



**STUDY REPORT SR 277/1 [2012]**

# **BEES** INTERIM REPORT

**Building Energy End-use Study - Year 5**

## **BUILDINGS - SIZE, MANAGEMENT AND USE**

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# **BEES (BUILDING ENERGY END-USE STUDY) YEAR 5: BUILDINGS - SIZE, MANAGEMENT AND USE**

## **BRANZ Study Report SR 277/1**

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## **Reference**

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## **Reviewers**

Ian Page and Nigel Isaacs – BRANZ Ltd

# PREFACE

Understanding how energy and water resources are used in non-residential buildings is key to improving the energy and water efficiency of New Zealand's building stock. More efficient buildings will help reduce greenhouse gas emissions and enhance business competitiveness. The Building Energy End-use Study (BEES) is taking the first step towards this by establishing where and how energy and water resources are used in non-residential buildings and what factors drive the use of these resources.

The BEES study started in 2007 and will run for six years, gathering information on energy and water use through carrying out surveys and monitoring non-residential buildings. By analysing the information gathered, we aim to answer eight key research questions about resource use in buildings:

1. What is the aggregate energy and water use of non-residential buildings in New Zealand?
2. What is the average energy and water use per unit area per year?
3. What characterises the buildings that use the most energy and water?
4. What is the average energy use per unit area for different categories of building use?
5. What are the distributions of energy and water use?
6. What are the determinants of water and energy-use patterns e.g. structure, form, function, occupancy, building management etc?
7. Where are the critical intervention points to improve resource use efficiency?
8. What are the likely future changes as the building stock type and distribution change?

Understanding the importance and interaction of users, owners and those who service non-residential buildings is also an important component of the study.

For the BEES study, non-residential buildings have been defined using categories in the New Zealand Building Code, but in general terms the study is mainly looking at commercial office and retail buildings. These vary from small corner store dairies to large multi-storey office buildings. For more information on the building types included in the study please refer to BRANZ report SR224 Building Energy End-use Study (BEES) Years 1 & 2 (2009) available on the BEES website ([www.branz.co.nz/BEES](http://www.branz.co.nz/BEES)).

The study has two main methods of data collection – a high level survey of buildings and businesses, and intensive detailed monitoring of individual premises.

The high level survey initially involved collecting data about a large number of buildings. From this large sample, a smaller survey of businesses within buildings was carried out which included a phone survey, and collecting records of energy and water use and data on floor areas. The information will enable a picture to be built up of the total and average energy and water use in non-residential buildings, the intensity of this use and resources used by different categories of building use, answering research questions one to four.

The detailed monitoring of individual premises involves energy and indoor condition monitoring, occupant questionnaires and a number of audits, including: appliances, lighting, building, hot water, water, and equipment.

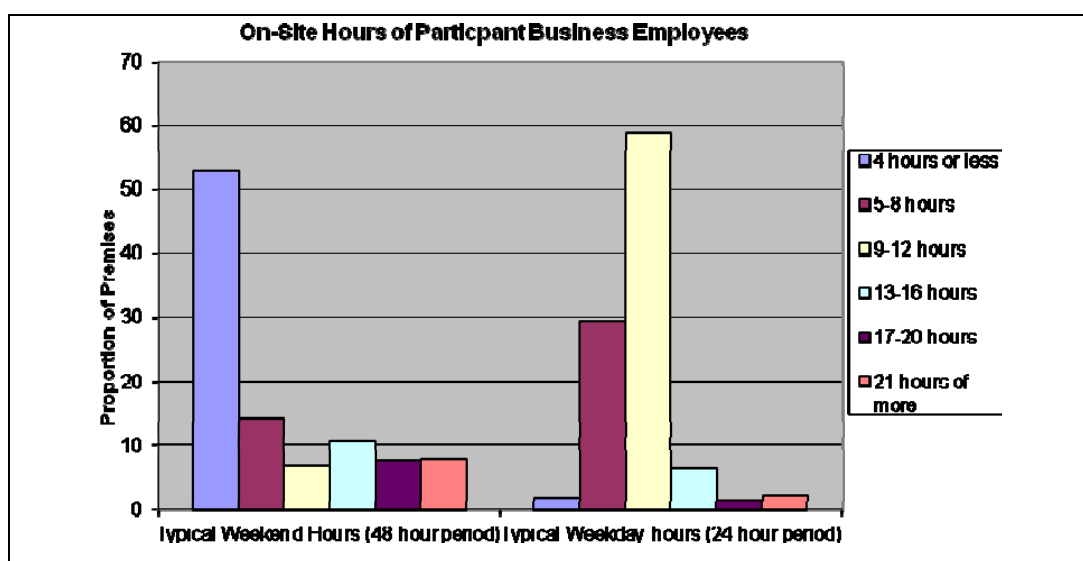
This report presents a summary of the data collected in the phone survey of 791 premises which was collected as part of the high level survey. This information collected in the phone survey is currently and will continue to be used to support analysis in all parts of BEES work.

## SUMMARY

- 791 premises from throughout New Zealand have participated in the BEES phone survey.
- The majority (85%) of premises surveyed are tenants with only 13% being owner-occupiers.
- Most premises (70.5%) pay for their energy directly to their supplier.
- Not surprisingly nearly all premises reported having reticulated electricity (99.4%)

This report presents basic data arising from the premise surveying undertaken within BEES. Now nearing completion, surveying has involved 791 premises to date.

The premises are strongly dominated by the following retail trade sectors: property; and business services. The majority of premises employ managerial, professional or clerical and administrative workers. Over two-fifths of premises report that they employ sales workers. About one-fifth of premises have technicians or trade workers working on site. Most premises have employees on site for nine-12 hours during week days, but ten percent have one or more employees on site for more than 21 hours on a single week day.



**Figure A: Hours Participating Business Employees On-Site Weekdays and Weekends**

The vast majority of premises (85.2 percent) are tenants, with only a tiny proportion (1.4 percent) of sub-tenants and the remaining businesses being owner-occupiers. These owner-occupier businesses make up a small (12.8 percent) but definite minority of businesses.

**Table A: Tenure Status of Participant Premises**

Tenure	Premises	% of Premises
Tenants	674	85.2
Owner-occupier	101	12.8
Sub-tenant	11	1.4
Don't know	5	0.6
Total	791	100.0

Just under two-thirds (62.2 percent) of the businesses have undertaken some sort of refit of the space within their current building, but the vast majority of reported refits are cosmetic and there is little evidence of incorporation of energy or water efficiency improvements. This is despite the majority of premises paying directly for energy rather than through their rent and, therefore, being exposed directly to energy

costs. Unlike energy costs, most premises are not directly exposed to water costs. Water use is only directly billed in a small number of premises.

**Table B: Energy Payments Pattern for All Sources of Energy**

<b>Energy Payment for All Sources</b>	<b>Premises</b>	<b>% of Premises</b>
All sources paid to suppliers	558	70.5
All sources itemised in lease or rent	94	11.9
All sources non-itemised in lease or rent	56	7.1
Mixed payment	22	2.8
Unknown or not specified	61	7.7
Total	791	100.0

The primary energy source of these businesses is reticulated electricity. Almost all premises (99.4 percent) report consuming reticulated electricity with significantly fewer businesses consuming gas or diesel fuel.

**Table C: Energy Types Reported by Participant Businesses**

<b>Energy Type</b>	<b>Premises</b>	<b>% of Premises</b>
Reticulated Electricity	786	99.4
Natural Gas	104	13.1
Diesel or Fuel Oil	22	2.8
Wood, Waste or Biomass	5	0.6
Self-Generated Electricity	10	1.3
Coal	2	0.3
Geothermal	1	0.1

Smaller buildings show a different profile of management and use from larger buildings. The survey data suggests that:

- Energy price signalling is likely to have a more direct impact on premises in smaller buildings;
- Premises in larger buildings are more likely to include energy costs within rents and have large numbers of tenants in a building who do not have to deal directly with energy costs;
- Opportunities for improved energy efficiency through building and facility management needs to be shaped according to building size because:
  - Large buildings are more likely to be managed by professional property, building or facility managers; and
  - Small buildings are either unmanaged or managed by owner-occupiers, tenants or landlords with little awareness or interest in resource efficiency.
- Small buildings should be designed for energy efficiency because occupancy tends to be of longer duration and the propensity to refit is low. By contrast, in large buildings the turnover of tenants is associated with refit. Fitting out currently tends to be cosmetic but offers opportunities to improve energy efficiency. Similarly there is limited potential to manage complex systems. Larger buildings are more, although by no means universally, likely to have professional or dedicated building/facilities management.

