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BUILDING PERFORMANCE

Targeted Consultation Document

Transforming Operational Efficiency Framework: Technical Methodology

Building for Climate Change programme

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MINISTRY OF BUSINESS, INNOVATION & EMPLOYMENT
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New Zealand Government

SECTION 1: CONTEXT

Introduction

New Zealand has committed to achieving net zero greenhouse gas (GHG) emissions, excluding biogenic methane, by 2050. Achieving this goal will require transformative change in many sectors – including building and construction, which contributes a significant proportion of New Zealand's total GHG emissions.

The Building for Climate Change programme was established within the Ministry of Business, Innovation, and Employment (MBIE) as a vehicle to reduce emissions from New Zealand's building and construction sector, and to prepare buildings for the ongoing effects of climate change in future.

The programme is developing two mitigation frameworks for new buildings:

- **Whole-of-Life Embodied Carbon Reduction** – which proposes to set mandatory reporting and measurement requirements for whole-of-life embodied carbon emissions, including from the materials used in construction, the construction process, construction waste, and the disposal of a building at the end of its life.
- **Transforming Operational Efficiency** – which proposes to set required levels of efficiency for energy use and water use, and define minimum Indoor Environmental Quality (IEQ) measures for buildings.

This consultation document should be read in conjunction with the 2020 Transforming Operational Efficiency Framework proposal document[1].

Purpose

The purpose of this consultation is to receive specialist, evidence-based feedback on three key technical components of the methodology that underpins the Transforming Operational Efficiency Framework. This is part of the ongoing process to develop the methodology in more detail, following on from the first consultation in October 2020.

This consultation seeks expert feedback on proposals and options regarding:

- **Building Services Cap scope**
- **Thermal Performance methodology**
- **Indoor Environmental Quality (IEQ) parameters and settings**

A related document proposing the methodology for conducting assessments for the Whole-of-Life Embodied Carbon Reduction Framework was also recently circulated for targeted technical feedback.

The aspects of the proposed methodology set out in this document are intended to support the Transforming Operational Efficiency Framework objectives of improving the operational efficiency and IEQ of New Zealand buildings.

[1] https://www.building.govt.nz/getting-started/building-for-climate-change/

Consultation scope

This document provides a valuable opportunity for specialist input into developing the methodology. It contains a series of key extracts from the methodology where technical feedback is sought.

The Building for Climate Change programme is continuing to develop and refine the methodology, using insights collected from wider engagement with the building and construction sector. MBIE has a good understanding of the sector's general views on operational efficiency due to the feedback collected over the past year. The recent Building Code consultation in May 2021 also provided clear indications on how the sector views the upcoming proposed operational efficiency changes.

Sector feedback has indicated strong support for the framework proposals overall. Some uncertainty was raised around the scope, implementation and methodology, which had not been fully developed at the time, and how the frameworks would operate in practice.

MBIE will be announcing the Building Code (H1) update in October which, while being constrained by the current compliance pathways, will increase operational efficiency. MBIE expects to consult on the full Transforming Operational Efficiency Framework regulatory package, including proposed caps and staging, following Cabinet decisions in 2022.

Audience

This consultation targets a select, limited number of specialists who have knowledge in the operational efficiency field. This includes both New Zealand and international technical experts. Feedback will help MBIE continue to develop and refine the proposed Transforming Operational Efficiency methodology to achieve the Building for Climate Change programme's intended outcomes.

It is not intended for wider distribution and we request that you do not share it outside your organisation. If you wish or need to seek feedback/input from colleagues with relevant technical expertise, please collate your collective feedback into a single submission.

Alignment with the New Zealand building regulatory system

The Transforming Operational Efficiency Framework proposals are being developed in alignment with the New Zealand building regulatory system. New Zealand's building regulatory system is built on the Building Act 2004 and anchored by a performance-based Building Code with a number of compliance pathways.

MBIE is working on two parallel work streams to revise the compliance pathways to decrease energy use and related emissions and improve health and wellbeing outcomes from buildings.

Work stream 1. Short term changes to the acceptable solutions and verification methods that can be issued under the current Building Act and Building Code regulation framework.

