STUDY REPORT

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Valuing sustainability and resilience features in housing

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Abstract

This study considers how sustainability and resilience features are valued by the market and the role various stakeholders play in educating the new-build and resale market about the value of these features. It includes a literature review of international studies estimating the market value of various features, as well as the findings from interviews with builders on their role in promoting these features. It summarises the results of two surveys that investigated the value that real estate agents and property valuers believe the market places on specific features. Finally, it includes a pilot study using hedonic pricing analysis to estimate the price premium that results from installing solar hot water in New Zealand houses.

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1. EXECUTIVE SUMMARY

This report summarises the work completed as part of year one of the study into valuing sustainability and resilience features in housing.

Defining "sustainable" and "resilient" homes

The work began by defining a "sustainable home" as a dwelling designed, built, operated, maintained or re-purposed to significantly enhance the dwelling's lifetime environmental performance and the occupiers' experience. For the purposes of the report, sustainable homes were defined as homes that have a significant number of sustainability features that make them distinct from a more traditional (volume-built) house typically constructed today.

"Resilient homes" are those designed to respond well to extreme weather or natural disaster events. They are able to better maintain critical life-support conditions if services such as power, fuel, water or sewerage services are lost, and sustain liveable conditions both during and post event.

The long-list of sustainability and resilience features

Having defined sustainable and resilient homes, a long-list of sustainability and resilience features that apply to new housing was identified. These include more obvious features of individual dwellings such as insulation and low-energy LED lighting. However, the list acknowledges the wider definition of these terms by including factors such as proximity to goods and services, flexibility of space and the like.

What the literature says about measuring the market value of these features

The features list was developed in tandem with a literature review, the primary focus of which was to determine how sustainability and resilience features are valued by the market internationally.

International studies focused almost exclusively on easily identified, discrete systems such as solar systems. Several studies identified premiums of several thousand dollars for solar systems. Other features that have been studied include various green labels, better insulation and glazing. Green labels appear to add between 4% and 10% to the value of a house, for instance.

The primary approach to determining how the market values sustainability features appeared to be various forms of hedonic pricing analysis. In this approach, the sales price of properties with sustainability features are compared to those without the features, while accounting for other differences such as size or number of bathrooms.

The role of builders, real estate agents and valuers in the market

Structured interviews with builders were undertaken to understand what role they played in informing and guiding views on sustainability features in the new-build market. A survey of real estate agents (REAs) and valuers gauged their knowledge of features, focusing on solar systems, and their estimates of how much resale value these added.

Builders' views on how much they should guide their clients on sustainability choices was mixed, but predominantly tended toward an agnostic view, simply delivering what the client wanted. Most believed clients would overwhelmingly choose better quality kitchens and bathrooms over sustainability features, given budget limitations.

Most builders did not have much independent advice to provide clients who asked about sustainability features, instead pointing them to manufacturers' datasheets or independent consultants.

REAs and valuers indicated that certain sustainability features such as solar hot water and solar electricity systems could add to the value of the house. However, the additional value tended to be less than the replacement cost of the solar system. For solar hot water, the lower bound and upper bound premiums at sale were $2,400 and $3,700 respectively. For solar electricity, they were $3,200 and $6,500 respectively.

A pilot study: hedonic pricing analysis

An initial pilot study was completed on the potential to use hedonic pricing to explain the premium (or lack thereof) added to a home's value by sustainability and resilience features. Hedonic pricing analysis compares the price paid for something (in this case a house) with or without specific features (in this case, solar hot water). The difference in price between houses with and without solar hot water, with all else held equal, indicates the premium for solar hot water.

This analysis used a group of Nelson suburbs for the case study. The study found that, in addition to the factors that usually lead to price differences, such as views, house and section size, solar hot water also resulted in a price premium. The premium was 1.35% of the house value, or around $7,250 per house on average.

However, the small number of houses sold with solar hot water (13 in a sample of over 1,000 houses) and the large number of variables meant the t-statistic was low. This means not too much should be read into the results. However, the study does indicate that this approach could work well, given a larger sample and perhaps a simplified equation.

Where to from here?

The focus of year two of the study will be to:

- calculate whole-of-life cost and benefit information for sustainability and resilience features, where possible, and highlight the benefits that cannot be measured
- develop datasheets and/or tools showing the value of features, which will be easy to use by builders, REAs, and valuers
- complete more comprehensive hedonic pricing analysis
- via a pilot programme, work with partners to train stakeholders on the value of features.

2. INTRODUCTION

2.1 Background

The industry frequently asks BRANZ to quantify the **financial and sustainability value** of various sustainability measures for the developer, builder or home owner**.** These measures include better-than-code insulation, double glazing, water conservation, solar water heating, air and water heat pumps, other heating, efficient lights, and house orientation**.**

Sustainability researchers often receive feedback that incorporating improved performance is not reflected in house values**.** This is possibly due to lack of understanding by designers, valuers and real estate agents about the merits (reduced costs, and improved amenity and comfort) of such features.

It is also recognised that, compared to other countries, New Zealand has a different set of sustainability criteria around its housing stock**.** This research will help inform the debate around why this is the case**.** In addition, BRANZ is asked about the **costs and benefits of making housing more resilient** against events such as floods, impact damage resistance, or of using more durable materials with lower maintenance costs**.** There is a gap in understanding what value going "beyond Code" could be delivering.

2.2 Definitions

There is no formalised definition of a "sustainable home" or "resilient home" or various alternative labels including "eco-home", "environmentally conscious home", "low-impacting", "earth-friendly" or "green" home**.** Branding associated with various environmentally-themed dwelling accreditation tools has further diversified the nomenclature around sustainable homes.

In New Zealand, the Beacon Consortium coined the term NOW Home® for mid-price new-build dwellings that simultaneously minimise consumption, materials and waste, and maximise thermal performance.

While none of these terms are entirely synonymous, typically they refer to dwellings designed, built and operated to significantly improve the dwelling's lifetime environmental performance while enhancing the occupiers' experience**.**

A "sustainable home" is defined in this report as one that has a significant number of sustainability features that make it distinct from a more traditional (volume-built) house typically constructed today. It is recognised that this is not a tight definition, as "significant" is sometimes hard to determine. Are, for example, photovoltaic (PV) panels always a sustainable add-on? Should there be a minimum number of eco-aspects addressed, and if so, which ones – environmental, economic or societal?

"Resilient homes" is a newer concept, also having no formalised definition and a range of possible definitions attached to it**.** For the purposes of this BRANZ research, **"resilient buildings" are those designed to respond well to extreme weather or natural disaster events.** Thus, they are able to maintain critical life-support conditions if services such as power, fuel, water or sewerage services are lost, and sustain liveable conditions both during and post event**.** Consequently, a resilient building:

- helps to protect during events such as storms, floods, extreme cold, landslips and erosion, and wildfires
- minimises damage and disruption to the occupants

- minimises the costs and time involved in recovering and repairing damage**.**

2.3 Research question

Incorporating sustainability and resilience features within a house adds to its performance, but how are these improvements valued by the owner, builder, designer, real estate agent or buyer?

This project aims to investigate what sustainability and resilience features are being used in housing, how owners make decisions to include them on defined budgets, and how the benefits can be quantified.

The ultimate goal of this project is to help buyers, designers, valuers and real estate agents more accurately value houses that have incorporated sustainability and resilience performance enhancements.

3. A LONG-LIST OF SUSTAINABILITY AND RESILIENCE FEATURES

The first step in the project was to list features and considerations that would fall within scope of the literature review and discussions with builders, estate agents and valuers. Table 1 sets out the list.

Table 1 The long-list of sustainability and resilience features and considerations

Domain	Feature/consideration
enhanced thermal envelope	good window orientation and sizing
	sun-smart room location
	windows IGU + framing upgrade
	wall insulation upgrade
	ceiling insulation upgrade
	floor insulation upgrade
	thermal mass utilisation (direct gain)
	Trombe wall (indirect gain)
	whole design thermal simulation
	north (external) shading devices
	other (external) aspect shading devices
	heat recovery device
	(post) construction blower door testing
	thermal drapes with pelmets
	ventilation strategies
energy and carbon efficiency [non-chattels only]	solar hot water heating (fluid)
	solar space heating (fluid)
	PV for general electrics
	other renewables for general electrics
	lowcarbon space heating (wood burner)
	wetback space heating
	wetback water heating
	(air or ground sourced) heat pump system
	energy efficient lighting
	Energy Star refrigeration
	induction hob
	heat transfer kit
	whole house post occupancy energy monitoring
	proximity to public transport
	proximity to key amenities
	(net) zero energy
	greenhouse gas emissions
water [non-chattels only]	grey water reuse
	black water treatment system
	efficient shower roses
	rainwater collection tank (small)
	rainwater collection tank (large)

Domain	Feature/consideration
	water efficient dishwasher
	water efficient toilets
materials	third party eco-rated
waste	in-kitchen recycling
	in-sink food digester
	composting on site
economics	decreased first construction costs
	decreased ongoing operating costs
	life cycle costs
	increased productivity
	better health
	cost-impact ratio
	quality of materials, components and finishes
other	(site) flood risk for whole building
	climate change adaptability
	voluntary sustainability certification (Homestar, Passive house, Living Building etc)
	green roof
	food garden
	sound proofed or attenuated zones
	community support
	timeless design
	future flexibility and adaptability
	prefabrication – offsite
	low-maintenance design
	demonstration-education house
	low (land area) footprint
	well day-lit with low glare
	Walkscore
	other (electrical-generating) renewable systems
	overall resource use (area/bedrooms)
	universal design [LifeMark certification level]
	lifetime cost – per area or per dweller
	specific issue net present value
	universal design elements
	'green' volume or spec builder
	land use change
	indoor air quality
	design for deconstruction
	construction waste
	connectivity of services (remote management)
	serviceability
	any post occupancy evaluation
	aesthetics

Domain	Feature/consideration
resilience – materials	wall claddings
	flooring materials
	lining materials
	internal doors
	trim
resilience – elements	roof profile
	skylights
	canopies, verandas and decks
	windows
	walls
	external doors
	heating
	cooking
	lighting
	hot water
	water supply

4. LITERATURE REVIEW

4.1 Method

The literature review begins by summarising a New Zealand study that considered the reasons why sustainable housing features have not been adopted more widely in New Zealand.

It then considers the history of sustainability valuation in the US, which leads the way in sustainability valuation literature and tools, even though uptake is still chequered.

The next three sections focus on specific examples of reports, journal articles, web resources and multi-criteria analyses that value sustainability and resilience features. Due to the field's rapid development, only reports, web information and rating tools from the last 10 years have been examined.

A critique of some approaches to valuing sustainability features is provided in the section starting on p.26.

4.2 Summary of key findings

Table 2 sets out the key numbers from the literature review, highlighting the estimated market value of various sustainability and resilience features and the costs associated with them.

International studies strongly indicate that a price premium is associated with each of several sustainability features. However, the scale of the premium varies widely from study to study.

4.2.1 The argument for valuing sustainability measures

There are four main arguments for the need to integrate sustainability aspects into the appraisals process (Austin, 2012):

- It is required by the transactions observed in the marketplace and foreseeable future market developments.
- The professional ethics of the valuation profession require acknowledgement of sustainable development and its effect on value.
- Poor property valuation can lead to a misallocation of capital.
- The alternative is the suboptimal results for investors currently seen.

Table 2 Estimated market value and costs of some sustainability and resilience features

Cost	Benefit	Link
Solar power		
$3,500 per kW installed	$1.4-$2,600 per kW premium on house value (plus interim energy savings)	Desmarais, LK (2013): Colorado Energy Office.
$35,967 on average before govt subsidy; $20,892 after subsidy	$22,554 or 3.5% premium on house price (plus interim energy savings)	Dastrup, S et al (2011): National Bureau of Economic Research, USA.
	$17,000K per 3.1kW system ($5.50 per W); premium is around 20 times the annual energy savings	Hoen, B et al (2011): Ernest Orlando Lawrence Berkeley National Laboratory, USA.
	$825 a year energy and comfort benefits	Stoecklein, A et al (2007): European Council for an Energy Efficient Economy.
	$4,000 per kW premium	Hoen, B et al (2015): Ernest Orlando Lawrence Berkeley National Laboratory, USA.
Green labels		
$4-10,000	9% premium on $400,000 house = $35,000	Kok, N et al (2012): UCLA, UC Berkeley, USA.
	Commercial buildings sold for a 15% premium, had 8% more rental income, saved 10-20% in operating expenses	McGraw-Hill Construction (2008): USA.
5-star Green Star houses in Australia cost 3-5% more	Green Mark homes in S'pore sell for a 6% premium	Ng, E (2013): University College London
0.66% - 6.8% premium	8-9% fall in operating expenses, 7.5% rise in building value, 6.6% rise in ROI, 3.5% rise, in occupancy rate, 3% rise in rental income	McGraw-Hill Construction (2008): USA.
	4.2%-9.6% premium, 18 days quicker to sell	Simmons, A et al (2010): Appraisal Institute, USA.
	Portland $432,000 v $390,000 for non-labelled Seattle $487,000 v $470,000 for non-labelled	Griffin, A (2009): Earth Advantage Institute
Better than standard façade insulation		
	3% premium on rent and on purchase price (95% confidence level)	Banfi et al (2008): Centre for Energy Policy and Economics, Switzerland
	$927 a year energy andcomfort benefits	Stoecklein, A et al (2007): European Council for an Energy Efficient Economy.
Improved window insulation		
	1% premium on value	Banfi et al (2008): Centre for Energy Policy and Economics, Switzerland
Housing ventilation system in new or existing buildings		
	4-12% premium	Banfi et al (2008): Centre for Energy Policy and Economics, Switzerland
	$566 a year energy and comfort benefits	Stoecklein, A et al (2007): European Council for an Energy Efficient Economy.
Costs of retrofitting various systems		
Various individual components		Page, I (2009): BRANZ / Beacon Pathway study

4.2.2 Sources and types of research

At the heart of the debate over the linkage between green buildings and asset value itself are the different notions of what constitutes “value”.

By far the most resources (background papers, discussion documents, evaluation tools and the like) are from the United States (US), followed by the United Kingdom (UK). Few relevant articles from other countries could be found. In New Zealand, reference documents are limited to the ones BRANZ has been involved in (through BEACON or CRESA). This result may in part reflect search engine bias, which is less likely to pick up EU/rest-of-world work.

Overall, the volume of resources dealing with the BRANZ research question is considerably larger for sustainability than for resilience. No papers were discovered that formally assess the **value** of more **resilient** houses, probably due to the newness of the topic.

The relationship between sustainability and market value has received considerable attention. This is reflected in the increase in the number of resources (documents, reports, guidelines and tools) in this area over the last 10 years. However, much of the early focus has been on normative research, indicating how sustainability “should” affect market value, and has been inconclusive. Only in the last few years has this been supported by a considerable amount of quantitative research on what impact these features have on market values.

The body of research can therefore be categorised as:

- discussion and analyses of stakeholders’ perceptions and sentiments
- normative studies that suggest the relationship “should” be present
- case studies used to demonstrate normative theory
- quantitative studies to quantify the effect of sustainability.

4.2.3 Current capability of the valuation industry

The international valuation industry is struggling with valuing sustainability on a number of levels. There seems to be a lack of data on the quantifiable effects on market value.

There is a probable risk of valuers making inappropriate adjustments or comparisons because of their lack of knowledge and limited sustainability assessment skills. Although there is an evolving body of knowledge, there is a need for unbiased, evidence-based research to provide guidance on the implications of sustainability in the valuation of real estate.

The authors found only one consistent, formalised, nationally recognised procedure to assist the environmental-specific evaluation process for house valuers, and this was in the US.

4.2.4 Specific tools and initiatives

In the last three to five years the US market has really seen a massive increase in the number of resources in this area:

- consistent green building definitions and terminology
- tailored data collection and appraisal tools
- appreciation of these homes for their lower risk and higher quality and comfort.

Of the formal country-specific initiatives, the US-based Appraisal Institute has been amongst the most active in considering the value of sustainability features. One of the Institute’s key outputs in this area has been the *Residential Green and Energy Efficient Addendum*. It provides a resource for appraisers to formally provide comparable and consistent reporting on sustainability

features. As a result, there has been an upswing in demand and sales of homes with sustainability features.

One particularly relevant initiative is the International Energy Agency Solar Heating and Cooling Programme IEA SHC Task 28 Solar Sustainable Housing and the World Green Building Council. Their focus is on the business opportunities to build the case of green building and how best to market it.

There is strong, robust and quantitative evidence (in various parts of the US at least) that homes with solar photovoltaic (PV) systems sell for a premium over homes without.

Sustainability-specific rating tools are not yet recognising resilience in a formal way. However, there are a few dedicated resilience-specific tools.

4.3 New Zealand case study: Barriers to adopting sustainable housing features

A Palmerston North study (Henry et al, 2013) interviewed housing policy, regulation, construction and sale-related professionals. It found four main barriers to the adoption of sustainability features in housing:

- **Performance uncertainty**: Although there is a broad appreciation of a range of sustainability features, people do not understand the complex practicalities of wrapping them into houses, or the performance of sustainability features. This uncertainty included not only people commissioning and buying buildings, but also the range of professionals involved in the design and building of houses.
- **Legacy:** Interviewees identified a legacy of associating sustainable housing with degrees of oddity, material discomfort, hippies and greenies. However, interviewees agreed that sustainability features had become more mainstream and the stigma was decreasing.
- **Fragmentation***:* Considerable time and cost may be involved in ensuring that new materials and systems comply with existing building codes. There was also the potential for fragmentation at the design stage if sustainability features were considered as an add-on rather than as an integral part of the design process.
- **Cost versus benefits:** The interviewees pointed out that sustainability features were not necessarily incorporated at early stages of the design process. However, when treated as an add-on they tended to be among the first items dropped off in order to reduce costs. People tended to focus on the upfront cost of sustainability features rather than the lifetime running cost, or payback period, of a feature.

4.4 The rise of sustainability valuation reporting and tools : The US experience

The US has no established market mechanisms that enable homeowners to have the financial value of home energy investments recognised at the time of sale. There are also no standard channels that allow home buyers to specifically search for high-performing homes.

Nevertheless, in recent years the significant growth in tools, materials and reporting for sustainability features in the US has resulted in it being seen as the leader in valuing sustainability.

4.4.1 A brief history of valuing sustainability in the US

For more than 30 years, the Appraisal Institute has taught a variety of valuation methods. These include: paired data analysis, gross rent multiplier, depreciated cost analysis, market participant surveys, discounted cash flow analysis, and impact studies. However, the theoretical basis for the integration of sustainability considerations into the property valuation process began in 1996 (see Harrison and Seiler, 2011, and Lorenz and Lutzkendorf, 2011). The US history of guidance

for the appraiser, excluding specialised or academic journals that are not typically utilised by practitioners, is much less extensive and includes the following:

- **1998**: Start of the more comprehensive, regionally-based, green building programmes in the US**.**
- **2008**: Appraisal Institute offers one-day seminars on the Introduction to Valuation of Green Commercial Buildings and Valuation of Green Residential Properties.
- **2009**: The International Code Council (2009) ICC-700 *National Green Building Standard* is issued**.** It is the first and only residential green building rating system to receive approval from the American National Standards Institute (ANSI)**.** For new and existing (remodelled) homes, it has been widely implemented throughout the industry, with thousands of dwelling units certified**.**
- **2009**: A government, non-profit and private industry collaborative in the US and Canada prepares the resource *High Performance Green Building: What's it Worth? Investigating the Market Value of High Performance Green Buildings* (Chappell and Corps, 2009).
- **2010**: The Green Multiple Listing Service (MLS) Tool Kit (http://www.greenthemls.org/). A collaborative effort among industry experts, including the Appraisal Institute, developed to help realtors and appraisers more effectively consider the characteristics of high-performing homes**.**
- **2010**: *The Appraisal Journal* publishes a paper entitled 'Valuing high performance houses' (Adomatis, 2010)**.**
- **2010**: The Appraisal Institute releases *An Introduction to Green Homes* (Simmons, 2010)**.** It provides the appraiser with an overview of programmes, organisations and products that relate to environmentally responsible building and remodelling.
- **2011**: The Appraisal Institute launches its Valuation of Sustainable Buildings professional development programme consisting of three one- and two-day courses on the valuation of high-performance residential and commercial buildings.
- **2011**: *The Appraisal Journal* republishes a paper from the 17th Annual American Real Estate Society Conference in 2010 entitled 'Energising Property Valuation: Putting a Value on Energy-efficient Buildings'.(Leopoldsberger et al, 2011).
- **2012**: The Real Estate Standards Organisation (RESO) releases the *Green Data Dictionary*, which assists multi-listing sites to adopt high quality and consistent "green fields" in describing listings.
- **2012**: Elevate Energy launches the Value for High Performance Homes campaign, and coordinates a learning network that actively implements ways to incorporate energy efficiency improvements within the transaction process.
- **2012**: The Appraisal Institute releases the five-page comprehensive *Green & Energy Efficiency Addendum***.** This documents the high-performance features of a home, helping the appraiser and sales agent to find comparable sales to assist fair valuations.
- **2012**: The Appraisal Institute releases *Residential Green Valuation Tools,* which provides a comprehensive overview of green housing and the valuation of high-performance homes.
- **2013**: The Building Performance Institute BPI-2101-S-2013 *Standard Requirements for a Certificate of Completion for Residential Energy Upgrades* provides a consistent way to record home energy upgrades completed on an existing home**.** The *Home Performance XML* (HPXML) standard defines data collection (BPI-2100) and data transfer (BPI-2200) standards for home energy upgrades**.**
- **2013**: The Appraisal Practices Board (APB) of the Appraisal Foundation releases *First Exposure Draft – Valuation of Green Buildings: Background and Core Competency*

(Baumgardner, 2013). It provides guidance to appraisers concerning the necessary background and core competencies needed to value green, high-performance or sustainable commercial and residential buildings.