# CONTENTS

<b>1.</b>	<b>INTRODUCTION .....</b>	<b>1</b>
<b>2.</b>	<b>BEES AND THE PREMISE SURVEYING.....</b>	<b>3</b>
2.1	BEES Data.....	3
2.2	The Premise Surveying .....	4
<b>3.</b>	<b>SURVEYING PREMISES .....</b>	<b>6</b>
3.1	Pre-Surveying Pilot Study .....	6
3.2	Implementing the Telephone Survey.....	7
3.3	Yield and Response Rates .....	8
<b>4.</b>	<b>THE PREMISES .....</b>	<b>9</b>
4.1	Business Characteristics of Premises .....	9
4.2	Building Characteristics and Refit Practices .....	10
4.3	Tenure, Lease and Management.....	11
4.4	Occupancy Characteristics.....	13
4.5	Premises and Energy Sources.....	15
4.6	Energy and Water Purchase .....	15
4.7	Equipment and Appliances .....	17
<b>5.</b>	<b>IMPLICATIONS OF BUILDING SIZE .....</b>	<b>19</b>
<b>6.</b>	<b>SOME LEARNINGS.....</b>	<b>25</b>

## INFOBOXES

Infobox 1: Data Sets and Acquisition Pathways.....	4
Infobox 2: Information Domains and Primary Sources.....	5
Infobox 3: Quotable Value Building Use Categories .....	19

## FIGURES

Figure 1: Distribution of Businesses Occupation of Current Premises (n=748) .....	13
Figure 2: Hours Participating Business Employees On-Site Weekdays^ and Weekends* .....	14
Figure 3: Distribution of Clients Visiting Premises on a Typical Day (52 missing cases) .....	15
Figure 4: Premise Energy Payments to Suppliers or In Rent by Building Size .....	22
Figure 5: Building Management by Building Size .....	23

## TABLES

Table 1: Estimated Size of Buildings in Which Eligible Premises are Located, by Sample Strata (n=791) .....	2
Table 2: Pilot Businesses Response Categories After Two Weeks' Telephone Contacting (n=100) .....	6
Table 3: Pilot Building Yield After Two Weeks' Telephone Contacting (n=37)* .....	7
Table 4: Premise Survey Participants by Wave .....	7
Table 5: Business Sector Categories and Participating Businesses .....	9
Table 6: Occupations Represented in Participant Businesses (n=791)* .....	10
Table 7: Estimated Size of Buildings in Which Premises Are Sited .....	10
Table 8: Specified Refit Components* .....	11
Table 9: Tenure Status of Participant Premises .....	12
Table 10: The Lease Arrangements of Tenants and Sub-Tenants (n=685) .....	12
Table 11: Duration of Occupation .....	12
Table 12: Premises Occupation of Floors .....	13
Table 13: Hours Participating Business Employees On-Site Weekdays^ and Weekends* .....	14
Table 14: Energy Types Reported by Participant Businesses (n=791) .....	15
Table 15: Proportion of Energy Payments Included in Lease or Rent by Energy Type .....	16
Table 16: Energy Payments Pattern for All Sources of Energy .....	16
Table 17: Equipment and Appliance Prevalence in Participant Businesses .....	18
Table 18: Building Use Type by Building Size .....	20
Table 19: Tenure Status for Premise by Building Size .....	21
Table 20: Premise Reported Building Management by Building Size .....	22
Table 21: Prevalence of Appliances in Premises by Building Size .....	24

# 1. INTRODUCTION

Establishing the patterns of energy and water use in non-residential buildings requires a robust understanding of the buildings that make up the non-residential stock, the premises that occupy those buildings and the way in which those premises operate from those buildings. While that interaction between building, premise and business use is recognised as an important interaction, BEES is one of the few research programmes that has attempted to capture data on each of these elements in a way that those interactions can be explored. In this sense, BEES is both unique and ambitious.

Like all ambitious research, it has presented a series of challenges both in relation to data collection and in relation to analysis. It has also required a gradual accretion of data and the matching of data from different data sets. To allow data to inform our own understanding and the wide range of research end-users in the building and construction, property management and energy sectors, sets of data have been analysed as data collection has progressed.

This report presents data drawn from the successive waves of premise telephone surveying that has been undertaken over the last two years. That process of data collection is now almost complete with only a few premises associated with businesses that have referred BEES to head offices or some government agencies yet to complete the telephone interviews or self-complete questionnaires. The data from that completed surveying of the 791 premises has now been partially matched to data related to the floor size of the buildings where data is available from other BEES datasets. This matching process will allow us to explore the relationship between building size, premise characteristics, occupancy and business.

This paper provides:

- A description of some of the data in relation to the key variables collected in the telephone survey. It extends the descriptive analyses that have been progressively released over the data collection process; and
- An initial description of some of the key characteristics of premises into the size of the buildings in which those premises are located.

The report is structured as follows:

- Section 2 sets out the broad objectives of this component of the research and describes its constituent parts including the telephone surveying;
- Section 3 describes the method used to acquire the data analysed in this report;
- Section 4 provides an analysis of the data related to 791 premises in relation to the way building size articulates with:
  - Business characteristics of the participant businesses;
  - Building characteristics in buildings which participants operate;
  - Tenure and lease environment in which participants operate;
  - Occupancy characteristics of the participants;
  - Energy sources used by participant businesses;
  - Mechanisms by which participants purchase energy and water; and
  - Appliances and equipment on the premises of the participant businesses.
- Section 5 provides descriptive statistics related to the profile of premises in differently sized buildings.

Table 1 sets out the estimated size of the buildings in which participant premises are located. Size estimates have been generated by triangulating data from a number of sources including: QV information, calculations undertaken using Street View, and premise self reports. It will be noted that in most cases the estimated size of buildings selected in the sampling process matches with the sample stratum from which they were drawn. The buildings in each sample stratum were allocated to that stratum on the basis of information contained in their valuation records.



Not all buildings, however, turned out to be the size indicated in the valuation records. The purple shading in Table 1 indicates buildings that are smaller than those expected in the sample stratum. The yellow cells are buildings that have a size consistent with their sample stratum.

The pink cells indicate buildings that are bigger than their allocated sample stratum. The Table also indicates that a number of buildings in each stratum are yet to have a size estimation established on the basis of the triangulation process.

**Table 1: Estimated Size of Buildings in Which Eligible Premises are Located, by Sample Strata (n=791)**

Estimated Building Size	Sample Strata				
	Stratum 1	Stratum 2	Stratum 3	Stratum 4	Stratum 5
1-649m <sup>2</sup>	53	5	2	1	0
650-1,499m <sup>2</sup>	6	56	11	2	0
1,500-3,499m <sup>2</sup>	0	8	88	13	0
3,500-8,999m <sup>2</sup>	1	2	16	144	25
9,000m <sup>2</sup> or more	0	0	1	17	204
Not estimated	6	15	23	50	42

## 2. BEES AND THE PREMISE SURVEYING

BEES is concerned with optimising the efficiency of energy and water use in New Zealand's non-residential building stock. The programme has evolved into the five components of:

- Aggregate resource use patterns focusing on energy use in particular, but also on water consumption;
- The determinants of resource use;
- Building dynamics;
- Optimising resource use; and
- Modelling.

Those components are designed to progressively establish:

- The patterns of energy and water use across the non-residential stock and how those patterns are distributed across the non-residential building sector;
- End-use patterns and determinants of energy and water consumption;
- How building dynamics impact or drive end-use patterns and consumption;
- What opportunities there are to optimise energy and water efficiency in buildings; and
- Models and simulations that provide an ability to forecast both macro- and micro-level non-residential building energy and water use.

### 2.1 BEES Data

The BEES programme gathers data from multiple sources which broadly fall into four categories:

- Administrative data sources, in particular:
  - Valuation data;
  - Energy supply data.
- Existing non-administrative data sources, in particular:
  - Business directory data;
  - Street View.
- Reported data from occupants/managers/owners of selected buildings.
- Observed data through:
  - Direct monitoring of resource use;
  - Direct on-site observations.

Some of this data can be directly accessed without dealing with building occupants, owners or managers. Those data are listed in Infobox 1 under the "Direct Source Pathway". Other data can only be gathered through direct contact with, or with the agreement of, building occupants. Those data are set out in the "Building/Business Pathway" in Infobox 1.

