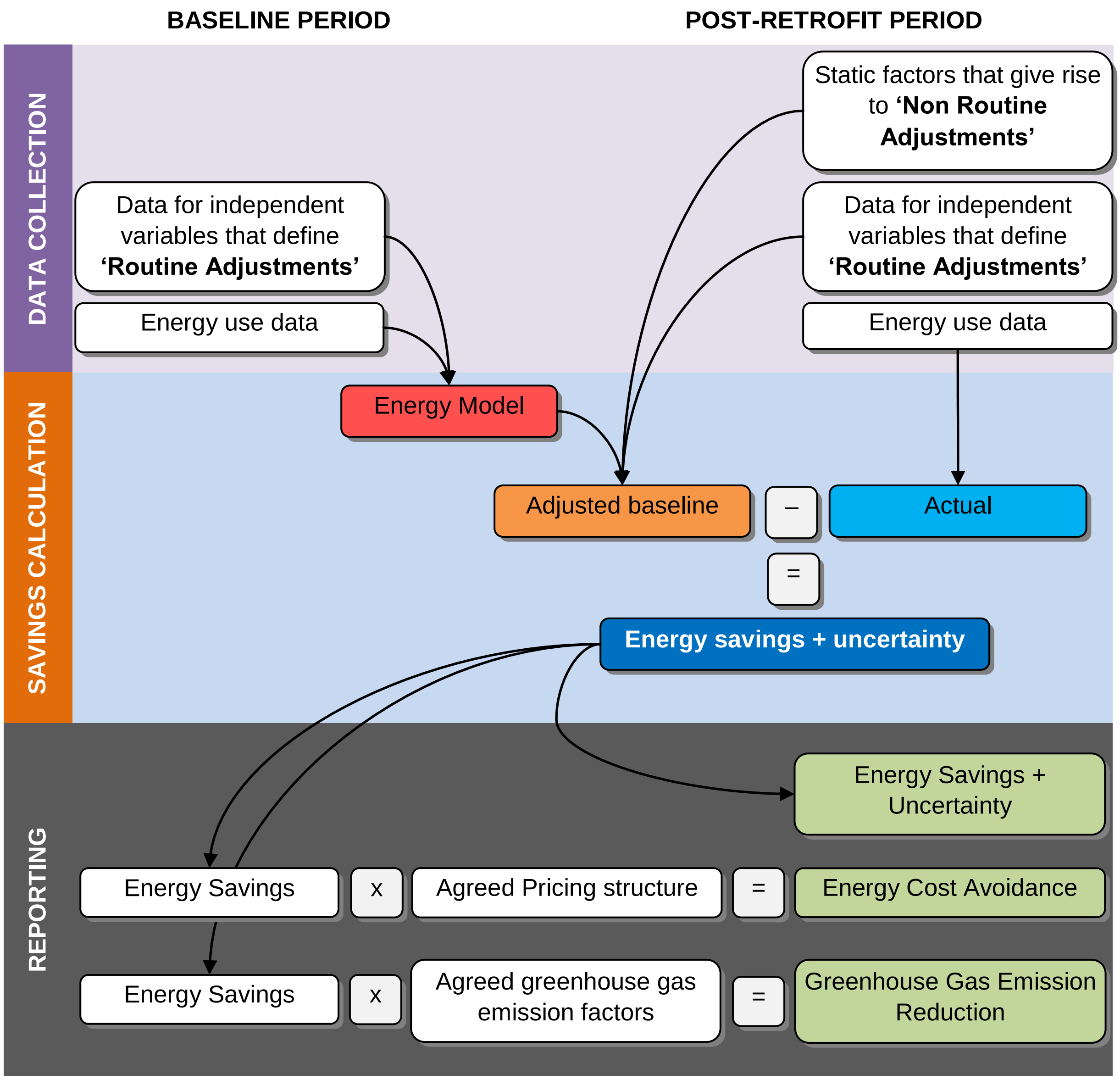


Figure 1: General M&V savings equation

5. Energy model

Regression analysis is one of a number of techniques for developing an energy model. It is a valuable technique for developing a model based on historical energy use and data for independent variables such as weather or production output.

An example energy model is shown in the chart below, in which changes in monthly energy use are evaluated against heating and cooling degree days, which are proxies for changes in ambient temperature.

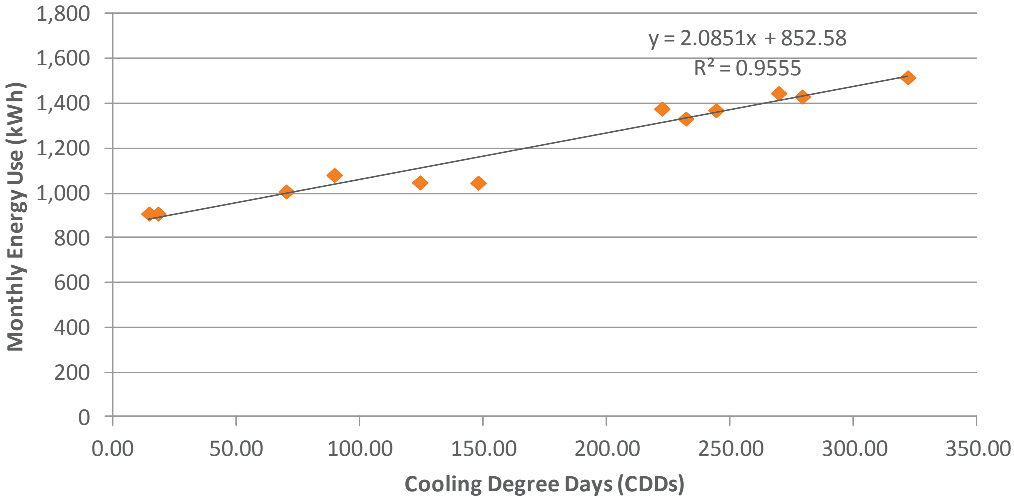


Figure 2: Example regression-based energy model

Successful energy models are used to provide a reliable prediction of energy use and are used to create a like-for-like comparison for determining savings.

Models rely on the following elements:

1. Accurate historical data for energy use to establish the baseline
2. Understanding and data related to independent variables which affect energy use. These are either static changes (e.g. plant/building changes) or changes that routinely occur (e.g. changing weather patterns, rainfall, production output), and
3. A defined measurement boundary to which the model relates.

5.1. IPMVP Option C

The IPMVP describes four generic approaches for conducting measurement and verification of savings. Option C is known as the 'Whole Building' method. This method relies on regression analysis of energy use against routine variables. The measurement boundary is defined as the 'whole facility' and energy use data is derived from available utility data.

A key advantage of using Option C is that historical utility data is readily available which covers the baseline and post-retrofit periods. This avoids the need for temporary metering. IPMVP Option C has been used for this project.

A key limitation of IPMVP Option C is that in order to apply this approach, anticipated site savings should be greater than or equal to 10% of baseline energy use.

Measurement and Verification Plan

6. Overview

This section outlines a Measurement and Verification (M&V) Plan that Energetics has implemented in order to measure and verify electricity savings associated with implemented energy savings projects at sites within the Energy Efficiency for Small Business Program.

This plan applies the formal techniques described within the International Performance Measurement and Verification Protocol (IPMVP) which is the defacto international standard for M&V techniques. It has been developed by a Certified Measurement and Verification Professional (CMVP) who is accredited by the United States Association of Energy Engineers (AEE).

This M&V plan has been developed in order to calculate electricity savings achieved through the implementation projects at nominated EESBP sites in order for the Office of Environment and Heritage to:

1. to confirm energy and bill savings achieved at each site
2. determine aggregated savings across the Energy Efficiency for Small Business Program (EESBP) population
3. develop an approach to future data collection and verification for Small businesses which is cost-effective, operable and robust enough to ensure the long term viability of energy savings verification for this sector

The proposed approach involves:

1. Gathering field measurements as outlined in this plan to gain a detailed understanding of whole facility electricity usage at each EESBP site. The period prior to each project's implementation date will become the baseline dataset, whilst the period directly following the implementation date will be the post-retrofit period.
2. Conducting regression analysis of baseline data against independent variables across four potential energy models to determine which model best describes and predicts energy consumption at given temperature conditions and on the basis of the current operating parameters.
3. Applying post-retrofit conditions to the energy model to adjust the baseline for the post-retrofit period (adjusted baseline dataset).
4. Calculating electricity savings for the stated measurement boundary by subtracting the post-retrofit actual usage from the adjusted baseline.
5. Calculating the uncertainty associated with the energy model and the electricity savings.
6. Aggregating usage and savings figures across all modelled sites to provide a summary view, stratified by implemented project's technology type, and by each site's industry type and climatic region
7. Reporting the outcomes to OEH.

6.1. M&V contextual data

6.1.1. EESBP participants

OEH has provided a detailed list of EESBP participant data to Energetics. This list has also been provided to Ausgrid and Essential Energy so that historical billing data can be matched.

The EESBP population contains 1,259 unique registration numbers covering diverse range of sites each with its own operating characteristics. These include:

- Industry sectors
- Size (ie energy usage)
- Operating patterns (occupancy hours, production volumes)
- Geographical location
- Data completeness, quality, frequency and amount of history available
- Availability of interval meter data
- Energy savings projects (type, number, size of savings, and implementation dates)

6.1.2. Estimated benefits

Estimated annual energy and cost savings from projects to be implemented within the EESBP population can be summarised as follows:

- 6,440 MWh of predicted annual energy savings
- $1.359m of predicted annual cost savings

6.1.3. Implementation timelines

The EESBP population lists sites that have already implemented projects. Implementation dates range from March 2009 to May 2011.

6.1.4. Drivers for M&V

The key drivers for pursuing formal M&V are:

1. Confirm overall EESBP program energy savings for reporting to OEH.
2. Develop a cost effective approach for future M&V for EESBP.
3. Investigate the potential for developing an IPART compliant RESA under which EESBP participants can claim Energy Savings Certificates (ESCs) under the NSW Energy Savings Scheme.

6.1.5. M&V issues and consideration

1. Scope involves analysis of almost 1,300 EESBP participants with a diverse range of sites involved. As such the independent variables will vary between sites. Each site should be analysed individually using a range of models to determine the appropriate one. Not all sites will successfully model.

2. Participants are located throughout NSW. Accessing data for the most appropriate weather station will be prohibitive.

3. M&V analysis will be conducted to map energy use against weather related variables only. This will not account for changes in energy use due to site-specific independent variables. This may include production or occupancy changes, other expansions or retrofits, etc. This will affect our ability to initially model a site, as well as affecting our ability to claim that any measured savings are due solely to the implementation of energy efficiency projects.

4. Usage only data will be provided. Cost will be estimated using an average rate.

6.1.6. M&V project personnel and project roles

The table below lists the key stakeholders within this M&V project:

Name / Company	Role
Various	**EESBP site participants**
Office of Environment and Heritage	**EESPB Program Owner**
Charles Xu	M&V Project Owner
Ausgrid, Essential Energy	**Network providers and data partners**
Robert Simpson (Ausgrid)	Ausgrid data provision key contact
Paul Smith	Essential Energy data provision key contact
Energetics	**M&V Practitioner**
Robert Sims	M&V design, planning and analysis
Nathan Rosaguti	M&V analysis

6.2. M&V Plan components

6.2.1. Measurement boundary

The measurement boundary definition consists of a nominated physical boundary at which the electricity savings will be assessed.

For this M&V Plan, a separate measurement boundary is defined for each unique EESBP registration number. Each measurement boundary consists of a 'whole facility' boundary based on the total incoming electrical supply. Where multiple NMIs exist for a single registration number, they will be added together to form a whole facility.

6.2.2. Key parameters and data sources

The key parameters are the data points that are to be measured, collected or estimated as part of developing the energy model, and they include input energy and independent variables such as ambient weather to explain or quantify energy usage.

The key parameters and proposed data sources for this project are:

Key Parameter	Data source
EESBP Participant Data	
List of EESBP participants including site information, and details of energy savings projects	OEH
List describing the linkage between EESBP registration data and NMIs against which billing data is listed	Ausgrid and Essential Energy to provide list of matched NMIs against EESBP registration numbers.
Input electricity demand/use	
Input electrical energy (kWh) Input maximum monthly demand (kW or kVA)	**Historical billing electricity data:** Ausgrid and Essential Energy to provide to Energetics historical billing data for the list of EESBP participants provided by OEH the period between 1 January 2008 and 30 April 2012. Ausgrid will provide pro-rated data, whilst Essential Energy will provide raw billing data. Energetics will pro-rata Essential Energy data. **3 months interval data:** Ausgrid and Essential Energy to provide to Energetics historical interval data or monthly maximum demand figures for the list of EESBP participants provided by OEH the period between 1 January 2008 and 30 April 2012.
Independent Variables	
Ambient temperature (Degrees Celsius)	Daily temperature data will be sourced from the Bureau of Meteorology.

6.2.3. IPMVP M&V Option

The IPMVP provides four options or approaches for evaluating energy savings. Based on the measurement boundaries and data available, this M&V plan is based on IPMVP Volume 1, EVO 10000 – 1:2012 and will utilise:

Option C – Whole Facility

Within this option, savings are determined by conducting regression analysis of historical utility data and corresponding data for independent variables to create an energy model which is then used to forecast electricity use across the post-retrofit period in order to determine actual savings.

6.2.4. Interactive effects

As the measurement boundary for each site relates to the whole facility, no interactive effects have been considered.

6.2.5. Baseline measurement period

The baseline measurement period will vary between sites. In general it is defined as the consecutive 12 month period immediately preceding the month identified as the “Install Date” within the EESBP participant data.

The baseline period may be adjusted backwards up to 12 months where it assists with developing a viable energy model.

6.2.6. Post-retrofit measurement period

The post-retrofit measurement period will vary between sites. In general it is defined as the consecutive 12 month period immediately following the month identified as the “Install Date” within the EESBP participant data.

The post-retrofit period will be 12 months in duration.

6.2.7. Approach for developing an energy model

Linear regression analysis will be used to identify a preferred energy model for each site. Regression analysis involves determining a linear relationship between changes energy usage based on corresponding changes to data for independent variables.

The resulting model will be in the form of an equation that will describe energy use as a function of each independent variable. The general form of this equation is:

$$Energy\ Use\ (kWh) = \ a_1x_1 + a_2x_2 + \cdots \ a_nx_n + b$$

Where a_1 to a_n are coefficients relating to variables x_1 to x_n and b is a constant.

For this project, four potential models will be tested for each site:

Model 1 – based on multivariable regression against Cooling Degree Days (CDDs) and Heating Degree Days (HDDs).

$$Energy\ Use\ (kWh) = A \times CDDs + B \times HDDs + Y$$

Model 2 – based on single variable regression against Cooling Degree Days (CDDs) only.

$$Energy\ Use\ (kWh) = A \times CDDs + Y$$

Model 3 – based on single variable regression against Heating Degree Days (HDDs) only.

$$Energy\ Use\ (kWh) = B \times HDDs + Y$$

Model 4 – based on single variable regression against days within each calendar month.

$$Energy\ Use\ (kWh) = B \times Days + Y$$

Refer to Section 9.2.1 for information about calculating CDDs and HDDs for ambient temperature data.

The model that demonstrates the highest correlation against actual baseline energy use will be selected as the preferred model and will be used for measuring energy savings.

6.2.8. Approach for adjusting the energy model and calculating savings

Models 1, 2 and 3 will be adjusted by applying updated data for ambient temperature obtained from the Bureau of Meteorology.

Model 4 will be adjusted by applying the number of days within each month within the post-retrofit period.

The adjustment of the models will form the “adjusted baseline usage”.

Measured energy savings will be calculated in accordance with IPMVP using the following equation:

Electricity Savings (kWh) = Adjusted Baseline (kWh) – Post-Retrofit (kWh)

6.2.9. Approach for calculating and reporting savings uncertainty

Each regression model will be validated in accordance with guidance contained within Appendix B of the IPMVP Volume 1, EVO 10000 – 1:2012. The absolute and relative precision will be calculated at 95% confidence level.

Calculation of overall uncertainty will involve determining the uncertainty associated with the preferred energy model. Energy data is sourced from billing data and so it is deemed to be 100% accurate.

Savings will be reported along with the absolute and/or relative precision and the associated confidence level.

6.2.10. Approach for calculating cost avoidance and greenhouse gas emissions reductions

Energy costs will be determined by applying an average rate of $0.20 / kWh to all data including the adjusted baseline and actual usage. Cost avoidance will then be calculated by subtracting the Adjusted Baseline Cost from the Actual Cost.

Reductions in greenhouse gas emissions will be determined according to the methods outlined within the National Greenhouse and Energy Reporting Act Measurement Determination. This method involves multiplying the measured energy savings by a state-based greenhouse coefficient.

The factor to be used for this project is 0.89 kg CO_2-e/kWh.

This factor accounts for emissions attributable to Scope 2 only.

Data analysis

7. Data sources

The proposed analysis combines data from the EESBP program, historical energy use data, as well as data for independent variables in the form of ambient temperature data.

