Department of
Building and Housing
Te Tari Kaupapa Whare

Energy efficiency of buildings (domestic hot water and commercial heating, ventilating and air-conditioning systems)

Consultation on energy efficiency revisions to the New Zealand Building Code and Compliance Documents (Part 2)

Closing date for public comment: **29 June 2007**

Published in April 2007 by
Department of Building and Housing
PO Box 10-729
Wellington
New Zealand

This document is also available on the Department's website:
www.dbh.govt.nz/energy-efficiency

ISBN: 0-478-29780-7 (document)
ISBN: 0-478-29781-5 (website)

Foreword

Our homes and workplaces are fundamental to the way we live and work and to our quality of life. Improving the way we use energy is a top priority for this Government.

This document asks for your feedback on some changes to the way we design hot water systems in houses and air-condition our commercial buildings. These changes will lower power and gas bills and limit the environmental impact of new buildings in the future.

The changes are:

- improving the energy efficiency of hot water systems in new homes
- requiring air-conditioning systems in new commercial buildings to be energy efficient

Energy efficiency is not just about making savings in energy bills. Lifting the energy efficiency of homes and commercial buildings means gains for the environment. Given that residential and commercial buildings, and the appliances in them, consume nearly a quarter of all energy in this country, this is an important area where efficiencies can be made.

Significant cost savings can be made in hot water heating by using environmentally friendly technology, using more water efficient fittings, and by designing hot water systems more smartly. Introducing a hot water system rating will allow designers to create cost-effective, energy-efficient hot water systems that limit our impact on the environment.

Greater energy efficiency in the workplace is also easily achieved. Large energy savings in the way commercial buildings are heated, ventilated and air-conditioned are readily available if these systems are designed and operated in smart ways. Improvements to the maintenance and operation of heating, ventilation and air-conditioning systems provide significant financial and environmental benefits, usually in a short time.

The Government will consider the submissions on these proposed measures and make decisions by October 2007. Putting the energy efficiency measures into place means changes to the Building Code and/or new Department of Building and Housing Compliance Documents. The New Zealand Building Code sets the standards buildings must achieve, but does not prescribe how to do it. Compliance Documents set out ways to design or build to meet the standards.

This is your opportunity to provide your input into the suggested ways of lifting the energy efficiency of residential and commercial buildings. The consultation closes on 29 June 2007. I urge you to have your say on the proposals to improve the energy efficiency in our homes and workplaces.

Hon Clayton Cosgrove MP
Minister for Building and Construction

Contents

Appendices

The appendices are available in electronic form on the Department's website (www.dbh.govt.nz/energy-efficiency).

Appendix A: Background notes on the proposed changes to H1 for HVAC Systems

Appendix B: Compliance Schedules and Building Warrants of Fitness (BWOF)

Appendix C: Background Analysis to Establish Energy Efficiency Requirements for Acceptable Solution H1/AS/7.0

Request for comment

The Department of Building and Housing seeks feedback on the proposed energy efficiency initiatives described in this document.

Your comment is sought on specific changes to the Building Code and Compliance Documents. All submissions received by the Department will be carefully considered before a final decision is made on the proposals contained in this document.

The proposals have been packaged together into one consultation document rather than releasing the proposed amendments individually. Comments can be submitted on individual topic areas.

How to comment

Please submit your comments in writing. Typed comments are preferred, but clear handwriting will be accepted. You can return comments by letter, fax or email. Copies of this document can be downloaded from the Department's website at www.dbh.govt.nz/energy-efficiency

They can also be obtained by calling the Department on 0800 242 243.

The closing date for submitting comments on the proposed changes is **29 June 2007**

They need to be sent or couriered to:

Consultation Feedback – Energy Efficiency
Department of Building and Housing
Building Quality and Performance
Level 6, 86 Customhouse Quay
PO Box 10-729
Wellington
New Zealand

or emailed to comments@dbh.govt.nz; please put 'Consultation Feedback – Energy Efficiency' in the subject line

or faxed to (04) 494 0290.

Important note

Please note that all responses will be public information. Responses may be the subject of requests for information under the Official Information Act 1982 (OIA). The OIA specifies that information is to be made available to requesters unless there are sufficient grounds for withholding it, as set out in the OIA. Submitters may wish to indicate grounds for withholding specific information contained in their submission, such as that the information is commercially sensitive or that they wish personal information to be withheld. Any decision to withhold information requested under the OIA is reviewable by the Ombudsman.

Executive summary of proposals

Proposals on domestic hot water systems

Proposal 1: Require domestic hot water systems to be constructed to facilitate the efficient use of hot water and provide a design rating method for domestic hot water systems to set system design limits

The Department is proposing to amend the Building Code to require domestic hot water systems be constructed to enable hot water to be heated and used efficiently. A design rating method and tool will be provided as part of the Acceptable Solution. It will set system design limits, depending on the size of the house, with projected CO_2 emissions as a basis to measure and compare different domestic hot water systems and improve their energy efficiency. This tool would be used to assess designs for domestic hot water systems. All new installations would have to meet its minimum criteria.

The rating tool uses CO_2 emissions as a measure of energy impact and sustainability. The Department's proposal would help designers and building owners choose energy and carbon efficient systems, and reduce carbon emissions.

Proposal 2: All hot water pipes to be insulated

The Department is proposing to amend the Acceptable Solution for energy efficiency to make domestic hot water systems in new homes more energy efficient by requiring all hot water pipes to be insulated.

This would reduce energy bills. Any cost in materials (insulation) would be offset by savings in energy bills.

Proposals on heating, ventilating and air-conditioning (HVAC) systems

Proposal 3: Energy-efficient HVAC systems

The Department is proposing that heating, ventilating and air-conditioning (HVAC) systems be covered by the energy efficiency requirements of Clause H1 of the New Zealand Building Code, leading to more stringent energy efficiency standards and lower energy use for such systems in commercial buildings.

The proposals are to:

- remove the Limit on Application to Clause H1.2 (a) on plant and equipment provided to change temperature and/or humidity

- establish an energy efficiency Performance requirement H1.3.6 for mechanical HVAC systems and controls
- revise the Acceptable Solution H1/AS1 to provide a way of complying with proposed Performance requirement H1.3.6
- develop a guide to help territorial authorities prepare compliance schedules for buildings that would be required to meet the Performance requirement H1.3.6.

Proposal 4: Maintenance of HVAC systems

The Department is proposing to make it easier to maintain HVAC systems so they continue operating efficiently by ensuring ease of access for maintenance.

This proposal is to:

- introduce a Performance requirement for access to allow maintenance of HVAC systems in the Building Code
- provide an Acceptable Solution to comply with new access requirements
- develop a guide to help territorial authorities prepare compliance schedules for buildings containing specified HVAC systems that have maintenance requirements.

Proposal 5: Metering energy consumption in buildings

The Department is proposing that buildings with HVAC systems will have meters installed to allow easy monitoring of energy consumption of the entire building. This will apply to buildings that require a compliance schedule. Meters would make it easier for building owners and users to monitor energy use and improve energy efficiency.

This proposal is to:

- introduce a Performance requirement to the Building Code to install meters to measure the consumption of electricity and gas energy used in buildings with HVAC systems
- provide an Acceptable Solution covering how to comply with the new metering requirements.

1 General reasons for the proposals

The Government is committed to promoting greater energy efficiency, energy conservation and use of renewable energy sources in New Zealand.

Achieving these goals would mean lower energy bills and warmer, healthier and drier homes for New Zealanders. Our air would be cleaner, our children healthier and our homes and commercial buildings more efficient and comfortable. Proposals presented in this discussion document relate to these goals for both residential and commercial buildings. We would consume less fossil fuel, especially for electricity generation, and reduce our impact on the environment, including carbon emissions.

These goals fit well with the strategic direction of the Department of Building and Housing, ensuring:

> "The people of New Zealand have access to quality homes and buildings that meet their needs and reflect our New Zealand environment."

Sustainable development is one of the purposes of the Building Act 2004. As well as saving money and improving comfort in homes and businesses, energy-efficiency measures can also contribute to sustainable development.

In October 2006, the Minister for Building and Construction, Hon Clayton Cosgrove MP, announced a package of initiatives to improve the energy efficiency of new and existing homes and commercial buildings, and to reduce their energy demand and associated greenhouse gas emissions.

The Minister identified five areas of priority for inclusion into the package of initiatives. These are:

- increasing the performance requirements for thermal insulation in new houses
- improving the documentation for solar water heating installations to comply with the Building Code
- looking into improving hot water systems for increased energy effectiveness and efficiency
- increasing the performance requirements for lighting systems in commercial buildings
- improving the performance requirements for heating, ventilating and air-conditioning (HVAC) systems in commercial buildings.

Detailed proposals on thermal insulation, lighting in commercial buildings and solar water heating were released for public comment in November 2006. Public comment was overwhelmingly in support of the proposals. The Government has decided that these changes will be implemented throughout 2007 and 2008.

The Department of Building and Housing (the Department) has undertaken more work on HVAC and domestic hot water systems. This document proposes changes to make these systems more energy efficient and, in the case of HVAC systems, easier to maintain.

The proposals in this document would give direct financial benefits to New Zealand home and business owners, as well as enhance their wellbeing and lower the environmental impact of these systems.

The Department considers these proposals an important step in improving the quality of New Zealand homes and buildings, contributing to the Government's energy efficiency and climate policy goals.

These proposals complement work that is being done by other government agencies, including the Energy Efficiency and Conservation Authority and the Ministry for the Environment. These proposals are part of a coordinated, multi-agency effort to meet the Government's energy efficiency and climate change objectives.

1.1 Building Code energy efficiency provisions

Building Code Clause H1 Energy Efficiency was last revised in 2001 and several factors have changed since then.

In real terms, the cost of energy has increased. The 2001 revision assumed that energy costs would increase by 2 percent per annum. Recent data show that electricity costs have increased by 3 percent per annum from 1995 to 2005, and that between 2000 and 2005, electricity costs rose by 4.4 percent per annum.

Over a 10-year period from 1995 to 2005, actual electricity price increase was 10 percent higher than projected. These increases, which are predicted to continue, make it worthwhile to strengthen the energy-efficiency provisions of the Building Code.

Certain technologies that reduce energy consumption have become cheaper, making energy efficiency initiatives more financially attractive. For example, it is now easier to get energy-efficient equipment for HVAC systems.

Improvements to the energy efficiency of buildings are important in achieving the Government's energy efficiency outcomes of lowering energy demand and reducing greenhouse gas emissions, as directed in the Building Act 2004, the Draft New Zealand Energy Efficiency and Conservation Strategy, the Draft New Zealand Energy Strategy and the Government's commitment to the Kyoto Protocol.

2 Background

This consultation document proposes initiatives to improve the energy efficiency provisions of the New Zealand Building Code (the Building Code) in the short term.

The Department of Building and Housing is reviewing the Building Code. The proposed amendments are in advance of a wider review supporting the Government's initiatives to improve energy efficiency and conservation. These are detailed in the following.

- The Building Act 2004, which promotes buildings be designed, constructed and used in ways that promote sustainable development.
- The Energy Efficiency and Conservation Act 2000 and the Draft New Zealand Energy Efficiency and Conservation Strategy, which identify decreasing energy demand and increasing the use of renewable energy sources as priorities
- Kyoto Protocol commitments, which require greenhouse gas emissions to be reduced.

2.1 The New Zealand Building Code

The New Zealand Building Code sets performance requirements for buildings but does not prescribe how these are to be achieved. For specific guidance, Compliance Documents issued by the Department of Building and Housing provide detailed methods for achieving compliance with the Building Code.

Compliance Documents include Acceptable Solutions and Verification Methods. Acceptable Solutions are examples of materials, parts and construction methods that if used or followed, establish compliance with the Building Code.

This consultation document proposes changes to the Building Code and Compliance Documents.

2.2 Energy use in buildings

Residential and commercial buildings consume 22 percent of the energy used in New Zealand. Additionally:

- 56 percent of electricity used in New Zealand is used in buildings
- the annual cost of electricity and gas consumed in residential buildings is about $2.3 billion
- about a third of total energy consumed in residential buildings is used to heat water, a third to heat space and a third to power household appliances and lights
- of the energy used in commercial buildings, about a third is used for lighting, a third for heating and cooling, and a third to power equipment.

3 Proposed transitional provisions for the H1 Compliance Document (Acceptable Solution H1/AS1) amendment

Should the proposals be adopted, the following transitional provisions would apply for changes to the H1 Compliance Document (Acceptable Solution H1/AS1).

PROPOSED PUBLISHING DATE	PROPOSED INTRODUCTORY PERIOD	PROPOSED EFFECTIVE DATE
1 December 2007	4 months	1 April 2008

Building consent applications submitted to building consent authorities before the effective date (1 April 2008) may either:

- use Acceptable Solution H1/AS1 as it stands before the proposed amendment or
- use the provisions of the proposed amendment as the basis for an alternative solution proposal or
- be based on another alternative solution.

Building consent applications submitted on or after the effective date (1 April 2008) must either:

- use the amended Acceptable Solution H1/AS1 or
- be based on an alternative solution.

3.1 Code compliance certificates for existing projects

Code compliance certificates for building consents issued before 31 March 2005 must be issued if the building complies with the Building Code in force at the time the consent was issued.

Code compliance certificates for building consents issued after 31 March 2005 must be issued if the building complies with the building consent.

3.2 Explanatory note

Acceptable Solutions are documents published by the Department of Building and Housing, which show one way of complying with the Building Code. Building consent authorities must accept designs based on an Acceptable Solution or other Compliance Document.

Alternative solution proposals are all other designs. Building consent authorities may accept these proposals if the authority is satisfied that the alternative solution proposal meets Building Code requirements.

4 Proposals on domestic water heating systems

Summary of proposals

The Department is proposing to make domestic hot water systems in new homes more energy efficient by:

- establishing an energy efficiency design limit for domestic hot water systems and creating a design rating tool to measure and compare different system designs
- amending the Acceptable Solution to require all hot water pipes be insulated.

The proposal would help make domestic hot water systems more energy efficient and would reduce energy bills. Any cost in materials (insulation) would be offset by savings in energy bills.

The rating tool uses CO_2 emissions as a measure of energy impact and sustainability. The Department's proposal would help designers and building owners choose energy and carbon efficient systems and also reduce carbon emissions.

4.1 Background

Hot water heating is a major use of energy in New Zealand homes. It represents roughly one-third of total domestic energy use. It is comparable to energy use for space heating and is increasing each year.

