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For New Zealand Homes

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Developing a Sustainability Framework for New Zealand Homes

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Summary

This aim of this project was to identify the key elements of a New Zealand-specific ‘sustainability framework’ for houses. It was just one part of a broad, five-year research programme being undertaken by Beacon Pathway Ltd (Beacon), which commissioned this work. Beacon is a New Zealand-based research consortium funded by shareholders and the Foundation for Research Science and Technology (FRST), to carry out research into the uptake of greater levels of sustainability in the residential built environment.

Much of the housing stock in New Zealand is considered to be below par for even basic sustainability issues such as energy and water efficiency, and in many cases is below World Health Organisation guidelines for human health requirements. Even houses perceived as higher quality are expected to fall short of future requirements proposed by upcoming national goals for sustainability (e.g. The Building Act 2004, The New Zealand Sustainable Development Programme of Action 2003).
As a result, Beacon’s goal is to establish a ‘sustainability standard’ for New Zealand houses, and inform a programme of interventions that will bring about uptake of greater levels of sustainability features such that 90%+ of houses meet the ‘standard’ by 2012. This project was intended to develop the structure and content of an overall sustainability framework to guide the pursuit of this goal.

The proposed framework creates a comprehensive view of sustainability and proposes actions that are strategic and enable a conscious process of decision-making. In sum, the proposed framework provides the potential for New Zealanders to live more sustainably through the delivery of more sustainable housing.

This paper describes the project, illustrates the results achieved to date, and further elaborates on the long-term aims of the programme.
1. Introduction

Beacon is a research consortium funded by shareholders and FRST to carry out research into the uptake of greater levels of sustainability in the residential built environment. Much of the housing stock in New Zealand is considered to be below par for even basic sustainability issues such as energy and water efficiency, and in many cases is below World Health Organisation guidelines for human health requirements. Even houses perceived as higher quality are expected to fall short of future requirements proposed by upcoming national goals for sustainability (e.g. The Building Act 2004, Sustainable Development Programme of Action 2003).

Beacon’s goal is to establish a ‘sustainability standard’ for New Zealand houses, and inform a programme of interventions that will bring about uptake of greater levels of sustainability features such that 90%+ of houses meet the ‘standard’ by 2012. In addition, Beacon intends to inform the development framework for neighbourhoods, so that as neighbourhoods are developed and/or redeveloped, the principles of sustainability are taken into account.

Beacon has defined a broad programme of research to be carried out over 2004-2010 to determine the means by which these goals will be achieved. The first stage (July-September, 2004) involved 11 ‘programme confirmation phase’ projects to ensure the overall programme was well informed and that the structure of the programme was optimal. This paper summarises the findings of one of these programme confirmation phase projects, identified as the ‘Sustainability Framework Design’ project.

1.1 Project scope

The purpose of this project was to recommend the key elements of a sustainability framework with the ultimate purpose of facilitating the implementation of sustainability outcomes at the level of ‘home’. In developing these recommendations the project team considered the following issues:

- the theoretical basis of different framework designs (i.e. framework structures) and their content
- the appropriateness of a selection of environmental assessment methods for the metric element of the framework
- the needs of different constituents of the framework and the uses these constituencies might make of the framework
- the ability for the addition/deletion of new factors as new information becomes available, or the importance of certain issues changes (i.e. future-proofing)

1.2 Defining the ‘Sustainability Standard’

Before we could begin to develop the sustainability framework for houses, what we meant by sustainable housing needed to be established. This is because without first defining a future ‘end-point’, reaching sustainability is an unlikely outcome of any effort. It is from this ‘end-point’ that the framework levels will be strategically designed. Using the Beacon vision, our ‘end-point’ is defined as: “to bring the vast majority (90%+) of New Zealand homes to a high standard of sustainability by 2012”. To do this, we need to know what the ultimate sustainable house is and what a ‘high standard’ would be in relation to this. Following the basic tenet of the Brundtland
Report (1987), the ultimate sustainable house should not only cater for the needs of the present generation, but also for those to come.

1.2.1 The ultimate sustainable house

To sustain something now and for future generations implies that its presence must not damage the environment in which it is set and which sustains both its initial creation and its subsequent continuation. This seems logical, as life cannot exist if the environment is damaged to the extent of no longer being able to support life. On this basis, a simple definition of a sustainable house would be as follows:

“A sustainable house causes no damage to the environment.”