Energetics received the following sets of data:

Table 1: Data sources

Source	Data type	Description
Office of Environment and Heritage	EESBP Participant Data	Microsoft Excel file containing details of EESBP participants, including • Unique Registration Number • site address details • climatic region • Industry type • Projects being implemented and cost • Forecast cost savings. *Filename:* *For Energetics_ EESBP tracking data_11May12.xls*
Ausgrid	Electricity Usage Data and matched NMI list	Microsoft Excel file containing the results of Ausgrid's NMI matching exercise, as well as prorated historical data for available NMI's. The data period spans 01 January 2008 to 30 April 2012. *Filename: OEH EESBP Ausgrid Final Data 280512.xlsx*
Essential Energy	Electricity Usage Data	Comma separated variable file containing historical billing data for matched NMIs. *Filename: meter_reads_upd.csv*
Essential Energy	Matched NMI List	Comma separated variable file containing a list of NMI's with corresponding Registration Numbers resulting from Essential NMI matching exercise. *Filename: EESBP_List.csv*
Bureau of Meteorology	Daily Maximum and Minimum Temperature Data	The daily maximum and minimum air temperature is nominally recorded at 9 am local clock time. It is the highest/lowest temperature for the 24 hours leading up to the observation. Data available from: http://reg.bom.gov.au/climate/data/

7.1. Weather stations

Sites participating within the EESBP are found throughout NSW, and weather conditions also vary across the state. In order to maximise the correlation achieved against weather data, it is important to reference a local weather station, rather than applying a single set of weather data to all sites.

With over 1,200 potential sites, the amount of weather data to be incorporated was prohibitive, and so a representative weather station was selected for each region of sites represented in the OEH Registration List. This list included a field called CMA, which contains a reference to a climatic region.

Data from the following weather stations was used in the regression analysis for sites with the listed CMA.

Table 2: Weather Stations used to represent each CMA

CMA	Representative Weather Station Reference
Sydney Metro	066062-Sydney (Observatory Hill)
Border River Gwydir	056032-Tenterfield
Central West	063291-Bathurst Airport AWS
Hawkesbury	058063-Casino Airport
Northern Rivers	058130-Grafton Olympic Pool
Southern Rivers	069134- Batemans Bay (Catalina Country Club)
Murray	072160-Albury Airport AWS
Lachlan	050017- West Wyalong Airport AWS
Hunter Central	061055-Newcastle Nobbys Signal Station AWS
Lower Murray Darling	047048- Broken Hill Airport AWS
Murrumbidgee	072150-Wagga Wagga AMO

8. Assumptions

Whilst analysing and reporting data for this project, the following assumptions were made:

- Any changes in consumption (savings or increases) have been attributed to the projects – no adjustments have been made to investigate or correct for changes in site usage that did not result from the project.
- Sites were mapped to one of 8 sets of weather data.
- Where a site registration number appears multiple times in the EESBP participant list, the first instance was used (install date). If multiple install dates were within 180 days, then predicted savings for multiple rows was combined.
- ‘Prior predicted savings’ for energy were back-calculated from ‘predicted cost savings’ data provided by OEH using a unit rate of 20cents/kWh.

9. Data analysis process

The EESBP Registration List was analysed in two parts as follows:

- Part 1 – determine that data is available and meets minimum criteria to be eligible for analysis
- Part 2 –analysis in an attempt to develop a valid regression model from four available models

The combined process is listed in Table 3 below:

Table 3: EESBP population data analysis process

Step	Description
1	OEH provided details of registered participants to Ausgrid and Essential. Details included customer name and address.
2	Ausgrid and Essential matched NMIs against customer details as best as possible and provided Energetics with lists of Registration Reference Numbers with their corresponding NMI(s).
3	Ausgrid & Essential supplied energy usage data to Energetics from January 2008 to April 2012. Ausgrid provided pro-rated monthly data, whilst Essential provided billing data with adhoc start and end dates.
4	Energetics: a) received data from OEH, Ausgrid and Essential. b) pro-rated the Essential usage data into calendar months and combined the various datasets in order to perform eligibility analysis. c) combined multiple NMIs against Registration Numbers d) adjusted for duplicate rego entries (aggregate initial savings estimates where projects are different but implementation periods overlap)
5	Energetics applied eligibility criteria to data, filtering for: a) "Good" NMI matches b) Sites with minimum 12 months of baseline data The result list contained Registration Numbers deemed eligible for further analysis
6	Representative weather stations were chosen for each geographical region (represented by CMA column within dataset) and obtained daily historical data for each weather station from the Bureau of Meteorology for the period between 01 January 2008 and 30 April 2012.
7	Energetics employed a site-specific modelling spreadsheet to conduct regression analysis for each site using four energy models. A worksheet was created for each eligible Registration Number.

<table>
<tr><th>Step</th><th>Description</th></tr>
<tr><td>8</td><td>Energetics conducted regression analysis based on baseline period 12 months immediately prior and post 12 months immediately following ‘install date’. The analysis consisted of applying four models to each dataset and using the most appropriate model for adjusting the baseline data. The models were based on regression against:
• Single variable – flat daily usage
• Single variable - Cooling degree days (CDDs)
• Single variable - Heating degree days (HDDs)
• Multi variable – CDDs and HDDs
Modelling was conducted in 2 passes:
1st pass: automated pass whereby models were tuned using a baseline period
2nd pass: Manual inspection and fine tuning for sites that did not correlate. Additional correlations were achieved by adjusting the baseline period to cover a nearby period which would result in a suitable regression.
The preferred model was then applied to the ‘post-retrofit’ period to create an ‘adjusted baseline’. Energy cost and greenhouse savings, and uncertainty (@95% confidence) were calculated.
Where sites could not be modelled savings were calculated by simply subtracting the usage from the post-retrofit period from the data from the baseline period without any adjustments being applied.</td></tr>
<tr><td>9</td><td>Results from each site worksheet were collated, aggregated and reported.</td></tr>
</table>

Figure 3 below illustrates this process and quantifies the number of eligible Registration Numbers at each step.

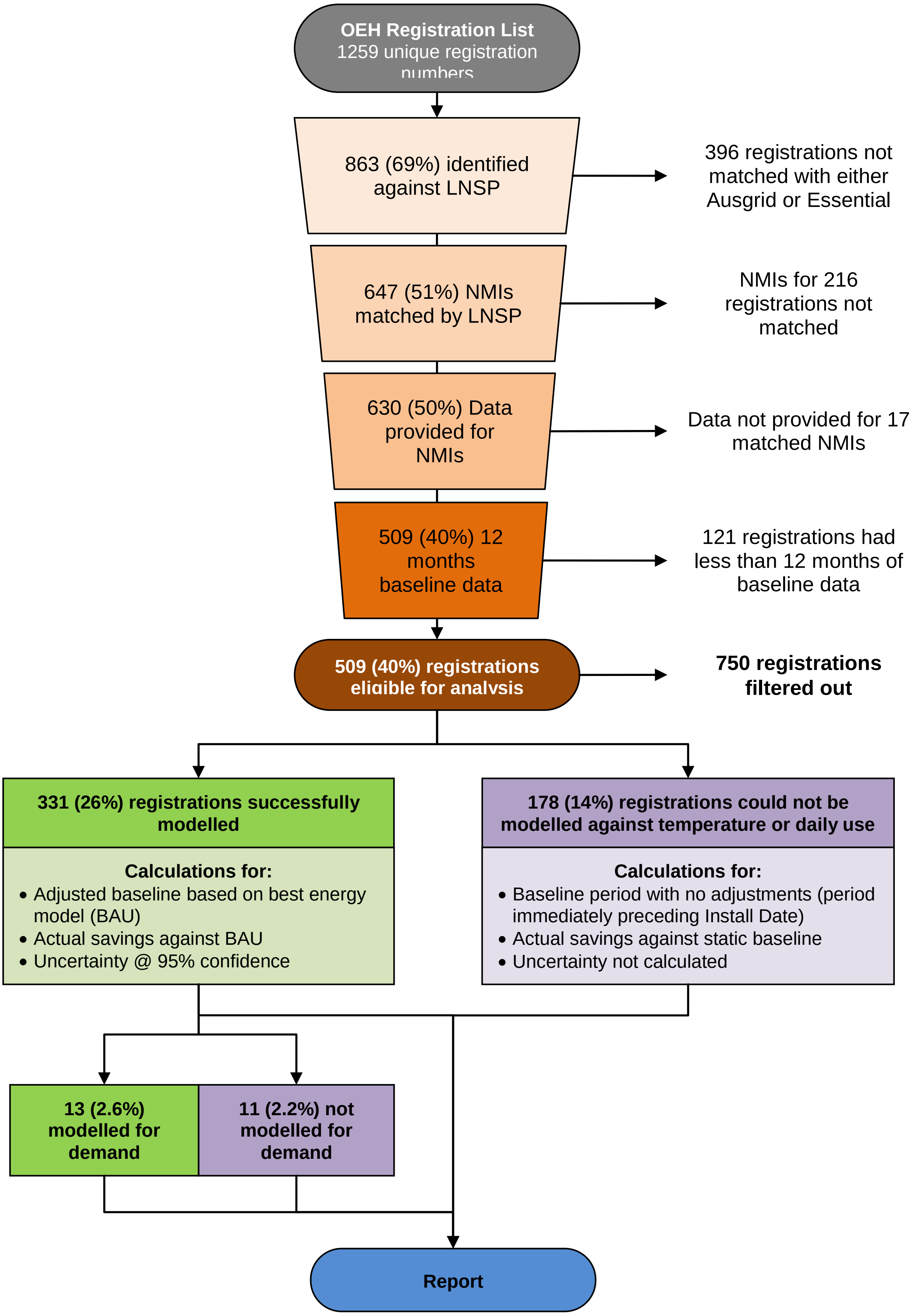


Figure 3: Data analysis process and registration number eligibility

9.1. Data analysis part 1: eligibility analysis

Table 3 and Figure 3 outlined the process for filtering the entire Registration List down to those sites eligible for site-specific M&V. The initial steps were conducted by Ausgrid and Essential prior to Energetics receiving the data.

Energetics then standardised the data formats, collated the data from each LNSP and applied the final steps to the process.

The table below summarises the filtering of Registration Numbers for each LNSP.

Table 4: Population eligibility by LNSP (number of eligible Registration Numbers resulting from each data analysis step)

Data Analysis Step	Ausgrid	Essential	Total	Notes
OEH rego list			**1259**	
Part 1: Eligibility				
Identification by LNSP	553	310	863	396 filtered
NMI matched	446	201	647	NMIs for 216 regos not matched/poor match
Data provided for NMIs	429	201	630	data not provided for NMIs for 17 regos
365 day baseline data?	401	108	509	121 sites did not have enough baseline data
Eligible for analysis			**509**	
Part 2: Modelling				
successfully modelled	**273**	**58**	**331**	**331 of 509 regos modelled**
% of matched regos	49%	19%		
% of all regos			26%	
Eligibility for demand modelling			24	Site must have been successfully modelled for energy and have interval data available.
Successfully modelled for demand	13	n/a	13	13 out of 24 modelled for demand

9.2. Data analysis part 2: site based regression

Energetics used proprietary analysis tools to conduct site based regression for each of the 509 eligible Registration Numbers. The intent was to apply the standard savings equation by:

1. Developing an energy/demand model to explain usage within the baseline period as a function of independent variables. If more than one model applies, then choosing the most appropriate model.
2. Validating the preferred model against regression analysis sanity checks.
3. Calculating the uncertainty associated with the preferred model to 95% confidence level,
4. Using the model to adjust the baseline for conditions within the 'post-retrofit' period
5. Subtracting the 'Actual' energy use/demand from the forecast to determine savings.
6. Applying default rates to calculate cost avoidance and greenhouse gas emission reduction.

9.2.1. Weather variance

Based on past experience, changes in ambient temperature conditions can greatly impact energy usage for sites that operate heating, air conditioning or refrigeration systems. These systems are controlled to achieve controlled internal conditions which are impacted by external conditions, which vary on an hourly, daily and annual basis.

For this project the changes in ambient temperature have been chosen as an independent variable and a proxy known as degree days has been determined to evaluate the effects of heating (Heating Degree Days) and cooling (Cooling Degree Days). Three of the four energy models analysed attempt to correlate energy use against either CDDs, HDDs or both.

Calculating Degree Days

Degree days are determined by:

1. Averaging the daily maximum and minimum temperatures obtained from the Bureau of Meteorology [Average Daily Temperature]
2. Choosing a reference or target temperature [Balance Point]
3. Applying the following formulas to calculate HDDs and CDDs:

   CDDs

   If *[Average Daily Temperature]* > *[CDD Balance Point]* then

   CDDs (1 day) = [Average Daily Temperature] - [CDD Balance Point]

   Else: *CDDs (1 day) = 0*

   HDDs

   If *[Average Daily Temperature]* < *[HDD Balance Point]* then

   HDDs (1 day) = [HDD Balance Point] - [Average Daily Temperature]

   Else: *HDDs (1 day) = 0*

4. The daily figures for HDDs and CDDs are then summated into monthly totals for comparison against the monthly energy use.

Trend in Figure 4 illustrates the monthly cooling degree days for the Northern Rivers CMA, calculated using a CDD balance point of 18°C. From the chart we can clearly see a seasonal trend with the peaks occurring during the summer months (months 10 to 2 each year). Interestingly the trends also vary between years.

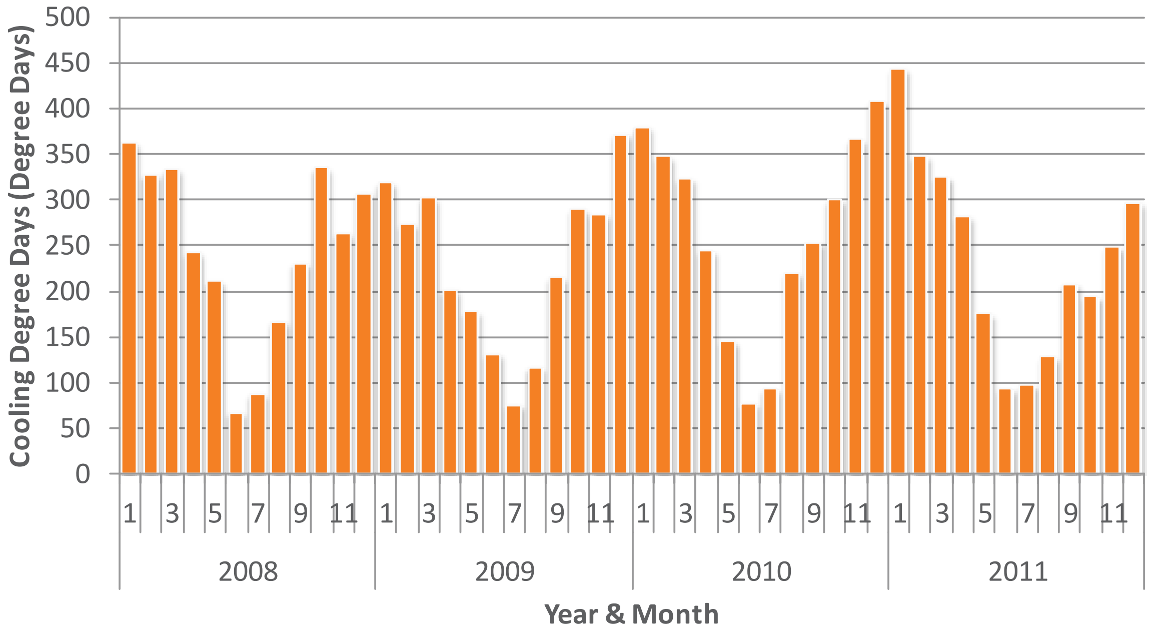


Figure 4: 4-Year monthly CDD trend for Northern Rivers CMA (balance point=18°C)

Table 5 below lists the total annual CDDs for each calendar year for the same weather station and balance point.

The last column contains the variance for each year against the 4-year average. We can see that the annual CDDs varies between 2827 and 3147, differences of -2.9% and +8.1% against the average.

Table 5: Calendar year CDDs for Northern Rivers CMA and variance against average (balance point=18°C)

Year	Total CDDs	Variance (%) against average
2008	2,926	+0.5%
2009	2,748	-5.6%
2010	3,147	+8.1%
2011	2,827	-2.9%
Average	2,912	-

Similar trends for CDDs can be calculated at different balance points. Within Figure 5 below we can see CDDs calculated for the same weather station, this time with a balance point of 25°C. Due to this high balance point we can observe:

- The overall number of CDDs is much smaller
- There are very small or zero CDDs in the winter months (essentially the average temperature never rises above 25°C).
- The year-on-year differences are more pronounced.

