

Carbon Emissions and Building Regulation

Report of the IRCC Workshop
Wellington, New Zealand
11 April 2008



NOTICE

This Report was prepared for the Inter-jurisdiction Regulatory Collaboration Committee (IRCC) with support from the Department of Building and Housing. The presentations associated with this Report were provided by the invited workshop speakers. Neither the IRCC, the Department of Building and Housing, nor any person acting on their behalf:

1. makes any warranty, express or implied, with respect to the use of any information, apparatus, method or process disclosed in this report or that such use may not infringe upon privately owned rights; or
2. assumes any liabilities of whatsoever kind with respect to the use of, or damage resulting from use of, any information, apparatus, method or process disclosed in this report.

Any opinions, findings and conclusions or recommendations expressed related to this Workshop and related materials are those of the author and do not necessarily reflect the views of the IRCC of the Department of Building and Housing.

Copyright 2008, IRCC. All rights reserved.

Foreword

Building regulations have traditionally focused on the health and safety of building users. People can escape in the event of a fire, buildings are designed to minimise fire spread, buildings will withstand all but extreme wind, earthquake, or snow events, public health is safeguarded with sanitary facilities. Over more recent years, building regulations have extended to consider the wellbeing of building users. Heating, lighting, ventilation, and protection from noise, are now often regulated. Regulations are legal instruments intended to ensure that buildings, when constructed in accordance with the regulations, provide socially acceptable levels health, safety and amenity for building occupants and for the community in which the buildings are located.

With international concern about sustainability and climate change, many governments are looking at building regulations in new light.

The built environment is a considerable source of greenhouse gas emissions. building regulations . The International Panel on Climate Change and many other organisations and individuals have published recommendations and warnings about climate change. Many governments are capacity to sustain the impact of population growth, economic development and the built environment, building regulators are being asked to on the sustainability of the world's economy and built environment,

Building regulations are legal instruments intended to ensure that buildings, when constructed in accordance with the regulations, provide socially acceptable levels of health, safety, welfare and amenity

to , being legal instruments of health, safety, welfare and amenity for building occupants and for the community in which the buildings are located. This is typically accomplished through regulatory controls on the design, construction and operation of buildings, covering such diverse areas as structural stability, fire safety, heating, lighting, ventilation, plumbing, sanitary facilities, indoor air quality, and energy.

Historically, these regulatory controls have generally been highly prescriptive in nature (e.g., the maximum travel distance to an exit shall not exceed 30 meters), allowing limited flexibility in alternative compliance options, and have often been based on reaction to significant events (e.g., fires, earthquakes, hurricanes, etc.). In the last 20 years, however, there has been a growing transition to objective-, functional- and performance-based building regulations. In these regulations, the focus has shifted from prescribing solutions to identifying objectives, functional requirements, and performance expectations (e.g., design the building so that occupants not intimate with the fire source can safely exit the building before untenable conditions are reached in egress paths), and allowing for a wider selection of compliance options.

One discussion focus in the performance environment is fire safety, which was chosen as the topic of an IRCC workshop, held at the Hotel de France in Vienna, Austria, on 10 October 2007. The intent of the workshop was to provide a forum for IRCC members to ask questions of, and gain insight from, invited experts with experience and expertise in fire science, fire safety engineering, and fire risk and performance concepts in regulation. In an area where functional and prescriptive regulations prevail, the lack of quantitative performance requirements makes it especially difficult to assess the compliance of alternative design solution which are based on fire safety engineering methods.

The Workshop presentations and discussions were necessarily wide-ranging, yet proved to be extremely insightful and beneficial to the IRCC members. Although it is impossible to capture the full extent of discussions and perspectives, the following provides a summary of some of the key issues that were discussed.

As performance-based building regulations will become more risk-informed and soundly based on quantitative performance criteria in the future, the discussions and professional connections made at this workshop shall help set the foundation for facilitating global cooperation and advancement in this important area.

Brian J. Meacham, Ph.D., P.E,
Editor

Acknowledgments

The success of any workshop is due ultimately to the participants, and this workshop is no exception. The core of the workshop participants – the source of issues to be addressed and factors to be considered – were the members of the IRCC. As representatives of organizations responsible for the development and support of nationally-adopted building regulations in eleven countries, the challenges you face and the experience you bring shaped the breadth and depth of discussion.