Given the large amount of energy used to heat water, any waste of hot water is a waste of energy. Hot water systems need to be designed to deliver good hot water service to building occupants without using too much non-renewable energy. Ideally, a hot water system should meet the needs of building occupants now and in the future, while considering the future affordability and sustainability of the heating energy required.

The Department is reviewing the Building Code energy efficiency requirements on hot water. The review aims to:

- ensure hot water service in houses is provided in an energy efficient way, and does not excessively consume non-renewable energy
- ensure the hot water service in houses is satisfactory and affordable for current and future occupants
- prevent excessive use of water
- enable hot water systems to be assessed, evaluated and compared with other systems, preferably in a way that is compatible with other rating schemes for household energy use, such as the Home Energy Rating Scheme (HERS) being developed by EECA(Energy Efficiency and Conservation Authority).

The review has used information from the BRANZ Household Energy End-use Project (HEEP) to determine what hot water service New Zealanders expect, and how much energy is consumed by providing domestic hot water. An analysis commissioned from BRANZ[1] provides relevant information and also incorporates the experience of other countries on this matter.

4.2 Building Code and Compliance Documents

The Building Code and the Energy Efficiency Regulations require hot water systems to limit heat loss from water storage tanks and certain hot water pipework. The Acceptable Solution H1/AS1 also contains minimum standards for gas water heater conversion efficiency.

The performance requirements for hot water systems in Clause H1 of the Building Code are as follows:

> **H1.3.4** Systems for the heating, storage, or distribution of hot water to *sanitary fixtures* or *sanitary appliances* must, having regard to the energy source used,
>
> (a) limit the energy lost in the heating process; and
>
> (b) be constructed to limit heat losses from storage vessels, and from distribution systems connected to storage vessels.

The Acceptable Solution for these requirements incorporates the New Zealand Standard NZS 4305: 1996, with a few changes. NZS 4305 has requirements for:

- standing heat loss of electric storage water heaters
- conversion efficiency of gas water heaters
- energy needed to maintain the temperature of gas storage water heaters
- reducing heat loss from pipes by insulation and limiting pipe length
- insulating pressure relief valves and providing cold water expansion valves on high pressure systems
- insulation of the vent pipe (in the case of open vented systems).

NZS 4305 controls only the specific aspects of the hot water system described above, and does not evaluate the whole system.

4.3 Hot water issues in NZ

Analysis revealed the following issues related to hot water supply and use.

- The majority of hot water is used for showering.
- Hot water consumption is dependent on a user's preference, therefore the energy used by domestic hot water systems varies.
- Energy savings that may be achieved by further improving water heater efficiency are small.

[1] Camilleri, M. *Hot Water Analysis*, BRANZ Limited, October 2006. (Project Number EC1247/01)

- In large houses, a single hot water system can result in long pipe runs with associated high heat losses. Installing an extra system, usually an instantaneous heater, can reduce these losses.
- Hot water systems may use different fuels and forms of energy. There should be some way to compare systems that use different fuels.
- Use of solar water heating should be encouraged.
- Energy efficiency improvements to hot water systems need to be achieved economically.
- There are several ways to make hot water systems perform better, but not all may be practical in every case.
- The Building Code applies to new buildings. It would be preferable for any assessment procedure to apply to existing buildings as well.
- Should requirements apply only to houses or to all buildings with domestic scale hot water systems?

4.4 Options to improve hot water energy efficiency

The following options were considered for improving the energy efficiency of hot water systems.

4.4.1 Option 1: Do nothing (not recommended)

Leaving the Building Code and Compliance Documents unchanged would rely on market forces to change how hot water systems are specified and installed, in the hope of achieving more energy efficient systems. Current construction trends do not suggest this is happening, nor is it likely to of its own accord.

The present regulations cover aspects of hot water system installation. The regulations improve components within the system, but do not improve the system itself, which is the major determinant of hot water energy use. Given the improvements in energy efficiency being introduced for homes, such as better insulation, merely keeping the present hot water requirements would unnecessarily result in water heating becoming the biggest use of energy in houses.

This option is not recommended as market forces have failed to deliver optimal systems.

4.4.2 Option 2: Mandate water efficient showerheads (not recommended)

Mandating water efficient shower heads was considered. This would reduce the hot water used for a shower, and therefore save water-heating energy.

Showering is the major use of hot water in most homes. The rate of flow from showers varies, with many people preferring the higher flow rates associated with high-pressure hot water systems.

However, the performance of a showerhead – that is its ability to provide a satisfactory shower, depends less on its flow rate than on other reasons. These include the spray pattern, the ability to wet a reasonable area of the user while still providing good projection and intensity, and the temperature difference of the spray as it falls – the more even the temperature, the better. A good shower provides a comfortable and effective shower with flow rates of between 6 and 7.5 litres per minute.

However, some people prefer showers with high flow rates or multiple heads. Such preferences should not be unreasonably denied provided alternative measures are taken to reduce the expense and environmental impact of high flow showers. Providing flexibility and choice within the Building Code and Compliance Documents is the reason this is not the recommended option.

4.4.3 Option 3: Mandate solar water heating (not recommended)

Compulsory solar water heating in the Building Code is not recommended because:

- there are areas and homes that do not get enough sun to make the technology economically or environmentally viable
- the Building Code is performance-based and should give people the flexibility and choice to develop energy efficiency solutions that best suit them.

In Spain, which is situated at the equivalent latitude as central New Zealand, it is becoming compulsory for new homes to meet a portion of their hot water needs from a solar water heater. The portion is between 30 and 70 percent, depending on the climate zone and the energy source for the remaining portion. In New South Wales, limits on the total energy use of new houses make it almost impossible to install a stand-alone electric resistance water heater, making it necessary to at least consider a solar water heater as an alternative. In Victoria, new houses must have measures to reduce their environmental effects, with solar water heating as one of the choices.

However, solar radiation available in New Zealand is less than in these other places. New Zealand’s solar radiation rates with the worst two of Spain’s five climatic zones. In comparison with Australia, it is at best equivalent to that of Tasmania. Therefore, the performance of solar water heaters in New Zealand would be less effective than in Spain or Australia. These factors coupled with differing economic and energy conditions in New Zealand make it difficult to justify the compulsory installation of solar water heaters. However, solar water heaters should be encouraged wherever suitable.

4.4.4 Option 4: Insulate all hot water pipes (recommended)

Requiring insulation on all hot water pipes was investigated. This measure provides a net benefit over the life of the building. Insulating hot water pipes improves the efficiency of a system by reducing the heat that is lost as hot water travels along the pipe to the tap. Energy is also saved when the tap is initially turned on as water sitting in the pipe will be warm compared to that in an uninsulated pipe (this effect is most useful when, for example, people are showering one after the other).

A 1980 [2] study concluded that insulating materials in common use then, and with assumed water usage patterns, there was no reason to insulate hot water pipes except for:

- pipes leading to storage cylinders (for example, those connecting to wetbacks or solar water heaters)
- pipework close to the storage cylinder
- pipes to frequently used outlets (in effect, the kitchen sink).

However, the improvement in insulation available (better insulation performance with lower thermal capacity) and changes in hot water use patterns, (particularly the use of showers instead of baths) mean that it is now worthwhile to review the situation.

Energy savings from insulating hot water pipes can be calculated by measuring average hot water use and the fall in heat flow out of an insulated pipe, compared to an uninsulated pipe.

BRANZ has studied household hot water use.[3] Its data reveals that the shower is in use for almost 30 minutes a day in an average home.

During this time, the heat loss per metre of uninsulated pipe is 18.8W. This heat loss may be reduced to 6.8W by insulating the pipe as specified in NZS 4305 – a saving of 12W. Over the course of a year, the reduction in heat loss due to insulation would be:

$$EnergySavings = \frac{12W \times 60secs \times 29.5mins \times 365days / year}{3{,}600{,}000W / kWh} = 2.15kWh / year / metre\ of\ \ pipe$$

In addition, each metre of 15 mm pipe contains 0.127 litres of water. For intermittent use, adding insulation delays water cooling to an unusable temperature by 45 minutes, compared to 15 minutes for an uninsulated pipe. How many times this delay in cooling will be worthwhile is unknown. However, given that hot water use often occurs in bursts of activity, it is likely hot water stored in the pipe will be used (as hot water) at least once per day when it would otherwise be wasted.

Pipe insulation therefore causes 0.127 litres of hot water a day to be saved from each metre of hot water pipe during intermittent use. Over a year, this saving amounts to 2.6 kWh.

Combining the savings from shower use with savings from intermittent use offers a total saving from insulating hot water pipes of 4.75 kWh a year for each metre of pipe. Assuming an energy price of 14 cents a kWh, savings amount to 66 cents a year per metre of pipe. The cost of insulation is slightly less than $5 a metre, and so offers a payback time of around 7.5 years. This equals an internal rate of return of 10.2 percent over 15 years and 13.3 percent over 50 years, assuming a constant fuel price.

[2] Elkis, W.J. *The Effect of Insulation on Energy Loss in Domestic Plumbing*, Research Report R33, Building Research Association of New Zealand, 1980.

[3] Camilleri, M. *Hot Water Analysis*, BRANZ Limited, October 2006. (Project Number EC1247/01)

Therefore, on the strength of the net financial benefit to a homeowner and the environmental benefits that will also result, the proposal is to insulate all hot water piping. The requirement would be introduced by changing the Acceptable Solution for hot water, which is based on NZS 4305.

If all hot water piping were insulated, it would have the added advantage of consistency throughout the building. At present, only some hot water pipes and parts of other pipes have to be insulated, making compliance checking difficult.

4.4.5 Option 5: Improving energy efficiency by setting a system design energy efficiency limit using a design rating for hot water systems (recommended)

The recommended option is for a design rating tool that assesses the energy efficiency of hot water systems, along with energy-efficiency requirements in the Building Code, as the best way to ensure hot water systems are designed to use less non-renewable energy.

An energy efficiency rating tool has been developed to measure and compare different hot water systems. The rating tool allows any hot water system to be assessed and does not limit the choices a person can make in the system design. It is important to appreciate the rating tool cannot calculate the actual use or the actual energy consumption of a system, instead it calculates the expected (that is, the design) energy consumption, based on estimates of average hot water use and system performance.

Any assessment of hot water systems needs to provide a way to compare fuels. The use of delivered energy does not account for some fuels having greater environmental impact than others. An electric heater may be more attractive than a gas one, for example, if you overlook the fact that the electricity may have been generated by burning twice as much gas as is used by the gas water heater.

A suitable measure of the sustainability of an energy source is the CO_2 emissions attributable to its use. The energy efficiency rating tool therefore uses CO_2 emission values in the comparison of fuels and in setting performance limits.

Details of the rating are given below in sections 4.6 to 4.13. The tool is available on the Department's website (www.dbh.govt.nz/energy-efficiency).

Compliance with the Building Code would be established by using the rating tool to show if a hot water system produces less CO_2 than a prescribed design target. The design target for a particular installation would depend on the estimated number of occupants in the dwelling and the need to provide a reasonable hot water service. It is assumed that the number of occupants depends on the number of bedrooms and floor area of the house.

4.4.6 Option 6: Develop a Verification Method for hot water systems (not recommended)

The development of a design rating for hot water systems (Option 5) goes some way to creating a Verification Method for hot water system energy efficiency.

A Verification Method is essentially a test (either physical or calculation) that directly measures performance against stated parameters.

The performance measure of a Verification Method needs to be in numeric form. In the case of hot water service, the aim is to deliver a satisfactory or adequate service, though perception of what constitutes such a service varies according to user preference and expectation. While there are established values for other building services — for example, temperature and light level, there is no established parameter for hot water service. For some purposes, a measure of litres of hot water per person per day could be used, but this does not recognise the factor of water efficiency.

A Verification Method also needs to be a complete solution. In other words, if a system passes the Verification Method, it is deemed to comply fully and there ought not to be other performance restrictions. In the case of hot water systems, there are some performance restrictions placed on certain water heaters by the Energy Efficiency (Energy Using Products) Regulations 2002.

The need for completeness means that the whole system needs to be taken into account. In the case of hot water systems, this would include consideration of:

- cold water temperatures throughout the year for the particular location
- ambient temperatures and airflows around hot water storage vessels and hot water pipes
- length and routes of hot water pipes
- performance of hot water heaters under different ambient conditions
- assumed water usage pattern.

This would result in a complex model and high compliance costs for design data input, with the model likely to correlate poorly with actual in-service use.

Therefore this option is not recommended and was not developed.

4.5 Recommended options

The Department is proposing that the best way to improve the energy efficiency of hot water systems is to:

- introduce a limit on the non-renewable energy that is used to heat water, expressed as a target of assessed CO_2 emissions (according to Option 5) – a rating tool that assesses the CO_2 emissions will be available to support the new requirements
- change the Acceptable Solution H1/AS1 to require that all hot water pipes be insulated (according to Option 4).

4.5.1 Implications of the recommended changes

Some implications of the proposed changes are below.

- There is a compliance cost in providing extra information for a building consent.

- In any proposal that requires or may require shower flows to be known, suppliers of shower assemblies and water heaters will have to provide such performance data.
- Low-flow showers may result in unsatisfactory service.
- In assessing a hot water system, actual values of heater performance and shower flow should be used where practical. If actual performance values are not known, default values may be used. Default values in the assessment tool have been selected to be reasonable, and not more favourable to the building owner than actual values.
- Problems could arise if other buildings block solar access and prevent hot water systems with solar water heating from operating efficiently.

4.6 Development of the rating tool

The development of a rating tool to limit the design consumption of non-renewable energy used for hot water systems (using CO_2 emissions as the measure) is described in section 4.10. Design values for hot water consumption and emission factors for CO_2 used in the rating tool are also described in sections 4.7 to 4.9.

Information from the BRANZ Household Energy End-use Project (HEEP) was used to determine the nature of the hot water service expected by New Zealanders and how much energy is consumed by domestic hot water use. An analysis commissioned from BRANZ[4] provides the relevant information. Similar steps taken by other countries were also studied.

4.7 Hot water service

From analysis of the HEEP data[5] with data from the BRANZ House Condition Survey[6], it is possible to define a hot water service that is typical and reasonable and performs satisfactorily under crowded conditions. The HEEP data show there is a wide variance in demand of hot water systems. This is due in part to the types of systems. Some of the old electric storage systems offer low pressure with water pressure provided by a header tank in the roof space. This often provides only a slow flow of water to a shower head. More recent systems are often mains or high pressure and can provide much greater flows and consequently have higher water use.

Representative hot water use daily amounts are as follows.

