LOW CARBON LIVING CRC

ISBN	N/A
Format	PDF
Keywords	Energy efficiency, rating systems, discosure, residential property, real estate
Editor	N/A
Publisher	CRC for Low Carbon Living Limited
Series	Prepared for the Cooperative Research Centre for Low Carbon Living Project RP3016 'Enhancing the market for low carbon homes at point of sale and lease'
ISSN	N/A
Preferred citation	Clark, M., Potts, J. (2014) The EnergyFit Homes Initiative Working Paper 6: Australian Information Systems for Household Energy Efficiency, Common Capital. Australia.

Acknowledgements

This report is a deliverable for the Project RP3016: 'Enhancing the market for low-carbon homes at point of sale and lease' funded by the CRC for Low Carbon Living. This project is publicly referred to as the EnergyFit Homes Project: Empowering consumers to recognise and value homes with better health, comfort and sustainability benefits and lower running costs.

Common Capital would like to acknowledge the support given by CRC for Low Carbon Living, supported by the Cooperative Research Centres program, an Australian Government initiative, and the project's financial partners: AGL Energy, Australian Window Association, Centre for Liveability Real Estate, Clean Energy Council, CSIRO, CSR, Energy Efficiency Council, Energy Efficiency Certificate Creators Association, Fletcher Insulation Australia, Knauf Insulation Australia, NSW Office of Environment and Heritage, and Stockland,

We would also like to acknowledge contributions received from Emily Yip (Office of Environment and Heritage) and Nina Hall (CSIRO).

Disclaimer

Contents

List of tables

List of Figures

Executive Summary

Almost nine in ten Australian households want to take action to reduce their household energy consumption. Despite this interest, most home-buyers and lessees do not consider the carbon performance of their future home. This project seeks to develop a pathway for enhancing the market for low carbon homes at sale and lease. It will combine research and analysis of existing literature, benchmarking of existing information systems, consumer tradesperson research and industry consultation. This report represents the findings of the first stage of the benchmarking, focused on Australian tools and information systems. The findings of this report will feed directly into the following research phases and overall project findings and recommendations.

This report is a desktop review of EnergyFit [1] information systems, national tools and systems relevant to benchmarking low carbon, EnergyFit homes. The review includes consideration of data sources, the credibility and usefulness of each source, and the availability or access costs and barriers to data use. The 23 information systems reviewed in this report include instruments such as rating tools, energy calculators, checklists, and technical information portals. The systems include both those that relate to the whole house, and those focused on one or more house features.

Credibility and influence of EnergyFit information systems

Section 2 of this report finds that with few exceptions, there is little transparency or public access to EnergyFit data sources and information systems. EnergyFit information systems do not publish their assumptions and methodology or underlying data sources, and the systems, governance and development are not open for review. The governance, administration and development of information systems in Australia is contained within individual organisations, with limited accountability and external oversight.

This lack of transparency and access for scrutiny potentially undermines the credibility and reliability of all systems. The users of each system and the recipients of EnergyFit information must trust that the developers have implemented robust and accurate processes and assumptions, as they cannot test these processes for themselves. This may limit the effectiveness of current systems, particularly those that involve detailed calculations (such as rating systems and online calculators). The limited evaluations available found a high error rate in data entry for complex information systems. This results in a lack of repeatability of the presented information for a house, which may further erode system credibility.

Evaluations of one point of sale system found a significant disengagement with buyers, sellers and property industry practitioners. To avoid this potential pitfall, EnergyFit information systems should focus on determining and providing information that is directly relevant to both consumers and experts in an engaging manner.

Consistency and credibility of EnergyFit information systems

While governance structures of EnergyFit information systems and their methodologies are isolated and not transparent, there is a good consistency between the available systems, and a strong potential for collaborative effort.

Section 4 of this report shows that the EnergyFit information systems currently in place have a consistent coverage. The systems present similar information that suits the targeted phase of the building lifecycle, as described in section 6. The various calculation models used in each system potentially leverages and builds on the information provided by the other systems, as described in section 5.2. The information conveyed during each phase of the building lifecycle often has relevance in other phases – for example, information provided to building occupants on the energy consumption of their current home may inform their next home purchase, or help them plan out a major renovation.

The technical review in section 5.3 also finds a good consistency between the information systems that model operational house energy use. The systems largely agree on modelled energy performance, proposed energy saving actions and the reported cost and benefit of these actions.

This consistency and correlation of results between information systems suggests that the provided information is largely robust.

[1] See section 1.2 for a definition of the EnergyFit terminology used throughout this report

Issues for consideration in the next steps of this project

The next stages of the EnergyFit Homes project include further research into consumer and industry attitudes and expectations of EnergyFit information systems, message testing of alternative information, and the development of improved system governance structures.

A number of recommendations for these next steps and potential outcomes of the EnergyFit project arise from the analysis of current information systems in this report:

Determining the most influential information at the point of sale:

For point of sale information systems, how important is the source of information in influencing consumer behavior? In particular, is self assessed information less influential than that completed by professionals?

Testing complexity messages with consumers – what is the consumer view of the right balance between cost and the complexity of assessment? How much are consumers willing to pay in time and effort for information?

Testing rigour of assessment against action orientation – how much do consumers want to know about what they currently have, compared to advice on what they should do to improve?

How important is the accuracy of the presented information in influencing behaviour? How important is reliability and repeatability of results?

Does information need to be tailored to the consumer to be influential?

Comparison is a key focus of consumer systems – is a comparative metric likely to be influential at the point of sale?

Most of the information systems provide information on energy savings, but are imprecise on the cost of actions. How important is information on implementation cost to stimulating action?

Establishing systems to support the effective delivery of point of sale systems:

What is the current perception of practitioners in the property industry on the usefulness of point of sale EnergyFit information? What processes are needed to enhance awareness and acceptance among practitioners?

What is the level of consumer confidence in current systems? In particular, does the high error rate found in NatHERS evaluations (which are disclosed at point of sale under the ACTHERS system) impact on the influence of ACTHERS?

Enhancing trust in EnergyFit information systems:

The EnergyFit Homes Initiative may consider establishing a quality assurance and appraisal methodology for all EnergyFit information systems under an EnergyFit banner. A rigorous appraisal methodology would need to be developed to ensure that the governance, quality assurance and methodology of each system could be graded accurately and appropriately.

To improve the interoperability, consistency and transparency of EnergyFit information systems, the EnergyFit Homes Initiative may consider establishing a protocol for EnergyFit calculation models that covers basic assumptions of occupancy and equipment efficiencies, standard formats for model inputs and outputs (including for example web services standards for direct sharing of modelled results between systems), and standard formats for communicating the costs and benefits of the recommendation actions.

1 Introduction

This report is a deliverable under the EnergyFit Homes Project, and is a desktop review of national tools and systems relevant to benchmarking low carbon, EnergyFit homes.

This report reviews tools and systems for the communication of information relevant to benchmarking EnergyFit homes, including development processes, administration and governance structures, assessment methods, the types and presentation of disclosed information, availability and access costs and market acceptance (where available)

The report reviews systems to provide information on:

- the transparency of the current systems;
- the extent of collaboration (or overlapping effort) in current systems;
- the methods taken by current systems to communicate information to consumers;
- the balance of cost and complexity in current systems; and
- the effectiveness of current systems in driving change.

The report also sets out a number of issues to be considered during the next steps in the research.

1.1 The EnergyFit Homes Project

This paper is an interim deliverable for the EnergyFit Homes project. The project is being delivered by CSIRO and Common Capital under the CRC for Low Carbon Living, in conjunction with the project partners set out in Table 1.

Table 1 EnergyFit Homes Initiative partners

CSIRO	CSR	Energy Efficiency Council
NSW Office of Environment and Heritage	Knauf	Clean Energy Council
AGL	Fletcher Insulation	Energy Efficiency Creators Association
Stockland	LJ Hooker	Australian Windows Association

Almost nine in ten Australian households want to take action to reduce their household energy consumption. Despite this interest, most home buyers and lessees do not consider the carbon performance of their future home. The numerous devices and rating tools that have been developed to monitor and motivate buyers and lessees of low carbon homes do not resonate with the market.

In response, this project seeks to develop a pathway for enhancing the market for low carbon homes at sale and lease. The project will take a consumer-facing, end-user perspective to understand the most effective content, format, source and delivery of tools and other resources to engage the new and existing home buyer and lessee market. Using this information, the project will develop a framework for a best practice rating system to measure and communicate low carbon home performance at the point of sale and lease, and develop the business case and plan for implementing it.

To do this the project aims to answer five key questions about the information people need on about home energy performance, to enhance the market for energy fit homes at the points of sale and lease. These are: what information, in what form, at what time, in what source and what is required to make this happen.

The project has seven main research streams to answer these questions:

1. National and international literature review
2. Benchmarking of national and international information sources and tools
3. Consumer focus groups
4. A national consumer survey
5. A national tradesperson survey
6. Consumer message testing
7. Industry consultation

The findings of this research will then be analysed to develop findings and recommendations on:

- Options to provide better information to support low carbon home purchases and leases
- A business case and implementation pathway to achieve this

This report represents the first part of the second phase – benchmarking national information sources and tools.

The findings of this report will feed directly into the following research phases and overall project findings and recommendations.

1.1 Definitions

Terms used throughout this report include:

- EnergyFit – is generally used in this report to describe energy efficiency and the associated co-benefits of health, running cost and greenhouse gas savings.
- EnergyFit homes – homes that incorporate EnergyFit features. EnergyFit homes provide health, comfort and sustainability benefits and lower running costs.
- EnergyFit information system - a communications instrument that is used to enhance the market for EnergyFit homes, features or actions. The information systems reviewed in this report capture instruments such as rating tools, energy calculators, checklists, technical information portals, etc. The systems include both those that relate to the whole house, and those focused on one or more EnergyFit features.
- EnergyFit feature – a component of the house that is linked to an improved EnergyFit performance. These features are generally associated with reduced operational energy use, all things being equal. For example, ceiling insulation is an EnergyFit feature. It helps retain heat in cold weather and stay cool in warm weather, reducing the need for heating and cooling appliances that use energy.
- EnergyFit actions – behaviours that are linked to improved EnergyFit performance. These actions include both decisions to invest in EnergyFit features and decisions to change habits to make the house more EnergyFit. For example, switching off lights in unoccupied rooms is an EnergyFit action, as it will save home energy consumption.
- EnergyFit information – information provided by an EnergyFit information system to encourage EnergyFit actions

1.2 Report methodology

This report is based on a desktop review of Australian EnergyFit information systems. A range of currently available systems was included in the review, along with the repealed Sustainability Declaration system. This system was included as it represents one of very few Australian efforts focusing on conveying information at the point of sale and lease, and differs from those systems currently in place.

This desktop review is primarily based on information that is publicly available on each of the analysed systems. Some unpublished evaluation documents were reviewed where available to the project team. The review covered information on system ownership, governance, development, delivery, coverage, assessment methodology and process, the information disclosed, general look and feel and market perception. The appendix in section 9 includes the detailed analysis for each system.

To establish the credibility and usefulness of EnergyFit information systems, this report reviews the public data available for each system, and includes a technical assessment of the information conveyed by each system. Evaluation data on each system is reviewed where available to the project team to further inform the assessment of credibility and reliability.

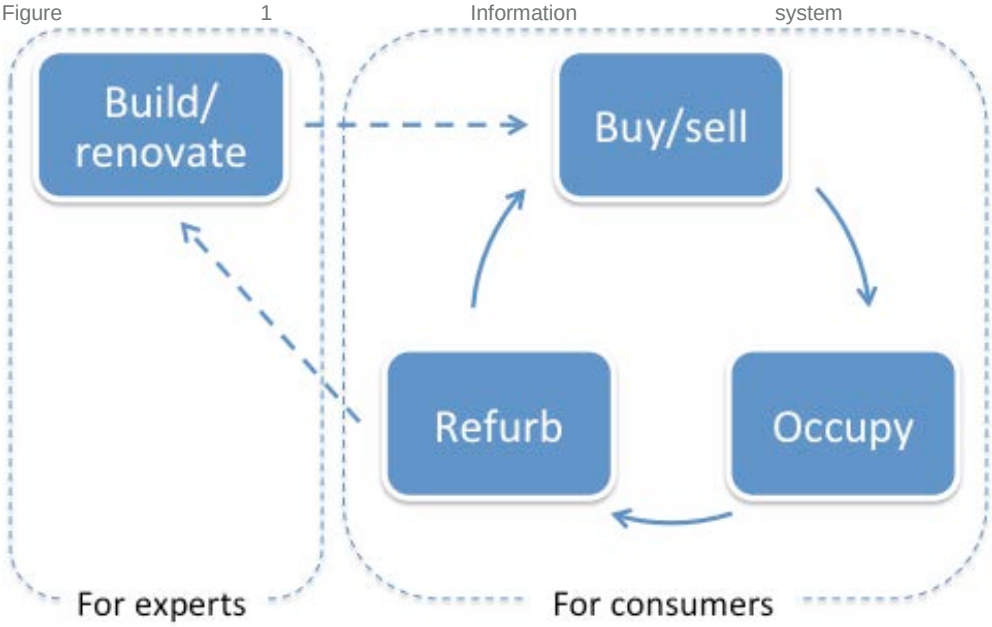
1.3 Report structure

This report is divided into sections that summarise findings on each aspect of EnergyFit information systems. Section 2 reviews the administration and governance structures of the various information systems to establish transparency and public access, and whether these governance structures enhance credibility. Section 3 considers the implications of the development processes and transparency of calculation methodologies on system credibility and effectiveness. Section 4 summarises at a high level the coverage and methodology of EnergyFit information systems as relevant to different stages in the building life cycle. Section 5 includes a technical review of the range of system calculations and a high level assessment of the variations between systems making similar assessments. Section 6 considers the type and presentation of information conveyed to system users and considers the relevance of this information at each stage in the building. Section 7 considers evaluations of the effectiveness and market acceptance of different systems, where evaluation documentation was published or available to the project team. Section 8 considers the implications of the findings in this report for the next steps in the EnergyFit project.

1.4 Australian information systems for EnergyFit homes

The Australian market features a broad range of information systems that seek to enhance the market for EnergyFit homes. To facilitate the analysis, systems have been grouped into four major phases that each focus on a different part of the building lifecycle and on different audiences, as depicted in Figure 1 below.

Figure 1 Information system phases



Build/renovate - information systems that target experts involved in the design and construction of buildings. These systems provide detailed calculations and advice on designing the building to be more EnergyFit.

Buy/sell - information systems for people choosing which house to buy/sell, and people seeking to inform potential buyers of the EnergyFit features in their house. These information systems aim to help purchasers identify the more EnergyFit home among the options they are considering. There are relatively few systems in this phase in Australia. This paper reviews three "Buy/sell" systems, including the Sustainability Declaration which was removed by the Queensland Government in 2012, and The 17 Things, launched in late 2013.

Occupy - information systems for people living in their home. These systems seek to help the occupant better understand their energy use, and options to become more EnergyFit through every day decisions such as behaviour and low cost equipment upgrades.

Refurb - information systems aimed at people planning significant improvements to their existing home. These systems help people identify opportunities to make their home more EnergyFit. The opportunities can be bundled up for a renovation, or installed piecemeal as refurbishments. These information systems cover a key decision point in the building life cycle that will lead into one of the other phases. A person engaging with systems in the refurb phase could move into the "build/renovate" stage if major renovations proceed, or the "buy/sell" stage if they decide to move to a new home rather than renovate. They could also decide to remain in the "occupy" phase in their current home.

Note that while the users of refurb phase systems are occupying their current home, these information systems differ from those in the occupy phase by focusing on higher cost options that are relevant during refurbishments or renovations, rather than the every day issues that are the primary focus of occupy systems.

This paper reviews 23 different systems, listed in Table 2. These systems are representative of the range of approaches that currently in place in Australia, and include both "whole-of-house" information and systems tailored to inform decisions on particular household elements. The list is not an exhaustive selection of every available system. Systems have been selected based on availability of information and to provide a broad view of the different ways EnergyFit information is conveyed in Australia.

Most of the reviewed systems are currently available with the exception of the Sustainability Declaration. This system has been repealed by the Queensland Government, and is included in the review as an example of a compulsory point of sale declaration.

Table 2 List of systems reviewed

Phase	Systems reviewed
Buy/sell	Sustainability Declaration
	Liveability Property Features and The 17 Things Checklist
	The ACT House Energy Rating Scheme (ACTHERS)
Occupy	National Australian Built Environment Rating System (NABERS) ratings
	NABERS Energy Explorer
	My AGL IQ
	Household Energy Use Calculator
	Low Carbon Lifestyles
	Ecologic
	Your Energy Savings (energy efficient living section)
Refurb	Smarter Renovations Planner
	Sustainability & Efficiency Evaluation of Dwellings (SEED)
	Energy Efficient Home Renovator
	Your Energy Savings (building and renovating section)
Build/renovate	Nationwide House Energy Rating Scheme (NatHERS) accredited software
	Building Sustainability Index (BASIX)
	eTool
	Energy Efficient Home Design
	Energy Efficient Home Designer
	Window Comparison Tool
	Green Star Multi Unit
	Your Home Technical Manual
	HIA GreenSmart Home

This paper does not analyse the recently announced My Star Energy Rating initiative of the Victorian Government, as it has not yet been released for public use. It is expected to be available in early 2015. The My Star Energy Rating will "allow households to investigate options to reduce their energy bill. Rated houses can be compared with each other, or compared before and after a renovation."2

[2] http://switchon.vic.gov.au/bills-pricing-and-meters/community-education-programs

2 Administration and governance structures

Government, businesses and not-for-profit organisations are all involved in governing and administering information systems for EnergyFit homes in Australia. This section summarises the development of these structures over time and, in particular, the influence of government policies across all phases. The appendix at section 9 contains a detailed table showing the ownership of all systems. A clear pattern emerges from the activity of these different organisations, with each focusing on different phases as summarised in Table 3.

Table 3 Typical information system administration structure by phase

Phase	Ownership	Demand drivers
Buy/sell	Mostly government	Mostly mandatory
Occupy	Mostly business	Voluntary
Refurb	Mix government / business	Voluntary
Build/renovate	Mostly government / not for profit	Mostly mandatory / some voluntary (beyond compliance)

2.1 Ownership of build/renovate phase systems

In the build/renovate phase, EnergyFit information systems are dominated by regulated systems managed by government, and not-for-profit systems that seek to establish standards to recognise EnergyFit activities that exceed regulatory requirements.

To date, the majority of government effort for EnergyFit home information systems is focused on the build/renovate phase, targeted at experts involved in home design and construction. This reflects regulatory efforts for the household sector. Minimum standards for house construction have been in place across Australia since the inclusion of energy efficiency provisions in the Building Code of Australia in 2003. Government has developed a number of information systems that support these provisions. The NatHERS suite of software packages is used to demonstrate code compliance. The detailed Your Home technical manuals support experts and informed householders seeking to build a compliant home by educating them on the energy efficiency considerations of building design elements. The NSW Government has developed the BASIX information system as an alternative to the national standard.

A number of not-for-profit organisations have developed systems that build on this significant government effort. For example, the HIA GreenSmart Home system uses information from NatHERS and the Your Home Technical Manual to establish an industry standard for “green” home design that exceeds the minimum regulatory requirements. The Australian Windows Association window comparison tool simplifies the process of choosing window systems to support improved NatHERS ratings and building code compliance. The Green Building Council of Australia’s Green Star rating uses the NatHERS system to measure the energy efficiency of the rated building, awarding points to buildings that significantly exceed minimum regulatory standards.

Combined, the government and not-for-profit information systems in this phase allows building designers to calculate the EnergyFit performance of the building, sets minimum expectations of this performance, and recognises performance that exceeds this minimum. Given this extensive effort from the government and not-for-profit sector, it is not surprising that there are relatively few information systems managed by individual businesses in the build/renovate phase. The privately developed eTool system is an exception. eTool takes a different approach to the measurement of EnergyFit homes by calculating building lifecycle energy costs, including the energy used in materials and construction. This energy cost is not considered by the other information systems, leaving space for innovation by private organisations such as eTool.

The significant government investment in information systems for the build/renovate phase may limit innovation in other areas, particularly for government created systems. Governments have created a standard in the NatHERS system for communicating the energy efficiency of homes during the build/renovate phase. The effort invested in this area means that they are not likely to develop or encourage information systems that are seen to undermine this standard. However, the NatHERS system as implemented may not be suited to information systems outside the build/renovate phase.

NatHERS is a sophisticated model of the energy transfers through the building fabric of a house. To ensure consistency of ratings for compliance purposes, NatHERS calculators do not allow users to vary important factors from regulated settings. These factors strongly influence the likely energy consumption of the home in operation,

including the occupancy of the building and the level of comfort expected by occupants. Enforcing the regulatory settings for all NatHERS calculations limits its relevance in information systems outside building compliance.

Government information systems for other phases, such as ACTHERS, seek to directly apply this information using the regulatory settings. This may lead to some confusion over the link between the NatHERS rating of an occupied home and expected energy costs. This issue is explored in greater detail in section 6.3.

2.2 Ownership of buy/sell phase systems

Government activity has strongly influenced the development of information systems in the buy/sell phase, particularly through proposed and enacted systems for the mandatory disclosure of EnergyFit information at the point of sale.

In the ACT, anyone offering a house that has been occupied for sale since 1999 must use ACTHERS. Under this system, all advertisements carry the energy rating of the building (calculated using a particular version of NatHERS accredited software), and the contract for sale includes an "EER Statement" which details the energy rating and a list of renovation opportunities that would improve the rating.

Following the successful introduction of ACTHERS, governments across Australia have considered implementing similar mandatory disclosure systems. In 2004 the Ministerial Council on Energy, comprising energy ministers from the Australian government and all states and territories, committed to introduce a national mandatory disclosure regime as part of the National Framework for Energy Efficiency3. The commitment was reiterated by ministers as part of the second phase of the national framework in 20074, and in 2009 by the Council of Australian Governments as part of the National Strategy on Energy Efficiency5.

In 2010 the Queensland Government introduced the Sustainability Declaration in advance of any national mandatory disclosure system. Under this system, a completed sustainability declaration was to be made available to potential buyers of any home offered for sale. The system was repealed in 2012, and the Queensland Government withdrew their support for a national disclosure system shortly thereafter6.

The pending introduction of a mandatory national information system has constrained activity by non-government actors in creating information systems for this sector. However, a lack of progress towards the promised government system has created space for innovative market solutions. In 2013 LJ Hooker launched the Liveability Property Features information system, which promotes EnergyFit features of homes to potential purchasers. The system is designed to incorporate any future government disclosure system.

In the absence of a national government information system for the buy/sell phase, the LJ Hooker system may become a standard for promoting EnergyFit features to home buyers. One barrier to the broad adoption of the Liveability Property Features system is the current ownership structure. Other stakeholders will likely need to be involved in the governance of the scheme if it is extended outside the LJ Hooker network. Alternatively, competitors may respond to any success by the Liveability Property Features by developing competing information systems for their own brands.