However, the construction of anything is likely to cause some environmental damage. Even the erection of a tent disturbs the soil, flattens plants etc. So, what we mean is that the environment must be safeguarded from deteriorating to such an extent that it diminishes the ability of the environment to recover both in the short and long term (Chiu 2003). The definition needs to be refined as follows to cover this aspect of reversible damage:

“A sustainable house causes no irreversible damage to the environment.”

This definition of the sustainable house so far deals only with the impact of the house on the environment. As housing provides one of the fundamental foundations upon which society exists, develops and survives, we need to add the dimensions of society and the economy into the equation. In keeping with the Brundtland definition, we can include these dimensions by stating that a sustainable house is one where social and cultural needs are met and where resources are (more) equally available to everyone. Incorporating this then:

“A sustainable house is one where social and cultural needs are met, where resources are (more) equally available to everyone, and where no irreversible damage to the environment is caused.”

Finally, to be thorough, we are concerned with the entire life-cycle of a house\(^1\) on its site (from construction to operation to demolition), given the following:

“A sustainable house is one where social and cultural needs are met, where resources are (more) equally available to everyone, and where no irreversible damage to the environment is caused during its entire life-cycle.”

Accepting this as our ultimate ‘end-point’, the next key question was to determine the ‘high standard’ in relation to this. At the time of writing, this issue was still under discussion. It is likely that the determination of the metric element of the framework will assist in finalising this issue (more on this to follow).

2. Sustainability framework structure

Sustainability is an immense area of study. It has many different definitions and interpretations, depending on the aspirations of the target audience. Because each target audience comprises of many different societal groups, it comes as no surprise therefore that there are many different

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\(^1\) ‘House’ is taken to mean any form of residential dwelling, e.g. apartment, town house, stand-alone etc.
approaches to sustainability. These approaches are expressed in varying forms such as principles, concepts, strategies, policies/legislation, guidelines, specifications, standards, processes, tools, best practice models, case studies, indicators and assessment methods etc.

In considering various approaches, it can be seen that while the components of each approach may be different, they tend to be organised or ‘framed’ in similar ways. In broad terms, there is usually an element that reveals the overarching principles/strategy/vision that the approach aims to achieve (and/or elements that suggest how to operationalise and measure progress towards those aims). Indeed, research by Robert et al (2002) argues for a ‘holistic systems model’ for analysing these elements in a useful way. They state that the many tools and approaches, when ‘viewed’ using this model, can be seen as complementary to each other and used in parallel in the process of making progress toward sustainable development. The model has five levels categorised as follows:

**Level 1:** Principles for the *constitution* of the system. Here the principles that constitute and construct the system under study are defined. The system under study is the global ecosystem or the ecosphere. The three dimensions of the global ecosystem or the ecosphere are economy, society and environment. How these dimensions are defined reveals the principles (worldview or philosophical base) underpinning the approach.

**Level 2:** Principles for a favourable *outcome* of planning within the system. Here the desired state of sustainability, or preferred principles to achieve a certain outcome, is stated. Level 2 is a critical stage, as it is this level that sets the strategic planning direction for the entire framework.

**Level 3:** Principles for the *process* to reach this outcome Here the principles for the process to achieve the successful outcome are determined (i.e. how do we achieve the desired sustainability state as stated in Level 2).

**Level 4:** *Actions, i.e. concrete measures*, that comply with the principles for the process to reach a favourable outcome in the system Here practical actions in line with the process principles in order to achieve the outcome within the larger system are outlined. It is important not to confuse concrete actions with the principles that underpin them (Level 2). All actions must comply with the process principles (Level 3).

**Level 5:** *Tools* to monitor and audit Level 5 is where the monitoring of the whole process is described and should be designed from a total systems perspective. There are two levels to consider: (i) the relevance of actions with reference to principles for the process (e.g. indicators of flows and key-figures to comply with principles for sustainability), and/or monitoring; (ii) the status of the system itself and impacts (e.g. ecotoxicity and on employment), or reduced impacts, as a consequence of strategically planned societal actions.