This includes proposals in the Building Code update 2021. MBIE is currently finalising the increase in element insulation requirements (R-values) within the current compliance pathways and providing a new verification method for the energy efficiency of HVAC systems in commercial buildings. These proposals are the first step toward the same goals that the Transforming Operational Efficiency framework seeks to achieve. They use current regulations to reduce emissions and make homes and buildings warmer, drier and healthier. In the short term, it is expected that future Building Code updates will continue to lay the groundwork to transform the sector.

Work stream 2. Long term changes to transition to holistic performance-based energy caps that will ultimately be set using the Transforming Operational Efficiency Framework methodology.

The Transforming Operational Efficiency framework and proposals in this document looks at the longer-term approach to decrease buildings' operational emissions. It is intended to be a transformational change to the methods and outcomes. The legislative process to make these changes is much longer and more involved than publishing new Acceptable Solutions and verification methods. Further policy and technical work is required to develop the tools, methodologies and supporting policies to implement this. This takes into account the feedback from both the recent Building Code consultation and the previous consultation on the frameworks. The longer term changes will eventually merge into Building Code updates. The longer term changes will eventually merge into Building Code updates.

Next steps

The next steps following this consultation will be to further develop and refine the methodology taking account of the technical feedback received. Policy work to further progress other parts of the frameworks (such as reporting mechanisms, staging, implementation of the proposed caps, incentives, and education and training initiatives) is ongoing, informed by broader sector feedback and stakeholder engagement.

In early 2022 MBIE will seek Cabinet's agreement to a full package of proposals for public consultation. Endorsement by Cabinet will be required given the transformational impact these proposals could have on the building system.

SECTION 2: TRANSFORMING OPERATIONAL EFFICIENCY

1. Framework Objectives

The Transforming Operational Efficiency Framework aims to improve the operational efficiency of buildings in order to reduce emissions, reduce water use and improve occupant health and wellbeing.

The Framework proposes to regulate the design and construction of buildings to drive energy efficiency improvements; it is not intended to regulate people's lifestyle choices while living and working in particular buildings and homes. A behaviour change strategy, supported by policy work on incentives and disincentives, is under development as part of the broader Building for Climate Change programme. This, rather than regulated caps and targets, will seek to grow carbon literacy, inform New Zealanders about the impact of their behaviour on carbon emissions, and shift people's behaviour in a way that helps realise Government's emissions reduction targets.

MBIE has set out three main objectives of increasing operational efficiency:

- **Reduce Operational Emissions:** Carbon emissions come directly from fossil fuel combustion and indirectly from using electricity and water in buildings. Increasing operational efficiency, and thereby reducing these three components, reduces operational emissions. The emissions are measured in kilograms of CO_2 equivalent per square meter per year, kg CO_2-e/m^2/yr.

- **Reduce Water Use:** While water use contributes to operational emissions, it is also important for climate change adaptation and resilience. The volume of water used in buildings impacts on the capacity of regional water supplies to meet demand.

- **Improve Occupant Health and Wellbeing:** It is important that operational efficiency is not considered in isolation from IEQ and that improved efficiency also leads to good occupant health and wellbeing outcomes. Buildings need to be:
  - Comfortable temperatures (warm in winter, cool in summer)
  - Dry (appropriate relative humidity)
  - Well ventilated

2. Framework Methodology Overview

The methodology sets out the parameters for modelling and reporting on the operational efficiency and IEQ of new buildings in New Zealand.

When the framework underwent consultation in 2020, it proposed to regulate new buildings' operational emissions[2] (in $kgCO_2$-e/m^2/yr), water use (in m^3/m^2/yr) and IEQ (using a variety of parameters). It was proposed that the operational emissions and water use from operating a new building would be capped, and that the caps would tighten over time.

The proposed caps in the Operational Efficiency Framework are as follows:

1. Operational Emissions Cap, made up of
    a. Fossil Fuel Cap, and
    b. Electrical Use Cap, made up of:
        i. Building Services Cap
        ii. Plug Loads
2. Thermal Performance Cap
3. Water Use Cap

As noted in the purpose above, this consultation seeks expert feedback on proposals and options regarding the:

- Building Services Cap scope
- Thermal Performance methodology
- IEQ parameters and settings

It is also important to note that the framework distinguishes between demand and delivered energy:

Demand energy (heating or cooling): the amount of heating or cooling modelled/calculated to be required to maintain the set IEQ. This is relevant to the Thermal Performance Cap being consulted on in this document.