**Infobox 1: Data Sets and Acquisition Pathways**

Dataset Type	Acquisition Pathway	
	<i>Building/Business Pathway</i>	<i>Direct Source Pathway</i>
<b>Administrative data</b>	Resource supplier data	Valuation data
<b>Other existing data</b>		Business directory data, Street View and satellite data, Whoiswhere <sup>1</sup>
<b>Reported occupant/owner data</b>	Interview-Based Data	
<b>Observed data</b>	Direct monitoring, Detailed on-site observation	Limited on-site observation

## 2.2 The Premise Surveying

The premise surveying is part of a broader set of work designed to address three questions:

- What is the aggregate energy/water consumption of non-residential buildings?
- What is the average kWh/m<sup>2</sup>/annum energy use and litres/m<sup>2</sup>/annum water use?
- What categories of non-residential buildings appear to contribute most to the aggregate energy/water consumption of the non-residential building sector?

The successful implementation of this component has involved:

- Collecting data from business directories, property valuation and Street View to:
  - Assist with drawing a robust sample of buildings;
  - Provide a unique point around which substantive data from other sources can be matched; and
  - Provide contacts with building occupants to allow recruitment into the surveying and monitoring processes.
- Surveying premises located in randomly selected buildings; and
- Collecting data around energy and water consumption from suppliers and/or directly from premises.

Infobox 2 sets out the information domains and primary sources of data used in this component.

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<sup>1</sup> A private organisation who supplied business contact information.

## Infobox 2: Information Domains and Primary Sources

Information Domain	Information	Source
<b><i>Building</i></b>	Age Number of floors Size of floor plate Total building floor area Building materials Building characteristics	QV Street View/Google/on site Street View/Google/on site Street View/Google/on site/QV Street View/Google/on site Street View/Google/on site
<b><i>Location</i></b>	Region City Suburb Address Density and mix environment	QV and Business Directory QV and Business Directory QV and Business Directory QV and Business Directory Statistics New Zealand
<b><i>Use</i></b>	QV classification Business names, phone number, postal address Business types	QV Business Directory Business Directory, Street View/Google/on site
<b><i>Occupation</i></b>	Total number of businesses Businesses per floor Employees per business Hours of use per business	Business Directory/survey Survey Survey Survey
<b><i>Building ownership and management</i></b>	Owner Contact address for owner Owner-occupied Tenanted Tenancy agreement Building manager Operation of heating and cooling	QV Possibly QV Business Directory/survey Business Directory/survey Survey Survey Survey
<b><i>Resource types</i></b>	Water Electricity Gas Other	Supplier and survey Supplier and survey Supplier and survey Supplier and survey
<b><i>Suppliers and billing</i></b>	Water Electricity Gas Other	Supplier and survey Supplier and survey Supplier and survey Supplier and survey

### 3. SURVEYING PREMISES

This section provides a brief overview of the surveying of premises in buildings selected through the sampling strategy which has been outlined in detail in the *BEES Years 1 & 2 Study Report* (Isaacs et al, 2009) which summarises the:

- Pre-surveying pilot study;
- Telephone survey that generated the data analysis in this report; and
- Response rates and yields.

#### 3.1 Pre-Surveying Pilot Study

Surveying of premises to acquire the data set out in Infobox 2 was piloted in early 2009 and reported in April of that year. The pilot tested a number of key processes necessary to establish the viability and costs around business surveying of premises in selected buildings. Those included testing processes for generating contacts for occupants of eligible buildings, interview instrumentation and response rates.

In relation to generating contacts for occupants in eligible buildings, the pilot concluded that the analysis of valuation data suggested that that dataset might have 25 percent or less of missing and incorrect data. The business/building matching process that was intended to establish contact information for surveying showed less certainty. Business/building matching through the business directory process generated matches for only 59.7 percent of buildings. In addition, there were errors with around 12 percent of identified businesses. That process appeared to understate the number of businesses within buildings, with business directory matching generating an average of 2.7 businesses per building while other search processes generated an average of 5.8 businesses per building.

The pilot also involved pre-testing the survey instrument prior to full piloting over a two-week period, with 100 businesses derived from the building/business matching process. To maximise response rates, the questionnaire was designed to be short and limit responses to relatively straightforward aspects of business life within buildings. The questionnaire was implemented by telephone with three attempts made in the two-week period of piloting to make contact with selected buildings and their associated businesses.

Fourteen percent of businesses agreed to complete the questionnaire, while 35 percent refused and 33 percent suggested that the interviewer needed to call back. A significant proportion of businesses could not be contacted or were ineligible (Table 2). The pilot report advised that response rates could be expected to be in the region of 20-50 percent.

**Table 2: Pilot Businesses Response Categories After Two Weeks' Telephone Contacting (n=100)**

Response Category	% of Pilot Sample Businesses
Agreed	14
Refused	35
Non-complete	1
Call back	33
No engagement	5
Not eligible/not contactable	12
Total	100

Similarly, the pilot indicated that building yield was sensitive to rules regarding the proportions of premises that required if aggregated energy and water use was to provide a representation of the building. The yield categories on a building basis for the pilot are set out in Table 3. That Table shows that 43 percent of

all buildings had either some businesses not partake or complete refusal. Twenty seven percent of buildings had all or some businesses in the building agreeing to participate.

**Table 3: Pilot Building Yield After Two Weeks' Telephone Contacting (n=37)\***

Response Category	Buildings	% of Pilot Sample Buildings
Agreed – some businesses	6	16
Agreed – all businesses	4	11
Refused – some businesses	10	27
Refused – all businesses	6	16
No engagement – some businesses	3	8
No engagement – all businesses	0	0
Call back – some businesses	8	22
Call back – all businesses	11	30
Not eligible/not contactable – some businesses	6	16
Not eligible/not contactable – all businesses	2	5

\*Multiple response table.

The pilot also found that while the instrumentation was appropriate, to avoid lowering response rates stringent control of the questionnaire length, assiduous call back and robust replacement strategies were required. The inherent problems of recruitment were clearly going to be exacerbated by uncertainty around the building/business coverage provided by the business directory approach.

## 3.2 Implementing the Telephone Survey

Subsequent to piloting, the business premise telephone based survey has been progressively undertaken since 2010 in three waves. Wave 1 consisted of surveying a set of Strata 1-4 buildings, followed by a set of Stratum 5 buildings which was undertaken by New Zealand Research Ltd in May and June 2010. This was subsequently followed in the latter part of 2011 and early 2012 with Wave 2 and Wave 3 surveying. Some premises chose to respond to self-complete questionnaires. For Wave 2 and 3, some of these are still to be collected. Table 4 sets out the numbers of premises participating in each wave.

**Table 4: Premise Survey Participants by Wave**

Building Size	Surveying Wave			
	Wave 1 2010	Wave 2 2011	Wave 3 2012	Total
1-649m <sup>2</sup>	39	5	17	61
650-1,499m <sup>2</sup>	48	11	15	74
1,500-3,499m <sup>2</sup>	64	6	37	107
3,500-8,999m <sup>2</sup>	78	57	48	183
9,000m <sup>2</sup> or more	92	64	56	212
<b>Total</b>	<b>321</b>	<b>143</b>	<b>173</b>	<b>637*</b>

\*136 not yet estimated and a further 18 are surveys completed separate to the surveying waves<sup>2</sup>.

The questionnaire used in surveying was redeveloped by CRESA in light of the pilot findings and to better accommodate the needs of New Zealand Research Ltd's CATI technology. It was also slightly amended in the light of Strata 1-5 Wave 1 survey results and to assist data matching from other datasets.

<sup>2</sup> Either self-complete surveys or surveys completed as part of the separate government department follow-up process.

### 3.3 Yield and Response Rates

In the pilot, 17 percent of businesses or premises were non-contactable or unusable. In Wave 1, Strata 1-4, 19 percent of premises were non-contactable or unusable. In Stratum 5, however, this proportion rose significantly to 44 percent. This reflected the inaccuracies associated with attempts to reduce front-end work by matching web-identified buildings with commercial directories. For Waves 2 and 3, premises and telephone numbers for premises in sampled buildings were identified through “Whoiswhere”. This provided an improvement on the directory approach used in Stratum 5 of Wave 1, with only 32 percent of premises unusable or non-contactable.