2.3 Ownership of occupy phase systems

The majority of private sector developed EnergyFit information systems relate to the occupy phase. Two factors support stronger business involvement in this sector – a reducing level of direct government involvement, and the prevalence of large businesses (energy retailers) with a strong existing and ongoing customer relationship with house occupants (as energy consumers).

Between 2007 and 2012, governments invested in a range of information systems that seek to better inform householders of the factors that contribute to their energy costs. Many of these systems were developed to support direct assistance programs such as grants and loan programs delivered at national and state level.

---

[3] Ministerial Council on Energy, *Statement on National Framework for Energy Efficiency - Overview Plan of Stage One Measures 2005 – 2007*, December 2004

[4] Ministerial Council on Energy, *Communique*, Perth 13 December 2007

[5] Council of Australian Governments (COAG),*National Strategy on Energy Efficiency*, July 2009

[6] Building Codes Queensland, *Building and Plumbing Newsflash 506*, October 2012

In recent years the level of government investment in energy efficiency programs for households has reduced. While there remains a significant number of government information systems focused on the occupy phase, many have been discontinued, and those that remain are no longer supported by large budgets for in-home assessments or subsidised energy saving equipment, but focus on self-assessment using online portals.

An increase in the number and availability of private sector information systems has accompanied this reduction in government effort. Energy retailers have been particularly active in generating new approaches for engagement with their direct customers. A number of independent app developers have also recently developed new approaches. These efforts suggest that the retreat of direct government involvement has left space for innovation, and has perhaps freed the market from complying with the previous standard implemented by government systems on the type and presentation of information for the "occupy" stage.

2.4 Ownership of refurb phase systems

These information systems focus on people thinking about more costly opportunities to refurbish or renovate their home. The government and the private sector provide complementary information systems for the refurb phase.

Most of the information systems in this phase rely on the Australian Government's Your Home Technical Manual, which contains detailed technical considerations of all the design options that may be considered when building a house. Systems in the refurb phase are primarily customised front end systems that provide concise, user friendly and tailored summaries of the Your Home data for people interested in renovations, and direct people to that system if they desire more detailed information.

2.5 Overview and implications of governance structures

Consumers are more likely to be influenced by information provided to them if they trust the appropriateness and accuracy of that advice for their situation. They may dismiss information from an untrusted source. For example, a potential homebuyer may disregard information if they do not trust the way it was determined or how it was provided to them.

The administrators and delivery agents for different EnergyFit information systems must actively build trust among their target audience if their systems are to be effective.

Building trust in information systems can be achieved in a number of ways:

Transparent and accountable governance, administration and methodologies

Objective verification of the accuracy of advice

Robust quality assurance regimes to support the provided information

Endorsement of the system by trusted organisations with appropriate technical credentials, such as government, academic institutions or research organisations

Avoiding inconsistent advice between systems, which may undermine trust in them all

The table in section 9.1 of the appendices details the governance arrangements for the reviewed systems. A number of important themes may be seen across the reviewed systems that likely undermine consumer trust and the credibility of the information provided to users.

Isolated system owners and limited external accountability

Section 9.1 also shows that the developers of the reviewed systems are relatively isolated. There are few developers involved in more than one system. Sustainability Victoria manages FirstRate, an accredited NatHERS calculator that underpins the ACTHERS system, as well as the Smarter Renovations Planner. The NSW Government manages NABERS and BASIX systems, although the administrators sit in different administrative branches which will hinder collaboration. The Australian Government manages Your Home, Your Energy Savings and NatHERS.

Only three of the reviewed systems use governance committees that include external oversight – the NABERS rating, NatHERS and Green Star. Aside from these systems, EnergyFit information systems are independently governed, with owners and developers accountable only to internal structures.

The limited external accountability of system administrators and independent administration of different systems does not facilitate collaboration between the various system developers and administrators. This closed approach to system administration carries through into system development and methodologies, as described in section 3.

Lack of quality assurance

Section 9.2 details the quality assurance systems in place for each system. This analysis shows that the only systems with a published quality assurance regime in place are those that provide information to a third party. These

systems - NatHERS, Green Star, ACTHERS, 17 Things and BASIX – are delivered by trained and accredited experts. They are used either to prove compliance with regulatory standards, or to promote information about the building at the point of sale.

While these systems have quality assurance in place, the rigour of this quality assurance is largely untested. None of the systems publish audit results or compliance rates ascertained in the course of the quality assurance tests. BASIX and NatHERS have been subject to limited evaluations into assessment quality and reliability, which are reviewed in section 7.6. The findings for NatHERS in particular suggest that the quality assurance regimes are not effective.

This lack of quality assurance further reinforces the closed nature of information system governance and the lack of transparency that would support improved consumer confidence.

3 Development of EnergyFit information systems

3.1 Closed system development

As shown in Table 4, most EnergyFit information systems are developed in isolation by the in-house resources of the owner of that particular system. Several developers have engaged the support or guidance of experts. Some systems do not disclose the approach taken to develop their system.

Table 4 Development methods

Phase	Developer	Method
Buy/sell	Primarily system owner	In house, some with external expert support
Occupy	System owner	In house or undisclosed
Refurb	System owner	Not disclosed
Build/renovate	Primarily system owner	In house, some with external expert advisors

There are only two reviewed systems in which the developer is not also the system administrator – the NatHERS calculation engine is developed by CSIRO, but the overall scheme is jointly administered by governments, and the ACTHERS system administered by the ACT Government is based upon a calculator developed by Sustainability Victoria. More detail on the administration and development of EnergyFit information systems is contained in the appendices at section 9.1.

With these few exceptions, each EnergyFit information system is owned, developed and administered by the one party. The only external involvement for most systems occurs when developers seek expert advice and input to their system. With such closed systems in place, there is little room for collaboration between developers or opportunity for critical review.

3.2 Protected methodologies

As noted above, many developers have not disclosed their development processes. The transparency of the actual methodologies implemented within each information system is even more limited.

Developing an EnergyFit information system is costly, and requires a significant effort and technical expertise. For example, the owners of eTool note that development is a "rather expensive exercise, costing well into the hundred of thousands of dollars"7. In 2009-10 the Australian Government set aside $8.7 million over four years towards "improving residential building energy efficiency standards and assessment and ratings approaches". This gives an indication of the administrative budget for the NatHERS system and ongoing development costs. In the same budget the Government committed a further $7.8 million to "develop and phase-in a new framework for the disclosure of energy performance information at the time of sale or lease"8, showing the significant cost of developing a new buy/sell phase information system.

These high costs may be a barrier to collaborative approaches between system developers who seek to recover costs from the delivery of the information system either directly or through brand or reputational benefits.

With very few exceptions, the assumptions, calculations and research underpinning Australian EnergyFit information systems are closely protected. These systems are black boxes and are not open to external scrutiny. The Climateworks developed Low Carbon Lifestyles system is the only one reviewed that has published a methodology showing how the information system was derived. None of the government or private sector developed systems has made the methodology underpinning calculations publicly available. The Green Star Multi Unit system comes closest to full transparency, with extensive documentation on the assumptions within their system. However the research and analysis supporting many of these assumptions is not published.

[7] eTool, *Software Development*, http://etoolglobal.com/software/

[8] Australian Government 2009, "National Strategy on Energy Efficiency", *Environment Budget Overview 2009-10*, p16

3.3 Implications of protected information

The secrecy over system development and methodology has a number of implications for the further development and implementation of EnergyFit information systems. In particular, the lack of system transparency leads to inefficiencies, with developers having to repeat work rather than building on that of others. It limits accountability, as systems are not open to review or constructive criticism. It also limits the applicability of systems beyond their immediate use.

This report shows that there is a good consistency in the coverage and methodology utilised by EnergyFit information systems (see section 4.2), and the potential for greater collaboration from shared calculation models (see section 5.3.2). Under the current closed system, each of these models have been built by different developers without reference to other systems, rather than building on work that has already been done. The NatHERS system is used to some extent by other systems (such as BASIX) but as presented it has limited application in models to predict likely energy consumption.

The protection of EnergyFit information systems severely inhibits accountability and external review. The fact that most developers also own and administer the system makes this lack of transparency of particular concern. Under these arrangements, the developer/owner/administrator of any particular system has a significant conflict of interest when it comes to disclosing shortcomings or concerns over the veracity of their system. Limited access to external review makes innovation less likely.

The protection of these systems also makes it less likely that the information provided by the systems is picked up and used in other contexts. System owners do not develop their systems in a way that could be built on by third parties – for example, by implementing web services allowing other apps and systems direct access to system calculations. This misses out on potential value add from an ecosystem of systems with a common basis, driven by a range of innovative developers able to focus on adapting the information to their intended user rather than recreating the calculations themselves. For example, apps built on the recommended actions from occupy or refurb phase systems could link directly to the energy efficiency products and services market, making it easy for a user to move directly from information to action within the one system.

The only systems that currently provide such a direct link are those in which the developer has internal capacity to deliver these systems (such as energy retailers), or has a direct agreements with suppliers (for example, the SEED system). Users may be hesitant to utilise these direct links when they come directly from the supplier themselves, and will perhaps be more sceptical about the recommendations of the system, seeing it as a sales pitch rather than credible and impartial information.

4 Methodology of EnergyFit information systems

The methodology used by the various EnergyFit information systems varies from calculators to tailor information to the particular user to generic information on the range of EnergyFit actions relevant to the targeted audience and stage in the building life cycle. Sections 9.2 to 9.5 in the appendix contain a detailed analysis of the methodology and delivery methods for all assessed systems. This section summarises the analysis for each phase.

4.1 Complexity

EnergyFit information systems increase in complexity as the focus shifts from consumer to expert, and the purpose shifts from inspiring consumer action to compliance.

Table 5 Complexity of EnergyFit information systems.

Phase	Users	Complexity	Range of costs[9]	Outputs
Occupy	Consumers	Low to moderate. Using general knowledge of home	$3-$21	Low cost actions
Refurb	Consumers	Low to moderate. Require some knowledge of main building elements.	$3-$358	Higher cost actions
Buy/sell	Experts	Moderate. Requires visual inspection and understanding of major energy using systems	$85-$360	Differentiate EnergyFit home. Higher cost actions.
Build/renovate	Experts	High. Requires knowledge of building materials and simulation expertise.	$400-$2400	Check against minimum standards

The costs shown are estimates only, and are presented to demonstrate the level of complexity and expertise required in each phase. For more detail on the cost and complexity of each individual system, see the appendix at section 9.5.

As shown in Table 6, systems in the occupy phase are the least complex. These systems are targeted at people as they occupy their home and aim for changing simple behaviours. Using these systems requires only a general knowledge of the energy using systems around the home. No expert knowledge is needed to interact with these systems. Some of the more complex systems in this phase have an option to add more detail and modify default assumptions if the user has a greater level of expertise.

Refurb phase systems are also aimed at non-experts, but are slightly more complex than the occupy phase systems, requiring some knowledge of building elements such as insulation and shading. The information presented on these elements is generic and aims at educating building owners on EnergyFit elements that should be considered during a renovation, and directs them to other sources if they desire more detailed information or wish to take action.

The information presented in Buy/sell phase systems is consumer focused, aimed at potential home buyers. Unlike occupy or refurb phase systems, this information is determined by one party (the home owner or their agent) and conveyed to another (the home buyer). The influence of this information depends upon the credibility of these systems, so they have implemented more robust and complex methodologies than other consumer focused systems. The information contained in buy/sell phase systems for a home is determined by an expert, and follows a more robust standard for compliance.

The build/renovate phase systems are aimed at building designers. They use highly detailed calculators that require significant expertise in building design, the different energy using systems within a house and interactions between them, and energy modelling. Like buy/sell phase systems, information in the build/renovate phase is determined

[9] estimated total cost range based on assumed time taken by consumers and experts and published quotes where available. For methodology see detailed appendix tables at Section 10

by an expert and conveyed to another party, in this case the appropriate building approval body. These systems are highly complex and customised to provide accurate and robust information about the building.

4.2 Coverage and method

Most existing information systems for EnergyFit homes cover as much of the energy use of the home as possible. This coverage depends upon the stage of the building lifecycle being assessed, as shown by Table 6.

Table 6 Coverage of current EnergyFit information systems

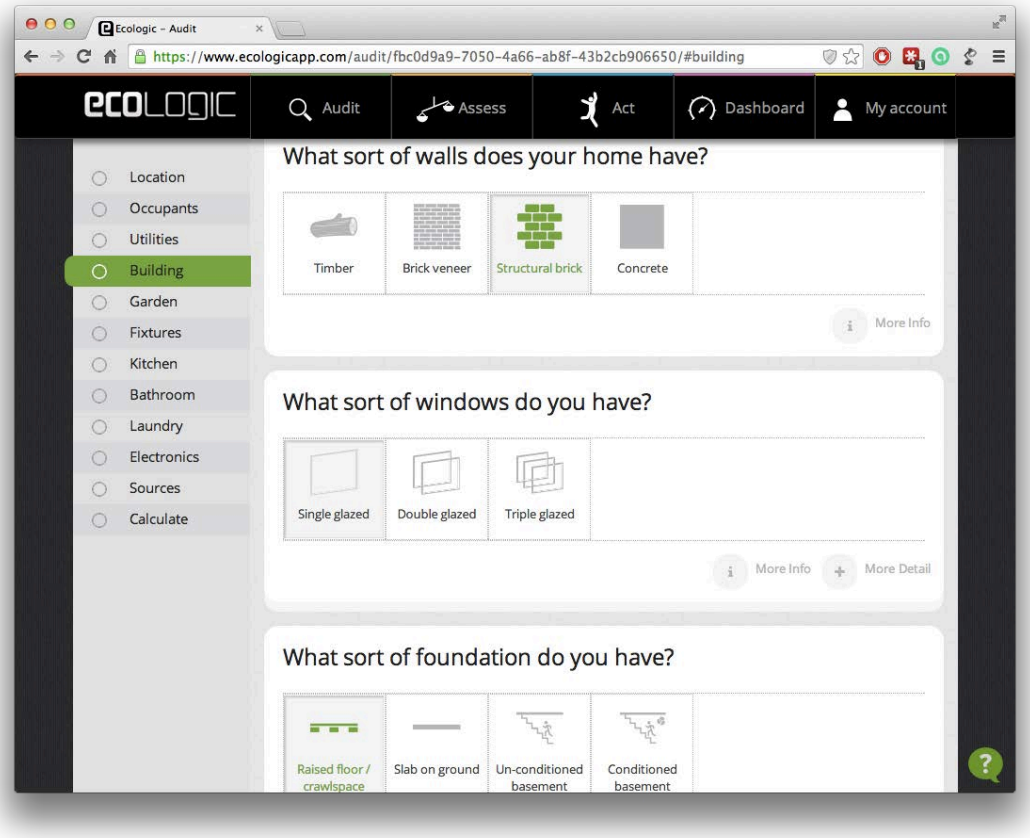
Phase	Coverage	Method	Outputs
Occupy	Whole-house energy consumption	Online calculator using appliance energy and user behaviours	Advice on behaviour and low cost savings options
Refurb	Specific actions on fabric and major appliances	Tailored checklists	Implement missing opportunities
Buy/sell	Similar to renovation	Tailored checklists or detailed simulation	Differentiate EnergyFit homes, implement missing opportunities
Build/renovate	Heating and cooling loads, major appliances	Detailed simulations	Mainly compliance

4.2.1 Occupy systems coverage and method

Occupy phase systems are used by the householder, and relate to all the energy used in the building. The information is customised to that household using an online calculator that can be completed using simple information on building materials and the type and use of equipment installed in the home.

These systems are designed for ease of use. The following diagrams demonstrate how a user engages with a typical occupy phase system to determine the heating and cooling energy use of the home. The householder inserts basic information about the building fabric of their home as shown in Figure 2.

Figure 2 Occupy system input - home fabric[10]

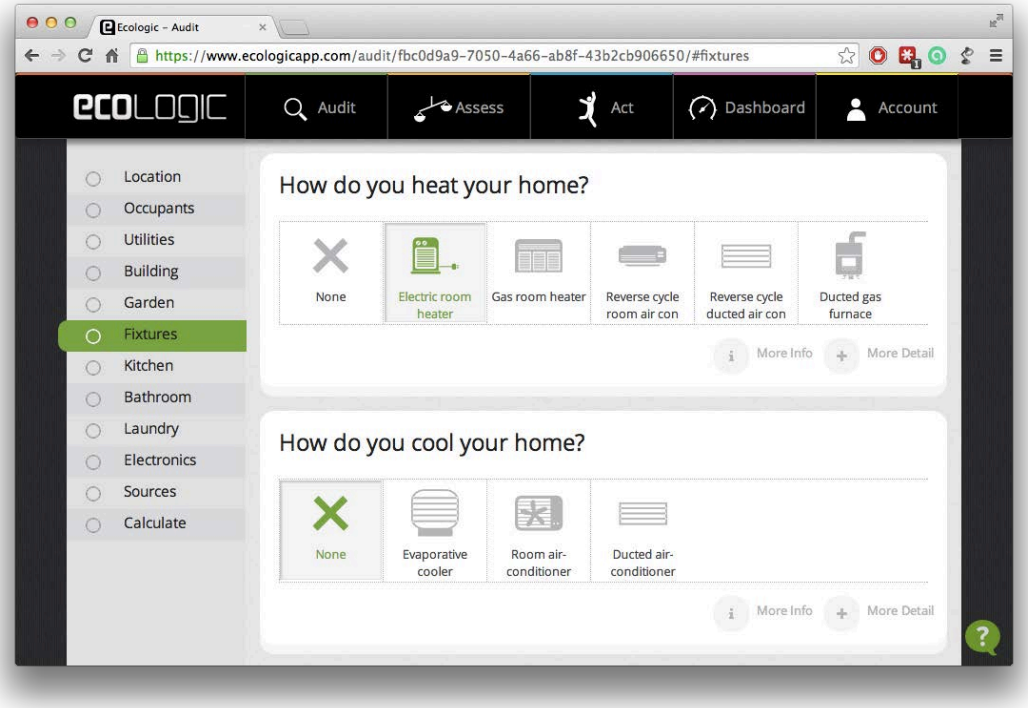


The details included in this step vary between systems. Most systems ask the user to identify whether the home has ceiling insulation and the type of windows installed in the home. The more complex of the occupy phase systems, such as the Ecologic system shown in Figure 2, also include information on wall and floor construction, and air tightness of the building. The defaults for each data point can be modified using the "more detail" setting. For example, "more detail" for window entry allows the user to choose the shading systems they have installed on windows, and Regardless of the extent of the questions asked, the level of detail required to complete the calculation is low for all systems, with generic inputs for each phase. The systems use this information to estimate the thermal efficiency of the home.

The NABERS Energy Explorer system takes an alternative approach, using a subjective measure of thermal comfort. Rather than estimate thermal efficiency using building fabric information, this system asks the user to estimate "how well does your home stay warm in winter", and a sliding scale from 0 representing "very cold, uncomfortable" to 12 "retains warmth very well".

[10] www.ecologicapp.com

Figure 3 Heating system input for occupy phase system[11]



To determine the estimated heating and cooling costs for the building, occupy phase systems also require the user to nominate the sort of heaters and cooling systems installed in their home. Figure 3 shows a typical entry page for household heating and cooling systems.

As in the previous step, different systems require different levels of detail. The Ecologic app shown asks the user to nominate the types of systems they have installed, which is typical of all systems in this phase. The NABERS Energy Explorer system and Ergon Home Energy Use Calculator also ask for details of how often each heating and cooling system is used.

The calculation methodology used by these systems is generally not published in detail. Each of the systems models the energy use of the home based on the user inputs and some assumed information on appliance energy consumption and the thermal efficiency of the home. Where calculations are referenced at all, most systems reference NatHERS for heating and cooling calculations, although Ecologic uses the EnergyPlus software developed by the US Department of Energy.

4.2.2 Occupy system comparative methods

While most occupy systems use a calculator to customise a list of opportunities to reduce energy consumption as described above, three reviewed systems, the NABERS rating system, My AGL IQ and Ecologic, also provide information on the energy use of the house compared to similar buildings.

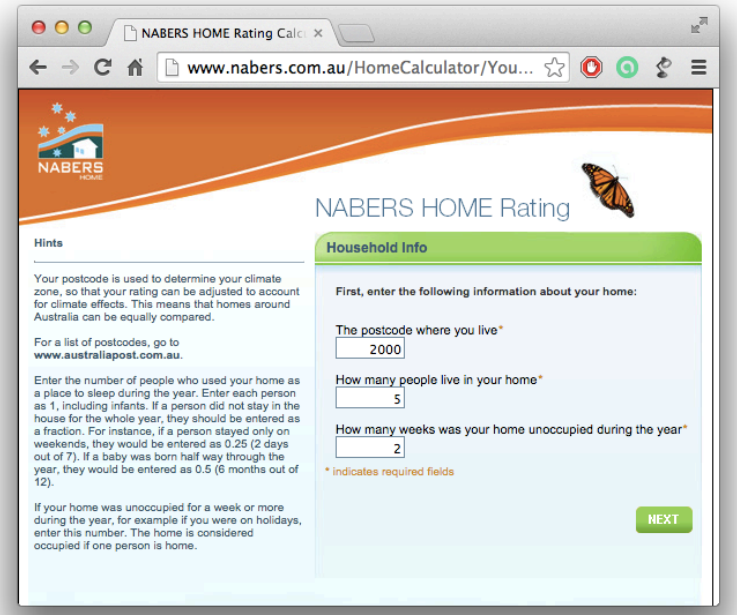
These systems seek to help the household understand whether they use more or less energy than their peers. The My AGL IQ system uses actual energy bill information directly sourced from the AGL systems, so is able to provide this comparative data without input from the householder. The energy consumption of the house is compared to “similar homes” which are defined by AGL as “homes of AGL customers which, based on data we have collected from various sources and our statistical modelling, we deem to have similar usage characteristics to yours.”12

[11] www.ecologicapp.com

[12] https://www.agl.com.au/aeo/iq/BenchMark/index?period=CurrentPeriod&filter=Usage

The NABERS rating system also relies upon billed energy use, although as it is a standalone system the user must gather and enter billing data directly. The user must also enter basic demographic data about the building including the number of building occupants and the postcode for the building.

Table 7 NABERS rating data entry



Based on these few data points, the NABERS rating system provides a comparative efficiency of the house on a one to five star scale. The rating represents the actual per person carbon emissions of the home against similar buildings in the same location, taking into account climate and energy sources. The calculations are based on a statistical analysis of actual per person energy use data from NSW and Victorian homes.

Both of these systems provide information with very limited active data entry from the user.

The Ecologic system provides comparative information based on modelled energy consumption rather than actual. All the information required to generate this comparative information is gathered from the user as part of the overall calculator entry described in section 4.2.1. Ecologic makes comparison to a "typical" home that has "building features and appliances that are typical to your local area", and an "efficient" home, which has an "affordable suite of energy savings measures installed". Both comparison houses have "the same building geometry, occupants and climate as your property"13. The assumptions and method for modelling these comparison homes is not published.

4.2.3 Refurb and buy/sell systems coverage

Information systems in the refurb and buy/sell phases have a very similar coverage. These systems focus on the efficiency of building elements irrespective of behaviour or use. In general, these systems provide information on building construction (including insulation, windows, shading, roof systems, ventilation and building materials), fixed heating and cooling systems, hot water systems, solar power and lighting.