To help the IRCC expand their knowledge of fire and performance issues, a small group of invited experts participated in the workshop, sharing their insights and experience, and making the workshop an incredibly valuable experience for all:

- Dr. Arthur Eisenbeiss, Institute for Fire Prevention, Linz, Austria
- Mr. Jukka Hietaniemi, VTT, Finland
- Dr. Björn Karlsson, Iceland Fire Authority
- Dr. Mamoru Kohno, National Institute for Land and Infrastructure Management, Japan
- Dr. Johan Lundin, WSP Fire & Risk Engineering, Malmö, Sweden
- Dr. Brian Meacham, Arup / Worcester Polytechnic Institute, USA
- Dr. Rainer Mikulits, Austrian Institute of Construction Engineering, Vienna, Austria
- Prof. Dr. Ulrich Schneider, Technical University of Vienna, Austria
- Dr. Paul Stollard, Scottish Building Standards Agency

We sincerely thank each of you for your generosity in sharing your time, experience and expertise with the IRCC – your participation is deeply appreciated.

Finally, no workshop happens without planning, organization and administrative support. IRCC extend their sincere appreciation to Dr. Rainer Mikulits and OIB for providing financial, administrative, program and technical support. Location: Museum Hotel, Cable Street, Wellington, New Zealand

Time: 9:00am – 5:00pm Friday, 11 April (Carbon Workshop)

Present

Brian Meacham	USA	(BM)
Mike Stannard	DBH, NZ	(MS)
Suzanne Townsend	DBH, NZ	(ST)
Rainer Mikulits	OIB, Austria	(RM)
Bill Dodds	SBSA, Scotland	(BD)
Denis Bergeron	NRC, Canada	(DB)
Rick Okawa	ICC, USA	(RO)
Mike Balch	ABCB, Australia	(MB)
Lam Pham	ABCB, Australia	(LP)
Cheng Zhijun	CABR, China	(CZ)
Liu Wenli	CABR, China	(LW)
Wataru Gojo	NILIM, Japan	(WG)
Hiroki Sunohara	MLIT, Japan	(HS)

Guests

Staffan Abrahamsson	Boverket, Sweden	(SA)
IJsbrand van Straalen	TNO, The Netherlands	(IvS)
Julia Liu	BCA, Singapore	(JL)
Ong See Ho	BCA, Singapore	(OSH)

From DBH

Peter Thorby	DBH, NZ	(PT)
Nick Locke	DBH, NZ	
Stephen Ward	DBH, NZ	
Paul Honeybone	DBH, NZ	(PH)

IRCC Workshop on CO₂ emissions

Friday 11 April

Venue: Museum Hotel, 90 Cable Street, Wellington

The purpose of the workshop is to obtain the international regulators' perspective on CO₂ emissions: what issues they might have, perceive or anticipate if they were to consider carbon emissions in their building standards and controls frameworks.

0830 - 0845	Welcome and Introduction
0845 - 1030	Session 1: Context Setting
0845 - 0900	The New Zealand Perspective – Mike Stannard, Department of Building and Housing
0900 – 0930	Resource Efficiency – from the review of the New Zealand Building Code – Peter Thorby, Department of Building and Housing
0930 - 1000	Resource Efficiency – How the NZBC can respond to New Zealand's broader climate change and sustainability goals - Paul Gandar, Ministry of Economic Development
1000 - 1030	Economically efficient regulation to control carbon emissions – Adolf Stroombergen, Infometrics Ltd
1030 - 1045	Discussion on session 1
1045 – 1100	Morning tea
1100 - 1200	Session 2: Australian Metrics, Research and Issues
1100 – 1145	An Australasian database of environmental impacts data (AusLCI) – Nigel Howard, BRANZ
1145 - 1215	Issues for the researcher/provider community - Barbara Nebel, SCION
1215 - 1230	Current energy efficiency research initiatives - Nigel Isaacs. BRANZ
1230 – 1300	Lunch
1300 - 1500	Session 3: International Experience
1300 - 1320	Low Carbon Building Standards Strategy for Scotland - Bill Dodds
1320 - 1340	Building Code of Australia, Carbon Issues – Lam Pham, CSIRO
1340 - 1400	MLIT policies for reducing greenhouse gas emissions from housing and buildings - Wataru Gojo, NILIM, Japan
1400 - 1500	Discussion – other countries perspectives (China, USA, Canada etc)
1500 - 1520	Afternoon Tea
1520 - 1700	Session 4: Making it real in practice
1520 - 1600	Issues for practitioners, Tools for designers, making the mind shift – Graeme Finlay, Warren and Mahoney
1600 - 1645	General Discussion
1645 - 1700	Summing Up