Delivered energy: the amount of energy modelled/calculated to be supplied (typically through the utility meter) to the building to meet the demand accounting for the COP[3] of the systems used. This is relevant to the overarching Energy Use Cap and also to the Building Services Cap being consulted on in this document.

[2] The m^2 metric refers to building floor area (reference area) for both emissions and water use.
[3] COP = Coefficienct Of Performance, i.e. the ratio of energy input to heating or cooling output.

2.1. Intended users of the methodology

This methodology is intended to be understood by anyone involved in the design, construction, operation and management of buildings. Three broad categories of users are recognised, with each having different levels of understanding and interest:

Group 1 Primary Users: design/energy specialists

- **Designers –** e.g. architects, engineers, consultants, energy modellers
- **Building Assessors** – e.g. operational efficiency assessors, third party peer reviewers, efficiency auditors, and building consent officers

Group 2 Secondary users: wider industry

- **Builders –** e.g. main contractors, house builders, subcontractors
- **Construction supply chain –** e.g. suppliers of building materials and products, waste contractors
- **Building Consent Authorities** – local government, councils
- **Educational providers –** those that teach the future designers and builders and assessors etc.

Group 3 Tertiary users: building owners, managers and general public

- **Building owners/clients –** e.g. property developers, homeowners, property managers, project managers

The different audience groups are expected to have different information needs and will use the methodology in different ways. Some professionals will need to develop a deep understanding of the methodology and parameters and conduct energy modelling and/or operational efficiency assessments themselves. Others, such as tradespersons or homeowners might simply be aware of the methodology in order to understand at a broader level how it might impact their building choices.

Establishing a methodology that can be understood by a wide audience will support growth in carbon literacy and understanding of operational efficiency across the sector.

2.2. When to apply the methodology

The methodology and parameters could be applied at any point in a building's life cycle, however it is intended and recommended they be applied in early design and concept stage decisions. This is when the greatest impact on operational emissions, water use and IEQ can be made. Early decisions can lock-in outcomes, so it is important the right outcomes get locked-in.

The methodology is also proposed to be used as the basis for future policies and regulations. The framework will make operational efficiency, water use and IEQ modelling/assessments mandatory as part of the building consent process. This means they would need to be undertaken prior to, and submitted as part of, applying for building consent, and updated when construction is complete for code compliance certification.

2.3. Methodology key principles

CONSISTENT The methodology produces consistent results that can be compared with each other and reliably used to make informed decisions.	**TRANSPARENT** Inputs, parameters and assumptions are clear and results can be trusted. The results are predictive so they represent likely outcomes not just a means of compliance.
ACCESSIBLE & UNDERSTANDABLE The methodology is simple and understandable by users across all areas of the sector. The outcomes are simple and clear for all people.	**OUTCOME-DRIVEN** The methodology produces energy and water efficient buildings with reduced operational emissions and improved occupant health and wellbeing.

SECTION 3: CONSULTATION QUESTIONS

A) Building Services Cap scope

Consultation Questions:

During the consultation in 2020, the scope of building services to be included in the framework was not defined. This document sets out which building services are proposed to be within scope for the Building Services Cap. MBIE is proposing that all building services or equipment listed, whether fixed or plugged-in, will fall within the Building Services Cap, and not within the plug load category.

- *Q1. Do you agree with each of the listed Service/Equipment categories being included for small and large buildings?*
- *Q2. Are there any additional Service/Equipment categories that should be included for small and large buildings?*

Proposed Cap

The proposed Building Services Cap is intended to drive the design, specification and construction of efficient building services in order to reduce electricity use. As the caps tighten this will emphasise the need for both efficiency at the system design level (e.g. short hot water pipe runs), and efficient equipment. This is important as the systems are mainly installed when a building is first constructed, are difficult to change later, and are usually there for the lifetime of the building with long maintenance and replacement cycles. In contrast, specific items of equipment may be relatively easy to replace and upgrade as technology advances (e.g. hot water storage.)

Where fossil fuel combustion is proposed to be used to meet any of the services demand, the Building Services Cap is reduced by the calculated demand being met by fossil fuels. For example, if space heating demand is calculated to be 30 kWh/m^2/yr and will be met by a fossil fuel heating system, the Electricity Use Cap and Building Services Cap is reduced by this amount (noting that that the final fossil fuel combustion cap is proposed to be zero).