This coverage matches the major opportunities to improve the inherent energy efficiency of the house. This information is useful for people considering a renovation by helping them understand where to focus efforts while renovating to reduce their future energy bills. People considering buying a home use this information to identify homes with more EnergyFit features, which will be cheaper to run and require less heating and cooling than homes

[13] www.ecologicapp.com "Your audit results"

without these features. In both cases, the opportunities relate to the building itself rather than how the building will be used.

Table 8 shows the consistency in coverage across information systems.

Table 8 Coverage of refurb and buy/sell phase systems

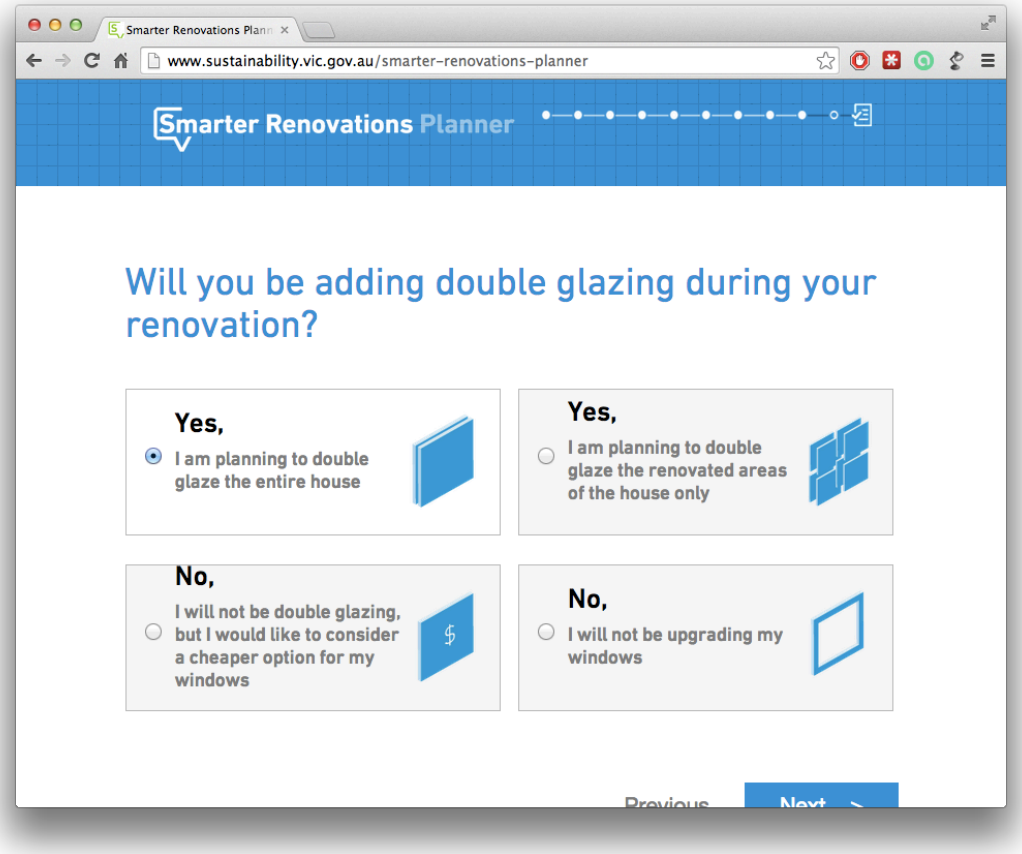
Action	The 17 Things	Sust. Dec'n	ACT-HERS	Smarter Reno's	SEED	Energy Eff. Home Reno.	Your Energy Savings
Insulation	Y	Y	Y	Y	Y	Y	Y
Windows	Y	Y	Y	Y	Y	Y	Y
Solar PV	Y	Y		Y	Y	Y	
Heating and cooling	Y	Y		Y	Y	Y	Y
Solar HW	Y	Y		Y	Y		Y
Lights	Y	Y		Y	Y		Y
Shading	Y	Y	Y			Y	Y
Orientation	Y		Y			Y	
Zoning	Y		Y			Y	
Roof colour	Y	Y	Y				
Roof ventilation	Y	Y	Y				
Fans	Y	Y	Y				
Draught proofing	Y			Y	Y		Y
Building material	Y		Y				

4.2.4 Refurb systems method

Refurb and buy/sell phase systems also primarily use a similar method for users. Both mostly use checklists that list EnergyFit features for a house. The user (either the householder for most refurb systems, or expert for buy/sell systems) checks off which of these features are present in the house during a walkthrough inspection.

The criteria for completing the checklist varies between refurb and buy/sell systems. Refurb systems are designed for internal, non-expert use, and the systems provide only generic guidance on how to identify the EnergyFit features currently installed in the home. The snapshot below from the Smarter Renovations Planner (Figure 4) demonstrates that these systems emphasise the EnergyFit options for each home feature (in this case, efficient windows) rather than what the home currently has in place.

Figure 4 Identifying EnergyFit features in a refurb information system[14]



Unlike other refurb information systems, SEED is assessed by an expert through an in home visit. The expert walks through the property with the occupant, and identifies and discusses opportunities to improve. The expert provides a report which contains information on all the identified opportunities, and may be readily adapted to a renovation checklist. Energymakeovers do not publish the specific methodology used during the assessment.

Buy/sell systems tend to employ a stricter approach to completing the checklist for a property. The expert completing the checklist must demonstrate that the selected EnergyFit feature meets specified standards to ensure that the information conveyed to potential buyers is accurate and credible.

The rigour of information included in the buy/sell phase systems is varied. The Sustainability Declaration, which was a mandatory inclusion with sale documents in Queensland between 2010 and 2012, had a low threshold. Figure 5 shows that users could complete the checklist based on the presence of EnergyFit features such as insulation or a light coloured roof, without meeting any particular minimum standard.

[14] http://www.sustainability.vic.gov.au/smarter-renovations-planner

Figure 5 Extract from the Sustainability declaration reference guide[15]

E5—Insulation

If you only have insulation installed in part of your home, tick the 'partial' box and state where it is located e.g. kitchen extension.

Roof/ceiling—if you can access your roof space, look for any insulation such as bulk fibres like wool, glass wool and insulation batts or reflective foil sheets on the ceiling or under the inside of the roof. Reflective foil looks similar to aluminium foil but is thicker and may be in single or multiple layers.

Walls—you may be able to see insulation in the wall cavities from inside the roof. It may look similar to that used in the ceiling.

Floors—this type of insulation is not commonly used in warmer parts of Queensland. However if your house has a suspended floor and is not enclosed underneath, you could look under the house for insulation such as bulk insulation or a combined bulk and foil product. If your floor is enclosed you could check

E6—Pale or light coloured roofs

Light colours like white, cream, light grey, beige and dull galvanised steel reflect the sun's rays and help reduce the heat entering your home.

E7—Roof ventilation

Check around your eaves and your rooftop to see if there is any visible roof ventilation, e.g. a whirlybird, eave vents.

Whirlybirds are a good example of roof ventilation

Conversely, the 17 Things checklist sets a high threshold for entry of information in the checklist. Experts completing a 17 Things assessment use a robust set of criteria that establish minimum standards for each of the items on the checklist, and, where compliance with these standards is not easily proven during a walkthrough inspection, proof that the standards have been met such as receipts from an accredited installer.16

The ACTHERS system also places a high threshold for information. Users completing this assessment require detailed design documentation and a full NatHERS assessment of the house. The assessment requires detailed knowledge of the construction materials and building elements used in the house to generate a NatHERS rating and list of upgrade opportunities.

[15] QLD Government 2011, Sustainability Declaration Reference Guide v5

[16] LJ Hooker 2014, Liveability Real Estate Specialist Handbook (not public)

Figure 6 Using the FirstRate 4 calculator for ACTHERS ratings[17]

Using FirstRate 4.0

To take advantage of these details, Sustainability Victoria have released Version 4.06 update for FirstRate 4.0 – available at:

http://www.sustainability.vic.gov.au/www/html/1795-firstrate-software-updates.asp

This update adds a new sub-floor ventilation type "Enclosed-Disconnected".

This sub-floor ventilation type may be selected if:

- the subfloor is 'enclosed'
- the only ventilation openings are those required for compliance with building codes
- any wall cavity that connects the subfloor to the roofspace or outside air is continuously blocked around its perimeter (eg by flashing)

n FirstRate 4.0, the wall cavity disconnection details can be activated when entering loor details by selecting **'Enclosed-Disconnected'** in the drop down menu under the Sub Floor Vent' entry detail box – refer below.

Figure 6 shows a typical data entry screen for an ACTHERS house assessment. Similar detailed information is required for all other building elements.

4.2.5 Build/renovate systems coverage and method

The coverage of build/renovate systems is similar to that of refurb and buy/sell systems. Build/renovate systems focus on the heating and cooling efficiency of the building, and the efficiency of major fixed appliances.

Information systems in the build/renovate phase use detailed calculators, and require significant design knowledge and expertise to complete. Figure 7 shows the complex data entry required for one element of the BASIX system. To complete the Green Star Multi Unit calculator, depicted in Figure 8, the user performs detailed calculations, usually involving a dynamic energy simulation, to estimate energy consumption and show that the building exceeds minimum energy efficiency standards.

[17] http://vic.hia.com.au/documents/vic%20-%20080625/FirstRate%204%20patch%20for%20timber%20floors.pdf

Figure 7 Example of detailed building element coverage (BASIX calculations)

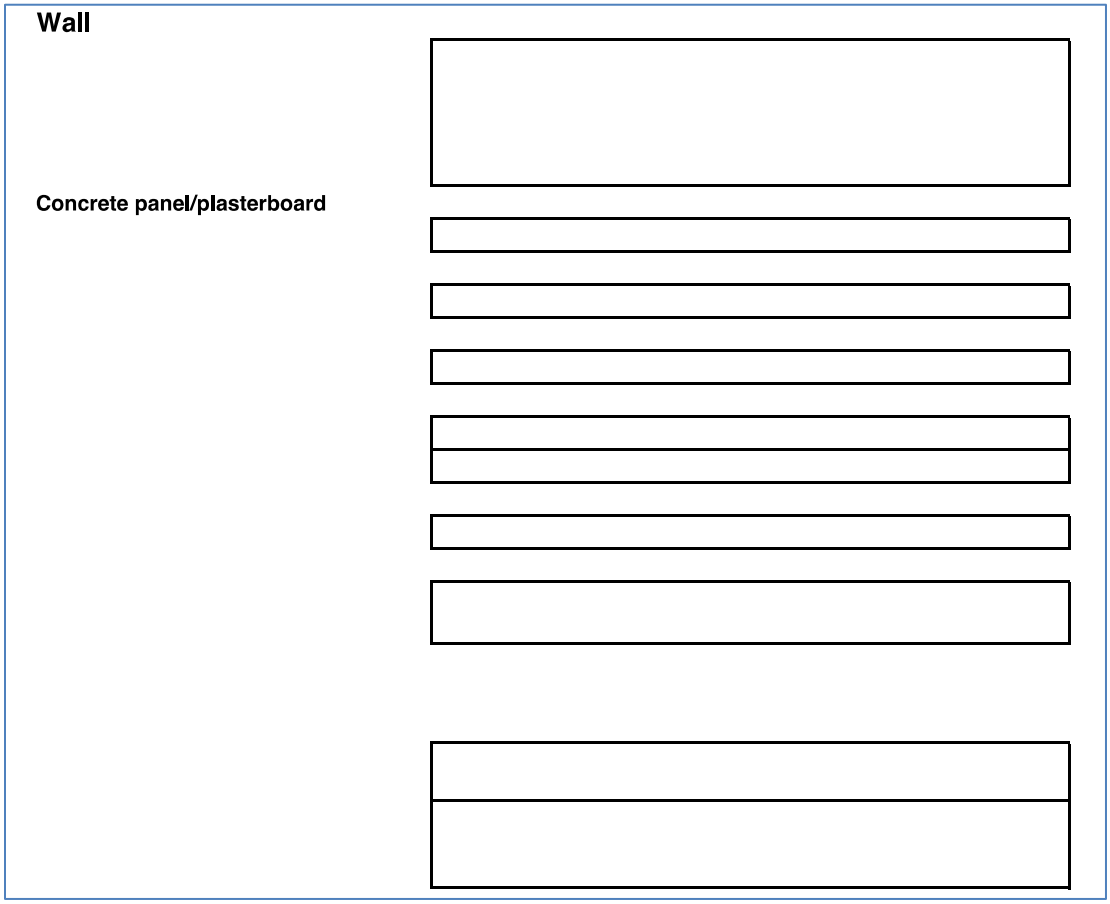
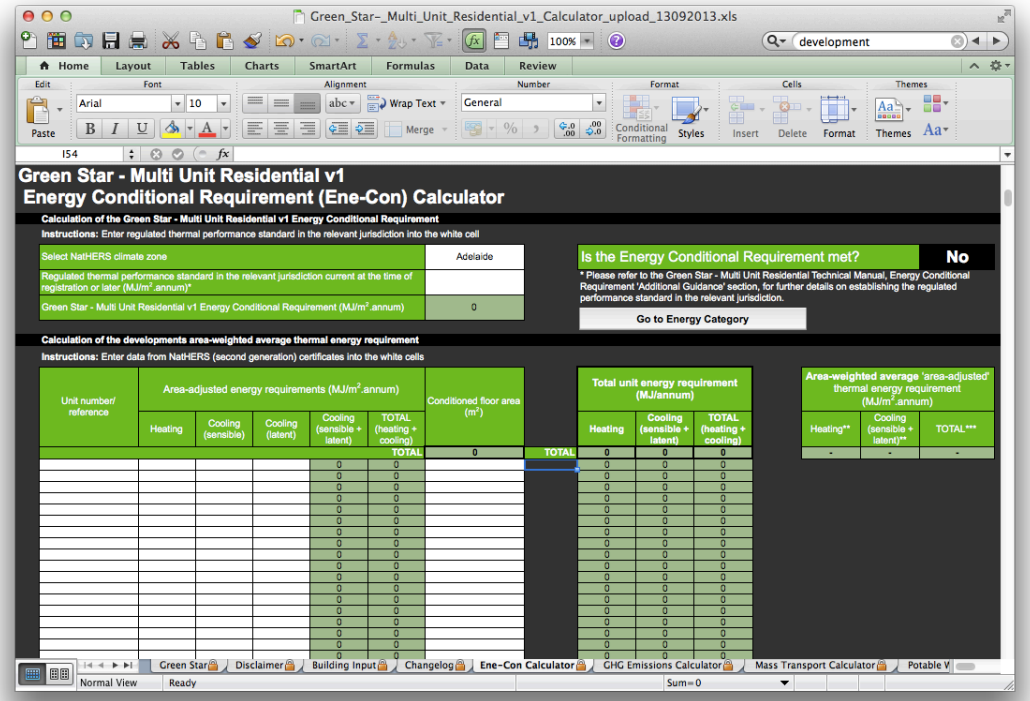


Figure 8 Green Star Multi Unit energy calculator



The complexity of these systems is facilitated by the availability of detailed information about the building during design and construction, and the high cost of building construction allowing for engagement of experts to perform these calculations. These factors, particularly the availability of building information, are not generally available at any other point in the lifecycle of the building. To perform a NatHERS assessment on an existing building, for example, the user will normally need to determine the building materials used throughout the house and create detailed floor plans during a walkthrough assessment.

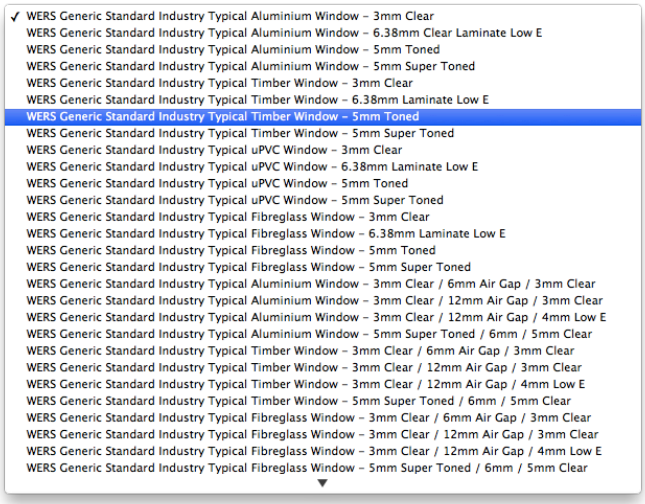
It would be very difficult for most house occupants to make sense of these systems, or to engage at the required level in the design options for a more EnergyFit home. At best, experts will use these systems to test EnergyFit features that they have discussed in concept with their client – for example, the designer may discuss increasing the level of insulation to make the home more comfortable with their client, but they are not likely to specify the R-value and installation details required to make an assessment using the build/renovate phase information system.

The level of complexity for information systems in the build/renovate phase is also strongly influenced by government expectations. The primary information systems used in the build/renovate phase are developed by or for the government, and are supported by government regulation. These systems are among the more complex and difficult to complete, presumably to generate more accurate information. Governments expect that the benefits of complying with minimum energy performance standards, primarily through lower energy bills, will offset the cost and complexity of these assessments.

If this regulation was not in place, the expected accuracy for build/renovate stage systems may change, leading to a reduction in complexity and cost.

Within the build/renovate phase, single building element information systems such as the Window Comparison Tool are simpler than whole building systems. The Window Comparison Tool requires only four inputs to compare windows – the size and postcode of the home in which the windows will be installed, and the windows being compared – which may include the windows already in the home, or two different design options. As in other systems in the build/renovate phase, using this system requires some expertise in building design – in this case, to differentiate between window systems as shown in Figure 9.

Figure 9 Selection of windows in the Window Comparison Tool [18]



4.3 Availability

Most of the assessed information systems are readily available at the relevant phase in the building life cycle as described in Table 9.

Table 9 Availability of EnergyFit information systems

Phase	Delivery	Trigger for information
Occupy	Free online self assessment	Householder finding system online
Refurb	Mostly free online self assessment	Householder considering renovation and finding system online
Buy/sell	Mostly fee-based expert assessment using in home visit or design documents	Point of sale regulation (ACTHERS, Sustainability Declaration) or offered by real estate agent (17 Things)
Build/ Renovate	Expert assessed from design documents	Minimum standard regulation or to recognise efforts beyond compliance

Occupy phase systems are readily available at any time. They are delivered at no cost through online portals, and can be accessed by any householder seeking more information about their energy use. While the My AGL IQ portal is available at no cost, it is restricted to AGL customers. Some other energy retailers have developed similar portals with restricted access.

Refurb systems are also readily available for householders considering whether to upgrade their home. One of the reviewed systems (SEED) is assessed by an expert, and is delivered at a fee. Each of the other systems is available for free.

Many of the build/renovate phase information systems are used by regulation during the design and construction of houses throughout Australia. Most systems are fee based, restricting access to the experts that use the systems in their course of business. With few exceptions, these experts must demonstrate their competence through accreditation and quality assurance processes.

[18] www.efficientglazing.net

Some build/renovate phase systems are freely available online, and may be accessed by anyone. In particular, the Your Home Technical Manual provides technical information that may be used by both experts and other people interested in understanding EnergyFit features in detail.

People looking to buy/sell or sell a house have very limited access to EnergyFit information compared with the other phases. The development of buy/sell phase information systems has been constrained by a pending government scheme for disclosure, as described in section 2.3. Prior to the recent launch of the 17 Things checklist by LJ Hooker, only people purchasing houses in the ACT (and in Queensland between 2010 and 2012) had access to any EnergyFit information.

The Liveability Property Features framework and 17 Things checklist has the potential to promote EnergyFit features to homebuyers. However, the system has been launched for less than a year, so is not yet widely available. At present, only a very small fraction of home buyers have access to EnergyFit information outside the ACT.

4.4 Methodology summary

Overall, the systems that provide self-guided information for consumers have minimised or eliminated cost by reducing complexity and making the system available online. House occupants interested in their current energy use or in renovating their home can find relevant information at a convenient time, and with little preparation.

An expert usually determines information about the house when it is to be communicated to a third party. The cost of these systems is varied and based on the complexity of the information system. Systems that are used at house purchase and during design and construction are more complicated, and supported by expert training, guidance documents and quality assurance protocols to ensure consistent and reliable advice. The most complicated systems are those used to demonstrate compliance with minimum building standards, which can be completed only by trained experts and rely upon detailed design information. As noted in section 7.4 below, cost and benefit analyses of these systems suggest that the benefits to the building owner in energy savings outweigh these costs.

5 Technical review

5.1 Methodology

This section reviews the technical composition of the information systems that provide a calculation of energy performance. While there is broad agreement over the scope of the different information systems, as described in section 4.2, there is limited overlap in how each of the systems collect inputs, make assumptions, calculate performance and provide reports. This makes it difficult to directly compare the information conveyed by different systems.

The technical assessment of EnergyFit information systems covers two categories – a technical assessment of the general modelling approach taken by each system, and, where appropriate to compare directly, a comparison of system results using information from a standard house.

5.2 Technical assessment of model approach

5.2.1 Operation of information systems

Generally, all of the information systems benchmarked operate in a similar way. They take a set of inputs and implied assumptions, perform calculations or reorganise that data, and provide output reports.

1. Inputs & Assumptions – assign values based on inputs from the user or from assumptions based on empirical evidence
2. Calculate/transform – use the inputs and assumptions to calculate outputs, select outputs or transform the inputs into a new format
3. Outputs – provide a report to the user to inform their future actions

Within that basic framework, there is a huge variation in the detail of how the systems operate. Because of those differences, it is very difficult to compare any two systems, let alone make technical comparisons across the entire suite of tools that have been examined.

5.2.2 Inputs & Assumptions

To calculate performance, systems require information that describes and quantifies characteristics of the house, the fixed and user appliances and the occupant behaviours. This information comes either from user inputs or from assumptions.

Assumptions can be used to guide the user inputs with some typical values or ranges of values. They can also be used to validate user inputs. In the case where a user chooses not to enter a value, a default assumption may be made. Additionally, all systems simplify the user interface by limiting the user inputs to that data which is important and appropriate for the purpose of the system. All remaining data must be provided through assumptions.

Reliable assumptions must be based on empirical evidence. There may be a role for EnergyFit to specify and reference some typical assumptions for systems to use. Alternatively, EnergyFit could provide guidance on best practice methods for collecting and analysing empirical evidence to base assumptions on.

Best practice guidance for publishing assumptions and data sources could also help to build trust and confidence in the outputs of the systems.

5.2.3 Calculations

All of the information systems are based on some sort of quantitative engine or model of the performance of the home. In most cases, those quantitative results are explicitly provided to the user to help them make informed decisions about actions they can take. In some cases, no quantified results are provided. However, even in those cases, some quantified assessment has been conducted to establish that those particular actions be recommended.

The different models can be categorised as follows:

- **Thermal model** – models the thermal performance of the building in the chosen climate by estimating the heating and cooling energy required to maintain a level of comfort year round, and may also calculate the energy inputs required to deliver that heating and cooling demand
- **Fixed model** – models the energy required to run all other fixed appliances in the home
- **Appliance model** – models the energy required to run the non-fixed appliances in the home
- **Calculator** – simple model of home performance or one aspect of home performance based on a limited number of inputs

- **Audit** – checks for the presence of desirable energy saving features or behaviours, the results can be presented as an audit report, a checklist for compliance or disclosure, or a list of tips or recommended actions to save energy. Each action may have estimated costs or benefits associated with it.