For gas-heated mains pressure systems in housing with normal density occupancy the water usage is:

- 44 litres a person for showering

[4] Camilleri, M. *Hot Water Analysis*, BRANZ Limited, October 2006 (Project Number EC1247/01).

[5] Camilleri, M. *Hot Water Analysis*, BRANZ Limited, October 2006 (Project Number EC1247/01).

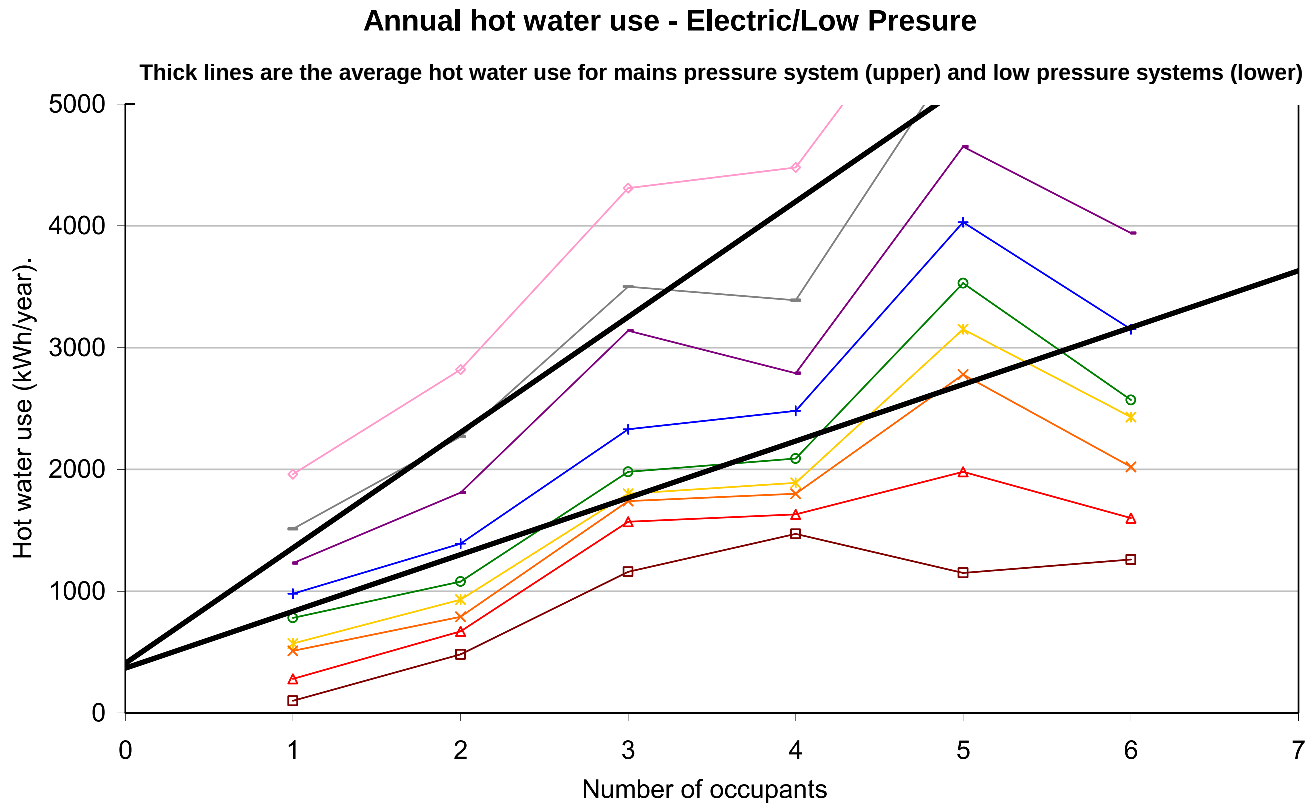
[6] Susan J. Clark, Mark Jones and Ian C. Page, Study Report No. 142 (2005) — New Zealand 2005 House Condition Survey, BRANZ 2005, ISSN: 0113-3675.

- 2.5 litres a person for other uses
- 20 litres total for household purposes.

For electric low-pressure systems in housing with higher density occupancy the water usage is:

- 20 litres a person for showering
- 2.5 litres a person for other uses
- 18 litres total for household purposes.

Figure 1 shows the difference in use patterns between electric systems (including old low-pressure systems) and gas (generally modern high-pressure) systems. These values are for hot water, as would be contained in a storage tank. Most use of water would mix this hot water with cold. For showers, the mixed water quantity for a high pressure system would be 81 litres (comprising 44 litres of hot water from the tank mixed with 37 litres of cold water) and for a low-pressure systems would be 37 litres (comprising 20 litres of hot water from the tank mixed with 17 litres of cold water).



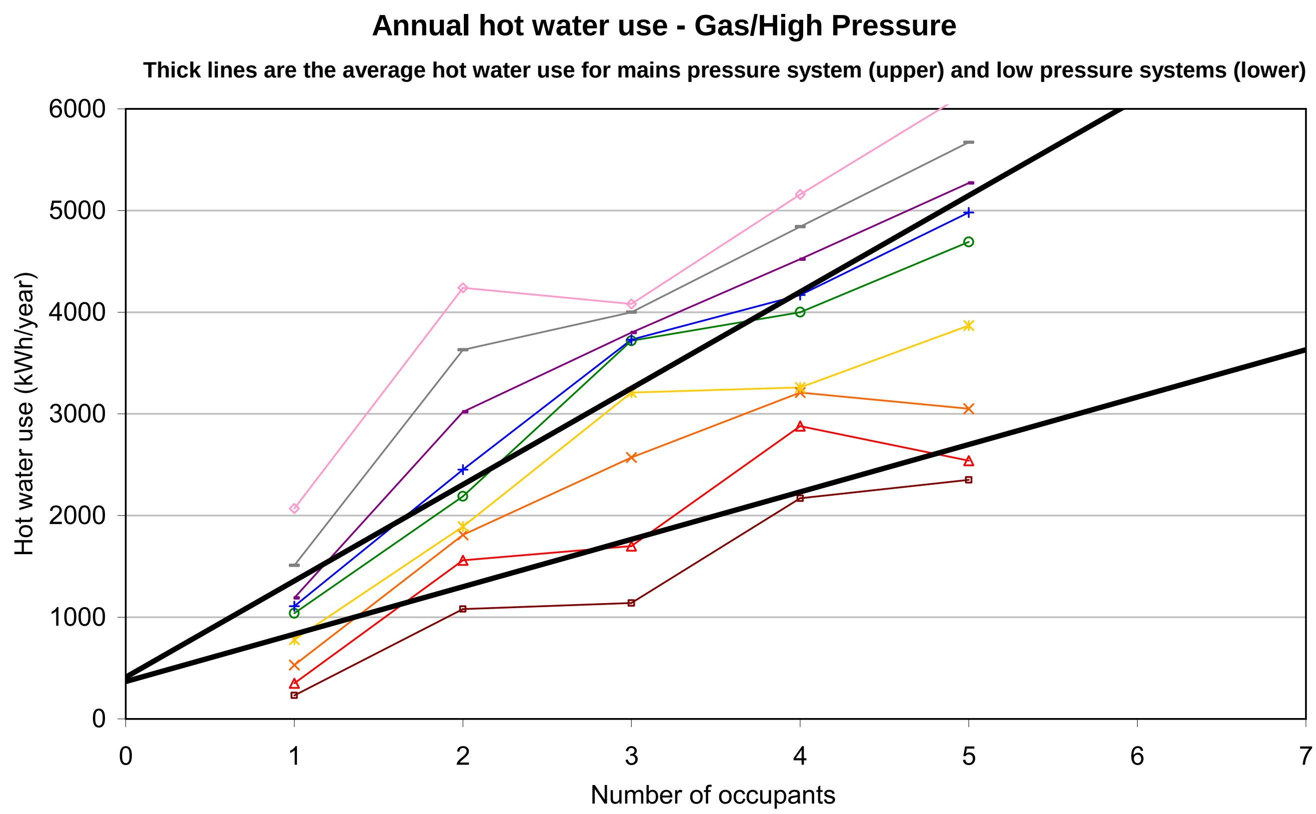


Figure 1: Annual hot water energy use (not including storage and other losses) for electric (top) and gas (bottom) systems

4.8 Occupancy densities

The HEEP data show that occupancy densities in housing vary between dwelling and over time. However, the average occupancy is best indicated by the number of bedrooms as represented by the formula:

Occupants = 1 + (0.69 x number of bedrooms)

At some time during a building's life, housing may be densely occupied or even overcrowded. Using HEEP, the maximum occupancy density is likely to be two people in a bedroom.

The use of the number of bedrooms to decide occupancy may be questionable when it is not easy to ascertain which rooms are bedrooms. Therefore, the rating procedure uses the floor area of the house to check the maximum occupancy density is no less than one occupant per 25 m^2.

4.9 Comparison of fuels

Electricity and gas are the predominant means of heating water in New Zealand. These could simply be compared based on the electricity or gas energy consumed in the home. However, the electricity may be produced in a gas-burning power station and hence represents a greater usage of gas than using gas to heat hot water directly. When gas is used to produce electricity, with that electricity then used to heat water, this results in twice as much gas being used than in direct gas water heating systems. By contrast, a solar water heater delivers hot water and has a smaller use of non-renewable energy, making it more favourable.

CO_2 emissions are a simple way to compare the relative efficiencies of different heating methods and technologies on consumption of non-renewable energy. Using CO_2 also reinforces a major driver for improving energy efficiency, the commitment to reduce greenhouse gas emissions. Applying recognised emission factors would provide a useful and suitable way to compare fuels and energy sources.

CO_2 emissions are calculated using emission factors that quantify the mass of CO_2 released into the atmosphere for a given amount of energy produced. Emission factors for various fuels and for electricity produced by different types of power station, are in a report commissioned by the Climate Change Office [7], and have been used in the rating tool. The relevant emission factors are as shown in the table overleaf.

[7] Concept Consulting Group, *An Electricity Emission Factor*, Climate Change Office, August 2003

FUEL	EMISSION FACTOR
Natural Gas	52 kg CO_2/GJ
Heavy Fuel Oil	75 kg CO_2/GJ
Coal	91 kg CO_2/GJ
Electricity produced by a combined cycle gas power station	103 kg CO_2/GJ (370kg CO_2/MWh)

Table 2: Emission factors

Deciding which of the emission factors for electricity, or a combination of them, are the most suitable to use must be further considered. Electricity is produced in New Zealand in several different ways, which all have different associated CO_2 emissions. Previous studies[8] used the emission factor matching the power station that would be built to provide extra electricity. In New Zealand, this has recently been the most efficient gas-fired power station. The approach of using an emission factor that matches with providing extra generation capacity, has been used in the rating tool. Using the emission factor for a gas-fired power station also provides a direct comparison between using gas directly in the home to produce hot water, or using that same gas to generate electricity that is then used to heat water.[9]

However, electricity used by storage water heaters is often controlled via ripple control so that electricity is used only at times when a high proportion of generation is from sustainable resources. Therefore, a more appropriate emission factor for systems with an electric storage water heater may be a marginal emission factor projected on a mix of new renewable and gas generation, namely 83 kg CO_2/GJ (or 300 kg CO_2/MWh). If a lower emission factor is adopted after evaluation of consultation submissions, then the emissions target would be adjusted accordingly.

Wood is generally considered carbon neutral, with the carbon emitted as it is burned being absorbed by replacement planting. There is non-renewable energy use associated with harvesting and transport of firewood, estimated to be 1kg CO_2/GJ. This is not significant when compared with other fuels, even with the value of 52kg CO_2/GJ for natural gas.

4.10 The rating tool

A design rating tool has been developed to assess the non-renewable energy consumption of a hot water system. The tool[10] uses input data to evaluate the design consumption of hot water

[8] For example, George Wilkenfeld and Associates *Energy Labelling and Minimum Energy Performance Standards for New Zealand*, 1994 report for EECA.

[9] The emissions factors used by the Climate Change Office allow for electricity transmission losses.

[10] A spreadsheet version is available on the Department's website www.dbh.govt.nz/energy-efficiency. The final version would be accessible at the same website address.

and then calculates the energy needed and equivalent CO_2 emissions produced in providing the hot water service. Input data include the number of bedrooms, floor area and type of system proposed. System information includes the type of water heater, shower flow rates and the number of showers. The calculated design CO_2 emission is compared with a target emission. If the design emission is greater than the target, the system is unsatisfactory. The user of the tool may alter the design to achieve a satisfactory hot water system.

Where exact input data are not available, a default value is assigned automatically. The default values have been selected to be reasonable, but at the less effective end of the expected range so it would not be favourable to the user to select the default value.

The tool does not check whether the system proposed is suitable for delivering the service needed. This remains a matter for the plumbing system designer to determine.

While the calculation tool is intended for use on new buildings, it can also be used for existing buildings. It will be possible to use it as part of a scheme for rating a house according to its energy efficiency, such as a Home Energy Rating Scheme (HERS).

To encourage builders and homeowners to make it easy to install a solar water heater in future, the rating tool includes a credit – a relaxation of the calculated CO_2 emissions, for providing the ability to easily install a solar water heater in future. This is because it is often difficult and expensive to adapt the existing plumbing and to support any extra storage tanks when a solar water heater is retrofitted. Providing for these features is not expensive if done during building.

In larger houses with more than one bathroom, the hot water pipework can be long and, even if insulated, incur significant heat loss. It is often preferable to install an extra water heater – perhaps an instantaneous type, for a second bathroom or ensuite. The calculation tool recognises the benefit of having such multiple systems by making a small drop in the calculated CO_2 emissions.

4.11 Application of the rating tool

4.11.1 Target for CO_2 emissions for a hot water system

A limit on the CO_2 emissions of a domestic hot water system needs to meet the dual requirements of saving energy while not unduly reducing the service provided. While there are several ways to enhance hot water systems, not all may be practical in particular cases. Some may also prove to be economically unattractive for the builder or homeowner. The main considerations in selecting a limit for CO_2 emissions were practicality and affordability, as well as effectiveness.

Using a water efficient shower is deemed a reasonable design as it has, at worst, a small cost, but will always provide tangible benefits. The design maximum limit for CO_2 was thus set so that a typical electric storage hot water system fitted with water efficient showers would nearly always comply with it. The design limit is set for a calculated annual CO_2 emission of 650 kg CO_2, plus 125 kg CO_2 per occupant.

The design limit will affect the different types of hot water system in different ways. As can be seen in Figure 2, instantaneous gas systems would generally meet the proposed limit, as would systems that use smaller sizes of gas storage water heaters. Hot water systems featuring large gas storage water heaters that only just meet the current efficiency requirements of the Acceptable Solution, may need some modification to meet the annual CO_2 emission design limit.

