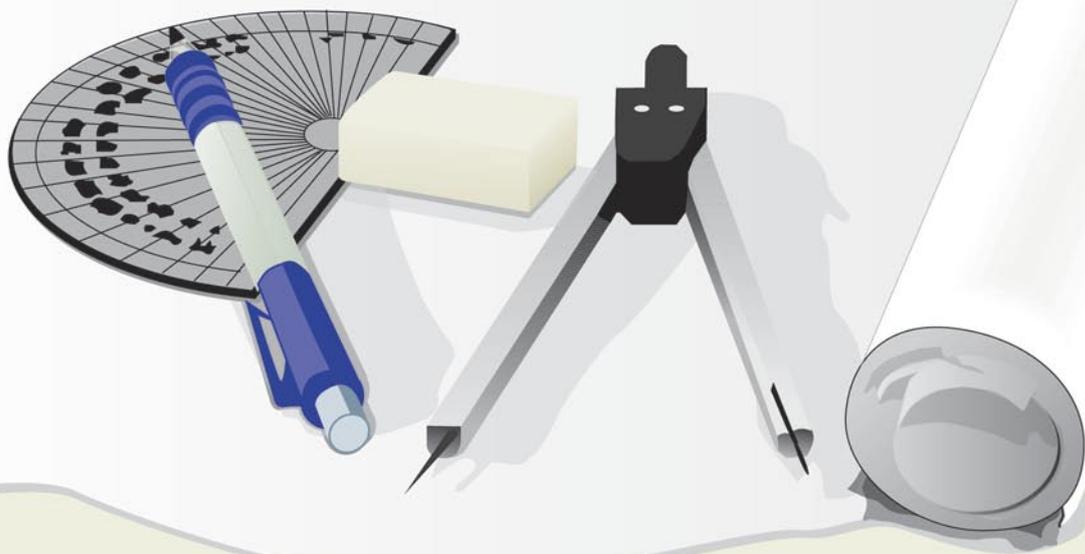


# Designing Homes for Climate Change

How to significantly improve the climate readiness of your proposed home through the design brief



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# Background

**There is now little doubt that climate change is a real phenomenon, one which will significantly affect humankind over the next 100 years. Society will have to adapt to its impacts in very fundamental ways. The built environment in which we live will certainly feel the effects of a changing climate. It is imperative that we take measures to modify the way we build now.**

This document is a response to this urgent threat and targets domestic buildings. It provides support at the very start of the building process – targeting the design stage to maximise the opportunities for change. Thus, it includes guidance starting from the selection of the site through to the design process – so that the final design will be better prepared for climate change. It depends to a degree on sustainable-supportive behaviour from the occupants – since this impacts significantly on the ongoing sustainability of the building.

**Objective:** to provide guidance that, if followed, results in houses that are substantially more 'climate-ready' than conventional houses while providing improved utility for the occupants.

## **Building-related climate change is examined from two aspects:**

1. The effect homes have **on** climate change, due to their use of carbon-based fossil fuels in their running and maintenance requirements. The ways and means of preparing a building to lessen its impacts on climate change is called **mitigation** (dealt with in the first four sections of this document).
2. The effect climate change has **on** homes, due to the increased frequency and magnitude of extreme weather. The ways and means of ensuring that the building is more responsive to climate change is called **adaptation** (dealt with in the last three sections of this document).

In terms of the climate mitigated buildings, ideally the goal is to have buildings that create no annual net CO<sub>2</sub> emissions from their operation – i.e. **carbon neutrality**. Although this is easy to meet through the use of carbon sinks and the purchase of carbon credits, this defeats the wider goal of treading lightly on our planet. This document adopts the approach that buildings should have very modest energy (carbon) needs in the first place if sited, constructed, run and recycled carefully. This is a key aspect of more sustainable living. It should be noted that carbon neutrality is one aspect of sustainable living. Other building-related issues such as water management, landscape, etc, are outside the scope of this document.

This booklet's aim is to assist the design of new houses in response to climate change, by providing suggestions to incorporate in the briefing document. This is the best time in which to make the biggest impact on the climate readiness of a proposed dwelling.

Only the most important climate-related issues are considered here. The method by which the issues were chosen and details on their relative contributions are provided in the associated background document *Towards Carbon Neutral and Climate Adapted Domestic Buildings* (2006) which can be downloaded from [www.branz.co.nz](http://www.branz.co.nz).

This document is, in theory, applicable to a range of house sizes, styles and locations. However, the focus is more on the traditional detached or semi-detached house types, due to the greater inherent flexibility of design solutions possible.

The intended audience is anyone who is influential in the design process for residential construction.

# How to use this document

**This document has been designed to be read electronically in a PDF format. Its functionality and user-friendliness is restricted if read as a hard copy.**

Hyperlinks are used throughout to assist navigation and to provide links for those wanting more comprehensive information. As a consequence, design influencers can choose select parts of the document at their discretion. For example, for:

- key information on climate mitigated dwelling [starts here](#)
- key information on climate adapted design [starts here](#)
- those needing to assess their proposed house design's climate change readiness in terms of carbon impact and climate change responsiveness [starts here](#)
- for good links and further contacts [starts here](#).