Some models combine the functionality of a number of these different models into a single system. Fixed models, for example, are usually integrated with a thermal model. The types of models in the benchmarked systems is presented in Table 10 below.

Table 10 Information system models

System	Thermal model	Fixed model	Applia-nce model	Calcul-ator	Audit
Sustainability Declaration					✓
The 17 Things					✓
ACTHERS	✓				
NABERS Home Rating				✓	
NABERS Home Energy Explorer	✓	✓	✓		
My AGL IQ				✓	✓
Household Energy Use Calculator				✓	
Low Carbon Lifestyles	✓	✓	✓		
Ecologic	✓	✓	✓	✓	
Smarter Renovations Planner					✓
SEED					✓
Energy Efficient Home Renovator					✓
Your Energy Savings					✓
NatHERS	✓				
BASIX	✓	✓			
eTool	✓	✓			
Energy Efficient Home Design					✓
Efficient Glazing Tool				✓	
Green Star Multi Unit					✓
Your Home					✓
GreenSmart					✓

5.2.4 Outputs

Each system uses different methods for communicating the results of the modelling or assessment. Generally, the outputs of the systems can be grouped as follows:

- **Performance metric** – actual or modelled energy consumption, quantified in energy units, dollars, points systems and/or star ratings
- **Benchmark** – benchmarking against regulatory minimum standards or statistically similar homes
- **Comparison** – comparison with other actual homes or appliances in the market
- **Checklist** – verification and disclosure of whether the home has particular features
- **Tips** – recommended actions for improving the performance of the home, usually with some quantified rationale

Table 11 below details how the different systems provide output results.

Table 11 Information system output types

System	Perform-ance metric	Bench-mark	Comp-arison	Check-list	Tips
Sustainability Declaration				✓	
The 17 Things				✓	
ACTHERS	✓				
NABERS Home Rating	✓	✓			
NABERS Home Energy Explorer	✓	✓			✓
My AGL IQ		✓			
Household Energy Use Calculator	✓				✓
Low Carbon Lifestyles					✓
Ecologic		✓			✓
Smarter Renovations Planner					✓
SEED	✓	✓			✓
Energy Efficient Home Renovator					✓
Your Energy Savings					✓
NatHERS	✓				
BASIX	✓	✓			✓
eTool	✓				✓
Energy Efficient Home Design					✓
Efficient Glazing Tool	✓				
Green Star Multi Unit	✓				
Your Home					✓
GreenSmart	✓				

Most systems provide results as either performance metrics or as tips (or recommended actions) for improving the home. The sections below look more closely at the quantified results for performance metrics and recommended actions across a number of tools.

5.2.5 System accuracy

The accuracy of system calculations is difficult to verify. An accurate calculation would correctly predict the actual energy consumption of the house.

Theoretically, system accuracy could be verified through a process of measurement and verification. Each system models performance of the home, as described in the model and under input or assumed operating conditions. This predicted performance would be verified against actual measurements of the energy use of the home. As well, it would be necessary to measure the actual characteristics of the home and the actual operating conditions. These measurements would need to be conducted at a frequency and over a sufficient period of time in order to provide confidence in the results.

In practice, this would be extremely complex and costly. A number of studies have undertaken limited measurement and verification for some of the regulatory systems, particularly NatHERS. However, measurement and verification has not been published for occupied homes at a scale that is significant enough to draw conclusions over the correlation between modelled and actual energy performance, and make detailed recommendations to system developers that would enhance the model.

Recommendation: A measurement and verification protocol for EnergyFit information system models could be developed to support the verification of information provided under each system. Performing this validation requires significant resources, and would require partnerships between government, energy retailers, system developers and independent researchers.

5.3 Detailed comparison

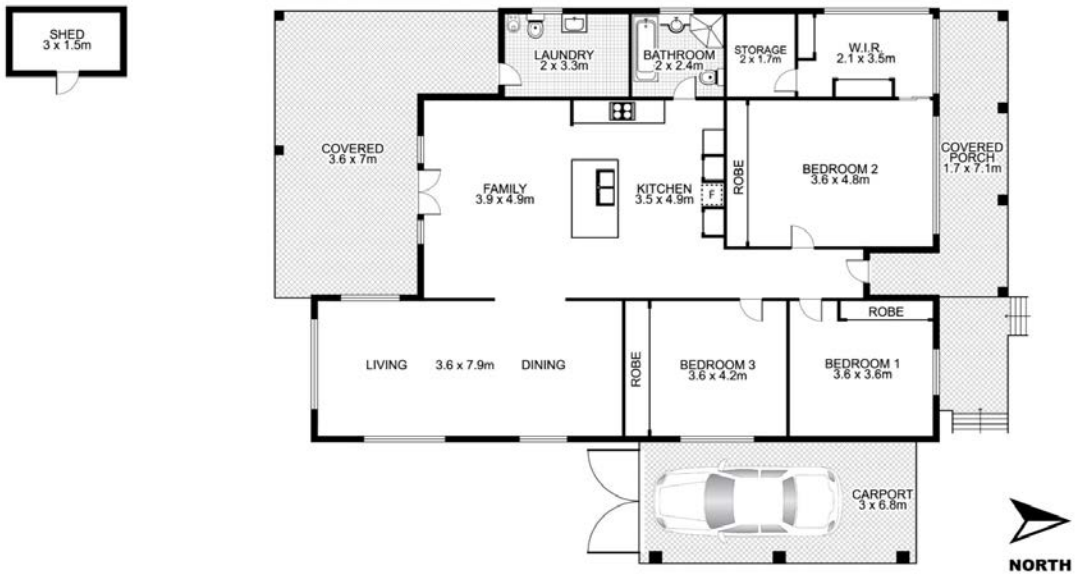
5.3.1 The standard house

A standard Western Sydney home has been defined to use in evaluating the consistency of quantitative information provided. For simplicity, a single house type was used. Technical benchmarking found that it was very difficult to compare results across the different systems. There are also a large number of variables, including location, building type, design, fixed appliances, user appliances and user behaviours. The standard house is described by over 100 variables to be input into the various tools. There would only be a marginal benefit of producing multiple standard homes.

The standard home was developed as a 30 year old single storey brick veneer. Many of its features and user behaviours are based on typical features and behaviours reported through surveys such as the IPART's *Household Survey of Electricity, Water and Gas Usage* or the ABS *Environmental Issues: Energy Use and Conservation* survey. Some variables were chosen deliberately leaning towards inefficient choices to allow tools to provide meaningful suggestions for action.

A floor plan of the standard house is provided in Figure 10 below, with details of all variables provided in Appendix 3 at section 11.

Figure 10 Standard house floor plan



5.3.2 Comparison of performance

Only five of the systems could be used to rate the performance of an existing detached home within the scope of this project. Other tools are either proprietary and out of reach for this study, or are aimed at different dwelling types.

The house performance was not assessed using a NatHERS model. NatHERS models a house under assumed usage patterns and only models thermal performance. It provides information on predicted annual heating and cooling thermal loads for the specified occupant behaviour. This information is not comparable with the energy required to service that demand, and the results are therefore not directly comparable with the information provided by any other model. Qualitative results are presented for NatHERS models where appropriate.

Table 12 Modelled standard home performance

System	Performance of standard house
NABERS Rating	1.5 stars (average home 2.5 stars)
NABERS Energy Explorer	1.0 stars (actual bill 1.5 stars) 12,301 kgCO2-e/year (5 star 2,225 kgCO2-e/year)
Ecologic	28 kWh/day (typical 26 kWh/day, efficient 16 kWh/day)
NatHERS	Estimates annual heating and cooling thermal loads only. Whole building not modelled.
BASIX	Energy: fail. 19% better than benchmark (40% is threshold) Thermal comfort: fail

Because each system presents the performance results completely differently, it is not possible to directly compare the outputs of each tool. The one exception is NABERS Energy Explorer, which provides a predicted NABERS Rating. It also asks the user for their billed energy consumption to directly provide the NABERS Rating comparison, presumably using the same engine.

Each system aims at a different part of the building life cycle. The analysis above suggests that consistent presentation of results across different stages of the cycle would benefit user understanding. Further, open access to calculation engines would allow interoperability. For example, building design systems could rate the design, but also predict operational ratings by connecting to an operational tool such as NABERS Rating. This would significantly enhance the overall credibility of EnergyFit information systems and allow innovation towards new communication methods, rather than repeated efforts to redesign calculation models.

All systems predicted that the standard house would perform less efficiently than the “average” or the threshold. The house modelled is a 30-40 year old design with inefficient appliances (brick veneer, off ground timber floor, no insulation, electric storage hot water, inefficient lights, inefficient refrigeration). BASIX predicted that the house would perform 19% more efficiently than an average house. This suggests that the benchmark house is extremely inefficient, and suggests that a 40% improvement against this benchmark may not be particularly stringent.

Some tools also provide a summary breakdown of how energy is used in the house. The results for the standard house are provided in Table 14 below.

Table 13 Energy use breakdown of standard house

System	Hot water	Refrigeration	Lighting	Heating	Cooling
NABERS Energy Explorer	41%	17%	14%	6%	
Ecologic	32%	12%	19%	5%	13%
BASIX	40%	N/A	8%	6%	7%

These results are reasonably consistent. The differences are primarily due to different scope of each model and assumptions about home characteristics and occupancy assumptions. For example the Ecologic tool only asks about the type of lighting and not about the number of lights and usage patterns.

Comparison of energy saving actions

A number of the different systems provide tips or recommended actions to make the home more efficient. These range from high cost changes to the house structure, such as replacing all windows with double glazed windows, through to low cost behavioural changes such as switching off a second fridge when not in use.

Each system has a different scope, depending on its purpose. Some will only recommend actions to improve building design, others will focus on low cost actions that householders can do themselves.

The different systems were compared by focusing on a single recommended action: installing ceiling insulation. This is within scope of most of the systems examined and is almost universally recommended as a cost-effective action for an uninsulated house.

Even where different systems recommend the same action, there is a lot of variety in how that action is recommended. This most likely arises because of the different target audiences, the different level of detail in the inputs, and how specific the modelled action is. The different descriptions of the “install ceiling insulation” action are presented in Table 15 below.

Table 14 Working of recommendations in EnergyFit information systems

System	Wording of recommendation
Sustainability Declaration	Insulation material in roof, ceiling, walls and floors.
NABERS Home Energy Explorer	Install or increase ceiling, wall and floor (if suspended) insulation. Ceiling insulation is particularly important.
My AGL IQ19	Install ceiling insulation.
Low Carbon Lifestyles	Upgrade your ceiling insulation from R1.5 to R4.
Ecologic	Install insulation batts in your roof cavity to reduce heating and cooling costs.
Smarter Renovations Planner	Top up your ceiling insulation.
SEED	Insulation, when correctly installed, is a proven, cost-effective way of keeping the warmth (and coolth) in your home from escaping outdoors.
Energy Efficient Home Renovator	Insulate your home by installing roof and wall insulation with a minimum R-value to suit your locality. In Queensland, this could range from R4.1 to R5.1 for the ceiling and around R2.8 for the walls.
Your Energy Savings	Install insulation.

These descriptions are reasonably consistent. There is some variation on the scope of the action, whether it includes wall or floor insulation as well. There is also variation on whether the ceiling has existing insulation or not, because the user has not specified the current situation. Some recommendations give reasons for undertaking the action (e.g. save heating and cooling costs). Some provide specific information about the level of insulation that should be installed.

Different audiences will always need information communicated differently, and there doesn't appear to be any need for consistency across different systems.

In addition, most systems also provided quantitative reasoning to support the recommendation. The types of metrics used to quantify the costs and benefits of an action include:

- Capital cost – initial upfront cost of goods and services to complete the action ($)
- Energy savings – the energy that could be saved each year (kWh/yr or MJ/yr)
- Bill savings – the annual bill savings ($/yr)
- % savings – an alternative way of communicating energy or bill savings
- Annualised cost – the annualised cost (or benefit) of the action, taking into account the initial capital cost and annual savings ($/yr)
- Simple payback period – the time taken for the savings to pay back the initial capital cost (years)
- Greenhouse gas savings – the annual greenhouse gas emissions savings attributed to reducing energy use ($kgCO_2$-e/yr)

None of the systems attempt to identify or explicitly quantify the other benefits or costs of an action, such as transaction costs/complexity, operational savings or other co-benefits. Your Energy Savings rates the "ease" of undertaking an action, which includes but since that encapsulates knowledge, effort and cost, but it is not transparent how large the transactional costs are.

The different outputs for the recommended action to install ceiling insulation in the standard house are presented in Table 16 below.

[19] This recommended action actually comes from the related site, *AGL Smarter Living*. The My AGL IQ tool did not recommend installing ceiling insulation as an action.

Table 15 Consistency of savings information

System	Cost ($)	Annual bill savings ($/yr)	% savings	Annual-ised cost ($/yr)	Pay-back (years)	GHG savings (kg CO2-e/yr)
Sustainability Declaration		$289	22%			
NABERS Home Energy Explorer	> $500					
My AGL IQ	~ $750	$270	17%			
Low Carbon Lifestyles				$59		211
Ecologic	$900	$125			7.2	
Smarter Renovations Planner	$2,442	$204	< 20%			
Your Energy Savings	> $500					

These figures are fairly consistent. There is intrinsically a high degree of variability in estimating capital costs and lifetime electricity tariffs. Most systems do not ask the user to input their tariffs or else inform the user what tariff has been assumed.

Low Carbon Lifestyles uses annualised cost as a way of comparing and ranking actions. However, to understand what those costs mean, the user has to refer to the extensive list of assumptions for each action. Even sophisticated users would struggle to understand the meaning of those numbers.

Recommendation: There could be a role for EnergyFit to define standard measures of performance for recommended actions to ensure that the costs and benefits of energy efficiency can be communicated clearly and consistently.

6 Types and presentation of disclosed information

The information presented by each different phase of EnergyFit information system is tailored to the intended audience. Systems that focus on influencing consumers generate simple, action-oriented information. Systems for experts generate detailed information about the house to allow improved design decisions, alongside a consumer-friendly overall metric.

Table 17 details the presentation of EnergyFit information by phase.

Table 16 EnergyFit information presentation by phase

Phase	Type of information	Key features
Occupy	Online	Normative component Highlight simple EnergyFit tips
Refurb	Online / printable report	User selected list of actions
Buy/sell	Printed report	Highlight EnergyFit features Star rating
Build/renovate	Certificate	Star rating Detailed information on EnergyFit features

6.1 Information presented by occupy phase systems

Occupy systems are designed to provide information to people about their household energy use, and inspire them to make energy efficient decisions. These systems incorporate two primary elements to influence behaviour: a normative component that give the occupant a basis for comparison, and an action component to persuade the occupant that it is possible and relatively easy to improve their relative performance.

6.1.1 Comparative information in occupant systems

As noted in section 4.2.2, the My AGL IQ, NABERS rating and Ecologic systems provide comparative information to the occupant. These methods help the user understand whether they use more or less energy than similar households. The My AGL IQ system also provides information that allows the user to compare their own performance over time. This information establishes energy use as a social norm, and is intended to motivate lower performers to match the performance of their peers, and to encourage more efficient households.

Figure 11 Comparative information in NABERS rating results - star rating

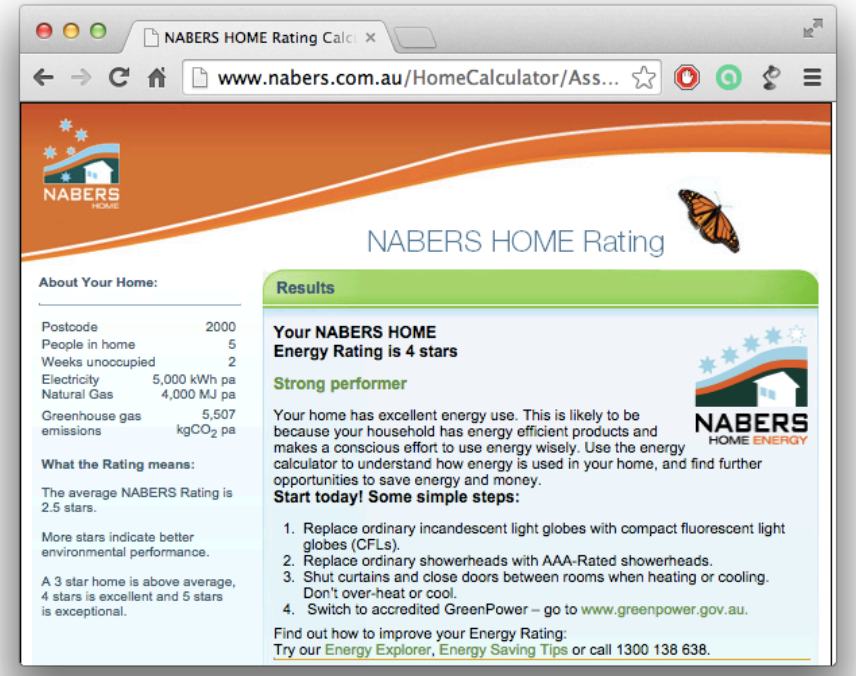


Figure 12 My AGL comparative information - peers

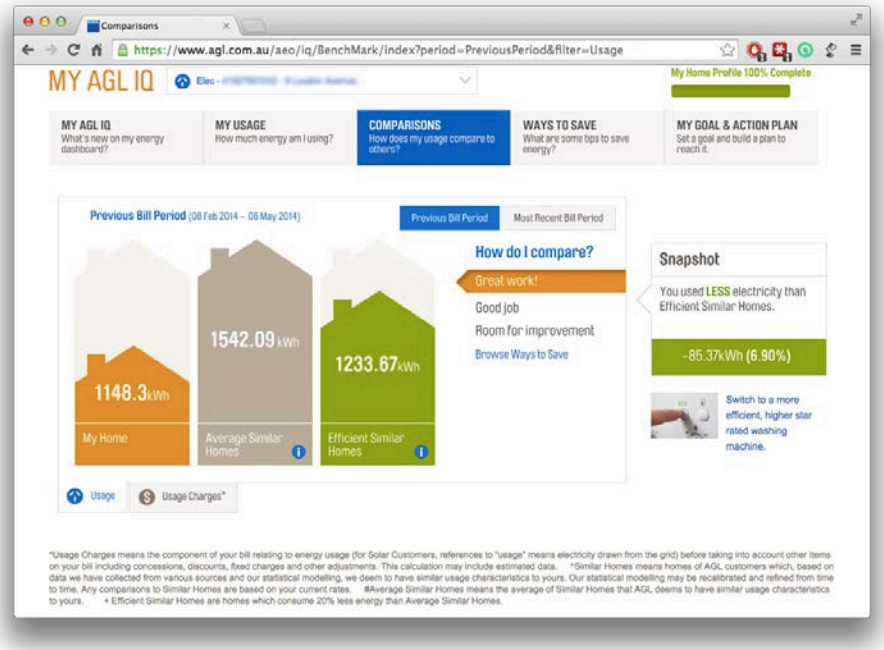
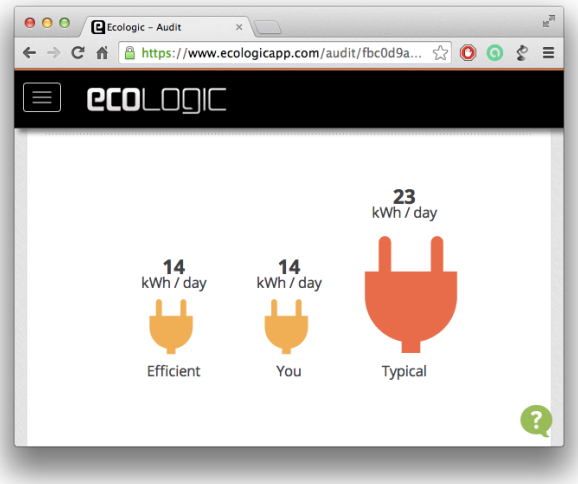


Figure 13 Ecologic app comparative information

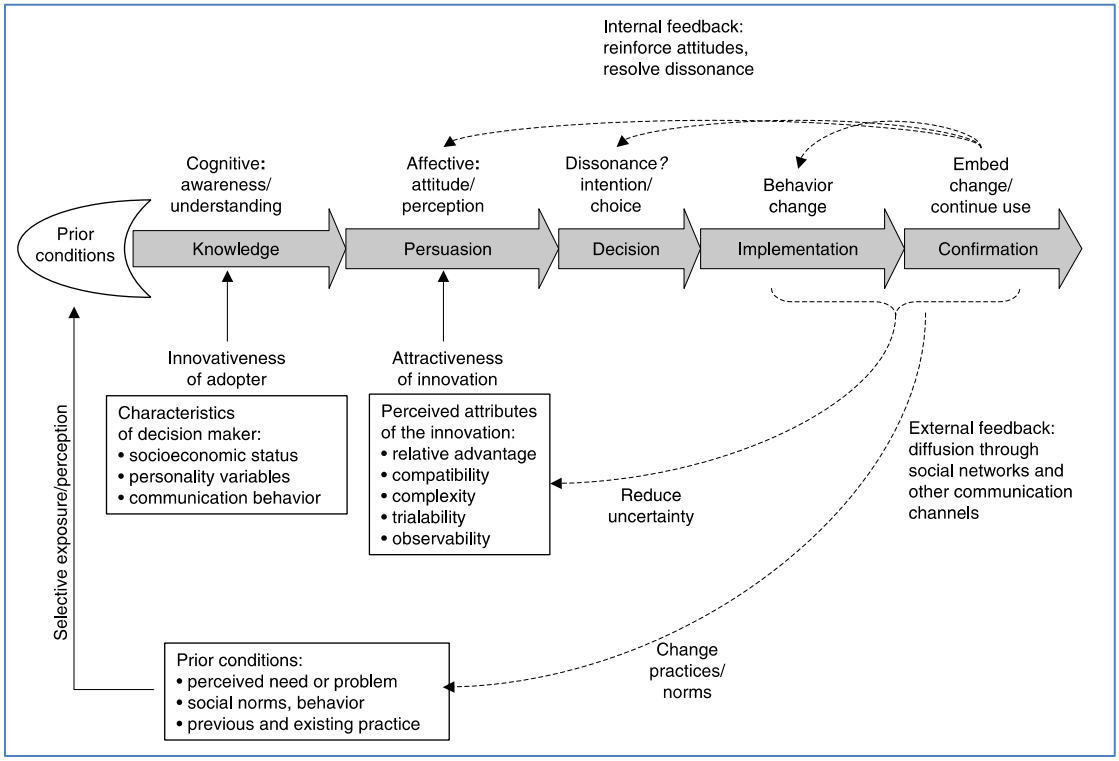


Research suggests that this form of presentation may be particularly influential in stimulating changed behaviours. Research into decision making for residential energy suggests "the most effective information in promoting residential energy efficiency was simple, salient, personally relevant, and easily comparable rather than technical, detailed, factual and comprehensive".[20]

Figure 14 outlines the decision-making process, and shows that the comparative information disclosed by systems such as these may be particularly effective in driving the "prior conditions" that stimulate decisions. Comparative information allows households to understand energy use as a social norm and the perceived need to change.