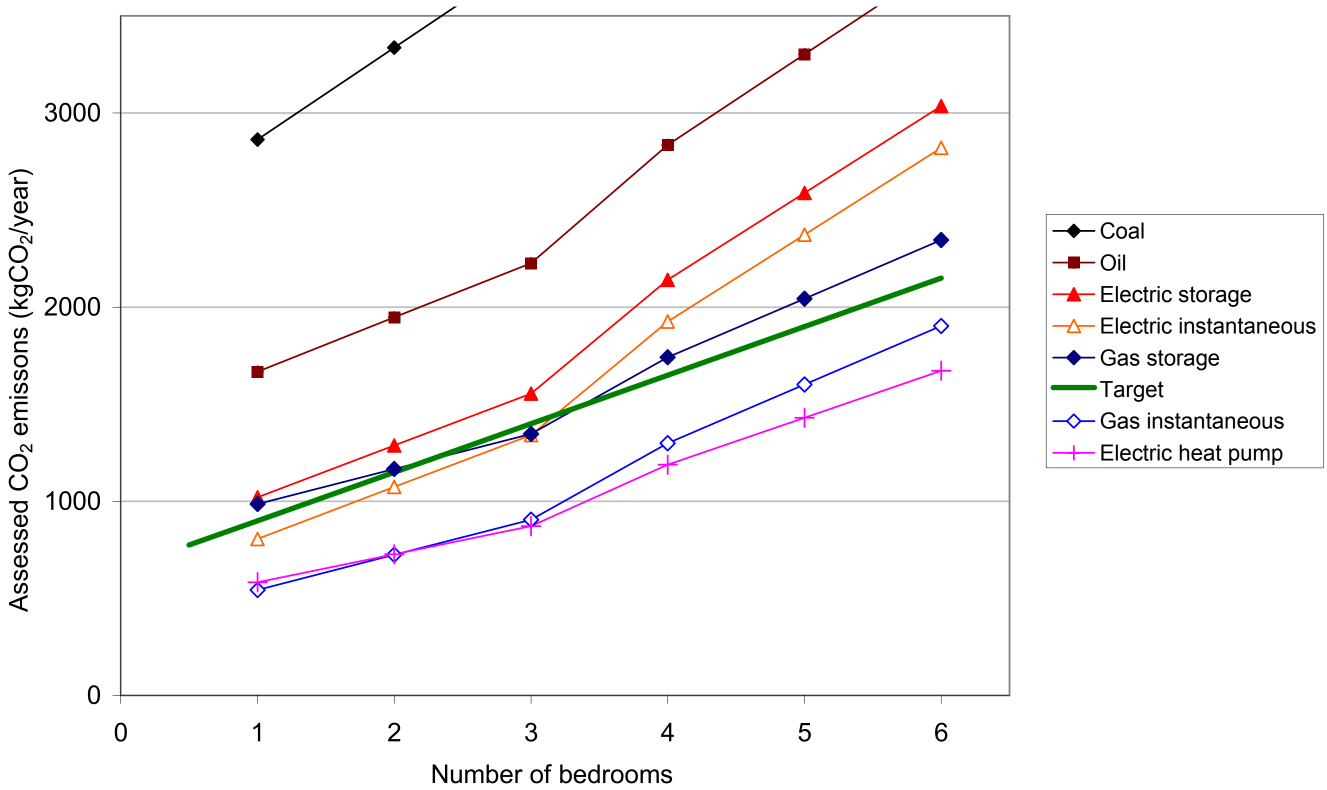


Figure 2: Comparison of hot water systems with different fuels

Systems with electric storage water heaters running at high pressure would likely need some modification. The choice of suitable modifications or combination of modifications will depend to some extent on the number of people who will use the system. Figure 3 shows the effect of adjusting a high-pressure electric storage hot water system in various ways. The use of a water-efficient shower[11] would generally make any electric storage system acceptable. Other measures may be used in lieu of or in conjunction with the water-efficient shower.

[11] Shower flow results from the combination of system pressure, the shower mixer, the shower head and any flow restriction device.

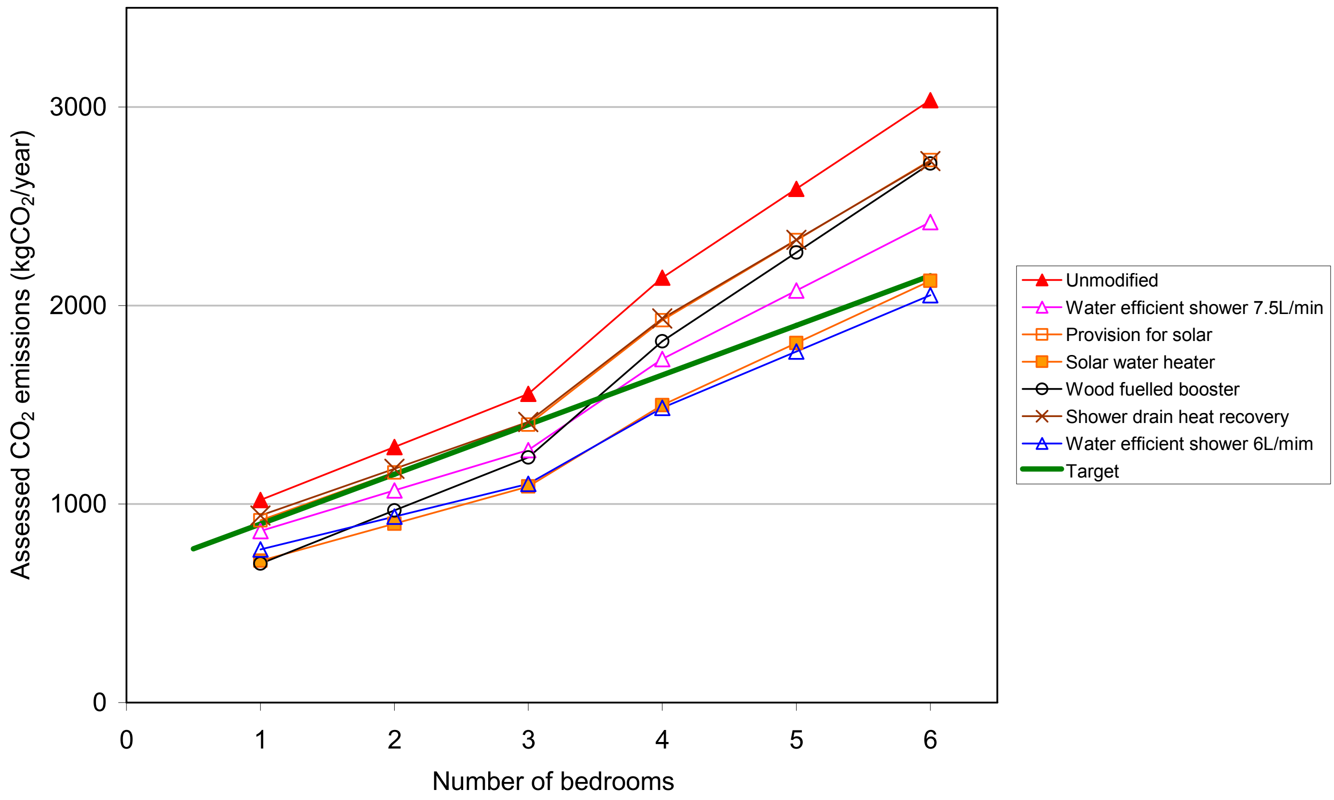


Figure 3: The effect of individual energy efficiency modifications on an electric hot water system's efficiency

The design limit is set at a level so that improvements made to a proposed hot water system for compliance, can be cost-effective and need not detract from the service provided by the system.

The application of the target CO_2 emissions would not restrict the amount of hot water that may be used by the occupants, rather it would ensure the hot water system provides a good service without incurring excessive energy bills or overuse of non-renewable energy. Designing a system to use large volumes of hot water would require the use of renewable energy sources.

4.11.2 Adjustments to a hot water system that improve CO_2 emissions

If a proposed hot water system is not designed to meet the annual CO_2 emission limit, there will be several ways to alter the design so it does comply. Modifications could include the following.

- Providing for a future solar hot water system. This would involve checking the site is not overshadowed by nearby hills or by other buildings, and either fitting a storage heater with an extra heating coil or making structural provision to install a future solar hot water storage vessel.
- Adding a shower drain heat recovery unit, which passes the incoming feed to the water heater through a heat exchanger fitted to the shower drain, thus using the heat from waste water to preheat water entering the water heater. This option is likely to be more effective in the

cooler parts of the country where there is a greater temperature difference between water in the shower drainage and the water supply[12].

- Using a low-pressure system as these systems have inherently lower flow rates than high-pressure systems. For systems with the header tank in the ceiling space, water in the header tank feeding the water heater may also absorb some of the ‘free heat’ in the roof space.
- Having water efficient showers – providing a comfortable and satisfactory shower without a fast flow rate.
- Including a wood-burner booster.
- Having a solar hot water system.
- Installing a heat pump water heater – this heats water by extracting heat from the outside air using a reverse refrigeration cycle in the same way as heat pump space heaters. For each unit of electricity used, a heat pump water heater provides two to three times as much hot water as a conventional heater using a conventional resistance element.

Table 3 shows representative annual cost savings from various energy efficiency measures. The values are based on a medium-sized three-bedroom house for which a storage electric hot water system is proposed. An electricity price of 14 cents per kWh was used.

ADJUSTMENT TO BASIC HOT WATER SYSTEM (WITH SHOWER FLOW RATE OF 10 L/MIN)	TYPICAL ANNUAL COST SAVING
Fit a shower that runs with a flow of 6 L/min	$171
Fit a shower that runs with a flow of 8.6 litres/minute (which in the example chosen meant the system just met the energy impact limit)	$60
Install a shower drain heat recovery unit	$55
Provide to install a solar water heater (assigned artificial value to help with future installation)	$59
Install a solar water heater	$206
Install a solid fuel water heater booster [13]:	
Climate Zone 1	$97
Climate Zone 2	$121
Climate Zone 3	$171
Use a heat pump water heater	$283

12 The effectiveness of shower drain heat recovery units in reducing non-renewable energy use is also reduced where there is a wood burning booster, but theoretically the units will be effective in reducing the amount of wood burnt

13 Climate zones 1, 2 and 3 are as defined in NZS 4218:2004. Approximately, zone 1 is the northern part of the North Island to Franklin and Thames Coromandel, zone 2 is the lower part of the North Island not including the Central Plateau, zone 3 comprises the Central Plateau of the North Island and the whole of the South Island.

Table 3: Representative annual energy cost savings for different energy efficiency measures

4.11.3 Buildings affected by the proposal

The proposed rating tool for hot water systems and the CO_2 emission target would only apply to new residential buildings. This part of the proposal excludes commercial and industrial buildings that have hot water systems installed.

The existing energy efficiency requirements for hot water systems in the Building Code apply to all domestic scale hot water systems, and so apply to many non-residential buildings. This is satisfactory for requirements that are aimed at parts (water heaters, pipework). However, the rating tool requires accurate estimates of occupant energy consumption behaviour and use patterns, presently not known for non-residential buildings. An example of this is the difficulty in assigning a deemed occupancy equivalent in a non-residential building.

4.11.4 Providing information for a Building Consent

There is a compliance cost in providing extra information for a building consent. Those responsible for the design of the hot water system would need to evaluate the design and check that it meets the CO_2 emission target. We expect the designer would use the calculation tool to do the check. The rating tool is simple and straightforward to use. Once a satisfactory system is decided upon, it would be possible to record the input data and meet the needs of the building control processes (for example applying for a building consent) by simple reference.

4.11.5 Providing performance data for parts

Suppliers of shower assemblies (comprising mixing valves, shower heads and any flow restricting devices) and of all types of water heaters, would be asked for performance data that could be used as input to the assessment tool. The data would need to be readily accessible and accurate[14].

Shower flow data would be the same as those for the water efficiency labelling scheme (WELS) being introduced by the Ministry for the Environment. From preliminary discussions with suppliers we do not consider it difficult to provide such information as this information is either already known or easy to get.

4.12 Low-flow showers may be unsatisfactory

An undue emphasis on ‘low flow’ showers may result in unsatisfactory shower service unless water efficient systems are used. It is possible for water flows to be unnecessarily fast though.

[14] In the future, it may be possible to link suppliers’ data to the assessment tool, so that the input to the assessment tool is made merely by selecting a particular product

The rate of flow from showers varies. Some prefer the higher flow rates associated with high-pressure hot water systems, although how a showerhead performs – that is its ability to provide a satisfactory shower, depends less on its flow rate than on other factors. These factors include the spray pattern, ability to wet a reasonable area of the user while still providing good projection and intensity, and the temperature difference of the spray – the more even the temperature, the better.

A good shower provides a comfortable and effective shower with flow rates of between 6 and 7.5 litres a minute.

The Department would provide guidance making it clear that a water efficient shower is not only one with a low-flow, and that care is needed in selecting a shower. The information would also highlight that a shower is a combination of water supply pressure, mixer valve, the showerhead and any flow restricting device, and not merely the showerhead.

4.13 Blocking of solar access

As other houses may depend on solar water heating, new buildings should not block existing solar access. This consideration is not unique to this proposal but is the case with all solar water heaters, including existing ones. Any action would be related to planning resource management and would not be within the scope of the Building Act 2004.

The Department will advise territorial authorities of this issue.

4.14 What are the benefits and costs of the proposed changes?

4.14.1 Benefits and costs of compulsory pipe insulation on all hot water pipes

The proposed changes will have the effect of saving the equivalent of 4.75 kWh of energy per year for each metre of hot water pipe not currently insulated. The length of hot water pipe affected will vary from building to building, and would generally be a minimum of five metres.

Over 25,000 building consents are issued for new dwellings every year[15]. There would also be some non-housing installations to which this provision would apply. This indicates a national energy saving of around 600 MWh/year (accumulating). This saving would be double in the second year, triple in the third year, and so on.

For individual installations, given a cost of insulation of slightly less than $5 per metre, the payback time would be 7.5 years, equivalent to an internal rate of return of 10.2%.

[15] Department of Statistics figure, obtained from www.stats.govt.nz accessed on 5 March 2007

4.14.2 Benefits and costs of a hot water system rating and target CO_2 emission

The system rating procedure has been designed to be applied not only to new hot water installations, but also to be incorporated in a home energy rating scheme, such as the one being developed by the Energy Efficiency and Conservation Authority. It would be used to assess existing hot water systems and to encourage owners with poorly performing systems to upgrade them. The rating procedure could also encourage those deciding on new hot water systems to select ones that will give them a higher home energy rating. Much of the benefit of the system rating procedure would thus be intangible.