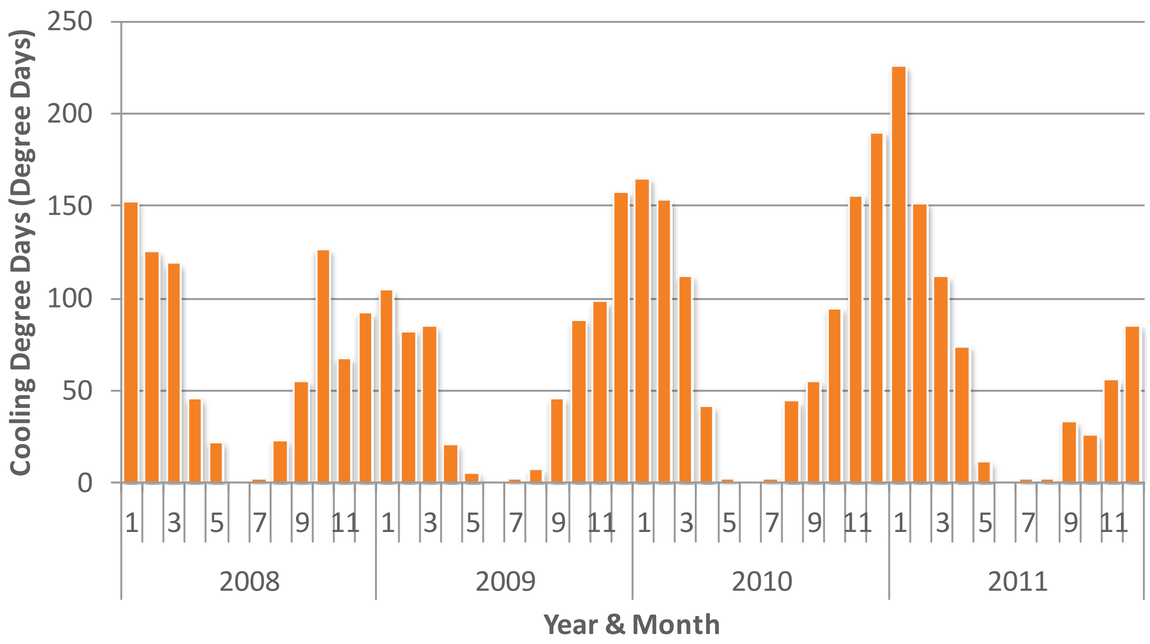


Figure 5: 4-Year monthly CDD trend for Northern Rivers CMA (balance point=25°C)

Looking at the annual totals as seen in Table 6, the increase in variance becomes more evident with annual totals varying between -16.4% to +22.9% of the average.

Table 6: Calendar year CDDs for Northern Rivers CMA and variance against average (balance point=25°C)

Year	Total CDDs	Variance (%) against average
2008	826	+0.1%
2009	690	-16.4%
2010	1,011	+22.4%
2011	775	-6.1%
Average	825	-

9.2.2. Weather data for demand analysis

The proposed analysis approach will be conducted on maximum monthly demand as well as energy. However the relationship between demand and CDDs or HDDs is different to that of energy. Unlike the energy/weather relationship, we are not interested in the cumulative effect of weather throughout each month. Rather we are interested in the relationship between the maximum monthly demand and the CDDs and/or HDDs for the corresponding day in which the maximum occurs, ignoring any other days.

This concept is summarised in the table below for a sample NMI. To determine the monthly CDDs for the energy analysis previously described we simply aggregate the daily CDDs. In this case, the monthly CDDs total 280.16.

For demand analysis, we locate the day within the month with the highest maximum demand, and then select the CDDs for that day only.

Table 7: Example of selection of CDDs for demand analysis

Day of Month	Daily Maximum Demand (kVA)	CDDs	Day of Month	Daily Maximum Demand (kVA)	CDDs
1	73.2	11.22	**17**	74.15	5.15
2	73.18	5.39	**18**	76.19	5.67
3	65.53	5.59	**19**	73.9	7.30
4	71.92	8.09	**20**	78.08	10.51
5	74.84	9.75	**21**	79.57	11.27
6	73.97	9.74	**22**	79.37	14.06
7	73.79	11.23	**23**	80.78	13.23
8	74.35	6.00	**24**	70.7	15.25
9	79.19	5.33	**25**	76.06	8.29
10	77.38	6.36	**26**	76.5	8.50
11	72.87	7.38	**27**	78.84	7.57
12	80.76	8.21	**28**	80.01	9.60
13	77.1	8.73	**29**	**82.38**	**10.44**
14	76.59	10.90	**30**	75.3	10.31
15	75.46	11.29	**31**	73.56	10.54
16	73.53	7.26			
Total CDDs for energy analysis					280.16
CDDs on day of maximum demand for demand analysis					10.44

9.2.3. Regression analysis

Each site was analysed using four energy models to determine the preferred model that best fit with the historical energy usage patterns. The energy models attempt to explain energy use as a function of the 'independent variables'.

An example of an energy model is shown for a single site in Figure 6 below in which energy use is correlated against cooling degree days.

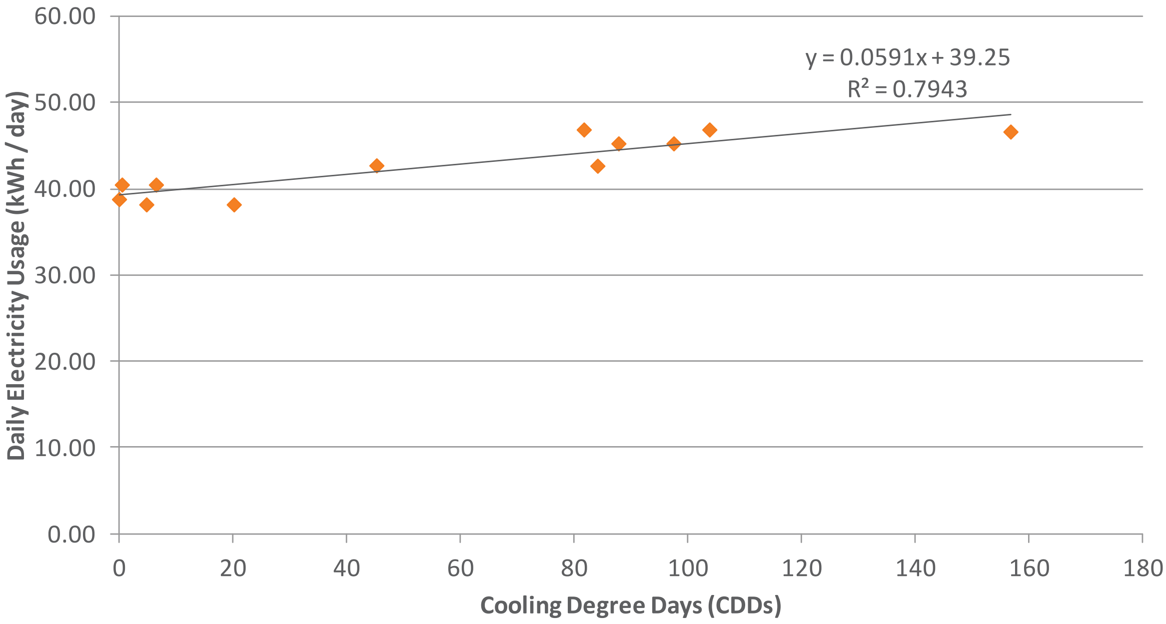


Figure 6: Example regression analysis (balance point=25°C)

We can see that the data points on the XY scatter plot form a linear trend, with energy use increasing in a linear fashion with a corresponding increase in CDDs. A line of best fit is also shown and the equation for that line becomes the energy model, namely:

Energy Use = 0.0591 x [CDDs] + 39.25

The coefficient of determination (R^2) describes the 'appropriateness of fit', or in other words, how well the data points fit the trend line. An acceptable R^2 value is 0.75 or better.

Iterative analysis was conducted for each model by altering the values for CDD and HDD balance points in order to maximise the R^2 value. As the balance points change, so too does the number of CDDs and/or HDDs. The change in CDDs is not uniform between months due to the unique weather patterns, and so the alignment of points along a line of best fit changes as the balance point changes.

In the case of CDDs, lowering the balance point increases the number of CDDs, which results in data points being shifted horizontally to the right.

Figure 7 below shows the same energy model for a balance point of 18°C. We can see that the trend no longer fits the line (noting that the line has also changed). The R^2 value has also dropped from 0.79 seen earlier to be 0.63, which is no longer acceptable. We have 'de-tuned' the model.

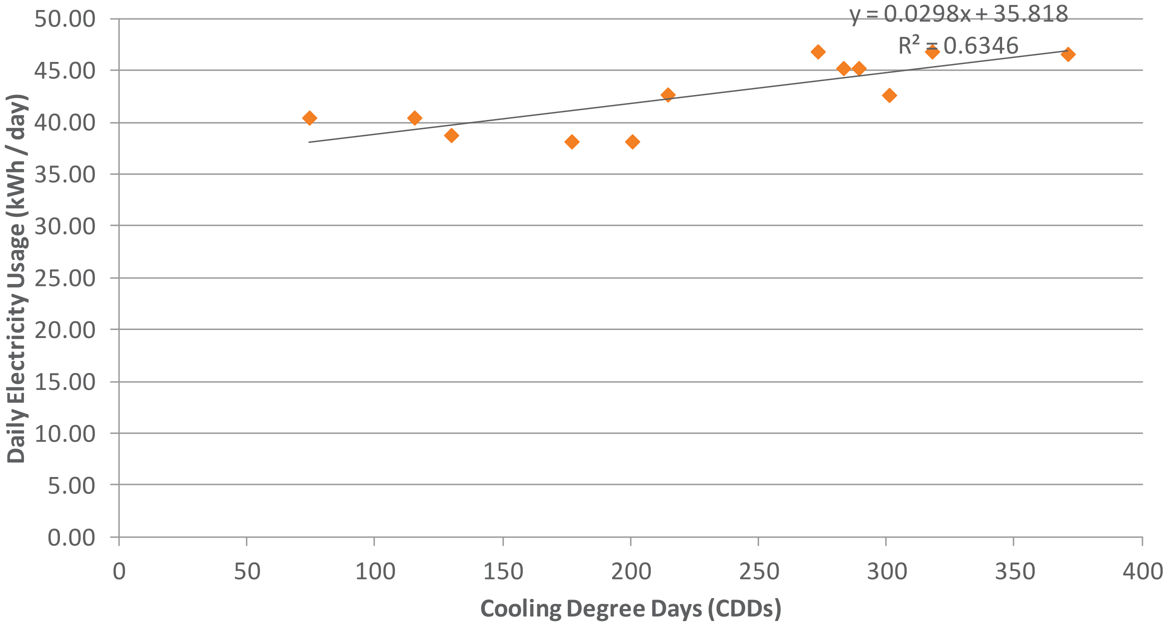


Figure 7: Regression Model (balance point=18°C)

Once all models were tuned, each model was validated to confirm the following requirements were met:

Temperature based regression models:	• $R^2 > 0.75$
	• Values for each coefficient > 0
	• t-stats for all coefficients > 2
Daily usage model:	• Standard Error < 5%

Finally, the preferred model was selected from all "VALID" models based on the model that has the smallest Standard Error. This model was then used to forecast 'business as usual' energy use across the post-retrofit period from which the project savings were then derived.

Alternatively where no models were deemed VALID, no forecast was made. Rather savings were 'approximated' by simply subtracting the energy usage from post-retrofit period from the energy usage from the baseline period without applying any adjustments.

9.2.4. Uncertainty associated with the preferred model and savings

Where a valid model was obtained, the uncertainty associated with the model and with the calculated savings was calculated.

The process for calculating savings uncertainty was:

1. The overall Standard Error ($SE_{baseline\ model}$) was obtained for the preferred model (units: kWh)
2. The Absolute Precision was calculated by multiplying the Standard Error by a t-statistic obtained from statistics tables for the sample size (12 months) and desired confidence level (95% confidence was chosen) as follows:

$$Absolute\ Precision = SE_{baseline\ model} \times T - Statistic$$

3. The Relative Precision was calculated by dividing the Absolute Precision by the average value outputted by the model.

$$Relative\ Precision = \frac{Absolute\ Precision}{Average\ Monthly\ Value\ from\ Model}$$

4. The Saving Uncertainty for month was determined as follows:

$$SE\ Savings(month) = \sqrt{SE_{baseline\ model}{}^2 - SE_{post-retrofit}{}^2}$$

$where: SE_{post-retrofit} = 0$ (as actual invoices are deemed to have no uncertainty)

5. Savings uncertainty for a year was determined as follows:

$$SE\ Savings(year) = \sqrt{12 \times (SE\ Savings_{month})^2}$$

6. Absolute Precision for savings was calculated by multiplying the Standard Error for the savings by a t-statistic obtained from statistic tables for the sample size (12 months) and desired confidence level (95% confidence was chosen) as follows:

$$Absolute\ Precision\ (savings) = SE\ Savings\ (year) \times T - Statistic$$

7. Finally, Relative Precision for savings was calculated by dividing the Absolute Precision for savings by the measured savings figure.

$$Relative\ Precision\ (savings) = \frac{Absolute\ Precision\ (savings)}{Measured\ Savings}$$

9.3. Site energy analysis results

An output table and charts was prepared for presenting the energy analysis results for each site.

Figure 8 and Figure 9 below illustrates the output of the analysis conducted.

Program	EESBP	Rego	12737	
Site		ANZSIC	Café / Restaurants	
NMI		CMA	Sydney Metro	
NMI#2		LNSP	Ausgrid	
Project type	Lighting			
Baseline Period	May-10	to	Apr-11	
Savings Analysis Period	Jun-11	to	May-12	
Correlating Function	f(CDD)			
Actual Savings	Electricity (kWh)	Cost ($ @ $0.2/kWh)	Greenhouse Gas Emissions (tCO_2-e @ 0.89kgCO2-e/kWh)	Uncertainty (% at 95% confidence)
Adjusted Baseline	249,848	49,970	222	19.3%
Actual Consumption	222,829	44,566	198	0.0%
Savings	27,019	5,404	24	
Savings %	10.8%	10.8%	10.8%	

Site details including Registration Number

Baseline and savings analysis time periods

Energy model

Analysis results

Figure 8: Site energy analysis data table

From the first chart on the next page, we can clearly see the baseline and post retrofit periods highlighted in red and blue respectively. The modelled usage (grey line) closely follows the actual baseline data.

This is magnified within the second chart, which focuses on comparing the actual data against the modelled data for each month within the baseline period.

Finally the savings during and after the post-retrofit measurement period are illustrated as the difference between the modelled forecast and the actual usage.

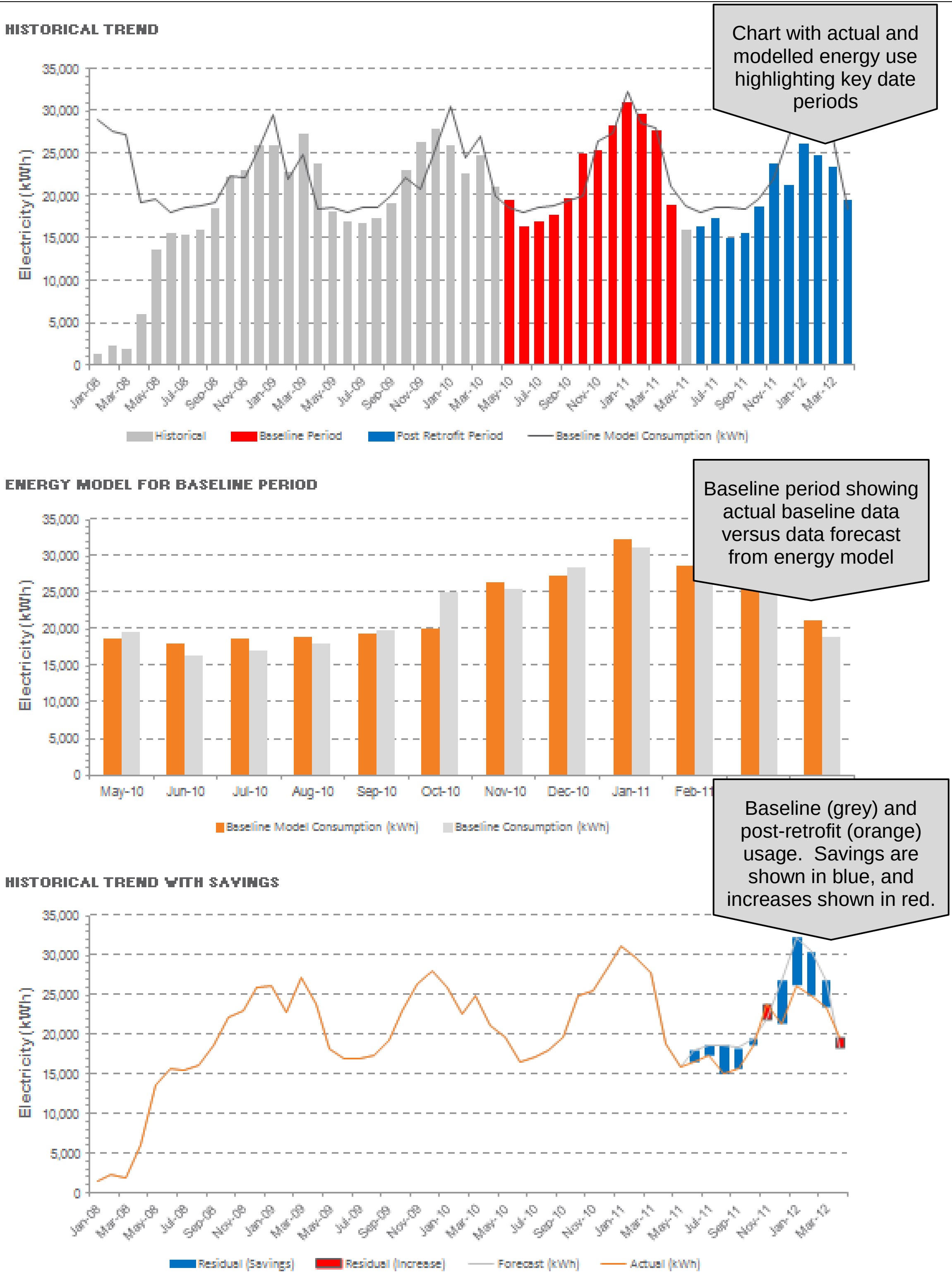


Figure 9: Site energy analysis charts

9.4. Site demand analysis results

An output table and charts was prepared for presenting the demand analysis results for each site.