IRCC Meeting

**Museum Hotel
Wellington NZ
10-12 April 2008**

Carbon Workshop Friday 11 April

Attendees:

Brian Meacham, USA (Chair)
Rick Okawa, International Codes Council, USA
Denis Bergeron, National Research Council, Canada
Dr Lam Pham, Australian Building Codes Board
Mike Balch, Australian Building Codes Board
Hiroki Sunohara, MLIT, Japan
Wataru Gojo, NILIM, Japan
Bill Dodds, Scottish Building Standards Agency
IJsbrand van Straalen, TNO Built Environment and Geosciences, Netherlands
Liu Wenli, China Academy of Building Research (CABR)
Cheng Zhijun, China Academy of Building Research (CABR)
Staffan Abrahamsson, National Board of Housing, Building and Planning, Sweden
Julia Leu, Building and Construction Authority, Singapore
Ong See Ho, Building and Construction Authority, Singapore
Rainer Mikulits, OIB, Austria

From Department of Building and Housing:

Mike Stannard (Secretary)
Peter Thorby
John Gardiner
Nick Locke
Stephen Ward
Serge Sablyak (Minutes)

Invited guests and speakers:

Paul Gandar, Ministry of Economic Development
Barbara Nebel, SCION
Nigel Howard, BRANZ
Nigel Isaacs, BRANZ
Adolf Stroombergen, Infometrics
Graeme Finlay, Warren and Mahoney
Andrew Alcorn, Victoria University
Angela Henderson, Standards New Zealand
Wayne Bretherton, WSP Buildings, UK

Carbon Issues Workshop

MS provided an introduction on the examination of the place for carbon in building regulation. Comment on the review of the New Zealand Building Code has given rise to proposals to use carbon as sustainability metric. This is set in the context of the increasing international awareness of carbon issues and climate change, which is also high on the New Zealand government's agenda. New Zealand has ratified the Kyoto Protocol and is setting up a trading regime for carbon. The national energy and energy efficiency and conservation strategies have been revised to improve sustainability and to tie in with Kyoto obligations.

One of the goals of New Zealand Energy Strategy is to bring in 90% renewable electricity generation by 2025. Total New Zealand emissions are low on the world scale, but the country depends on international trade and its clean, green image.

The New Zealand greenhouse gas inventory shows that the majority of emissions are from agriculture. Another 40% are from energy in the broadest sense. Buildings contribute about 9%. Compared to other countries, the carbon load is fairly low per capita. The benign climate and small population contribute to that. However, there has been a large increase – 50% since 1990.

Upcoming issues for New Zealand include the findings of the Building Code review, the implementation of climate change policy objectives and the potential economic impact of regulation.

Peter Thorby – Carbon and resource efficiency

The New Zealand Building Act 2004 put in new requirements for buildings, including sustainable development (sustainable use of energy, water, materials and reduction in waste).

The Department of Building and Housing thinks of sustainability as a system outcome. This is because people do not stand alone. Resource use occurs in a community, national and international context.

The New Zealand Building Code addresses only operating energy through energy efficiency of space conditioning, water heating and lighting. There are no requirements around water consumption, materials or construction waste. Questions remain about how the Code can address lifecycle resources. Is energy the best measurement or would something else be more appropriate?

Energy availability is not necessarily the issue – more arrives from space every day. The effects of energy use are more important.

Sources of carbon emissions in buildings include construction, use, maintenance and replacement. There is also the issue of water, which requires energy to carry to houses. Sun can be used to minimise in-use energy, for example, through solar water heating. Insulation is also an option, although at the expense of embodied energy.

In New Zealand, three key Acts govern sustainable development, the Local Government Act 2002, the Building Act 2004 and the Resource Management Act 1991. Their interplay is a complex issue and illustrates the point about interconnectivity.

Suggestions have been made in the Building Code review to manage ongoing energy costs. However, ongoing compliance monitoring is difficult. How does the designer demonstrate

this at the building consent stage? The key answer may be to minimise carbon footprint (as a whole) from the start.

Buildings currently have an infinite life unless it is specified to less than 50 years. Should life to be specified to account for carbon and energy costs?

Paul Gandar – Sustainable development, climate change and building performance

There are at least four dimensions to this issue – economic, social, cultural and environmental. Building regulations needs to address all four.

In New Zealand, there has been a shifting emphasis. In 2006, the economic lens was applied to sustainability. A year later, the environmental was emphasised. Contributors to this would have been the Stern Report and the shifting international focus on sustainability. This represents a significant philosophical and practical change.