- **2013**: Demand for Home Energy Ratings soars. US homes that were energy rated and issued a Home Energy Rating System (HERS) index score skyrocket 70 percent over the year before due to energy costs and mortgage default risk. Energy Star-rated homes are 32 percent less likely to go into default than non-Energy Star homes.
- **2014**: GuildQuality, North America's leading provider of customer satisfaction surveying for the building industry conducts a study of those who purchased or built a certified green home. It produces the *Homeowner's Perspective: The Value of a Green Home* (GuildQuality, 2014)

4.4.2 Current US initiatives and changes

Stakeholders from energy efficiency, utility, real estate, and financial industries, as well as policy and regulatory agencies, have identified several elements to valuing energy efficiency improvements at time of sale. These include home performance data transparency and standardisation, automated data transfer solutions, and training and education opportunities for real estate professionals.

- The home performance industry standardises energy/environmental data collection and transfer protocols.
- The real estate industry standardises green and high-performance home fields in MLS systems.
- The appraisal industry adds an addendum to document energy efficiency and green features of a home.

Better integration of the energy efficiency and real estate industries is also being encouraged and pursued at the federal level. For example, one of the priorities for the US Department of Energy's residential Building America programme in 2015 is to accelerate energy efficient homes achieving fair value on sale (US Department of Energy, 2013).

The Value for High Performance Homes campaign was launched in 2012 by Elevate Energy. The campaign coordinates a learning network of (currently) 10 US markets that are actively implementing ways to incorporate energy efficiency improvements in the real estate transaction process. They aim to identify and advance what is already working, accelerate learnings, improve evolving ideas and highlight progress.

The White House Council on Environmental Quality has been encouraging better coordination, beginning with mortgage products that are managed by the US Department of Housing and Urban Development (US HUD). Some potential improvements include the publication of alternative valuation methods for high-performance homes that meet underwriting guidelines.

There are already a number of alternative approaches to valuation, including triple bottom line, full-cost accounting and multiple accounts evaluation. All seek to model value more holistically by integrating environmental, societal and community as well as strictly financial concepts, and all have yet to achieve universal (or even nationwide) acceptance.

4.5 Reports and journal articles on the value of sustainability

Willingness to pay for energy-saving measures in residential buildings

Banfi, S, Farsi, M, Filippini, M, & Jakob, M. (2008).

Abstract: The paper uses a choice experiment to evaluate the consumers' willingness to pay for energy-saving measures in Switzerland's residential buildings. These measures include air renewal (ventilation) systems and insulation of windows and façades. Two groups of respondents consisting of apartment tenants and house owners were asked to choose between their housing status quo and several hypothetical situations with different attributes and prices. Respondents indicated a 3% premium on rents and purchase price for a shift to better than standard façade insulation, and a 4%–12% premium for housing ventilation systems. Only a 1% premium was recorded for a shift to enhanced window insulation.

Comments: The study provides useful benchmarks for the possible capitalisation of the value of sustainability features.

The value of green labels in the California housing market: An economic analysis of the impact of green labelling on the sales price of a home

Kok, N and Kahn, M**.** (2012).

Abstract: This is the first study to provide statistical evidence that, holding other factors constant, a green label on a single-family home in California adds a premium of 9%**.** Labels included were: Energy Star Version 2, GreenPoint Rated, or LEED for Homes**.** The research also indicates that the price premium is influenced by local climate and environmental ideology**.** To reach these conclusions, researchers conducted an economic analysis of 1.6 million homes sold in California between 2007 and 2012. Variables known to influence home prices were controlled in order to isolate the added value of green home labels**.** The economic approach used, called hedonic pricing analysis, controlled a large number of variables that affect real estate pricing, such as vintage, size, location (by zip code) and the presence of major amenities (e.g., pools, views and air conditioning).

Comments: The study uses a similar (suggested) approach for uncovering demand influences. The study is useful in that it shows that widespread adoption of green labelling in housing has enabled the price premium to be quantified**.** The sample size of rated homes was 4,231, and the control group (i.e**.** non-rated) was 1.6 million non-certified homes.

The impact of solar panels on the price and saleability of domestic properties in Oxford

Morris-Marsham, C. and Moore, G. (2011).

Abstract: Studies into energy efficiency and micro-generation in the built environment tend to focus on the economic or environmental paybacks of installed technologies. However, features that reduce the energy consumption of a property may also play a role in influencing property value. To date, research into whether and to what extent energy efficiency and micro-generation technologies, such as solar panels, affect the price and saleability of properties has been limited in the UK. This paper reports the results of a study that examined property buyer responses to solar panels. It explored the expectations of householders and estate agents surrounding solar panels and value in domestic properties in Oxford. The study concludes that demand for properties with solar panels in Oxford does exist amongst prospective homebuyers but it is not, at present, being translated into increased property values. Estate agents were largely negative or uncertain about the added value and saleability of properties with solar and, in the majority of cases, did not factor them into valuations. The study found considerable ambivalence towards solar panels with around half of the prospective buyers surveyed stating the presence of solar panels would not affect their purchase decision. The study hypothesises that this may partially

stem from a lack of information given to prospective buyers on the fuel bill savings associated with solar panels.

Comments: Interesting study, used for the basis of the BRANZ REA and valuers surveys.

The impact of photovoltaic systems on market value and marketability

Desmarais, L. (2013).

Abstract: This study was conducted on behalf of the Colorado Energy Office to provide an analysis of the impact of solar photovoltaic (solar PV) systems on the home-buying process. It includes the analysis of 30 homes in the northwest Denver metro area, with homes ranging in sale price from US$200,000 to $680,000**.** The goal of the study is to better understand the impact solar PV has, if any, on market value and marketability**.** All properties used as case studies were sold between January 1, 2011 and May 31, 2013**.** The 30 case studies each consist of a single-family residential home that had a PV system installed at the time of sale**.** All of the PV systems included in this study are owned, and not leased, by the homeowner**.** Findings included:

- The overwhelming majority of real estate agents surveyed believe owned PV systems increase the market value and marketability of homes.
- Real estate agents are continually increasing the frequency with which they use marketing materials with words such as "energy" and "solar" in them**.** The market's reaction to PV systems is that:
    - PV systems are unlikely to have a negative value impact.
    - Marketing times were notably lower for homes with PV systems.
    - 22 of 30 case studies indicated PV systems contributed US$1,400 to $2,600 per kW to market value.
    - The market does place value on the utility savings realised from PV systems.

Comments: The study is very useful as it provides specifics (approach, quantitative data and analysis) on a key issue and is recent**.**

Understanding the solar home price premium: Electricity generation and 'green' social status

Dastrup, S., Joshua S**.,** Zivin, G., Costa, D. L., Kahn, M. E. (2011)*.*

Abstract: This study uses a large sample of homes in San Diego and Sacramento, California, to provide some of the first capitalisation estimates of the sales value of homes with solar panels**.** Although the residential solar home market continues to grow, there is little direct evidence on the market capitalisation effect**.** Using both hedonic pricing and a repeat sales index approach, the study finds that solar panels are capitalised at roughly a 3.5% premium**.** This premium is larger in communities with a greater share of college graduates and of registered Prius hybrid vehicles**.**

For the average installation, the authors found that solar panels added a US$20,194 premium to the sales price of the house based on repeat sales data. Houses were in the mid-US$500,000 range**.** Homeowners appear to recover approximately 97% of their investment costs – in addition to the savings associated with reduced energy bills**.** By contrast, the study suggests a luxury kitchen remodel brings a 60% payback, citing Hanley Wood's 2010–2011 *Cost Versus Value* report.

Comments: Very good as it provides quantitative values based on recognised economic analysis methods.

An analysis of the effects of residential photovoltaic energy systems on home sales prices in California.

Hoen, B., Wiser, RH, Cappers, P., and Thayer, M. (2011).

Abstract: The study finds strong evidence that homes with solar photovoltaic (PV) systems sell for a premium over homes without solar systems**.** A key point the study makes is that, on average, the premium paid is around 20 times the annual energy savings from the solar panels.

The research finds that homes with PV in California have sold for a premium – expressed in dollars per watt of installed PV – of approximately US$3.90 to $6.40/watt**.** This corresponds to an average home sales price premium of approximately US$17,000 for a relatively new 3,100 watt PV system. This compares to an average investment that homeowners have made to install PV systems in California of approximately US$5/watt over the 2001–2009 period**.**

Comments: The study, like that by Dastrup et al (2011), suggests that PV systems broadly recover their upfront cost in resale, in addition to the energy savings the owner accumulates during ownership. It is worth noting that the cost to install PV systems has also fallen substantially in recent years, so a 3,100 watt system is likely to cost far less than US$17,000 today. This report was updated by the authors in 2013: *Exploring California PV Home Premiums* and is available at: http://emp.lbl.gov/publications/exploring-california-pv-home-premiums

Cost benefits of sustainable housing retrofits.

Page, I**. (**2009**).**

Abstract: This report considers the cost benefits of a variety of sustainable retrofits for the existing housing stock in New Zealand**.** The retrofit interventions costed are mainly energy and water related, and values are calculated for the four main centres and 11 house and multiunit typologies**.** Health and comfort benefits are considered and the costs include initial costs of the measures and their replacements**.** Future operating costs are discounted and the results are expressed as net present values and benefit-cost ratios**.** Typologies and locations are scaled up to derive national benefits**.** A spreadsheet model is provided on which users can change parameters and try various packages of measures.

Comments: The study is focused more on the economic value to the owner than the perceived value to the potential buyer, developer or builder. Nevertheless, the economic value to the owner is theoretically the gain the next home owner would realise on the same house. The study does indicate what the premium for the house should be if sustainability measures are accurately priced into the sale price.

Certified home performance: Assessing the market impacts of third party certification on residential properties.

Griffin, A. (2009).

Abstract: The report presents an analysis of the market performance of third-party certified sustainable residential properties in the Portland and Seattle metropolitan areas**.** In each location, a sample of third-party certified homes was selected and comparable homes were found**.** The author documents that certified homes in the Seattle metro area sold at a price premium of 9.6% when compared to noncertified counterparts, based on a sample of 68 certified homes**.** In the Portland metro area, certified homes sold at a price premium ranging between 3% and 5%**.** In addition, the certified homes stayed on the market for 18 days less than noncertified homes**.**

These results are based on a sample of 92 certified homes and comparable properties approved by a project appraiser. This is one of the earliest reports to explore this issue.

Comments: Useful economic study that addresses a wide range of sustainability issues.

Sustainability and income-producing property valuation: North American status and recommended procedures

Austin, G. W. (2012).

Abstract: The valuation of property with "sustainability" aspects is not a new property type nor does it call for a deviation from the traditional valuation methods for the appraisal of income-producing properties. However, there can be numerous and significant differences between sustainable and traditional properties that appraisers must consider, research, and address. This paper provides a systematic procedure for evaluating sustainable property with practical guidance for the integration of this procedure into the valuation process for all consumers of appraisal services. The proposed procedure is consistent with the ''valuation process'' promulgated by the Appraisal Institute. It is also consistent with the Uniform Standards of Professional Appraisal Practice, as well as the methodological and conceptual valuation literature.

Comments: The study provides a good historical overview and associated references. It includes a detailed procedural assessment and information on hedonic pricing approaches.

The study effectively summarises work in this area with many useful references. It recommends appraisers expand the scope of their work to fully integrate sustainability aspects into the valuation process. Appraisers should consult sustainability experts as required. They should be able to provide the client with a cause-and-effect relationship between sustainability features and the valuation adjustment factor. They should avoid general statements and assertions that certified buildings always command a value premium across all property types, areas and market conditions. These recommendations mainly relate to commercial buildings, but also apply to most residential buildings.

Unlocking the value of an energy efficient home: A blueprint to make energy efficiency visible in the real estate market

CNT Energy and the National Home Performance Council. (2013).

Abstract: This document was developed to help energy efficiency programme sponsors and stakeholders in the home performance industry document and value sustainability improvements. It recognises that there is a disconnect between the energy efficiency program implementers, real estate agents, and the homebuyer and seller. Making information about energy efficiency improvements visible to home buyers and others involved in a home sale transaction will play a crucial role in ensuring that improvements are fairly valued at sale. The paper provides a blueprint that programme sponsors can use to integrate information about improved existing homes into the real estate transaction process. The intended outcome of this blueprint is that energy efficient features that are often invisible to the naked eye can be accurately valued. The blueprint is divided into a programme that includes:

- standardised documentation
- disclosure
- education
- coordination with real estate agents

- automation between actors.

Comments: Although the study is US-centric and focuses on only one strand of sustainability (energy efficiency), it provides a useful insight into a possible solution pathway.

Valuing home performance improvements in real estate markets

Stukel & Scheu. (2014).

Abstract: Many regions and communities have adopted residential energy efficiency goals as part of their sustainability plans. Consumer demand for high-performing homes has increased in recent years, and successful energy efficiency programmes have contributed to the growing inventory of efficient homes. Yet, energy efficiency is still largely invisible in residential real estate markets. This is due to a disconnect between programme implementers, the real estate community, appraisers and homebuyers and sellers.

The study argues that these gaps prevent high-performing homes from being fairly valued at time of sale and limit the investment potential for residential energy efficiency. It describes existing barriers to integrating energy efficiency data into real estate markets, and illustrates recent efforts to address them. National cross-industry collaborations have resulted in standard data collection and transfer tools that allow home performance data to be shared across industries. Real estate markets in some regions have begun including these data into multiple-listing services, making them visible during real estate transactions.

Lessons from two early adopters can assist other regions in developing a tailored approach to helping identify high-performing homes in other real estate markets. Closing this gap could create incentives for homebuilders, lenders and homeowners to invest in energy improvements.

Comments: An up-to-date study (published in mid-August 2014) highlighting trends in data sharing and standardisation in the US. It includes many useful references and links to recent studies.

Residential green valuation tools

Adomatis, S. (2013).

Abstract: The market for high-performance homes is growing, and appraisers who want to appraise these homes competently need to stay up to date on the latest green terms, home features and organisations. The study explains what the term “green” means as it applies to housing and how to determine exactly how green a particular property is. In-depth guidance is provided on properly completing the Appraisal Institute’s *Residential Green and Energy Efficient Addendum* form for appraisal reports (see below). The valuation of Energy Star homes, passive solar houses, solar PV systems, and net-zero energy homes is also discussed.

Comments: This study is useful in its examination of the tools (e.g. cost analysis, gross multiplier, discounted cash flow analysis and paired data analysis) appraisers use to provide reliable valuations. It showcases the appraisal of specific sustainability featured homes:

- PV equipped
- net zero
- passive solar
- Energy Star.

Residential green and energy efficient addendum

Appraisal Institute**. (**2013)**.**

Abstract: This is a formalised appraisal pro forma addendum for real estate appraisers that was created to:

- provide one central place in a report for green and energy efficient features
- standardise the reporting process
- organise and expand the description sections of the residential forms
- provide a basis for comparable sale selection
- proactively prepare appraisers for the proposed legislation known as the *Sensible Accounting to Value Energy (SAVE)* bill
- be part of a proactive movement to prepare for the SAVE bill, which may become law in the near future.

Comments: The addendum provides a useful indication of which issues are important for the Appraisal Institute**.**

Studies Show Green Housing is a Solid Investment

Courtland, M. (2013).

Overview: A compilation of pertinent and recent US studies showing the value of sustainable building, technology and labelling is an important consideration for everyone in the market**.** Written in 2013**.**

Comments: Good background document.

4.6 Web resources on the value of sustainability

Immovalue

www.immovalue.org

Overview: Financed by the Intelligent Energy Europe Program, the project aimed to improve the market impact of energy certification by introducing energy efficiency and life-cycle costs into property valuation practice**.** In the first step, the project team developed solid "modified" valuation approaches**.** In the second step, the approaches were checked through a series of pilot project valuations and through a comprehensive expert review process**.** In the third step, the newly developed standards for property valuation were disseminated to the market**.**

Comments: The website has useful resources – papers and presentations with an EU focus**.** The main findings of the project (as of late 2010):

- There is a gap between the general acknowledgement of the importance and the practical integration of energy efficiency and life-cycle cost analysis (LCCA) into valuation practice**.** Practically all valuation reports deal with these issues only in a qualitative, descriptive way rather than in quantitative terms.
- The IMMOVALUE project contributed to bridging this gap by offering methodologies based on standard valuation approaches**.**

- Fifteen case studies demonstrated that the modified approaches work well and deliver reasonable results**.** However, the value impact is, in general, limited**.** Only highly energy efficient and sustainable properties generated a premium of 5–10%**.**
- The lack of data sets limits the broad application of the modified valuation approaches**.** In most cases, data on energy efficiency, LCCA and other sustainability aspects is very vague**.** For a broad application, valuers need reliable databases on reference buildings**.** In addition, valuers need training to interpret energy benchmarks, the results of LCCA and other technical characteristics of the building.

4.7 Multi-criteria tools related to sustainability and resilience

Key information on the most well-known sustainable building and resilience rating schemes operating today is provided in the tables that follow**.** Only those schemes that are comprehensive (in terms of the number and extent of issues examined) are listed.

Table 3 Comparison of international sustainability-related rating tools for dwellings

Green rating tool name	Status	Type of certification	Tool developer	Main issues examined	Cost (approx.)	Number of houses assessed
Leadership in Energy and Environmental Design (LEED)	voluntary	independent third party verification for homes	US Green Building Council	sustainable sites; waste efficiency; energy and atmosphere; materials and resources; indoor air quality; location; education; innovation	$1200 registration and $2750+ certification	22,000+
Living Building Challenge	voluntary	performance-based standard and certification program for buildings	International Living Future Institute	site; water; energy; health; equity; beauty. All areas are requirements	registration $900 + $1750+ certification	dozens only of standalone houses
National Green Building Rating Standard	required in some circumstances	nationally-recognisable standard definition of green building	US National Association of Home Builders and International Code Council	lot design; resource efficiency; water efficiency; water efficiency; IEQ; operation	$500	42,000+
BREEAM	previously voluntary	originally as EcoHomes, which morphed into government-endorsed Code for Sustainable Homes	BRE Global – BRE manages and develops the technical contents of the Code; BRE started development in 1990	energy in use; water in use; internal environment; pollution; transport; materials; waste; ecology; management process	£2000 for a small project	thousands
CASBEE	voluntary	assessment tools for pre-design, new construction, existing building and renovation.	JSBC (Japan Sustainable Building Consortium) and its affiliated sub-committees	energy efficiency; resource efficiency; local environment; indoor environment		dozens only of standalone houses
BASIX (Building Sustainability Index)	compulsory	an integrated part of the planning system, implemented under the Environmental Planning Act; applies to all residential dwelling types in NSW	NSW Government	BASIX sets sustainability targets for water and energy as well as minimum performance levels for the thermal comfort of the proposed development	$50	thousands
Green Star (Australia, South Africa etc.)	voluntary	comprehensive, national, voluntary environmental rating system for multi-unit	.	management, indoor environment quality, energy, transport, materials, land use and ecology, emissions	various, but between $5,000 and $30,000 in Australia	dozens only of standalone houses
Esidama	compulsory	villas	Abu Dhabi planning council	integrated development process; natural systems; precious water; resourceful; energy; stewarding materials; innovating practice	not fully established yet	none
HomeStar	voluntary	various domestic building typologies	NZGBC (New Zealand Green Building Council)		$500–$800	dozens only
DGNB (German Sustainable Building Council)	voluntary	new, modernisation and existing and residential buildings, hotels and mixed	German Sustainable Building Council and the Federal Ministry of Transport, Building and Urban Affairs (2007)	global and local environment; utilisation of resources; performance, health, comfort, functionality; quality	unknown	dozens only

Table 4 Comparison of key international resilience-related rating tools for dwellings

Resilient rating tool name	Purpose	Country of origin	Tool initiator/developer	Main issues examined	Cost (approx.)	number of houses assessed
Building Resilience Rating Tool	intended to rate the resilience of your home to common extreme weather hazards	Australia	Insurance Council of Australia and the Australian Resilient Taskforce and Edge Environment	inundation, storm, cyclone, bushfire, earthquake, extreme heat	nil	still in development
Climate Change Sustainability Index	provides a numeric rating for key climate change related effects on houses, to determine vulnerability	NZ	BRANZ Ltd	looks at both impacts (overheating risk, flooding risk, tropical cyclones) and emissions (green house gases)	nil	unknown
Fortified for Existing Homes – Hurricane Standard	provides ratings based on their ability to withstand extreme wind events; also: Resilience STAR™ for single-family homes in hurricane-prone communities to make them more disaster-resistant	USA	Insurance Institute for Business and Home Safety and The U.S. Department of Homeland Security (DHS)	more resistant to hurricanes, tropical storms, hailstorms, high winds and wind-driven rain associated with thunderstorms.	varies according to the level of achievement	about 1,000 FORTIFIED homes; about 5 only Resilience STAR™ certified homes (started Sept 2014)
Harden Up plan	checkbox/tick system to enable preparation for unique household and local hazard most likely to encounter, by answering a few simple questions	Australia (Queensland)	Green Cross Australia	bushfire, storm, flood, cyclone	nil	unknown

4.8 A critique of current approaches to valuing sustainability features

New Zealand Cabinet instructions for regulatory change require a regulatory impact statement (RIS). The RIS outlines the reasons for the regulation, the proposed measures, the market failure addressed by regulation, and what other approaches have been investigated in considering the regulation. A cost-benefit analysis (CBA) is often included in the RIS, with the assumptions and parameters (i.e. prices, discount rates, period of analysis, sensitivity analysis). Generally, a benefit-to-cost ratio of over 1.0 is required for the proposed regulation to be adopted.

Building-related CBAs carried out in New Zealand have included:

- regulation of thermal insulation of the building envelope
- passive and active fire protection measures
- safety from falling from heights
- improved acoustic insulation in apartments.

In most cases, the cost side of the proposed measures is relatively straightforward to estimate. This usually involves selecting representative buildings and calculating the additional cost of the proposed measure. There may be some issues in assessing prices when there is a step change in the design requirement and quantities, such as going from single glazing to double glazing. But usually there is some information to forecast likely prices of new components. There may be training and information costs in bringing the industry up to speed with the new requirements.