Figure 10 and Figure 11 below illustrates the output of the analysis conducted.

Program	EESBP	Rego	2311	
Site		ANZSIC	Health / Community servi	
NMI		CMA	Sydney Metro	
NMI#2		LNSP	Ausgrid	
Project type	Lighting			
Baseline Period	Apr-10	to	Mar-11	
Savings Analysis Period	Jun-11	to	May-12	
Correlating Function	f(CDD)			
Actual Savings	12 Month Aggregated Demand Saving (kVA)	Savings for Peak Month Only (kVA)	Capacity/Ratchet Savings (kVA)	Uncertainty (% at 95% confidence)
Adjusted Baseline	825	82	82	178.0%
Actual Consumption	629	60	64	0.0%
Savings	196	22	18	235.6%
Savings %	23.8%	26.6%	21.9%	

Site details including Registration Number

Baseline and savings analysis time periods

Demand model

Analysis results

Figure 10: Site demand analysis data table

Results from the analysis were calculated in three ways:

1. 12 month aggregated demand savings – The first column lists the sum of monthly demand savings for the 12 month post-retrofit period. This figure would be used for sites that are billed for monthly maximum demand without any capacity charges.

2. 'Peak Month' demand savings – This column lists the savings associated with the month within the post-retrofit period that has the highest forecast maximum monthly demand. The savings figure represents the saving that has been made within that month between the business as usual forecast and the corresponding actual demand.

3. Capacity/Ratchet demand savings – This column lists the savings associated with a change in an annual capacity charge. This is calculated as the difference of the two maximum monthly demand figures within the same 12 month post-retrofit period, irrespective of the month in which they occurred. This figure estimates the potential drop in an annual capacity or ratchet based demand charge.

From the first chart on the next page, we can clearly see the baseline and post retrofit periods highlighted in purple and light blue respectively. The modelled demand (grey line) closely follows the actual baseline data.

This is magnified within the second chart, which focuses on comparing the actual data against the modelled data for each month within the baseline period.

Finally the savings during and after the post-retrofit measurement period are illustrated as the difference between the modelled forecast and the actual demand.

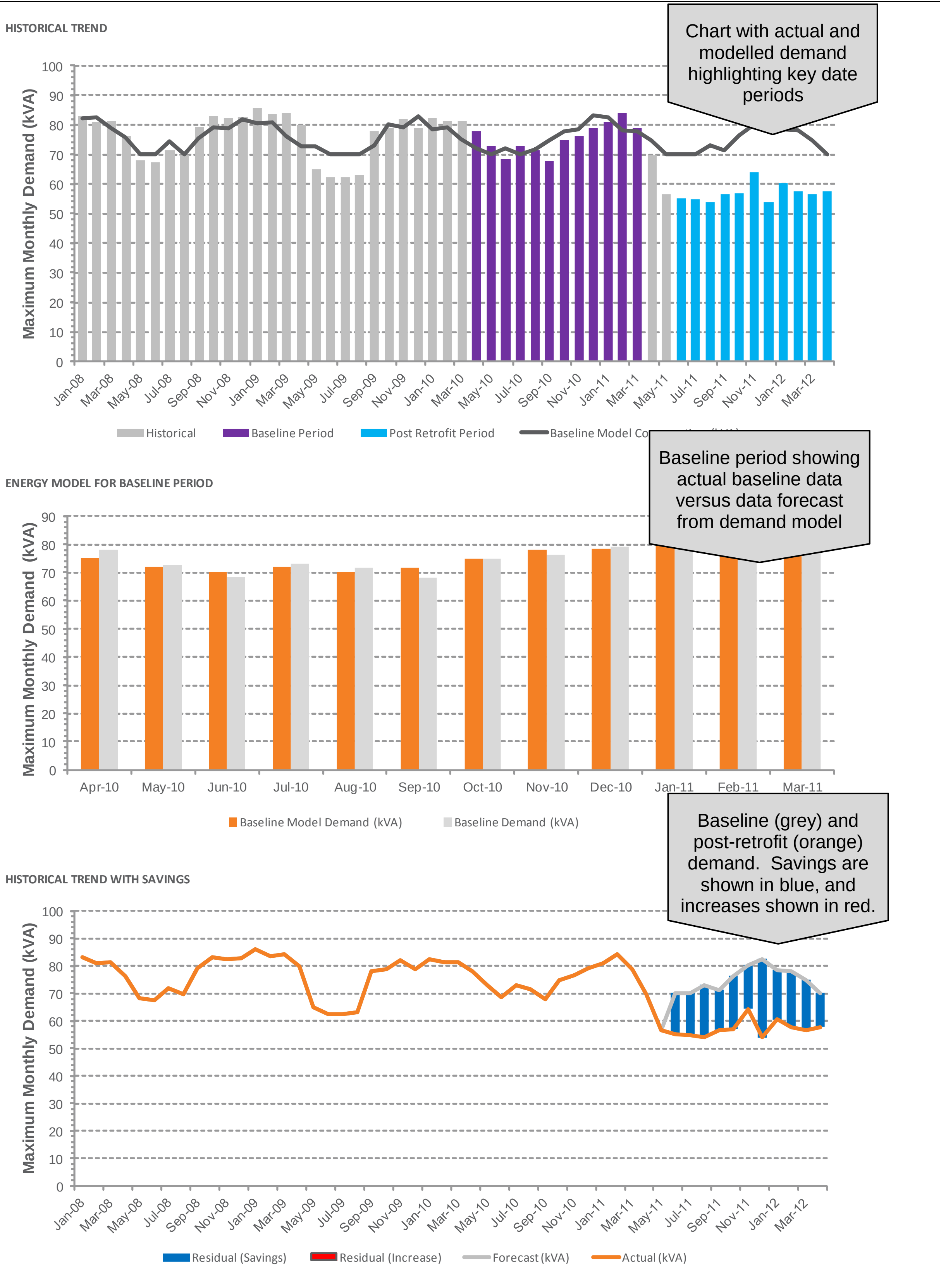


Figure 11: Site demand analysis charts

Results

As described earlier, 1,259 unique registrations were analysed and filtered down to 509 unique registrations for the purposes of calculating results.

Of those 331, or 65%, were successfully modelled. In these cases, the calculated savings represents the baseline usage adjusted for changes in ambient conditions minus the actual post-retrofit usage.

For the remaining 178 registrations, energy use could not be explained to an acceptable level by any of the four chosen models. In these cases, the calculated savings represents the actual baseline usage without any adjustments minus the actual post-retrofit usage.

10. Overall results

Table 8 below describes the overall results from the 509 registrations.

Table 8: EESBP savings analysis results for eligible sites

	Number of Regos	BAU Usage (kWh)	Actual Usage (kWh)	Usage Savings (kWh)	Cost Savings($ @ $0.20/kWh)	GHG Emissions Reduction (tCO_2-e @ 0.89kgCO_2-e/kWh)	Savings % of BAU
Successfully modelled sites	331	22,521,145	20,654,406	1,866,739	$373,348	1,661	8.3%
Non-modelled sites	178	7,637,192	6,813,681	823,511	$164,702	733	10.8%
All Regos	**509**	**30,158,338**	**27,468,087**	**2,690,250**	**$538,050**	**2,394**	**8.9%**

NOTE: 'usage savings' represents the difference in actual energy use and the business as usual forecast. A key assumption within the figures above and those that follow is that the change in usage is due to the implemented project.

This is further explained in the next section.

The usage savings represent the 'first year' savings for each site, based on the 12 months immediately following project implementation.

Refer to Appendix A for detailed figures for registrations and "savings" for the population by industry type and technology type.

11. Variance in 'savings'

As mentioned, the term 'usage savings' implies that all non-routine and routine adjustments for each site have been considered and incorporated into the energy models in order suitably adjust the baseline and create a 'like-for-like' comparison against actual usage.

Without contacting each site to gain a detailed understanding of changes to site operations we cannot guarantee that the changes in usage are attributable to the energy projects. However the following statements are also true:

- For the successfully modelled sites, a stable baseline has been obtained when adjusted for one of the four chosen energy models
- The population only contains sites that have implemented projects, and so we expect to see a change in performance against baseline

It is clear from reviewing the trends at a site level that there are sites where the change in performance is obvious as the baseline is stable and the change is consistent. For other sites the consumption patterns are less predictable or there has been no obvious improvement in performance.

For the purposes of this project, the population has been divided into sites that were successfully modelled and those for which a model wasn't obtained. Within the next section the results for the modelled sites are analysed.

The non-modelled sites are not analysed in further detail as a viable energy model could not be obtained, and therefore we have not been able to satisfactorily explain baseline performance. However for the purposes of completeness and comparison between the two groups, these results are summarised in the overall results.

All sites within each group have been included in analysis as we are unable to differentiate between project savings and changes in usage due to other reasons. The intention is to capture the overall change in performance and focus on the larger subcategories for more detailed information.

When sub-categorised into Industry Type, Technology Type or Climatic Region the numbers of sites within smaller subcategories may cause outliers to skew specific results.

As stated within Table 8 the aggregated 'savings' for modelled and non-modelled sites are 8.3% and 10.8% respectively.

When analysed at the site level, the individual savings vary significantly. This is illustrated in Figure 12 for modelled sites and Figure 13 for non-modelled sites.

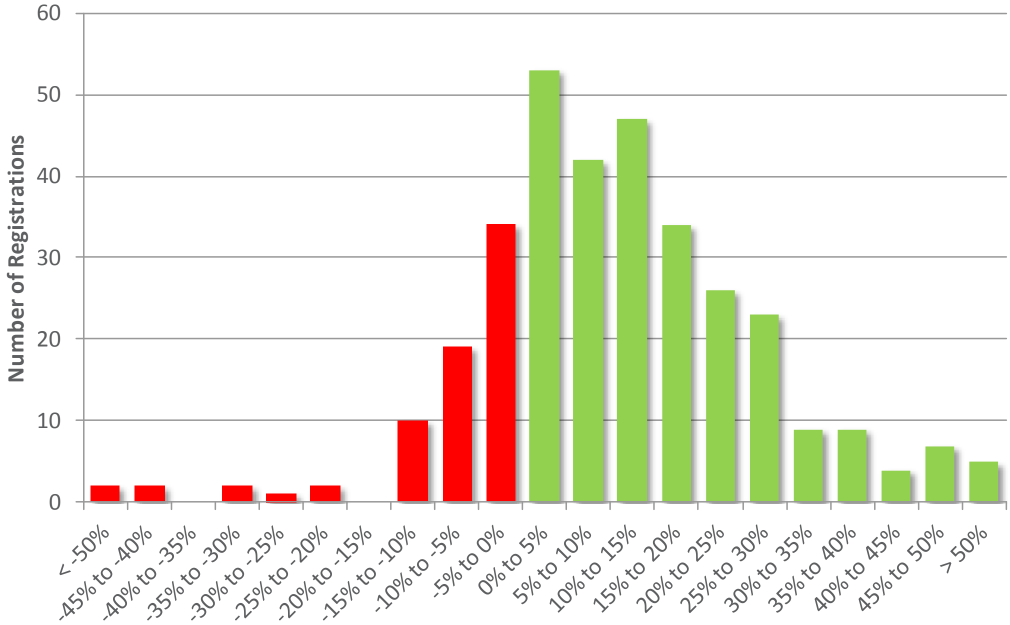


Figure 12: Histogram of site savings against BAU - modelled sites

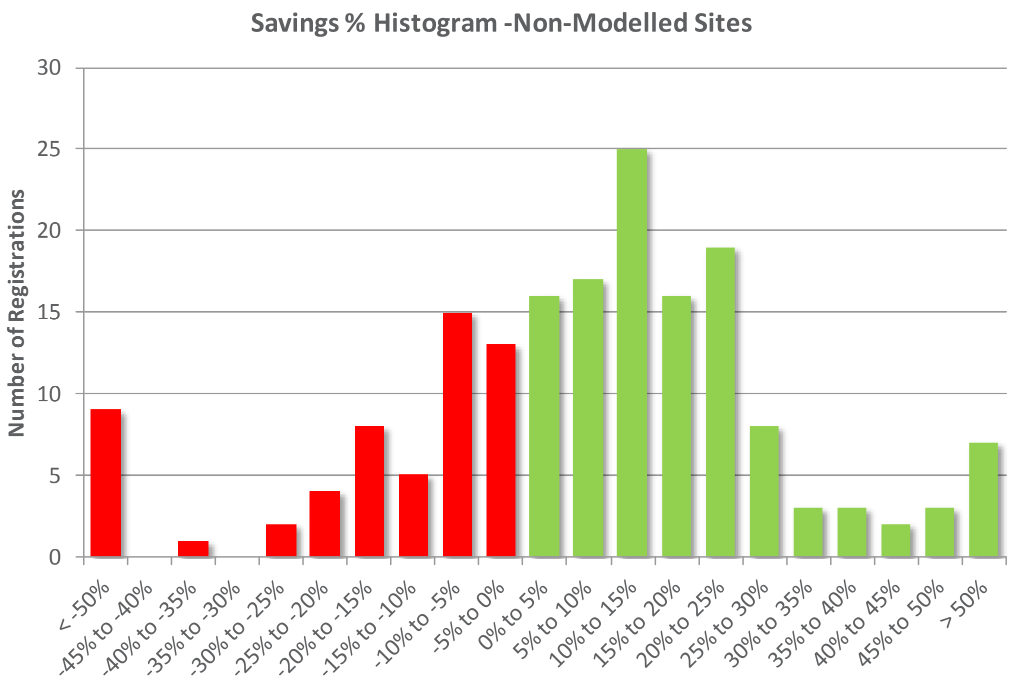


Figure 13: Histogram of site savings against BAU - non modelled sites

It can be seen in both cases that there are a significant number of sites that have not achieved any savings; indeed usage has increased. However the overall distribution supports the total savings result with "average" savings of 9.3% for modelled sites and 5.4% for non-modelled sites (with one outlier removed).

This inclusive view and resulting 'lack of savings' at some sites explains why some figures in the following sections are negative.

12. Analysis of modelled sites

12.1. Summary of modelling

As mentioned, 331 or 65% of sites were successfully modelled. Of those 153 sites correlated against Cooling Degree Days "f(CDD)", followed by 114 that exhibited flat profiles "f(days)".

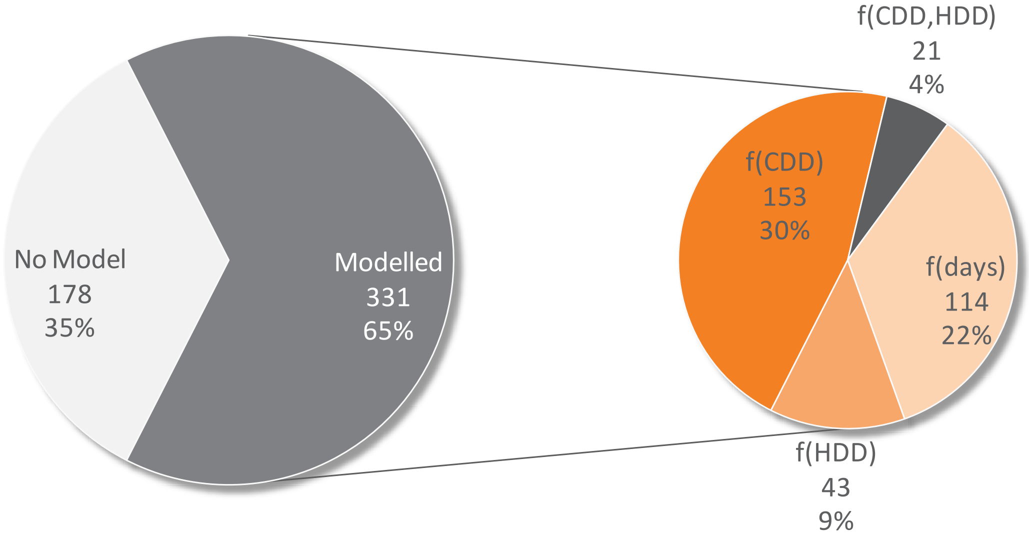


Figure 14: Break up of sites based on preferred energy model

The preferred model and number of sites that successfully modelled varied between site Industry Types. Figure 15 below illustrates the percentage of models obtained within each Industry Type. As expected, industry types operating air conditioning and refrigeration typically resulted in higher success rates. Activities such as agriculture, mining and manufacturing yielded lower success rates.