In addition to the hyperlinks, unfamiliar terms marked in **bold gold underlined text** contain explanatory notes. The notes are accessible by hovering your mouse over the term, where the note will be displayed as a pop-up box.

Being a briefing support document, a series of suggested design-related targets are given, providing key climate change-related design goals. These targets are a means of establishing credible benchmarks for determining the overall 'climate readiness' of a house. Targets are divided into two categories, according to

their perceived/calculated impact and ability to be practically implemented:

**Core issues – i.e. considered mandatory for near carbon neutral/climate mitigated living and are displayed in bold red type.**

**Optional issues – i.e. seen as very important, but not critical, for near carbon neutral/ climate mitigated living and are displayed in regular red type.**

Although not all the targets set will be able to be achieved for **all** new dwellings under **all** situations, at least the core targets should be achievable and met by the final design in most situations. This is necessary if a credible attempt at addressing climate change is desired.

# Choosing the right site

**The choice of a site has major implications for the ongoing energy use, and therefore the carbon footprint, for the home dwellers. Two key site-related issues which have carbon implications are the links the site has with amenities (transportation) and its solar access potential.**

## TRANSPORTATION

Transportation-related CO<sub>2</sub> emissions are often overlooked in many supposedly sustainable-homes. Transportation-related carbon intensity depends on: the mode of transport (see Appendix for comparative CO<sub>2</sub> intensities), the length of journey required, fuels used and the proximity and frequency of public transportation. Only the house siting-related aspects issue will be overviewed here.

Both short and longer term transport needs should be considered as part of the site assessment. Although it is difficult to predict the infrastructure developments, possible scenarios should be kept in mind to ensure that limitations on, for example, transportation availability are unlikely – at least in the foreseeable future.

The targets set are considerably easier to achieve in a well-planned, medium density suburb or township, which either has a good transportation set-up or alternatively a good range of nearby amenities.

In high density developments, there may be important carbon trade-offs which are not immediately obvious. For example, individual food production becomes impossible<sup>1</sup> and good solar access becomes extremely difficult. These implications are important as it has been found that the energy (i.e. carbon) attributable to commercially purchased food is similar in magnitude to the transportation needs of a typical household living in a suburban environment.

## TARGETS

- 1. The residential site selected is within walking distance (say 500 m) of at least three key amenities such as: employment, schools, shops, banks, recreation and worship facilities.**
- 2. Alternatively, choose a site which is within walking distance (say 500 m) of a public transportation service. The service should be regular and frequent, at least for the working week.**

<sup>1</sup> A food garden also has important carbon implications due to the distances involved in bringing in bought food, but is outside the scope of this document.

## SOLAR ACCESS

When choosing a site, select one that allows you to design and build a north-facing home which has good access to the sunlight year round. Thus, the selected site should not be overshadowed in winter by buildings, large trees, fences or other obstructions to the north.

The potential for solarising a house is best aided by:<sup>2</sup>

- larger (> 800 m<sup>2</sup>) sites that allow more opportunity to place the home facing due north
- rectangular sites that are deep north-south, especially if the sites are less than 500 m<sup>2</sup>
- sites where obstacles such as other northern ( $\pm 30^\circ$ ) located buildings, fences or evergreen trees are located a distance from the proposed building that is at least twice the obstructions height, to prevent wintertime shading (see Figure 1)
- sites that slope down to the north more than  $10^\circ$
- sites where a street or park is located to the north, that is not likely to have any future construction which will alter the sun envelope.

## TARGETS

1. At least one of the solar access checklist items conditions above is met.
2. There is good utilisation of winter sun in the house design, so that the completed building can take significant advantage of solar energy.

[Links to lower carbon site selection](#)