4.8.1 The challenge of measuring benefits

The difficulty mainly arises in assessing the benefits. Some benefits, such as energy savings from better insulation, are fairly easy to model using representative buildings. In addition, health benefits from improved indoor temperatures have been quantified from before-and-after retrofit studies of selected low-income households with zero insulation and low initial indoor temperatures.

Mitigation of injury during construction and in use can be estimated using Accident Compensation Corporation (ACC) injury data, but the expected reduction is often an estimate. Actual reductions may not be apparent until some years after the introduction of the new measure. Further, the regulation is unlikely to be retrospectively reviewed and amended if found to be net negative. For

instance, structural loading standard changes are usually revised only after larger-than-expected actual events. These events change the risk profile and hence the likelihood of events of given magnitude. Hence, the expected savings in the future can be estimated.

Apartment acoustic mitigation benefits have been quantified overseas in terms of reduced health costs or hedonic pricing and this data has been used locally for proposed revisions.

For energy use regulation, decisions are required on how much energy savings actually occur. Households will take some or all of the theoretical gains as increased comfort levels when pre-existing indoor temperatures are low (below 14°C). In this case there are likely health cost savings but when insulation is added to some existing insulation the health cost savings become more difficult to estimate. A feeling of well-being is associated with improved comfort (or indoor temperature) but the question is can it be measured and, if so, how?

4.8.2 Contingent valuation method

One technique to assess benefits is the contingent valuation (CV) method. This was first developed for environment goods such as parks and reserves, or bio-diversity maintenance. People get satisfaction from these goods but there is no market price for them. In the CV method, people are surveyed on their willingness to pay for the provision of such goods. Alternatively, when such a good exists, they are surveyed on their willingness to accept the loss of this good in terms of cash as compensation.

There has been substantial criticism of the method over the years, mainly on the basis that it is not "real money" at stake. In 1993, the National Oceanic and Atmospheric Administration (NOAA) (Arrow et al, 1993) reported on its consultation with a large group of eminent economists. Their recommendations were in the context of the use of CV in environment protection measures to be funded through local taxes. The most important recommendations were that:

- Personal interviews be used to conduct the survey, as opposed to telephone or mall-stop methods.
- Surveys be designed in a yes or no referendum format put to the respondent as a vote on a specific tax to protect a specified resource.
- Respondents be given detailed information on the resource in question and on the protection measure they were voting on. This information should include threats to the resource (best and worst-case scenarios), scientific evaluation of its ecological importance and possible outcomes of protection measures.
- Income effects be carefully explained to ensure respondents understood that they were to express their willingness to pay to protect the particular resource in question, not the environment generally.
- Subsidiary questions be asked to ensure respondents understood the question posed.

The guiding principle behind these recommendations was that the survey operator has a high burden of proof to satisfy before the results can be seen as meaningful. The NOAA panel also felt, in general, that conservative estimates of value were to be preferred. One important consequence of this decision is that they recommended CV surveys measure willingness to pay to protect the environment good rather than willingness to accept compensation for the loss of the resource.

4.8.3 Case study: The Auckland Retrofit Your Home programme

A social return on investment (SROI) evaluation of the Auckland Retrofit Your Home (RYF) programme was undertaken in 2014 (Rohani et al, 2014). It offers a useful starting point for

evaluating the social benefits of sustainability features (i.e. heat pumps and better insulation) but also offers opportunities to learn from some of the criticisms of the study.

The RYF evaluation estimates that $3.1 of benefit are derived for each $1 invested as part of the RYF programme. However, a number of factors suggest this value may not be as accurate as one might wish. The following analysis highlights some learnings that emerge from criticisms of the study.

Avoid biases in survey questions

The survey used for the study asks RYF respondents: "What amount of money would you need to be paid to go back to living in your house prior to the retrofit? Please take a moment to reflect, and provide a best estimate." (Q67)

This willingness-to-accept question is biased in that it does not allow for the possibility that the respondent may in fact believe they are now worse off. Perhaps they don't like the noisiness of the heat pump, or have been surprised by bigger energy bills than expected because they are using the heat pump much more.

A large proportion of respondents (30%) answered "Don't know" for this question. It is unclear whether this was because respondents really had no idea of an appropriate value to place on the RYF benefit, or they were unsure how to respond with a negative answer.

Nevertheless, it is likely that the phrasing of the question led to overly positive responses to the question, which brings the validity of the outcome into doubt. This is especially true given the importance of Q67 in estimating the overall benefits of the RYF programme (around 40% of all recorded benefits).

Do not confuse net present values with annual undiscounted benefits

Continuing from the previous point, the study makes the additional error of counting multiple times the money people would be willing to pay to stay in their retrofitted house. Contingent valuations are already presented in net present value terms. That is, if someone says they would pay $20,000 to stay in their warmer, drier house, the assumption is not that they would then pay a similar amount the following year. They are already presenting the stream of future benefits as a one-off payment.

As page 62 of the study shows, the "Increased feeling of satisfaction with living situation" value derived from Q67 is counted (albeit discounted by a "drop off" percentage) for three years. Even after further discounting to put these figures in net present value terms, the benefit of "Increased feeling of satisfaction with living situation" is overestimated by a factor of at least 2.0. Because it is the largest component of the total benefit of the RYF programme, this error alone inflates the net present value (and thus return on investment) by 25%.

Most other factors, such as financial savings from energy use, time saved on maintenance, or increased quality of life, correctly count benefits each year because they are recurring.

Stick with one method: contingent valuation vs component estimation

Leading directly from the previous point, it appears it would have been much simpler to adopt one approach rather than a bulky mix of two approaches to estimating benefits. Either the willingness-to-accept approach should be used to estimate an average net present value of benefits, or the approach of trying to measure each of the sub-components should have been used. A hybrid

model requires esoteric adjustments such as the 55% correlation (p.33) removed from the "Increased feeling of satisfaction with living situation" component.

It would have been better to produce an average willingness-to-pay net present value (Q67), and then to sum the estimates of the other components as an alternative method. The two sets of results could then be compared as a sense check.

Avoid double counting

To its credit, the study does attempt to remove some double counting. It explains that 55% of the benefits calculated as being associated with "Increased feeling of satisfaction with living situation" are subtracted because of the correlation of 0.55 between willingness-to-accept and other outcomes.

Nevertheless, significant proportions of double-counting seem to remain. One reason for this appears to be through making the mistake of assigning a value to both an outcome (e.g. cleaner air) and the benefit it provides (e.g. better quality of life).

The report does appear to partially separate out health impacts into health impacts that accrue to:

- residents of uninsulated, cold houses (section 6.2.2)
- society at large due to use of environmentally poor heating choices (section 6.5).

Nevertheless, many of the societal benefits may be covered by the health benefits that accrue to residents, which are a function both of improved air quality and drier homes.

Interrogate assumptions carefully

Several instances in the study appear to be particularly optimistic assumptions as to the likely benefits of the RYF programme. Examples include:

- Improved relationship within the family (p.38–39):
    - The assumption that families go out rather than stay at home in winter because it is cold. The study highlights the types of expenses families incur when they go out as "restaurant meals and ready-to-eat food", "recreation and cultural services", "accommodation services", "package holidays" and "miscellaneous domestic holiday costs". It assumes families will go out half as much in winter if their households are warmer, saving half of this spending. Yet the type of spending people are making outside the home suggests they are obtaining significant utility from those activities that may be independent of better heating at home.
- Time saved in maintenance and cleaning (p.42–43):
    - Presumably most of these savings come from "messier" heating such as wood burners that need sweeping out, and not from electrical heaters, which have low maintenance needs. As these heat sources will only be used in winter, the savings of 2.9 hours a month should only be applied to the six months when the heating is used. This immediately halves the benefit.
    - The value of time is particularly optimistic. "Free time" is typically valued far lower than work time (see New Zealand Transport Agency estimates for instance). A generous valuation of free time would be to value free time at the same rate as the minimum wage (currently $14.25 an hour). This all but halves the value of this benefit again, to little more than a quarter of the published value.

- Improved educational attainment for students (p.44–46):
    - It is assumed that the benefit to students of being able to study better at home is measurable by the avoided cost of a maths tuition class. At a cost of $2,320 per student per year, however, it is unlikely that many households taking advantage of a government-run RYF programme could afford the tuition. This is not to say no allowance should be made, but this is probably beyond the means of most parents. An alternative may have been to evaluate the impact on future earnings of better school level achievement, but that may be difficult to accurately apportion.
- Financial savings from working from home more often (p.46–49):
    - It may be unrealistic to assume a 50% increase in the number of days a worker works from home. For most jobs, particularly among households that take advantage of government-run RYF programmes, an increase to more than three days a week of working at home seems unlikely.
    - The study assumes the petrol cost of each worker driving to work alone. i.e. it makes no allowance for the use of cheaper public transport or shared transport.
    - It again assumes a high value of free time of $27 an hour, almost double what a reasonably conservative approach would.
    - No allowance is made for the increased costs of working at home – greater use of energy, home computer, coffee and other consumables usually paid for by an employer.

Choose appropriate discount rates

The RYF evaluation appears to adopt particularly optimistic real discount rates. For the benefit analysis, a real discount rate of 4% has been applied. According to the study (p. C-2), this discount rate is recommended by Auckland Council CBA, with sensitivity analyses to be undertaken at 6% and 8%. Points to note are that:

- The New Zealand Treasury generally recommends significantly higher discount rates as standard (6% to 9%). A low discount rate may over-inflate the value of the future benefits stream.
- The required 6% and 8% sensitivity analyses are not presented in Table 28 (p.67) with all the other sensitivities.
- At the very least, an argument should be made for the lower discount rate. World Health Organization (WHO) and New Zealand Fire Service support quality-of-life measures where real discount rates of 3–3.5% are used, while a real discount rate of less than 6% appears weak.

Set a consistent evaluation period

In adding benefits and costs, a consistent evaluation period should be chosen, typically the life of the asset or 25 years, whichever is shorter. The study shows that the first five years of the life of a heat pump are when it is most efficient and under warranty. However, some benefits are counted for three years, while others for five. This suggests an inconsistency in the cost-benefit calculation which is unhelpfully confusing and possibly erroneous.

5. BUILDERS, SUSTAINABILITY AND RESILIENCE

Ten of New Zealand's largest builders were interviewed across Auckland, Christchurch and Tauranga. Full interview summaries are included in the appendices, but this chapter highlights the key points.

5.1 Most builders aim to deliver what the client wants and not to offer advice

Most builders did not believe their role was to advise clients on which features to include and which ones had the best payback periods. Most would try to accommodate the specific features their clients were interested in. Some exceptions included:

- **Personal experience**: Some sales or design team members had personal experience with certain products or systems, and were passionate about particular features. They would personally promote these features.
- **Features already included**: Some builders are already including a number of features as standard (see discussion below). In these cases, the client would need to opt out of certain features to bring the price of the build down.
- **Impact on build timeline**: Some builders struggled to find providers of sustainability features and services that they could rely on to get work done within their build timeframe. Where builders were concerned that a sub-contractor would delay completion of the home, they would discourage the client from using that sub-contractor or possibly including the feature.

Those who did try to advise their clients would use probing questions to understand what the client really wanted, including:

- What is the purpose in having this feature?
- How long will you live here (i.e. will the payback period be sufficient?)

5.2 Few clients ask about these features

Very small proportions of clients asked about specific sustainability and resilience features. Most preferred to spend money on "things you can see". Builders pointed out that this was almost always the number of bedrooms and bathrooms, garage size, kitchen features or carpets. Many people see spending on sustainability and resilience features as a direct reduction in the footprint they can afford to buy.

Some builders pointed out that in many cases, the female desired a house with a nice kitchen and bathroom, while the male partner wanted a nice TV. This made it unlikely they would pursue sustainability and resilience features.

One Christchurch builder pointed out that for many clients the question was not about sustainability, but rather "how do I best heat my home?" where "best" was likely to be a combination of affordability and comfort.

All three Christchurch builders pointed out that the earthquake rebuild had some unusual impacts. First, some insurers offered sustainability clauses in their contracts, whereby insurance payouts were $15–20,000 bigger if the additional money was spent on sustainability features. This encouraged spending on sustainability features as the money was "free" on top of the payout for a damaged house. Second, some Christchurch residents had waited up to four years to rebuild. This meant they had a lot of time to research the best way to rebuild their homes, and what features to include.

Features that were most commonly asked about include:

- solar panels
- hot water heat pumps
- underfloor heating
- LED lighting
- wetbacks (in rural areas)
- heat transfer kits/ducted heat pump systems
- DVS systems
- insulated garages (to allow flexibility for later conversion)
- off-the-grid solar options where the cost of connecting to the grid was prohibitive.

Even fewer clients purchase sustainability and resilience features once they understand the price. While LED lights were becoming standard, solar hot water, hot water heat pumps and other features were typically incorporated by well under 10% of builds, and in many cases by under 2–3%. In most cases, upfront cost was prohibitive and clients did not perceive sensible payback periods.

5.3 Most don't claim much sustainability and resilience expertise

Most interviewees claimed little to no technical knowledge about sustainability and resilience features, except for the occasional interviewee who had personal experience with various features. In almost all cases, client questions would be directed to manufacturers or specific consultants that the builder recommended.

One example was LED lighting. While many were including this as standard now, the main reasons were that they looked more attractive, lasted longer, and did not require changing as frequently. Few builders were aware of the significant energy savings of being able to cover LED downlights with insulation, rather than abut traditional downlights.

One piece of advice that builders offer is how easily a particular feature could be retrofitted if a client decides later they want it. If something is easily retrofitted, there may be less reason to install it upfront. However, some features, such as gas heating, need to be installed upfront.

5.4 Few see any impact on resale value of the home

Builders who commented mostly felt that sustainability and resilience features added little to the resale value of a home despite many acknowledging they had little expertise on the payback period of features.

This is why some of them asked clients how long they planned to live in the house. If the stay was short, they would advise that it is unlikely the feature would pay for itself.

Others believed that, at resale, potential buyers could see sustainability and resilience features as a "bonus" but that they would not add significantly to the value of the property.

5.5 Some are already incorporating sustainability and resilience features

Several builders are already incorporating sustainability and resilience features as standard in their specifications. This did, however, vary widely from builder to builder.

The most common feature was above-Code insulation, which almost all builders offer, with some offering up to R5.0 ceiling insulation.

Other features that some builders offer as standard include:

- LED lighting
- thermally-broken windows
- heat exchanges for fresh air
- thermal breaks on steel studs
- more efficient tapware, shower roses and toilets
- waffle pod floors
- passive solar design
- prefabrication
- low maintenance claddings with higher R-values
- concrete tile roofs that reduce noise
- start up control on tapware to limit water wastage
- Homestar 6 ratings within Special Housing Areas
- plasterboard with higher fire ratings
- steel framing (recyclable).

It was encouraging that some builders, through vertical integration or securing strong supplier relationships, were able to offer several sustainability features as standard without a significant price increase. This meant if budgets were tight, prospective clients would have to opt out of the features, rather than opt in. This meant that most of their clients would adopt the sustainability features by default.

One builder even indicated that by including continual improvements in their standard specifications, they could help clients make better decisions, as clients often did not understand the value of particular features.

5.6 Most see value in more independent advice and support of what works

The vast majority of builders spoken to saw the value in providing an independent source of advice that was not linked to a particular manufacturer of a product or service.

However:

- They cautioned there is a lot of “noise” in the marketplace from dozens of other websites that claim to offer independent advice, through which any new information would need to be heard.
- They advised that any new source of data would need to be fiercely independent.
- Some interviewees felt sufficiently strongly that they were to “give the client what they want” that they were not interested in more independent advice.
- The advice needed to be practical and easily understood by both builders and the client making decisions about features within their budget.

The preference seemed to be for datasheets of some type or for an interactive tool. This tool would allow builders or clients to enter the specifications of their building and be advised as to whether specific sustainability and resilience features made sense for that building.

More than one interviewee highlighted the fact that overseas, features that were seen as good investments were subsidised by the government. This sent clear signals to the market as to which features made sense and would encourage people to change their preferences.

6. REAL ESTATE AGENTS' AND VALUERS' VIEWS ON VALUE

Surveys of real estate agents (REAs) and valuers were undertaken to gauge their views on the value that sustainability and resilience features add to a house. The full results of the surveys are set out in the appendices.

This section highlights the key findings of the studies, which were relatively similar.

6.1 REAs: Key findings

Overall, the survey suggested that REAs have limited knowledge and information on various sustainability and resilience features, using solar systems as a proxy. Agents put values on solar systems in houses, but these were typically well below market rates. This suggests that either house purchasers do not value these features, or that REAs are not currently equipped to accurately attribute part of the sale price to sustainability and resilience features.

REA experience with and knowledge of solar systems

Most REAs had no experience with houses equipped with solar panels (28% only). For those that did, most had experiences with solar thermal (78%, reflecting their popularity). Only about half of REAs who have come across solar systems have actually provided any information about them to prospective buyers.

The majority of REAs surveyed were interested in obtaining independent information on solar systems, indicating that there is a need for further education in this area.

How REAs believe solar systems affect buyer interest and sales prices

Solar thermal was seen as affecting the buyer's decision-making process, while solar PV was split evenly between those that thought it did and those who didn't. REAs indicated that there was far more interest in solar thermal in their respective markets than in solar PV, probably reflecting both the greater number installed and longer history.

REAs provided a wide range of answers to the question of what value they think solar thermal and solar PV added to house values. These are summarised in Figure 1 and Figure 2. Averages across respondents are in blue. Note that many responses were for zero added value and this is why the average value is quite low.

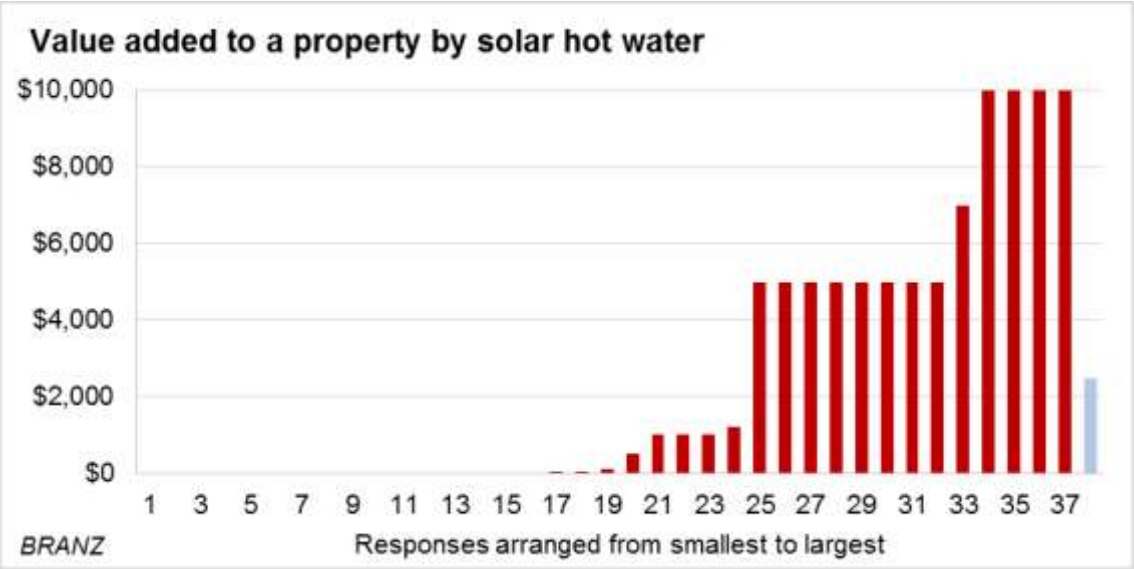

Figure 1 Value added to a property by solar hot water, REAs

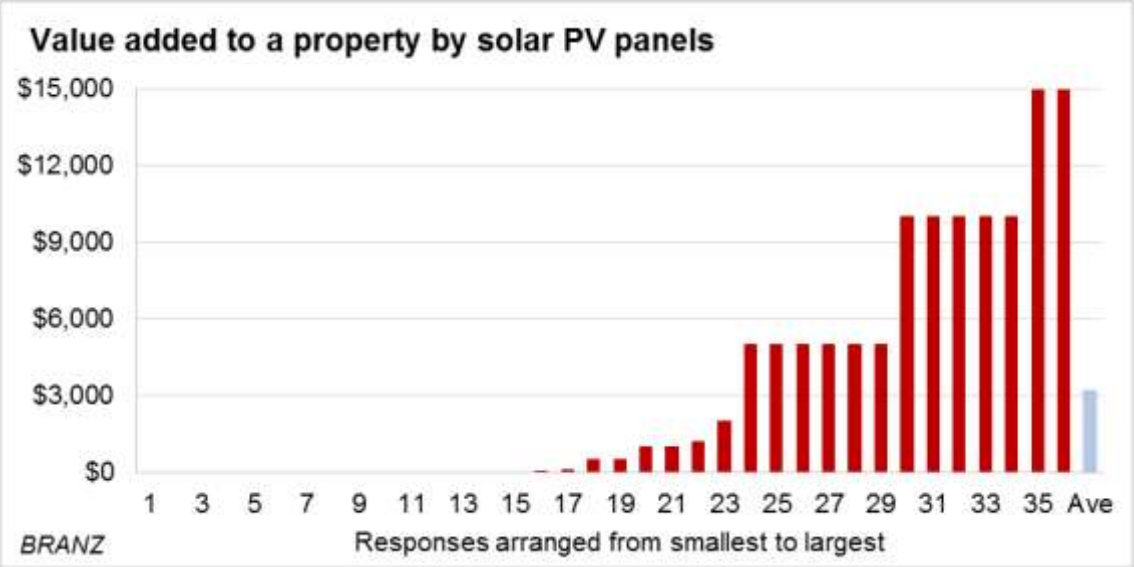

Figure 2 Value added to a property by solar PV panels, REAs

The average estimate of the value of solar thermal was around $2,500, and of PV systems, around $3,200. These values are well below the typical cost of installing these systems.