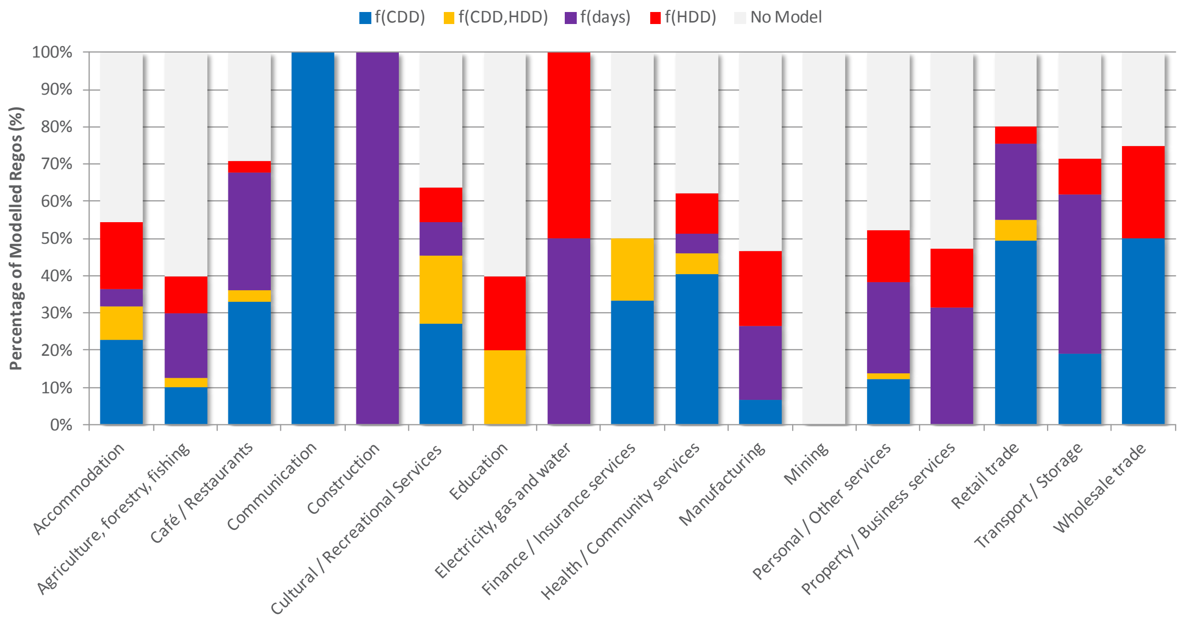


Figure 15: Percentage of modelled sites by Model and Industry Type

12.2. Results for modelled sites by project technology type

This section summarises the savings associated with modelled sites according to the type of savings project that was implemented.

Table 9: Savings summary for modelled sites by Project Technology Type implemented

Technology	Sites	BAU Usage (kWh)	Actual Usage (kWh)	Usage Savings (kWh)	Cost Savings($ @ $0.20/kWh)	GHG Emissions Reduction (tCO_2-e @ 0.89kgCO_2-e/kWh)	Savings % of BAU (kWh)
Air compression	2	77,139	65,904	11,236	$2,247	10	14.6%
Boilers	4	313,372	284,955	28,417	$5,683	25	9.1%
Hot water	21	1,035,020	966,406	68,615	$13,723	61	6.6%
HVAC	56	3,167,029	2,921,560	245,469	$49,094	218	7.8%
Insulation	3	86,698	86,777	-78	-$16	0	-0.1%
Lighting	124	7,895,893	6,865,519	1,030,375	$206,075	917	13.0%
Motors and VSDs	5	394,204	344,933	49,272	$9,854	44	12.5%
Refrigeration	86	7,924,563	7,670,508	254,056	$50,811	226	3.2%
Multiple	30	1,627,226	1,447,847	179,379	$35,876	160	11.0%
Grand Total	**331**	**22,521,145**	**20,654,406**	**1,866,739**	**$373,348**	**1,661**	**8.3%**

The majority of projects implemented fall within Lighting, Refrigeration and HVAC. Together, these three technologies contribute 1,530 MWh or 82% of overall savings and represent a combined saving of 8.1% as against the overall savings percentage of 8.3%.

The 'average' energy saving and % against business as usual for each technology type are presented in the charts below.

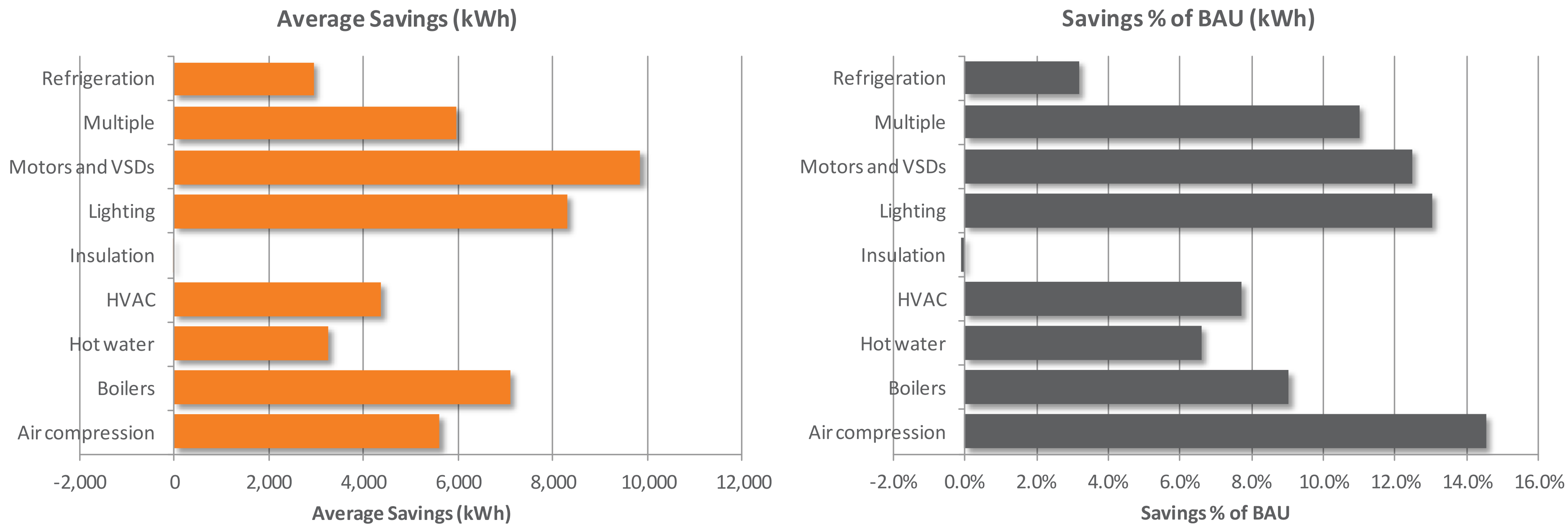


Figure 16: Average savings by Technology Type

It can be seen that Motors and VSDs, lighting and boilers produce the highest energy saving, whilst Air compressor, lighting projects and Motor and VSD projects produce the largest percentage savings against total site usage.

12.3. Results for modelled sites by industry type

This section summarises the savings associated with modelled sites according to the industry type of the site where the project was implemented. Retail Trade and Cafe / Restaurants are the two most prevalent industry types.

ANZSIC Category	Sites	BAU Usage (kWh)	Actual Usage (kWh)	Usage Savings (kWh)	Cost Savings($ @ $0.20/kWh)	GHG Emissions Reduction (tCO_{2}-e @ 0.89kgCO_{2}-e/kWh)	Savings % of BAU (kWh)
Accommodation	12	1,522,165	1,363,717	158,448	$31,690	141	10.4%
Agriculture, forestry, fishing	16	966,600	905,360	61,240	$12,248	55	6.3%
Café / Restaurants	90	7,470,554	7,155,684	314,870	$62,974	280	4.2%
Communication	2	110,886	112,483	-1,597	-$319	-1	-1.4%
Construction	1	29,465	25,970	3,496	$699	3	11.9%
Cultural / Recreational Services	7	789,082	774,476	14,606	$2,921	13	1.9%
Education	2	34,226	31,257	2,969	$594	3	8.7%
Electricity, gas and water	2	14,265	13,314	951	$190	1	6.7%
Finance / Insurance services	3	50,948	41,369	9,578	$1,916	9	18.8%
Health / Community services	23	1,326,758	1,183,512	143,246	$28,649	127	10.8%
Manufacturing	7	462,415	607,952	-145,537	-$29,107	-130	-31.5%
Personal / Other services	34	1,083,088	952,225	130,863	$26,173	116	12.1%
Property / Business services	9	155,761	131,723	24,038	$4,808	21	15.4%
Retail trade	105	6,345,803	5,592,693	753,109	$150,622	670	11.9%
Transport / Storage	15	2,066,009	1,700,393	365,616	$73,123	325	17.7%
Wholesale trade	3	93,122	62,278	30,843	$6,169	27	33.1%
Grand Total	**331**	**22,521,145**	**20,654,406**	**1,866,739**	**$373,348**	**1,661**	**8.3%**

The 'average' energy saving and percentage saving against business as usual for each business industry type are presented in the charts below.

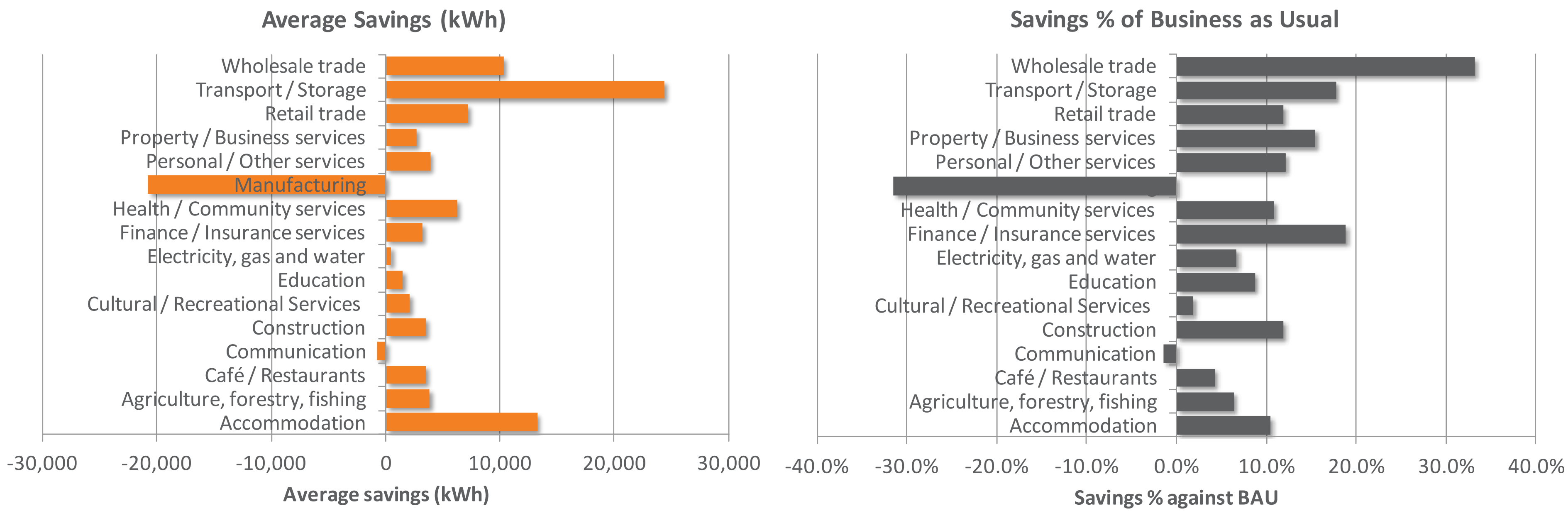


Figure 17: Average savings by Industry Type

It can be seen that the average savings are highest in Transport /Storage and Accommodation industry types. From a percentage reduction perspective, Wholesale trade, Finance / Insurance Services and Transport / Storage industry types have seen the highest percentage reductions against total site business as usual consumption.

The manufacturing data consists of 7 sites, one of which has seen a 74% increase in consumption. When this site is ignored the average saving is still negative but reduces to 1,392 kWh per annum.

12.4. Results for modelled sites by climatic region

This section summarises the savings associated with modelled sites according to the region where site is located.

Climatic Region	Sites	BAU Usage (kWh)	Actual Usage (kWh)	Usage Savings (kWh)	Cost Savings($ @ $0.20/kWh)	GHG Emissions Reduction (tCO_2-e @ 0.89kgCO_2-e/kWh)	Savings % of BAU (kWh)
Border River Gwydir	4	496,515	503,618	-7,103	-$1,421	-6	-1.4%
Central West	6	482,917	487,222	-4,305	-$861	-4	-0.9%
Hunter Central	53	4,237,057	4,139,457	97,600	$19,520	87	2.3%
Lachlan	2	40,508	30,971	9,537	$1,907	8	23.5%
Lower Murray Darling	1	5,246	7,446	-2,200	-$440	-2	-41.9%
Murray	1	141,405	145,269	-3,864	-$773	-3	-2.7%
Murrumbidgee	2	51,548	54,517	-2,969	-$594	-3	-5.8%
Northern Rivers	28	2,478,036	2,501,772	-23,736	-$4,747	-21	-1.0%
Southern Rivers	9	611,298	517,632	93,666	$18,733	83	15.3%
Sydney Metro	225	13,976,615	12,266,503	1,710,113	$342,023	1,522	12.2%
Grand Total	**331**	**22,521,145**	**20,654,406**	**1,866,739**	**$373,348**	**1,661**	**8.3%**

The vast majority of projects within the modelled sites have been implemented within the Sydney Metro, Hunter Central and Northern Rivers regions.

The 'average' energy saving and percentage saving against business as usual for each climatic region are presented in the charts below.

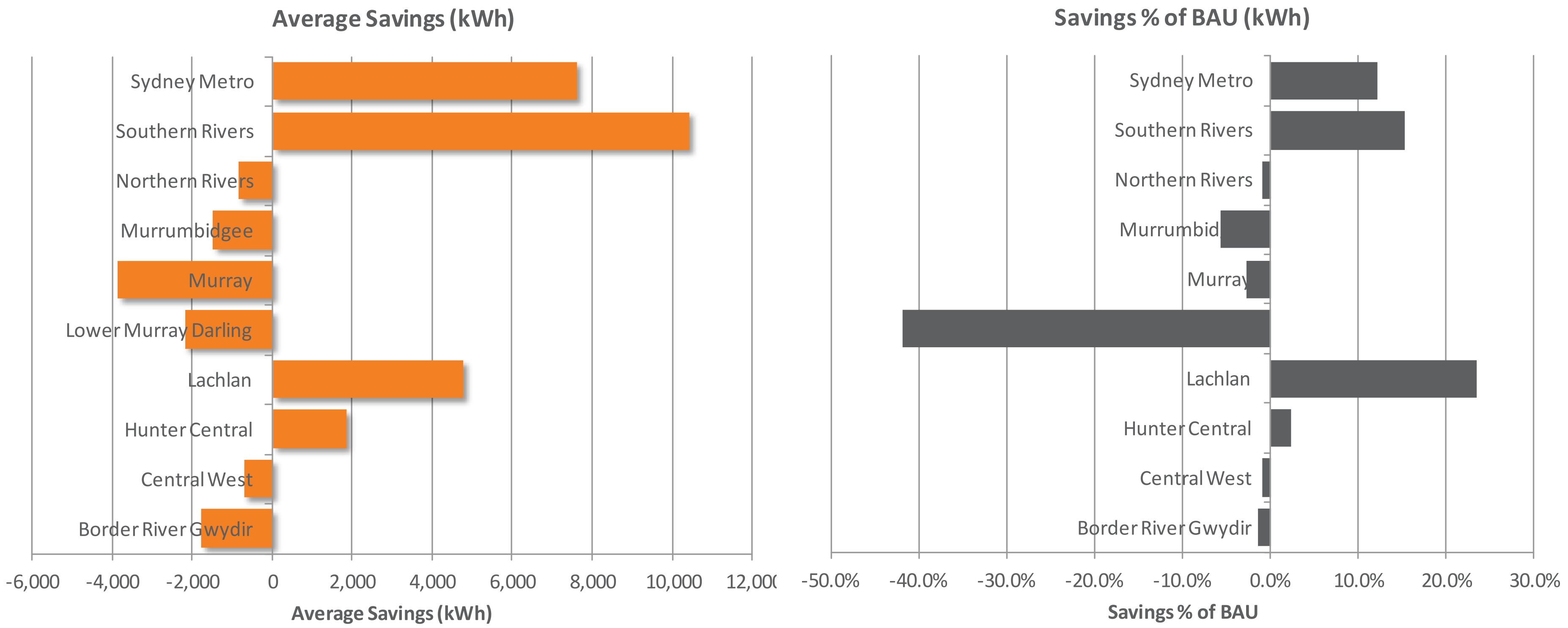


Figure 18: Average savings by Climatic Region

Seven of the ten climatic regions listed contain analysis for 10 sites or less. It can be seen in the chart above that for many of these climatic regions the analysis has showed an increase in energy use. Northern Rivers also shows 'negative' savings despite this population containing 28 sites.

The key point to note from this analysis is that savings are not reliable between sites within similar climatic regions. However this may be more due to the Industry Type rather than the climatic region.

12.5. Comparison of measured savings versus prior predicted savings figures

The following table summarises the comparison of measured savings for successfully modelled sites against the prior predicted energy savings based on initial audit findings and/or engineering estimates. When summarised by technology the measured savings accurately reflect the initial estimates with a total difference of 0.3%. Insulation projects appear to have the largest variance however the sample sizes are too small to be conclusive.