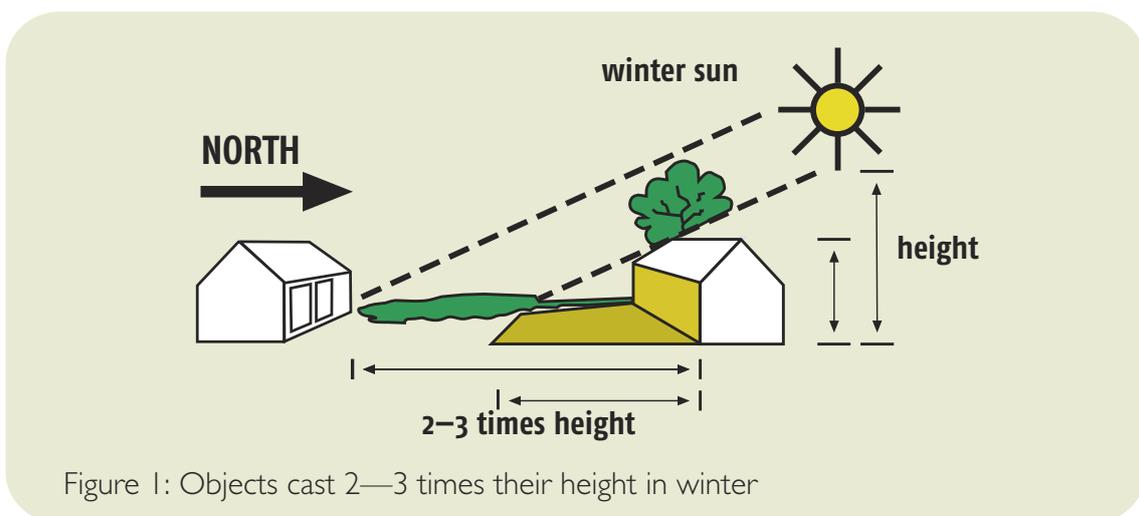


Figure 1: Objects cast 2—3 times their height in winter

<sup>2</sup>. Adapted from *Energy Smart Housing Manual*, Sustainable Energy Authority, Australia.

# Heating and cooling

**Designing to ensure comfortable all-year temperatures is a fundamental requirement for a near carbon neutral house. This requires good planning, careful design and considered construction. Both summertime cooling and wintertime heating will be examined in this section.**

Cold ambient wintertime temperatures can be moderated with plenty of insulation (to conserve the warmth), the right materials (to store solar energy) and thoughtful window design (to admit adequate solar radiation). Achieving the best balance between these aspects can be a challenge, even for experienced designers. Using some form of computer-based thermal design aid is considered essential for examining a building critically and comprehensively. BRANZ's ALF 3 thermal analysis tool is an excellent introduction.

The insulation performance will only be maximised under proper detailing and careful installation. This is required to minimise **thermal bridges** wherever practical. This is particularly critical with increasing insulation **R-values**.

**Thermal mass** which gets exposed to the sun is critical for the overall performance of the house. How much thermal mass is optimum depends on many construction factors – the insulation levels of the house, orientation, window size and placement etc. However, enough of it should be used so that its benefits can be felt for internal temperature moderation.

For window design, in terms of proper sizing, placement, orientation and shading, the rules of passive solar design described in *Design for the Sun* (1993) should be followed. In choosing the most appropriate double glazing system, its lifetime ability to insulate should be weighed against its lifetime durability and maintenance requirements.

It can be reasonably assumed that the predicted amount of uncomfortable temperatures in the near future for New Zealand will be considerable (see Table 1), due to climate change. The ability of a dwelling to minimise year round overheating is an integral part of good passive solar design.

**Table 1: Days where maximum temperature exceeds 25°C, by year<sup>3</sup>**

Region	Now	2030	2070
Auckland	20	25 – 37	31 – 81
Wellington	3	4 – 7	5 – 21
Christchurch	26	29 – 36	32 – 64
Invercargill	2	2 – 3	3 – 11

As a house becomes highly insulated, its heat loss potential is reduced, so its potential to overheat is increased. To counter this, techniques to ensure good internal air movement need to be integrated into the design. For best effect, a raft of techniques should be employed – such as combining the use of large openable windows, external solar control systems and the careful sizing of westerly windows. For times when there is no driving external air pressure, **passive stack ventilation** methods must be used.

## TARGETS

- 1. A thermal analysis tool, such as ALF 3, is used as a minimum design aid.**
- 2. The specification and working drawings include reference to the careful detailing and installation of insulation.**
- 3. A massive building element (such as a well-insulated, sun exposed, northern orientated, uncovered, concrete floor) is used to provide a reduction of at least 20% of the space heating needs of the house. If a concrete slab-on-**

3. From Camilleri, M, *Implications of Climate Change for the Construction Sector: Houses*, BRANZ 2000.

ground is used, it must be fully insulated with at least 50 mm of high density polystyrene both underneath and around its perimeter.

4. The whole house heat loss values are not greater than:
  - a. 215 W/°C for Auckland and Northland
  - b. 190 W/°C for all but the volcanic plateau, Auckland and Northland regions, and the South Island
  - c. 180 W/°C for the remaining areas.
5. A comprehensive cooling strategy is used to minimise overheating that includes:
  - a. openable, securable windows, usable for both stack and wind-effect, while capable of allowing a high volume flow of air
  - b. good solar control for windows by relying on appropriate external shading devices – i.e. horizontal-based systems in the northern orientated walls and vertical-based systems in the westerly and easterly walls
  - c. adequate ventilation on calm days, by utilising the stack effect, so that the inlet/outlet openings in key conditioned areas are separated 2 m or more vertically.
6. If possible, achieve a whole house heat loss value of less than 160 W/°C for ALL climate zones.