People are the global imperative. Every hour, the world's population increases by 10,000 people. As a result, we are not living sustainably. If inequity is added, the global challenge is immense. All resources, such as water, oil, metals, land, etc are finite. Under business as usual, unsustainable carbon levels in the near future are a reality.

The New Zealand government has a number of objectives. The ultimate goal is aspirational: be carbon neutral over time. Under that headline goal, more definable targets have been set: 90% of electricity from renewables, increase in forested area, reduced emissions from transport, and agricultural emissions reductions from technological and scientific improvements.

Strategies for achieving carbon neutral status include emissions trading. Under Kyoto, everyone must cap emissions at five times 1990 gross emissions. For this, each country gets an assigned amount of units. Where allotted units are exceeded, additional units have to be purchased on the international market.

Government actions for avoiding emissions include prices (emissions trading), regulations and Standards (the Building Code), subsidies, information provision (labelling), R&D, and sector-by-sector reduction strategies.

These are supplemented by voluntary actions – reducing emissions through individual actions, firms facing pressure to reduce, opportunity driven reductions (creating offsets on marginal projects to flip over into profitability).

The New Zealand emissions trading scheme focuses on all greenhouse gasses, not just carbon. There will be staged entry for sectors, with the most sensitive, such as agriculture, coming in later.

Measures in other jurisdictions include:

- EU – trading scheme in operation, set to expand
- Australia – scheme in draft, should be introduced by 2010
- US – state and regional schemes in operation (election in November could spearhead federal scheme)
- Canada – running below target, but set to cut 20% by 2020.

Typical concerns over trading schemes and mitigation measures include economic damage, loss of competitiveness, adverse individual impacts, and the debate over the speed and reach of measures. A major issue is what happens in the second commitment period. Should the basis for country allocations be modified?

In terms of building codes, there is a shifting from prescriptive regulation to fixing problems. Greater emphasis is being placed on sustainability.

There has been a shift in how the debate is framed. In the big picture, climate change and sustainability will not go away. Shocks will occur. Effects will be felt on buildings, and will require behaviour change.

Adolf Stroombergen, Infometrics – General equilibrium analysis of options for meeting New Zealand’s international emissions obligations

Adolph presented the findings of a study, based on the general equilibrium model, to estimate the economic impact on New Zealand of meeting its emissions obligations. The model accounts for economic behaviour, tracks impacts from one industry to another, can accommodate government policies and allows for international economic shocks. It is designed as a ‘what if’, not an economic forecast. The main initial point is that there is no invariant standard of value.

Several scenarios were presented for the economic impact of emissions trading. Depending on the international price of carbon, the economic impact could be significant. High economic growth (sufficient to move New Zealand into the top half of the OECD in terms of GDP/capita) and significant emissions abatement are probably mutually exclusive goals. However, much depends on the rate of technological change, the rate of greenhouse gas reductions in competitor countries, and policy reactions if the international price of carbon becomes “too high”.

Nigel Howard, BRANZ – Australian database of environmental impacts

Business as usual is not acceptable. Serious effects if action not taken to reduce greenhouse gas emissions.

What drives change? There are only four types of decision that people make: what to buy, where to invest, where to work, and how to vote.

Voluntary tools, such as the Greenstar building rating scheme, act in the voluntary range of the market to give additional value. Over time, the market shifts towards better practice. However, the voluntary approach is too slow. Government will have to regulate. The issue is how best to and how quickly.

Options for regulation include the building fabric, energy efficiency, air tightness, efficient building services and control systems. It is important to optimise the use of natural resources, such as geothermal energy, wind, etc.

Trade-offs are inevitable, for example, embodied CO₂ versus operational CO₂, and reductions versus, for example, no heating and the consequent health effects. An example of striking this balance is the British sustainable building code. It creates a balance between operational and embodied energy consideration. The code reconciles the health comfort trade-off with optional voluntary credits, creating a bridge between regulated and voluntary measures.

The Australian Life Cycle Analysis project (AusLCI) exists to build a raw set of impacts, engaging every sector of the Australian industry. It is trying to establish an Australian national LCI database, with consistency and stakeholder agreement.

Nigel Isaacs, BRANZ – Why building codes need good data

In 2006, New Zealand completed a major study of domestic energy use, the Household Energy End-use Project (HEEP). HEEP looked at energy use in 400 houses across the

country and where the energy was derived from. Its findings have completely changed the understanding of domestic energy efficiency and energy use, and have helped inform building, health, infrastructure, climate change and economic policies.