Tangible benefits will depend largely on the annual CO_2 emission design limit ultimately selected and the choice of fuel for each hot water system. Almost all new hot water systems use electricity or gas as the primary means of heating. The exact proportion of each is not known. Gas is generally preferred and installed in the majority of new housing in areas it is available.

An estimate of the lower bound of savings attributable to the introduction of the system rating procedure, assumes that one-third of new hot water installations are electric and two-thirds gas. The average electric system would need to reduce emissions by an equivalent of 430 kWh/year, while most gas systems will meet the annual CO_2 emission design target and would not require modifications.

The national savings would therefore be a minimum of 3,500 MWh per year (accumulating). These savings could be achieved at a cost of merely selecting a suitable shower (mixer, showerhead and flow regulator) and adding the compliance cost of assessing the proposed system. Given the availability of an assessment tool, the latter will be minimal.

The consumer value of 3,500 MWh at $0.14 per kWh is $490,000.

5 HVAC proposal - energy efficient heating, ventilating and air-conditioning systems

Summary of proposals

The Department is proposing that heating, ventilating and air-conditioning (HVAC) systems be covered by the energy efficiency requirements of Clause H1 of the New Zealand Building Code, leading to more stringent energy efficiency standards and lower energy use for such systems in commercial buildings.

The proposals are to:

- remove the Limit on Application to Clause H1.2 (a) on plant and equipment provided to change temperature and/or humidity
- establish energy efficiency Performance requirement H1.3.6 for mechanical HVAC systems and controls
- revise the Acceptable Solution H1/AS1 to provide a way of complying with the proposed Performance requirement H1.3.6
- develop a guide to help territorial authorities prepare compliance schedules for buildings that would be required to meet the Performance requirement H1.3.6.

5.1 Background

When the New Zealand Building Code was reviewed in 1996, Clause H1 Energy Efficiency included a limit on the application of Functional Requirement H1.2 (a) so that it did not apply to "plant and equipment provided to modify temperature, humidity, or both".

The reason for this exception was a belief at that time that there was difficulty in getting suitable energy efficient plant and equipment parts for HVAC systems. It was the intention that complete HVAC systems would be required to comply with H1.2 (a).

There appears to be a widespread industry assumption that HVAC systems in buildings are covered by the limit on application and do not need to comply with energy efficiency requirements.

Since 1996, there have been major advances in the design and manufacture of HVAC system components and limits on the supply of energy efficient plant and equipment no longer apply. Thus, the limit on the application to Clause H1.2 (a) is no longer relevant.

The proposed changes to Clause H1 both clarify the original intent of H1.2 (a) and reflect the improved availability of energy efficient parts for HVAC systems. HVAC systems are a major part of total energy use in commercial buildings, making large energy savings possible. The energy efficiency of these systems should be considered during design, construction, and operation of buildings.

5.2 What options were considered to improve HVAC efficiency?

The Department examined two options to improve the energy efficiency of HVAC plant and equipment.

5.2.1 Option 1: Do nothing (not recommended)

Leaving the Building Code unchanged would rely on market forces to bring about change in the specification, construction and running of HVAC systems. The failure of market forces to deliver optimal systems in the past and the confusion caused by the present limit on application to Clause H1.2 (a), means that keeping matters as they are is not recommended.

5.2.2 Option 2: Amend Clause H1 of the Building Code (recommended)

The Department considers the best way to improve the energy efficiency of HVAC systems are as listed below.

- Remove the Limit on Application to Clause H1.2 (a) in the Building Code on plant and equipment provided to change temperature, humidity, or both. Mechanical air-handling systems and their parts would have to be adequately energy efficient when that energy is used for changing temperature and/or humidity.
- Introduce a Performance requirement H1.3.6 into the Building Code specifying that mechanical HVAC systems and controls should be designed and run to use minimum energy.
- Revise the Acceptable Solution H1/AS1 to include a means of complying with the proposed Performance requirement H1.3.6. Compliance would include showing specific energy efficiency measures for systems and their parts.
- Develop a guide to help territorial authorities prepare compliance schedules for buildings containing specified systems, which would need to meet the proposed Performance requirement H1.3.6. The guide would include suggested inspection, maintenance and reporting procedures to ensure the systems continue performing properly.

5.3 Implications of the proposed amendment to Clause H1 of Building Code

Energy efficiency cannot be assured simply by designing and installing suitable equipment. Buildings need to be run, managed and maintained properly. Introducing the proposed Performance requirement, that HVAC systems be designed and run to use energy efficiently, would introduce an on-going requirement for the systems to be operated and maintained as designed. This would be checked under the building warrant of fitness regime because:

- HVAC systems are already classified as specified systems in the Building Regulations
- the performance standards, which would include the proposed energy efficiency requirements, for specified systems are detailed on the compliance schedules (note that compliance schedules are required for buildings containing specified systems)

- the annual building warrant of fitness certifies that the specified systems (including HVAC systems) meet the performance specified in the compliance schedule.

An explanation of the Building Act requirements is given in the appendices.

The proposed amendment is not expected to disrupt the HVAC industry, as the requirements simply reflect current industry practice. The Department understands most designs and installations of HVAC systems already consider energy efficiency. The proposed changes to the Building Code specify energy efficiencies at a lower level than that regarded as industry best practice, and possibly industry good practice. The proposed changes are intended to remove any existing worst practice activity.

The Department considers that building owners would recognise the financial advantages of achieving better energy efficiency than that required by the Building Code, and that HVAC systems would be built to achieve these higher levels. Efforts of 'best practice' would be supported by the Green Star New Zealand building rating, which includes a major energy component in the overall building rating. International experience has shown that tenant demand and differentiation in the market provide strong incentives for building developers and owners to improve their building ratings.

Specifying minimum energy efficiencies of major HVAC equipment, such as chillers and boilers, in the proposed Acceptable Solution, would ensure that inferior equipment would not be sold in New Zealand. The proposed levels are set below present industry best practice and are in-line with similar requirements in the United Kingdom, USA, Australia and many other countries. Much HVAC equipment is imported and should comply with such international requirements. New Zealand manufacturers of HVAC equipment working in international markets, already make products that achieve the proposed levels of efficiency. These minimum efficiency levels will complement EECA's Minimum Energy Performance Standard (MEPS) regulations that are in force in New Zealand.

5.4 Development of the Acceptable Solution

With the proposal to remove the present limit on application to Building Code Clause H.1.2(a) on plant and equipment provided to change temperature and/or humidity, an energy efficiency Performance requirement is needed. Once this Performance requirement has been established, a means of showing compliance with the requirement is also needed. A draft Acceptable Solution has been developed for this.

The Department considered developing a specific New Zealand code of practice for HVAC commissioning, but this task could not be completed in the time available. Future work on such a code, in association with the New Zealand HVAC industry, would contribute to ensuring energy efficiency best practice.

When developing the Acceptable Solution for HVAC energy efficiency, the Department looked at existing New Zealand and international energy efficiency standards, codes of practice and building codes. It considered using one or more of these documents as an Acceptable Solution, but no single existing document was suitable. Some of the existing documents are unnecessarily complex and others are specific to conditions in other countries.

The Department extensively reviewed building codes and regulations to discern energy efficient ways to design, build, install and run HVAC equipment. The proposed Acceptable Solution is based mainly on the Building Code of Australia (BCA) 2006, Volume One, Section J (Energy Efficiency), but also uses parts of the British Building Regulations Part L2A, Conservation of fuel and power, April 2006, on control systems.

Both the Australian and British documents which introduced new energy efficiency requirements during 2006, were based on extensive research and consultation. The Department believes the similarity of conditions in the countries, the cost benefits of energy efficiency and the pressing need to make New Zealand buildings more energy efficient, justify these international specifications being adopted. The growing adoption of joint building standards by New Zealand and Australia also supports the move to adopt common energy efficiency performance standards.

Notes explaining the origin and purpose of the proposed energy efficiency measures are included in the appendices.

5.5 Climate comparison between Australia and New Zealand

The Building Code of Australia (BCA) is applied to eight separate climate zones across Australia. Table 4 shows the basis for the Australian zones ('heating degree days' is an index of the time the temperature is below a base level. The BCA uses a base level of 18ºC.). These zones have been compared with the New Zealand climate to discern which of the zones are suitable for use in New Zealand.

The New Zealand Standards (NZS 4218 and NZS 4243) incorporated in the current Building Code Compliance Documents for Energy Efficiency refers to three climate zones, as follows:

- the Auckland region and areas to its north
- the rest of the North Island, excluding the Central Plateau
- the South Island and Central Plateau of the North Island.

Comparison of Table 4 with New Zealand climate data (1941-1974)[16] shows there are no areas in New Zealand that match the Australian zones 1-4 (that is, none have average January maximum temperatures of more than 30ºC, or a high humidity summer). Even zone 5 is too warm, as nowhere in New Zealand has less than 1,000 heating degree-days using an 18ºC base.

Most New Zealand locations have a climate similar to those covered by BCA zones 6 and 7. The Australian zone 6 covers those areas where average January temperatures are less than 30°C, and annual heating degree-days are between 1000 and 2000. Zone 7 describes areas with average January temperatures of less than 30°C, and annual heating degree-days between 2000 and 3000. Few populated areas of New Zealand have heating degree-days above 3000, which matches the Australian alpine climate zone 8.

[16] New Zealand Meteorological Service, *Average Degree-Day Tables Selected New Zealand Stations,* 1978

While energy efficiency requirements in the BCA vary across some climate zones, they are all the same within zones 6 and 7. The Department considers that energy efficiency requirements in Australian zones 6 and 7 can be applied to all of New Zealand without adjustment.

CLIMATE ZONES (BCA)	DESCRIPTION	AVERAGE JANUARY MAXIMUM TEMPERATURE	AVERAGE JULY MEAN TEMPERATURE	AVERAGE ANNUAL HEATING DEGREE DAYS
1	High humidity summer, warm winter	≥ 30ºC	-	
2	Warm humid summer, mild winter	< 30ºC	-	
3	Hot dry summer, warm winter	≥ 30ºC	≥14ºC	
4	Hot dry summer, cool winter	≥ 30ºC	<14ºC	
5	Warm temperate	< 30ºC	-	≤1000
6	Mild temperate	< 30ºC	-	1000 to 1999
7	Cool temperate	< 30ºC	-	2000 to Alpine
8	Alpine			

Table 4: Basis for BCA energy efficiency climate zones

5.6 Building control systems

The development of sophisticated, computer-based Building Automation Systems (BAS) and Building Management Systems (BMS) has allowed precise control over how buildings systems are run and can lead to significant energy savings. However, because BAS and BMS systems are complex and sophisticated, excessive energy use can result from poor design, installation, and programming skills, as well as from changing or overriding control features. There are many documented cases of commercial buildings where high energy consumption has been traced to poorly performing building control systems.

The basic guidance provided in the proposed Acceptable Solution is derived from the British Building Regulations Part L2A, and is intended to ensure the first principles of control design are followed. The first check of the correct operation of systems should be made during the inspection done for the issue of a code compliance certificate. On-going inspection, as part of the building warrant of fitness regime, should identify any control-related problems.

5.7 What is the impact on building consents, compliance schedules and warrant of fitness?

Before issuing of a code compliance certificate, a Licensed Building Practitioner (LBP) would have to certify that all specified systems in the building could perform to the performance standards set out in the building consent.

5.8 What are the benefits and costs of requiring energy efficient HVAC equipment?

5.8.1 Benefits and Cost

The proposed changes are not expected to increase the cost of a new building, as their objective is to introduce a baseline for energy efficiency that is below present industry best practice.

There will be extra costs in running buildings due to higher compliance costs of energy efficiency checking and better maintenance regimes. These costs are likely to be more than offset by lower energy costs and longer equipment life.

There would be other non-financial benefits, including to the health and wellbeing of building users and to the environment, such as reduced carbon emissions.

The Australian Building Codes Board (ABCB) carried out significant benefit cost work before adopting energy efficiency measures into the BCA. A summary of the ABCB work is given in its Regulation Impact Statement (RIS 2006-02), which is available on the ABCB web site (www.abcb.gov.au). The Australian studies are considered relevant to New Zealand. Additional information on work undertaken by the ABCB is provided in the appendices.

5.8.2 Financial implications

The Department does not expect the changes to energy efficiency requirements for HVAC equipment will significantly increase the cost of a new building. This is because the proposal sets up a baseline that is below present industry best practice, and possibly even good practice. When combined with other building energy efficiency requirements in Building Code Clause H.1, it is likely that informed design will lead to smaller capacity HVAC equipment being specified. These proposals are cost-effective, based on current predictions of energy and equipment prices, and reduced social and environmental impacts.

6 HVAC proposal - maintenance of systems

Summary of proposals

The Department is proposing to make it easier to maintain HVAC systems so that they continue operating efficiently by ensuring ease of access for maintenance.

This proposal is to:

- introduce a Performance requirement for the maintenance of HVAC systems in the Building Code
- provide an Acceptable Solution to comply with the new access requirements
- develop a guide which will include maintenance requirements, to help territorial authorities prepare compliance schedules for buildings containing specified systems.

6.1 Background

Maintaining HVAC plant and equipment is essential to ensuring it continues to work efficiently and as designed. Efficient running reduces energy consumption.

Maintenance access is dealt with by a proposed Performance requirement H1.3.7, which requires HVAC systems to be designed and installed so they can be maintained easily. The ability to access plant, equipment and parts easily for inspection, monitoring and maintenance is fundamental to running the services efficiently and effectively.

The need for maintenance is covered in the building compliance schedule, where HVAC is listed as a specified system that must be checked yearly. The compliance schedule requires a maintenance regime to ensure the specified systems continue to perform at their original energy efficiency level. Building owners must be aware of the elements within their building that need to be maintained, and to what standard. Therefore, the compliance schedule should contain clear details on the equipment needing maintenance and provide details of how and when this maintenance should be done.

The Building Code allows for maintenance access in the Acceptable Solution G4/AS1, which specifies that, "Air-handling systems shall: Be installed and maintained to the requirements of NZS 4302 Sections 202 to 214." NZS 4302, section 209.2.3, in turn requires that "Coils and trays shall be accessible for inspection and maintenance".

The proposed clause H1.3.7 extends this requirement to cover all HVAC system parts. There is an inherent implication that a means of access will be provided for maintenance.