House buyer interest in sustainability and resilience features

Around half of REAs indicated that potential house purchasers would ask about the energy performance of a house that was older than 30 years. They were seldom asked about Homestar ratings, an independent measure of sustainability. Around 71% of REAs believed houses with solar systems were no more likely to be purchased or were unsure if solar systems added more value.

The key factor influencing the buyer's decision to purchase a property with solar thermal or PV panels was keeping costs down, followed by greater energy independence. Concern for the environment was third.

6.2 Valuers: Key findings

Most valuers had valued properties with solar systems. Their estimates of the value of these systems varied significantly, but were higher than for REAs. In valuing solar systems, valuers appear to have a focus on the appearance of the systems, rather than on the energy (and financial) savings they might generate.

Valuer experience with and knowledge of solar systems

Most valuers had valued houses equipped with solar panels (72%). For those that did, most had experiences with solar thermal (92%), but nearly two-thirds had also valued homes with solar PV.

The majority of valuers (86%) surveyed were interested in obtaining independent information on solar systems, indicating that there is a need for further education in this area.

How valuers believe solar systems affect buyer interest and sales prices

While no respondent suggested that their clients had no interest in solar systems, valuers believed more of their clients would be interested in PV systems than solar hot water systems. This is the opposite of what the REAs suggested.

None of the respondents believed the presence of solar panels would discourage a purchase, while more than 50% thought it would encourage a purchase.

Valuers provided a wide range of answers to the question of what value they think solar thermal and solar PV added to house values. In fact, some valuers individually provided a range, presumably taking into account different scales and qualities of solar systems. These ranges are summarised in Figure 3 and Figure 4.

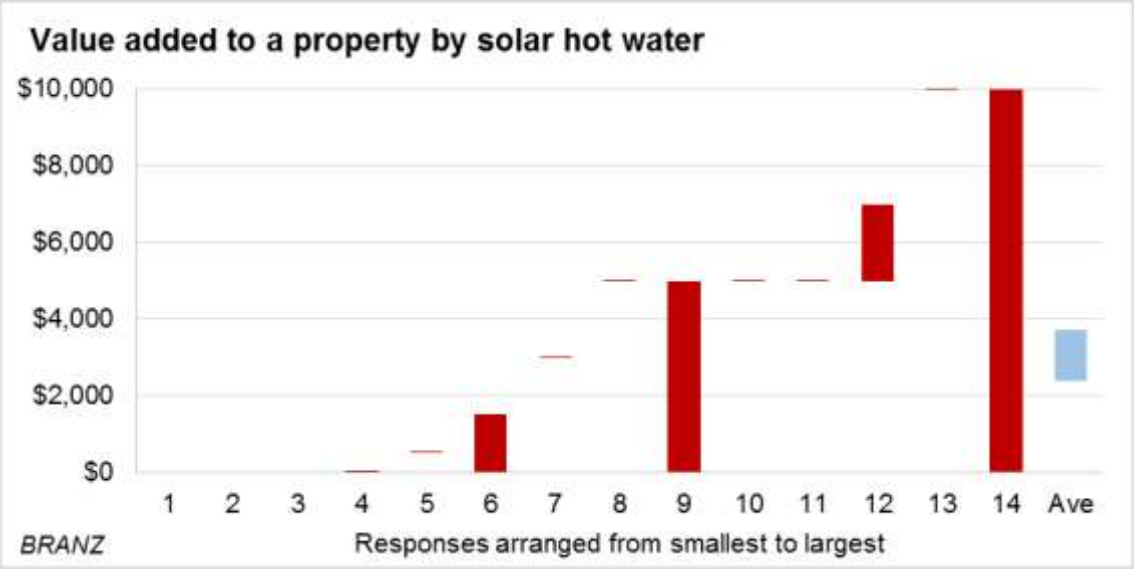

Figure 3 Value added to a property by solar hot water, valuers

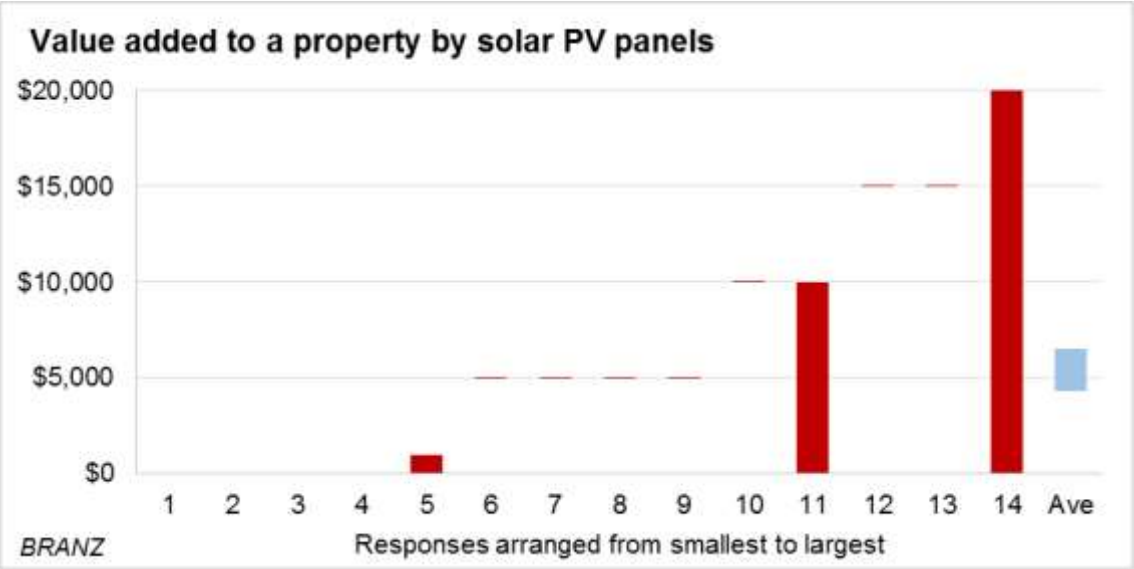

Figure 4 Value added to a property by solar PV panels, valuers

The average estimate of the value of solar thermal was between $2,400 and $3,700, and of PV systems, between $4,300 and $6,500. Interestingly, valuers placed a higher value on solar systems than REAs did.

Factors in assessing the value of solar systems

REAs saw their clients value solar systems based on their energy savings, energy independence, and concerns for the environment. On the other hand, valuers valued solar systems on the basis of the age of panels, overall condition of the system, likely (energy) savings and orientation of the panels.

This suggests that, in many ways, valuers focus on the **appearance** of the solar systems, while purchasers may focus on the **energy savings**.

7. PILOT STUDY: THE IMPACT OF SOLAR HOT WATER ON HOME SALE PRICE

This pilot study was completed by Michael Rehm of Auckland University, commissioned by BRANZ. Further detail can be found in the appendices.

7.1 Introduction

This study seeks to determine the price premium, if any, enjoyed by houses that feature solar water heaters (SWHs). Clearly there are energy saving benefits to homeowners of such equipment but no estimates have been made as to how such a sustainability feature contributes to house price.

As such analysis has not previously been undertaken, this research takes a pilot study approach. The housing submarket of Stoke, a suburb of Nelson, was identified as a suitable study area given its relatively high concentration of recently sold homes that feature a SWH system.

7.2 Data and methodology

The data for this study come from two sources. Firstly, the Energy Efficiency and Conservation Authority (EECA) supplied its database of recipients of SWH system grants from 2009 through 2012. Although the grant programme began in 2006, records were unfortunately not available at the address level for these earlier installations.

The second data source involves sales transaction data purchased from Core Logic NZ covering arm's-length residential sales in Stoke, Nelson from quarter 2, 2012 through quarter 3, 2014. Specifically, the study area comprises the following contiguous 2013 statistical area units: Ngawhatu, Enner Glynn, Maitlands, Isel Park, Langbein, Saxton and Nayland.

Transactions were excluded from analysis if they were suspected to include data entry errors or had any missing data for any of the variables of interest. Also, transactions were deleted that were flagged as outliers within the dataset (standardised residuals beyond three standard deviations). In total, 1,031 single-family sales transactions were analysed over the study timeframe.

This study employs a hedonic pricing model to estimate SWHs' contribution to home price. In addition to multiple-regression modelling, comparisons are made between the houses sold with confirmed SWH installations and other properties sold from quarter 2, 2012 through quarter 3, 2014.

As the EECA database of SWH grant recipients was limited to installations from 2009 to 2012, very few properties featuring SWHs changed hands following installation. A preliminary count of installations by housing market found the highest concentration to be in Nelson. Out of 299 SWH grant recipients in and around Nelson, only 27 of these houses, or 9%, sold between quarter 2, 2012 and quarter 3, 2014. After mapping these 27 properties in a geographic information system, a comparatively tight cluster of 13 sales were located in the submarket of Stoke. Thus, Stoke was used for this study.

7.2.1 Hedonic specification

The hedonic pricing model used to estimate the contributory value of a SWH is comprised of the following function: P(**X**) = P(**S, G, T, L**). This essentially maps the characteristics of the properties sold during the study timeframe onto market value. Specifically, this function maps each home's structural characteristics:

- **S** (floor area, site area, vintage, etc)
- **G** for green features (solar hot water system)
- **T** for temporal (quarter when transaction occurred)
- **L** for location (suburb where the house is located).

More detail on this can be found in the appendices.

7.2.2 Descriptive statistics

In addition to analysing sales data through a hedonic pricing model the author considered the summary statistics of the two populations of properties being analysed:

1) homes sold that feature a SWH system, and

2) homes sold without a SWH.

Figure 5 presents the key descriptive statistics that relate back to the hedonic model. The two groups of sales clearly differ.

In short, homes in the study area that sold from quarter 2, 2012 through quarter 3, 2014 and did feature a SWH system:

- commanded a 32% higher mean sales price
- were 29% larger in floor area on average
- boasted considerably larger land sections
- had more bedrooms and bathrooms on average
- were relatively newer

than homes that did not feature a SWH.

This distinct difference in attributes between the two groups of properties reinforces the importance of including a strong set of control variables in the hedonic pricing model. If such independent variables were omitted, the coefficient estimating the influence of the existence of a SWH system would be biased and potentially overestimate their value contribution.

Table 5 Comparison of mean descriptive statistics

Variable	Homes sold with a SWH	Homes sold without a SWH
Sales price	$537,019	$407,070
Floor area	200	155
Site area (m^2)	1,061	660
Bedrooms	3.62	3.23
Bathrooms	1.77	1.45
Year built	1995	1982
N	13	1,018

7.3 Results

Table 6 (below) presents the unstandardised coefficients of selected variables along with model summaries for the hedonic pricing model. The chosen specification fits the data exceptionally well with adjusted coefficients of determination (R^2) of 0.866.

Overall, the results are largely as anticipated, with most of the variables significant at the 0.01 level and in the expected direction. Specifically, floor area and floor area squared are significant and maintain the expected positive-negative signs. This conforms to the law of diminishing marginal utility, whereby the sales price increases with floor area but does so at a diminishing rate. In terms of interior and exterior condition, houses noted as being in 'good' condition generally commanded a price premium, while properties categorised as 'poor' tended to be subject to price discounts.

One anomaly was the variable *Interior_Poor* which held a slightly positive rather than negative sign, but the coefficient did not achieve statistical significance. As anticipated, it can be seen that a non-linear vintage effect exists, with the popular 1920s bungalow selling near parity to recently built homes.

As for the variable controlling for cross lease title, its negative relationship to sales price is as expected and corroborates the findings of recent cross lease research conducted by the author. Lastly, the quarterly dummy variables controlling for differences in date of sale within each model generally meet expectations and reflect the market cycles within the study timeframe.

Table 6 Summary of variables

Variable	b	Std error	t statistic
(Constant)	12.331	.040	306.96***
Floor_Area	3.65E-03	3.65E-04	10.00***
BFA2	-3.89E-06	9.47E-07	-4.11***
Site_Area	2.12E-04	2.54E-05	8.36***
Site_Area2	-2.09E-08	7.16E-09	-2.91***
Beds_2_or_less	-.038	.011	-3.48***
Beds_4_or_more	.011	.009	1.23
Baths_2_or_more	.021	.009	2.28**
Interior_Good	.060	.017	3.51***
Interior_Poor	.007	.049	0.14
Exterior_Good	.028	.010	2.91***
Exterior_Fair_Poor	-.068	.033	-2.04**
Steep_Contour	-.017	.019	-0.90
Deck	.014	.008	1.80*
Pool	.059	.020	2.96***
Water_View_Slight	.037	.016	2.36**
Water_View_Moderate	.043	.014	3.02***
Water_View_Wide	.066	.021	3.12***
Cross_Leased	-.056	.011	-5.32***
SWH_Featured	**.013**	**.028**	**0.49**
au581715	.085	.013	6.55***
au581723	.067	.013	5.01***
au583600	.011	.019	0.56

Variable	b	Std error	t statistic
au583800	.054	.011	4.71***
au583900	.018	.012	1.60
au584000	.098	.012	7.94***
V1910	-.259	.038	-6.75***
V1920	-.083	.047	-1.78*
V1930	-.183	.043	-4.30***
V1940	-.214	.022	-9.82***
V1950	-.208	.018	-11.54***
V1960	-.214	.017	-12.34***
V1970	-.260	.018	-14.60***
V1980	-.208	.017	-12.27***
V1990	-.172	.015	-11.79***
V2000	-.076	.013	-6.01***
Sold_2012_Q3	-.001	.013	-0.07
Sold_2012_Q4	.004	.014	0.28
Sold_2013_Q1	.041	.013	3.14***
Sold_2013_Q2	.046	.013	3.51***
Sold_2013_Q3	.036	.013	2.76***
Sold_2013_Q4	.070	.013	5.25***
Sold_2014_Q1	.061	.013	4.56***
Sold_2014_Q2	.055	.014	3.89***
Sold_2014_Q3	.060	.014	4.34***

Moving to the variable of interest, *SWH_Featured*, the unstandardised beta coefficient is quite small, at 0.013. The associated standard error is comparatively large at 0.028. This indicates there is a large degree of variability in the price effects associated with SWHs. Given the relatively high amount of error in the estimate, the variable does not achieve statistical significance. Aside from this, the estimated contribution to value enjoyed by having a SWH system is 1.35% of mean house price. In dollar terms, the model suggests that, on average, houses sold with SWH in place enjoyed a price premium of $7,250.

7.4 Conclusions

This study considered the price influence that SWH systems have on single-family houses in the suburb of Stoke, Nelson. The author used EECA's database of SWH system grants to identify the housing stock that features such improvements.

An inherent limitation on such an approach is not all homes with SWHs will be included in the database, as there are probably some solar owners who installed without grant assistance. Also, despite this grant being in place from 2006 through 2012, the data related to grant recipients before 2009 was not made available due to data unreliability. This had the effect of limiting the number of sales transactions featuring a SWH. After a preliminary analysis of the geographic concentrations of grant recipients, the submarket of Stoke was identified as the most suitable case study area.

Despite having a considerably higher concentration of properties featuring SWHs, only 13 sales transactions were identified that featured such systems out of a total pool of 1,031 sales. With

such a low number of transactions containing the attribute being studied, the relatively small average price effect was overcome by a comparatively large amount of variability.

The natural solution to such an issue is to widen the study area and/or timeframe to capture a greater number of observations that contain the attribute of interest: SWH systems. Given the limits on the EECA database, the only way to widen the study timeframe is to repeat this analysis in the future after more houses with SWHs have changed hands. Alternatively, the study area could be expanded. Extending the study to include all of Nelson may enable sufficient observations to overcome the relative variability in price effects for SWHs in Stoke.

8. WHERE TO FROM HERE?

Year one of this study has shown that:

- home purchasers seldom value sustainability and resilience features over other features, such as a nicer kitchen, in a house
- there is little independent, reliable information to help builders, REAs and valuers help home purchasers value sustainability and resilience features fairly
- nevertheless, there is a price premium on certain sustainability features at resale
- the premium paid on resale of a house may not accurately reflect the value of the sustainability features in the home.

Year two of the study will include four stages to:

- quantify the costs and benefits associated with various sustainability features
- further quantify how much the market is willing to pay for these features (versus what they are worth)
- pilot an approach to upskill builders, REAs and valuers on the net benefits of these features.

Stage one: Calculate whole-of-life cost and benefit information for features

In the past, BRANZ has done some work on whole-of-life costs of various features. These need to be updated and new features added, and then combined with benefits data such as energy savings, to yield a picture of net benefits. Some benefits (such as comfort) are not as easily quantified in monetary terms. As a result, the outputs of this stage may take a form whereby the costs of a system are compared with a partial analysis of the benefits. The results would then be presented as "if all other benefits including comfort, better health, and noise reduction are worth more than the net daily cost, this feature makes sense".

Stage two: Develop datasheets and/or tool showing value of features

Once a more comprehensive picture of the net costs or benefits of various features has been developed, this information needs to be made accessible to builders, REAs, and valuers. Ideally, it should be available to home owners as well.

This knowledge transfer process needs to take place through easy-to-use datasheets, probably combined with more technical Excel-based online tools that help people make better decisions.

Stage three: Complete more comprehensive hedonic pricing analysis

A more comprehensive hedonic pricing analysis that considers a bigger market and a larger range of features needs to be completed. This may include various forms of heating (heat pumps, gas fireplaces or woodburners), retrofitted insulation or double glazing and other features that would increase the value of a home.

The biggest challenge is getting access to data on what features are included in each house. There are a number of ways to do this, with the preference being to work with a large real estate agency. There are significant benefits to the agency and to this research from being able to use a consistent database covering potentially thousands of sales over a two to three-year period.

Alternatives to working with a real estate agency have been explored, ensuring this work can be done with or without these links.

Stage four: Work with partners to train stakeholders on value of features

BRANZ has already discussed a plan to work with Community Energy Network, a national network of community enterprises working together to create a healthy environment for all New Zealanders. The idea is to pilot a training programme that would:

- educate builders, REAs and valuers as to the utility and quality benefits of various sustainability features
- highlight the monetary costs and benefits of these features
- equip builders, REAs and valuers to help their clients make better choices on features.

If this pilot programme succeeds, it will provide a platform for continuing to show builders, REAs and valuers the value of sustainability features, which can then be used to inform their clients.

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10. APPENDIX A: BUILDER INTERVIEW SUMMARIES

This section summarises the interviews with nine of New Zealand's largest group building franchises and large independent builders.

10.1 Interviewee A

Interviewee A is a large Auckland-based builder. He said clients rarely asked about sustainability features beyond the basics such as heat pumps.

Instead, owners prefer to spend on things they can see, such as the kitchen and/or carpet. Also, clients generally only stay five years on average, which is a barrier as payback periods are likely to be longer.

He was comfortable that he knew the costs involved with the typical sustainability features people asked for. This included:

- solar panels at a cost of around $7,000
- heat pumps at $2–3,000
- gas water heated pipes in floor slabs ($15–20,000) although these were typically only installed on high-end ("$1.2 million") homes

The interviewee was looking at making LED lights standard but did not believe prices were low enough yet. He did not have data on the cost savings associated with LED lights at this point.

The standard specifications offered by the builder did not include any specific sustainability features as yet but the option existed for clients to upgrade to these.

Interviewee A would like to play a greater role in advising his clients as to which features offered good savings, but he lacks reliable information on payback periods. He suggested datasheets showing savings for various household sizes – for example, 4-person water savings with low-flow heads, energy savings at various times and levels of heating and cooling (using a heat pump for instance). He showed strong interest in this information even if it indicated savings were not great.

He added that one of his customers with extra insulation kept power accounts to show to the next prospective buyer to provide quantitative data on the value of sustainability features.

Interviewee A mentioned that his firm is building six terraced units (three-storey). He expects to break even, using it as a learning experience because he sees increased demand for these multi-units as housing affordability falls.

10.2 Interviewee B

Interviewee B is a large Auckland-based builder. He indicated that the firm has a number of sustainability features as standard, including:

- R2.6 in their walls for their two grades (specifications) of house
- R5.0 in the ceiling in their higher grade
- heat exchange on fresh air (balanced venting at a cost of $3.5–6,000)
- thermal breaks on their steel studs
- rainwater tanks for all clients in rural locations.

Interviewee B is currently looking at PVC windows, LED lights (three times the cost of incandescent), low-e glass and heat pump hot water for their higher grade specifications. He does not offer solar water or PV because of cost and assumed low savings.

That said, the interviewee does not have any specific information on the savings of the sustainability measures adopted as standard.

About 80% of sales are the standard specifications, with 20% the higher offer.

Interviewee B is a strong supporter of steel framing, believing it is a lot more sustainable than timber framing. This view is based on US data on land areas affected by forest cutting versus land area taken by steel mining and smelting.

Interviewee B does not see it as the builder's role to provide information on the financial savings to a prospective client. Clients rarely ask about sustainability features and payback periods are never mentioned by clients or offered as advice by the sales person.

The builder does not "push" sustainability as such, but believes that his basic offer is already highly sustainable because of the features offered, including steel framing and better insulation. A quite high spec kitchen is available for their basic and higher offers, which may mean more money is available for sustainability measures if the client so desires. However, they don't direct clients into additional sustainability measures because clients don't ask for them.

10.3 Interviewee C

Interviewee C is a large Auckland-based builder. He said clients rarely asked about sustainability features. When they did ask about these features, he would refer them to advisers that knew about the features at hand.

His houses do not include sustainability features as standard, and are not part of the Home Star scheme. However, they use consultants to help clients decide on specific sustainability features such as solar panels.

Interviewee C does not have specific information on the financial savings of various sustainability features. He believed datasheets on payback would be helpful for their sales team, and he would definitely be interested.

Interviewee C typically asks clients for their wish list of features. These almost always relate to number of bedrooms and bathrooms, garage size and kitchen features. Solar water is specified in perhaps 2–5% of houses, rainwater tanks are specified for rural customers, and one client had wind turbines installed (provided by others).

10.4 Interviewee D

Interviewee D is an Auckland-based builder. His clients seldom had specific questions on sustainability features, but when they did, he referred them on to the developer of the sub-division.