[20] Wilson and Dowlatabadi, 2007, "Models of Decision Making and Residential Energy Use", *Annual Review of Environment and Resources*, vol. 32 pp 169-203

Figure 14 The innovation decision process.[21]



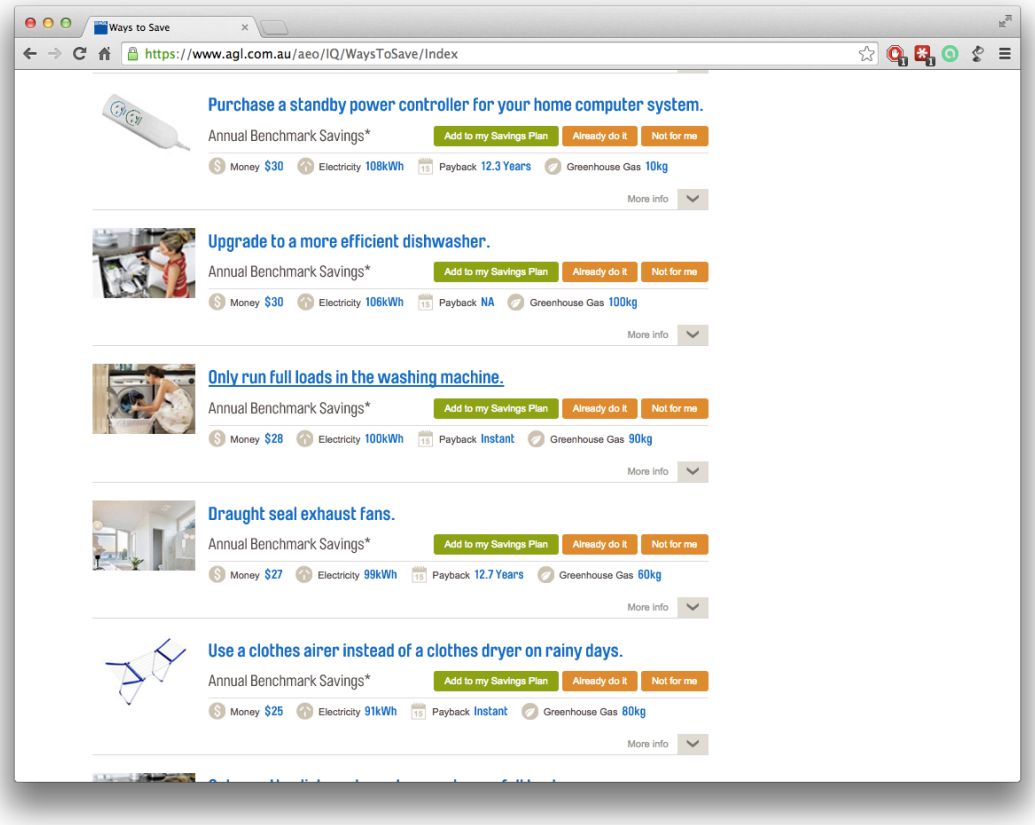
While this information provides a potential precursor for EnergyFit decisions, it does not in itself provide knowledge of the innovations that would lead to improved performance. The comparative information presented in these systems links directly to information from one of the typical occupy phase information systems described in section 4.2.1. These systems diagnose the drivers of the energy use of the home, and give advice on actions to further reduce their energy consumption. The NABERS rating links to the NABERS Energy Explorer information system, and a similar calculator is included in the My AGL IQ suite. The Ecologic app integrates comparative information with the diagnostic calculator, so action oriented information is presented alongside this comparative data.

6.1.2 Action oriented information in occupant systems

The information provided by typical occupy phase information systems highlights future actions ahead of current performance. As described in section 4.2.1, these systems take user input to tailor information to the occupant. The resulting information is presented to make the actions easy to find. The systems typically show EnergyFit actions alongside estimated savings for the household in dollars and/or energy units.

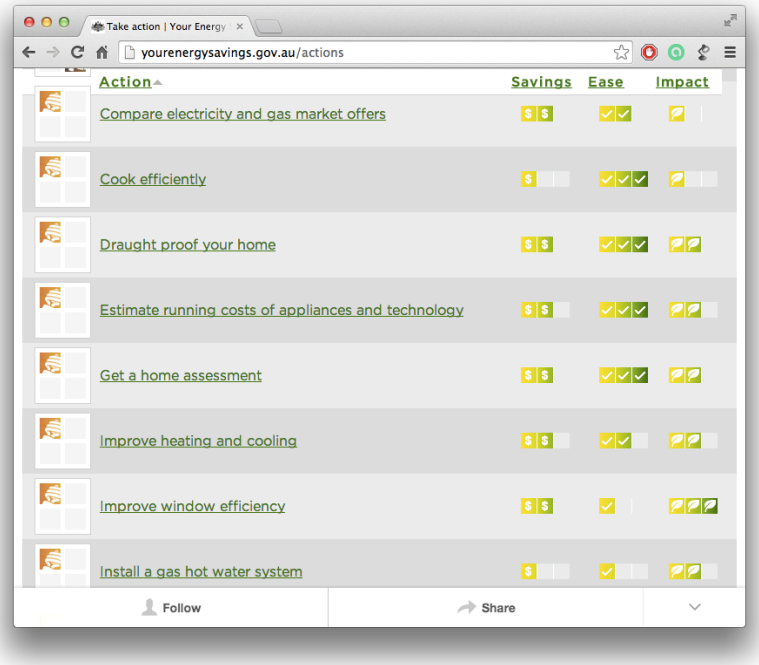
[21] Wilson and Dowlatabadi, 2007, "Models of Decision Making and Residential Energy Use", *Annual Review of Environment and Resources*, vol. 32 pp 169-203

Figure 15 Typical results page for occupy phase system (My AGL IQ)



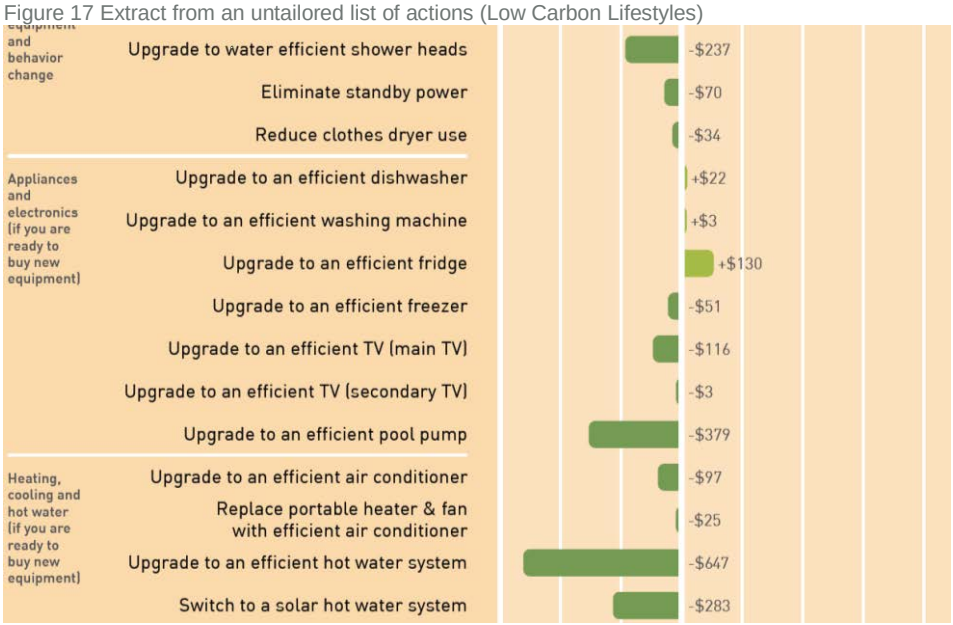
Some of the reviewed occupy phase systems such as Low Carbon Lifestyles and Your Energy Savings provide generic EnergyFit actions without tailoring the information to the user. These systems tend to deliver very long lists for the occupant to peruse. As the lists are not tailored to them, it is up to the occupant to work out whether the action is relevant for their home. Figure 16 shows an extract of actions recommended by Your Energy Savings. The action page lists 28 energy savings actions and includes actions to reduce car travel alongside EnergyFit actions.

Figure 16 Generic EnergyFit action recommendations (Your Energy Savings)



The Low Carbon Lifestyles system addresses this to some extent by categorising information for three "typical" users, and publishing separate guidance documents for each state in Australia. The typical scenarios include an apartment, a small home and a large home. The occupant can match themselves against one of these scenarios, select the relevant state-specific document, and view the list of recommended actions along with generic savings figures. Figure 17 shows an extract of the recommended actions for a large house in NSW.

Figure 17 Extract from an untailored list of actions (Low Carbon Lifestyles)

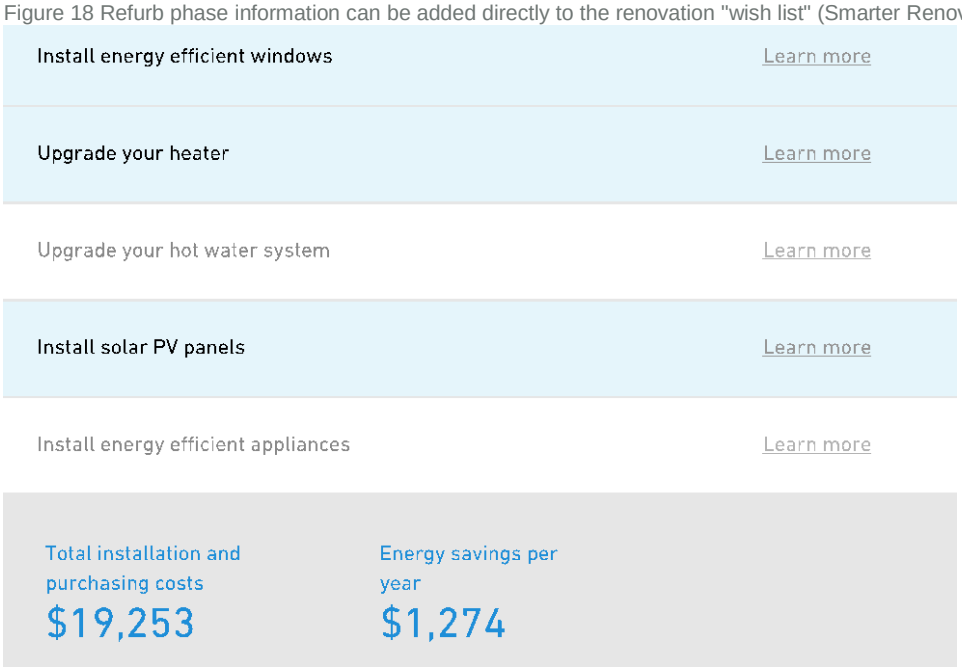


6.2 Checklist based information in refurb systems

The information generated by systems for potential renovators is tailored to potential upgrades to their home. A checklist format is the most common presentation of information, and fits well with the general renovation process. For example, the NAB describes the first two steps for people planning a renovation as “assess your current home, write down your renovation wish list”.[22] The Housing Institute of Australia advises renovators to first consider “setting goals for improved function, comfort and convenience” and to “develop your wish list and priorities”.[23]

The refurb EnergyFit information systems provide a checklist of EnergyFit actions for the home that can be directly added to the renovation “wish list”, as shown in Figure 18.

Figure 18 Refurb phase information can be added directly to the renovation "wish list" (Smarter Renovations Planner)

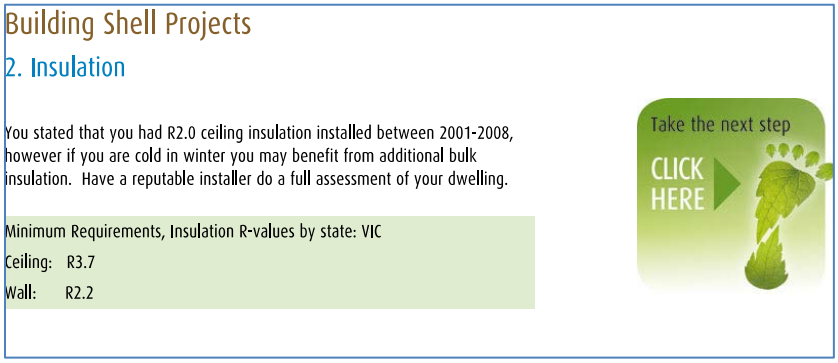


The SEED information system provides both a checklist of opportunities to install EnergyFit features in the house, and links directly to suppliers that can implement these features. This means the information can be used for both renovations and lower cost refurbishments or during general home maintenance. Figure 19 shows an extract from a sample SEED report showing both the identified action, and a “next step” button to take action now.

[22] http://learn.nab.com.au/youve-decided-to-renovate-now-what/

[23] http://housinglocal.com.au/renovating/planning-your-renovation.aspx

Figure 19 Extract from a sample SEED report showing EnergyFit opportunities [24]

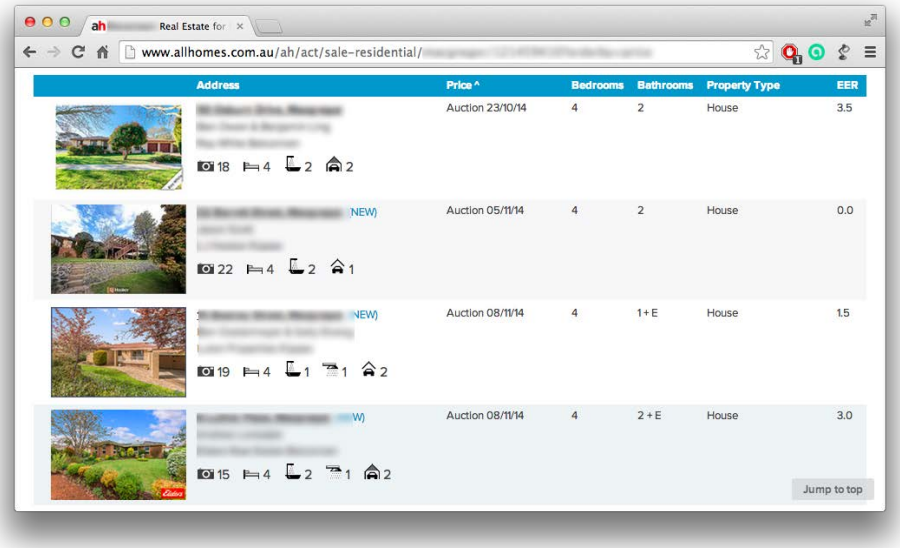


6.2 Information presentation in buy/sell systems

There are two main forms of information presented by information systems in the buy/sell phase.

The primary information conveyed for houses offered for sale under ACTHERS is an Energy Efficiency Rating. The Energy Efficiency Rating is a NatHERS rating that shows the thermal efficiency of the home as a star rating. This comparative information has much in common with that described in section 6.1.1 for occupy systems. It is a very simple metric that allows for an immediate comparison between otherwise similar buildings. A home buyer in the ACT can include a particular star rating amongst the list of features they would like in their new home. Figure 20 is a snapshot of some houses for sale in the ACT in October 2014. The houses appear similar but have different Energy Efficiency Ratings, allowing potential buyers to filter the results if they consider the rating an important factor.

Figure 20 Real estate portal showing key house features including the Energy Efficiency Rating



While the Energy Efficiency Rating allows these quick comparisons, it may also create confusion. Generating the simple comparative metric for houses involves detailed calculations of the building efficiency. Potential home buyers must take the rating on face value as they cannot easily replicate the calculations and validate the results. They must also accept that "your mileage may vary" from the modelled results based on how they use the home.

[24] http://www.energymakeovers.com.au/wp-content/uploads/Sample-SEED-Report.pdf

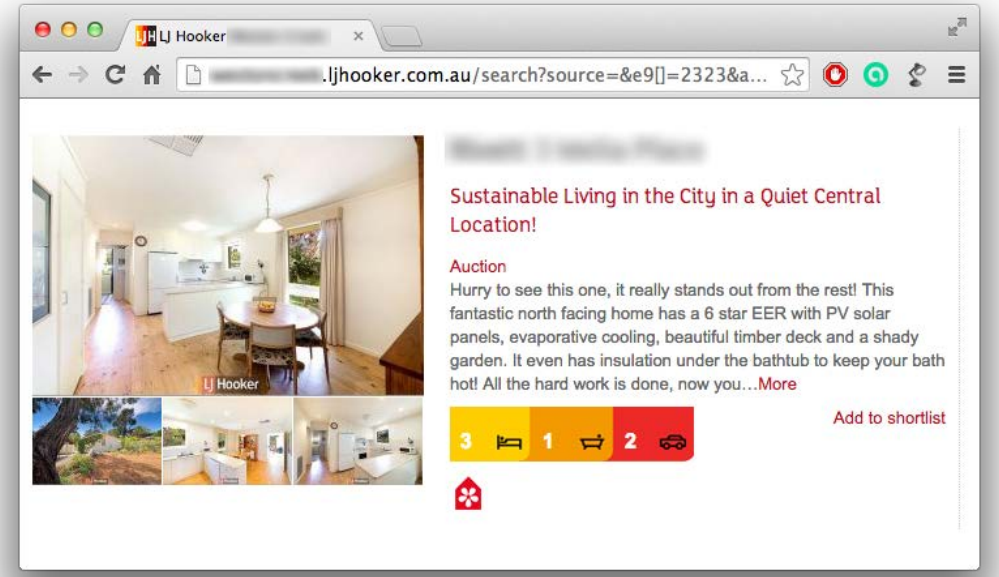
Kordjamshidi et al (2005)[25] note that simulation results (such as those used in the NatHERS system) give "quite poor agreement" with actual energy use, and outline a number of shortcomings in these rating systems that limit the likely correlation between building ratings and actual energy consumption. Of most relevance for people considering buying a house are the NatHERS assumptions of house occupancy. The authors quote a number of studies suggesting that occupant behaviour is the "most significant determinant of actual energy use" accounting for variations of 50% or more. They note that NatHERS ratings are based on an "extremely conservative" occupancy scenario and that "a more realistic view might be employed to accurately evaluate a building". They also quote a study that suggests lightweight buildings may be "disadvantaged unnecessarily" by the NatHERS occupancy settings, which could pose problems if the ACTHERS scheme was extended to cooling climates.

From a buyer perspective, if buildings are equally affected this may not be problematic, as the star rating is a relative figure – as long as their likely energy consumption in a high star rated building is lower than it would have been in a lower rated building, they have enough information to make a comparison. However, a poor correlation between prediction and reality may still dent confidence in the system and make it less influential.

These matters may be addressed through technical adjustments to the rating, or by choosing rating systems that closely model the likely home energy use. In any case, the effectiveness of any single rating figure depends on the trust of the home buyer that the calculation is accurate and reflects the likely relative energy use of the home.

The Sustainability Declaration and The 17 Things communicate a checklist of EnergyFit features in the house. This approach complements the general communication of properties at the point of sale by features such as the number of bedrooms and bathrooms. The 17 Things system also includes a headline "Liveability Property Features" logo which flags that the house has completed the 17 Things checklist and has at least 6 of the 17 Things. Figure 21 shows a house listing including this logo. This house is also in the ACT, so the text contains information on the Energy Efficiency Rating.

Figure 21 House listing showing Liveability Property Features icon



LJ Hooker has also developed icons for each of the features in The 17 Things that can be used in property marketing.

[25] Kordjamshidi, King and Prasad (2005), "Towards the development of a Home Rating Scheme for free running buildings", *ANZSES conference 2005*

Figure 22 The 17 Things icons[26]

Unlike the Energy Efficiency Rating, or the headline Liveability Property Features logo, each of The 17 Things is something that a potential buyer can see during a property inspection. Making the features more tangible in this way may avoid some pitfalls with a single headline figure. Potential buyer may be sceptical of the accuracy of an energy rating, or of the relevance of the rating to their personal energy use. They may also be more likely to trust information that they can test themselves by walking through the property than a calculated figure that they cannot personally check. Using physical features of the buildings also allows the 17 Things to be marketed in a similar manner to other property features such as number of bedrooms, having a pool, granite benchtops etc.

The Sustainability Declaration checklist included all the possible EnergyFit items and indicated which of them was present on that particular property, as shown in Figure 23. Like The 17 Things, these features could possibly be tested by potential buyers.

[26] http://www.liveability.com.au/about/

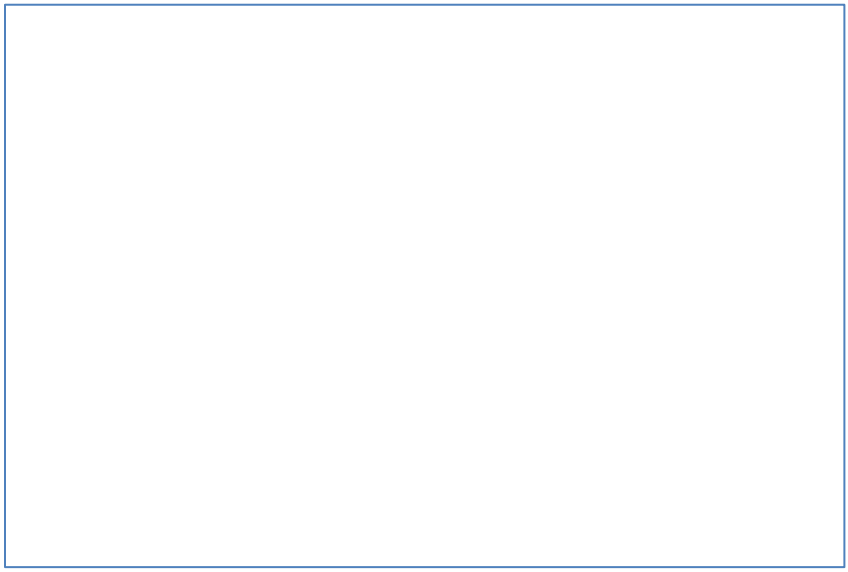
Figure 23 Sustainability Declaration extract

If you don't know the answer to any question, please leave the box blank.

1. Energy		Did you know?
Please tick if known		Potential savings in electricity costs per year of up to:
☐	**E1** Solar power (if known, ____ kilowatts [kW])	$546 or 42%
☐	**E2** Solar hot water system	$346 or 26%
☐	heat pump hot water system	$263 or 20%
☐	gas hot water system	$346 or 26%
☐	**E3** No swimming pool or spa **or**	$650 or 50%
☐	pool or spa pump connected to off-peak tariff (e.g. tariff 31 or 33)	
☐	**E4** A covered outdoor living area attached to an indoor living area	$140 or 10%
	E5 Insulation material in:	
☐	• roof ☐ partial in _____ (location)	
☐	• ceiling ☐ partial in _____ (location)	$289 or 22%
☐	• walls ☐ partial in _____ (location)	
☐	• floors ☐ partial in _____ (location)	

Each of the buy/sell phase information systems could also be used as a refurb system. The items that were not found to be present in the house during a 17 Things or Sustainability Declaration assessment could form a renovation "wish list". Along with the headline Energy Efficiency Rating, homes assessed under ACTHERS must attach a certificate to the sale documents. The certificate details the Energy Efficiency Rating along with actions identified by the ACTHERS assessor that would improve the rating of the home, as shown in Figure 24. Again, these items could be added to the "wish list" by a potential renovator.