**[Links to heating and cooling strategies and construction details](#)**

# Material efficiency

Two themes are examined under this category:

- *spatial considerations* which determine the quantity of materials used and the types of spaces created by those materials
- *material selection* for longevity and efficiency.

The choice of house size is an important carbon footprint issue to consider which can easily be overlooked. House size is a proxy for the amount of space heating, materials used and the associated material-related maintenance and refurbishment needed. To reduce a house's carbon footprint, specify a modest house size in the first instance.

There is no standardised method for determining whether a house is of a 'modest' size and therefore spatially efficient. Certainly, today's average new 207 m<sup>2</sup>, three-bedroom mansions are not a good representation of 'spatial efficiency'. Compare this with the three-bedroom 'Now House'<sup>4</sup> which has a floor area of only 124 m<sup>2</sup>, yet is considered by the original occupants as "roomy".

One way of determining a house's spatial efficiency is shown in Table 2.

## PROCEDURE

1. Determine the NET floor area of the proposed house, i.e. the space **conditioned area**, excluding any 'home-office' space(s), garages, workshops etc.
2. Knowing the number of bedrooms in the proposed house, read down the appropriate column to find the next higher floor area figure.
3. Once this next higher figure is established, move to the right of the table to find the corresponding Spatial Efficiency Score. This provides an indication of the likely lifetime carbon intensity associated with the house.

**Table 2: Spatial efficiency calculator tool (adapted from Vermont Green Builder)**

	Number of bedrooms				Spatial Efficiency Score
	2	3	4	5	
Maximum	108 m <sup>2</sup>	122 m <sup>2</sup>	140 m <sup>2</sup>	155 m <sup>2</sup>	Excellent
NET	127 m <sup>2</sup>	142 m <sup>2</sup>	159 m <sup>2</sup>	177 m <sup>2</sup>	Very good
Floor	146 m <sup>2</sup>	162 m <sup>2</sup>	180 m <sup>2</sup>	200 m <sup>2</sup>	Good
Area	165 m <sup>2</sup>	182 m <sup>2</sup>	201 m <sup>2</sup>	222 m <sup>2</sup>	Fair

## Notes on Table 2:

1. Unconditioned (i.e. uninsulated) space has been excluded since it is likely to be less carbon intensive than the conditioned spaces.
2. Home office space has been excluded due to the likelihood that the carbon benefits from having it (in reduced daily travel) will outweigh the costs.

In terms of material-related CO<sub>2</sub> data that considers the whole life-cycle, there is currently not enough to provide comprehensive advice. However, some general guidance is found within the following TARGETS.

<sup>4</sup> The Now House details can be found at [www.nowhome.co.nz](http://www.nowhome.co.nz).

## TARGETS

1. **The Spatial Efficiency Score achieved is 'Very good' or better for the proposed house.**
2. An 'Excellent' Spatial Efficiency Score is achieved.
3. The usefulness of spaces is maximised within the design through:
  - a. having multi-purpose spaces (i.e. 'long life, loose fit'), wherever possible
  - b. eschewing dedicated transition areas, such as hallways, if practical
  - c. aiming for simplicity in form to enhance the flexibility of the spaces.
4. The design aims to:
  - incorporate more neutral colours while excluding fashion-based architecture
  - use materials and systems which have long-life surface finishes, but not much longer than the expected lifetime of the building if the intent is not to reuse the item, and
  - apply deconstruction principles and technical details, if possible, to assist materials reuse in other buildings/applications.

**[Links for better spatial/material efficiency](#)**

# Main appliances

Ideally, *all* appliances should be closely examined in terms of their energy (and therefore CO<sub>2</sub> emissions) requirements, as part of the near carbon neutral household. With the advent of energy labelling, comparative energy information is now very easy to access.

Representative CO<sub>2</sub> emissions in an all-electric household for each of the appliances selected is shown in Figure 2 below. As can be seen, the largest contributors are for water and space heating, followed by cooking and refrigeration. In this section, briefs for 'fixed' appliances only will be suggested, with the exception of lighting (due to its cross-over attributes).

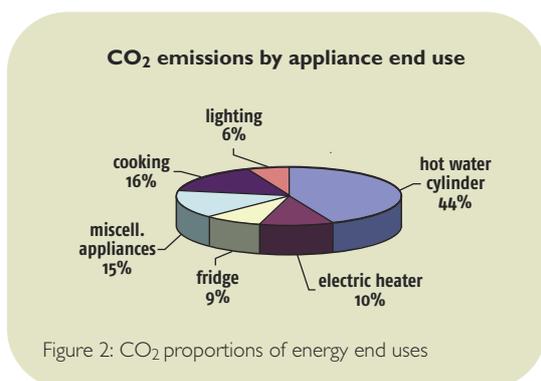


Figure 2: CO<sub>2</sub> proportions of energy end uses

## HOT WATER HEATING

It is recommended that one of the following hot water heaters be chosen to minimise lifetime operation-related CO<sub>2</sub> emissions. Two sets of estimations are given – for marginal and non-marginal electricity mixes – since the consumer is able to select the fuel mix to some degree for this appliance.