Table 10: Comparison of measured savings against prior predicted estimated savings by Technology Type

Project Technology Type	Regos	BAU Usage (kWh)	Measured Actual Usage (kWh)	Measured Savings (kWh)	Measured Savings % of BAU (kWh)	Prior Predicted Savings (kWh)	Prior Predicted Savings % of BAU	Actual minus Predicted Savings (kWh)	Actual minus Predicted Savings % of BAU
Air compression	2	77,139	65,904	11,236	14.6%	7,785	10.1%	3,451	4.5%
Boilers	4	313,372	284,955	28,417	9.1%	41,835	13.3%	-13,418	-4.3%
Hot water	21	1,035,020	966,406	68,615	6.6%	88,273	8.5%	-19,659	-1.9%
HVAC	56	3,167,029	2,921,560	245,469	7.8%	241,599	7.6%	3,870	0.1%
Insulation	3	86,698	86,777	-78	-0.1%	20,118	23.2%	-20,196	-23.3%
Lighting	124	7,895,893	6,865,519	1,030,375	13.0%	814,088	10.3%	216,287	2.7%
Motors and VSDs	5	394,204	344,933	49,272	12.5%	49,248	12.5%	24	0.0%
Multiple	30	1,627,226	1,447,847	179,379	11.0%	187,480	11.5%	-8,101	-0.5%
Refrigeration	86	7,924,563	7,670,508	254,056	3.2%	339,670	4.3%	-85,615	-1.1%
Grand Total	**331**	**22,521,145**	**20,654,406**	**1,866,739**	**8.3%**	**1,790,096**	**7.9%**	**76,643**	**0.3%**

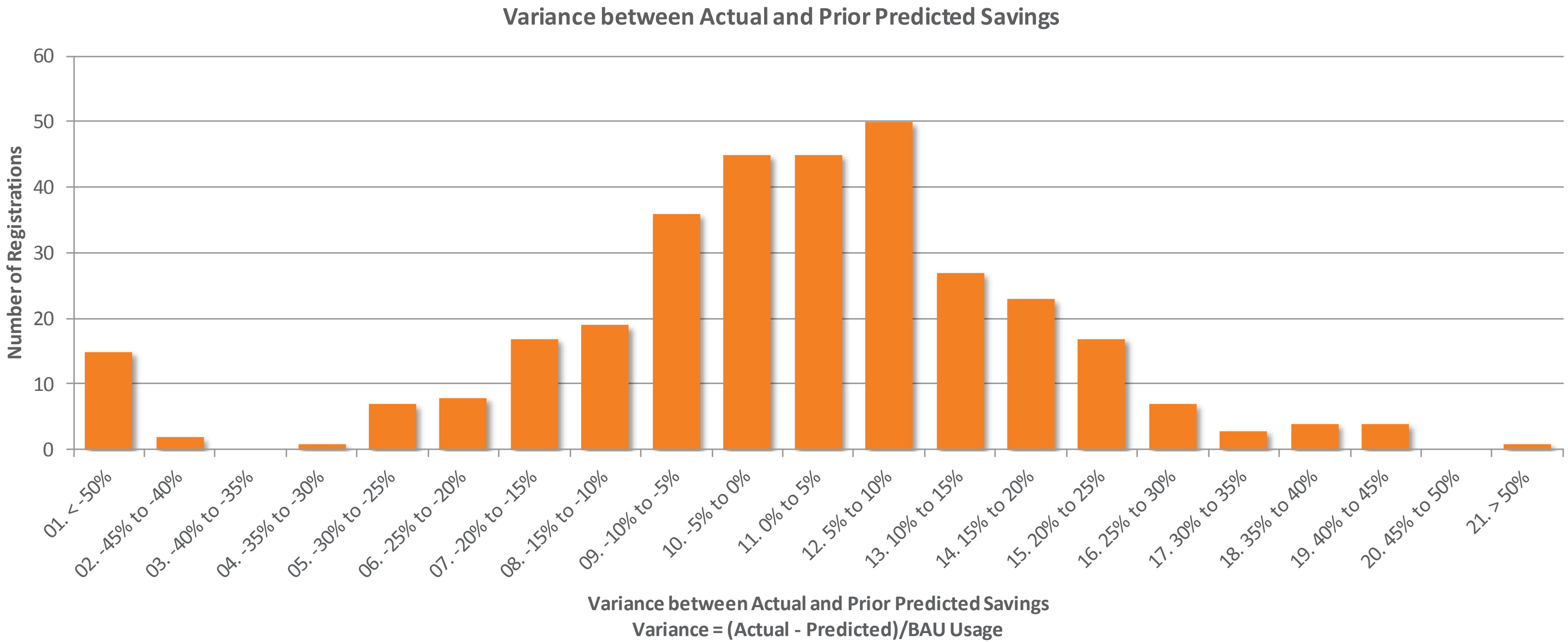


Figure 19: Histogram of variance between Actual Savings and Prior Predicted Savings by site

Although the overall variance between Actual and Predicted savings is 0.3%, at a site level the variance is more unpredictable. Figure 19 above shows a histogram of the variance in savings between actual and predicted across modelled sites.

12.6. Savings uncertainty for modelled sites

Savings uncertainty was calculated for each site where an energy model was obtained. The reason for this is that we are applying an energy model which is a 'best fit' to forecast business as usual. The fact is that the true value falls within a range close to the modelled value.

Savings uncertainty uses statistics, based on a normal distribution curve centred on the modelled value, to provide a range or tolerance in which the true savings values falls based on the of the energy model.

Expressing uncertainty is based on providing a both a range and confidence as they are related. As we increase the range in which the value may fall, our confidence also increases.

Savings uncertainty can be expressed as either:

Absolute Precision: units = kWh

Relative Precision: units = %

The process for calculating savings uncertainty is described in Section 9.2.4. Absolute and Relative Precision was calculated for each modelled site, as well as the population. Overall figures for the population are shown below:

Table 11: Savings summary including Absolute and Relative Precision for modelled sites

Metric	Value
Number of Regos	331
BAU Usage (kWh)	22,521,145
Actual Usage (kWh)	20,654,406
Measured Usage Savings (kWh)	1,866,739
Savings % of BAU (kWh)	8.3%
Absolute Precision (@ 95% confidence)	±70,474
Relative Precision (@ 95% confidence)	±3.8%

Thus the savings for modelled sites can be stated as:

First Year savings from modelled sites = 1,866,739 kWh ± 3.8% at a 95% confidence level, or

= 1,866,739 kWh ± 70,474 kWh at a 95% confidence level

Alternatively we can state that:

We are 95% confident that First Year savings from modelled sites falls between:

1,796,265 kWh and 1,937,213 kWh, or

8.0% and 8.6%

At a site level the Absolute Precision varies significantly due to the size of the site's energy usage. The Relative Precision also varies significantly, as it is a function of both the Absolute Precision and more significantly, the size of the savings.

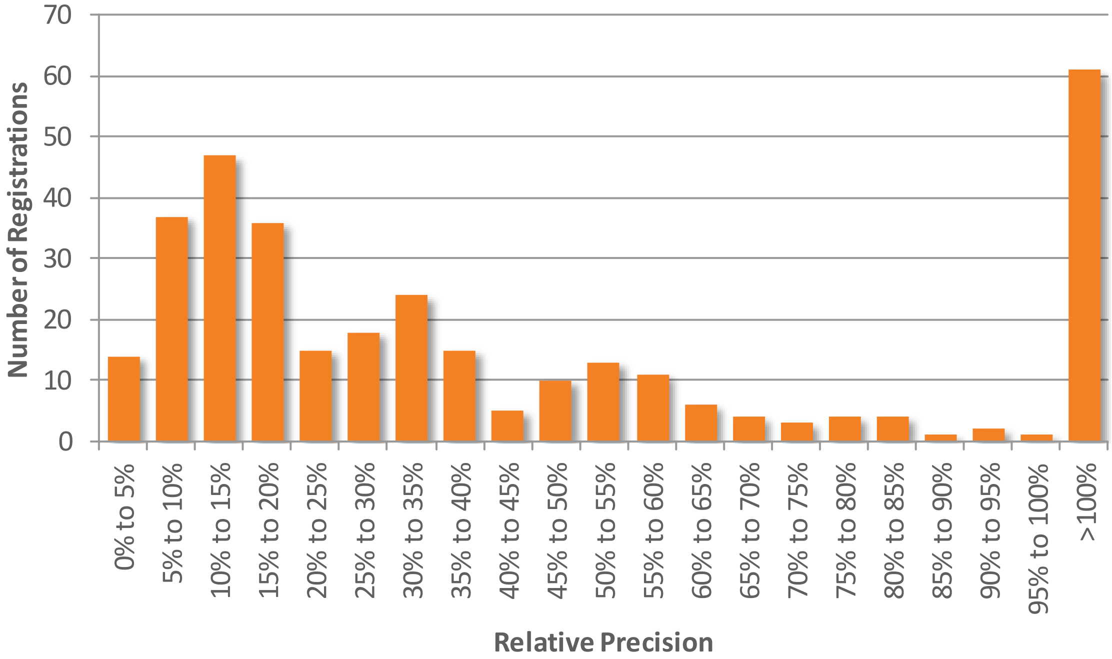


Figure 20: Histogram of Relative Precision by Site (@ 95% confidence)

In the above figure we can see that there is a broad range in the Relative Precision, noting that 61 registrations have a Relative Precision greater than 100%. The relationship between the size of savings and Relative Precision is best illustrated by the figure below.

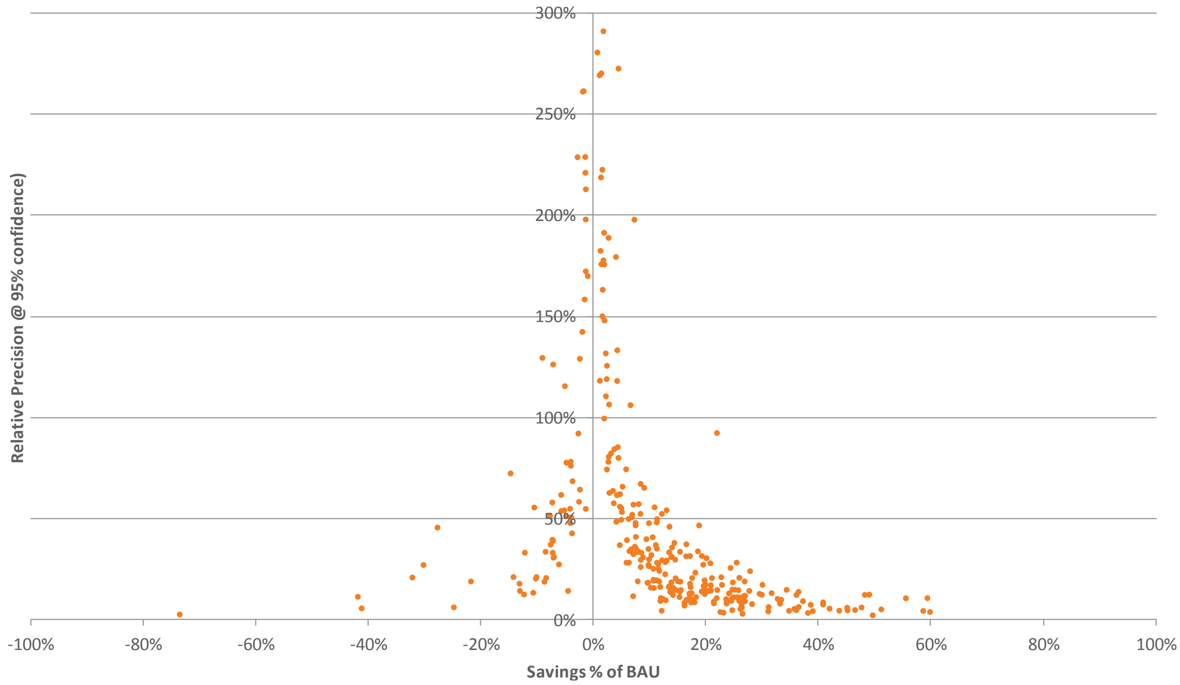


Figure 21: Relative Precision versus Savings against BAU by site

12.7. Applying the minimum 10% threshold for savings as per Option C limitations

Within the IPMVP, the following limitation is placed on use of Option C. Predicted energy savings should be greater than 10% the total site baseline energy usage. This limitation has not been applied within the analysis described to this point, as by doing so, we would be assuming that all measured savings are due to the implemented projects. Without confirming that other static changes to site operations have not occurred, it was deemed that by applying this filter would create an artificially inflated view of the true savings.

Within Table 12 below the 10% savings limitation is applied to the data. A technology type view is presented with comparable data to that within Section 12.2.

Table 12: Savings summary by Technology Type filtered for sites with savings greater than 10% of BAU

Technology	Number of Regos	BAU Usage (kWh)	Actual Usage (kWh)	Usage Savings (kWh)	Cost Savings($ @ $0.20/kWh)	GHG Emissions Reduction (tCO2-e @ 0.89kgCO2-e/kWh)	Savings % of BAU (kWh)	Absolute Precision (@ 95% confidence)	Relative Precision (@ 95% confidence)
Air compression	1	55,272	46,185	9,087	$1,817	8	16.4%	±2,893	±31.8%
Boilers	2	130,192	80,931	49,261	$9,852	44	37.8%	±2,252	±4.6%
Hot water	4	278,013	208,522	69,491	$13,898	62	25.0%	±4,914	±7.1%
HVAC	26	1,451,552	1,203,501	248,051	$49,610	221	17.1%	±17,392	±7.0%
Insulation	0	0	0	0	$0	0	0.0%	±0	±0.0%
Lighting	83	4,983,017	3,845,751	1,137,267	$227,453	1,012	22.8%	±37,084	±3.3%
Motors and VSDs	2	119,405	70,106	49,299	$9,860	44	41.3%	±2,407	±4.9%
Multiple	18	846,431	680,923	165,508	$33,102	147	19.6%	±7,707	±4.7%
Refrigeration	28	1,995,780	1,604,233	391,548	$78,310	348	19.6%	±29,775	±7.6%
Grand Total	**164**	**9,859,662**	**7,740,151**	**2,119,511**	**$423,902**	**1,886**	**21.5%**	**±51,643**	**±2.4%**

We can see that the number of reported registrations drops from 331 to 164 (approximately half), however the total measured savings increases from 1,866 MWh to 2,120 MWh representing a 14% increase. The relative precision has reduced from ±3.8% to ±2.4%. Finally the overall savings percentage against the business as usual baseline has increased from 8.3% to 21.5%

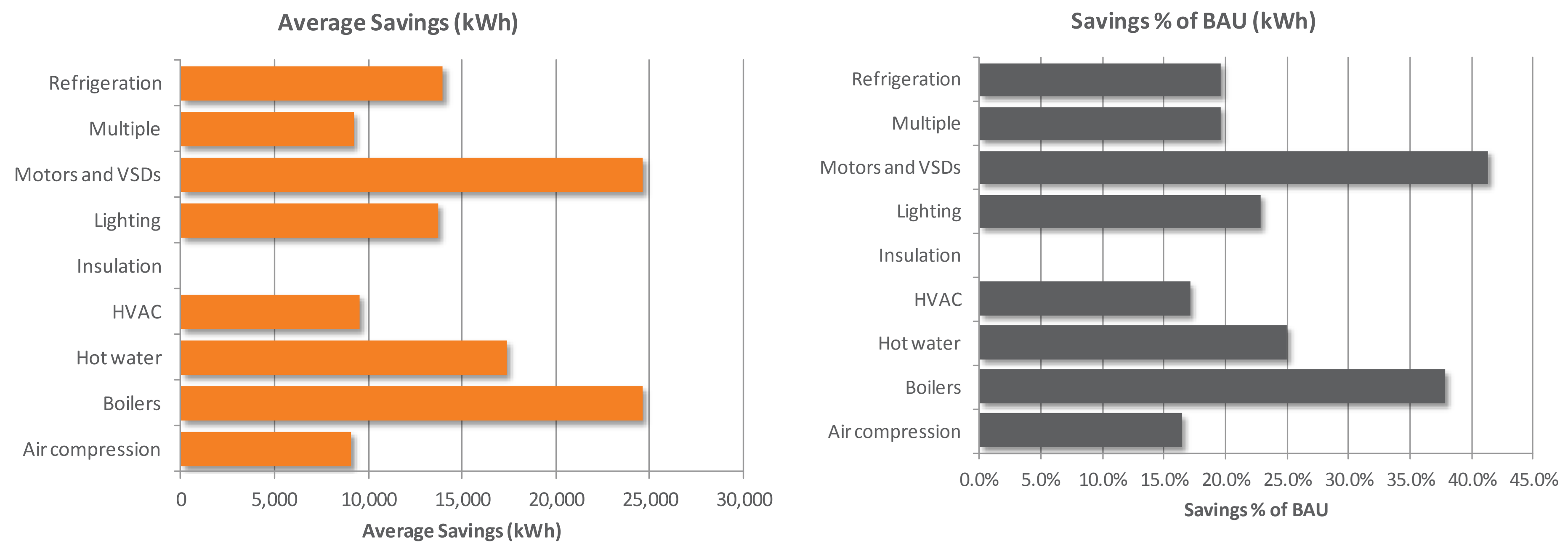


Figure 22: Average savings by Technology Type for sites with savings greater than 10% of BAU

As we would expect when we take the 'best of breed' outcomes, the average savings has improved significantly, showing between 9,000 kWh and 24,000 kWh average savings. The savings percentage against the business as usual baseline has also improved due to the removal of all the lagging data points. Savings percentages are now in the order of 16% to 41% across the various project types.

The measured savings of 2,120 MWh are double the values of the corresponding prior predicted savings 1,010 MWh for this group.

12.8. Demand analysis

In addition to modelling energy savings, a select group of NMIs was chosen for modelling demand reduction. As described previously the overall approach was similar to that for energy analysis, however the CDDs and/or HDDs used corresponded to the day within each month that the maximum occurred, rather than comprising a sum of degree days across all days within each month.