Figure 24 ACTHERS information showing options to improve the rating [27]



6.3 Information presentation in build/renovate systems

Information systems for the design and construction of houses are mainly targeted at experts. Most of these systems provide detailed information about the energy efficiency of the house design to encourage improved design practices.

Figure 25 Technical details from a BASIX report

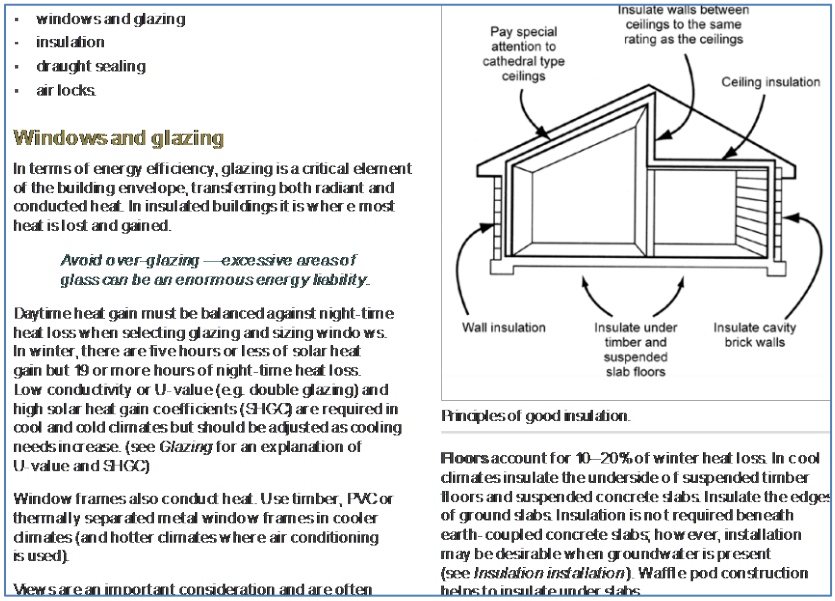
Thermal Comfort Commitments	Show on DA plans	Show on CC/CDC plans & specs	Certifier check
Windows, glazed doors and skylights			
The applicant must install the windows, glazed doors and shading devices described in the table below, in accordance with the specifications listed in the table. Relevant overshadowing specifications must be satisfied for each window and glazed door.	✔	✔	✔
The dwelling may have 1 skylight (<0.7 square metres) and up to 2 windows/glazed doors (<0.7 square metres) which are not listed in the table.	✔	✔	✔
The following requirements must also be satisfied in relation to each window and glazed door.	✔	✔	✔
- Except where the glass is 'single clear' or 'single toned', each window and glazed door must have a U-value no greater than that listed and a Solar Heat Gain Coefficient (SHGC) +/-10% of that listed. Total system U-values and SHGC must be calculated in accordance with National Fenestration Rating Council (NFRC) conditions.			✔
- The leading edge of each eave, pergola, verandah, balcony or awning must be no more than 500 millimetres above the head of the window or glazed door, except that a projection greater than 500 mm and up to 1500 mm above the head must be twice the value in the table.	✔	✔	✔
- Pergolas with polycarbonate roof or similar translucent material must have a shading coefficient of less than 0.35.		✔	✔
- Unless they have adjustable shading, pergolas must have fixed battens parallel to the window or glazed door above which they are situated, unless the pergola also shades a perpendicular window. The spacing between battens must not be more than 50 mm.		✔	✔

Window/glazed door no.	Orientation	Maximum area (square metres)	Type	Shading	Overshadowing
W1	N	5.00	standard aluminium, single clear (or U-value:7.63, SHGC:0.75)	eave/verandah/pergola/balcony 450 mm	not overshadowed
W2	E	5.00	standard aluminium, single clear (or U-value:7.63, SHGC:0.75)	eave/verandah/pergola/balcony 450 mm	not overshadowed
W3	S	10.00	standard aluminium, single clear (or U-value:7.63, SHGC:0.75)	eave/verandah/pergola/balcony 450 mm	not overshadowed
W4	W	5.00	standard aluminium, single clear (or	eave/verandah/pergola/balcony 450	not overshadowed

The BASIX report, for example, gives details of the building elements that must be installed during construction. Expertise in building materials and design is needed to interpret and apply the information.

[27] www.heat.net.au

Figure 26 Technical details in a typical Your Home Technical Manual document



- windows and glazing
- insulation
- draught sealing
- air locks.

Windows and glazing

In terms of energy efficiency, glazing is a critical element of the building envelope, transferring both radiant and conducted heat. In insulated buildings it is where most heat is lost and gained.

Avoid over-glazing — excessive areas of glass can be an enormous energy liability.

Daytime heat gain must be balanced against night-time heat loss when selecting glazing and sizing windows. In winter, there are five hours or less of solar heat gain but 19 or more hours of night-time heat loss. Low conductivity or U-value (e.g. double glazing) and high solar heat gain coefficients (SHGC) are required in cool and cold climates but should be adjusted as cooling needs increase. (see *Glazing* for an explanation of U-value and SHGC)

Window frames also conduct heat. Use timber, PVC or thermally separated metal window frames in cooler climates (and hotter climates where air conditioning is used).

Views are an important consideration and are often

Principles of good insulation.

Floors account for 10–20% of winter heat loss. In cool climates insulate the underside of suspended timber floors and suspended concrete slabs. Insulate the edges of ground slabs. Insulation is not required beneath earth-coupled concrete slabs; however, installation may be desirable when groundwater is present (see *Insulation installation*). Waffle pod construction helps to insulate under slabs.

As shown in Figure 26, the Your Home Technical Manual presents detailed information on more energy efficient design practices, including the theory behind these practices. Many of the other information systems reference this manual for people that seek a detailed understanding of energy efficient design options.

Figure 27 Window Comparison Tool information presentation

Information systems for building elements present simpler information than those for the whole building. The Window Comparison Tool shown in Figure 27 presents relatively simple information to compare the energy savings associated with different window systems, allowing building designers to quickly choose a more efficient option and to communicate benefits to their clients.

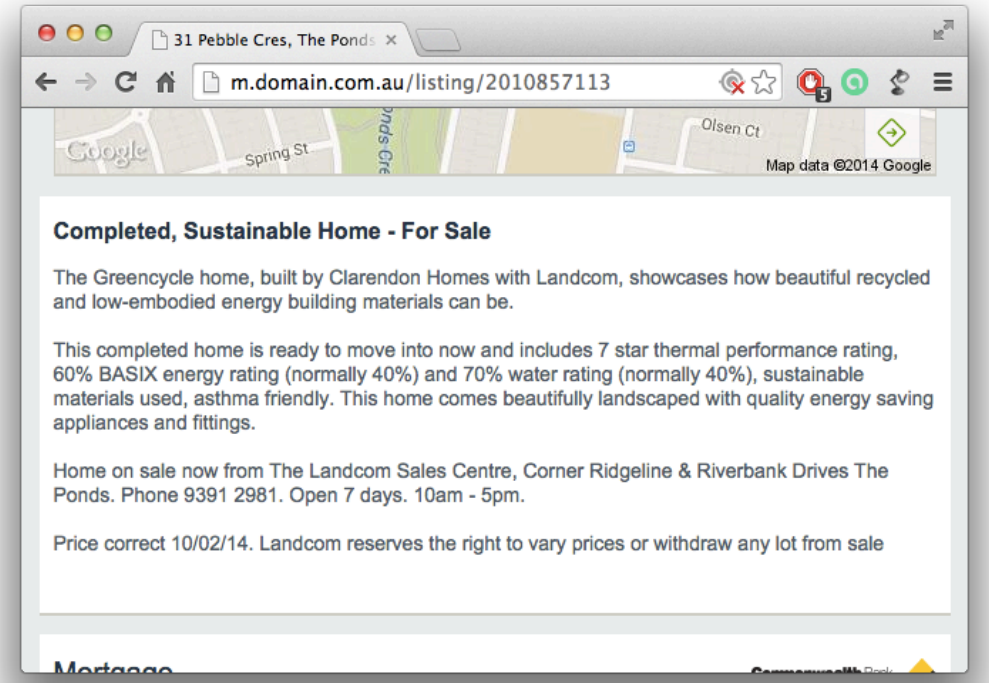
The regulatory NatHERS and BASIX systems each convey both detailed technical information, and a headline figure for compliance purposes. The NatHERS system conveys an Energy Efficiency Rating for the building in stars. This rating is the same as that used in the ACTHERS system. The main purpose of the rating is to show compliance with minimum standards, which are expressed in building regulations as stars. The use of a comparative, consumer friendly metric will allow designers to quickly convey to clients whether they comply with the standard. The rating of a house shows at a glance how far it sits from the compliance standard, and may be used either to show that the preferred design must be modified to reach compliance, or to reward over-compliance.

BASIX uses a score as a headline figure. The BASIX score are calculated reflect the per person reduction in estimated greenhouse gas emissions for the measured home compared with a state benchmark, and expressed as a

percentage reduction. The state benchmark is the average NSW annual greenhouse gas emissions from the residential sector on a per capita basis.[28] Houses need a score of 40 to comply – that is, their estimated greenhouse gas emissions must be 40% lower than the state benchmark. A house with a BASIX score of 60 is 60% lower than the benchmark.

The absence of effective buy/sell phase information systems means that some builders use NatHERS or BASIX information to market their new homes as energy efficient, as in Figure 28.

Figure 28 Property listing featuring NatHERS (thermal performance) rating and BASIX scores



As noted in section 4.2.5, using the NatHERS or BASIX systems is a relatively complicated process, and requires both expert design knowledge and detailed design documentation. This limits the practical use of these systems in buy/sell systems to houses that have already used them to demonstrate compliance with minimum building standards – that is, houses that are newly designed. Using the systems in existing houses is complicated, and the lack of documented information on the home may lead to inaccuracies as the assessor guesses at the building construction. This makes comparison difficult for potential buyers, as only the new homes have the rating, and only those that exceed compliance show it – a relatively small part of the market.

6.4 Information presentation summary

The information presented by each system is tailored to the intended recipient. The buy/sell, retrofit and occupy systems focus on influencing decisions by consumers, and use a simple communication methodology. Expert focused information conveys both detailed information that informs the expert users, and simple headline figures that helps experts discuss the implications of design alternatives.

Importantly, the information presented in each phase can have an impact in other phases. In particular, information presented at the point of sale includes both a headline figure to engage the attention of the consumer (an Energy

[28] https://www.basix.nsw.gov.au/basixcms/about-basix/basix-assessment/basix-targets.html

Efficiency Rating or a Liveable Property Features logo), and a checklist of opportunities to improve the property which may be used for renovation.

The information in the detailed NatHERS build/renovate phase system is already implemented at the point of sale through the ACTHERS system, although it appears that this may introduce confusion along with an engaging headline number.

While it is not currently implemented, information in the detailed occupy systems could also be used in retrofit or buy/sell scenarios. While these systems currently focus on every day decisions and low cost actions, they could be tailored to provide retrofit opportunities and information relevant to point of sale (using suitable defaults for occupancy assumptions).

The consistency of information provision across the current suite of systems, and potential suitability of the information across the building lifecycle suggests that a framework for the calculation and presentation of EnergyFit information may support improved consumer engagement. Such a framework may encourage collaboration in calculation methods and allow developers to build mutually reinforcing rather than competing systems.

7 Evaluation of effectiveness and market acceptance

Very few studies or formal evaluations of systems for their effectiveness are publicly available. A limited number of evaluations have been published for the regulatory information systems - BASIX, NatHERS, Energy Efficiency Rating (EER) and QLD Sustainability Declaration. These studies or evaluations vary greatly in terms of their objectives, scopes, methodology and criteria for evaluation. The findings of these evaluations present some useful lessons learnt, although these variations in prevent "like-to-like" comparisons between systems.

Section 10 contains a matrix mapping the major findings from these studies or evaluations across 6 themes: market acceptance – householders, market acceptance – practitioners, effectiveness in changing market practice and driving demand for more sustainable choices, cost benefits, energy savings and quality in terms of delivery and implementation. The overall findings for each theme are summarised below. A list of citations for this analysis is contained in section 10.1.

7.1 Market acceptance - Householders

Householder awareness and perception is the focus of evaluations of point of sale systems such as ACTHERS and Sustainability Declaration. These evaluation reports clearly show that ACTHERS has better market awareness and influence than the Sustainability Declaration, which could be partly due to the length of the implementation time, the climate condition and the perceived credibility of the information presented by the systems. The evaluations report that policy failures in the Sustainability Declaration include a lack of awareness among buyers and sellers, and a lack of interest among buyers when the template was provided.

This suggests that developers of point of sale systems should consider engagement with buyers and sellers. In particular, engaging the interest of prospective buyers is paramount, so systems should focus on determining and providing information that is directly relevant in an engaging manner.

Design systems such as BASIX and NatHERS and their results/certificates are not intended for direct use householders so public perception of this information is not included in evaluations. An evaluation of BASIX includes some consideration of the affect of BASIX compliance on householders' use of heating and cooling systems and their perception in thermal comfort. The evaluation suggests that people in BASIX compliant homes tend to use less air conditioning in summer and heating systems in winter. However the evaluation does not directly consider household perception, so it is not possible to say whether these behaviours are due to BASIX compliance or other unrelated factors.

7.2 Market acceptance - Practitioners

The findings show that design systems that stipulate mandated minimum standards (BASIX) are perceived by practitioners as having a greater impact in decision-making than point of sale systems. BASIX is perceived to have influenced professional rather than householder behaviour and BASIX design choices are likely to be made by professionals rather than requested by households. This is expected given the complexity of design information systems and the expertise required to engage with them as discussed in section 4.2.5.

Practitioners (such as real estate agents, builders, architects/designers) are more sceptical to the impact of point of sale systems like ACTHERS and Sustainability Declaration on the buyers' decision-making process. This suggests that there need to be some work done to secure buy/sell-in from practitioners to form an integrated understanding and communication message about the system in their respective work areas.

7.3 Effectiveness in changing market practice and driving demand for more sustainable choices

The two build/renovate phase systems with evaluations (BASIX and NatHERS) are used to mandate minimum standards in house design. As a result these systems are very effective in changing market practice and driving demand for more sustainable choices and products. These systems also heavily influence the design of house layout and style, particularly where these may previously have been applied inappropriately in areas with unsuitable climate conditions.

The influence of point of sale systems (ACTHERS and Sustainability Declaration) is more apparent in buyers and sellers decision making process, not necessarily at the point of sale, but before or after the sale when householders prioritise their energy efficiency improvements, reinforcing the importance of the link between buy/sell and refurb phase systems discussed in section 6.3.

The findings also suggest that while the information presented by these systems are not seen as important factors for buying a house, householders do tend to take the information into consideration when making the final purchase

decision. This shows that as more options of sustainable houses with disclosed performance become available, the chances of householders relying on the disclosure information when making their final purchasing decision will be higher.

Many believe that a point of sale system will help to create additional value for more sustainable houses in terms of sale prices. While the ABS study for the ACTHERS shows that a statistically significant relationship does exist between the sale price and the star rating of houses in ACT in 2005 and 2006, the study cannot conclude that the relationship is a causal one. 2011 market research by Instinct and Reason shows that only 5% of the 250 ACT buyers surveyed claimed that ACTHERS affected the sale price of their houses. More study on recent sale prices in ACT versus the star rating could be useful in understanding the relationship and promote the benefit of a point of sale system.

7.4 Cost benefits

Both BASIX and NatHERS have been subject to cost and benefit analyses as part of regulatory approvals. These analyses suggest that both systems are effective in delivering cost savings to householders in terms of heating and cooling costs. Interestingly, it was found that it cost less to build houses that meet the minimum 5 star NatHERS standards than houses with lower ratings. This finding may be useful to change the public perception that sustainable houses usually cost more to build.

No information on cost benefits of the point of sale systems can be found publicly.

7.5 Energy Savings

Similar to the above, only BASIX and NatHERS have some findings on the delivery of actual energy or greenhouse gas emissions. The BASIX findings are based on estimation rather than post occupancy evaluation of actual performance. A recent study into NatHERS, which is based on monitoring of actual performance, shows that greenhouse gas emissions were reduced in winter in higher-rated houses, but that summer emissions increased in higher-rated houses in all 3 of the cities studied. The higher cooling energy used in summer is more prominent in Brisbane than in Adelaide and Melbourne. This shows that the there are some scope for modifications on the design assumptions used for modelling the cooling requirements in summer, and perhaps reinforces the report cited in section 6.4 that the occupancy settings for NatHERS need to be more realistic.

Again, no information on energy savings of the point of sale systems can be found publicly. There is a significant opportunity to evaluate the real impact of the ACTHERS system given the large number of houses assessed since the scheme was introduced. The government should consider mapping longitudinal energy billing information against house star ratings to determine the correlation between ratings and actual energy use, and whether the scheme influences household energy consumption after sale.

7.6 Quality in terms of delivery and implementation

The BASIX and NatHERS systems have evaluation findings on the quality of compliance by assessors and designers.

Findings on the quality of BASIX information are limited to the presentation of BASIX commitments on design plans and documents for the planning approval process. There has been no evaluation of whether these commitments are actually installed in houses.

The NatHERS evaluation looks at the quality of assessments conducted by assessors and found a high level of error in NatHERS ratings irrespective whether assessors were accredited or not. This suggests that accreditation will not be sufficient in ensuring the quality of assessment, and compliance measures such as an audit program will be needed to maintain the credibility of the system.

This finding has a significant implication for the ACTHERS system that provides NatHERS ratings to potential homebuyers. The high level of error found in NatHERS ratings for new buildings is likely to be repeated in those for established building. If anything, the limited data availability in existing houses is likely to exacerbate this error. This raises serious questions of the reliability and credibility of ACTHERS Energy Efficiency Ratings, and must affect household confidence in the ACTHERS system. Further research in this area will help to understand the importance of consumer confidence in the accuracy of systems for point of sale disclosure, and whether a more reliable system would be more effective.

A major downfall of the Sustainability Declaration is that the form can be filled out by anyone (home owners, real estate agents or even third party providers that offer the service of filling out these forms online). This creates a question on the credibility of the information presented and results in low interest from buyers to make use of the information at the point of sale. The lesson from this failed scheme suggests that the credibility of the information is important as well as the person delivering the information.

8 Conclusion and opportunities for next steps

This report shows that the presentation of EnergyFit information systems is relatively consistent across each phase, and that information is tailored to the final audience.

The governance, administration and development of information systems in Australia is contained within individual organisations, with limited accountability and external oversight. This has implications for the implementation and ongoing development of future systems.

The credibility and reliability of all systems is undermined by a lack of transparency and access for scrutiny. The users of each system and the recipients of EnergyFit information must trust that the developers have implemented robust and accurate processes and assumptions, as they cannot test these processes for themselves. This may limit the effectiveness of current systems, particularly those that involve detailed calculations (such as rating systems and online calculators). The limited evaluations available found a high error rate in data entry for complex information systems. This results in a lack of repeatability of the presented information for a house, which further undermines system credibility.

Evaluations of point of sale systems also found a significant disengagement with buyers, sellers and property industry practitioners. This is particularly relevant to future EnergyFit information systems, which should focus on determining and providing information that is directly relevant to both consumers and experts in an engaging manner.

There is a significant opportunity for collaboration between system developers, perhaps informed by a framework for the calculation and presentation of EnergyFit information. This framework could build on the consistent information provided across the current suite of systems, and reinforce the potential for use of the information from each system across the building lifecycle. Such a framework may encourage collaboration in calculation methods and allow developers to build mutually reinforcing rather than competing systems, and enhance consumer engagement.

The next stages of the EnergyFit Homes initiative project include further research into consumer and industry attitudes and expectations of EnergyFit information systems, message testing of alternative information, and the development of improved system governance structures.

A number of recommendations for these next steps and potential outcomes of the EnergyFit project arise from the analysis of current information systems in this report:

Determining the most influential information at the point of sale:

- For point of sale information systems, how important is the **source** of information in influencing consumer behavior? In particular, is self assessed information less influential than that completed by professionals?
- Testing complexity messages with consumers – what is the consumer view of the right balance between cost and the complexity of assessment? How much are consumers willing to pay in time and effort for information?
- Testing rigour of assessment against action orientation – how much do consumers want to know about what they currently have, compared to advice on what they should do to improve?
- How important is the accuracy of the presented information in influencing behaviour? How important is reliability and repeatability of results?
- Does information need to be tailored to the consumer to be influential?
- Comparison is a key focus of consumer systems – is a comparative metric likely to be influential at the point of sale?
- Most of the information systems provide information on energy savings, but are imprecise on the cost of actions. How important is information on implementation cost to stimulating action?

Establishing systems to support the effective delivery of point of sale systems:

- What is the current perception of practitioners in the property industry on the usefulness of point of sale EnergyFit information? What processes are needed to enhance awareness and acceptance among practitioners?
- What is the level of consumer confidence in current systems? In particular, does the high error rate found in NatHERS evaluations (which are disclosed at point of sale under the ACTHERS system) impact on the influence of ACTHERS?

Enhancing trust in EnergyFit information systems:

- Consider establishing a quality assurance and appraisal methodology for all EnergyFit information systems under an EnergyFit banner. A rigorous appraisal methodology would need to be developed to ensure that the governance, quality assurance and methodology of each system could be graded accurately and appropriately.

- To improve the interoperability, consistency and transparency of EnergyFit information systems, consider establishing a protocol for EnergyFit calculation models that covers basic assumptions of occupancy and equipment efficiencies, standard formats for model inputs and outputs (including for example web services standards for direct sharing of modelled results between systems), and standard formats for communicating the costs and benefits of the recommendation actions.