Accessibility would depend on the plant and equipment and their associated maintenance requirements. Where replacement of major parts is expected during the life of the building, access must be provided to allow these parts to be easily installed, including providing for large plant replacement.

The financial and space limits often imposed on designers and installers of HVAC systems have sometimes hampered access to the systems for maintenance. The Department's proposal should stop such problems in the future.

Building owners and designers will appreciate that effective design is not only concerned with the needs of building occupants, but includes ensuring building infrastructure and services, can be easily maintained. Good design will ensure the building functions as intended while reducing long-term building running costs and possible health implications.

6.2 What options were considered for maintenance access?

Maintenance of building equipment is essential to ensure the services continue to perform to their design levels. Maintenance regimes would be specified in the building's compliance schedule.

The Department examined two options for ensuring maintenance access.

6.2.1 Option 1: Do nothing (not recommended)

Providing access for and space to carry out maintenance of services should be a basic consideration of design and installation. Good designs and installations provide suitable access to plant and equipment enabling proper maintenance. However, HVAC systems are being installed with inadequate maintenance access. Maintenance is vital to the continuing energy efficiency of HVAC systems. In support of good industry practice, keeping the voluntary provision of maintenance access is not recommended.

6.2.2 Option 2: Amend Clause H1 of the Building Code (recommended)

The ability to maintain plant and equipment easily is critical to the continued energy efficient running of HVAC systems, making it is necessary to mandate that maintenance access is provided.

The Department's recommendations for ensuring satisfactory maintenance access for HVAC systems are listed below.

- Remove the Limit on Application to Building Code Clause H1.2 (a) on plant and equipment provided to change temperature and/or humidity (as for Section 5).

- Introduce a new Performance requirement H1.3.7 into the Building Code that specifies mechanical HVAC systems must have features that enable maintenance of systems and parts, to ensure they perform to a standard no less than they were originally required to achieve. Access would have to be provided to all plant, equipment and parts that require maintenance.

- Update the Compliance Documents H1/AS1 by adding an Acceptable Solution to comply with H1.3.7. The means of showing compliance would include a declaration that the designer has considered all requirements of space, position, access and repair (or replacement) for commissioning and maintaining equipment.

- Develop a guide to help territorial authorities in preparing compliance schedules for buildings containing specified systems that are required to meet the performance requirements of H1.3.7. This will help ensure that a code compliance certificate is only issued when a building adequately provides for maintenance, and that ongoing maintenance is performed.

6.3 Why was option 2 chosen?

The main purpose of the proposed amendments is to ensure that buildings operate in an energy efficient way. It is vital for HVAC systems and their components and controls, be inspected and maintained regularly to continue to meet these performance requirements.

Experience gained from recommissioning existing buildings has shown that poorly maintained equipment and wrongly operated controls are the primary reasons for buildings not meeting energy efficiency requirements. Benefits of good maintenance are longer life, fewer breakdowns, quieter operation and energy savings.

Maintenance must not be hindered by a lack of satisfactory access and space. Requiring satisfactory maintenance access would endorse current industry practice. The Department understands most designs and installations of HVAC systems provide maintenance access. The proposed changes would simply remove any existing worst practice activity.

The proposed change also supports the need to provide details of inspection, maintenance and reporting procedures for the compliance schedule and building warrant of fitness regimes arising from the changes in Section 5 (removing the limit of application of H1.2(a)).

6.4 What is the impact on building consents, compliance schedules and warrant of fitness?

Before a code compliance certificate is issued, a Licensed Building Practitioner (LBP) would have to certify that all specified systems in the building could perform to the performance requirements set out in the building consent. Under the proposal, the inspection required before the LBP can certify compliance, would need to include checks that required access for maintenance has been provided.

As part of the annual building warrant of fitness inspection, there would need to be a check that ensures no changes have been made limiting access. The maintenance provider could certify that satisfactory access is available and maintenance has been done.

6.5 What are the benefits and costs of requiring maintenance access?

6.5.1 Benefits and costs

The proposed changes are not expected to increase the cost of a new building. The aim of the proposed changes to Building Clause H1 is to confirm the need for design and installation considerations that simply reflect good industry practice.

Other non-financial benefits would grow from improved maintenance, including the health and wellbeing of building users, and to the environment, including lower carbon emissions.

No specific cost-benefit analysis has been done for this proposal.

6.5.2 Financial implications

The Department does not expect this proposal to significantly increase the cost of a new building because the proposed changes only confirm current good industry practice. The proposal is cost-effective when the benefits of good maintenance are considered. These benefits include reduced energy consumption, increased economic life of plant and equipment, improved internal conditions in the building and reduced environmental impacts.

7 HVAC proposal - metering energy consumption in buildings

Summary of proposals

The Department is proposing that buildings with HVAC systems will have meters installed that will allow easy monitoring of energy consumed in the whole building. This proposal will apply to those new buildings that require a compliance schedule.

The objective is to make it easier for building owners and users to monitor energy use and to improve energy efficiency.

This proposal is to:

- introduce a Performance requirement into the Building Code to meter the electricity and gas energy used in buildings
- provide an Acceptable Solution to comply with the new metering requirements

7.1 Background

Many building leases and tenancy contracts are structured with no financial incentive for energy to be used efficiently. If a building owner pays for the energy, tenants have no incentive to run the building in an energy efficient manner. Similarly, where tenants pay the energy bills, the owner has no incentive to provide or maintain an efficient building.

Informing all stakeholders of energy consumption in a building might provide financial incentives for both building owners and tenants to minimise energy use. Both parties stand to gain through lower energy bills or improved rents.

Heating, ventilation and air-conditioning (HVAC) systems are major users of energy. These systems are also the least likely to be performing efficiently within the building. Being able to record overall building energy used, would allow for the identification of under performing HVAC systems that are wasting energy. Being able to accurately determine the energy consumption figures for a building would also support schemes such as the Green Star building rating that promotes energy efficiency in buildings. These ratings are easily accessed by prospective owners or tenants and encourage energy efficiency. Energy consumption figures would help the in-service building rating to be established accurately and easily.

Energy consumption figures would also allow building owners to easily benchmark their buildings and identify where financial savings could be made. If energy information is readily available, it allows energy contracting companies to proactively follow opportunities to improve the running of poorly performing buildings.

The electricity and gas consumed in a building is recorded by tariff meters for charging purposes. There may be a number of tariff meters in a building, particularly when there are multiple occupants. The consumption details of each meter are provided to each user on their energy invoice but details of the energy used in the complete building is unavailable.

The Department proposes that buildings with HVAC systems be required to have single electricity and gas meters, which can record the entire building's consumption of electricity and gas energy. The information would allow building owners to monitor the energy efficiency of the HVAC system over its life. It would also ensure the building continues to meet the Performance requirements it was designed to achieve, as outlined in the compliance schedule.

7.2 What options were considered?

7.2.1 Option 1: Do nothing (not recommended)

The lack of energy performance data available for multi-occupancy buildings makes it difficult to assess and monitor the energy efficiency of these buildings. It is also difficult to find out if a building is achieving energy efficiency targets set in the compliance schedule.

Without energy consumption data being available, there are few forces to drive more efficient running of HVAC systems in a poorly performing building. The past failure of market forces to deliver well-operated HVAC systems in all buildings suggests that market forces will not provide for improvements, hence keeping matters as they are is not the recommended option.

7.2.2 Option 2: Amend Clause H1 of the Building Code (recommended)

The Department considers that the availability of on-going energy use data is an important tool in achieving energy efficient and sustainable buildings. Making this data available will allow the energy efficiency of systems, including HVAC, to be checked. It is proposed that buildings with HVAC systems should have meters installed that measure and record electricity and gas consumption for the entire building. Energy would not be required to be recorded, but the proposal would enable owners and occupants to monitor energy use.

While the amount of energy used in a building may be influenced by more than just its energy efficiency, a measure of actual energy used would provide a look into the building's performance. Having energy consumption data available would allow building operators to more easily check the buildings energy efficiency and would allow building owners to record the building's performance, and compare it against industry benchmarks.

7.3 Limits and implications of the proposed changes

Buildings covered by the proposed Performance requirement would be only those with mechanical ventilation or air-conditioning systems for which a compliance schedule is required. Most domestic residences would be exempt from the requirement. Only new buildings would be affected.

The proposed changes would require these new buildings to have meters that measure and record the total annual consumption of electricity and gas.

The proposal is restricted to measuring and recording electricity and gas use as the Department considered the measurement of other forms of energy, such as coal, would be difficult to conduct. In addition, electricity and gas comprise most of the energy used in buildings.

Most buildings that consume electricity or gas have use meters. For most single occupancy buildings, energy consumption information is available to the building owner and the user, often the same party in these cases. When a building has multiple occupancies, occupants often receive individual consumption details and pay for their own energy use. There is often no measure of the total energy used within the building. The proposal would overcome this problem by helping measure total building energy use.

Monitoring energy use will help identify poorly performing HVAC systems.

The Department expects that new, multiple occupancy buildings would be fitted with meters measuring electricity and gas used in the whole building. These are unlikely to be tariff meters and would be installed at a point before these services are split to individual tenancies.

7.4 What are the benefits and costs of measuring energy consumption?

7.4.1 Cost benefits

The proposed changes are not expected to greatly increase the cost of new buildings. Fitting a 'whole-of-building' energy meter or meters during construction would be inexpensive. Most buildings using gas already have a single tariff meter from which consumption data is readily available.

7.4.2 Financial implications

The Department does not expect that this proposal would significantly increase the cost of new buildings. The expectation is that by being able to watch energy use, a building owner would be more aware of the HVAC system and the building's overall energy performance. Awareness of excessive energy use is more likely to be recognised and steps taken to repair faults. The resultant savings in energy would offset any costs.

8 Proposed changes to the Building Code and Compliance Documents on Domestic Hot Water Systems

Proposed wording changes to Clause H1: Energy Efficiency

CURRENT TEXT	PROPOSED CHANGES
Performance **H1.3.4** Systems for the heating, storage, or distribution of hot water to *sanitary fixtures* or *sanitary appliances* must, having regard to the energy source used, — (a) limit the energy lost in the heating process; and (b) be constructed to limit heat losses from storage vessels, and from distribution systems connected to storage vessels.	**Performance** **H1.3.4** Systems for the heating, storage, or distribution of hot water to *sanitary fixtures* or *sanitary appliances* must, having regard to the energy source used, — (a) limit the energy lost in the heating process; (b) be constructed to limit heat losses from storage vessels, and from distribution systems connected to storage vessels; and (c) be constructed in a manner that facilitates the efficient use of hot water.

Proposed wording changes: Acceptable Solution H1/AS1

CURRENT TEXT	PROPOSED CHANGES
5.0 Hot Water Systems **5.0.1** Hot water systems complying with NZS 4305, as modified in Paragraphs 5.0.2 and 5.0.3, satisfy the requirements of NZBC H1.3.4 for the provision of hot water to *sanitary fixtures* and *sanitary appliances.* **COMMENT:** NZS 4305 deals with domestic type electrical and gas systems having a storage water heater capacity of up to 700 litres. Larger systems and their associated piping are not controlled by the NZBC.	**5.0 Hot Water Systems** **5.0.1** Hot water systems complying with NZS 4305, as modified in Paragraphs 5.0.2 and 5.0.3, satisfy the requirements of NZBC H1.3.4 for the provision of hot water to *sanitary fixtures* and *sanitary appliances.* *Existing comment deleted*

CURRENT TEXT	PROPOSED CHANGES
5.0.2 NZS 4305 is modified by deleting "shall" in the first sentence of clause 3.3.1 and replacing with "should".	*No change*
COMMENT: When NZS 4305 was published it was assumed valve insulation packages would be readily available. This is not the case at the date of this document, therefore insulation of these valves is not mandatory to comply with the NZBC.	*Existing comment deleted*
5.0.3 NZS 4305 is modified by deleting clauses 2.1.1 and 2.1.2 and Tables 1 and 2 and substituting the following: "**2.1.1** Electric storage water heaters shall have a minimum insulation material thickness of 25 mm. The insulation material shall have a thermal conductivity of less than 24 mW/m°C when tested to ASTM C518-76."	*Existing modification deleted as the performance of electric storage water heaters is now specified by the Energy Efficiency (Energy Using Products) Regulations.*
COMMENT: Table 1 in NZS 4305 gives the 'A' grade electric water heater performance. Water heaters with 'A' grade performance cannot be manufactured in sufficient numbers as at the date of this document because of the limit imposed by Government on the import of the HCFC insulation foaming agent, which is an ozone depleting substance.	*Existing comment deleted*

CURRENT TEXT	PROPOSED CHANGES
New entry	**5.0.3** NZS 4305 is modified by inserting the following: "**4 SYSTEM PERFORMANCE REQUIREMENTS** This section 4 applies only to hot water systems in residential buildings. The maximum CO_2 emissions for a hot water system in a home are given in clause 4.1, and vary depending on the number of people / size of the home. The calculation method for determining the assessed household water use is given in clause 4.2, and calculation of the associated CO_2 emissions is provided in clause 4.3.