The sites chosen for analysis fit two key criteria:

1. Each site had been successfully modelled for energy, and
2. Interval data must be available for the site.

Thirteen of the 24 sites were modelled against demand with results either from CDD based model or one with a flat demand profile. Interestingly, 4 of the 13 modelled sites correlated using a different model type to that used to model energy savings for the corresponding site.

For the sites that successfully modelled, demand savings were calculated by subtracting the post-retrofit ‘Actual’ maximum monthly demand from the ‘business as usual’ forecast maximum monthly demand as determined by the model. For sites that did not model, the post-retrofit ‘actual’ demand was subtracted from the ‘baseline’ maximum monthly demand without applying any adjustments, apart from ensuring that corresponding months were aligned (ie January compared to January).

For all sites, the following changes in demand were calculated:

1. 12 month aggregated demand savings – the sum of monthly demand savings for the 12 month post-retrofit period.
2. ‘Peak Month’ demand savings – the savings associated with the month within the post-retrofit period that has the highest forecast maximum monthly demand. The savings figure represents the saving that has been made within that month between the business as usual forecast and the corresponding actual demand.
3. Capacity/Ratchet demand savings – the savings associated with a change in an annual capacity charge. This is calculated as the difference of the two maximum monthly demand figures within the same 12 month post-retrofit period, irrespective of the month in which they occurred. This figure estimates the potential drop in an annual capacity or ratchet based demand charge.

The table below summarises the comparison between site energy savings, aggregated annual demand savings, peak month demand savings and capacity savings. As can be seen, the savings are most predictable and most certain for the sites that were modelled.

Table 13: Demand analysis results summary

Metric	Energy Use (kWh)	12 Month Aggregated Demand (kVA)	Peak Month (kVA)	Capacity (kVA)
Modelled sites				
Business as Usual	3,461,959	10,089	983	983
Actual	3,107,259	8,900	792	879
Savings	**354,700**	**1,189**	**190**	**104**
% Savings	**10.2%**	**11.8%**	**19.4%**	**10.6%**
Non-modelled sites				
Business as Usual	2,610,176	8,853	972	972
Actual	2,604,929	8,868	838	931
Savings	**5,248**	**-16**	**134**	**41**
% Savings	**0.2%**	**-0.2%**	**13.8%**	**4.2%**

Refer to Appendix B for results for the 24 sites where demand related analysis was conducted.

The figure below illustrates the comparison between site energy savings, aggregated annual demand savings, peak month demand savings and capacity savings. The sites are sorted according to the % of Capacity Savings in descending order. It can be seen that there is not a consistent relationship between energy savings (black), aggregated demand savings (orange) or capacity savings (red).

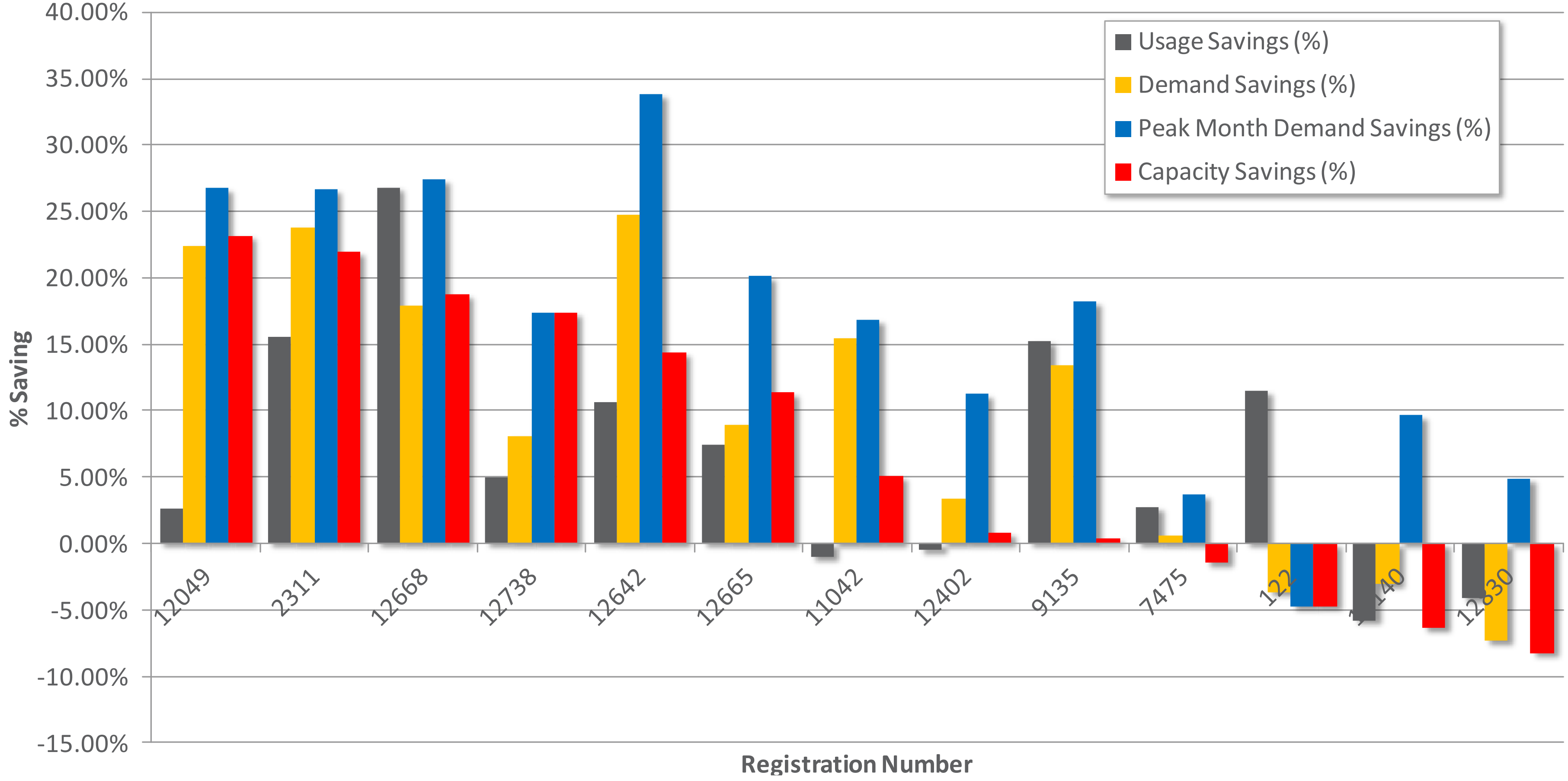


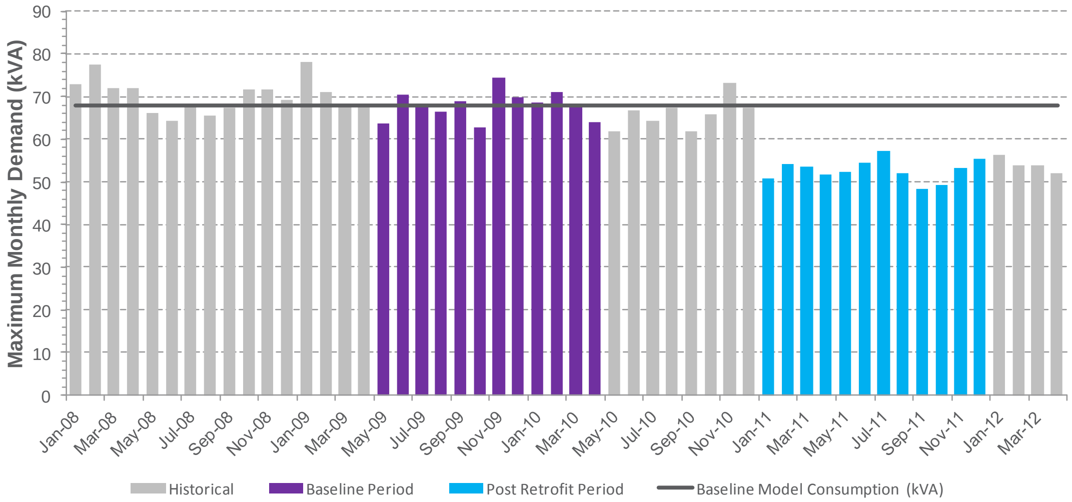
Figure 23: comparison of demand savings percentages for modelled sites

In the business of climate change

Citing some examples from above with trend charts shown:

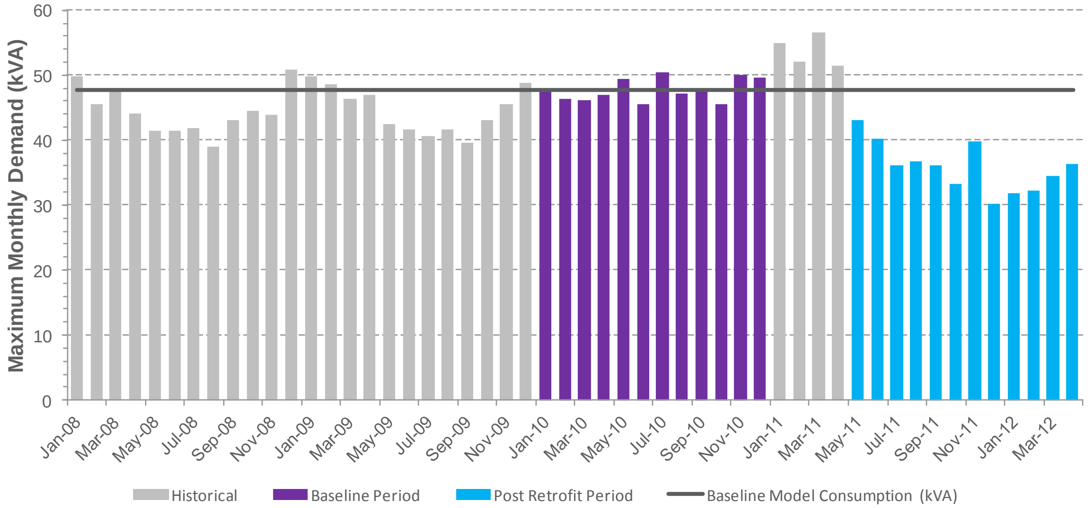
Site 12049

Demand savings (monthly and annual) are in the order of +20% however annual energy savings are less than 3% of business as usual.



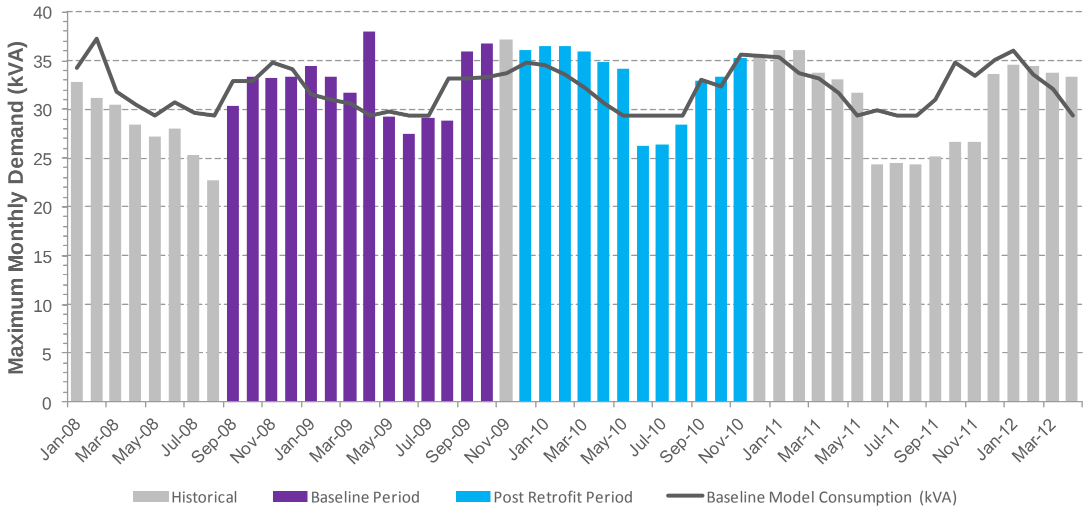
Site 12642

Peak Month demand savings are significantly higher than the Capacity savings, which means that the annual peak would be seen in a different month of the year; one that is much closer to the baseline annual peak than the Peak Month savings figure would suggest.



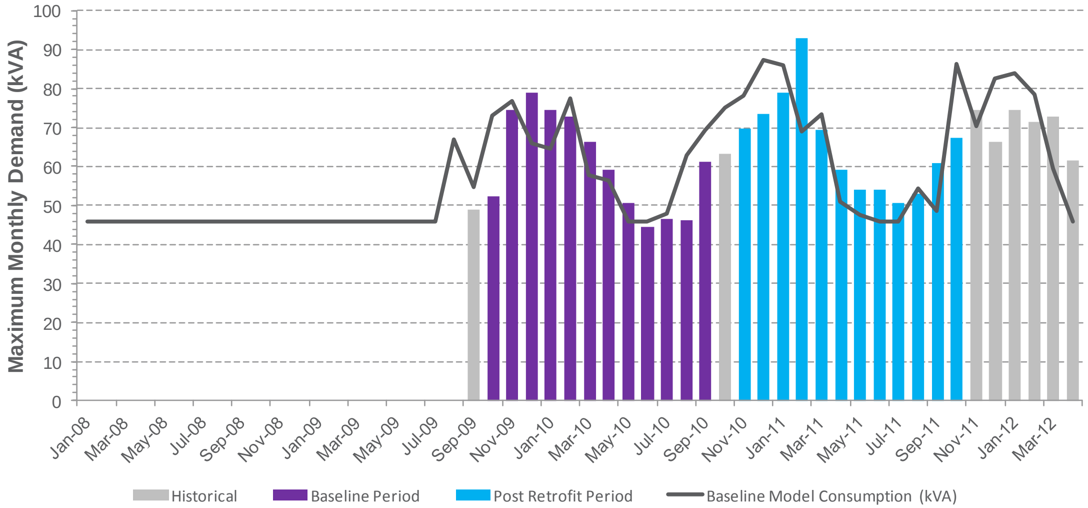
Site 122

The site has seen 11% reduction in energy use however all demand metrics have increased (ie increase in monthly maximum demand and annual capacity)



Site 10140

Site has seen a rise in energy use (ie no savings) as well as an increase in overall aggregated annual demand and capacity. However the site has seen a reduction in Peak Month demand.



Conclusion, recommendations and next steps

13. Analysis outcomes

In summary we believe that bottom-up analysis approach used within this project provides OEH with a verifiable, broad-based dataset from which it can evaluate the EESBP program.

The aggregated savings of 1,867 MWh (8.3% of BAU) provides a realistic first pass outcome, based on robust site based analysis, in the absence of confirmation with sites regarding the reasons or site-specific variables that may be causing adjustments.

Once the 10% savings limitation that applies to Option C is applied, the overall savings increases to 2,120 MWh (21.5% of BAU). Although we are confident in the analysis approach used to obtain this result, we do not believe that this figure should be used to represent the outcomes of this project as the necessary confirmation regarding site-specific adjustments has not been incorporated.

At a macro level:

- 331 or 65% of registrations have been successfully modelled against weather or flat daily usage.
- The measured savings for the modelled sites has been determined to an uncertainty of ±3.8% at 95% confidence.
- The measured savings figure is within 0.3% of the prior predicted savings achieved through desktop analysis.

At a site level:

- The measured savings form a fairly normal distribution around the 9% average, however for any given site the savings range is ±100%.

From this we conclude that developing a generic savings equation from the aggregated data would not suitably represent the savings at any given site without further work to stratify the dataset (by project sub-type, business size, etc) to reduce the distribution of savings.

Rather, we believe that the developed, bottom up methodology and approach can be repeated in the future either at program level or disaggregated for analysis within smaller bundles.

We anticipate that the fundamentals of this process could be used to form the basis of a Recognised Energy Savings Activity under the NSW Energy Saving Scheme for the purpose of creating Energy Savings Certificates. This is further discussed in Section 14.

13.1. Future improvement recommendations

13.1.1. Plan and process improvements

Energetics recommends the following changes to the EESBP:

Recommendation	Description
Capture NMIs upfront	This project was achieved following an exhaustive matching exercise conducted by Ausgrid and Essential Energy. Moving forward, Energetics recommends that correct NMIs are obtained from sites as part of their initial engagement with the program. This will ensure that data for the right NMIs is sourced and eliminate the need for matching against customer data.
Obtain authority to acquire data upfront	Ausgrid and Essential Energy went to great lengths to provide data to Energetics to ensure confidentiality of customer data. The key reason for this was that OEH did not have EESBP participant permission to access it directly. This report does not contain any references to specific customers or EESBP registration numbers due to confidentiality reasons. Moving forward, Energetics recommends that OEH obtains written consent for it to request historical billing data from retailers and network providers on behalf of EESBP participants.
Obtain rights to any ESCs that may arise from projects (see Section 14)	Subject to OEH's preferred approach for developing a RESA and creating ESCs, it may be necessary for EESBP participants to sign over their rights (to OEH or a 3rd party Accredited Certificate Provider) to any ESCs claimable through the projects being implemented.
Build M&V into overall process (where cost effective), and identify & capture data relating to site-specific adjustments	Better and timelier M&V results will be achieved by taking steps to build OEH's M&V goals into the EESBP. By considering M&V earlier in the process, OEH may take advantage of other available M&V options (Options A, B or D). OEH may ultimately opt to employ a combination of approaches including: • Broad based Option C across the population, either through projects like this one, or investing in ongoing M&V systems and tools. • Targeted M&V for significant projects using Option A,B or D It is important that the costs versus benefits are considered when seeking to either conduct M&V in-house or via sub-contractor, or place additional requirements on EESBP participants. When considering this initiative, OEH should keep in mind the $538,000 overall annual savings figure observed via this project as well as internal budgets. Indicatively, an annual M&V budget would be in the order of $20,000 to $40,000 per annum.