Nevertheless, they had adopted higher-than-Code insulation in the particular sub-division they are currently working on, at R2.8 in the walls. This is the maximum insulation grade within 90mm studs.

Other features they had looked at included solar hot water (at a cost of $7,000). Heat pump hot water is more common (about 10% uptake) because of the lower cost of around $3,000. Around 5% of people included PV systems in their homes in their largest sub-division.

Interviewee D had little independent data on the financial savings of different sustainability features. Clients did not talk about paybacks. Interviewee D did not see a huge amount of value in the builder having any data on savings or paybacks, as this was ultimately a client decision. These types of questions were typically referred to the developer.

In his experience, emotional factors dominate logic or hard data in the home buying and building space. He suggested that in many cases, the female partner makes many of the purchase decisions, with a focus on how the house feels as a home. i.e. things such as the kitchen and bathroom are more important to new owners than solar hot water or PV. He does not believe sustainability savings data would be particularly useful.

However, if sustainability is presented “more emotionally” then it could be a selling point. If the choice is between an extra bedroom and sustainability features, the former is chosen.

10.5 Interviewee E

Interviewee E is a large Christchurch-based builder. Around 70% of their builds are spec-built, with around 30% design-and-build/one-offs.

Their standard specifications include wall cavities with associated insulation improvements, and above-Code insulation.

Most clients do not mention sustainability features; perhaps 5–10% do. Some upgrades that people ask for include thermally-broken windows and PV systems. However, a related question people do ask a lot is “How do I best heat my home?”

Interviewee E estimated that probably 1% of people are “switched on” to the costs and benefits of different options. They felt it was good when clients were clued up as this allowed them to think outside the square.

However, when costs were included, most people did not do most of what they may originally have liked to do.

The fact that many people in Christchurch were building due to the earthquake had some interesting impacts. Some people “just want a house”. Others are able to include sustainability features because of generous pay-outs. Still others have actually received larger pay-outs (in the order of $15,000) specifically for sustainability features as per their insurance contracts. Features some insurers allow under this coverage include LED lights, insulation upgrades and argon windows.

The most common features with associated costs are:

- better insulation in walls and ceilings, adding $1.5–3,000
- thermally broken windows (20% more expensive than standard windows) or gas-filled for a further $2,000
- LED lights – these are typically costed on site and are paid direct to the electrician by the home owner
- PV systems, where a 3.0 kW system could cost $9–10,000
- wetbacks in rural areas, adding $1,000
- heat transfer kits, starting at $500 depending on the system
- DVS systems at $2–3,000 depending on how many rooms were included.

Interviewee E relies on what clients ask for and on feedback from electricians, plumbers, and sales people to determine what people want and therefore what features future spec-builds may include.

They are forming alliances with various providers, such as solar panel providers, to ensure competitive prices and adequate quality.

When people do ask for a specific feature, such as PV, interviewee E tries to understand what purpose the client sees for the feature. They will ask questions to encourage the client to think through their choices. These may include:

- What is the purpose in having this feature? (Some answer that it is the feature of the home, others choose for lifestyle or as prices fall.)
- How long will you live here? (i.e. will the payback period be sufficient?)

The reason this final question appears to be so important is that interviewee E sees little likelihood of the client getting more money at resale because of sustainability features. This means that unless the client lives at the property long enough to recoup their money, it does not make economic sense to invest in sustainability upfront.

Interviewee E is building a new show home that will include sensors allowing for real-time monitoring of energy, temperature and other data. He intends to advise clients in future about how to reduce energy costs and increase comfort.

Interviewee E said they would be interested in receiving independent data on sustainability features. They said it would need careful client presentation to ensure clients were given an easy choice to decline if wanted.

10.6 Interviewee F

Interviewee F is a large Christchurch-based builder. They see their role with regard to sustainability features as two-fold:

- to provide options and advise clients on perceived benefits of various sustainability features
- to alter specifications to build smarter as standard.

Interviewee F suggested they were already including a number of sustainability features in their standard specifications while remaining cost competitive. These include:

- thermally broken windows
- R5.0 insulation in ceilings
- LED downlights
- more efficient shower roses
- heat regulators on tapware
- separate heaters at taps
- pod-style floors with polystyrene insulation
- steel framing, which has a high resilience value against earthquakes, and is 100% recyclable, unlike treated timber structural framing.

Interviewee F believed the Christchurch market is a lot more educated than other markets. People who have been forced to rebuild have in some instances had several years to study what they really want. They want to know: “If I put this [sustainability feature] in, how long until I get a payback/capital gain?” That is, it is about “bang for your buck”. The interviewee believed that for many features, including PV systems, the payback period was just too long for it to see major uptake.

Sometimes, clients did not understand the value or comfort an upgrade could add to a house, so by including continual improvements in standard specifications, the firm could help clients make these decisions.

One insurance company was paying out on insurance policies that included a sustainability features clause, whereby people received $15–20,000 more to include these features in their rebuild. As a result, many people were including upgrades they might otherwise not have.

Some of the more common sustainability features, with associated costs, include:

- steel framing, which was only slightly more expensive than timber framing, because the company is vertically-integrated and is thus able to supply its own framing cost effectively
- thermally-broken windows, again included cost-competitively because of vertical integration, but otherwise costing $6–9,000
- ducted heat pumps, at a cost of around $17,000.

Often, however, when clients had a limited budget, they would look to cut back on some of the optional features. There were ways to do this that did not mean cutting quality. For instance, switching to standard sliding glass doors rather than bifolds, or removing a window, could save $2–3,000.

Interviewee F's group has its own research and development team that travels the world looking at emerging trends in other markets. It examines the claims made by various manufacturers to determine if a product is appropriate for New Zealand, before recommending their introduction.

Interviewee F believed the media's approach to coverage of sustainability features is scattergun. There was no consistent message, and the topic today would be forgotten in a week. When clients did ask for a product it was often the result of the media impact, whether news articles or advertising.

The interviewee saw some value in an independent source of information. However, they were concerned that any new data source could be swamped by existing sources. It was important that any new data source educate, rather than endorse.

10.7 Interviewee G

Interviewee G is a large Christchurch-based builder. They pointed out that housing affordability is one of the biggest challenges the industry faces today. Most sustainability features are seen by the industry and clients as things that just add cost.

Most clients who asked about features had seen advertisements and had done minimal research of their own. The interviewee did not see much interest for these features in general,. They found that given the choice between a TV/another visible feature and better sustainability features, the former would win often.

Interviewee G believed that house value was governed by location, appearance and size. Sustainability features would be seen as "a bonus" on resale, but would not add significantly to the value of the house. In addition, many sustainability features were not very attractive.

That said, they did find that clients from Europe tended to be more quality-focused and were more likely to want PVC windows or heating systems used in Europe.

The interviewee included a heat pump in practically every house, and LED lights were standard, at an additional cost of around $2,000 per house. The main benefit was seen in the reduced maintenance costs of LED lights – not having to change bulbs as often. This was particularly attractive in Housing New Zealand houses. As an example, when a standard lightbulb fails and a maintenance person has to be called, the cost is far greater than installing an energy-efficient LED light upfront.

The interviewee also included above-Code insulation in ceilings, passive solar design, and prefabrication (which cuts wastage) in their standard offerings. They are able to keep prices competitive, partly through economies of scale in buying insulation, for example.

Interviewee G saw their main role not really as guiding people, but giving the client what they wanted in a home. At the same time, they are able to provide guidance on some things, such as assessing their budget and helping them think through the type of house they're building. Sources for this information include the EECA website and suppliers' websites and brochures.

One piece of advice interviewee G often gives to clients is to think about what can be easily retrofitted. Gas heating cannot easily be retrofitted, whereas solar hot water can be added later, for instance.

In terms of measuring costs and benefits of different features, the interviewee felt there was no real science. Purchasing sustainability features is a "fuzzy" decision, not made on cold hard numbers in most cases.

Interviewee G believed that government subsidies of features that did stack up from an economic perspective would also encourage people to make changes in their preferences.

The interviewee saw value in a tool that would allow people to plug in their own numbers and determine whether a particular feature made financial sense for them.

10.8 Interviewee H

Interviewee H is a large Tauranga-based builder. They see the role of the builder as providing a product that is durable, sustainable, built with low maintenance materials within a fiercely competitive industry.

They target the under $530,000 market. These clients evaluate the materials used, the content of the house, maintenance needs, and quality. Clients often begin by stating their budget and asking what they can get for the money. If they can afford a house within their budget, they typically have a wish-list of upgrades they would like to include using left-over funds.

Because payback on sustainability features is often 7–10 years, this makes them less attractive to many clients who may not plan to live in the house that long. The interviewee did not believe that features like PV add to resale value. Thus, if a client does not believe they will get payback within the time they live in the house, they are unlikely to add the feature.

Some typical sustainability features that interviewee H included were:

- low-maintenance brick and tile materials
- Homestar 6 ratings, which added $12–13,000 per house, and were generally only included because Special Housing Areas required them, as there was little interest from the public in this rating system
- concrete tile roofs which are hardy and reduce noise by about 30 dB
- pod-style floors
- LED lighting
- slow start-up control on tapware to limit water wastage
- Rheem hot water cylinders (HWCs) that exceed minimum standards. From later this year, all HWCs will have better ozone depletion potential ratings
- all vitreous china uses an anti-bacterial glazing
- toilets, tapware and shower roses conform with the WELS water efficiency rating system, with ratings from 3 to 6 star.

The interviewee will work with the client to understand what they aim to achieve, which determines the appropriate solution. They typically have a price on hand for all the typical upgrades, allowing them to offer the client options for sustainability and design.

The general consensus, however, was that most people wanted instant gratification in housing decisions. People tended to focus on heating options, followed by floor covering upgrades, and due to cost, usually backed out of options such as PV systems.

Interviewee H thought it would be useful to have an independent website that provided information on how products are rated, what that means, and therefore how clients can make better decisions.

10.9 Interviewee I

Interviewee I is a large Tauranga-based builder. They see their role as primarily working with the customer to fit a house within their budget. Then, variations can be included that cover sustainability features. The target segment for this builder is mostly entry-level clients or possibly second-time clients.

In general, these clients have straightforward needs – 3 or 4 bedrooms, double glazing, and as large a house and section as they can afford. Interviewee I pointed out that many people see a cost of (say) a $10,000 PV system as a direct reduction in the footprint they can afford to buy. Thus, these features are unattractive.

In considering sustainability features, most people evaluate upfront costs against expected energy savings. While the firm is already using energy saver bulbs in its houses, LED downlights are an upgrade they are often asked about. Conversion rates are around 10%.

People still have the perception that solar is expensive. The builder sees their role as linking people with suppliers who can answer their questions about a particular upgrade. One challenge is delivering a house on time when this delivery is dependent on external suppliers installing particular features. As a result, the interviewee prefers to work with suppliers they know, who can deliver on time.

Specific features that are included are:

- energy saver light bulbs
- in-sink waste disposers
- pod-style foundations with insulation.

The interviewee also requires all contractors to remove and safely dispose of all construction waste each day.

The most common upgrades requested are:

- LED lights
- insulation upgrades
- internal insulation/acoustic insulation
- double glazing
- insulated garages (allowing for conversion at a later date).

Interviewee I was interested in an outcome of the project possibly being an interactive website that gives advice, to help open people's eyes to the value of certain features.

10.10Interviewee J

Interviewee J is a large Tauranga-based builder. Around 80% of this builder's work is one-offs/design-and-build projects. He felt that "everyone has something on their sustainability list", but his firm is already including a number of features that he believes are better for the environment. These include:

- steel framing, which:
    - is fully recyclable
    - is more resilient to earthquakes
    - produces less/negligible waste as it is factory-made and pre-punched
    - does not require trades people to work in a toxic environment of treated timber framing
    - reduces fire risk
- Gib Ultraline, which has a better fire rating, and offers better acoustic and insulation performance
- R5 batts in ceilings, while walls are R2.8
- fire-rated building paper and wraps, as fire risk is reduced if the fire can be starved of fuel
- brick cladding, which is low maintenance and a low fire risk
- window systems that are aluminium-based
- thermally broken windows as standard
- LED lighting.

Site orientation to maximise solar gains was always an important consideration.

Other sustainability features are seldom requested, but include:

- grey water re-use capability (maybe 1 in 50 clients)
- porticos and covered areas to manage the sun
- gas infinity heating
- boreholes in rural/lifestyle block areas
- solar water heating (at a cost of $4–5,000), estimated to have a payback period of around 5 years
- pre-wiring for PV to allow this as an option later (with energy companies reducing payments for energy fed back into the grid, this has become far less attractive)
- wetbacks
- underfloor hot water heating run through solar and gas
- off-the-grid solar options in rural areas where the cost of connection to the grid is prohibitive.

Interviewee J believed that people decided to investigate these features based on discussions with various builders as part of their builder selection process, and relied on the interviewee to propose ideas.

The interviewee believed any independent, more accurate statistics that help people to understand the costs and benefits or payback period of various features would be useful.

11. APPENDIX B: SURVEY OF REAL ESTATE AGENTS AND VALUERS

Sixty real estate agents (REAs) from across the country responded to a survey on the role of sustainability and resilience features in setting the resale value of a property. Eighteen valuers responded to a separate, slightly different survey on the role of sustainability and resilience features in valuing a property.

11.1 BACKGROUND

There have been a number of studies concerning how people value sustainable features in homes, as highlighted earlier in this study. Only a few studies (e.g. Warren Myers and Reed, 2010) focus on how those involved in the valuing and sale of residential buildings view solar panels and how buyers might respond them. As far as the authors could find, no New Zealand-specific research exploring the case for *residential* buildings has been conducted. However, some useful information can be derived from the New Zealand study that examined the perception of the photovoltaic market and explored evidence examining the relationship between sustainability and market value.

For this study, it was decided that targeting the REAs and valuers/appraisers via a survey could be an effective way to gauge market valuation of sustainability features in homes. These groups were seen as necessary for sustainability to receive serious investment, because they need to understand the effects of sustainability and its relation to value (Ellison and Sayce, 2006). These two groups have been shown in previous research to produce a reliable and accurate assessment of market value (Sims and Dent, 2005).

Solar panels were used as a proxy for other sustainable home features, reflecting other international studies (such as Morris-Marsham and Moore, 2011).

In New Zealand there are some 2,000 registered residential sales agents and around 500 valuers (as at Dec 2014 – personal communication with REINZ Dec 2014).

11.2 METHOD

The survey format was only loosely based on that developed by Morris-Masham (2010), as part of a Masters project, as it was extensively modified.

The surveys were kept purposefully short, transparent and to the point, to maximise numbers completed. The average completion time envisioned for the questionnaires was estimated at 10 minutes. SurveyMonkey, an online survey tool that provides an easy way to develop, manage and analyse surveys, was used for this project, as it met BRANZ needs well.

Other factors that were seen to assist respondents' participation were:

- the independence and impartiality of BRANZ
- the 'by proxy' endorsement of their governing bodies, by having the request come via their body newsletters
- its multi-choice nature, which supports ease of completion.

The survey was designed to answer some key questions, in particular:

- How are solar energy systems (whether solar thermal or solar electrical) valued by the REAs and professional residential valuers?
- If they are valued, how do they impact on price?

The respective communication managers at the real estate and valuation bodies were contacted in early December 2014 and asked to vet a draft version of the questionnaire. Two issues were seen as especially important – clarity and the appropriateness of the questions. Responses from both agencies were provided and improvements to the survey were made as a result.

An open invitation to participate in the surveys was then provided in the newsletters of the two organisations in January 2015, which invited those involved in residential selling/valuing to participate. This was seen as the best way to gain the maximum response rate possible. As an incentive to encourage participation, respondents were given the option of entering into a prize draw for $150 of petrol vouchers, provided they completed all the compulsory questions.

One particular concern when designing the survey was that respondents would understand the difference, and be able to correctly identify, between PV and solar thermal. Identifying the difference visually can be quite challenging in some instances and is important to the research. The recent advent of PV for solar hot water has been due to the massive reduction in solar array prices, further complicating system classification/characterisation. However, this setup is extremely rare even overseas and was discounted for this survey. Thus, it was decided to assess both the electrical and thermal systems together, and define the different systems at the start of the questionnaire.

Up to 2,000 REAs were invited to participate through their industry newsletter. Assuming 25% of them read the invitation to participate, and given 60 replied to the survey, it is estimated that around 12% responded. The questionnaires were left open for 4 weeks.

11.3 REA survey responses

It should be noted that for these types of surveys there is always a degree of self selection.

Q. 1. Where is your sales region?

Although Auckland features heavily (at just over 25%), there is a good representation of other localities, such as Northland, Waikato, Wellington, and Canterbury. Representation is roughly in line with population distribution.

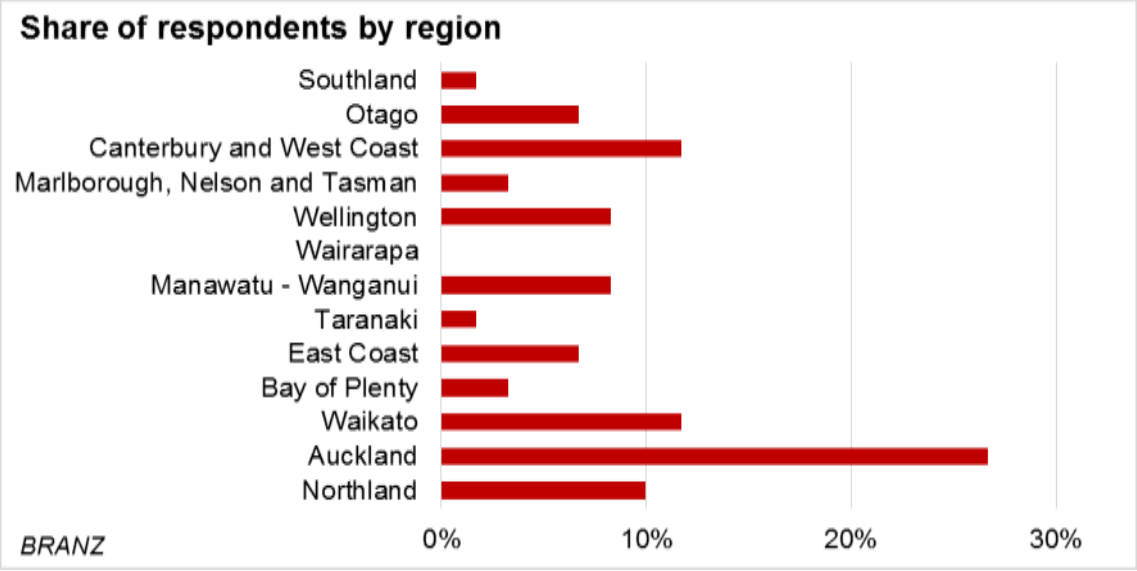

Figure 5 Share of real estate survey respondents by region

Q. 2. Have you ever sold a residential property with solar panels?

Less than a third of respondents (28% or 17 agents) had sold a residential property with some sort of solar panel on it.

Table 7 REAs who have sold properties with solar panels

Have you ever sold a residential property with solar panels?		
Answer Options	**Response Percent**	**Response Count**
YES	28.3%	17
NO	70.0%	42
Unsure	1.7%	1

Q. 3. What was the type of solar panel(s) present?

Of the applicable respondents, by far the majority had assessed solar thermal systems rather than solar PV, even accounting for those who were unsure what systems they had seen. A very few had come across houses with both types of solar panel. Few REAs even answered this question, suggesting even greater uncertainty as to the different types of panels.

Table 8 Type of solar panel present at sale

What was the type of solar panel(s) present? [Tick as many as apply].		
Answer Options	**Response Percent**	**Response Count**
Solar Thermal (for producing hot water)	77.8%	14
Solar Photovoltaic (for generating electricity)	22.2%	4
Not sure	11.1%	2

Q.4. Do you believe the solar panel(s) affected the buyer's decision to purchase the property?

The majority thought solar thermal affected the buyer's decision to purchase the property (whether positively or negatively).

Table 9 Does a solar panel affect the buyer's property purchase decision?

Do you believe the solar panel(s) affected the buyers decision to purchase the property?				
Answer Options	**Yes**	**No**	**Not sure**	**Response Count**
For solar hot water	13	3	1	17
For solar electric	3	3	1	7
Answer Options	**Yes**	**No**	**Not sure**	
For solar hot water	*76.5%*	*17.6%*	*5.9%*	
For solar electric	*42.9%*	*42.9%*	*14.3%*	

Q. 5. Do you give prospective buyers any information about solar panels when they are looking at the property?

Approximately 50% of those that had come across solar panel installations provided any (let alone substantial) information on them for prospective homeowners. It is unknown why some respondents opted out of this question.

Table 10 Does the REA provide any information on solar panels to viewers?

#	Response Text
1	**Yes, purely as a cost saving benefit**
2	No
3	**Generally no but I do have the ability to refer a buyer to a local installer**
4	Copies of the Owners accounts, a brochure on the panels and installation certificates and invoices.
5	**Usually verbally but will improve on that next time.**
6	Cost saving
7	**No not really most people already know about it**
8	Age size and cost savings
9	**Only what vendor has provided**
10	No
11	**Passed on information from vendor**
12	Yes, although the benefits discussed, the main priority is a suitable home in the right location. Often we discuss potentially installing units to reduce ongoing costs but doesn't seem to be a contributing factor in an existing home to clinch the sale. The buyers are prepared to install if required, if already installed just an added bonus.
13	**No - refer to installer/manufacturer**
14	Yes - cost savings
15	**Not unless the owner has given me that information to pass on to the buyers**

Q.6. How much interest is there for solar panels in your region?

The respondents thought solar hot water was mostly either of ‘some’ or ‘little’ interest to new homeowners, with the solar electric garnering ‘little’ interest from potential homeowners.