The study found that New Zealand homes are generally cold, even where the inhabitants are quite wealthy. A quarter of houses had winter evening temperatures below 16°C. The coolest houses used open fire, while the warmest had gas or wood burners.

The study found that there was a third/third/third split in the use of energy between water heating, space heating and appliances (including lighting). However, since HEEP was finished, there has been an increasing adoption of heat pumps for heating (and cooling), which is changing the energy use profile.

BRANZ is now engaged in a new project, BEEP, the Building Energy End-use Project, which will look at energy use in commercial buildings.

Barbara Neville, Scion – Issues for the researcher/provider community

One of the main issues for researchers involved in carbon issues is the broad range of stakeholders. If all do not work together and believe in the same methodologies, the research will not be productive. There is a role for scientists and practitioners to work together.

A life cycle analysis was performed on a typical New Zealand timber-framed house. Seven different designs were tested, and the analysis looked at embodied and operational costs.

Bill Dodds – Low carbon standards strategy for Scotland

In the UK, buildings relate to 45% of carbon emissions, as opposed to 8% in New Zealand. The recommendations of the Sullivan Report were published in 2007, setting ambitious but achievable goals for sustainability and carbon reduction. The report set the strategic route for developing future policies. It has 56 recommendations, including a review of energy standards, carbon emission reduction and zero carbon building. Implementation issues include costs, performance in practice, existing buildings and compliance.

Previous drivers for change have included the EU Directive on the energy performance of buildings (EPBD) and changes to regulations in England and Wales. The EPBD is a set of rules imposed by the European Parliament. It asks the member states to promote improvement in energy performance to conserve resources, improve building user comfort and reduce carbon emissions from buildings. Member states must adopt a methodology, set minimum standards for both new and renovated buildings, consider LCZ technologies, require energy performance certificate and require inspection of boilers and air-conditioning systems.

The new Scottish government's manifesto included a commitment to look at energy efficiency in the first 100 days. An expert panel was appointed to look into the issue in August 2007.

Further research is needed to address technical issues, improve methodologies and to look at future standards and compliance.

Lam Pham – Emissions trading in Australia

Australia has a new Prime Minister and Minister for climate change. One of the first actions of the new government was to ratify the Kyoto Protocol.

An emissions trading scheme is planned to be implemented by 2010. It will be cap and trade, which is internationally consistent. The goal is to achieve 60% emissions reductions by

2050, while being economically responsible and fair. The focus of the scheme will be the stationary and transport energy sectors, which in Australia account for about 70% of emissions.

The impact of the scheme will depend on the international cost of carbon. A range of scenarios have been prepared with the price ranging from \$40-\$200. Implications for buildings include the flow-on economic effects, the calls by the Australian timber industry for credits for carbon stored in timber framing and responsibility for design. Issues to be addresses include the barriers to optimal energy efficiency, such as imperfect information, culture and lifestyle, small project size and regulatory barriers.

Australia's energy efficiency standards are lower than other countries'. Regulatory action helps with economies of scale, but there could be an impact on long term affordability.

Wataru Gojo – MLIT policies for reducing greenhouse gas emissions from housing and buildings

The present trend is not showing emissions decreases at the level needed. In addition, the contribution to emissions from buildings has not been quantified.

The contribution to energy use from appliances has increases, but heating and cooling have remained constant. People consider heating and cooling to be the main sources of energy use, but this is at odds with reality.

Several work streams are in progress to improve energy use. The amendment to the law for rational use of energy will see mandatory energy efficiency reports on newly built or extensively refurbished buildings. This will consider the heat loss coefficient through roofs, walls, floors and vents. Another work stream is looking at creating a comprehensive assessment system for building environmental efficiency, which could be undertaken by local government bodies. A third work stream is looking at future directions, including promoting the energy efficiency of existing building stock and star rating systems.

Graham Finlay – Issues for practitioners

Alignment is needed between policy and the market perspective if the effects of climate change are to be avoided. Sustainability represent the greatest commercial opportunity of the modern age. Yet, there is no 'Silicon Valley' of eco commerce.

Green buildings offer significant commercial benefits, as well as improving the environment that surrounds the building, as well as improving user experience on the inside. New material and technologies will play a key role in this.

The pace of change is rapid, and the market and regulation must move in tandem. The key requirements for market change are value to the consumer, time to plan, and the opportunity to profit. Players in the equation include innovators, value creators, profit makers, regulators and consumers. Local examples of value creators include Greenstar, which is a sustainability benchmark, and Greenbuild, which connects the vendor and the consumer at the time of product selection.