The preferred hot water heaters (based on non-peak generated electricity), in order of least polluting first, are:

1. wet-back using either logs or wood pellets
2. heat pumps (i.e. air, water or ground-based with a coefficient of performance > 2.5)
3. electric assisted solar
4. gas assisted solar.

The preferred hot water heaters (based on peak generated electricity), in order of least polluting first, are:

1. wet-back using either logs or wood pellets

2. gas assisted solar
3. efficient heat pumps (with a coefficient of performance > 2.5).

In addition, the installed water plumbing set-up and fittings (e.g. tap-ware and shower roses) should be water efficient. This is being made easier with the introduction of a water rating efficiency scheme for the comparative selection between products. The scheme's ratings and associated flow rates are summarised below:

## Water Efficiency Labelling Scheme

**AAAAA** Rating: Excellent (< 6 litres per minute)

**AAAA** Rating: Very High (< 7.5 litres per minute)

**AAA** Rating: High (< 9 litres per minute)

**AA** Rating: Good (< 12 litres per minute)

**A** Rating: Moderate (< 15 litres per minute).

## TARGETS

1. **One of the top-ranked hot water heating appliances listed above which is applicable for the location must be chosen.**
2. **The plumbing system and fittings is chosen for its high (AAA or better) water efficiency.**

[Links for water efficiency](#)

## SPACE HEATING

The space heating requirements for a well-designed (i.e. passive solar-based) near carbon neutral house will be minimal or zero for all but the coldest/sunless parts of New Zealand. Indeed, it is likely that most of the wood burners available on the market today will be considerably overpowered for use in near carbon neutral buildings, unless used in combination with wet-backs, for example. Thus, space heating's carbon significance is likely to also be minimal. However, suggestions for the design brief will be included here for completeness and for the minority of situations where a significant amount of space heating is needed.

It is recommended that one of the following space heaters is chosen to minimise lifetime operation-related CO<sub>2</sub> emissions (in order of least polluting first):<sup>5</sup>

1. very high efficiency double wood/pellet burner (i.e. thermal efficiency  $\geq 75\%$ )
2. high efficiency double wood/pellet burner (i.e. thermal efficiency  $\geq 65\%$ )
3. gas heated flooring
4. flued natural gas.

### TARGET

**One of the space heating appliances above is chosen, if a heating appliance is necessary.**

[Links to lower carbon space heating](#)

## LIGHTING

There are several design strategies that will lead to a significant reduction in the amount of lighting-related CO<sub>2</sub> emissions. They include:

1. Designing for natural lighting. The most energy efficient lighting with the least CO<sub>2</sub> emissions is natural lighting. Well-designed windows, clerestories and light tubes will let in light without compromising thermal design.
2. Specifying fluorescent or compact fluorescent lighting in all areas apart from those used very briefly (e.g. in cupboards, toilets and pantries) or in areas that require more powerful lighting (such as in some outdoor situations).
3. For those areas that require powerful outdoor lighting, alternatives to the common tungsten halogen lamps should be used, due to their high energy requirements. More efficient alternatives include: high pressure sodium lamps, low pressure sodium lamps, mercury halide lamps and mercury lamps.
4. Ensuring that the building's **conditioned area** is not compromised due to the presence of recessed lighting. This can be accomplished either through specialised insulation detailing and specification or the omission of this type of luminaire completely.

5. Ensuring that only as much lighting as is necessary for the task is specified by directing the light to where it is required. An example is the use of task lighting instead of general lighting, where possible.
6. Incorporating energy-efficient controls, such as daylight sensors, proximity sensors and timer switches, where appropriate. Typically, these will be in hallways, entry points, garden walkways etc.

### TARGETS

1. **Design for the best use of natural lighting to reduce dependence on artificial lighting, year round, while minimising glare and overheating.**
2. **Greater than 75% by count of all lighting must be fluorescent-based.**
3. **Recessed down-lights must not be used if they penetrate through the conditioned area of the house, whatever lamp type they are.**
4. Energy-efficient controls, such as daylight sensors, proximity sensors and timer switches, should be incorporated where appropriate.

[Links to lower carbon lighting](#)

## COOKING APPLIANCES

There are few recent, comprehensive and credible energy efficiency comparisons for cooking appliances. The comparisons cited were only for 'convenience' cooking systems. Thus, combined cookers that are also used for heating were not considered under this umbrella, and are unknown in their efficiency.

### TARGET

1. It is suggested that the design incorporates one of following preferred cooking appliances:
  - a. for the range top, either gas or electric – as long as a pilot light is not used in the gas appliance
  - b. for the oven, a combination of the efficient microwave oven and a convection electric oven with or (without) self-cleaning capabilities.

[Links to lower carbon cooking](#)

<sup>5</sup> The ranking is according to at-the-margin generated electricity.