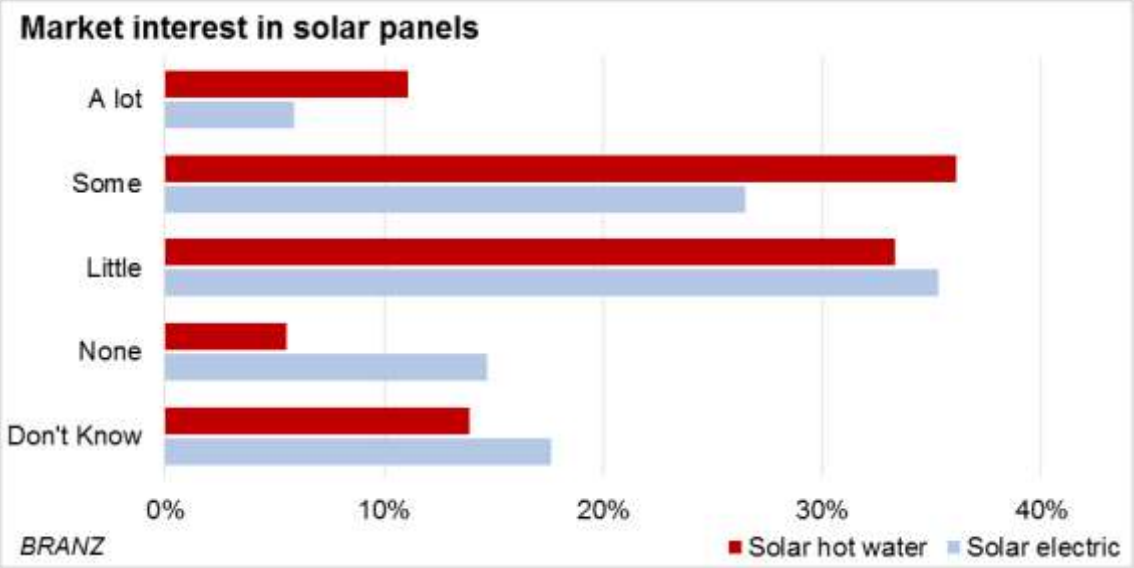

Figure 6 How much interest is there for solar panels in your region?

Q.7 How much do solar hot water panels affect property sales price, typically?

Of those that the question applied to, all thought that solar hot water panels increased the sales price of the home – by an average of nearly $2,500. This is considerably less than an average system costs, at between $4,000 and $10,000 per system (BRANZ LEVEL states that a 3kW system is about $10,000).

Table 11 How much (in dollar terms) do solar thermal panels affect property prices?

How much do solar hot water panels affect property sales price, typically?				
Answer Options		Response Average	Response Total	Response Count
Increase of $	$	2,482	91,846	37
Decrease of $	$	-		0

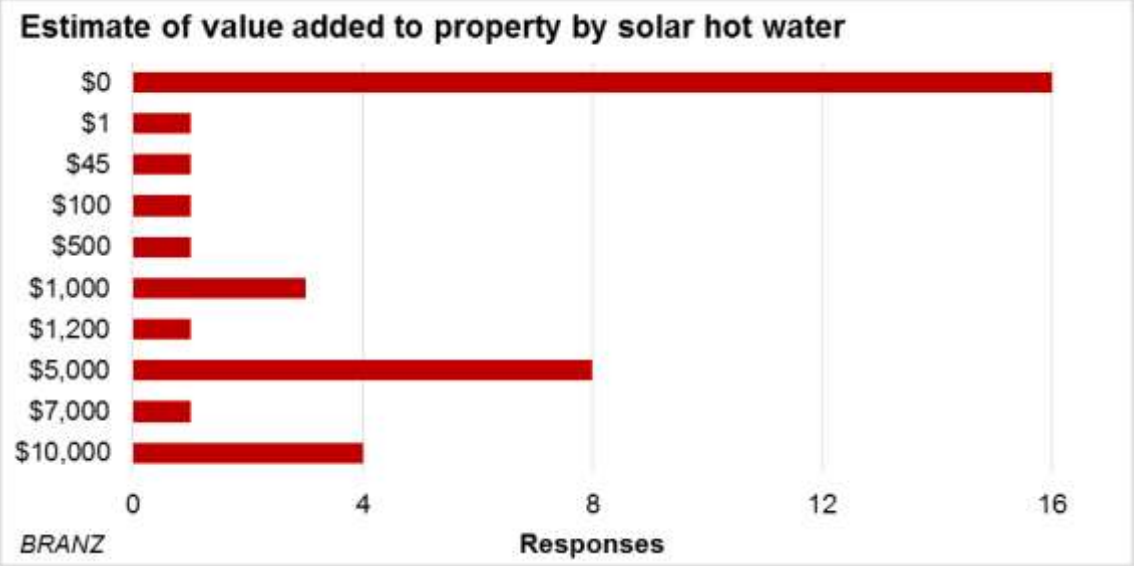

Figure 7 Estimate of value added to property by solar hot water, REAs

Q.8. How much do solar electric panels affect property sales price, typically?

Of those that answered, 16 thought that solar PV panels provided $0 extra in terms of increased property sales price, with the maximum price given at $15,000. There seemed to be little in terms of standardisation of prices for this question.

Table 12 How much (in dollar terms) do solar PV panels affect property prices?

How much do solar electric panels affect property sales price, typically? [Only fill in one text box].				
Answer Options		Response Average	Response Total	Response Count
Increase of $	$	3,231	116,301	36
Decrease of $	$	11	11	1

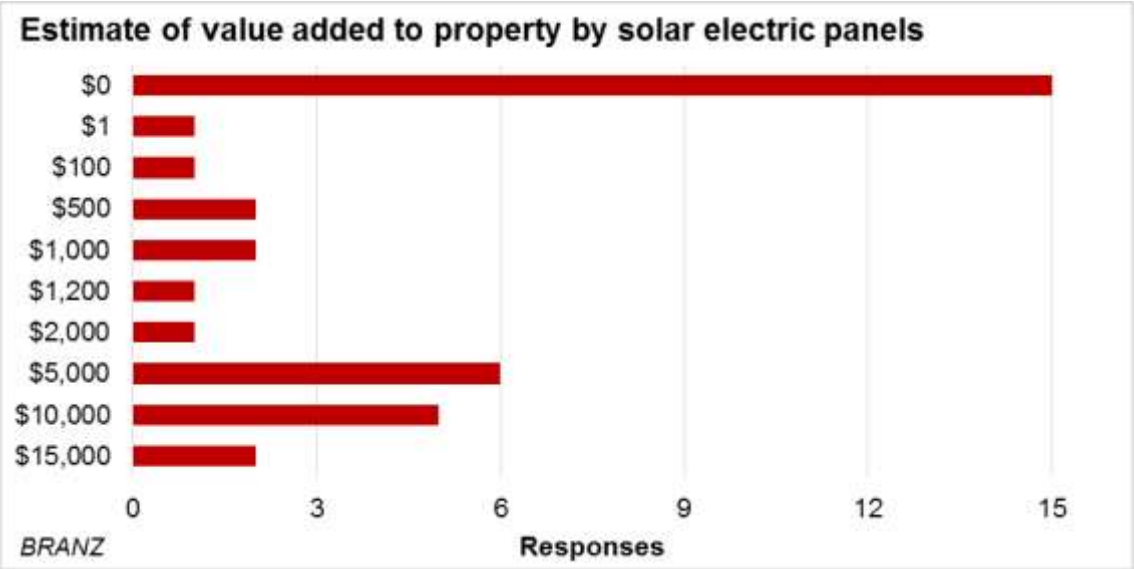

Figure 8 Estimate of value added to property by solar electric panels, REAs

Q.9. How often are you asked about the energy efficiency of property older than 30 years?

Turning to other sustainability measures, around half of respondents stated that they were asked about the energy efficiency of older properties, including such things as insulation in the walls, ceilings or underfloor.

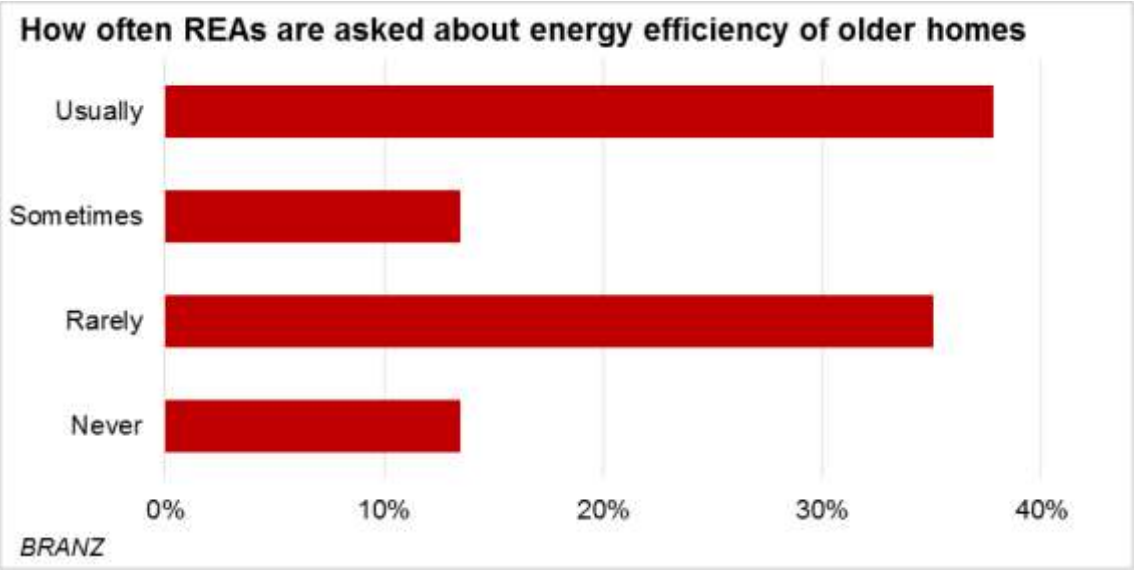

Figure 9 How often REAs are asked about energy efficiency of older homes

Q.10. How often are you asked about whether the property has been Homestar(TM) rated?

Homestar ratings, a measure of sustainability in a broader sense that includes proximity to services and transport, is seldom discussed. More than 70% of respondents said it was never discussed, or they did not know what it is.

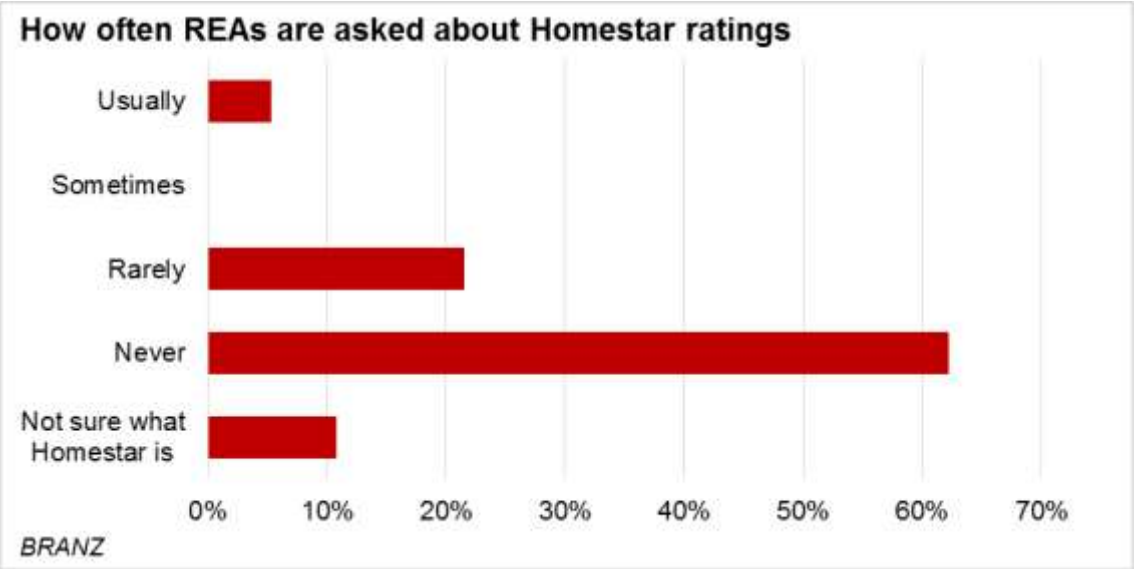

Figure 10 How often REAs are asked about Homestar ratings

Q.11. Would your clients be more or less likely to purchase a property with solar panels?

The responses for the two types of solar panels were similar in this instance. By far the majority of responses were that clients were neither more nor less likely to purchase a property with solar panels. However, there was a fair degree of uncertainty displayed, with 20% unsure of what the impact would be.

Table 13 Would your clients be more likely to purchase a property with solar panels?

Would your clients be more or less likely to purchase a property with solar panels?					
Answer Options	**More likely**	**Neither (neutral)**	**Less Likely**	**Unsure**	**Response Count**
Solar panels that produce hot water	9	18	1	7	35
Solar electrical panels that generate energy	10	18	0	7	35
Answer Options	**More likely**	**Neither (neutral)**	**Less Likely**	**Unsure**	
Solar panels that produce hot water	25.7%	51.4%	2.9%	20.0%	
Solar electrical panels that generate energy	28.6%	51.4%	0.0%	20.0%	

Q.12. What do you think are the key factors influencing the buyer's decision to purchase a property with solar hot water panels?

The most common factor influencing the buyer was keeping energy costs down (at nearly 80%) by a considerable margin. This was followed by greater energy independence (at 43%) and concern for the environment (at 34%).

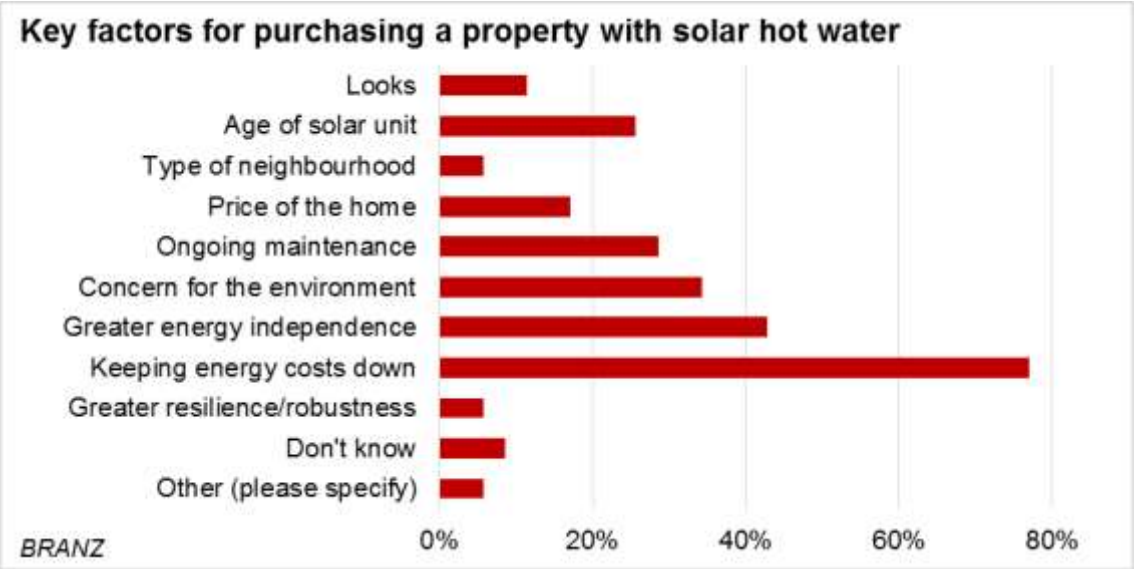

Figure 11 Key factors for purchasing a property with solar hot water

Q. 13. What do you think are the key factors influencing the buyer's decision to purchase a property with solar electric panels?

The results were similar to the responses from the previous question, both in terms of percentage values and order for the top three influencers. The most common factor influencing the buyer was keeping the energy costs down (at nearly 80%) by a considerable margin. This was followed by greater energy independence (at 46%) and concern for the environment (at 40%) which ties for third place with ongoing maintenance. This could mean that education around PVs' minimal maintenance issues is being noticed and communicated widely.

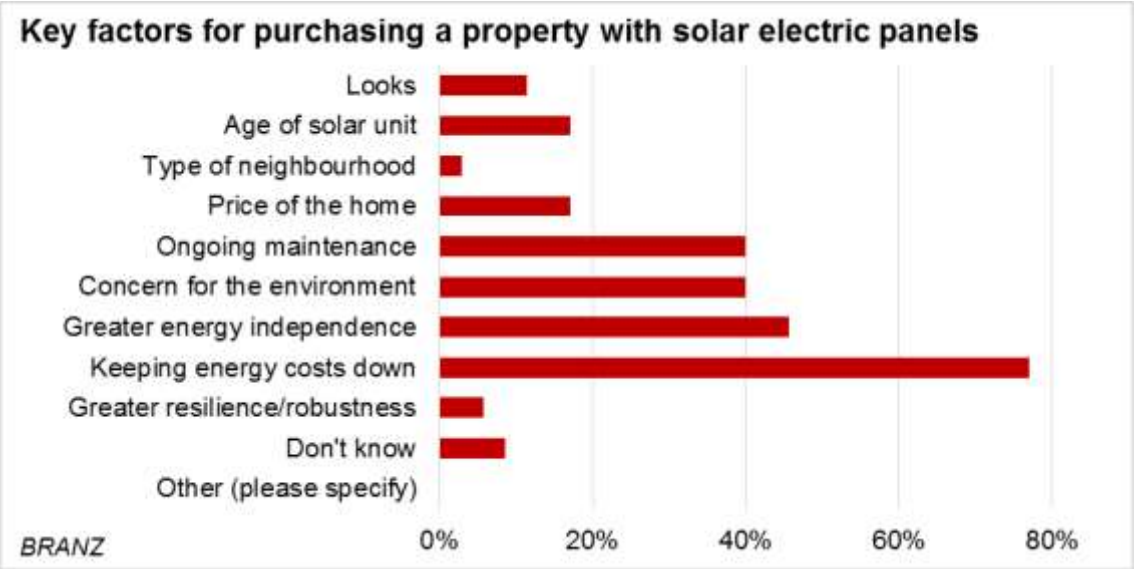

Figure 12 Key factors for purchasing a property with solar electric panels

Q. 14. Would you like to have more independent information available to you on solar hot water and solar electric systems?

By far the majority of the respondents wanted more information on solar systems – which is encouraging for future educational opportunities, whether through BRANZ or education providers.

Table 14 Would REAs like more independent information on solar systems?

Would you like to have more independent information available to you on solar hot water and solar electric systems?		
Answer Options	Response Percent	Response Count
Yes	60.0%	21
No	25.7%	9
Unsure	14.3%	5

Q. 15. Do you have any other comments, questions or concerns?

There were 18 respondents for this question. Of these, 5 were “no” answers. The rest of the replies are far ranging in their scope, with no strong themes coming through.

Table 15 Other comments from REAs

#	Response Text
1	**It is not very common here in Whangarei where I sell real estate, but as prices come down for solar units in the future it will become more popular.**
2	Solar electric is just breaking into the market. Amortization is likely to take sometime and this needs to be fully explained together with information about servicing and maintenance.
3	**Most questions would stem around cost and maintenance.**
4	I prefer to refer a buyer to a solar panel expert
5	**Having solar panels can be a deterrant, as buyers are often cautious because the do not understand the cost of maintenance, they are often worried about "what if;s", like if they break down will they cost four times more to fix than regular hot water etc.**
6	Could there be a solar electric system that simple heated the existing hot water cylinder by replacing the existing 230volt element with a dual 230 and 12volt element fitted in it's place.Hook this up to low output solar panel(say a few amps) and during the day the cold water (after morning showers and house hold water use)would be heated for free and only need night rate mains power to top it up.
7	**In Picton there are approximately only 5 homes that I know of that have solar panels. Out in the Sounds however where there is no electricity more homes have solar systems as well as running petrol generators.**
8	No
9	**The perception remains with buyers is that the capital cost and on going maintenance of solar systems, tend to outweigh the cost savings in the longer term.**
10	Comment, we have a whole new subdivision with mandatory electric solar systems so there is more than usual interest in Cambridge.
11	**No**
12	No
13	**No**
14	As a real estate salesperson this is not part of my field of expertise and therfore would not feel comfortable passing the information on unless I had been trained to do so as a risk within the industry if I misrepresented is value or use
15	**Buyers are not normally focused on the extras and beneifts of homes, an added bonus for them but purchasing based on location and property type/size for buyers age.**
16	No
17	**Have been selling homes since 1989 and have never sold a home with solar panels.**
18	Here in the North, we do not receive requests for homes with solar benefits. There is curiosity though

11.4 Valuer survey responses

It should be noted that for these types of surveys there is always a degree of self selection.

Q. 1. Where is your sales region?

Although Auckland features heavily (at just under 25%), there is a good representation of other localities, such as Marlborough, Wellington, and Otago.

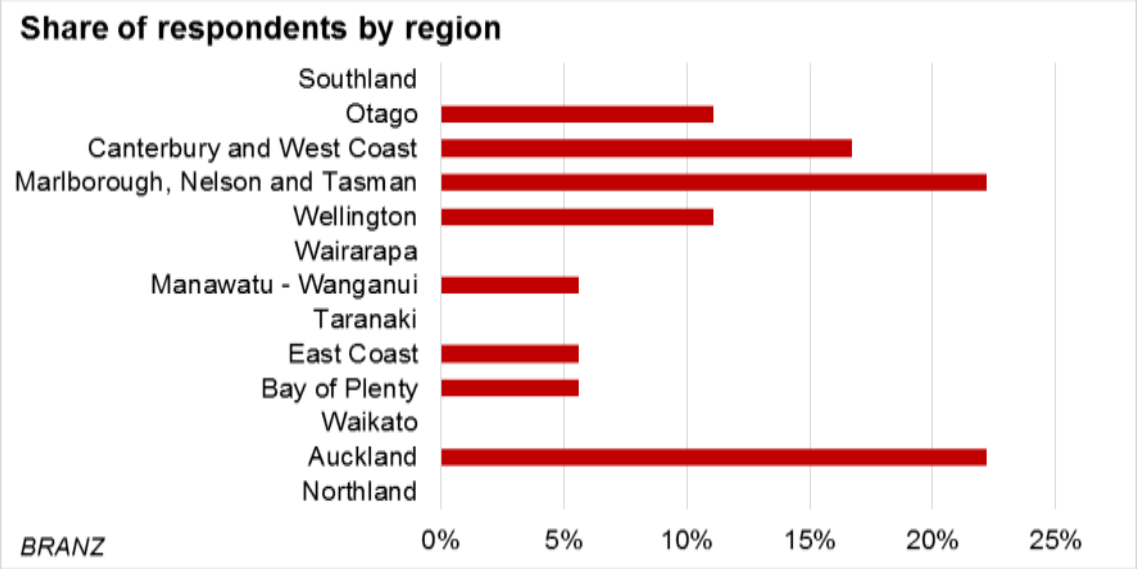

Figure 13 Sales regions of participating valuers

Q. 2. Have you ever valued a residential property with solar panels?

Over 70% of valuers had valued a residential property with some sort of solar panel (whether PV or solar thermal) on it. This high figure is understandable given the likelihood of valuers being asked to price more expensive/unusual residences.