The response and yield for each wave were:

- Of the 1,656 business listing for strata 1-4:
  - 170 were unusable (10.3 percent);
  - 142 were non-contacts (8.6 percent);
  - 1020 were refusals (61.9 percent);
  - 63 were head office referrals (3.8 percent);
  - 261 were completed interviews;
  - The response was 20.3 percent for contacted, eligible and non-referred premises.
- Of the 1,659 business listing complied for stratum 5:
  1. 383 were unusable (23.0 percent);
  2. 347 were non-contacts (20.9 percent);
  3. 735 were refusals (44.0 percent);
  4. 87 were head office referrals (5.2 percent);
  5. 107 were completed interviews;
  6. Of the contacted, eligible and non-referred premises the response was 12.7 percent.
- Of the 1,949 businesses listed for survey in Waves 2 and 3:
  - 314 were unusable (16.1 percent);
  - 314 were non-contacts (16.1 percent);
  - 98 were head office referrals (5.0 percent);
  - 821 refused (42.1 percent);
  - 402 were completed interviews (20.6 percent);
  - Of the 122 in which contact was made, the building eligible and not referred to head office, the response was 32.9 percent.

## 4. THE PREMISES

The data from the eligible 791 business premises responding to the successive interviewing continues to be treated as a quota sample in the following analysis. The analysis profiles the:

- Business characteristics of the participant businesses;
- Building characteristics in buildings which participants operate;
- Tenure and lease environment in which participants operate;
- Occupancy characteristics of the participants;
- Energy sources used by the participant businesses;
- Mechanisms by which participants purchase energy and water; and
- Appliances and equipment on the premises of the participant businesses.

### 4.1 Business Characteristics of Premises

Less than half (41.0 percent) of the participating premises were multi-site businesses. The profile of the premises is strongly dominated by the retail trade and the sectors of property and business services. Together these constituted over half of the participant premises (Table 5).

**Table 5: Business Sector Categories and Participating Businesses**

Business Sector	Premises	% Premises
Retail Trade	221	27.9
Property and Business Services	200	25.3
Health and Community Services	70	8.8
Accommodation, Cafes and Restaurants	63	8.0
Finance and Insurance	62	7.8
Personal and Other Services	48	6.1
Government Administration and Defence	38	4.8
Construction	18	2.3
Cultural and Recreational Services	17	2.1
Manufacturing/Other Manufacturing	17	2.1
Education	14	1.8
Communications Services	8	1.0
Wholesale Trade	8	1.0
Electricity, Gas and Water	6	0.8
Not Stated/Unclear	1	0.1
Total	791	99.9*

\*Due to rounding.

It should be noted that while participant premises allocated themselves to certain business sectors, Statistics New Zealand provides a set of standardised categorisations. Some of these may be quite difficult for participants to differentiate, while others are quite easy. For instance, it is unlikely that those providing health and community services would be likely to report themselves as finance or insurance. However, for some participants the difference between property and business services may not be as apparent.

Statistics New Zealand defines the property and business services category as an extremely inclusive one which constitutes:

- Property operators and developers;
- Real estate agents;
- Non-financial asset investors;
- Machinery equipment hiring and leasing;
- Scientific research;



- Technical services;
- Computer services;
- Legal and accounting services; and
- Other business services.

For many premises, however, it may not always be obvious whether the activities carried out at the premise fall into that property and business services category or the finance and insurance category. The latter is certainly more narrowly defined by Statistics New Zealand. It includes all banking and financial investors as well as insurance of all kinds, including superannuation providers. However, it also includes those businesses that provide services to the finance and insurance sector which may of course be interpreted as including computer services and so forth.

For those reasons, the data on business sectors should be treated with some caution. It cannot be assumed that individual participants in the survey who are reporting on the premises they own or work in, are aware of or use the standard definitions promulgated by Statistics New Zealand. Nevertheless, the employment profile of employees on site is consistent with the industry profile of the premises.

The majority of premises employ managerial, professional or clerical and administrative workers (Table 6). Over two-fifths of the premises reported that they employ sales workers. About one-fifth of premises have technicians or trade workers on site.

**Table 6: Occupations Represented in Participant Businesses (n=791)\***

Occupation	Business Premises	% of Premises
Managerial	734	92.8
Professional	496	62.7
Clerical and administrative staff	454	57.4
Sales workers	329	41.6
Technicians and trades workers	181	22.9
Machinery operators and drivers	72	9.1
Community and personal service workers	66	8.3
Labourers	35	4.4

\*Multiple responses possible.

## 4.2 Building Characteristics and Refit Practices

The majority of the buildings in which the participant premises are sited are in buildings less than 3,500m<sup>2</sup> (Table 7), although the majority of premises are in buildings 3,500 m<sup>2</sup> or more. This indicates the way in which larger buildings tend to have a multiplicity of premises located within them.

**Table 7: Estimated Size of Buildings in Which Premises Are Sited**

Building Size m <sup>2</sup>	Premises	% Premises
1-649m <sup>2</sup>	61	7.7
650-1,499m <sup>2</sup>	75	9.5
1,500-3,499m <sup>2</sup>	109	13.8
3,500-8,999m <sup>2</sup>	188	23.8
9,000m <sup>2</sup> or more	222	28.1
Not estimated	136	17.2
Total	791	100.1 <sup>^</sup>

<sup>^</sup>Due to rounding.

In relation to the building structure:

- 72.4 percent of businesses report that they occupy buildings with no double glazing;
- 64.3 percent of businesses occupy buildings with centralised cooling systems;
- 46.1 percent of businesses report that their building has a centralised heating system;
- 45.0 percent of businesses are in buildings in which staff can open and close windows;
- 12.5 percent of businesses occupy buildings which are entirely or partially double glazed.

Just under two-thirds (62.2 percent) of the businesses have undertaken some sort of refit of their space within their current building. Participants tend simply to characterise these as full refits and are unwilling or unable to specify further what those have involved. A content analysis of the components of refits actually specified by participants is set out in Table 8.

**Table 8: Specified Refit Components\***

<b>Refit Components</b>	<b>Components Specified</b>	<b>% of All Components</b>
Partitioning	169	32.8
Paint, Carpets, Furnishings	163	31.7
Plumbing	44	8.5
Lighting	44	8.5
Air Conditioning	28	5.4
Wiring	28	5.4
Specialised Equipment	18	3.5
Information Technology Cabling	16	3.1
Heating	4	0.8
Insulation	1	0.2
Total	515	99.9^

\*Multiple responses possible. ^Due to rounding.

Table 8 suggests that refits tend to be cosmetic in nature, although a small number of premises reported that the refit and refurbishment had been associated with either a significant extension of the building or building rebuild.

Reconfiguring office space or meeting rooms was particularly commonly reported. This was followed with various forms of refurbishment such as painting, carpeting or installation of furnishing and shelving. A few premises reported refurbishment of central systems with air conditioning or installation of new cabling, often associated with the installation of various forms of specialised equipment evident. Premises report a wide occurrence of the latter ranging from specialised computer-related hardware to extractor fans to chillers.

Wiring, plumbing and lighting were also prominent in premise reports. In one case it was reported that the lighting had been specifically designed to reduce energy costs. This seemed to involve a joint approach by the building owner and the premise occupants to installing lighting sensitive to the availability of daylight. For other premises, like the reported plumbing refurbishments, the purpose of the refurbishment appeared to be primarily aesthetic rather than reflecting concerns around resource use efficiencies. The extent of refurbishment does, however, offer opportunities to promote the installation of efficient lighting, taps and toilets.

### **4.3 Tenure, Lease and Management**

Of the 791 participant business premises, the vast majority (85.2 percent) are tenants with only a tiny proportion (1.4 percent) of sub-tenants and the remaining businesses being owner-occupiers (Table 9). These owner-occupier businesses make up a small (12.8 percent) but definite minority of businesses.

**Table 9: Tenure Status of Participant Premises**

<b>Tenure</b>	<b>Premises</b>	<b>% of Premises</b>
Tenants	674	85.2
Owner-occupier	101	12.8
Sub-tenant	11	1.4
Don't know	5	0.6
Total	791	100.0

There are a wide range of lease arrangements although fixed-term leases were widespread, with 457 of the tenants reporting they had a fixed lease with lease terms varying between one and 30 years. Over half (51.7 percent) of tenants reported that they had a right of renewal. A considerable proportion of tenants, reported that their tenure was governed by periodic tenancies while other tenants were unclear about the tenancy mechanism and its conditions (Table 10).