# Rainfall

**Rainfall changes resulting from climate change may take on a number of forms, including that of more intense rainfall, increased driving rain and more extreme rainfall events. The impacts on buildings from increased rainfall include damage to building facades, internal structural damage, leaky buildings, rain penetration around openings and greater pressure on drainage systems.**

Design principles should be employed to achieve good moisture management: deflection (i.e. keeping water away from potential entry points), drainage (providing a means of removing the water that does not enter), drying (allowing remaining water to be removed) and appropriate durability.

The weathertightness risk of a building can be assessed at the design stage using the comprehensive matrix within the Acceptable Solutions of NZBC E2/AS1. A 'Building Envelope Risk Matrix' is used for each face of the building, examining the elements' construction characteristics to determine suitable wall claddings. This matrix should be applied in this briefing support document, but with higher benchmarks required.

## TARGET

- 1. A well-integrated approach is taken to identify and reduce the external water-related risks in the proposed design so that no 'Very High Risk' scores (as defined in NZBC E2/AS1) in the areas of envelope complexity and deck design are achieved.**
- 2. Each elevation of the building has a risk score of 12 or less (as defined in NZBC E2/AS1) equating as a 'Medium Risk'.**
- 3. Each elevation of the building has a risk score of 6 or less (as defined in NZBC E2/AS1) equating as a 'Low Risk'.**

[Links to weathertightness information](#)

# Strong winds

It is unknown what the impacts of a changing climate will be on the frequency, duration and intensity of wind in New Zealand. Tropical cyclonic activity due to climate change is not fully understood. However, due to its destructive potential, and the increasing frequency of high winds in the Auckland/Northland regions, it would be prudent to adapt against them now.

High winds could cause structural damage with roofs being the most likely part of the house to succumb. However, damage to windows or guttering from direct wind or flying debris and increased weathering of a building is also possible.

NZS 3604 provides a simplified method for light timber-framed buildings to determine the design wind speed for a specific situation. Although it is recognised that the resulting structural requirements based on this method are conservative, it is suggested that it would be prudent to increase the structural strength to the next higher NZS 3604 wind zone to limit any potential damage. The impact of this is probably more useful for houses assessed at the margin of a wind speed category, which are more vulnerable to increases in wind speed.

## TARGET

- 1. Increase the structural strength to the next higher NZBC design wind speed (see NZS 3604), to limit any potential future damage from cyclonic and strong wind activity.**
2. Reduce risk of roof damage through:
  - a. increasing the steepness of the pitch
  - b. extra fixings at the roof edges
  - c. extra hold-down straps on purlins over external wall lines
  - d. constructing mansard roofs.

[Links to improving structural strength](#)

# Flooding

**Flooding of both coastal and inland areas is predicted to increase with increased rainfall and cyclones, while flood return periods decrease. Flooding could become four times more likely across New Zealand. However, flooding risks are very region/area specific, with some parts of New Zealand more likely to be flooded than others.**

Results of flood activities on buildings include water damage (e.g. internal plasterwork, underfloor and wall insulation), drain damage (e.g. to guttering), damage to infrastructure, increased corrosiveness from sea water and run-off from agricultural land. Dwellings could possibly be completely destroyed in flood-prone coastal or inland areas.

The best suggestion is not to build in a vulnerable site, i.e. avoid siting buildings on river flood plains and low-lying coastal areas. There are a number of measures to minimise the risk and severity of flooding:

1. Research the risk of flooding in any given site in any given region by flooding return period.
2. Exceed the minimum floor level clearance requirements in order to reduce the risk of flood damage.
3. Design with flooding in mind for the lowest levels of the house and installing essential, vulnerable equipment as high as possible.
4. Use water resistant materials if practical:
  - Insulation** – closed cell foam (extruded polystyrene or polyurethane)
  - Floors** – concrete (bare or coated), durable or treated timber
  - Walls** – fibre-cement, concrete block, durable or treated timber, PVC, brick (glazed or faced)
  - Interior** – concrete block, fibre-cement, durable or treated timber.

## TARGET

1. **DO NOT build in a flood-prone area – determine by examining the geography and researching the risk from historical data.**
2. **Exceed the minimum floor level clearance requirements in order to reduce the risk of flood damage.**
3. Design with flooding in mind for the lowest levels of the house and installing essential, vulnerable equipment as high as possible.

[Links to improved flood-proofing](#)

6. What is considered 'critical' is somewhat subjective. The emphasis here is on what are considered to be more influential building-related issues under typical conditions.

# Assessing house designs for climate change readiness

## INTRODUCTION

The following is a simple assessment to determine just how climate change ready your proposed building is. The targets examined are based on the preceding briefing targets. Only the most critical building-related design aspects have been included in the key targets checklist (over the page). Some of the targets may be relatively easy to achieve, while others may be extremely difficult. For simplicity, all the targets examined are given equal weighting.