The proposed caps are presented here for reference only. We are still developing the caps including the figures, staging and timing.

	Initial Cap	Intermediate Cap	Final Cap
Services Efficiency[4] (delivered, annual)	120	60	30
kWh/m^2/yr			

[4] We use kWh/m^2/yr as the metric, it could also be written as kWh/(m^{2}a).

Proposed scope

The scope of building services proposed to be included in the Framework was not set out in the 2020 consultation document.

We are proposing that the following building services are included in the scope of the Building Services Cap:

Service/Equipment	Small Buildings[5]	Large Buildings[6]
Space heating	✓	✓
Space cooling	✓	✓
Air conditioning/humidity control	✓	✓
Water Heating	✓	✓
Ventilation (incl. supply, extract and recirculation equipment etc.)	✓	✓
Artificial lighting	✓	✓
Elevators and escalators	✓	✓
Auxiliary (Pumps, fans)	✓	✓
Security and alarm systems	✓	✓
Data & comms systems	✓	✓

The Building Services Cap is based on the required delivered energy to meet the full modelled or calculated demand. Therefore, regardless of whether a building service is fixed to the building when constructed or will be provided as a plug-in appliance, it would fall within the scope of the Building Services Cap, and would not fall within the plug load category. This will mainly apply to space heating

For example, a building with a very low heating demand may have no fixed heating appliances installed when it is built. This would be based on the assumption that the occupants will use plug-in heating appliances to be comfortable. However, the calculated delivered energy required to meet the modelled/calculated space heating demand must still be included in the Building Services Cap. In this situation, where no fixed appliance is included, the delivered heating energy will be assumed to be direct electric (COP=1) by default.

Update since 2020 consultation

Feedback to our previous consultation indicates that most people agreed that building services (e.g., heating and cooling systems, hot water systems, ventilation systems) should be included in the framework, but also considered services efficiency to be only one part of a building's broader operational performance. They considered that, because of this, it would be difficult to regulate building services without also considering the overall efficiency of a building. Some also questioned whether having both an Electricity Use Cap and Building Services Cap would be too rigid or stifle innovation

[5] Small buildings are those that are 3-storey or less and 300m^2 or less gross external floor area.

[6] Large Buildings are those that are greater than 3-storey or greater than 300m^2 gross external floor area.

The framework proposes both Electricity Use and Building Services Caps, in order to avoid Building Services efficiency and Plug Loads being played off against each other. There is a risk that this could happen if there were to just be one overarching Electricity Use Cap. For example, claiming low Plug Loads to balance less efficient Building Services.

Building Services contribute significant electricity use and are relatively long-lived elements of a building. They are mainly installed when a building is first constructed and are usually in place for the lifetime of the building subject to maintenance and replacement cycles. In contrast, Plug Loads vary considerably depending on the occupancy and use of a building, and are likely to change much more frequently over time. Plug-in equipment and appliances etc. (e.g. computers and monitors) may also increase in efficiency more rapidly due to improved technology and short replacement/upgrade cycles.

Benefits to having a Building Services Cap as well as an Electricity Use Cap:

- It provides a level of flexibility - higher/improved building services efficiency (below the Building Services Cap) gives more headroom within the Electricity Use Cap to account for higher plug loads where necessary, for example in large office buildings. We also consider that suitable constraints as proposed can help drive innovation.

- It enables the same cap figures to apply to small and large buildings as proposed. It is expected that small buildings could meet the Electricity Use Cap relatively easily once they meet the proposed Thermal Performance Cap. Therefore, the Building Services Cap will drive further energy efficiency and operational emissions reductions that just an Electricity Use Cap alone would. For large buildings, it is expected that both the Building Services Cap and Electricity Use Cap will drive energy efficiency and operational emissions reductions.

Consultation feedback identified that it was unclear if Building Services cap included the heating and cooling demand calculated for the Thermal Performance Cap. To clarify this, aside from categorising the Thermal Performance Cap separately, the Building Services Cap figures have been adjusted to make it clear they include the delivered electricity used for heating and cooling to meet the Thermal Performance Cap.