**Table 10: The Lease Arrangements of Tenants and Sub-Tenants (n=685)**

<b>Lease Arrangements</b>	<b>Premises</b>	<b>% Tenanted Premises</b>
Fixed-term lease	457	66.7
Periodic	139	20.3
Other	14	2.0
Unknown	75	10.9
Total	685	99.9*

\*Due to rounding.

Table 11 sets out the duration of occupation by participant businesses in their current building and the distribution is graphically portrayed in Figure 1. There is a strong clustering of businesses with durations of less than six years, with 57.5 percent of businesses being in that category. Notable, however, is the 11.4 percent of businesses that have been in their buildings for more than 16 years.

**Table 11: Duration of Occupation**

<b>Duration of Occupation</b>	<b>Premises</b>	<b>% Premises</b>
1 year or less	104	13.9
2-6 years	326	43.6
7-11 years	156	20.9
12-16 years	76	10.2
17-21 years	30	4.0
22 years or more	56	7.4
Total	748*	100

\*43 missing cases.

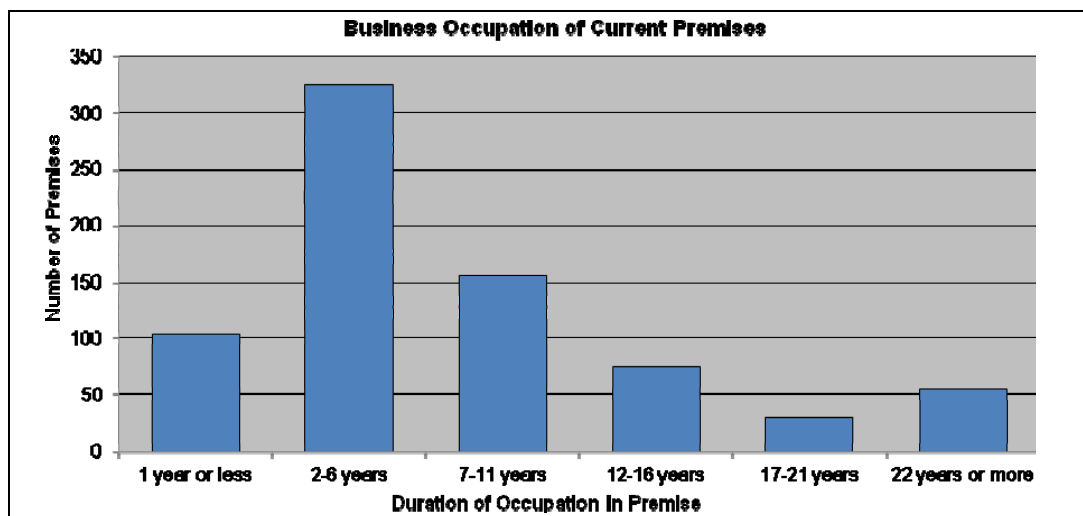


Figure 1: Distribution of Businesses Occupation of Current Premises (n=748)

As with lease arrangements, participant businesses reported a wide range of building management arrangements. A substantial proportion (13.5 percent of premises) reported that their building was neither managed by a building manager nor their landlord. By way of contrast, 8.1 percent of premises reported their building was managed by both a landlord and a building manager while over a third of premises (35.3 percent) reported that the landlord undertook the building management. Just over two-fifths (41.2 percent) reported their building was managed by a building manager and 1.9 percent of premises simply did not know.

#### 4.4 Occupancy Characteristics

Considerable further analysis is required to establish the precise disposition of premises over the building set. Data regarding the number of storeys in a building in other BEES datasets will be integrated with this dataset to undertake that analysis. Within the confines of this dataset, data related to floor occupation or building occupation are reported.

A small proportion of premises (8.7 percent) occupied all floors in their building.. Table 12 shows that 88.4 percent of premises report occupying two floors or less.

Table 12: Premises Occupation of Floors

Floor Occupation	Premises	% Premises
Up to 1 floor	372	47.0
1-2 floors	327	41.4
3-4 floors	14	1.8
5 or more floors	7	0.9
All floors – number unspecified	69	8.7
Not stated	2	0.3
Total	791	100.1 <sup>^</sup>

<sup>^</sup>Due to rounding.

The total number of employees represented by the premises located in these sample buildings is 22,512. On average, the participant businesses reported that 28.5 employees worked in the participant premise. However, the median number of employees was considerably less at six employees. The range of employees across participant businesses is considerable, stretching from one person to 3,500 people.

Figure 2 sets out the distribution of employees occupying the participant premises on typical weekdays and typical weekends. Of course, these premises do not only accommodate employees. In addition to employees on site, 81.9 percent of businesses report having clients coming into the building. The number of clients visiting buildings in a day varied considerably (Figure 3).

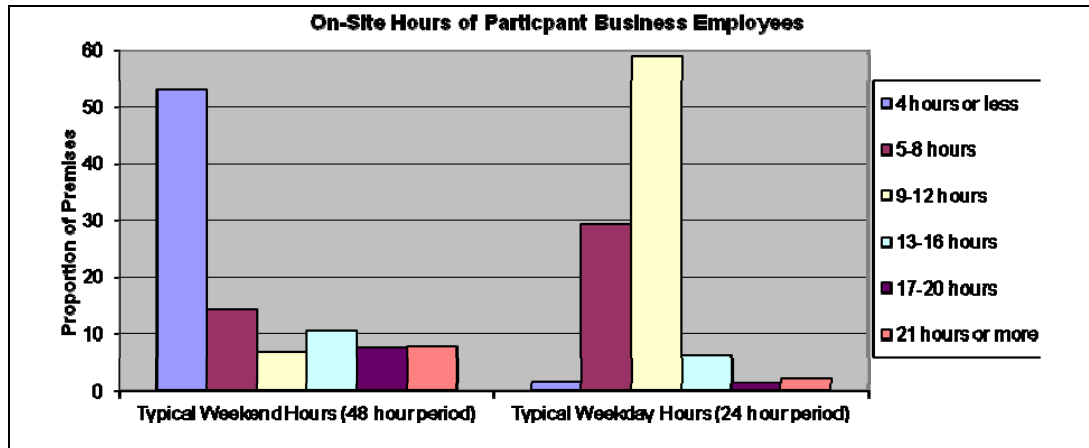


Figure 2: Hours Participating Business Employees On-Site Weekdays^ and Weekends\*

Table 13: Hours Participating Business Employees On-Site Weekdays^ and Weekends\*

	Typical Weekend Hours (48 hour period)	Typical Weekday Hours (24 hour period)
4 hours or less	52.9%	1.8%
5-8 hours	14.2%	29.3%
9-12 hours	6.8%	58.9%
13-16 hours	10.6%	6.3%
17-20 hours	7.7%	1.4%
21 hours or more	7.9%	2.3%

\*21 missing cases. ^10 missing cases.

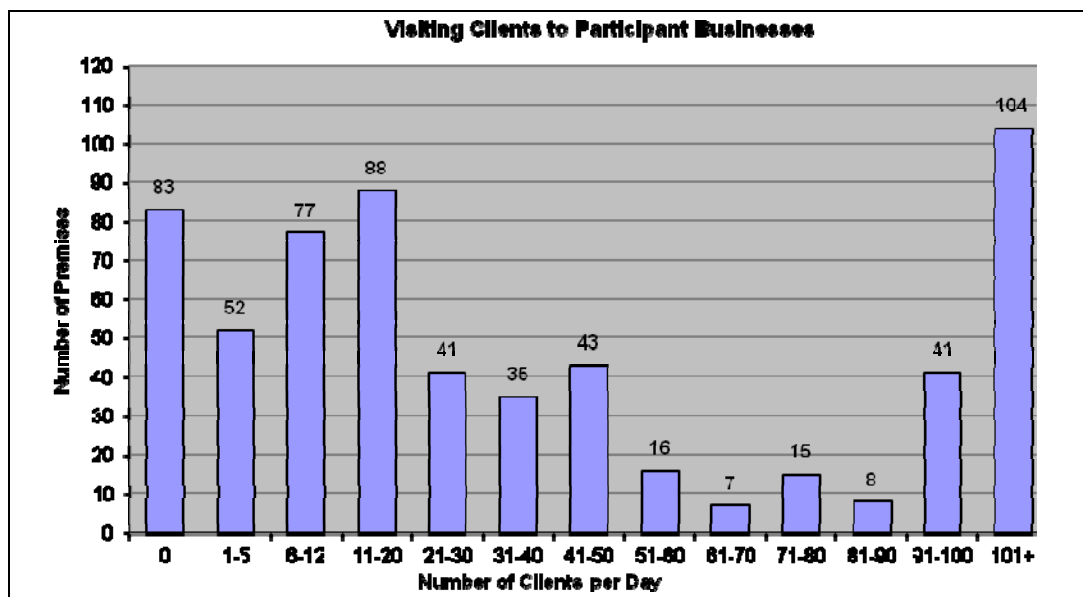


Figure 3: Distribution of Clients Visiting Premises on a Typical Day (52 missing cases)

## 4.5 Premises and Energy Sources

The primary energy source of these businesses is reticulated electricity. Almost all premises (99.4 percent) report consuming reticulated electricity with significantly fewer businesses consuming gas or diesel fuel (refer Table 14).