Table 16 Valuers who have valued properties with solar panels

Have you ever valued a residential property with solar panels?		
Answer Options	Response Percent	Response Count
YES	72.2%	13
NO	27.8%	5
Unsure	0.0%	0

Q. 3. What was the type of solar panel(s) present?

Of the respondents who had valued properties with solar panels, the majority had assessed solar thermal systems rather than solar PV. Although fewer had come across houses with solar PV, there was a much higher response rate than for the REA survey.

Table 17 What were the types of solar panel(s) present?

What were the types of solar panel(s) present?		
Answer Options	Response Percent	Response Count
Solar Thermal panels (for producing hot water)	92.3%	12
Solar Photovoltaic panels (for generating electricity)	61.5%	8
Not sure	0.0%	0

Q.4. How large is the demand for solar panels in your region?

The majority thought that both solar thermal and PV were desired by their clients, with no clients not liking the feature. Just under a third of valuers thought more than 20% of their clients would like solar thermal. Similar numbers were obtained for solar PV.

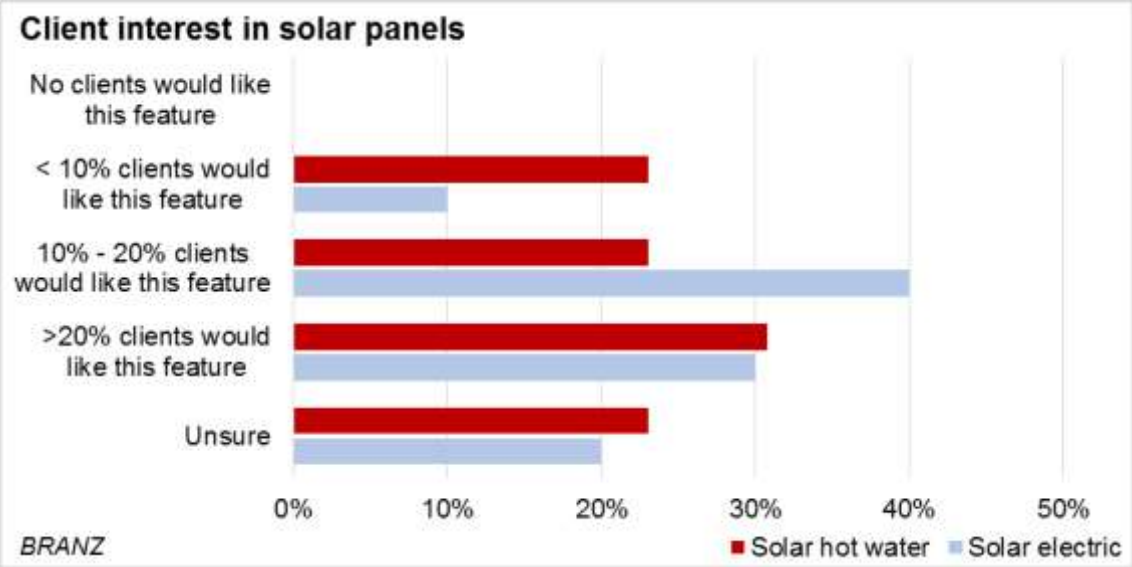

Figure 14 Demand for solar panels

Q. 5. Do you think prospective homeowners are more or less likely to purchase a property with solar panels, everything else being equal?

The surveyed valuers thought that, everything being equal, homeowners would be either more likely (or neutral) to purchase a house with solar panels. None of the respondents thought homeowners would be less likely.

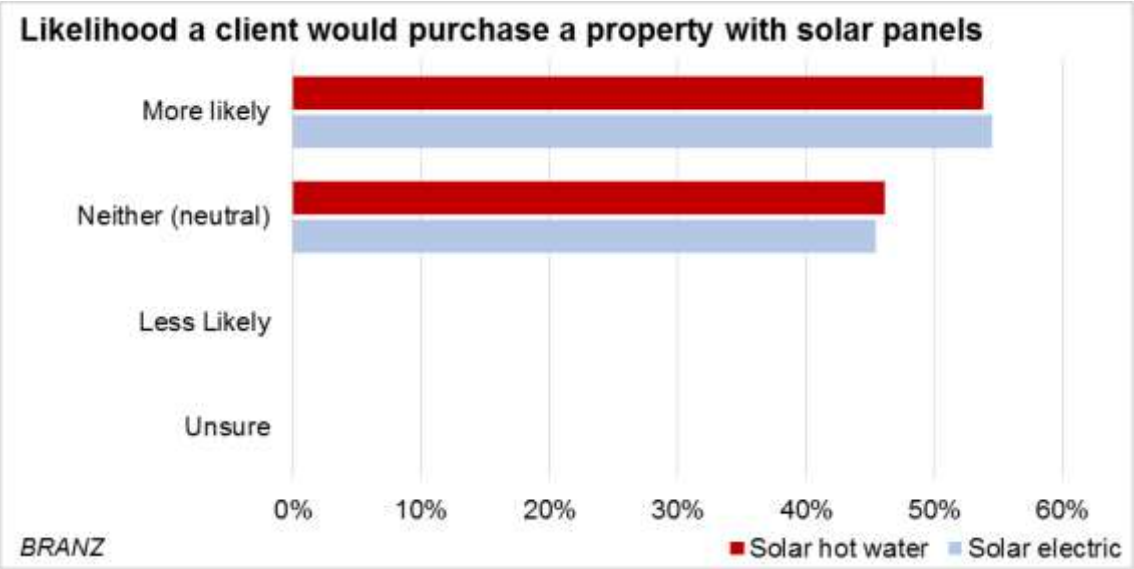

Figure 15 Likelihood a client would purchase a property with solar panels

Q.6. When assessing a residential property, if you came across a solar hot water panel, which of the following would you consider?

Valuers chose the age of the panel, its overall condition and orientation/shading aspects as being the most import features when assessing a residential property. The age of the panels is seen by renewable energy experts as a lesser issue due to the durability of the systems – usually, they are now warranted for 25 years.

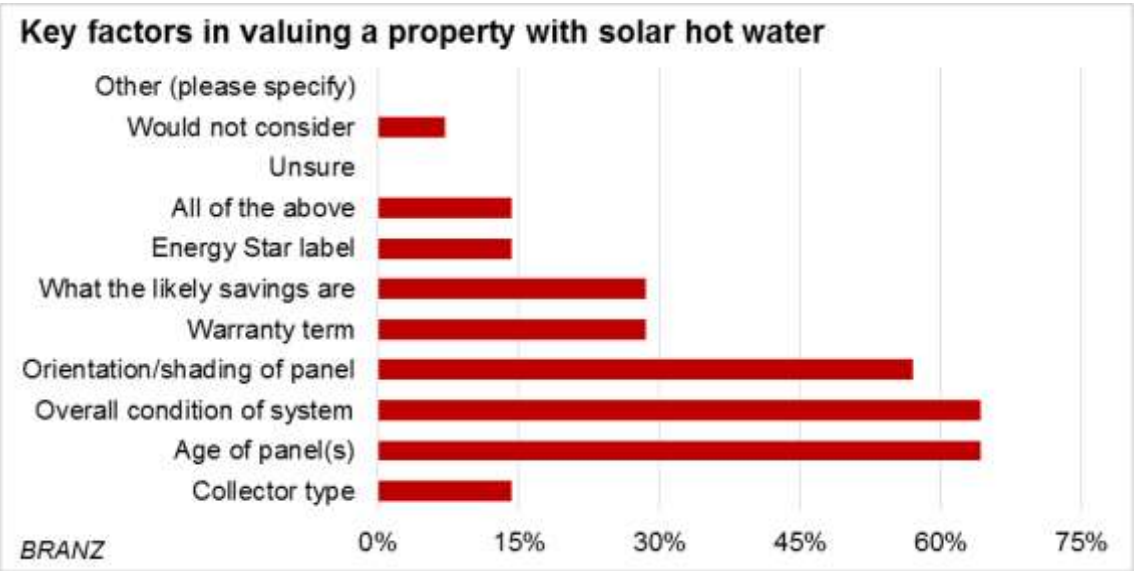

Figure 16 Key factors in valuing a property with solar hot water

Q.7 When assessing a residential property, if you came across a solar electric panel, which of the following would you consider?

Valuers thought that when assessing a residential property with PV panels, the age of the panels and the overall condition are the most important characteristics to consider. What savings are likely came in third, at 36% of respondents.

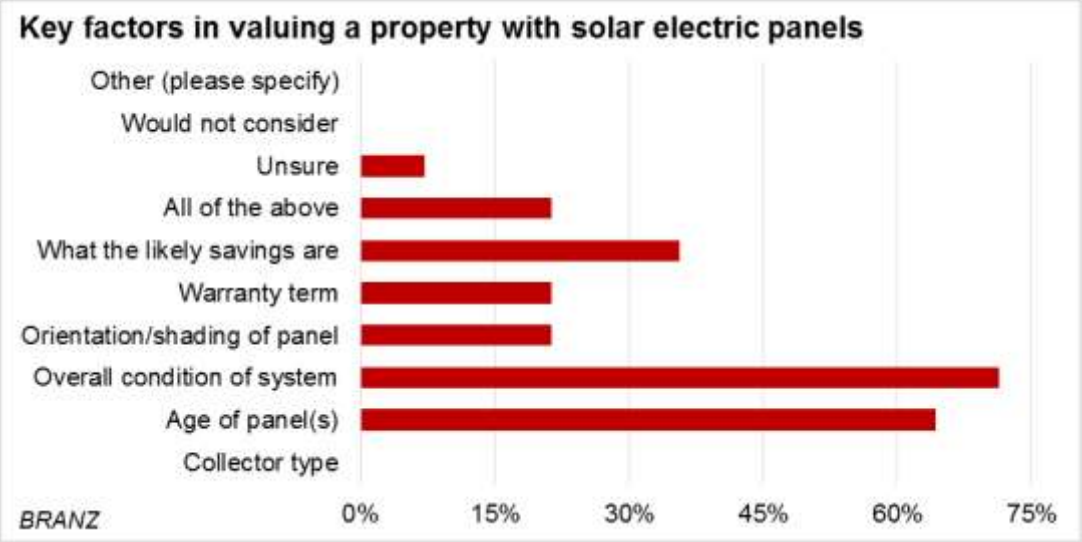

Figure 17 Key factors in valuing a property with solar electric panels

Q.8. When assessing a residence with a solar hot water panel, typically how much would it affect its value?

No respondents thought solar hot water would decrease the property's value. However, there was little agreement on what value it would add, ranging from $0 through to $10,000. Four respondents provided a range of figures, perhaps indicating that a typical figure was not practical. Three respondents thought PV systems would not provide any extra value. The average dollar value of the responses was $2,393 to $3,714.

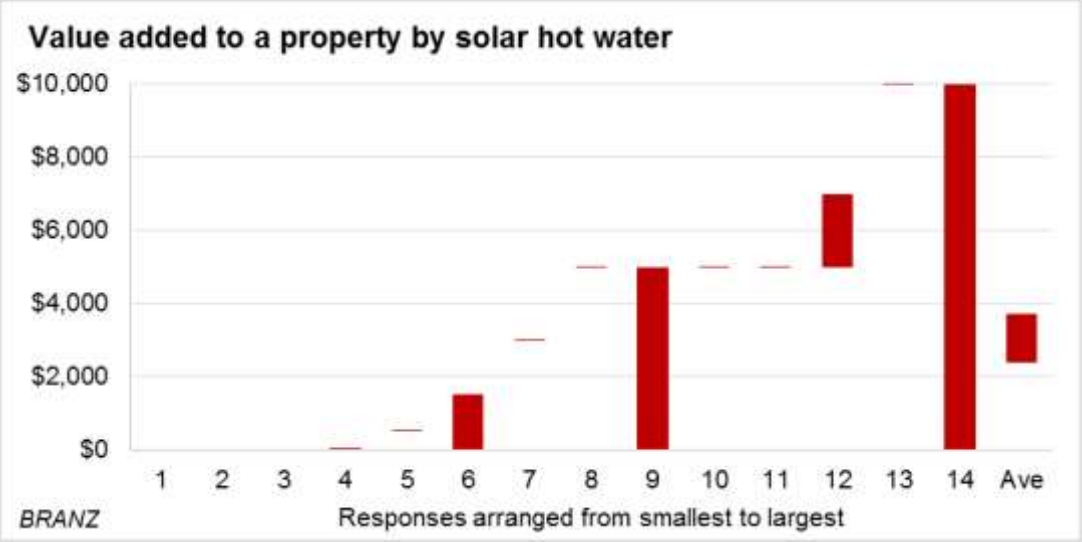

Figure 18 Value added to a property by solar hot water

Q.9. When assessing a residence with a solar electric panel, typically how much would it affect its value?

No respondents thought solar electricity panels would decrease the property's value. However, there was little agreement on what value it would add, ranging from $0 through to $20,000. Three respondents provided a range of figures, perhaps indicating that a typical figure was not practical. Four respondents thought PV systems would not provide any extra value. The average dollar value of the responses was $4,285 to $6,500.

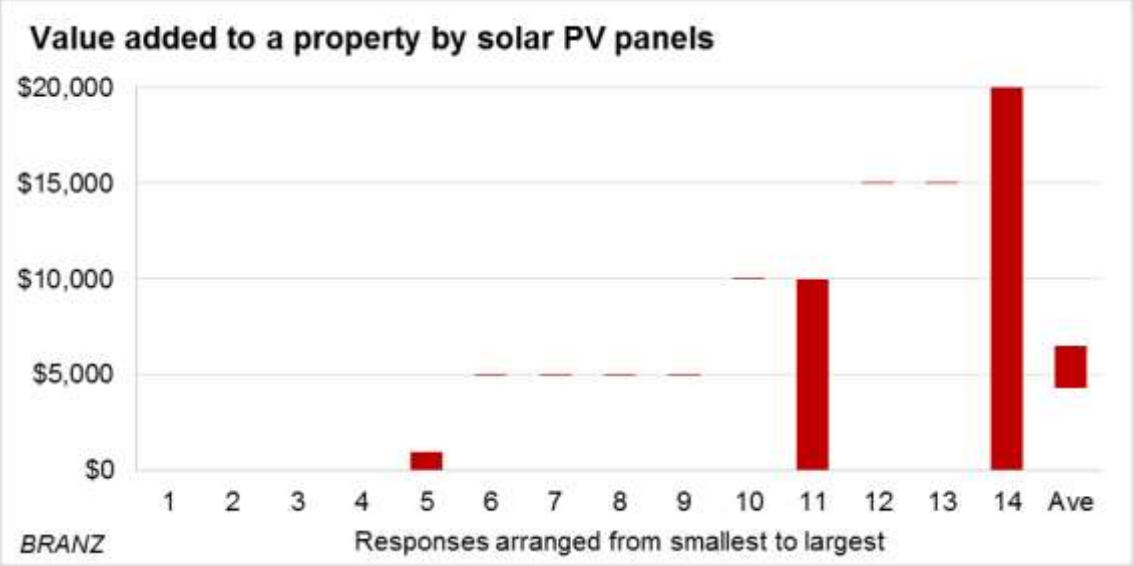

Figure 19 Value added to a property by solar electricity panels

Q. 10. Would you like to have more independent information available to you on solar hot water and solar electric systems?

By far the majority of the respondents wanted more information on solar systems (at 86%) – which is encouraging for future educational opportunities, whether through BRANZ or other education providers. 7% said no, while the remaining 7% were unsure.

Table 18 Would valuers like more independent information on solar systems?

Would you like to have more independent information available to you on solar hot water and solar electric systems?		
Answer Options	Response Percent	Response Count
Yes	85.7%	12
No	7.1%	1
Unsure	7.1%	1

Q. 11. Do you have any other comments, questions or concerns?

There were only five respondents to this question. There were no common themes in the answers.

Table 19 Other comments from valuers

#	Response Text
1	**Awareness of alternative power systems increasing. Remote locations is a must. Storage systems appear to restrict use of alternative power systems**
2	In Auckland, the effects on value are minimal as cost of solar hot water is less than the rounding of the value of the property. Solar electric installation for my property was going to be $15k but would not negate the power bill. A purchaser would be expected to pay a second hand price for an installation. Therefore an increase in value would be minimal and likely to disappear in the rounding.
3	**Items such as solar hot water and energy generation systems have to be assessed in the general overall context of the dwelling and it is difficult to look at the specific value added of such a system in isolation.**
4	Response to Questions 8 & 9 is very much dependent on market context.
5	**Having solar panels can be a deterrant, as buyers are often cautious because the do not understand the cost of maintenance, they are often worried about "what if;s", like if they break down will they cost four times more to fix than regular hot water etc.**
6	The differing design qualities are always present how are we to know if one system is better than another.

12. APPENDIX C: OTHER RESOURCES REVIEWED

These reports are additional to those in the main body of the literature search and are judged to be of lesser importance to those in the main body.

Methodology for real estate appraisal of green value.

Popescu, D, Mladin, EC, Boazu, R & Bienert, S**.** (2009).

Abstract: Green buildings are considered a quick and effective approach to protect the environment by slowing down the consumption rate of primary energy resources and by reducing greenhouse gas emissions. In Europe, appraisals of properties should take into consideration this new feature of buildings by implementing data from Energy Performance Certificates (EPC) into real estate assessment. A methodology is proposed and analysed that could be used in the sales comparison real estate valuation process. The methodology considers the costs of 'wasted' or 'saved energy' as a proxy for depreciation or appreciation of the value of the building due to changing energy efficiency. Wasted or saved energy is considered to be the difference between the energy demand of a reference building and the energy demand of the subject property.

Comments: Provides some useful references. Romanian perspective**.**

Business opportunities in sustainable housing: A marketing guide based on the experiences of 10 countries.

International Energy Agency. (2006).

Abstract: A marketing guide based on the success stories of 18 sustainable home case studies from 10 countries around the world**.** The stories were produced as part of the SHC Task 28 endeavour, and were analysed using the following template: Intro/spec of product, target market, the players, the action taken, results and analysis**.** Chapter 2 covers marketing aspects – trends, strategies and processes**.** SWOT analysis is used for the case studies**.** Non-energy benefits for the consumer include: better air quality, higher comfort levels, a better house, and a better quality of living**.**

Comments: Limited usefulness, as it concentrates more on marketing issues than valuing**.**

The business case for green building: A review of the costs and benefits for developers, investors and occupants.

World Green Building Council. (2013).

Abstract: In recent years, a wide range of studies have outlined elements of the 'business case' for green buildings. This report attempts to synthesise credible evidence from around the world into one definitive resource. It includes global examples and thought pieces from leading experts**.** It tackles the question of whether it is possible to attach a financial value to the benefits of green buildings, which is crucial information for real estate lenders and the investment community.

Comments: Mostly focused on commercial buildings, its chapter on risk mitigation is useful.

Impact of green buildings on the value of property.

Ng, EL. (2013)**.**

Abstract: The paper reviews the relationship between sustainability and property value in commercial real estate and provides some suggestions for valuers in recognising the features of sustainability in property valuation**.** Research and studies by professional bodies on the relationship between sustainability and value are reviewed to identify key factors that could influence or impact the valuation of commercial property**.** A survey of stakeholders in the real estate industry was conducted to gather their views on the importance of sustainability factors. A case study was undertaken to provide evidence on the value of a Green Mark certified building in Singapore**.**

Some guidelines are proposed: to improve data collection and storage in a more comprehensive manner and enhance current valuation parameters to incorporate financial benefits of sustainability features**.** Further, the increasing role of sustainability needs to be better addressed in valuation practice**.** The study highlights some of the issues faced by valuers and how information and data gathering should be improved and education furthered to encourage continual learning and understanding of sustainability features.

Comments: Mostly focused on commercial buildings, the study is of limited value to this work.

Homeowners perspective: The value of a green home.

Guildquality**. (**2014).

Abstract: Focuses on feedback from green home owners exploring how satisfied they were with the features of their home and with their decision to buy or build their home**.** Previous studies about green homes concentrated more on potential buyers and their interest in buying or building a green home, rather than on homeowner satisfaction**.** The survey included quantitative and qualitative questions**.** A total of 187 responses were received**.** Key findings included:

- 94% of respondents strongly agreed that, based on their satisfaction levels, they would recommend a green home to others
- 55% knew their home may have cost more than a non-green home, but they believe the benefits outweigh the costs
- 91% believed green homes are, overall, of higher quality.

Comments: Although homeowner focused, the study potentially provides a good starting point for discussions in workshops. A more detailed white paper is also provided. The study is largely qualitative in nature.

Green Value: Green buildings, growing assets. A major collaboration into the study of building value by building green.

The Royal Institution of Chartered Surveyors. (2005)**.**

Abstract: This study sets out to test the sceptical null hypothesis, that 'There is no relationship between the market value of a real estate asset and its green features and related performance'**.** The evidence gathered through literature review and case studies led the authors to conclude that the sustainable features of green buildings can add value to real estate.

Comments: The study makes some useful recommendations on page 8 and provides useful information on valuation on pages 17–18**.** It considers a range of building typologies (including multi-tenant residential).