Consultation questions

Question no.	Question
1	*Do you agree with each of the listed Service/Equipment categories in the table below being included for small and large buildings?*

Service/Equipment category	Small Buildings	Large Buildings
Space heating	Y / N	Y / N
Space cooling	Y / N	Y / N
Air conditioning/humidity control	Y / N	Y / N
Water Heating	Y / N	Y / N
Ventilation (incl. supply, extract and recirculation equipment etc.)	Y / N	Y / N
Artificial lighting	Y / N	Y / N
Elevators and escalators	Y / N	Y / N
Auxiliary (Pumps, fans)	Y / N	Y / N
Security and alarm systems	Y / N	Y / N
Data & comms systems	Y / N	Y / N

2	*Are there any additional Service/Equipment categories that should be included for small and large buildings?* *If yes, please specify and indicate whether you think the category/ies should be included in small or large buildings, or both.*

B) Thermal performance

Consultation Question:

Feedback from the consultation in 2020 included strong support for the Thermal Performance Cap. As we develop the Thermal Performance aspects of the methodology further we would like specific feedback on whether the cap should be for annual demand or peak load.

Q1. Should the Thermal Performance Cap for heating and cooling be measured by annual demand in kWh/m^2/yr (option 1) or peak load in W/m^2 (option 2)?

Proposed Caps

The proposed Thermal Performance Cap for heating and cooling will drive the design, specification and construction of thermally-efficient building envelopes in order to reduce energy use for heating and cooling and ensure IEQ requirements are met. This can reduce peak demand on the electricity grid and associated emissions[i]. As the Thermal Performance Cap tightens, designers will increasingly need to consider building orientation, efficient building form, effective shading, ventilation for cooling (cross-ventilation and night ventilation), sufficient insulation, efficient glazing, limiting air leakage, limiting thermal bridging, and efficient ventilation systems with high efficiency heat recovery in order to meet the caps.

In the previous consultation document, the proposed Thermal Performance Cap was for annual heating/cooling demand in kWh/m^2/yr. Further research[ii] has indicated there may be benefit setting the Thermal Performance Cap according to heating/cooling peak load in W/m^2 instead. We note that regardless of which metric is used for the Thermal Performance Cap, both will need to be calculated in order to establish compliance with the Building Services Cap and Electricity Use Cap, and to correctly size heating and cooling equipment.

In keeping with the guiding key principles set out above, the preference is for a single Thermal Performance Cap metric for simplicity and consistency. That is, either annual demand or peak load, not a metric for both/either. We have outlined our current thinking about some of the pros and cons of each approach below and seek feedback on most effective approach to achieve the Framework's objectives.

Option 1: Annual Demand (kWh/m^2/yr)

This is the total heating (or cooling) needed, per square meter, per year to maintain the indoor temperature range set in the IEQ parameters. It does not indicate how much heating or cooling output is needed for any specific point in time.

Pros:

- Directly relates to annual heating and cooling costs, therefore energy bills, and so can be readily understood by the sector and the general public.
- Reduced annual heating and cooling demand will reduce annual emissions from energy use.
- Reduced annual demand will reduce peak load on the national electricity grid (but not as much as using peak load as the metric) and therefore reduced emissions from electricity grid.

- More commonly referenced in other jurisdictions[7], voluntary standards/rating schemes[8] and in the industry[9].

Cons:

- Heating demand is significantly influenced by heat gains, particularly solar heat gains in small buildings. This can encourage designs with large glazing areas to maximise solar heat gain to compensate for greater heat losses in colder climates. This in turn risks increasing overheating frequency and cooling demand and may increase capital costs[10].
- Similarly, heating demand in small buildings is strongly influenced by building orientation for solar heat gain and by shading from surrounding buildings or topographical features. This can make it more difficult in shaded sites (e.g. urban locations).
- Not easy to estimate with simple calculations.

Proposed Thermal Performance Caps are included for context and comparison. These have not been finalised.

Thermal Performance approach 1: Annual Demand			
	Initial Cap	**Intermediate Cap**	**Final Cap**
Heating Demand (annual)	60	30	15
Cooling Demand[11] (annual)	60	30	15
kWh/m^2/yr			

Option 2: Peak Load (W/m^2)

This is the largest amount of heating (or cooling) needed, per square meter, at the coldest time or hottest time to maintain the indoor temperature range set in the IEQ parameters. It does not indicate how much heating and cooling is needed over a whole year (or any period of time). The peak load is often used as the basis for sizing heating and cooling systems and equipment.