This assessment provides a simple indication of a building's 'climate readiness'. Due to the complex interaction between the construction elements, the building as a whole and its occupants, the results are for quick comparisons only.

## PROCEDURE

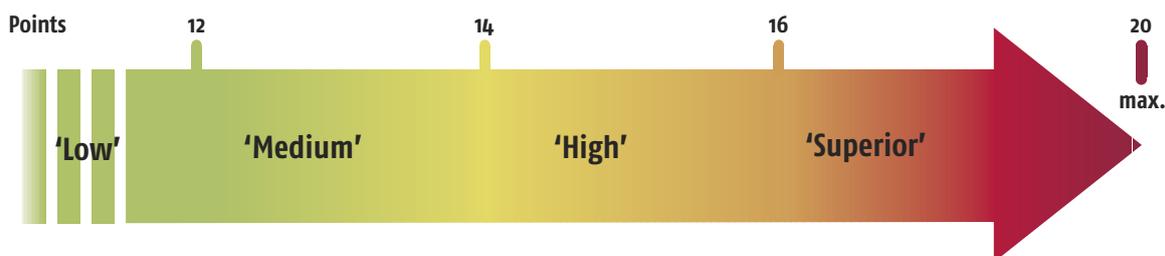
A point system is used, with one point being assigned for each key target being examined. For simplicity, equal weight is given to each issue. The steps are:

- Run down the list of 20 key climate change-related targets (over the page).
- For each target met by the proposed design, award the proposed design one point.
- Tally the number of points as you progress through the issues.
- Finally, determine how climate change friendly your proposed house design is using the scale at the end of this page. If the design achieves a low score, you may want to alter your design accordingly.

For specifics on individual targets, the related chapter should be read in conjunction with the Key Links page at the end of this document.

## Proposed house's climate change readiness

The scale below shows the proposed building's overall 'climate change readiness' – both in terms of its ability to reduce its impact on climate change and the reduced ability of the effects of climate change to impact on it.



Climate Change Readiness Scale

Chapter	Target Number	Key Targets	Points
Site	1	Site is within 500 m of at least three key amenities such as: employment, schools, shops, banks, recreation and worship facilities OR within 500 m of regular public transportation.	1
Solar access	2	The solar access of the site has been investigated and at least one of the bullet pointed conditions is met, indicating the building's solar potential.	1
	3	The proposed design actually utilises winter sun in a significant manner.	1
Heating and cooling	4	A thermal analysis tool, such as ALF 3, has been used as a thermal design aid (as a minimum).	1
	5	The specification refers to the careful detailing and installation of insulation for thermal integrity.	1
	6	A massive building element that is well-insulated, sun exposed and northern orientated is used to provide at least 20% of the space heating needs of the proposed house.	1
	7	The following whole house heat loss targets are met by the proposed building, i.e. less than: <ul style="list-style-type: none"> <li>• 215 W/°C for Auckland and Northland</li> <li>• 190 W/°C for all but the volcanic plateau, Auckland and Northland regions, and the South Island</li> <li>• 180 W/°C for the remaining areas.</li> </ul>	1
	8	A comprehensive cooling strategy is used to minimise overheating, incorporating several of the linked recommendations, including cooling in calm conditions.	1
Material efficiency	9	In terms of Spatial Efficiency, the proposed design achieves a 'Very good' rating or better.	1
Hot water heating	10	The hot water heater is assisted by a wet-back, a heat pump, geothermal, solar energy or gas.	1
	11	AAA or better rated tap-ware and plumbing used for the majority of fittings in the house.	1
Space heating	12	A high efficiency wood/pellet burner, gas heating flooring or flued natural gas is used for the space heating requirements OR all space heating is passively supplied.	1
Lighting	13	Design for the best use of natural lighting to reduce dependence on artificial lighting, year round, which does not significantly compromise thermal and visual aspects.	1
	14	Fluorescent-based lighting is utilised for greater than 75% (by count) of all lighting on-site.	1
	15	Recessed down-lights that penetrate the conditioned area of the house are not used, whatever lamp type they are.	1
Rainfall	16	No 'Very high' risk scores in the areas of envelope complexity and deck design are achieved, as defined in NZBC Acceptable Solution E2AS1.	1
	17	Each elevation of the building has a risk score of 12 or less, as defined in NZBC Acceptable Solution E2AS1 (equating to <i>Medium Risk</i> category or lower).	1
Strong winds	18	Increase the structural strength to the next higher NZBC design wind speed (see NZS 3604), to limit any potential future damage from cyclonic and strong wind activity.	1
Flooding	19	Proposed house not built in a flood-prone area, as determined through historical information from local councils and environment agencies.	1
	20	Exceed the minimum floor level clearance requirements.	1

# Appendix

Use Table 3 to choose the most CO<sub>2</sub>-efficient mode of transport. All figures are approximate and based on typical occupancy rates mainly taken from Robert Vales' work<sup>7</sup>, with diesel car figures based on petrol/diesel multipliers used in the *BRANZ Easy Guide to Being a Climate Friendly Kiwi* (2005).