9 Appendix 1 – detailed tables

9.1 System administration and development

System	Phase	Administrator	Organisation Type	IP arrangements	Governance - final authority	Developer	Development method
Sustainability Declaration	Buy/sell	QLD Government	Government	Owned by Queensland Government	Queensland Government	Queensland Government	In house
The 17 Things	Buy/sell	LJ Hooker	Private	LJ Hooker	LJ Hooker	LJ Hooker	In house with expert support
ACTHERS	Buy/sell	ACT Government	Government	Owned by Victorian Government (Sustainability Victoria)	Calculator - Victoria government ACTHERS scheme - ACT government	Sustainability Victoria	In house
NABERS	Occupy	NSW Government	Government	Owned by NSW Government (Office of Environment and Heritage), licensed to other Governments	National Steering Committee, comprising representatives of state governments and the Commonwealth	NSW Government	By contract, with expert advisors
NABERS Energy Explorer		NSW Government	Government	Owned by NSW Government (Office of Environment and Heritage)	NSW Government	NSW Government	In house
My AGL IQ	Occupy	AGL	Private	Not disclosed	Not disclosed	AGL	Not disclosed
Household Energy Use Calculator	Occupy	Ergon Energy	Private	Not disclosed	Ergon Energy	Ergon Energy	Not disclosed
Low Carbon Lifestyles	Occupy	ClimateWorks	Private	Copyright to ClimateWorks	N/A	ClimateWorks	In house
Ecologic	Occupy	Ecologic	Private	Privately owned	Ecologic	Ecologic	In house
Smarter Renovations Planner	Refurb	Victorian Government	Government	Sustainability Victoria	Sustainability Victoria	Sustainability Victoria	Not disclosed
SEED	Refurb	Energymakeovers	Private	Energymakeovers	Energymakeovers	Energymakeovers	Not disclosed
Energy Efficient Home Renovator	Refurb	Synergy	Private	Synergy	Synergy	Synergy	Not disclosed
Your Energy Savings	Refurb, Occupy	Australian Government	Government	Australian Government	Australian Government	Australian Government	Not disclosed
NatHERS	Build/renovate	Governments	Government	IP of the tools stay with the original developer	Steering committee that includes representatives from the Australian Government and all state and territory governments.	CSIRO	In house with expert advisors
BASIX	Build/renovate	NSW Government	Government	Owned by NSW Government (Department of Planning)	NSW Government	NSW Government	In house
eTool	Build/renovate	eTool	Private	eTool	eTool	eTool	In house
Energy Efficient Home Design	Build/renovate	SA Government	Government	SA Government owned	SA Government owned	SA Government	Not disclosed
Window Comparison Tool	Build/renovate	Australian Windows Association	Not-for-profit	Not disclosed	AWA	Australian Windows Association	In house
Green Star Multi Unit	Build/renovate	Green Building Council of Australia	Not-for-profit	Green Building Council of Australia	Green Building Council of Australia Board	Green Building Council of Australia	In house with expert advisors

Your Home Technical Manual	Build/renovate	Australian Government	Government	Australian Government	Australian Government	Australian Government	Expert authors
HIA GreenSmart House	Build/renovate	HIA	Not-for-profit	HIA	HIA	HIA	Not disclosed

9.2 Delivery methods

System	Phase	Delivery	User accreditation	User qualifications	User training	Quality assurance
Sustainability Declaration	Buy/sell	Home seller, likely under guidance from real estate agent or other expert. A copy must be "prominently displayed" during open house inspections. Otherwise homebuyers must proactively request a copy of the declaration.	No	No	No. Fact sheets support system delivery	No, but legal remedies - the seller can be liable for any losses incurred by the buyer as a result of false or misleading information contained on the form.
The 17 Things	Buy/sell	Only a trained Liveability Real Estate Specialist is able to use The 17 Things Checklist and the Liveability Property Features icon to list and sell properties.	Yes - "training delivered by a registered training organisation". Details not currently published.	To be eligible to do the Liveability Real Estate Specialist training, the real estate office must be signed up to the 3Ps Efficiency Program, which involves monitoring their paper, power and petrol usage with a customised environmental dashboard in the office.	One-day training course and then followed by a six-week probationary period which includes online training units and two practical assessments.	"Spot audits are conducted on our Liveability Real Estate Specialists' listings, marketing and checklists throughout the year to ensure the specialists are using The 17 Things™ Checklist in accordance with the guidelines and maximising the checklist's potential." (Liveability website)
ACTHERS	Buy/sell	Accredited ACT House Energy Rating Scheme Assessors	Assessors producing Energy Efficiency Rating Statements for the sale of residential property need to be registered or, from 1 March 2011, hold a Class A building assessor licence or current ACT House Energy Rating Scheme registration.	Page 7 of the Construction Occupations (Licensing) (Mandatory Qualifications) Declaration 2012 (No 3) specifies the mandatory qualifications for holding a Class A building assessor licence.	Software operation training modules from the accredited course "91318NSW" Building Thermal Performance Assessment (Residential) delivered by a Registered Training Organisation or Certificate IV in NatHERS Assessment.	Registered energy efficiency assessors are subject to a code of practice, as well as the Guidelines, which inform auditing requirements, protocols for assessing building elements and lodging EER certificates with ACTPLA.
NABERS	Occupy	Online self-assessment	No	No	No	No
NABERS Energy Explorer	Occupy	Online self-assessment	No	No	No	No
My AGL IQ	Occupy	Online self-assessment	No	No	No	No
Household Energy Use Calculator	Occupy	Online self-assessment	No	No	No	No
Low Carbon Lifestyles	Occupy	ClimateWorks hosts documents on their website	No	No	No	No
Ecologic	Occupy	Householder	No	No	No	No
Smarter Renovations Planner	Refurb	Online self-assessment	No	No	No	No
SEED	Refurb	Energy auditors engaged by or contracted to Energymakeovers	Energymakeovers auditors have to demonstrate "proof of HSA accreditation under ABSA or proof of receiving HSA training" [a certificate IV qualification in Home Sustainability Assessment]	No particular qualifications (basic literacy and numeracy)	Yes, certificate IV in Home Sustainability Assessments	Not disclosed
Energy Efficient Home Renovator	Refurb	Online self-assessment	No	No	No	No
Your Energy Savings	Refurb	Online self-assessment	No	No	No	No
NatHERS	Build/renovate	Accredited assessors for regulatory compliance	Accreditation of assessors is managed by Assessor Accrediting Organisations (AAOs) which are accredited by the National Administrator of NatHERS. The two current AAOs are Association of Building Sustainability Assessors (ABSA) & Building Designers Association of Victoria (BDAV). Requirements of AAOs are outlined in the NatHERS Protocol for Assessor Accrediting	Certificate IV in NatHERS Assessment	Certificate IV in NatHERS Assessment delivered by Registered Training Organisations (RTOs)	The NatHERS Protocol for Assessor Accrediting Organisations provides criteria for the number of assessors that must be Quality Assured in a financial year by an AAO. It is up to the AAO how many Assessors are reviewed at Level 1, but the Protocols require 10% of all NatHERS assessors to be reviewed at Level 2 and 5 % of all assessors to be reviewed at Level 3 nationally.

			Organisations.			For ABSA, all NatHERS Assessors that have issued certificates are checked at Level 1. This provides an indication of those assessors who may need following up for a Level 2 review. Following the results of a Level 2 review, ABSA will determine if an assessor is required to be reviewed at Level 3. Assessors may also be reviewed at Level 3 at the request of a certifying authority or through a report of inappropriate activity.
BASIX	Build/renovate	Designers/assessors;	Accreditation needed for those using the NatHERS Thermal Comfort Simulation Method for the Thermal Comfort assessment component in BASIX. Accreditation is managed by Association of Building Sustainability Assessors (ABSA) and Building Designers Association of Victoria (BDAV).	Certificate IV in NatHERS Assessment if using the NatHERS Thermal Comfort Simulation method.	Certificate IV in NatHERS Assessment if using the NatHERS Thermal Comfort Simulation method. The couse is delivered by Registered Training Organisations (RTOs)	No, there is no regular formal audit/compliance system for BASIX. However, there are periodical review on the quality aspects of the scheme, for example the 2013 BASIX Compliance Audit program study which examined a sample of application to assess how BASIX certificate commitments are recorded on plans and documents for assessment by consent and certifying authorities. The Thermal Comfort Simulation using NatHERS is subjected to audit/compliance as specified by the Accredited Assessor Organisations as per NatHERS "Protocol for Assessor Accrediting Organisations".
eTool	Build/renovate	Designers	No	Design expertise	No	No
Energy Efficient Home Design	Build/renovate	Online self-assessment	No	No	No	No
Window Comparison Tool	Build/renovate	Online self-assessment	No	No	No	No
Green Star Multi unit	Build/renovate	Anyone can submit an application, but process would normally be managed by Green Star Accredited Professionals. A technical manual ($600) is required to complete the assessment.	Managed by the Green Building Council of Australia	No particular qualifications	Mandated training for delivery agents includes an online introductory course, a half-day "Foundation Course" covering the fundamentals of Green Star Design and As Built, and ongoing CPD requirements. All delivered by GBCA	Green Star ratings are assessed by a panel of third-party Certified Assessors to validate that the documentation for all claimed credits is in adherence with the Compliance Requirements as outlined in the Technical Manual that accompanies each rating tool. Projects may be asked to resubmit for a second round evaluation if the panel is not satisfied with the first submission.
Your Home Technical Manual	Build/renovate	Online	No	No	No	No
HIA GreenSmart House	Build/renovate	HIA	Yes, GreenSmart Professional accreditation managed by HIA	No. Prerequisite is "knowledge of building terminology and practices."	Yes, 2 day course to become a GreenSmart Professional	Accreditation for projects is assessed by HIA to ensure that the project meets the GreenSmart protocol.

9.3 Calculation methodologies

System	Phase	Scope	Basis of any calculations	Published methodology	Evidence for methodology	Date calculations set	Updates
Sustainability Declaration	Buy/sell	13 energy efficiency actions: alternative power sources, low GHG hot water systems, off-peak pool pump, covered outdoor living area, insulation, light coloured roof, roof ventilation, window shading, energy efficient windows, lights, cooking, air conditioners and fans	Not disclosed	No	Not disclosed	2009	N/A
The 17 Things	Buy/sell	Energy components include climate zone, orientation, cross-ventilation, zoning, insulation, building materials, windows, shading, heating and cooling devices, lighting, hot water, PV, energy rating	The features included are based on consultation with specialist sustainable design consultant	No	Not disclosed	2013	New system
ACTHERS	Buy/sell	Based on the theoretical amount of energy required to heat and cool the home to a comfortable temperature. It relates only to the building and relevant external objects that may shade the building and does not consider the effect of occupant behaviour or the appliances used in the building. The relevant elements include orientation, building materials, ceiling height, windows, building openings, shading, insulation, air tightness and ventilation, ceiling fans, floor coverings, solar access.	NatHERS rating (using FirstRate v4.05 software)	No	Not disclosed	Not disclosed	No. Uses superseded version of NatHERS software
NABERS	Occupy	All energy use in the home	Comparison of actual per person carbon emissions of the home against benchmarks that represent the performance of other similar buildings in the same location, taking into account climate and energy sources.	No	Statistical analysis of actual per person energy use data from NSW and Victorian homes. Involved "thousands of data points" (http://www.xgl.com.au/policy.html)	2004	No
NABERS Energy Explorer	Occupy	All energy use in the home	Not disclosed	No	Not disclosed	2010	No
My AGL IQ	Occupy	All energy use in the home	Actual energy use records for comparison between similar homes “based on data we have collected from various sources and our statistical modelling”	No	Not disclosed	Not disclosed	Website suggests that the statistics may be revisited over time.
Household Energy Use Calculator	Occupy	All energy use in the home	Modelled based on user input and assumed appliance energy consumption. Data sources are not published	No	Not disclosed	Not disclosed	Unknown
Low Carbon Lifestyles	Occupy	All energy use in the home	Savings are based on modelled energy consumption for three scenarios (flat, small/large houses with "average" / inefficient equipment).	Yes	Published research methodology	2012	No
Ecologic	Occupy	All home energy use	EnergyPlus simulations, assumed house characteristics based on user entry choosing from limited set of options	No	Not disclosed	2014	New system
Smarter Renovations Planner	Refurb	The system provides a checklist that covers the following: ceiling insulation; wall insulation; floor insulation under timber floors; draught proof; lighting; windows; heater; hot water service; solar PV panels and appliances.	Not disclosed	No	Not disclosed	2014	New system
SEED	Refurb	All energy use, including building shell and appliances. Specific areas: weather sealing, insulation, glazing, lighting, hot water, heating and cooling, Fridge, "other appliances", PV	Not disclosed	No	Not disclosed	Not disclosed	Not disclosed
Energy Efficient Home Renovator	Refurb	Information provided on shading, PV, solar hot water, insulation and heating/cooling	N/A	N/A	Fact sheets reference Your Home	Not disclosed	Not disclosed
Your Energy Savings	Refurb	Information provided on orientation, appliances, windows and building fabric, outdoor living areas, shading	N/A	N/A	References Your Home	Not disclosed	Not disclosed
NatHERS	Build/renovate	NatHERS accredited computer software simulates how heat enters and escapes a house every hour of every day of the year, assuming the occupants open and close windows and any blinds or awnings to make best use of the local climate. For non-regulatory uses, the expanded tools AccuRate Sustainability and BERS Pro Plus have	A NatHERS star rating depends on how much cooling or heating a 'standard family' (the occupants) may need to stay comfortable during a typical year. The rating depends on:	No	Each software package uses the same: • weather files compiled from Bureau of Meteorology records	The first generation software were developed in 1990s and the second generation software were released in 2006	Modifications to software are made where robust evidence supports such a change. In some instances these modifications are

		additional functionality to allow modelling of water use and other energy impacts such as lighting, hot water and major fixed appliances.	• the layout of the home • the construction of its roof, walls, windows and floor • the orientation of windows and shading to the sun's path and local breezes • how well these suit the local climate.		• occupancy settings for a 'standard family' • heat loads to take into account the internal 'heat load' of a building that impacts on its thermal comfort • star rating scale for the home's location.		made in response to evidence from research studies funded by industry investment.
BASIX	Build/renovate	Energy consumption and savings are assessed based on: • Hot water system • Heating and cooling • Ventilation • Lighting • Pools and spas • Alternative energy sources • Other energy uses • Central systems The Thermal Comfort assessment are based on: • Orientation • Windows • Ventilation • Insulation • Thermal mass; and • Shading- balancing heat, light and glare.	The BASIX calculator calculates how a single dwelling, alteration and addition or multi-unit is likely to perform against a benchmark development of the same type. It uses comprehensive data sets supplied from utility organisations, state agencies and the Australian Bureau of Statistics to analyse and compare the proposed development against the NSW 'average'. This data includes resource demand, occupation levels, and market penetration rates of technology, climate and other factors.	No	The data sets are supplied by utility organisations, state agencies and the Australian Bureau of Statistics	2004	There was an update on the Thermal Comfort Protocol in 2013.
eTool	Build/renovate	Life cycle costs - embodied carbon and operational energy use for all home elements	Australian LCI inventory, user specified operational energy use	No	Not specified	Not specified	Regular updates by eTool at developer discretion
Energy Efficient Home Design	Build/renovate	Information on insulation, heating and cooling, water heating, lighting, draught proofing, appliances, solar, metering and bills	N/A	No	Not specified	Not specified	Not disclosed
Window Comparison Tool	Build/renovate	Window energy use	Number and size of windows is based on modelled home. Three home designs (small, medium, large) all well-insulated new homes with deep eaves. Savings based on difference in AccuRate modelled energy consumption between windows of the selected types.	No	AccuRate modelling data	2009	No
Green Star Multi unit	Build/renovate	Lighting, HVAC, hot water, lifts and amenities, cooking, on-site electricity generation	Comparison with a benchmark building that complies with the legislated minimum energy efficiency performance in the Building Code of Australia 2008 (BCA) Section J. The efficiency of the building components not covered in the BCA is established to represent standard practice.	Methodology to determine benchmarks not disclosed	The methodology was developed in house in conjunction with expert advice.	Original 2009	Yes, annual review
Your Home Technical Manual	Build/renovate	All building elements	N/A	N/A	Not specified. Each fact sheet nominates an expert author and includes references where appropriate	Originally developed in 2001, 5th edition published 2013	Yes, regular updates
HIA GreenSmart House	Build/renovate	Mandatory components: minimum expectations in thermal performance, orientation, glazing, natural ventilation, zoning, flooring, air tightness, hot water, lighting, clothesline, energy use meter. Must also choose from leading practice in 2 of these categories or by installing PV, alternative heating/cooling, high efficiency appliances, etc.	Your Home is extensively referenced in guidance documents. Methodology to determine acceptable level for each component not disclosed.	No	Published information primarily Your Home.	Original protocol 1999, new versions published at least 2009, 2011, 2013	Yes, protocol is reviewed regularly.

9.4 Assessment process

System	Phase	Assessment initiation	Assessment process	Information needed for an assessment	Information gathering	Quality expectations	Expiry
Sustainability Declaration	Buy/sell	Must be completed prior to advertising the home for sale	In-home visit or by seller	Presence of the 13 energy efficient options	Walkthrough of home	Information must not be misleading. A fact sheet sets definitions of the energy efficient options, but open to interpretation (eg window shading should be "reliable including wide eaves, tree shading or external shutters, blinds or awnings", energy efficient windows "may have a blue, green or bronze colour to them", or be double/triple glazed, or shown on plans, lights include "fluorescent tubes, CFL, LED, neon and metal halide lights")	Yes, expires when building is sold or withdrawn from sale
The 17 Things	Buy/sell	Real estate agents offer vendors to do the assessment as an additional service for marketing the property	Site visit by the real estate specialist	Check for presence of the 17 Things	Walkthrough of home, Some features requires independent documentation to verify (insulation, glazing, PV and energy rating).	External validation of certain elements. Delivery agents supported by handbook detailing requirements for proving each feature.	Not disclosed. Likely to be valid for the duration of the sale campaign unless there are changes made to the property.
ACTHERS	Buy/sell	At the point of sale (for existing homes) or at design stage (for new homes)	Home visit for existing homes and off the plan for new homes	Site location, size of dwelling and detailed information of energy, water and thermal comfort features in the home design.	Site visit, plans and documentations	The quality of the gathered information is specified in detailed in the Code of Practice.	An EER Statement is defined as current if: (1) it reflects the status of construction and rateable building elements of the relevant building; and (2) for premises that have been occupied, the vendor or the owner of the relevant property has commissioned the EER; and (3) the EER is not older than 6 months since it was issued; or (4) if the EER is older than 6 months since it was issued, it is accompanied by a statutory declaration made by the vendor under the Statutory Declarations Act 1959 (Commonwealth) declaring that the fabric of the building and external elements used in the EER have not been materially.
NABERS	Occupy	Householder finding calculator online. No promotion outside the NABERS website	Online self-assessment	Twelve months worth of energy bills, information about location and number of people in the home	By householder during assessment	None	No
NABERS Energy Explorer	Occupy	Householder finding calculator online. No promotion outside the NABERS website	Online self-assessment	Twelve months worth of energy bills, information about location and number of people in the home	By householder during assessment	None	No
My AGL IQ	Occupy	Householder finding calculator online, or linked from bill	Online self-assessment	Basic information about home characteristics (number of people, appliance data)	By householder during assessment	None	No
Household Energy Use Calculator	Occupy	Householder finding calculator online.	Online	General knowledge of the home, detailed usage information, some detailed knowledge of appliance sizes and energy consumption	By householder during assessment	None	No
Low Carbon Lifestyles	Occupy	Householder finding document online	By reading document.	None	N/A	N/A	N/A
Ecologic	Occupy	Householder finding calculator online.	Online	General knowledge of the home	By householder during assessment	None	No
Smarter Renovations Planner	Refurb	Householder finding the system online.	Online self-assessment	Information about the house: size of house, occupancy pattern, building	By householder during assessment	None	No

				material, orientation; Information of energy related features and the intention to upgrades these: existing heating systems, hot water appliances and windows.			
SEED	Refurb	Homeowner opting in through website	In home visit	Basic information on the home shell and appliances	During visit by walkthrough and discussion with homeowner	Not disclosed	No
Energy Efficient Home Renovator	Refurb	Householder finding tool online	Online self-assessment	None	N/A	N/A	N/A
Your Energy Savings	Refurb	Householder finding tool online	Online self-assessment	None	N/A	N/A	N/A
NatHERS	Build/renovate	At design stage to meet regulatory compliance	Desktop assessment with modelling software	Detailed design and building material information	Building plans/drawings and other specifications	Accredited assessors are bound by the Code of Practice which commit them to: • a high level of diligence and professionalism to ensure that their Assessments are as accurate as possible; - operating at all times in compliance with all applicable laws • producing assessments in compliance with relevant building regulations, including any state or territory-specific requirements • applying the most recent version of the NatHERS Technical Notes and using the most recent version of NatHERS Software in effect at the time the assessment is completed • The assessments are also subjected to the compliance and audit procedure set up by the AAOs.	Not specified
BASIX	Build/renovate	At design stage in preparation for DA submission	Online assessment based on design plans	Site location, size of dwelling and detailed information of energy, water and thermal comfort features in the home design.	From design plans and documentations	The BASIX certificate commitments' such as floor areas, landscaped areas, appliances, insulation and glazing etc. are recorded on plans and documents that are submitted for assessment by consent and certifying authorities. BASIX certificates are reviewed by Council and checked during the building process. Any inconsistencies may result in costly changes to development.	A BASIX certificate is valid for 3 months, prior to submission to council or accredited certifier. Once the BASIX certificate is lodged with the council or accredited certifier it is valid for the maximum life of the development application. If the BASIX certificate is not lodged within 3 months a new certificate needs to be generated. If changes are made to the project, the BASIX certificate will need to be updated by completing another BASIX assessment and printing a new certificate.
eTool	Build/renovate	Voluntary – client finding system online, or designer suggesting use	By designer online, or by eTool assessor for formal certification	Detailed design information from other sources (eg MJ/m2 energy use from all sources, m2 of every material used in the house, etc)	By designer	None	No
Energy Efficient Home Design	Build/renovate	Householder finding tool online	Online self-assessment	None	N/A	N/A	N/A

Window Comparison Tool	Build/renovate	Householder finding calculator online, or designer seeking generic information to help window choice.	Online	General knowledge of the home location, some understanding of different window technologies and terminology	By householder during assessment	None	No
Green Star Multi unit	Build/renovate	At discretion of building owner	By expert using spreadsheet	All design documentation for building	By designer	Not specified.	Green Star design ratings are valid for two years after practical completion of building. As built ratings do not expire.
Your Home Technical Manual	Build/renovate	N/A	Online	Detailed	N/A	N/A	N/A
HIA GreenSmart House	Build/renovate	At discretion of designer / builder / developer	By expert from design documentation	Detailed design information	By designer/builder	N/A	N/A

9.5 Assessment time estimates[29]

System	Phase	Assessor	Householder time	Assessor time	Estimated time in data preparation	Household cost	Expert cost	Total cost
Sustainability Declaration	Buy/sell	Seller or agent completing PDF checklist	30 minutes	30 minutes	None	$10	$75	$85
The 17 Things	Buy/sell	Liveability Real Estate Specialist	N/A	30 min to 1 hour by the real estate specialists	30 min if using externally validated information.	$42	$150	$192
ACTHERS	Buy/sell	Accredited Assessors	N/A	Varies depending on the size of the house and the quality of documentations. Online quotes vary from $200 to $30030	Varies depending on the size of the house and whether existing documentations are available and complete	$0	$300	$300
NABERS	Occupy	Householder	5 minutes	N/A	30 minutes for householder	$2	$0	$12
NABERS Energy Explorer	Occupy	Householder	60 minutes	N/A	0 minutes	$21	$0	$21
My AGL IQ	Occupy	Householder	10 minutes	N/A	5 minutes	$3	$0	$5
Household Energy Use Calculator	Occupy	Householder	10 minutes	N/A	0, but requires detailed knowledge of home and behaviour	$3	$0	$3
Low Carbon Lifestyles	Occupy	Householder	N/A	N/A	N/A	N/A	N/A	N/A
Ecologic	Occupy	Householder	20 minutes	N/A	0, but requires detailed knowledge of home and behaviour	$7	$0	$7
Smarter Renovations Planner	Refurb	Householder	5 minutes	N/A	Fairly easy; 5 minutes.	$2	$0	$3
SEED	Refurb	Energy auditor	Not published	Not published. Cost $29531	Not published	$62	$296	$358
Energy Efficient Home Renovator	Refurb	Householder	N/A	N/A	N/A	$0	$0	$0

[29] Note – author estimates, not based on published data. Household cost is based on median weekly equivalised disposable household income ($790, source: ABS 6523.0 Household income and income distribution), made per hour at 38 hours per week. Where quotes are not published, expert time cost is estimated at $150 per hour.