Pros:

- Peak heating load is not significantly more difficult in colder climates because it is a point in time not accumulative across the whole year and is therefore likely to be more readily achievable across all NZ climates.

[7] For example, the majority or EU member states in accordance with the Energy Performance of Buildings Directive, the British Columbia Energy Step Code, City of Vancouver Building By-law.
[8] For example, NZGBC's Homestar rating tool and BRE Global's BREEAM rating tool reference annual demand, the international Passive House standard offers both annual demand and peak load options.
[9] Kāinga Ora – Homes and Communities (NZ state housing provider) are using Homestar or all new build projects and Passive House on some pilot projects. They also referencing the BfCC proposed Thermal Performance Cap as annual demand on some projects and presentations. For example: https://kaingaora.govt.nz/assets/Investors-Centre/investor_presentation_.pdf
[10] Windows cost more than walls and are lower thermal performance than walls so both gain and lose more heat.
[11] Dehumidification aspects of cooling demand have not been developed yet.

- It is the better metric for reducing peak load[12] on the national electricity grid which is dominated by residential heating and therefore reducing electricity grid emissions[iii] and reducing the need to build further electricity generation infrastructure.
- Peak heating load is driven largely by heat losses, particularly when there is little or no solar heat gain (e.g. overnight, cloudy periods, windows facing away from the sun or fully shaded). This encourages reduced glazing areas, thereby also reducing overheating frequency or cooling load and capital costs (see Annual Demand note).
- Peak cooling load is driven largely by excess solar heat gain. Reducing glazing areas to meet peak heating load also reduces peak cooling load or overheating frequency.
- Heat losses are not strongly determined by orientation or shading from surrounding buildings or topographical features and therefore suited to a broad range of locations including shaded sites and urban areas.
- It is relatively easy to estimate the peak heating load[13] with simple calculations and could be calculated by some professionals early in the design process, even before an energy modelling tool is used.

Cons:

- Most of the pro points apply to small buildings and are less relevant to large buildings.
- May result in higher annual heating or cooling demand, and therefore higher annual emissions, compared to using annual demand as the metric.
- May result in less glazing and therefore less daylight, or more costly higher thermal performance glass for designs with larger glazing.
- May encourage incorporating additional thermally massive elements to reduce temperature swings and therefore peak loads, which would have the perverse outcome of increasing embodied carbon.
- The level of detail used in the energy modelling (hourly/daily/monthly) may return different results.
- May require more detailed climate data and modelling to account for the weather conditions in different climate zones that determine the peak loads.
- Does not directly relate to heating and cooling costs, so may not be so readily understood by the general public.

Proposed Thermal Performance Caps are included for context and comparison. These have not been finalised.

Thermal Performance approach 2: Peak Load			
	Initial Cap	**Intermediate Cap**	**Final Cap**
Heating Load (peak)	30	20	10
Cooling Load (peak)	30	20	10
W/m^2			

[12] Although peak load on the electricity grid does not have a 1:1 relationship with emissions from the grid, as hydro is often used to meet peak load, there is still a close correlation. And as electricity demand in total grows, it is the peak load that determines how much new capacity is required. Reducing peak load on the grid reduces the amount of new infrastructure that needs to be built, with all the associated carbon emissions.

[13] Although this wouldn't typically account for factors such as internal heat gains, thermal mass and the time constant of the building which would be included in energy modelling.

Update since 2020 consultation

The proposal to include a Thermal Performance Cap received strong support during the 2020 consultation, and again during the Building Code consultation in 2021. Therefore, no further changes are proposed to the original methodology, other than clarification on whether the metric for the Thermal Performance Cap should be annual demand or peak load.

Consultation questions

Question no.	Question
1	*Should the Thermal Performance Cap for heating and cooling be measured by annual demand in kWh/m2/yr (option 1) or peak load in W/m2 (option 2)?* *Please tell us the reason for your choice and/or any supporting evidence on which you have based your answer.*

C) Indoor Environmental Quality (IEQ) parameters

Consultation Questions:

One of the objectives of the Transforming Operrational Efficiency Framework is to improve occupant health and wellbeing. Therefore it is important that the framework includes the right IEQ parameters and gets the settings correct..

Q1: Do you agree with the listed IEQ parameters being included?
Q2: Do you agree with each of the listed IEQ settings (or approach to settings)?
Q3: Are there any additional IEQ parameters that should be included?
Q4: Are ventilation rates a suitable proxy for CO_2 concentration, Relative Humidity (RH) and Indoor Air Quality (IAQ) alone or are other parameters or measures required?