Table 3: CO <sub>2</sub> emissions by mode for transport		
Transportation mode	kg CO <sub>2</sub> per km travelled	Occupancy percentages
Cycling/walking	Negligible	100%
Electric bicycle/scooter	Negligible	100%
Train – electric	0.07	50%
Bus (average) – diesel	0.08	20%
Car 1.0 litre – diesel	0.11	35%
Hybrid-car 1.5 litre – petrol/electric	0.12	35%
Car 1.5 litre – diesel	0.14	35%
Car 1.0 litre – petrol	0.16	35%
Car 2.0 litre – diesel	0.16	35%
Car 1.5 litre – petrol	0.19	35%
Ferry, catamaran (not A/C)	0.19	20%
Car 2.0 litre – petrol	0.22	35%
Car 2.5 litre – petrol	0.26	35%
Ferry, catamaran (air conditioned)	0.29	20%

7. Personal communication July 2004.

# Key links for climate friendlier dwelling

## Choosing a site for lower carbon living

1. [Siting and solar access](#): Chapter 4: *Siting and Solar Access*, Sustainable Energy Authority, Australia
2. [Choosing a site](#): from the Australian *Your Home Technical Manual*
3. [Orientation](#): from the Australian *Your Home Technical Manual*
4. [Landscape design](#): Chapter 10: *Landscape Design*, Sustainable Energy Authority, Australia
5. [Car travel and its implications](#): *The Real Cost of Car Travel* – from Sustainable Households Programme – scroll down to Travel and Fitness.

## Heating and cooling strategies and construction details

Computer-based thermal design assistance tools

- a. [ALF3](#) (for homeowners and designers) – offers a simple, step-by-step method of calculating the energy performance of conventional houses
- b. [Design Navigator](#) (for homeowners and designers) – offers an easy-to-use range of energy calculation tools and also provides solar design FAQ's and case studies
- c. [SUNREL](#) (for energy consultants and scientists) – offers a detailed, dynamic thermal analysis program for calculating the interactions between the building envelope, its environment and its occupants.

### Hard copy documents

EECA. 1993. *Design for the Sun: Residential Guidelines for New Zealand* (Volume 2 Reference Manual). Energy Efficiency and Conservation Authority, Wellington, New Zealand.

Donn M, Van Der Werff I and Miller G. 2000. *Design Guidelines: Passive Solar Design in New Zealand*. Ministry of Commerce, Wellington, New Zealand.

Donn M, Van Der Werff I and Miller G. 2000. *Construction Issues: Passive Solar Design in New Zealand*. Ministry of Commerce, Wellington, New Zealand.

### Electronic media

[Air movement](#): Chapter 8: *Air Movement* from Sustainable Energy Authority, Australia

[Installing insulation](#): Chapter 7: *Insulation* from Sustainable Energy Authority, Australia

Window efficiency rating scheme and insulation values [click here](#)

[Thermal mass](#): Chapter 6: *Thermal Mass* from Sustainable Energy Authority, Australia

[Control of overheating in future housing – design guidance for low energy strategies](#), UK.

### Spatial/material efficiency

1. [Small houses](#)
2. [Designing for Deconstruction](#) from the Scottish Ecological Design Association

### Water efficiency

[The Water Services Association of Australia](#) (WSAA) – National Labelling Scheme is a useful measure to use in reducing water consumption through water-efficient products and fittings. For more information go to Products and Initiatives then to Water Ratings and Labelling Scheme.

### Main appliances

For examination of the energy (carbon) implications of appliances, excellent web-based resources such as [Australia's energy rating site](#) are suggested.

## Rainfall/strong winds/flooding

[Risk Matrix Guidance document and associated NZBC E2 External Moisture document](#)

Services, lighting and appliances guidance can be found in chapter 9 of [Australia's Energy Smart Housing manual](#).

## OTHER USEFUL REFERENCES AND RESOURCES

### BRANZ publications on climate change and buildings

BRANZ Ltd has a range of supporting publications to this document. Many of them are freely downloadable from the BRANZ website ([www.branz.co.nz](http://www.branz.co.nz)). They include but are not limited to:

- *Implications of Climate Change for the Construction Sector: Adaptation and Mitigation Strategies and Revised CCSI*, Camilleri (2001)
- *Towards Carbon Neutral and Climate Adapted Domestic Buildings*, Jaques (2006)
- *Summertime Overheating in New Zealand Houses – Influences, Risks and Mitigation Strategies*, Jaques (2002)
- *Implications of Climate Change for the Construction Sector: Houses*, Camilleri (2000)
- *Climate Change Adaptation*, O'Connell and Hargreaves (2004)
- *Coping with Climate Change*, BRANZ Bulletin 414
- *Restoring Houses after Flooding Damage*, Bulletin 455