CURRENT TEXT	PROPOSED CHANGES
	4.1 Carbon dioxide emissions attributable to hot water service in housing, $CO_{2\ HWH}$, shall not exceed $650 + (125 \times N_{occupants})$ kg/year $\geq CO_{2\ HWH}$ where $N_{occupants}$ = the expected number of occupants, and shall be calculated as in clause 4.1.1 $CO_{2\ HWH}$ = the sum of the assessed carbon dioxide emissions for each hot water system installed in the dwelling, as determined in Clause 4.3 4.1.1 The number of expected occupants, $N_{occupants}$, shall be the value of N_A, N_B or N_C which results in the greatest assessed hot water use, L, as calculated in 4.2, but with a maximum of 12. $N_A = 1 + (number\ of\ bedrooms \times 0.69)$ $N_B = \frac{Floor\ area(m^2)}{25}$ $N_C = number\ of\ bedrooms \times 2$ 4.2 The assessed hot water use of a household (litres/day), L, shall be the greatest of L_A, L_B or L_C, but with a maximum of 291.75 L/day. $L_A = (N_A \times 46.375) + 20$ L/day $L_B = (N_B \times 22.8125) + 18$ L/day $L_C = (N_C \times 22.8125) + 18$ L/day 4.2.1 Bathing water use (litres/day), L_W, shall be calculated as $L_W = N \times 43.875$ where N is the greatest of N_A, N_B and N_C as defined in 4.1.1 4.2.2 (i) The showering water use, L_{Shr} shall be the greatest of L_{ShrA}, L_{ShrB}, and L_{ShrC}, calculated as follows: $L_{ShrA} = N_A \times 43.875$ $L_{ShrB} = N_B \times 20.3175$ $L_{ShrC} = N_C \times 20.3175$ where N_A, N_B and N_C are defined as in 4.1.1. (ii) The modified shower water use, L_S, shall be calculated as follows:

CURRENT TEXT	PROPOSED CHANGES
	$$L_S = L_{Shr} \times Flow/9$$ where L_{Shr} is as defined in 4.2.2 (i) *Flow* = the maximum flow rate of the shower. Note: where there is more than one shower on a system, the fastest flow rate shall be used.
	4.2.3 Water use from other activities (litres/day), L_O, shall be the greatest of L_{OA}, L_{OB}, and L_{OC}, calculated as follows: $$L_{OA} = 20 + (N_A \times 2.5)$$ $$L_{OB} = 18 + (N_B \times 2.5)$$ $$L_{OC} = 18 + (N_C \times 2.5)$$ where N_A, N_B and N_C are defined as in 4.1.1 4.2.4 Assessed hot water use for a system, L_{sys}, (either a single system or one of many within a dwelling) (i) For a hot water system with a shower/s, the system usage (litres/day) is, L_{sys}, calculated as, $$L_{sys} = \frac{L_S}{n_{Sh}} + \frac{L_O}{n_{total}}$$ where L_S is as defined in 4.2.2 L_O is as defined in 4.2.3 n_{Sh} = the number of hot water systems with showers n_{total} = the total number of hot water systems installed in the dwelling (ii) For a hot water system with no shower, in a dwelling that has no showers, the system usage (litres/day), L_{sys}, is calculated as, $$L_{sys} = \frac{L_W + L_O}{n_{total}}$$ where L_W is as defined in 4.2.1 L_O is as defined in 4.2.3 n_{total} = the total number of hot water systems installed in the dwelling (iii) For a hot water system with no shower, in a dwelling that has a shower installed in a separate hot water system, the system usage

CURRENT TEXT	PROPOSED CHANGES
	(litres/day), L_{sys}, shall be calculated as, $$L_{sys} = \frac{L_O}{n_{total}}$$ where L_O is as defined in 4.2.3 n_{total} = the total number of hot water systems installed in the dwelling
	4.3 $CO_{2\ HWH} = \Sigma\ CO_{2\ sys}$ where $CO_{2\ HWH}$ = the total (sum of) assessed CO_2 emissions for all the hot water systems in a dwelling $CO_{2\ sys}$ = the assessed CO_2 emissions for an individual hot water system within a dwelling, as defined in 4.3.1 to 4.3.7 4.3.1 If the hot water system uses an electric storage water heating then the CO_2 emissions, $CO_{2\ sys}$, are calculated as, $$CO_{2\ sys} = 103 \times (E_{sys} - ER_{sys})$$ where: $$E_{sys} = (L_{sys} \times 365 \times 0.2016\text{x}10^{-3}) + (H \times 365 \times 3.6\text{x}10^{-3})$$ 103 = CO_2 emission factor for electricity (kg CO_2/GJ) ER_{sys} = energy reduction as defined in clause 4.4 L_{sys} = the hot water use given in 4.2.4 365 = the number of days per year 0.2016 = heat content of water (MJ/L) H = the heat loss from the storage vessel in kWh/day, and if unknown is taken from 2.1.1 or 2.1.2 $3.6\text{x}10^{-3}$ = conversion from kWh to GJ 4.3.2 If the hot water system uses an electric instantaneous water heating then the CO_2 emissions, $CO_{2\ sys}$, are calculated as, $$CO_{2\ sys} = 103 \times (E_{sys} - ER_{sys})$$ where: $$E_{sys} = L_{sys} \times 365 \times 0.2016\text{x}10^{-3}$$ 103 = CO_2 emission factor for electricity (kg CO_2/GJ) ER_{sys} = energy reduction as defined in clause 4.4

CURRENT TEXT	PROPOSED CHANGES
	L_{sys} = the hot water use given in 4.2.4 365 = the number of days per year 0.2016 = heat content of water (MJ/L) 10^{-3} = conversion from MJ to GJ
	4.3.3 If the hot water system uses an electric heat pump water heating then the CO_2 emissions, $CO_{2\ sys}$, are calculated as, $CO_{2\ sys} = 103 \times (E_{sys} - ER_{sys})$ where: $E_{sys} = \frac{(L_{sys} \times 365 \times 0.2016 \times 10^{-3}) + (H \times 365 \times 3.6 \times 10^{-3})}{2}$ 103 = CO_2 emission factor for electricity (kg CO_2/GJ) ER_{sys} = energy reduction as defined in clause 4.4 L_{sys} = the hot water use given in 4.2.4 365 = the number of days per year 0.2016 = heat content of water (MJ/L) H = the heat loss from the storage vessel (kWh/day), and if unknown is taken from 2.1.1 or 2.1.2 365 = the number of days per year 3.6×10^{-3} = conversion from kWh to GJ 4.3.4 If the hot water system uses a gas storage water heating then the CO_2 emissions, $CO_{2\ sys}$, are calculated as, $CO_{2\ sys} = 52 \times (E_{sys} - ER_{sys})$ where: $E_{sys} = \frac{L_{sys} \times 365 \times 0.2016 \times 10^{-3}}{\eta} + (J \times 24 \times 365 \times 3.6 \times 10^{-3})$ 52 = CO_2 emission factor for natural gas (kg CO_2/GJ) ER_{sys} = energy reduction as defined in clause 4.4 L_{sys} = the hot water use given in 4.2.4 365 = the number of days per year

CURRENT TEXT	PROPOSED CHANGES
	0.2016 = heat content of water (MJ/L) η = the conversion efficiency of the heater, and if unknown is taken from 2.2.1 J = the gas consumption rate in kW to maintain the hot water temperature, and if unknown is taken from 2.2.2 $3.6x10^{-3}$ = conversion from kWh to GJ
	4.3.5 If the hot water system uses a gas instantaneous water heating then the CO_2 emissions, $CO_{2\ sys}$, are calculated as, $CO_{2\ sys} = 52 \times (E_{sys} - ER_{sys})$ where: $E_{sys} = \frac{L_{sys} \times 365 \times 0.2016 \times 10^{-3}}{\eta}$ 52 = CO_2 emission factor for natural gas (kg CO_2/GJ) ER_{sys} = energy reduction as defined in clause 4.4 L_{sys} = the hot water use given in 4.2.4 365 = the number of days per year 0.2016 = heat content of water (MJ/L) η = the conversion efficiency of the heater, and if unknown is taken from 2.2.1 10^{-3} = conversion from MJ to GJ 4.3.6 If the hot water system uses a coal fired water heating then the CO_2 emissions, $CO_{2\ sys}$, are calculated as, $CO_{2\ sys} = 91 \times (E_{sys} - ER_{sys})$ where: $E_{sys} = \frac{L_{sys} \times 365 \times 0.2016 \times 10^{-3}}{\eta} + (J \times 24 \times 365 \times 3.6 \times 10^{-3})$ 91 = CO_2 emission factor for coal (kg CO_2/GJ) ER_{sys} = energy reduction as defined in clause 4.4 L_{sys} = the hot water use given in 4.2.4 365 = the number of days per year

CURRENT TEXT	PROPOSED CHANGES
	0.2016 = heat content of water (MJ/L) η = the conversion efficiency of the heater, and if unknown shall be assumed to be 0.5 J = the coal consumption rate in kW to maintain the hot water temperature, and if unknown shall be assumed to be 0.5 $3.6x10^{-3}$ = conversion from kWh to GJ
	4.3.7 If the hot water system uses oil-fired water heating then the CO_2 emissions, $CO_{2\ sys}$, are calculated as, $CO_{2\ sys} = 75 \times (E_{sys} - ER_{sys})$ where: $E_{sys} = \frac{L_{sys} \times 365 \times 0.2016 \times 10^{-3}}{\eta} + (J \times 24 \times 365 \times 3.6 \times 10^{-3})$ 75 = CO_2 emission factor for heavy fuel oil (kg CO_2/GJ) ER_{sys} = energy reduction as defined in clause 4.4 L_{sys} = the hot water use given in 4.2.4 365 = the number of days per year 0.2016 = heat content of water (MJ/L) η = the conversion efficiency of the heater, and if unknown shall be assumed to be 0.7 J = the oil consumption rate in kW to maintain the hot water temperature, and if unknown shall be assumed to be 0.35 $3.6x10^{-3}$ = conversion from kWh to GJ 4.4 The annual energy reduction for a hot water system, ER_{sys}, shall be calculated as, $ER_{sys} = ER_{wood} + ER_{solar} + ER_{shower} + ER_{multi}$ where ER_{wood} is as defined in clause 4.4.1 ER_{solar} is as defined in clause 4.4.2 ER_{shower} is as defined in clause 4.4.3

CURRENT TEXT	PROPOSED CHANGES
	ER_{multi} is as defined in clause 4.4.4
	4.4.1 If a wood stove with a water heater booster is installed, a hot water heating energy reduction (GJ/year), ER_{wood}, shall be: In climate zone 1, $ER_{wood} = 2.5$ In climate zone 2, $ER_{wood} = 3.1$ In climate zone 3, $ER_{wood} = 4.4$ 4.4.2 Solar Water Heating (i) The energy reduction due to input by a solar water heater shall be calculated for the particular installation. (ii) Alternatively, solar water heaters that meet the requirements of part 5 shall be assumed to provide a hot water heating energy reduction (GJ/year), ER_{solar}, of: In climate zone 1, $ER_{solar} = 0.35 \times E_{sys}$ In climate zone 2, $ER_{solar} = 0.30 \times E_{sys}$ In climate zone 3, $ER_{solar} = 0.30 \times E_{sys}$ where: E_{sys} is as defined in clauses 4.3.1 to 4.3.7 (iii) A system that has no solar water heater but that has both solar access in accordance with clause 5.1 and provision for future installation of a solar water heater in accordance with clause 5.2 shall use a hot water heating energy reduction (GJ/year), ER_{solar}, in recognition of the increased likelihood of a solar water greater being installed in the future, of: $ER_{solar} = 0.10 \times E_{sys}$ where: E_{sys} is as defined in clauses 4.3.1 to 4.3.7 4.4.3 A system that has heat recovery units fitted to all showers shall be assumed to provide a hot water heating energy reduction (GJ/year), ER_{shower} of: In climate zone 1, $ER_{shower} = 0.075 \times \frac{L_{shr}}{L_{sys}} \times \left(1 - \frac{ER_{wood}}{E_{sys}}\right)$ In climate zone 2, $ER_{shower} = 0.100 \times \frac{L_{shr}}{L_{sys}} \times \left(1 - \frac{ER_{wood}}{E_{sys}}\right)$

CURRENT TEXT	PROPOSED CHANGES
	In climate zone 3, $ER_{shower} = 0.125 \times \frac{L_{shr}}{L_{sys}} \times \left(1 - \frac{ER_{wood}}{E_{sys}}\right)$ where: E_{sys} is as defined in clauses 4.3.1 to 4.3.7 ER_{wood} is as defined in clause 4.4.1 L_{sys} is as defined in clause 4.2.4 L_S is as defined in clause 4.2.2
	4.4.4 Where more than one hot water system is installed in a dwelling, each system shall be assumed to provide a hot water heating energy reduction (GJ/year), ER_{multi} of: $ER_{multi} = 0.02 \times E_{sys}$ where: E_{sys} is as defined in clauses 4.3.1 to 4.3.7
New entry continued	**5 Solar water heaters** 5.1 Requirements for solar access When assessing a hot water system, for a dwelling to claim credit for having solar access, the roof of the dwelling (or other location of the collector of a solar water heater) must have an unimpeded view of the sun's path at winter solstice for at least five hours between three hours before solar noon and four hours after solar noon. Alternatively, the dwelling must have a specific design for the solar hot water system and that system must have its contribution to the hot water service calculated. 5.2 When assessing a hot water system, for a dwelling to claim credit for provision for future installation of a solar water heater it must meet the following criteria. (i) The dwelling shall have solar access as define in clause 5.1. (ii) The storage tank of the proposed system shall have provision for the future connection of a solar water heater. This requirement may be satisfied by the heater having a heating coil, or by the system operating at low pressure with an open vent. Alternatively (and always in the case of systems with an instantaneous heater) the building shall have structural and space provision for a solar water heater system hot water storage vessel. (iii) There shall be adequate provision for the installation of the solar hot water system pipework. 5.3 When assessing the performance of a solar water heating system in part 4, the performance shall be calculated for the particular installation, or shall

CURRENT TEXT	PROPOSED CHANGES
	meet the requirements of clause 5.3.1
	5.3.1 When assessing the performance of a solar water heating system in part 4, default values may be used for calculations provided the system meets the following criteria: (i) The dwelling shall have solar access as defined in clause 5.1. (ii) The solar water heater shall include a collector with a minimum area of 2.5% of floor area. (iii) The system shall include a hot water storage container that has a minimum storage volume of 135 litres or 1.2 litres per square metre of the dwelling floor area, whichever is the greater. (iv) The hot water system shall be controlled to ensure maximum benefit from the solar water heater. In particular, the controls shall prevent heating using energy from a mains distribution system (e.g. gas or electricity) from heating all or most of the water in the storage vessel before the end of the solar heating day. [Examples of allowable control measures include using solar with a separate storage container as a pre-heater, time or photocell switching of electric elements, a cylinder that has only a boost element that is located one third of the cylinder height from the top of the cylinder and that has features which ensure stratification of the heated water.] (vi) Where applicable, the solar water heater shall include measures to protect against frost.

9 Proposed changes to the Building Code and Compliance Documents for HVAC Systems

Proposed wording changes to Clause H1: Energy Efficiency

CURRENT TEXT	PROPOSED CHANGES
Objective **H1.1** The objective of this provision is to facilitate efficient use of energy.	*No change*.
Functional requirement **H1.2** *Buildings* must be *constructed* to achieve an *adequate* degree of energy efficiency when that energy is used for- (a) modifying temperature or humidity, or both; or (b) providing hot water to *sanitary fixtures* or *sanitary appliances*, or both; or (c) providing artificial lighting	*No change*.
Limits on application Requirement H1.2(a) does not apply to *assembly service buildings*, *industrial buildings*, *outbuildings*, or *ancillary buildings*, or to plant and equipment provided to modify temperature, humidity, or both.	Requirement H1.2(a) does not apply to *assembly service buildings*, *industrial buildings*, *outbuildings*, or *ancillary buildings*.
New entry	**Performance** **H1.3.6** Mechanical heating, cooling, ventilation or air-conditioning systems and controls must, to the degree necessary, be designed and constructed to use minimum energy.