The effect of sustainability on property value.

Moran, K. (2010).

Abstract: This paper evaluates sustainability, its place in current valuation processes and the relationship between value and sustainable buildings. Past research indicates the lack of ability to define sustainability with a precise dollar value. The recent rise in interest in sustainability may be a cause for the difficulty in assessing market values of sustainable features. Although the market value of sustainability is hard to assess, market value is not the only value that sustainability can add to a building. Sustainability also offers values that positively affect health, efficiency and productivity. These sustainable features result in a monetary savings, thus increasing the property value. The thesis focus is on understanding sustainability's part in increasing property value, and analyses various types of valuation methods that can assess the market value of sustainability.

Comments: Cursory overview with some good references to residential schemes.

How to effectively integrate sustainability into property valuation.

Pengfei, W. (2011).

Abstract: The purpose of this paper is to find a feasible and effective way to integrate green issues/sustainability into the property valuation process. The thesis begins with a discussion of the concept of sustainability, green buildings and the traditional valuation approach. Valuable information is extracted from the reports of the IMMOVALUE project, which aims to improve the market impact of energy certification, introducing energy efficiency and life cycle cost into property valuation practice. A survey collecting Swedish valuers' opinions towards sustainability finds that energy efficiency/Energy Performance Certificate (EPC) is a catalyst for the integration of green issues into property valuation practice. This is the most feasible way to quantify the effects of green features on property. Some modified methodologies based on the three traditional valuation approaches are proposed and the income-related approach is the most suitable one here.

Comments: The study has a limited focus on energy certificates and life cycle costs only.

Value beyond cost savings: How to underwrite sustainable properties.

Muldavin, SR. (2010).

Abstract: The real estate industry is struggling to quantify and articulate the value of sustainable property investment. The vast majority of investment decisions, even by sophisticated investors, are being made based on simple payback or simple return on investment (ROI) calculations. The study argues that failure by property investors to appropriately incorporate revenue and risk considerations into sustainable investment decisions has led to underinvestment in sustainability. The book is designed to assist private investors in making better financially based sustainable property investment decisions. The book:

- describes how to address the role of certifications in financial analysis
- presents Green Building Finance Consortium GBFC's Sustainable Property Performance Framework, which identifies the 'missing link' in performance assessment critical to valuation
- introduces GBFC's Sustainable Property Cost-Benefit Checklist, a comprehensive 40+ page assessment of the positive and negative risks of sustainability
- introduces a six-step sustainable property financial analysis methodology
- details special considerations in the underwriting of energy efficiency investment and space user demand

- provides specific recommendations for modifications to underwriting and due diligence guidelines for sustainable properties.

Comments: This is a comprehensive study but with the focus on non-residential for the most part.

Why invest in high performance green building? Utilizing smart building strategies to reduce environmental impact, ensure occupant satisfaction, drive better business outcomes, and maximize asset value.

O'Mara, M and Bates, S**. (**2012).

Abstract: Property investors and developers are constantly seeking new strategies to deliver sustainable buildings that attract tenants and buyers while maximizing 'green value'. Investments in green buildings can produce measureable financial value, such as increased rental rates and asset value, reduced risk of depreciation, and higher tenant attraction and retention rates**.**

Meanwhile, occupants want buildings that help them attract and retain the best talent, foster collaboration and innovation, and increase employee productivity and well-being**.** At the same time, they need to reduce operating costs, energy use, and environmental impacts**.** All of these factors help organisations meet corporate social responsibility goals.

The study argues that increased market demand and financial rewards, coupled with mounting government regulations and shareholder pressures, provide incentives to own and occupy high-performance green buildings**.** It outlines strategies on how to make green buildings perform on several levels – from profitability to sustainability.

Comments: The report is largely a 'justification' (sales) document but good for background information and understanding the situation. It differentiates between high performing and sustainable**.**

Energy efficiency and property values: A discussion paper.

Reed, RG et al. (2011).

Abstract: Property valuers, managers and analysts must remain up to date regarding changes, but little research has been conducted into how increased energy efficiency affects a property's highest and best use, value and lifecycle**.** This paper examines the understanding about energy efficiency in the marketplace, especially in relation to property values with the emphasis placed on a cost-benefit analysis from both an owner's and tenant's perspective**.** It may be argued that incorporating energy efficiency into a new office building is cost prohibitive on a financial cost-benefit basis. However, often minor steps can be taken to upgrade the energy efficiency of an existing building**.** This paper highlights the links between energy efficiency and property value over the short term and long term**.** The intent is to encourage discussion in these areas.

Comments: The study is a non-residential examination only.

Catalysing climate and disaster resilience: Process for identifying tangible and economically robust strategies.

The Risk to Resilience Study Team**.** (2009). eds. Moench, M., Fajber, E., Dixit, A., Caspari, E., & Anil Pokhrel.

Abstract: The report is based on fieldwork undertaken in Nepal, India and Pakistan**.** The analysis suggests that disaster risk reduction can generate economic returns that are both positive and

competitive with other channels for public investment. All forms of risk reduction do not generate equally high returns, however. In fact, when indirect costs and negative impacts (disbenefits) are considered, some forms of risk management, such as the construction of embankments for flood control, may not be economically efficient at all.

The fact that the cost of an embankment may outweigh its benefits does not imply that infrastructure-based flood control strategies are inherently inappropriate. Instead, it points toward the need for selecting strategies carefully and for implementing them in ways that both respond to local conditions and reflect the costs, benefits and disbenefits associated with them. The Pakistan study demonstrates even strategies that generally have high benefit-cost ratios can generate negative returns if they are not carefully designed to minimise costs and account for maintenance.

Comments: The study looks at both qualitative and quantitative strategies, using specific case studies.

Investing in resilience: Ensuring a disaster-resistant future.

Cornell University ILR School and Asian Development Bank. (2013).

Abstract: This report offers an approach and consideration of how we can ensure that the actions required to strengthen resilience are actually taken. It is primarily aimed at investors in the public sphere, namely governments and their development partners. The report intentionally applies a loose definition of investment and investors, looking beyond financial outlays on physical infrastructure.

It covers the investment of a wide range of resources, including political commitment, human resources utilization, knowledge, know-how, and personal time and dedication. It considers an array of structural and structural instruments and mechanisms to identify and assess risk, reduce risk, and manage remaining risk. It includes investments in, for instance, institutions, legislative and regulatory frameworks, financing mechanisms, incentives for change, and systems of accountability. It encourages investors to integrate investments in resilience into their own areas and modes of work and to promote, incentivize, and coordinate on the part of the private sector and households.

Comments: The study is targeted primarily at governments.

The value of sustainability in real estate: A review from a valuation perspective.

Warren-Myers, G. (2012).

Abstract: This paper synthesises the range of research that has been conducted into the relationship between sustainability and market value in real estate. It analyses the research and the applicability of sustainability and value research in valuation practice.

Existing research conducted into the relationship between sustainability and market value has not provided the valuation profession with evidence that allows the incorporation of normative theories in valuation practice. This review highlights the lack of evidence, and the applicability of current research into sustainability and value to the valuation profession in providing guidance and information in valuing real estate incorporating sustainability.

The lack of historical evidence or information on the quantifiable effects on market value of this new trend (sustainability), leaves the valuation profession uncertain as to its relationship with market value. There is a probable risk of valuers interpreting strategic research incorrectly, and

making inappropriate adjustments or comparisons because of their lack of knowledge and limited sustainability assessment skills**.** There is a need for extensive analysis of unbiased, evidence-based research in individual and broader markets to provide guidance on the implications of sustainability in the valuation of real estate.

Comments: Although useful, the latest research papers cited are from 2009, so not much very recent information is provided**.**

Trends in real estate valuation: Spatial econometrics, land values and sustainability.

Krause, A et al. (2012)**.**

Abstract: In the aftermath of the recent boom and bust of the US real estate market, both a refinement and a deeper understanding of real estate valuation methods have become critical concerns**.** Three major trends in the field of real estate valuation research were identified:

- the expansion of spatial econometrics
- the recognition of the differences between land values and improvement values
- acknowledgement of value premiums stemming from more sustainable forms of development**.**

This paper offers a brief summary of the latest work in these emerging areas of academic valuation research.

Comments: Only an abstract was included, with a non-residential focus.

Sustainability metrics: Translation and impact on property investment and management.

United Nations Environment Programme. (2014).

Abstract: This report provides a framework for a corporate real estate sustainability management (CRESM) system for property investment and management organisations**.** The framework can be used as:

- a means to meet their environmental, social and governance responsibilities whilst addressing the financial/risk implications of sustainability
- as an overall quality assurance tool and mechanism**.**

Recommendations for best practices are made for different levels: corporate, portfolio and single building**.** These recommendations are a response to the findings that:

- the property investment community has developed a largely shared understanding of what sustainability means in relation to single buildings and investment vehicles
- although most of the information and data factors required for sustainability performance assessment and management are already being captured, this is not yet performed in a systematic and well-organised manner**.**

Key challenges are identified for property investment and management firms. These include organising information flows more efficiently, ensuring data accessibility and comparability across different corporate departments and between business partners and service providers, and developing and implementing appropriate decision-support instruments**.**

Comments: The report makes some interesting points, but is more targeted for the property investor community**.**

An introduction to green homes.

Simmons, AF. (2010).

Abstract: *An Introduction to green homes* provides the appraiser with an overview of programmes, organisations, and products that relate to environmentally responsible building and remodeling. Green home and product certification programs are described, as are popular green home products and features. This guide also provides appraisers with a variety of online resources where the most up-to-date information is available. Case studies focusing on various attributes of green homes are provided. The text concludes with a thorough discussion of how green features affect the valuation of homes. *An Introduction to green homes* provides a solid foundation for residential appraisers to diversify their practices and become knowledgeable about one of most important forces influencing today's housing market.

Comments: Chapter 6 (13 pages in all) provides an overview of green appraisal issues looking at various types of appraisal approaches, which is reasonably useful.

PV value: User manual.

Johnson, J et al. (2012).

Abstract: The document describes the methods used to develop a model for appraising the value of a photovoltaic (PV) system installed on residential and commercial properties. This model follows the income capitalization approach used by appraisers to determine the value of a PV system as a function of the potential energy produced over the system's lifetime. Instructions on how to properly input values into the spreadsheet tool are presented along with a detailed description of each parameter. PV Value® is intended for use by real estate appraisers, mortgage underwriters, credit analysts, real property assessors, insurance claims adjusters, and PV industry sales staff. More can be found at:

www.pvvalue.com or http://energy.sandia.gov/?page_id=8047

Comments: It provides a very detailed appraisal of system. Typical economic metrics used for an appraisal valuation are examined based on either the sales comparison (comparable), cost or income capitalization approaches. Now being migrated to a web-only version.

Value beyond cost savings: How to underwrite sustainable properties: Evaluating property sustainability.

Muldavin, S. (2010). Expanded Chapter 3.

Abstract: This is the third chapter of the six-chapter book *Value beyond cost savings: How to underwrite sustainable properties*. Evaluating a property's sustainability can be difficult and confusing. This chapter provides some insights and methods for evaluating a property's sustainability from a financial performance perspective and identifies resources to assist in this effort. Expanded Chapter 3 provides a framework for evaluating a property's sustainability, provides detail on sustainable property features, and assists readers in assessing the role of certifications in financial analyses and valuation. This chapter is presented in the following sections:

- What is a sustainable property?
- Sustainable property features
- Measuring a property's sustainability
- How sustainable property certifications affect value

- Key research comparing sustainable rating systems.

Comments: Useful, even though a considerable amount targeted more to the North American market.

How PV system ownership can impact the market value of residential homes.

Klise, GT and Johnson, JL. (2014).

Abstract: There are multiple ways for a homeowner to obtain the electricity generating and savings benefits offered by a photovoltaic (PV) system**.** These include purchasing a PV system through various financing mechanisms, or by leasing the PV system from a third party with multiple financial options. The different ownership options available to homeowners present a challenge to appraisal and real estate professionals during a home sale or refinance. It is hard to develop a value that is reflective of the PV system's operational characteristics, local market conditions, and lender and underwriter requirements**.** This paper presents these many PV system ownership options with a discussion of what considerations an appraiser must make when developing the contributory value of a PV system to a residential property.

Comments: The study has many useful references as well as insight into financial analysis.

Residential solar photovoltaics: Comparison of financing benefits, innovations, and options

Speer, B. (2012)**.**

Abstract: This report examines relatively new, innovative financing methods for residential photovoltaics (PV) and compares them to traditional self-financing methods**.** It provides policymakers with an overview of residential PV financing mechanisms, describes relative advantages and challenges between the various financing mechanisms, and analyses differences between them where data is available**.** Because these innovative financing mechanisms have only been implemented in a few locations, this report can help enable their wider adoption.

Comments: The study is useful but is limited to the homeowner perspective. It has many worthwhile references.

The challenges of identifying and examining links between sustainability and value: Evidence from Australia and New Zealand

Warren-Myers, G, Reed, R. (2010).

Abstract: Industry stakeholders believe the financial benefits of sustainable real estate investments are difficult to quantify**.** The lack of transparent financial correlations between sustainability and economic return has created major issues for real estate appraisers and valuers**.** Argues that the lack of transparency with financial drivers restricts substantial investment in sustainability because stakeholders have limited metric abilities to understand the impact on value**.**

Comments: As well as measurement difficulties, there is a disconnection between valuers who, if they consider sustainability at all, use rating tools. Investors prefer to have actual operations data**.** The analysis is for commercial buildings but the findings are likely to apply to residential buildings as well.

Zero and low energy homes in New Zealand: The value of non-energy benefits and their use in attracting homeowners

Stoecklein, A, and Skumatz, L. (2007).

Abstract: Analyses indirect hard-to-measure 'non-energy-benefits' (NEBs) associated with zero and low energy homes in New Zealand. Features include double glazing, super insulation, solar water and solar design features**.** The NEBs included reduced noise, improved comfort, better control over power bills, effect on the environment, and health benefits.

Comments: Respondents were asked to rate the value of the NEBs as a proportion of the energy saved for each efficiency measure installed**.** For example, super insulation was assessed to have a value of 37% of the energy savings from the insulation alone. This is a difficult approach to adopt as it implies the respondent understands the energy savings of each individual sustainability feature. It further assumes that they can separate out in their minds the NEBs from the energy savings.

Elevate Energy *Value for high performance homes* campaign

www.elevateenergy.org/value-high-performance-homes-campaign/home/

Overview: The US-based *Value for high performance homes* campaign supports high performance home transactions by making upgrades transparent to the market – encouraging their fair value**.** Real estate, appraisal, and energy efficiency professionals work together to remove barriers and demonstrate the value of energy efficient and high performance homes in the single family market**.** They work across the entire chain of real estate stakeholders, including the home seller, high performance builder or contractor, listing agent, buyer's agent, appraiser, underwriter, lender, and home buyer**.**

Comments: The study (Stukel & Scheu, 2014) provides very good links to relevant supporting studies (under *Related research*, and key resources for industry (under *Tools and resources*)**.** The study was updated in 2014**.**

Green Resource Council courses

www.greenresourcecouncil.org/green-courses/green-course-information

Overview: This is a series of courses by the US National Association of Realtors**.** They are:

- Green 100: Real estate for a sustainable future
- Green 200: The science of green building
- Green 300: Greening your real estate business**.**

Comments: Interesting to note how further advanced the Association is compared to industry initiatives in New Zealand. Possibly useful guidance on the next steps for New Zealand.

Edgewaterhaus

http://edgewaterhaus.com/?p=787

Overview: Blog about personal journey into high performance homes from an architectural design practice**.**

Comments: Useful for a practical appraisal of the US experience – even if only one person's experience.

Listed Green

www.listedgreen.com

Overview: A US-wide residential listing site for energy efficient, sustainable homes and green developments listed for sale to help realtors connect with buyers and sellers. Also, to help buyers shop for green homes for sale and help realtors and buyers find an energy auditor**.** Aims to help elevate the market value of green homes and sustainable developments for sale.

Usefulness: Minor – just to see what's available currently.

Real estate benchmark takes sustainability to the capital markets

Kok, N. (2015).

www.greenbiz.com/blog/2014/04/15/gresb-standard-key-greener-real-estate-value-chain

Overview: Personal blog by researcher on 2014 Survey on the annual assessment of the sustainability performance of property portfolios around the globe**.** The goal is to provide real estate investors with the tools they need to monitor and manage sustainability performance accurately, and to prepare for increasingly rigorous related obligations**.** Investors need this information to better understand immediate sustainability risks surrounding issues such as flooding or regulation regarding minimum energy-efficiency requirements**.** Written 2014**.**

Usefulness: Mostly in the links provided – article written by one of the industry's heavyweights in this specialist area.

Energy Star

www.energystar.gov/index.cfm?c=bldrs_lenders_raters.nh_benefits_appraisers

Overview: Hub of the Energy Star label for homes – a government-backed label administered by the US Environmental Protection Agency (EPA) that serves as the symbol for energy efficiency for new home construction. The EPA sets strict criteria that must be met by builders that assure energy performance that is better than standard requirements, along with improved comfort and durability. Provides builders with a point of difference along with a free, comprehensive marketing and educative resources. The study was updated in 2014**.**

Comments: Interesting due to it being builder-targeted and essentially based on tried and true methods which ensure higher quality homes result. So far, over 1 million homes have met the certification requirements. Contains access to a comprehensive set of resources.

Green home appraisals might not mean more 'green' in your pocket

Araj, V. (2011). www.quickenloans.com/blog/green-home-appraisals-green-pocket

Overview: Article highlights the current gap between perceived value and actual value of green homes in the USA, citing what it sees as some core problems today that must be overcome. Recognises that while demand for higher performing environmental housing is growing, green home appraisal values do not take into account the economic benefits of green efficiency**.** Written in 2011**.**

Comments: The (now slightly out of date) article sees the key green appraisal problems as:

- lack of education
- lack of consistency
- lack of green appraisal.

13. APPENDIX D: HEDONIC SPECIFICATION CONTINUED

Parameters of hedonic equations are frequently estimated by using a semi-logarithmic functional form to conform to rules of parametric tests. This specification regresses the natural log of gross sales price on a linear combination of housing characteristics. The semi-log functional form is given by:

$$\mathbf{P} = e^{\mathbf{X}b+e}, \quad (1)$$

where P is the market value, X is a vector of housing characteristics, b is the vector of unknown hedonic coefficients, and *e* is the residual. Taking natural logs of Equation (1) yields the transformed equation:

$$\mathbf{Z} = \ln \mathbf{P} = \mathbf{X}b+e, \quad (2)$$

The empirical hedonic specification for the analysis is

$$\ln(P_i) = b_0 + b_{1\text{-}2}(\text{Floor\_Area}) + b_{3\text{-}4}(\text{Site\_Area}) + b_{5\text{-}6}(\text{Beds}) + b_7(\text{Baths}) + b_{8\text{-}9}(\text{Interior}) + b_{10\text{-}11}(\text{Exterior}) + b_{12}(\text{Steep\_Contour}) + b_{13}(\text{Deck}) + b_{14}(\text{Pool}) + b_{15\text{-}17}(\text{Water\_View}) + b_{18}(\text{Cross\_Lease}) + b_{19}(\text{SHW\_Featured}) + b_{20\text{-}29}(\text{D1990, etc}) + b_{30\text{-}38}(\text{Sold\_2012\_Q3, etc}) + b_{39\text{-}44}(\text{au581715, etc}) + e$$

Where:

P_i	gross sales price of the *i*th property;
Floor_Area	property's total building floor area in square meters;
Floor_Area2	Floor_Area squared;
Site_Area	area of the land plot in square meters;
Site_Area2	Site_Area squared;
Beds_2_or_less	dummy variable for whether the home has 2 or less bedrooms with the default category being 3 beds;
Beds_4_or_more	dummy variable for whether the home has 4 or more bedrooms;
Baths_2_or_more	dummy variable for whether the home has 2 or more bathrooms with the default category being 1 bath;
Interior_Good	dummy variable for whether the property's interior fixtures and finishes were coded by the appraiser as being in 'Good' condition with the default category being 'Average';
Interior_Poor	dummy variable for whether the property's interior fixtures and finishes were coded by the appraiser as being in 'Poor' condition;
Exterior_Good	dummy variable for whether the property's exterior walls were coded by the appraiser as

	being in ‘Good’ condition with the default category being ‘Average’;
Exterior_Fair_Poor	dummy variable for whether the property’s exterior walls were coded by the appraiser as being in ‘Fair’ or ‘Poor’ condition;
Steep_Contour	dummy variable for whether the property’s land is categorised as having either a steep fall or steep rise;
Deck	dummy variable for whether the property features a deck;
Pool	dummy variable for whether the property features a swimming pool;
Water_View_Slight	dummy variable for whether the home features a slight water view from the main living area with the default category being no appreciable water view;
Water_View_Moderate	dummy variable for whether the home features a moderate water view from the main living area;
Water_View_Wide	dummy variable for whether the home features a wide water view from the main living area;
Cross_Lease	dummy variable for whether the property is on a cross lease title with the default category being a freehold title;
SWH_Featured	dummy variable for whether the home features a solar water heating system;
D2000, D1990, etc	set of dummy variables corresponding to the vintage (decade) in which the house was built with the default category being 2010;
Sold_2012_Q3, etc.	dummy variable for the quarter in which the property was sold with the default category being quarter 2, 2012;
au581715, etc	set of dummy variables corresponding to the 2013 Area Unit[i] in which the house is located;
e	random error.

The main variable of interest is the independent variable *SWH_Featured* which codes individual sales as having a solar water heating system or not. Specifically, properties that have received an EECA grant associated with the installation of an approved solar water heating system. Furthermore, a combination of published photographs contained in expired online sales listings, images from Google Street View and Google Earth were used to confirm the existence of rooftop

solar water heating. The remaining independent variables serve as controls for the myriad of factors known to contribute to house price.

[i] Area Units are the second smallest enumeration units employed by Statistics New Zealand. In urbanised areas the target size for an Area Unit is 3,000 to 5,000 people.