Table 14: Energy Types Reported by Participant Businesses (n=791)

Energy Type	Premises	% of Premises
Reticulated Electricity	786	99.4
Natural Gas	104	13.1
Diesel or Fuel Oil	22	2.8
Wood, Waste or Biomass	5	0.6
Self-Generated Electricity	10	1.3
Coal	2	0.3
Geothermal	1	0.1

## 4.6 Energy and Water Purchase

Irrespective of the type of energy used, the vast majority of premises purchase their energy directly from the energy supplier. Only small minorities have energy itemised or included non-itemised in their lease or rental payments. Table 15 sets out the proportions of premises reporting energy payments by way of lease or rent.

**Table 15: Proportion of Energy Payments Included in Lease or Rent by Energy Type**

Energy Type	Premises	% of Premises
Reticulated Electricity (n=786)	98	12.5
Natural Gas (n=104)	20	19.2
Diesel or Fuel Oil (n=22)	6	27.2
Wood, Waste or Biomass (n=5)	1	20.0
Coal (n=2)	1	50.0

Across all of the energy sources, 70.5 percent of premises purchase all of their energy directly from the supplier, while 11.9 percent purchase all of their energy from their landlord as an itemised component in their rent. A further 7.1 percent of premises reported that their energy was included in their lease or rent and this was not itemised. The 2.8 percent of premises who had a mix of arrangements regarding payment, predominantly paid at least one source of energy to a supplier. There is one premise with a mix of energy sources whose payment includes both non-itemised and itemised inclusions within their rent payment.

As Table 16 shows, 7.7 percent of participants were unaware of how their premise's energy is purchased.

**Table 16: Energy Payments Pattern for All Sources of Energy**

Energy Payment for All Sources	Premises	% of Premises
All sources paid to suppliers	558	70.5
All sources itemised in lease or rent	94	11.9
All sources non-itemised	56	7.1
Mixed payment	22	2.8
Unknown or not specified	61	7.7
Total	791	100.0

Overall, it is concluded that most premises are exposed to energy pricing mechanisms. Nevertheless, there is a substantial proportion of premises that are not exposed to energy prices. Somewhere in the region of 15 percent of premises are possibly receiving no pricing signals. A further 11.9 percent who pay their energy by itemised payments within their rent also probably receive only muted price signalling. Given this pattern of energy payment, the critical dynamic to improving energy efficiency probably resides in the principal-agency dynamic with all the issues of moral hazard that are played out in that dynamic.

There are striking differences between energy and water purchasing:

- Around one-quarter (25.9 percent) of premises report that they do not pay for water at all, compared to zero premises reporting no energy payment;
- More than twice as many premises (17.6 percent) either do not know how they pay for water or have not stated compared to energy payments;
- While 70.5 percent of all premises pay for all of their energy by direct payments to a supplier, only 14.5 percent of premises report directly paying for water to their supplier;
- Over one quarter of premises report that they pay for water as a non-itemised component within their overall rental or lease payments; and
- Only 16.8 percent of premises pay for water as an itemised component of their rent or lease.

In effect, the vast proportion of participant premises are not exposed to water pricing mechanisms and it may be expected that they have little awareness of their water consumption and little incentive to reduce it.

## 4.7 Equipment and Appliances

Business premises have a wide range of equipment and appliances that can be broadly divided between those which are business specific and those which provide for the needs of staff. In the first category are:

- Computers;
- Printers;
- Photocopiers;
- Servers;
- Fax machines;
- Projectors; and
- Electronic whiteboards.

In the second category are:

- Refrigerators;
- Microwaves;
- Dishwashers;
- Cooktops and/or ovens; and
- Water coolers.

Clearly, there may be some overlap between these two categories. Certain types of businesses may require refrigeration and cooking facilities as a direct part of their service provision. This dynamic will be better understood through the monitoring of end-use undertaken in BEES. The telephone surveying revealed:

- 90.8 percent of businesses report computers;
- 82.4 percent of businesses report printers;
- 88.1 percent of businesses report refrigerators and freezers;
- 84.1 percent of businesses report microwaves;
- 64.6 percent of businesses report computer servers;
- 65.1 percent of businesses report photocopiers;
- 48.5 percent of businesses report standalone fax machines;
- 32.9 percent of businesses report projectors;
- 43.6 percent of businesses report dishwashers;
- 54.1 percent of businesses report water coolers;
- 34.5 percent of businesses report cooktops and/or ovens; and
- 20.2 percent of businesses report electronic whiteboards.

Table 17 sets out the total number of equipment and appliances accounted for by the 791 participant businesses, the mode of equipment/appliances per business as well as the median and average numbers of these appliances and equipment.



**Table 17: Equipment and Appliance Prevalence in Participant Businesses**

<b>Equipment/Appliance</b>	<b>Total Number</b>	<b>Mode</b>	<b>Mean</b>	<b>Median</b>
Computers	17,280	1.0	21.9	4.5
Printers	2571	1.0	3.3	2.0
Refrigerators/Freezers	1782	1.0	2.3	1.0
Computer Server	1277	1.0	1.6	1.0
Microwaves	1249	1.0	1.6	1.0
Photocopier	1219	1.0	1.6	1.0
Water Cooler	726	0	0.9	0
Dishwasher	646	0	0.8	0
Cooktop/Oven	548	0	0.7	0
Standalone Fax Machine	535	0	0.7	1.0
Projector	472	0	0.6	1.0
Electronic Whiteboard	406	0	0.5	0

## 5. IMPLICATIONS OF BUILDING SIZE

There is currently available data for the size of the buildings in which 712 premises from the phone survey are sited. There is much analytic work to be undertaken to explore the relationships between premises, building size and the impact of occupancy and occupancy mix. The following analysis provides an initial description of the characteristics of premises in relation to the size of buildings in which they operate.

Although the characterisation of buildings in Quotable Value data is not always consistent it does provide a reasonable profile of building use. The specification of the Quotable Value building types relevant to BEES is set out in bold with grey shading in Infobox 3.

**Infobox 3: Quotable Value Building Use Categories**

Use	Description/Definition
CC	Cinema, theatre and public hall-type complexes
CE	Rest homes for elderly
<b>CL</b>	<b>Liquor outlets including taverns etc</b>
<b>CM</b>	<b>Motor vehicle sales, service etc</b>
<b>CO</b>	<b>Office-type use</b>
CP	Parking buildings etc
<b>CR</b>	<b>Retailing use</b>
<b>CS</b>	<b>Service stations</b>
<b>CT</b>	<b>Tourist-type attractions and non-sporting amenities</b>
<b>CV</b>	<b>Vacant land when developed will have a commercial use</b>
<b>CX</b>	<b>Numerous commercial uses or use not previously specified</b>
<b>IS</b>	<b>Service industrial, direct interface with the general public</b>
<b>IW</b>	<b>Warehousing with or without associated retailing</b>

For BEES these were aggregated into five categories which were constituted from the Quotable Value Building Use Categories as follows:

- CO as defined by Quotable Value;
- CR constituted from CR, CL, CM, CS, CT;
- CX as defined by Quotable Value;
- IS as defined by Quotable Value; and
- IW as defined by Quotable Value.

As Table 18 suggests, premises located in buildings characterised as offices tend to be in larger buildings, while almost two-fifths (39.3 percent) of premises in small buildings are described by Quotable Value as Commercial Retail (CR) buildings.