This model provides a useful way of breaking down and untangling various sustainability approaches. In doing this, we are better able to understand the basis for why decisions were made, why different tools were chosen over others etc. In some cases, we may find that a particular approach hasn’t had a strategically defined direction in its planning process, there is a lack of clarification about the ultimate objectives, and the metrics are often chosen or designed in an unclear way. So, not only does it give us the means to disentangle various approaches, by using the model as a development tool, we can design a sustainability framework that is integrated, comprehensive and robust.
For this project, the project team utilised the Robert et al model and adapted it to include two further levels (see Figure 1). We recommend starting with our ‘definition of success’ (discussed above). We also suggested the addition of a Level 6 to identify how different end users could use the framework and take into account any difference in approach for new vs existing houses (there have been four user groups identified: consumers, industry, central and local government). An important aspect of Level 6 is to make the limitations of the framework explicit to ensure it is used appropriately in decision-making. The indication of feedback between Levels 4, 5 and 6 allows for advances in technology and methodology and takes into account the adaptive learning capacity of stakeholders/user groups.

![Figure 1: Proposed sustainability framework structure (adapted from Robert et al 2002)](image)

3. Framework content

After deciding the framework structure, the next step was to recommend the content for each level.

**Level 1:** Principles for the *constitution* of the system. The programme documentation clearly indicated that this project is about striving for ‘a high standard of sustainable housing’. What we were therefore looking for was a robust set of sustainability principles that offered significant changes in ways of developing knowledge and solutions that will move the New Zealand housing sector towards sustainability as we have (or will have) defined it. This being the case, the project team argued that the economic and social dimensions of sustainable housing should be developed *within* the context of environmental sustainability (characterised by strong or naturalistic models of sustainability).

The ‘strong’ approach to sustainability views the three dimensions of sustainability (economy, society and environment) as wholly reliant on (and fully integrated with) one another. This approach recognises that the economy is a sub-set of society (i.e. it only exists in the context of a society), and that many important aspects of society do not involve economic activity. Similarly, human society and the economic activity within it are totally constrained by the natural systems of our planet. The economy may expand or contract, and society’s expectations and values may change over time, but to function in a sustainable way we must not exceed the capacity of the biosphere to absorb the effects of human activities (PCE 2002). The naturalistic worldview of
sustainability concurs with this view in that it focuses on the biophysical environment, flows of materials within larger natural systems, working within the limits of the earth. It follows that society and thus the economy rely wholeheartedly on the larger environmental system.

**Level 2:** Principles for a favourable *outcome* of planning within the system. The project team then decided that the sets of principles that best fit the strong sustainability model or naturalistic worldview included:

- The four system conditions of the Natural Step Framework (a) in the sustainable society, nature is not subject to systematically increasing concentrations of substances extracted form the Earth’s crust, (b) concentrations of substances produced by society, (c) degradation by physical means, (d) and, in that society human needs are met worldwide
- Daly Principles (addresses the regenerative and assimilative capacities of natural capital and the rate of depletion of non-renewable resources)
- Natural Capitalism (refers to the earth’s natural resources and the ecological systems that provide vital life-support services to society and all living things)
- The Precautionary Principle (to prevent harm to the environment and to human health)

For the purposes of the project, the project team considered The Natural Step and Natural Capitalism as the better options, as they are internationally and nationally recognised and have been practically demonstrated across a number of different applications (including buildings).

**Level 3:** Principles for the *process* to reach this outcome. In considering the literature and the case study information involving The Natural Step and Natural Capitalism principles, the process of ‘back-casting’ is described as a preferred approach, and as such, was recommended as the content for Level 3 of the framework. Back-casting is a systems thinking process which determines how to proceed from where we are today to get to the ‘end-point’ or desired sustainability state. Another way of describing it is as a technique that helps create a clear vision of a preferred future, and then to devise strategies to make the preferred future. The result: a timeline with specific events/steps/actions that are needed to make the vision a reality.

**Level 4:** *Actions, i.e. concrete measures,* that comply with the principles for the process to reach a favourable outcome in the system. The following recommended actions (see Table 1) are derived from the principles endorsed by the preceding sections. Although the list of actions is *not exhaustive or finalised* at the time of writing, it provides an indication of the types of actions that will be required to move towards a fully sustainable state. We recommended that these actions be further elucidated in the next phase of the research programme.
Table 1: Proposed actions for achieving a ‘high standard of sustainability’ in housing