Energetics recommends the following enhancements and future data analysis advice for this M&V Plan and process:

Recommendation	Description
Incorporate more localised weather station	Eligible sites modelled within this project were modelled using one of eight representative weather stations. In some cases a site demonstrated a correlation with temperature; however the R^2 value was not high enough to be usable. One reason for this may the lack of use of a localised weather station. In addition, sites that did correlate may have achieved a higher correlation if a more appropriate weather station was used. Energetics suggests that this be considered in future analysis or be built into automated analysis tools so that the maximum number of sites can be successfully modelled.
Quarterly versus monthly data	This project used pro-rated monthly data, which was then normalised into daily figures. However in some, indeed many cases, this was simply a normalisation of quarterly billing data with adhoc read dates. The prorating of quarterly data increases the number of data points, which may lead to higher correlations and lower uncertainty. Conversely, the 'triplication' of some bills can create visible 'steps' or blocks in the historical trend, which no longer aligns date wise with corresponding changes in weather. Energetics observed a number of sites that may have successfully modelled if this issue was explored further. Energetics recommends that this issue be considered in future analysis.
Further investigate sites that failed to model	For approximately 35% of eligible sites, a valid energy model could not be obtained. This may be due to many reasons; data related, changes in operations, correlation against a metric not explored within this project. Energetics recommends that OEH considers further investigating the 'significant' sites (high usage, large savings) to better understand the how the energy models may be enhanced to achieve a correlation. We believe that around 85% of sites could be modelled with further understanding. Note that it is likely that some sites simply won't correlate.
Aim to repeat analysis for existing sites to examine savings 'persistence' and add new sites as more sites become eligible.	OEH may wish to repeat this analysis in the future to obtain updated savings figures. For 331 of these sites the baseline has already been developed, and it is simply a case of updating the data. New sites could also be added. OEH may also seek to investigate savings persistence from its projects. Options for future analysis include: 1. Repeat analysis on an annual basis using similar techniques 2. Commercialise modelling tool for wider distribution 3. Further investigate ways to develop ongoing M&V reporting capabilities.

Recommendation	Description
Expand the demand analysis to the top summer and top winter demand days	The demand analysis M&V process was conducted on the maximum monthly demand for each of month during the baseline and post-retrofit periods. OEH may wish to expand this analysis to the ten top demand days during the summer months and the ten top demand days during the winter months. These top peak days drive demand charges for customers using the ratchet methodology; therefore this analysis will provide more insight into the impact of EESBP on participants' energy bills. In addition, these top demand days are of specific interest to network businesses as they drive the need to extra network capacity.

14. Seeking ESCs for EESBP projects

From the modelled sites, Energetics estimates there are potentially 2,000 ESCs that could be claimed under the ESS each year. Using an average ESC price of $25/ESC, this equates to a potential for the modelled sites to provide $50,000 per annum worth of ESCs.

If the 'greater than 10%' view is taken, then this potential rises to 2,250 ESCs with a value of around $56,000.

The figures also rise when the non-modelled sites are also considered. Four scenarios are summarised in the table below.

Scenario	Potential annual ESCs	Potential annual value ($) (@$25/ESC)
Modelled sites (331)	2,000	$50,000
Modelled sites with >10% savings (164)	2,250	$56,250
All sites within population (509)	2900	$72,500
All sites with >10% savings (251)	3,400	$85,000

The challenge is to develop a RESA that IPART will approve of. As previously stated, Energetics advises against attempting to developed an 'aggregated' based RESA, whereby a single savings equation would be adopted for each site.

Energetics proposed options include:

1. Prepare a single RESA covering analysis from this project. This has the advantage of the analysis being completed once, centrally each year. This could be achieved with a CarbonScope M&V style approach or by using a spreadsheet approach as per this project.
2. Prepare tools and simple guidance to assist sites to analyse Option C quickly and easily. OEH may prepare a site-based RESA that all EESBP participants would be granted access to, and participants would become ACPs or claim through an aggregator. This approach would require upfront work from OEH to develop the RESA with IPART, develop a commercialised

tool that it can distribute to participants and ensure other requirements (such are record keeping are adhered to)

3. As an alternative, OEH may simply consider pursuing ESCs for lighting projects via the Deemed Savings Method by use of the deemed lighting calculator, as lighting projects represent over half of total savings within our analysis.

Key hurdles for OEH to overcome are:

- the issue of ESC ownership - OEH may seek to have EESBP participants sign over ESC rights, or act as a facilitator
- who will act as the Accredited Certificate Provider?

Energetics recommends that IPART is engaged to review the findings of this project and to discuss the possible scenarios above.

Appendix A. Population energy analysis summaries

Table A1: All sites – Registrations

Industry Type	Air compression	Boilers	Hot water	HVAC	Insulation	Lighting	Motors and VSDs	Multiple	Refrigeration	Grand Total
Accommodation			2	7	1	2		3	7	**22**
Agriculture, forestry, fishing		2	12	2		1	13	3	7	**40**
Café / Restaurants		1	10	15		22		12	67	**127**
Communication				1		1				**2**
Construction						1				**1**
Cultural / Recreational Services			2	2		3		2	2	**11**
Education					1	3	1			**5**
Electricity, gas and water			1			1				**2**
Finance / Insurance services			1	2		1		2		**6**
Health / Community services				7	3	21		5	1	**37**
Manufacturing	2	1		1	1	6	1	3		**15**
Mining						1				**1**
Personal / Other services	1	2	5	14	2	29	2	7	3	**65**
Property / Business services				2	2	14			1	**19**
Retail trade	1	1	2	27	2	57		12	29	**131**
Transport / Storage	1		2	1		14		2	1	**21**
Wholesale trade				1		3				**4**
Grand Total	**5**	**7**	**37**	**82**	**12**	**180**	**17**	**51**	**118**	**509**

Table A2: All sites – Measured Savings for modelled sites and estimated savings for non-modelled sites (kWh)

Industry Type	Air compression	Boilers	Hot water	HVAC	Insulation	Lighting	Motors and VSDs	Multiple	Refrigeration	Grand Total
Accommodation			11,264	67,504	701	34,258		-3,302	36,533	**146,957**
Agriculture, forestry, fishing		4,251	165,240	5,171		3,580	133,757	25,051	-4,531	**332,519**
Café / Restaurants		-16,854	116,921	-17,257		190,444		46,616	66,645	**386,515**
Communication				-3,489		1,892				**-1,597**
Construction						3,496				**3,496**
Cultural / Recreational Services			5,803	7,232		77,247		2,368	-1,451	**91,199**
Education					312	4,283	-527			**4,068**
Electricity, gas and water			146			805				**951**
Finance / Insurance services			438	10,279		10,890		5,699		**27,306**
Health / Community services				-15,882	820	153,111		27,537	7,441	**173,027**
Manufacturing	-710	-3,989		1,256	-1,091	-142,960	4,113	-14,606		**-157,987**
Mining						6,045				**6,045**
Personal / Other services	21,083	-4,640	77,112	40,083	43,219	159,923	1,545	21,627	-7,446	**352,507**
Property / Business services				3,731	-4,689	80,586			-12,409	**67,219**
Retail trade	9,087	41,014	8,296	167,928	8,697	422,818		115,745	91,361	**864,947**
Transport / Storage	2,149		108	128		357,259		4,896	-2,899	**361,641**
Wholesale trade				595		30,843				**31,438**
Grand Total	**31,609**	**19,781**	**385,328**	**267,280**	**47,969**	**1,394,520**	**138,888**	**231,631**	**173,243**	**2,690,250**

Table A3: Modelled Sites – Registrations

Industry Type	Air compress ion	Boilers	Hot water	HVAC	Insulation	Lighting	Motors and VSDs	Multiple	Refrigerat ion	Grand Total
Accommodation			1	5	1	1		2	2	**12**
Agriculture, forestry, fishing		1	4	2		1	4	1	3	**16**
Café / Restaurants		1	8	11		13		8	49	**90**
Communication				1		1				**2**
Construction						1				**1**
Cultural / Recreational Services			1	1		2		1	2	**7**
Education					1	1				**2**
Electricity, gas and water			1			1				**2**
Finance / Insurance services			1	1				1		**3**
Health / Community services				4		13		5	1	**23**
Manufacturing		1		1	1	4				**7**
Mining										**0**
Personal / Other services			3	7		16	1	4	3	**34**
Property / Business services				2		7				**9**
Retail trade	1	1	2	20		49		7	25	**105**
Transport / Storage	1			1		11		1	1	**15**
Wholesale trade						3				**3**
Grand Total	**2**	**4**	**21**	**56**	**3**	**124**	**5**	**30**	**86**	**331**

Table A4: Modelled Sites – Measured Savings for modelled sites (kWh)

Industry Type	Air compression	Boilers	Hot water	HVAC	Insulation	Lighting	Motors and VSDs	Multiple	Refrigeration	Grand Total
Accommodation			-259	62,390	701	32,256		445	62,916	**158,448**
Agriculture, forestry, fishing		8,247	-12,332	5,171		3,580	49,255	4,445	2,873	**61,240**
Café / Restaurants		-16,854	69,886	19,820		98,987		56,924	86,108	**314,870**
Communication				-3,489		1,892				**-1,597**
Construction						3,496				**3,496**
Cultural / Recreational Services			2,580	5,795		7,311		370	-1,451	**14,606**
Education					312	2,657				**2,969**
Electricity, gas and water			146			805				**951**
Finance / Insurance services			438	6,464				2,677		**9,578**
Health / Community services				-14,741		123,009		27,537	7,441	**143,246**
Manufacturing		-3,989		1,256	-1,091	-141,713				**-145,537**
Mining										**0**
Personal / Other services			-140	21,239		103,019	17	14,175	-7,446	**130,863**
Property / Business services				3,731		20,307				**24,038**
Retail trade	9,087	41,014	8,296	137,705		381,429		69,064	106,514	**753,109**
Transport / Storage	2,149			128		362,496		3,742	-2,899	**365,616**
Wholesale trade						30,843				**30,843**
Grand Total	**11,236**	**28,417**	**68,615**	**245,469**	**-78**	**1,030,375**	**49,272**	**179,379**	**254,056**	**1,866,739**

Table A5: Non Modelled Sites – Registrations

Industry Type	Air compression	Boilers	Hot water	HVAC	Insulation	Lighting	Motors and VSDs	Multiple	Refrigeration	Grand Total
Accommodation			1	2		1		1	5	**10**
Agriculture, forestry, fishing		1	8				9	2	4	**24**
Café / Restaurants			2	4		9		4	18	**37**
Communication										
Construction										
Cultural / Recreational Services			1	1		1		1		**4**
Education						2	1			**3**
Electricity, gas and water										
Finance / Insurance services				1		1		1		**3**
Health / Community services				3	3	8				**14**
Manufacturing	2					2	1	3		**8**
Mining						1				**1**
Personal / Other services	1	2	2	7	2	13	1	3		**31**
Property / Business services					2	7			1	**10**
Retail trade				7	2	8		5	4	**26**
Transport / Storage			2			3		1		**6**
Wholesale trade				1						**1**
Grand Total	**3**	**3**	**16**	**26**	**9**	**56**	**12**	**21**	**32**	**178**

Table A6: Non Modelled Sites – Estimated savings for non-modelled sites (kWh)

Industry Type	Air compress ion	Boilers	Hot water	HVAC	Insulation	Lighting	Motors and VSDs	Multiple	Refrigerat ion	Grand Total
Accommodation			11,524	5,114		2,001		-3,747	-26,383	**-11,492**
Agriculture, forestry, fishing		-3,996	177,572				84,502	20,606	-7,404	**271,279**
Café / Restaurants			47,035	-37,077		91,457		-10,307	-19,462	**71,645**
Communication										
Construction										
Cultural / Recreational Services			3,223	1,437		69,936		1,998		**76,593**
Education						1,626	-527			**1,099**
Electricity, gas and water										
Finance / Insurance services				3,816		10,890		3,022		**17,728**
Health / Community services				-1,141	820	30,102				**29,781**
Manufacturing	-710					-1,247	4,113	-14,606		**-12,450**
Mining						6,045				**6,045**
Personal / Other services	21,083	-4,640	77,252	18,844	43,219	56,905	1,529	7,452		**221,644**
Property / Business services					-4,689	60,279			-12,409	**43,181**
Retail trade				30,223	8,697	41,389		46,681	-15,153	**111,838**
Transport / Storage			108			-5,237		1,154		**-3,975**
Wholesale trade				595						**595**
Grand Total	**20,374**	**-8,636**	**316,713**	**21,811**	**48,048**	**364,145**	**89,616**	**52,252**	**-80,812**	**823,511**

Appendix B. Population demand analysis summary

Rego	Technology summary	Aggregated demand savings				Peak Month Demand Savings				Annual Capacity Reduction			
		BAU Demand (kVA)	Actual Demand (kVA)	Demand Savings (kVA)	Savings % of BAU	BAU Demand (kVA)	Actual Demand (kVA)	Demand Savings (kVA)	Savings % of BAU	BAU Capacity (kVA)	Actual Capacity (kVA)	Capacity Savings (kVA)	Capacity Savings % of BAU
12642	Lighting	572.7	431.0	141.7	24.7%	50.32	33.31	17.01	33.80%	50.32	43.10	7.22	14.35%
11504	HVAC	1,160.1	1,168.1	-7.9	-0.7%	146.85	101.48	45.38	30.90%	146.85	148.10	-1.25	-0.85%
1442	Refrigeration	1,526.8	1,387.9	138.9	9.1%	186.78	134.71	52.07	27.88%	186.78	144.33	42.45	22.73%
12668	Lighting	2,493.0	2,047.6	445.4	17.9%	257.11	186.67	70.44	27.40%	257.11	208.93	48.18	18.74%
12049	Lighting	816.6	633.7	182.9	22.4%	74.47	54.58	19.89	26.71%	74.47	57.22	17.25	23.17%
2311	Lighting	825.2	628.9	196.3	23.8%	82.40	60.45	21.96	26.65%	82.40	64.32	18.08	21.95%
12665	Refrigeration	498.6	454.0	44.6	9.0%	44.78	35.79	8.99	20.08%	44.78	39.71	5.08	11.34%
9135	Lighting	439.3	380.4	58.9	13.4%	38.27	31.31	6.96	18.19%	38.27	38.12	0.15	0.39%
12738	Lighting	912.0	838.2	73.9	8.1%	96.39	79.64	16.75	17.38%	96.39	79.64	16.75	17.38%
6127	Lighting	447.9	396.0	52.0	11.6%	47.21	39.16	8.04	17.04%	47.21	44.45	2.75	5.83%
11042	Lighting	652.8	552.0	100.8	15.4%	58.83	48.93	9.90	16.82%	58.83	55.84	2.99	5.08%
636	Lighting	778.9	698.2	80.7	10.4%	72.26	62.04	10.22	14.15%	72.26	66.52	5.74	7.95%
4545	HVAC	1,011.1	962.5	48.5	4.8%	101.17	87.31	13.86	13.70%	101.17	100.21	0.96	0.95%

Rego	Technology summary	Aggregated demand savings				Peak Month Demand Savings				Annual Capacity Reduction			
12402	Refrigeration	723.7	699.4	24.3	3.4%	70.16	62.28	7.88	11.24%	70.16	69.60	0.56	0.80%
12737	Lighting	1,059.9	1,032.2	27.8	2.6%	116.70	104.00	12.71	10.89%	116.70	108.63	8.08	6.92%
10140	Refrigeration	761.4	784.7	-23.3	-3.1%	87.19	78.80	8.39	9.62%	87.19	92.75	-5.56	-6.37%
11639	Lighting	464.2	454.4	9.8	2.1%	43.90	41.09	2.81	6.40%	43.90	44.64	-0.74	-1.69%
12830	Refrigeration	613.0	658.0	-45.0	-7.3%	54.01	51.37	2.64	4.89%	54.01	58.47	-4.46	-8.25%
7475	Refrigeration	398.0	395.5	2.5	0.6%	33.90	32.66	1.24	3.66%	33.90	34.41	-0.51	-1.49%
12212	Refrigeration	785.9	776.4	9.5	1.2%	94.47	91.16	3.31	3.51%	94.47	91.16	3.31	3.51%
13478	Refrigeration	437.4	477.8	-40.4	-9.2%	41.24	40.86	0.38	0.91%	41.24	43.89	-2.65	-6.44%
122	Refrigeration	382.4	396.4	-14.0	-3.7%	34.78	36.44	-1.65	-4.75%	34.78	36.44	-1.65	-4.75%
11817	Refrigeration	643.3	688.9	-45.5	-7.1%	63.49	67.12	-3.63	-5.71%	63.49	67.12	-3.63	-5.71%
1197	Lighting	537.3	826.1	-288.8	-53.8%	57.81	68.93	-11.12	-19.23%	57.81	72.13	-14.32	-24.76%