**Table 18: Building Use Type by Building Size**

Estimated Building Size	QV Building Use Category	Premises	% of Premises
1-649m <sup>2</sup>	CO	21	34.4
	CR	24	39.3
	CX	9	14.8
	IS	7	11.5
	IW	0	0.0
	Total	61	100
650-1,499m <sup>2</sup>	CO	18	24.0
	CR	24	32.0
	CX	24	32.0
	IS	8	10.7
	IW	1	1.3
	Total	75	100
1,500-3,499m <sup>2</sup>	CO	32	29.4
	CR	25	22.9
	CX	33	30.3
	IS	10	9.2
	IW	9	8.3
	Total	109	100.1
3,500-8,999m <sup>2</sup>	CO	76	40.4
	CR	48	25.5
	CX	48	25.5
	IS	3	1.6
	IW	13	6.9
	Total	188	99.9
9,000m <sup>2</sup> or more	CO	74	33.3
	CR	84	37.8
	CX	60	27.0
	IS	2	0.9
	IW	2	0.9
	Total	222	99.9
<b>Overall</b>		655*	

\*136 missing cases.

The premises in larger buildings are largely tenants or sub-tenants. Only 6.8 percent of premises in buildings of 9,000m<sup>2</sup> or more are owner-occupiers. This compares to 31.1 percent of premises in buildings less than 650m<sup>2</sup>.

**Table 19: Tenure Status for Premise by Building Size**

Estimated Building Size	Tenure	Premises	% of Premises
1-649m <sup>2</sup>	Tenant	41	67.2
	Sub-tenant	1	1.6
	Owner-occupier	19	31.1
	Total	61	99.9
650-1,499m <sup>2</sup>	Tenant	62	82.7
	Sub-tenant	0	0.0
	Owner-occupier	13	17.3
	Total	75	100
1,500-3,499m <sup>2</sup>	Tenant	87	79.8
	Sub-tenant	2	1.8
	Owner-occupier	20	18.3
	Total	109	99.9
3,500-8,999m <sup>2</sup>	Tenant	164	88.1
	Sub-tenant	5	2.7
	Owner-occupier	17	9.1
	Total*	186	99.9
9,000m <sup>2</sup> or more	Tenant	202	92.2
	Sub-tenant	2	0.9
	Owner-occupier	15	6.8
	Total^	219	99.9

\*2 missing cases. ^3 missing cases.

Not surprisingly, respondents in premises located in larger buildings are most likely to report that they have air conditioning. More than three-quarters (76.6 percent) of premises in buildings of 9,000m<sup>2</sup> or more reported air conditioning compared to about a third (34.4 percent) of premises in buildings less than 650m<sup>2</sup> and 48 percent of premises in buildings between 650m<sup>2</sup> and 1,499m<sup>2</sup>. Over half (55.0 percent) of premises in 1,500-3,499m<sup>2</sup> buildings had air conditioning while 70.7 percent of premises in buildings between 3,500m<sup>2</sup> and 8,999m<sup>2</sup> had air conditioning.

The pattern is similar for central heating but the differences are less pronounced with 28.0 percent of premises in buildings less than 650m<sup>2</sup> reporting central heating, compared with 56.3 percent of premises in buildings 9,000m<sup>2</sup> or more.

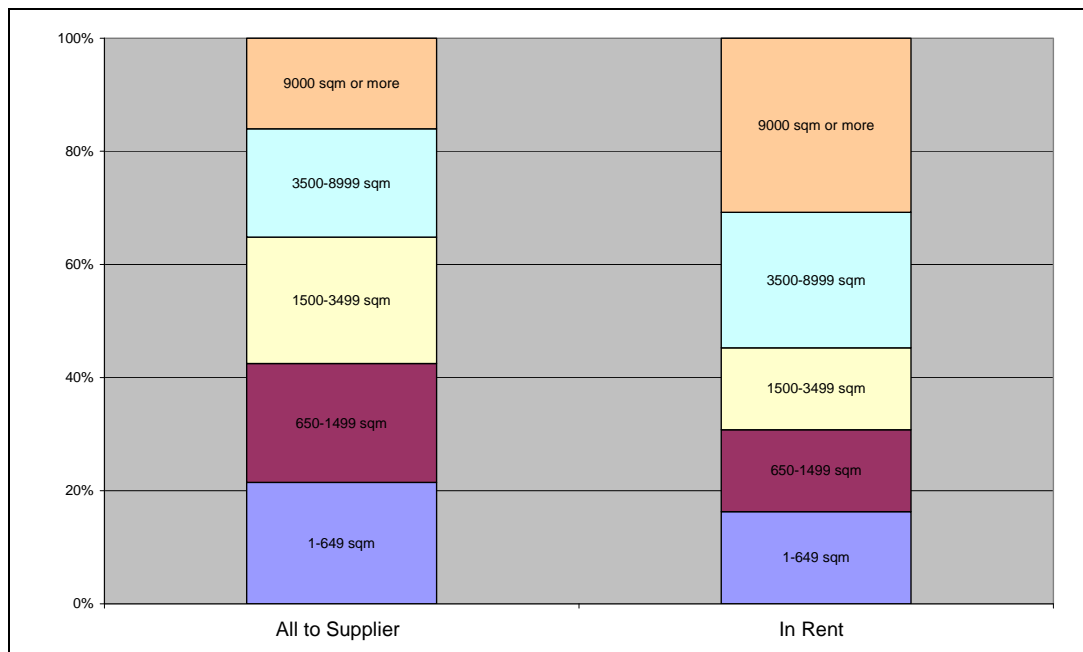
The ability to open windows shows the opposite pattern. Only about one-fifth (21.6 percent) of premises in very large buildings have windows that open compared to 72.1 percent of premises in buildings less than 650m<sup>2</sup>. However, similar proportions of premises report double glazing irrespective of building size. Proportions range between 11.2 percent and 13.1 percent of premises.

There is a tendency for premises with longer occupancy durations to be concentrated in smaller buildings. Over a quarter (26.2 percent) of premises in buildings less than 650m<sup>2</sup> have been in the same buildings for 17 years or more. This compares to 17.4 percent of premises in 650-1,499m<sup>2</sup> buildings, 11 percent of premises in 1,500-3,499m<sup>2</sup> buildings and 7.5 percent of premises in buildings of 9,000m<sup>2</sup> or more.

Despite these differences in occupancy durations, the proportion of premises that have undertaken a new fit-out shows little differentiation according to building size. Around 46 percent of premises in the smallest category of buildings had undertaken a fit-out while 69.4 percent of premises in the largest buildings had

done so. This proportion is similar to the premises in 650-1,499m<sup>2</sup> buildings, 68 percent of which reported undertaking a refit.

Around one-quarter (25.3 percent) of premises in the largest building category have some or all of their energy costs included in their rent or lease. This is distinctly different from premises in the smallest building category. In that category, only 11.5 percent of premises have their energy costs included in a rental payment. This is similar to 13.4 percent of premises in 650-1,499m<sup>2</sup> buildings and 11.9 percent of premises in 1,500-3,499m<sup>2</sup> buildings. Premises in buildings 3,500-8,999m<sup>2</sup>, like premises in the largest buildings but in contrast to premises in smaller buildings, have a large minority proportion of 19.7 percent that have energy costs included in their rent. Figure 4 shows clearly the tendency for large buildings to be more evident as the premises that pay for their energy via rents.



**Figure 4: Premise Energy Payments to Suppliers or In Rent by Building Size**

The predominance of the lease as a mechanism for energy charging is associated with the tendency for building managers to be the dominant player in managing large buildings. In smaller buildings, premises report that landlords are much more likely to be involved in the management of the building. Substantial proportions of premises in these smaller buildings report that there is no discernible building management by a landlord or a building manager (Table 20 and Figure 5).