<table>
<thead>
<tr>
<th>Housing element</th>
<th>Principle 1 eliminates fossil fuel, metal and mineral use</th>
<th>Principle 2 eliminates use of toxic and synthetic substances</th>
<th>Principle 3 eliminates encroachment upon nature</th>
<th>Principle 4 meets human needs fairly and efficiently</th>
</tr>
</thead>
<tbody>
<tr>
<td>Materials and Design</td>
<td>Material selection and design favour deconstruction, reuse, and durability appropriate to the service life of the structure</td>
<td>All materials are non-persistent, non-toxic and procured either from reused, recycled, renewable, or abundant (in nature) sources</td>
<td>Solid waste is eliminated by being as efficient as possible, or (a) where waste does occur, reuses are found for it on-site, or (b) for what is left, reuses are found off-site; (c) any solid waste that cannot be reused is recycled or composted</td>
<td>Source materials and labour locally and where appropriate support local economies. Material selection and design meets social and cultural needs. House is affordable for a diversity of residents</td>
</tr>
<tr>
<td>Energy</td>
<td>All energy sources used are 100% renewable and are: a) created without rare metals or persistent or toxic materials, e.g. certain types of photovoltaics; (b) not systematically degrading the water table nor releasing toxic substances, e.g. unsustainable geothermal sources; (c) “fish friendly” hydro (fish flows are not systematically degraded); (d) “bird friendly” wind (bird migration patterns are not systematically degraded)</td>
<td>Design favours excellent levels of thermal comfort (minimise the amount of purchased energy required)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Water</td>
<td>Pumping systems powered by 100% renewable energy</td>
<td>The quality, temperature and rate of flow of the water, both on-site and leaving the site, have no damaging impact on the natural systems of the watershed (i.e. does not need chemical treatment before release)</td>
<td>The water budget does not exceed the water that falls on or flows through the site: (stormwater control methods, greywater / blackwater systems etc).</td>
<td>House design favours source control for run-off and allows for community-based waste water treatment systems</td>
</tr>
<tr>
<td>Air</td>
<td>Indoor air quality maintained by passive means</td>
<td>The purity of ambient air surrounding and flowing off-site is as pure as or purer than the air flowing into the site. This means that air is not a waste sink for harmful particulates or gasses that may contain heavy metals, fossil fuel by-products, or hazardous or persistent compounds</td>
<td>Changes to airflow or air temperature do not systematically degrade natural systems</td>
<td>Indoor air quality maintains or improves health of occupants</td>
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<tr>
<td>Transport</td>
<td>Transportation energy sources (related to construction, operation and demolition of the house) are renewable</td>
<td>Transportation energy sources have no synthetic or toxic additives. Transportation infrastructure uses no synthetic or toxic substances</td>
<td>If changes to the infrastructure occur, any degradation of natural systems resulting from paving land and increased driving is repaired or restored</td>
<td>Existing infrastructure is used wherever possible by selecting building sites that fit within the current transportation infrastructure</td>
</tr>
<tr>
<td>Habitat</td>
<td>No requirement for petrochemical-based fertilisers</td>
<td>No requirement for synthetic pesticides or herbicides</td>
<td>Restore enough of the same habitat within the local area to replace the natural systems that have been disrupted by the construction of the building and its site. Whatever disruption does occur does not extend beyond the boundary of the construction-site development. This means that wetlands, soil or stream habitat downstream of the site are not disturbed. Any vegetation used is compatible with the local natural systems</td>
<td>Design for on-site or community-based food production</td>
</tr>
</tbody>
</table>
Table notes:

a) Reused means reused or remanufactured in the same form, such as re-milled lumber, in a sustainable way.

b) Recycled means the product is 100% recycled and can be recycled again in a closed loop in a sustainable way.

c) Renewable means able to regenerate in the same form at a rate greater than the rate of consumption.

d) Abundant means human flows are small compared to natural flows, i.e. aluminium, silica, iron etc. Additionally, the extraction of renewable or abundant materials has been accomplished in a sustainable way, efficiently using renewable energy and protecting the productivity of nature and the diversity of species.

e) If the needs exceed site water limits, the difference may be purchased from sites that have excess water to sell, as long as this process has no damaging impact on the natural systems.

f) Habitat refers to the living space and systems required by any species to support its existence. Since buildings always impact habitat, the goal is to not systematically degrade the services provided by nature that are necessary to sustain life.

g) The philosophy regarding habitat is the same as that used with water and energy budgets, namely that the net degradation on the natural systems is zero.