CURRENT TEXT	PROPOSED CHANGES
New entry	**Performance** **H1.3.7** Mechanical heating, cooling, ventilation or air-conditioning systems must have features that facilitate the maintenance of systems and components to ensure that they perform to a standard not less than they were originally required to achieve. Access must be provided to all plant, equipment and components that require maintenance.
New entry	**Performance** **H1.3.8** A building which has a mechanical heating, cooling, ventilation or air-conditioning system for which a *compliance schedule* is required must have facilities to allow the measurement and recording of all the electricity and gas used in the building.

Proposed wording changes: References for H1/VM1 and H1/AS1

REFERENCES		
CURRENT TEXT	**PROPOSED CHANGES**	
		Where quoted
New entry	**Standards New Zealand**	
	AS/NZS 3823.1.2:1998 Performance of electrical appliances, air-conditioners and heat pumps	AS1 7.4.3
	British Standards Institution	
	BS 7190:1989 Method for assessing thermal performance of low temperature hot water boilers	AS1 7.4.2
	BS 845:1987 Methods for assessing thermal performance of boilers for steam, hot water and high temperature heat transfer fluids	AS1 7.4.2
	Air-Conditioning and Refrigeration Institute	
	ARI 460:2005 Remote Mechanical-Draft Air Cooled Refrigerant Condensers	AS1 7.4.5
	ARI 550/590:2003 Performance Rating of Water Chilling Packages Using the Vapor Compression Cycle	AS1 7.4.4

7.0 Mechanical Heating, Cooling, Ventilation or Air-conditioning systems

…………………………………………

Achieving these design limits satisfies NZBC H1.3.6

7.1 Controls

Systems shall be provided with appropriate controls to enable the achievement of reasonable standards of energy efficiency in use. In normal circumstances, the following features would be appropriate for mechanical heating, cooling, ventilation or air-conditioning system controls:

7.1.1 The systems shall be sub-divided into separate control zones to correspond to each area of the building that has a significantly different solar exposure, or pattern, or type of use; and

7.1.2 Each separate control zone shall be capable of independent timing, and temperature control, and, where appropriate ventilation and air recirculation rate; and

7.1.3 The provision of the service shall respond to the requirements of the space it serves. If both heating and cooling are provided, they should be controlled so as not to operate simultaneously; and

7.1.4 Central plant shall only operate as and when the zone systems require it. The default condition should be off.

7.1.5 In addition to these general control provisions, the systems shall meet specific control and efficiency standards as set out in the paragraphs below.

7.2 Air-conditioning and ventilation systems

7.2.1 Mechanical heating, cooling, ventilation or air-conditioning systems shall be constructed and maintained in accordance with the NZBC G4 Ventilation.

7.2.2 An air-conditioning unit or system must—

(i) be capable of, where the air-conditioning unit or system has motorised outside air and return dampers, closing the dampers when the air-conditioning unit or system is inactivated,

(ii) have any supply and return ductwork insulated and sealed in accordance with **Specification H1.1**, and

(iii) have an outdoor air economy cycle when the unit capacity is over 50 kWr, and

(iv) when the air flow rate is greater than 1000 L/s, be designed so that the total motor shaft power of the fans in the system does not exceed—

- (a) 12 W/m^2 for a building of not more than 500 m^2 floor area, and
- (b) 15 W/m^2 for a building of more than 500 m^2 floor area, and

(v) the requirements of (iv) do not apply to—

- (a) fans in package air-conditioning plant complying with **7.4.3**, and
- (b) the input power for an energy reclaiming system that preconditions *outdoor air*, and
- (c) the input power for process related components such as high efficiency particulate air filters,

(vi) when serving a conditioned space, not provide mechanical ventilation in excess of the minimum quantity required by NZBC **G4** by more than 50% other than where there is—

(a) additional outside air supplied—
to provide free cooling, or
to balance required exhaust ventilation such as toilet exhaust, or
to balance process exhaust such as from a health-care building or laboratory, or

(b) additional exhaust ventilation needed to balance the required mechanical ventilation; or

(c) an energy reclaiming system that preconditions outside air.

7.3 Smoke and ventilation

The requirements of paragraphs 7.1 and 7.2 must not inhibit—

(i) the smoke hazard management operation of air-conditioning and mechanical ventilation systems; and

(ii) essential ventilation such as for a garbage room, lift motor room, gas meter enclosure or gas regulator enclosure or the like.

7.4 Heating and chilling systems

7.4.1 Systems that provide heating or chilling for air-conditioning systems must—

(i) have any piping, vessels, heat exchangers or tanks containing heated or chilled fluid insulated in accordance with **Specification H1.2,** except those whose insulation levels are covered by Minimum Energy Performance Standards (MEPS), and

(ii) where water is circulated by pumping at greater than 2 L/s—

(a) be designed so that the total of the motor shaft power to the air-conditioning pump does not exceed—

- 3 W/m^2 for a building of not more than 500 m^2 floor area; and
- 4 W/m^2 for a building of more than 500 m^2 floor area; and

(b) have the pump capable of varying its speed when it is—

- operating for more than 3,500 hours per year; or
- is more than 11 kW of motor shaft power, except where the pump is required to run at full speed for safe or efficient operation; and

(iii)if the system contains more than one water heater used for heating the building, chiller or coil, be capable of stopping the flow of water to those not operating.

7.4.2 (i) A water heater, such as a boiler in a heating system for a building, must achieve a minimum thermal efficiency of 80% when gas fired and 78% when oil fired when tested in accordance with BS 7190 or BS 845.

(ii) A boiler with capacity equal or greater than 500 kWh is to be fitted with a modulating burner.

7.4.3 Package air-conditioning equipment, including a split unit and a heat pump, must have an energy efficiency ratio complying with **Table 7.4.3** when tested in accordance with AS/NZS 3823.1.2:1998 at test condition T1.

Equipment capacity	**65 kWr to 95 kWr**	**More than 95 kWr to 125 kWr**
	Minimum energy efficiency ratio	
Air-conditioner — cooling	2.7	2.8
Heat pump — cooling	2.6	2.7

Table 7.4.3 Minimum energy efficiency ratio for packaged air-conditioning equipment

7.4.4 A refrigerant chiller over 125 kWr capacity must have an energy efficiency ratio complying with **Table 7.4.4** when determined in accordance with ARI 550/590.

Table 7.4.4 Minimum energy efficiency ratio for refrigerant chillers

Minimum energy efficiency ratio	Full load	Part load
Water cooled chiller		
More than 125 kWr but not more than 525 kWr	4.2	5.2
More than 525 kWr but not more than 1000 kWr	4.5	5.6
More than 1000 kWr	5.5	6.1
Air cooled or evaporatively cooled chiller		
More than 125 kWr but not more than 525 kWr	2.2	3.0
More than 525 kWr	2.5	3.1

7.4.5 An air cooled condenser fan motor, other than one that is part of package air-conditioning equipment in paragraph 7.4.3, must not use more than 15 W of motor shaft power for each kW of heat rejected from the refrigerant when determined in accordance with ARI 460.

7.4.6 The fan of a cooling tower must not use more than—

(i) if a propeller or axial fan, 310 W of motor shaft power for each L/s of cooling water circulated, and

(ii) if a centrifugal fan, 590 W of motor shaft power for each L/s of cooling water circulated.

7.4.7 The fan of a closed circuit cooler must not use more than—

(i) if a propeller or axial fan, 500 W of motor shaft power for each L/s of cooled fluid circulated; and

(ii) if a centrifugal fan, 670 W of motor shaft power for each L/s of cooled fluid circulated.

7.4.8 The fan of a evaporative condenser must not use more than—

(i) if a propeller or axial fan, 18 W of motor shaft power for each kW of heat rejected, and

(ii) if a centrifugal fan, 22 W of motor shaft power for each kW of heat rejected.

7.4.9 The spray water pump of a closed circuit cooler or evaporative condenser must not use more than 150 W of pump motor shaft power for each L/s of spray water circulated.

7.5 Miscellaneous exhaust systems

7.5.1 A miscellaneous exhaust system with an air flow rate of more than 1000 L/s, that is associated with equipment having a variable demand such as a stove in a commercial kitchen or a chemical bath in a factory, must—

(i) have the means for the operator to—

(a) reduce the energy used, such as by a variable speed fan, and

(b) stop the motor when the system is not needed, and

(ii) be designed to minimise the exhausting of conditioned air.

7.5.2 The requirements of paragraph 7.5.1 do not apply

(i) where additional exhaust ventilation is needed to balance the *required* outside air for ventilation, or

(ii) where air flow must be maintained for safe operation.

8 Access for maintenance

…………………………………………

8.1 The requirements of NZBC H1.3.7 are satisfied if:

At the design and construction stages regard is given to all requirements of space, position, access and repair (or replacement) in order to commission and maintain the equipment in an efficient operating condition, without undue difficulty, when using normally accepted maintenance procedures.

9 Measurement of energy use

……………………………………………

9.1 The requirements of NZBC H1.3.8 are satisfied if:

Single meters are installed individually measuring and recording the whole of building consumption of electricity and gas if these forms of energy are used in the building. Meters must be readily accessible for reading or have a form of remote reading.

Proposed Specification for Acceptable Solution H1/AS1, paragraph 7.2.2(ii)

SPECIFICATION H1.1 SEALING DUCTWORK INSULATION AND SEALING

1. Scope

This Specification contains the requirements for the sealing and the insulating of supply and return ductwork used in a system that heats or cools a building.

2. Ductwork sealing

(a) Heating or cooling ductwork and fittings must be sealed against air loss—

(i) by closing all openings in the surface, joints and seams of ductwork with adhesives, mastics, sealants or gaskets in accordance with the duct sealing requirements of AS 4254 for the static pressure in the system, or

(ii) for flexible ductwork at an operating static pressure of less than 500 Pa, with a sealant and draw band encased with adhesive tape.

(b) The requirements of (a) do not apply to ductwork and fittings located within the last conditioned space served.

3. Ductwork insulation

(a) Ductwork and fittings for heating or cooling must be thermally insulated with insulation complying with AS/NZS 4859.1 to—

(i) achieve the Total R-Value specified in **Tables 3a** and **3b**, or

(ii) achieve a minimum Total R-Value of 1.0 for flexible ductwork of not more than 3 m in length from an outlet or the like.

(b) Insulation on ductwork conveying cold air must be protected by—

(i) a vapour barrier on the outside of the insulation, and

(ii) overlapping adjoining sheets of the membrane by 50 mm and bonding or taping the sheets together where the vapour barrier is a membrane.

(c) Ductwork insulation must—

(i) be protected against the effects of weather and sunlight, and

(ii) abut adjoining insulation to form a continuous barrier, and

(iii) be installed so that it maintains its position and thickness, other than at flanges and supports.

(d) The requirements of paragraph 3(a) do not apply to heating and cooling ductwork and fittings located within the last conditioned space served.

Table 3a DUCTWORK - MINIMUM TOTAL R-VALUE (For systems of no more than 65 kW_r and 65 $kW_{heating}$ capacity)

Ductwork element	**Minimum Total R-Value for ductwork and fittings**		
	Evaporative cooling system	**Heating-only system or refrigerated cooling system**	**Combined heating and refrigerated cooling system**
Ductwork.	0.6	1.0	1.5 (see note)
Fittings	0.4		

Note:

The minimum Total R-Value required may be reduced by R0.5 for combined heating and refrigerated cooling systems if the ducts are-

(a) under a suspended floor with an enclosed perimeter; or
(b) in a roof space that has insulation of not less than R0.5 directly beneath the roofing.

Table 3b DUCTWORK - MINIMUM TOTAL R-VALUE (For systems greater than 65 kW_r and 65 $kW_{heating}$ capacity)

Location of ductwork and fittings	**Minimum Total R-Value for ductwork and fittings**	
	Evaporative cooling system	**Heating system or refrigerated cooling system**
Within a conditioned space other than where the space is the only or last space served.	Nil	1.3
All other locations	0.9	1.8

Proposed Specification for Acceptable Solution H1/AS1, paragraph 7.4.1(i)

SPECIFICATION H1.2 INSULATING PIPING, VESSELS, HEAT EXCHANGERS AND TANKS

1. Scope

This Specification contains the requirements for the insulating of piping, vessels, heat exchangers and tanks containing heated or chilled fluid.

2. Insulation

(a) Insulation must—

(i) be protected against the effects of weather and sunlight, and

(ii) be able to withstand the temperatures within the piping, and

(iii) for piping, achieve the Total R-Value in **Table 2**, and

(iv) for vessels, heat exchangers and tanks, achieve a minimum Total R-Value of—

(A) 2.5 if the content is low temperature brine or glycol, or

(B) 1.8 if the content is chilled water, or

(C) 1.3 if the content is heated water, or

(D) 2.5 if the content is steam.

(b) Insulation on piping, vessels, heat exchangers and tanks containing chilled fluid must be protected by a vapour barrier on the outside of the insulation.

(c) The requirements of paragraph (a) do not apply to heating water piping—

(i) located within the space being heated where the piping is to provide the heating to that space, or

(ii) encased within a concrete floor slab which is part of a floor heating system.

Table 2 PIPING - MINIMUM TOTAL R-VALUE

Location	Minimum Total R-Value
1. Heating water piping for systems of no more than 65 $kW_{heating}$ capacity	
(a) Located internally	0.2
(b) Located within a wall space, an enclosed sub-floor area or an enclosed roof space	0.45
(c) Located outside the building or in an unenclosed sub-floor area or an unenclosed roof space	0.6
2. Heating water piping for systems of more than 65 $kW_{heating}$ capacity	
(a) Located internally	0.6
(b) Located within a wall space, an enclosed sub-floor area or an enclosed roof space	0.7
(c) Located outside the building or in an unenclosed sub-floor area or an unenclosed roof space	0.8
3. Cooling water piping for systems of no more than 65 kW capacity but less than 250 kWr capacity	
(a) Located internally	0.9
(b) Located within a wall space, an enclosed sub-floor area or an enclosed roof space	1.0
(c) Located outside the building or in an unenclosed sub-floor area or an unenclosed roof space	1.1
4. Cooling water piping for systems of more than 250 kWr capacity	
(a) Located internally	1.2
(b) Located within a wall space, an enclosed sub-floor area or an enclosed roof space	1.3
(c) Located outside the building or in an unenclosed sub-floor area or an unenclosed roof space	1.4
Note: Piping to be insulated includes flow and return piping, cold water supply piping and pressure relief piping within 500 mm of the connection to the heating or cooling system.	