**Table 20: Premise Reported Building Management by Building Size**

Building Size (m <sup>2</sup> )	% of Premises in Sized Buildings by Building Management				
	Landlord	Building Manager	Both	None	Don't Know
1-649m <sup>2</sup> (n=61)	44.2	13.1	1.6	39.3	1.6
650-1,499m <sup>2</sup> (n=75)	46.7	22.7	4.0	26.7	2.7
1,500-3,499m <sup>2</sup> (n=109)	41.3	35.8	1.8	15.6	1.8
3,500-8,999m <sup>2</sup> (n=188)	34.1	48.4	5.3	10.1	2.1
9,000m <sup>2</sup> or more (n=222)	28.4	47.7	16.2	5.0	2.7

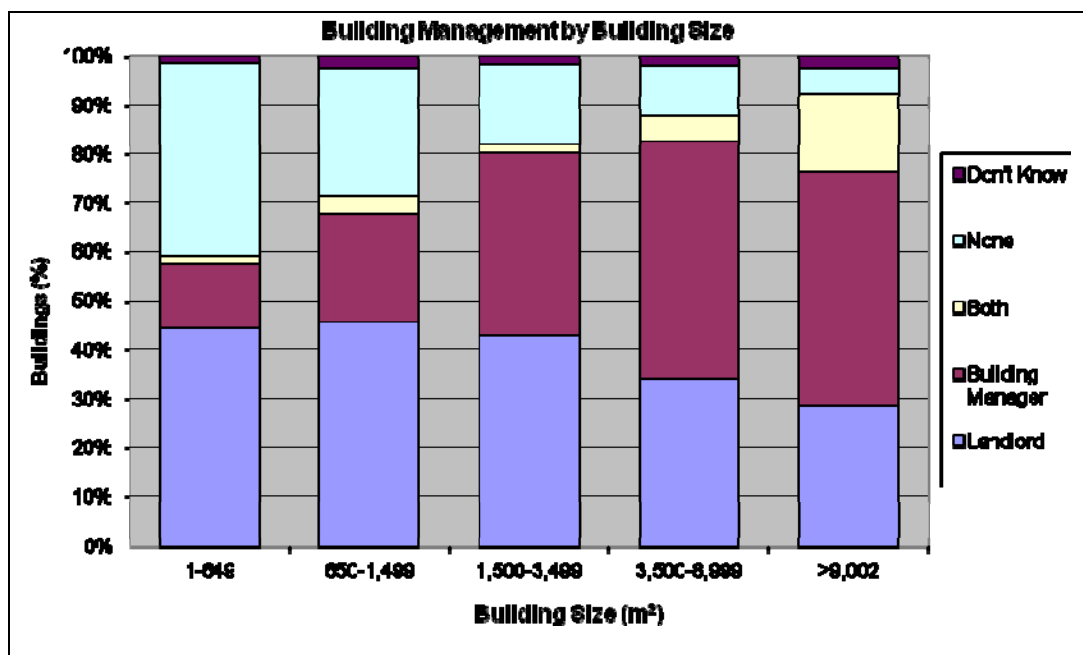


Figure 5: Building Management by Building Size

Finally, the prevalence of appliances by premise tends to reflect the size of the buildings in which the premises are located. This is probably, in part, because larger premises are likely to be in larger buildings. However, the analysis of premise size and their relationship to buildings will be undertaken in future analysis. So any such conclusion must be treated with caution. Particularly as multiple small premises may be clustered in large buildings. Whether primarily retail buildings such as malls or in office towers.

Indeed as Table 21 shows, the mean prevalence of certain appliances such as computers tends to be higher than the medians. This suggests the distribution is strongly skewed in some buildings. The most notable example of this is among premises sited in buildings of 9,000m<sup>2</sup> or more. The average number of computers is 35 but the median is only five computers.

**Table 21: Prevalence of Appliances in Premises by Building Size**

Building Size m <sup>2</sup>		Computers	Computer Servers	Electronic Whiteboards	Projectors	Printers	Photocopiers	Faxes	Cooktops or Ovens	Refrigerator or Freezers	Dishwashers	Water Coolers	Microwave
1-649	Mean	4.51	0.84	0.02	0.20	1.95	0.80	0.57	0.52	1.89	0.33	0.43	1.08
	Median	2.00	1.00	0.00	0.00	2.00	1.00	0.00	0.00	1.00	0.00	0.00	1.00
	Mode	0 <sup>a</sup>	0	0	0	0	0	0	0	01	0	0	1
	Minimum	0	0	0	0	0	0	0	0	0	0	0	0
	Maximum	21	12	1	2	10	4	6	6	12	2	5	4
	Sum	275	51	1	12	119	49	35	32	115	20	26	66
650-1499	Mean	7.28	0.93	0.11	0.33	2.31	0.92	0.64	0.64	2.05	0.53	0.53	1.07
	Median	4.00	1.00	0.00	0.00	2.00	1.00	1.00	0.00	1.00	0.00	0.00	1.00
	Mode	2	1	0	0	2	1	1	0	1	0	0	1
	Minimum	0	0	0	0	0	0	0	0	0	0	0	0
	Maximum	60	6	1	3	16	4	2	8	12	4	2	4
	Sum	546	70	8	25	173	69	48	48	154	40	40	80
1500-3499	Mean	11.21	1.32	0.19	0.60	3.00	1.02	0.53	0.72	2.38	0.85	1.04	1.29
	Median	5.00	1.00	0.00	0.00	2.00	1.00	0.00	0.00	1.00	0.00	1.00	1.00
	Mode	2	1	0	0	2	1	0	0	1	0	0	1
	Minimum	0	0	0	0	0	0	0	0	0	0	0	0
	Maximum	120	15	3	15	20	10	4	7	40	25	40	25
	Sum	1,222	144	20	65	324	110	57	78	259	92	113	141
3500-8999	Mean	23.65	1.36	0.67	0.66	3.71	2.13	0.68	1.06	2.58	0.83	1.00	1.64
	Median	6.00	1.00	0.00	0.00	2.00	1.00	0.00	0.00	1.00	0.00	1.00	1.00
	Mode	1	1	0	0	1	1	0	0	1	0	0	1
	Minimum	0	0	0	0	0	0	0	0	0	0	0	0
	Maximum	1,200	40	20	20	130	130	8	70	80	20	20	50
	Sum	4,399	248	125	123	694	399	127	198	479	155	186	306
9000 or more	Mean	35.06	2.08	0.83	0.86	3.61	1.48	0.76	0.59	2.09	0.84	0.86	2.00
	Median	5.00	1.00	0.00	0.00	2.00	1.00	0.00	0.00	1.00	0.00	0.00	1.00
	Mode	1	1	0	0	1	0	0	0	1	0	0	1
	Minimum	0	0	0	0	0	0	0	0	0	0	0	0
	Maximum	1,000	90	20	12	120	19	12	12	20	20	20	134
	Sum	7,714	455	184	192	794	328	168	131	457	185	189	440

## 6. SOME LEARNINGS

This report is essentially descriptive. It is intended to present basic data arising from the premise surveying undertaken within BEES which is now nearing completion. The data does indicate patterns that have significant implications for initiatives to improve the energy efficiency of the non-residential building stock.

It has been noted in the *BEES Year 4: Insight Into Barriers* study report (Saville-Smith, 2011) that the use of technical solutions that would improve the energy efficiency of non-residential buildings, either in new-builds or in retrofit, have been characterised by low take-up. This is an international phenomenon and reflects, in part, the complexity of non-residential building sectors' value chains. That complexity encourages circles of blame as well as encourages split incentives and moral hazard.

BEES research on barriers also noted that overseas initiatives have frequently treated building owners and tenants as homogenous. In reality, both are diverse groups. Building owners can, for instance, be segmented into three types:

- Building owners who are primarily interested in building ownership as a form of self-employment;
- Building owners who treat ownership as an investment and service sector; and
- Building owners for whom buildings are part of their business infrastructure.

Further research exploring the implications of those differences is nearing completion. However, data to date suggests that owner-occupiers and owners that see building ownership as a form of self-employment have low levels of awareness and/or interest in energy efficiency.

What the analysis of this set of premise data, derived from the premise surveying, highlights is that smaller buildings are also managed and used differently from larger buildings. Building size when articulated with building ownership, use and occupancy generates segments. Initiatives to improve energy efficiency need to be carefully matched to segments defined by particular combinations of owner, occupant and building type. In relation to building size, the survey data suggests that:

- Energy price signalling is likely to have a more direct impact on premises in smaller buildings;
- Problems of moral hazard are likely to be greater in larger buildings because larger buildings are more likely to include energy costs within rents and have large numbers of tenants in a building;
- Opportunities for improved energy efficiency through building and facility management need to be shaped according to building size because:
  - Large buildings are more likely to be managed by professional property, building or facility managers; and
  - Small buildings are either unmanaged or managed by owner-occupiers, tenants or landlords with little awareness or interest in resource efficiency.
- Small buildings should be designed for energy efficiency because occupancy tends to be of long duration and the propensity to refit is low. By contrast, in large buildings the turnover of tenants is associated with refit. Fitting out currently tends to be cosmetic but offers opportunities to improve energy efficiency. Similarly, while in small buildings there is limited potential to manage complex systems larger buildings are more, although by no means universally, likely to have professional or dedicated building/facilities management.



## REFERENCES

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