Aim of the IEQ parameters

The proposed IEQ parameters are intended to ensure good occupant health and wellbeing outcomes while delivering the intended operational emissions reductions outcomes. They would also work as design parameters for the required energy modelling and calculations that is proposed.

As well as being used for the energy modelling/calculations, the parameters also need to be practically measurable in a regulatory context. For instance, CO_2 concentration and Relative Humidity (RH) are good proxies for Indoor Air Quality (IAQ) and can be measured relatively accurately and easily through building monitoring devices. Other pollutants such as Volatile organic compound (VOC) concentrations, for instance, are harder to measure accurately. However, for energy modelling/calculations, the ventilation rate (air movement into and out of a building, which transports heat with it) is the practical and measurable parameter. Ventilation is a strong determinant of CO_2 concentration, RH and therefore, IAQ, and it can also be verified in a building for compliance purposes.

Rationale for proposed IEQ parameters

It is proposed that the Framework apply current international standards and expectations for IEQ parameters that relate to energy efficient buildings. In many instances this will set higher performance standards for buildings than those achieved through current Building Code requirements. The primary standard referenced is BS EN 16798-1:2019[14]. This was developed in relation to the European "Energy Performance of Buildings Directive"[15] as a standard that describes health and comfort related performance criteria that should be used in the context of energy calculations and assessments for energy efficient buildings.

[14] BS EN 16798-1:2019 Energy performance of buildings. Ventilation for buildings. Indoor environmental input parameters for design and assessment of energy performance of buildings addressing indoor air quality, thermal environment, lighting and acoustics. Module M1-6
[15] Energy Performance of Buildings Directive 2010/31/EU (EPBD) and subsequent amendments

Proposed IEQ parameters

The below table sets out the proposed IEQ parameters and settings:

IEQ parameter	Setting	Notes
Air temperature - minimum	20°C	This is the heating set point for the energy modelling/ calculations[16] for comfort in accordance with BS EN 16798-1:2019 requirements for Category II[17] buildings where the temperature range in winter is to be 20-24/25°C Additional context: • ASHRAE 55:2017 Thermal Environmental Conditions for Human Occupancy considers 20-28°C[18] a comfortable temperature range. • The WHO minimum temperature of 18°C for health purposes is often cited but critically in the context of this methodology it does not relate to a set point used for the purposes of energy modelling or comfort. The recommendation is heavily caveated in the WHO report[19] and is not described as "comfortable." Additionally, the WHO notes 18°C is not sufficient for several groups of people and recommends a temperature 2-3°C warmer for elderly, children, sick people, and disabled persons.
Air temperature - maximum	25°C	This is the set point for modelling/ calculating overheating and cooling in accordance with BS EN 16798-1:2019 requirements for Category II buildings. We are proposing a minor departure in that BS EN 16798-1:2019 has a temperature range in *summer* of 23-26°C. As the Framework IEQ parameter is proposed to apply all year round, the winter maximum of 25°C from BS EN 16798-1:2019 is referenced We may allow this to be exceeded by a certain amount and/or for a portion of the time[20]. This may vary according to occupancy type and has yet to be determined. We are proposing that individual dwellings, apartments, office floors etc, that comprise a single thermal zone contained within a building, would need to comply individually. Therefore, Large Buildings may need additional simulations to demonstrate compliance.

[16] This is not proposed to be a requirement for maintenance of a internal temperatures. And it is distinct from regulated heating appliance provisions, for example, the Residential Tenancies (Healthy Homes Standards) Regulations 2019 which require that Landlords provide fixed heaters that can heat the main living room to a maintained temperature of at least 18 C. This relates to sizing the heating equipment in an often poorly insulated amd difficult to heat existing dwelling

[17] Category II is medium level thermal environment, I being high and III low

[18] Converted from 67-82°F given in the standard

[19] "..there is no demonstrable risk to the health of healthy sedentary people living in air temperatures of between 18°C and 24°C. The temperature range applies under conditions of appropriate clothing, insulation, humidity, radiant temperature, air movement and stable physiology." Health Impact of Low Indoor Temperatures, World Health Organisation, 1985.

[20] We may also need to consider if future climate conditions (i.e., a hotter climate) need to be accounted for.