[30] http://www.canberrahomeconsultants.com.au/ $190, http://residentialreports.com.au/selling-a-house-in-the-act $290, http://www.actbis.com.au/index.php/prices $275,

[31] http://www.energymakeovers.com.au/energy-assessments/

Your Energy Savings	Refurb	Householder	N/A	N/A	N/A	$0	$0	$0
NatHERS	Build/renovate	Accredited assessors for regulatory compliance	N/A	1 - 2 hour to complete. Online quotes vary from $200-90032	Should be fairly straightfoward - probably less than 30 min to 1 hr.	$0	$500	$500
BASIX	Build/renovate	Building professionals such as designers/architects/planners;	N/A	Varies as it depends on the complexity of the project and whether simulation method is used for the thermal comfort assessment. Online quotes $150-$70033	Varies depending on the complexity of the project and whether the documentations are complete	$0	$400	$400
eTool	Build/renovate	Designer	N/A	Estimate 8 hours	Not difficult if design documentation available. Involves estimating operational use which may need research / evidence.	$0	$1,200	$1,200
Energy Efficient Home Design	Build/renovate	Householder	N/A	N/A	N/A	N/A	N/A	N/A
Window Comparison Tool	Build/renovate	Householder	2 minutes	N/A	0 minutes	$0	$5	$5
Green Star Multi unit	Build/renovate	Green Star assessor	N/A	For energy component only, estimate 16 hours	Not difficult if design documentation available	$0	$2,400	$2,400
Your Home Technical Manual	Build/renovate	N/A	N/A	N/A	N/A	N/A	N/A	N/A
HIA GreenSmart House	Build/renovate	Builder / designer	N/A	Estimate 2-3 hours	N/A	$0	$450	$450

[32] http://www.denebdesign.com.au/basix%20certificate.html $430-$885, http://www.arcinovationz.com.au/thermal.html $200-$400, http://www.energymakeovers.com.au/energy-assessments $425, http://crispgreenhomes.com/service-1/existing-homes $495

[33] http://www.arcinovationz.com.au/thermal.html BASIX plus ABSA $400-$600, http://www.denebdesign.com.au/basix%20certificate.html $150-$685

9.6 Information conveyed

System	Phase	Information in report	Presentation	How was presentation method chosen	Evidence of effectiveness	Expertise to understand	Retention of information
Sustainability Declaration	Buy/sell	Complete list of energy efficient options, with checks against those present in the home.	Checklist	Not disclosed	Yes, QUT research one year after launch	None	No
The 17 Things	Buy/sell	A checklist that shows which of the 17 features are available in the property.	A hardcopy checklist. In order for a property to be able to show the Liveability Features™ symbol in online property marketing it has to have at least 6 of the specially selected features within the checklist.	In-house research and consultation with industry partners	Not disclosed	Easy to understand	Not disclosed
ACTHERS	Buy/sell	imprint of the assessor's stamp stating the number of points and stars achieved by the dwelling, the date the assessment was completed and the assessor's printed name, signature and registration number. A rating summary sheet should be attached with a detailed house data table and, for properties that have been occupied and are being sold, an "Improving Your Rating" sheet and, in cases where a statutory declaration is to be provided, a signed, dated and witnessed declaration.	Certificate	Based on the rating output from the designated tool i.e. FirstRate	A study by the Australian Bureau of Statistics of houses sold in 2006 in Canberra showed that for each increase in half a star the capital value of the property increased by 2%.	The information on the certificate are fairly easy to understand.	On government registry
NABERS	Occupy	Star rating as primary metric, greenhouse emissions (raw) - listed in technical information and small font. Suggests it is not considered as important for users	Online results page	Based on established success of NABERS rating for office buildings.	Not disclosed	Star rating is intended to be intuitive. Greenhouse gas emissions is technical information, likely requires understanding of scale of other greenhouse emissions etc.	No
NABERS Energy Explorer	Occupy	Actual and estimated NABERS ratings, estimated CO2 emissions, breakdown of major end uses, list of actions including $savings and cost range from free to $$$	Online results page and PDF "Energy Savings Action Plan"	Not disclosed	Not disclosed	None.	Yes, on NABERS website for future user reference
My AGL IQ	Occupy	Actual energy consumption by day/week/month/year, comparison to similar / efficient homes, and basic energy saving tips	Online results page	Not disclosed	Not disclosed	None	Yes, by AGL website to allow regular user interaction
Household Energy Use Calculator	Occupy	Estimated energy cost per day by major appliance phase. Generic tips on energy savings opportunities (not tailored).	Online	Not disclosed	Not disclosed	None	No
Low Carbon Lifestyles	Occupy	Information on broad range of savings activities defined at three specific scenarios. Not tailored to home or user.	PDF	N/A	Not disclosed	None.	N/A
Ecologic	Occupy	Estimate of electricity and gas use per day compared with "efficient" and "typical" (defined as homes with the same building geometry, number of occupants and climate. Typical has "similar building features and appliances that are typical to your local area", and an efficient home has an "affordable suite of energy savings measures installed").	Online	Not disclosed	Not disclosed	None	Yes, stored on ecologic website for future access by user.

		Results also include a modelled breakdown of energy use. An "act" page lists the efficient energy savings measures as a call to action.					
Smarter Renovations Planner	Refurb	A checklist that covers suggestions for the following measures: ceiling insulation; wall insulation; floor insulation under timber floors; draught proof; lighting; windows; heater; hot water service; solar PV panels and appliances. Based on the measures selected, the checklist generates an estimated total installation and purchasing costs for the selected measures and the Energy savings per year in $.	Online, can be printed as a hardcopy checklist too.	Not disclosed	Not disclosed	Easy to understand, the checklist also provides links to more detailed information for each suggested measures.	No
SEED	Refurb	List of tips	Online + report	Not disclosed	Not disclosed	None	Yes, on Energymakeovers website
Energy Efficient Home Renovator	Refurb	High level information on design considerations for each major phase. Not tailored to home or user.	Online	N/A	Not disclosed	None. Would be most useful as a guide for discussion between household and designer during renovations or new build.	N/A
Your Energy Savings	Refurb	High level information on design considerations for each major phase. Not tailored to home or user.	Online	N/A	Not disclosed	None. Would be most useful as a guide for discussion between household and designer during renovations or new build.	N/A
NatHERS	Build/renovate	Rating between 1 to 10 stars stamped on plans and a Homeowners Certificate. Ratings of 5 or 6 stars mandatory for new houses depending on state legislation.	Certificate and plans	Not sure	AccuRate has been verified against the International Energy Agency BESTEST protocol, which compares the results of a set of base houses under varying conditions against eight reference programs from Europe and the US. Empirical testing conducted by the CSIRO has further verified the accuracy of AccuRate.	Star rating is intended to be intuitiven but some level of expertise may required to understand the other technical output from the tools	Accredited assessors are required to lodge all assessments conducted for regulatory purposes with the AAO to which they are accredited
BASIX	Build/renovate	The certificate shows the project score for energy and water (i.e. the percentage reduction in energy and water consumption) and indicates whether the proposed development meets the prescribed thermal comfort performance. The BASIX commitments (i.e. items will be included in the construction), along with information which identifies and describes the proposal, will be shown on the BASIX Certificate.	Certificate can be printed at a cost if the proposal successfully meets the prescribed targets	The metrics are chosen to ensure that the proposed development meets a minimum target of percentage reduction in emissions or water consumption from the NSW average benchmarks.	5-year outcome report summarises the outcomes of BASIX from 2004 to 2009. The outcomes are primarily based on estimations rather than actual post evaluations. The University of Canberra has also completed a study and produced a report "Building professionals' and homeowners' perceptions of BASIX". The survey found while respondents generally considered BASIX has been effective in reducing residential energy and water consumption, BASIX is perceived to have influenced professional rather than householder behaviour.	The results as indicated on the certificate are quite straightforward and easy to understand.	Yes, some information are retained in the BASIX database. Detailed information of the proposed development (i.e. plans and documentations, simulations etc.) are submitted to the consent authorities.
eTool	Build/renovate	Total GWP plus improvement options	Online + certificate	Not disclosed	Not disclosed	Design expertise	Yes on eTool website
Energy Efficient Home Design	Build/renovate	Detailed information on design considerations for each major phase. Not tailored to home or user.	Online	N/A	Not disclosed	None. Would be most useful as a guide for discussion between household and designer during renovations or new build.	N/A
Window Comparison Tool	Build/renovate	Estimated financial and GHG savings with the more efficient windows.	Online	Not disclosed	Not disclosed	None	No
Green Star Multi unit	Build/renovate	Star rating and overall score for	Online + certificate	Not disclosed	Not disclosed	None	Yes on GBCA website

		Energy phase					
Your Home Technical Manual	Build/renovate	N/A	N/A	N/A	N/A	N/A	N/A
HIA GreenSmart House	Build/renovate	Allow use of logo	Certificate	Not disclosed	Not disclosed	None	No

10 Appendix 2 - Mapping Evaluation Findings of Systems by Themes Around Effectiveness

	BASIX	NatHERS	ACTHERS	Sustainability Declaration
Market acceptance - householders	A study on "Building professionals' and homeowners' perceptions of BASIX" found householders in homes built after July 1, 2006 tended to use less air conditioning in summer and heating systems in winter compared to those in the houses built before that time. The later a home was built, the higher householders perceived the quality of indoor thermal insulation quality. (NSW Department of Planning and Environment (a), 2011)	-	An unpublished 2006 report for the Australian Government on the perception of ACTHERS finds that awareness of the requirement for an Energy Efficiency Rating (EER) is high (80%). The majority (80%) of buyers and sellers understood that the EER star rating is an indication of energy efficiency of the dwelling. (Consult, 2006) An unpublished market research in 2011 found that 77% of the 250 ACT buyers surveyed recalled seeing the EER at the point of sale (Instinct and Reason, 2011)	Research by Bryant & Eves (2011) in a survey of real estate agents showed that widespread disengagement with the sustainability declaration process was recorded from sellers, and even more so, from buyers. Results indicate that 98% of buyers do not ask for a copy of the sustainability declaration at any time during the sales process. Unpublished market research in 2011 found that only 24% of the 250 QLD buyers surveyed recalled seeing the Sustainability Declaration at the point of sale (Instinct and Reason, 2011).
Market acceptance - practitioners	The "Building professionals' and homeowners' perceptions of BASIX" study found while respondents generally considered BASIX has been effective in reducing residential energy and water consumption, BASIX is perceived to have influenced professional rather than householder behaviour. The survey responses indicated that BASIX design choices are likely to be made by professionals rather than requested by households. (NSW Department of Planning and Environment (a), 2011)	-	The unpublished 2006 report for the Australian Government shows that many stakeholders such as real estate agents, builders, architects and designers are sceptical of the value of the scheme for existing homes. (Consult, 2006)	Whilst agents are not required by law to provide sustainability declarations to potential buyers, many do (60%). Therefore, up to 40% of the forms completed by sellers, are never provided to any potential buyer. Of those that are used, virtually none (96%) impact the buyer's decision making process (Bryant & Eves, 2011)
Effectiveness in changing market practice and driving demand for more sustainable choices	The introduction of BASIX significantly decreased the use of inefficient electric storage hot water systems and increased the use of alternative water sources, particularly water tanks, to most new dwellings. BASIX has almost entirely phased out high emission electric storage and instantaneous hot water systems in new homes and drive the demand for alternative gas, solar and heat pump hot water system types even before the mandatory phasing out of these systems. New pools are not permitted to install high emission electric resistance heating systems under BASIX. (NSW Department of Planning and Environment (b), 2011)	A study by CSIRO in 2013 comparing 5-star and above houses with houses of lower star ratings found increases in the amount of insulation and an apparent shift to more rectangular house design were the most influential aspects observed in 5-star and above houses. (Ambrose, James, Law, Osman, & White, 2013)	A study by the Australian Bureau of Statistics of houses sold in 2006 in Canberra showed that for each increase in half a star the capital value of the property increased by 2%. This report concluded that "a statistically significant relationship does exist". (Australian Bureau of Statistics, 2008) Unpublished market research in 2011 found that 39% of the surveyed sellers said the EER influenced them to act to improve energy efficiency of the dwellings prior to selling, while 23% of the surveyed buyers claimed the EER helped them prioritise energy efficiency improvements they made. The research also found that many consumers dismiss mandatory energy efficiency disclosure as not relevant to their choice of house to buy/sell but when the final dwelling purchase decision is being made, energy efficiency is factored into the final choice for 40% of buyers. 5% of buyers claimed that the sale price was affected by the EER (Instinct and Reason, 2011)	Research by Bryant & Eves, (2011) suggested that "whilst sustainability features may be desirable to a proportion of home buyers [eg 30% showed interest in ceiling insulation], they are not of a sufficient impact to sway decision making". An unpublished market research in 2011 found that only 19% of the 500 QLD buyers and sellers surveyed had done something to make the dwelling they bought or sold more energy efficient. Unpublished market research in 2011 found that 28% of the surveyed sellers said the Sustainability Declaration influenced them to act to improve energy efficiency of the dwellings prior to selling, while 13% of the surveyed buyers claimed the Sustainability Declaration helped them prioritise energy efficiency improvements they made. The research also found that only 19% of surveyed QLD buyers factor in energy efficiency when making the final dwelling purchase decision, and just 2% claimed that the sale price was affected by the Sustainability Declaration (Instinct and Reason, 2011)

Cost benefits	Economic analysis conducted in 2009 estimated that to 2050, new BASIX certified dwellings will generate a positive benefit to New South Wales of between $1.20 and $1.60 for every dollar spent complying with BASIX through lower household bills, emission reductions and avoided electricity network expansion. For an average new home, BASIX compliance is estimated to deliver between $287 to $368 a year in water and energy bill savings (NSW Department of Planning and Environment (b), 2011)	The CSIRO study found that the net annual heating and cooling costs in Brisbane were greater in higher-rated houses, whereas Adelaide and Melbourne costs were lower for the higher-rated houses. The study also showed that based on the sampled house designs, it has actually been less expensive to meet the 5-star standard than the previous standard. The higher-rated houses cost at least $5000 less in Adelaide and Melbourne for those elements of the building related to energy efficiency than lower-rated houses, and up to $7000 less in Brisbane. (Ambrose, James, Law, Osman, & White, 2013)	-	-
Energy savings	New BASIX homes certified between 2004 and 2009 are predicted to have already saved up to 693,000 tonnes of greenhouse gases. (NSW Department of Planning and Environment (b), 2011)	The 2013 CSIRO research shows that the 5-star standard significantly reduced the energy needed to maintain house temperatures in winter in the houses studied. As well as saving energy, higher-rated houses were on average held at a temperature around 1 °C higher than lower-rated houses during winter. However, The average cooling energy use in summer was greater in the 5-star or above houses in Brisbane and Melbourne. Greenhouse gas emissions were reduced in winter in higher-rated houses in all the 3 cities but summer emissions increased in higher-rated houses in all 3 cities. Overall, greenhouse gas emissions were still reduced by 7% for the higher-rated houses over the year, despite the summer season increase. (Ambrose, James, Law, Osman, & White, 2013)	-	-
Quality in terms of delivery and implementation	The only compliance related evaluation done on BASIX is around how BASIX certificate commitments are recorded on plans and documents for assessment by consent and certifying authorities. The findings show that the current standard of submitted DA and CC documents and plans that reflect BASIX Certificate commitments is generally fair to good, with the exception of some aspects of thermal comfort compliance (Eckstein, 2013)	A NatHERS benchmarking study was done in 2013 to measure the accuracy of NatHERS assessments. 344 assessors participated in the study (self nominated, not random sample) and were randomly allocated one of four houses to rate and their assessments were compared with a solution set prepared by a committee of expert assessors. Approximately 100 questions about NatHERS data entry for each house were developed to specifically test how assessors applied Technical Notes 1 and 2, whilst also testing accuracy of general data entry techniques. Only 21% of assessments obtained the correct rating with 64% of assessors had an error greater than 0.25 of a star. This study found that there was a high level of error in NatHERS ratings irrespective whether assessors were accredited or not. (Floyd Energy, 2014)	-	In Queensland a secondary market was created where online ‘sustainability declaration ’providers who for a fee as low as $100 will help the owner generate the necessary declaration. (O’Leary, 2012)

10.1 Works Cited

Ambrose, M., James, M., Law, A., Osman, P., & White, S. (2013). *The Evaluation of the 5-Star Energy Efficiency Standard for Residential Buildings.* Prepared for the Department of Industry by CSIRO.

Australian Bureau of Statistics. (2008). *Energy efficiency rating and house price in the ACT*. Prepared for the Department of the Environment, Water, Heritage and the Arts.

Bryant, L., & Eves, C. (2011). Sustainability and mandatory disclosure in Queensland: an assessment of the impact on home buyer patterns. *In 17th Pacific Rim Real Estate Society Conference, 16-19 January 2011, Gold Coast, Australia.*

Consult, E. (2006). A study of the Impact of Mandatory Energy performance Disclosure Requirements for Class 1 Buildings in the ACT. Prepared for the Department of Environment and Heritage.

Eckstein, D. (2013). *BASIX Compliance Audit program.* Prepared for the NSW Department of Planning and Environment.

Floyd Energy. (2014). *NatHERS Benchmark Study 2013.* Prepared for the Department of Industry.

Instinct and Reason. (2011). Impact of Residential Mandatory Disclosures Scheme Market Research Report: Understanding behaviour, attitudes and preferences relating to energy efficiency of their homes. Prepared for the Department of Climate Channge and Energy Efficiency.

NSW Department of Planning and Environment (a). (2011). Building professionals' and homeowners' perceptions of the NSW Building Sustainability Index (BASIX) - an overview.

NSW Department of Planning and Environment (b). (2011). *BASIX outcomes - 5 year summary.*

O'Leary, T. (2012). Residential energy and mandatory disclosure practices. Eighteenth Annual Pacific-Rim Real Estate Society Conference, Adelaide, Australia, 15-18 January 2012.

11 Appendix 3 - Standard home details for technical comparison

Category	Item	Units	
General			
	Name		Home 1
	Description		Inefficient western Sydney detached home
Building			
	Age	years	30
Location	Address		30 Darcy St
	Suburb		Parramatta
	Postcode		2150
	NatHERS climate zone		28 Richmond
	State		NSW
	Attachment		Detached
	Orientation		South
	Exposure		Suburban
Building type	Storeys		1
	Roof type		Attic
Size	# bedrooms		3
	# living areas		2
	Bedroom 1 + storage	m2	23.04
	Bedroom 2	m2	15.12
	Bedroom 3	m2	12.96
	Kitchen	m2	17.15
	Living	m2	19.11
	Dining	m2	28.44
	Bathroom	m2	4.8
	Laundry	m2	6.6
	Entranceways	m2	4.68
	Floor area	m2	131.9
	Covered outdoor living area	m2	25.2
Building materials	External walls		Brick veneer
	Internal walls		Plasterboard on stud walls
	Roof		Tiles

	Floor		Timber
Insulation	Ceiling insulation	R-value	0
	Wall insulation	R-value	0
Windows	Glazing type		Single glazed aluminium frame
	# windows		13
	Average window height	m	1.2
	Average window width	m	1.5
	Window glazing area	m2	23.4
	Perimeter	m	70.2
	Window shading		0%
	Curtains + pelmets		0%
Glass doors	# glass doors	#	1
	Average door height	m	2.1
	Average door width	m	1.5
	Door glazing area	m2	3.15
	Perimeter	m	7.2
	Total glazing area	m2	26.55
Solid doors	External doors	#	2
	Average door height	m	2.1
	Average door width	m	1
	Area	m2	4.2
	Perimeter	m	12.4
Weather sealing	Chimney sealed		N/A
	Vents sealed		N/A
	Air changes	#/hour	1
Covered outdoor living area			Yes
	Area	m2	30
Fixed appliances			
	Hot water system		Electric resistance
	Size	litres	315
	Age	years	5
	Stove		Electric resistance
	Oven		Electric resistance
	Central heating / cooling		N/A

	Pool pump		N/A
	Pool heater		N/A
Energy supply			
	Electricity	kWh	11000
	Gas	MJ	0
	LPG		0
	Greenpower	%	0
	Solar PV	kW	0
	Hot water tariff		Continuous
	Pool pump tariff		N/A
	Electricity tariff	$/kWh	$0.30
	Feed-in tariff	$/kWh	$0.06
	Gas tariff	$/MJ	$0.03
	Water tariff	$/kL	$2.20
Usage/behaviours			
Occupancy	# of adults		2
	# of children		2
	# of persons		4
	Occupied daytime weekday		100%
	Occupied weekend		100%
	Unoccupied	days/year	28
HVAC	Summer temperature	°C	25
	Winter temperature	°C	21
	Air conditioner use	hours/year	180
	Heating use	hours/year	720
Hot water	Total shower time per week	minutes/week	280
	# full baths per week		0
	Cold water clothes wash		100%
Laundry	Use washing machine	loads/week	8
	Washing machine program		Normal
	Use dryer	loads/week	2
	Hanging out clothes	loads/week	6
	Hanging out clothes	%	75%

Kitchen	Use second fridge	days/year	365
	Use dishwasher	loads/week	7
	Dishwasher program		Normal
	Wash dishes by hand	# times/week	14
	Use stove	# times/week	5
		mins/day	30
	Use oven	# times/week	1
		mins/day	20
	Use microwave	mins/day	15
Living	Use TV	hours/day	3
	Use computer	hours/day	6
Lighting	Living area lights	hours/day	8
	Bedroom/bathroom lights	hours/day	1
	Outdoor lights	hours/day	0.5
Lighting			
Living areas	50W halogen downlight	#	6
	70W halogen GLS	#	2
Bedrooms	70W halogen GLS	#	4
Bathroom etc	30W fluorescent	#	4
Outdoors	100W floodlight or GLS	#	3
User appliances			
Kitchen	Primary fridge size		Top mount 420L
	Energy rating	stars	2
	Secondary fridge size		Bar fridge 120L
	Secondary freezer type		Chest freezer 220L
	Microwave		Yes
	Dishwasher		Large
	Energy rating		1
	Kitchen tap aerators		No
Laundry	Washing machine type		Top loader
	Size	kg	6
	Energy rating	stars	1
	Clothes dryer type		Electric

	Size	kg	6
	Energy rating	stars	1
Bathroom	# showerheads		1
	Showerhead		Inefficient
	Basin tap aerators		No
Living	Air conditioner		RCAC split system
	Star rating		1 star
	Computer type		Desktop + LCD + Printer
	TV		55" LCD
	Heating		RCAC split system above
Other appliances			None