(Ref: www.ortns.org/docs/TNS%20Construction%20Paper-draft%209.pdf, last accessed 25/2/05)

Level 5: Tools to monitor and audit. After undertaking an analysis of a number of international environmental assessment methods, the tool which appeared to be the most relevant and useful for the SF1.1 framework was the BREEAM\(^2\) method. It is building focused, applicable to both new and retrofit houses, widely used, internationally accepted and adopted, its investigated dimensions fit well with the proposed actions, and the presentation of results as a ‘number’ could be used for benchmarking progress towards our ‘high standard’. Adjusting BREEAM for New Zealand houses is also not expected to be overly difficult.

Level 6: End-user analysis. Level 6 will need to be developed after the detailed content of levels 1-5 has been further defined through the later phases of the SF programme. Only once the actions and tools have been defined will it be possible to establish exactly how different end users would utilise the framework and what the framework’s limitations are. However the following issues should be addressed as part of Level 6:

- appropriate use of the framework by the different user groups
- potential use of the framework as a legislative vs. voluntary tool

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\(^2\) The Building Research Establishment (BRE) is based in the UK and provides research-based consultancy, testing and certification services for buildings. In 1990, the BRE developed an Environmental Assessment Method (BREEAM) which is used to review and improve the environmental performance of buildings. Since 1990, some 600 major office buildings have been assessed. The homes version of BREEAM is called EcoHomes. It provides an authoritative rating for new and converted or renovated homes and covers houses, apartments and sheltered accommodation (BRE 2004).
• description of the limitations of the framework, such as uncertainties in the measurements applied at Level 5 and the need to consider issues that may not be measurable as part of the framework

• a process for transparent decision-making, applying the framework as a tool (highlighting that the framework is only a tool, but that it will lead to more informed decision making if used appropriately)

• the appropriateness or otherwise of trade-offs between different platforms within the metric tool chosen (assuming that there will be various platforms)

• how to practically consider all levels of the framework (it is likely that the practical application will concentrate on Levels 4 and 5; however Levels 1 to 3 need to also be considered in decision-making, i.e. checking that the numbers in Level 5 are consistent with the overall aims).

The project team sees a need for Level 6 to avoid inappropriate use of the framework. Anecdotally, there are examples of where sustainability frameworks and more specifically Level 5 type tools have been used without acknowledging their limitations or initial purpose (e.g. a home energy rating which includes thermal efficiency but neglects inclusion of efficiency for water heating). This practice has lead to sub-optimum outcomes that sometimes are inconsistent with the overall aims of sustainability.

4. Conclusion

The purpose of this project was to recommend the key elements of a sustainability framework with the ultimate purpose of facilitating the implementation of sustainability outcomes at the level of ‘home’. The project team recommended the following structure and content (the key elements) of the sustainability framework for housing (Figure 2):

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**Definition of success**
That 90%+ of housing in New Zealand reaches a high standard of sustainability by 2012. A sustainable house is one where social and cultural needs are met, where resources are (more) equally available to everyone, and where no irreversible damage to the environment is caused during its entire life-cycle. A high standard is defined by the achievement of a rating as determined by the sustainability framework metric (to be finalised).

**Level 1: Principles for the constitution of the system**
The strong sustainability model and naturalistic approach

**Level 2: Principles for sustainability as the desired outcome**
The Natural Step and Natural Capitalism

**Level 3: Principles for the process to reach the desired outcome**
Backcasting

**Level 4: Actions and concrete measures**
Actions related to achieving 100% sustainability in 7 areas: materials and design, energy, water, air, transport and habitat

**Level 5: Tools and metrics to monitor and audit**
To be finalised (revised BREEAM)

**Level 6: End-user analysis**
To be finalised (consumer view, industry view, central government view and local authority view)
The structure and content of the sustainability framework as recommended by the project team is biased, deliberately so, towards best practice. As a result, the project team expect to see a significant shift in participating sector groups in the programme beyond a ‘business-as-usual’ (house) construction paradigm. The project team also believe that the proposed framework creates a comprehensive view of sustainability and proposes actions that are strategic and enable a conscious process of decision-making. In sum, the proposed framework provides the potential for New Zealanders to live sustainably through the delivery of sustainable housing.

Where to from here? The results from this initial project (programme confirmation phase) will inform the remaining project phases of the Beacon research programme for this objective area. During 2005, the framework content will continue be finalised and the finalised model tested with end-user groups. By mid-2006, it is anticipated that the framework will be customised for stakeholders and be ready for national implementation by the end of 2006.

Acknowledgement

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References