Relative Humidity (RH)	40 – 60 %	The Relative Humidity (RH) is to be reflected in the energy modelling through the heating, cooling and ventilation settings. Ventilation rates particularly are intended to be set to maintain RH within the acceptable range. The comfort range for people is generally given as 40-60% RH, with the lower figure sometimes given as 30%. Aside from comfort, RH values exceeding 60% also increases condensation risk and the likelihood of microbial growth[21]. Recent research[22] also tends to indicate that a bottom limit of 40% offers good protection against viruses such as covid-19 rather than a lower RH. The design RH range may require exceptions for specific building uses. For example, in buildings where documents, taonga or special artefacts are stored or displayed.
CO_2 concentration	Upper Limit setting to be determined	The CO_2 concentration upper limit is to be reflected in ventilation settings used in the energy modelling. Ventilation rates are intended to be set to maintain CO_2 concentration below the upper limit rather than regulating the CO_2 concentration limit directly. Options being considered: • Option1: different CO_2 concentration requirements depending on the building type and occupancy as an elevation above outdoor CO_2 concentration per BS EN 16798-1:2019. This would use the average outdoor CO_2 concentration in NZ (or locations within NZ) • Option 2: an absolute upper limit setting for building type and occupancy.
Ventilation	Rates for balanced supply of outdoor air and extract of indoor air being developed.	Ventilation rates are to be used for modelling/ calculating thermal performance, and as set out above, to be a proxy for RH and CO_2 concentration and therefore Indoor Air Quality (fresh air and dilution/removal of pollutants). Ventilation rates are likely to be based on BS EN 16798-1:2019 method 3 predefined ventilation airflow rates, at least for small buildings, using Category II building rates. However, detailed analysis of the 3 methods described in BS EN 16798-1:2019 has not been undertaken yet and the other methods may also be available (e.g., for complex large buildings). While ample fresh air supply is important, we do not want to unintentionally reduce RH to detrimental levels with high ventilation rates. Air speed in ventilated spaces to be limited to 0.1 m/s to avoid discomfort (BS EN ISO 7730:2005)

[21] ANSI/ASHRAE 62.1-2019 Ventilation For Acceptable Indoor Air Quality https://ashrae.iwrapper.com/ASHRAE_PREVIEW_ONLY_STANDARDS/STD_62.1_2019

[22] An Overview on the Role of Relative Humidity in Airborne Transmission of SARS-CoV-2 in Indoor Environments https://aaqr.org/articles/aaqr-20-06-covid-0302

		Although not currently in this framework, CO_2 monitoring of completed buildings may also be implemented in some form[23] as part of the Building for Climate Change programme.
Temperature Factor (f_{Rsi})	Minimum values to be determined for each climate zone.	Construction details are to meet the minimum Temperature Factor for the climate zone and be demonstrated by following minimum requirements (e.g., insulation level, location of conductive materials, air/vapour control), using approved details or by specific modelling/calculations. The Temperature Factor is a dimensionless number that is a constant, construction-specific value that is independent of any temperature difference between indoor and outdoor climate. (i.e., it can be calculated without knowing the specific indoor or outdoor temperatures, which vary in practice and over time.) To be calculated in accordance with BS EN ISO 13788:2012. The minimum Temperature Factor requirement protects against areas of cooler internal surfaces caused by thermal bridging. Cooler surfaces can lead to condensation and the risk of mould growth. It also protects against localised discomfort[24] from convection draughts and lower radiant temperature.

Update since 2020 consultation

Feedback received during the previous consultation indicated support for including measures around daylight provision, acoustics and Indoor Air Quality (IAQ). While daylight and acoustics contribute to IEQ and play a role in occupant health and wellbeing, these factors do not interact with the other parameters in the same way and are addressed in the existing building regulatory system and may be updated where necessary. As such, they are not proposed to be included in the Framework. IAQ is proposed to be included, with ventilation rates as a practical and measurable proxy as described above.

[23] For example, a BfCC monitoring programme to provide a feedback loop and validation, or incentivisation for building owners to undertake monitoring, or support for independent research to be carried out

[24] Thermal comfort relates to the operative temperature which is a combination of the air temperature and mean radiant temperature of surfaces and air speed (draughts).

Consultation questions

Question no.	Question
	Bearing in mind the Framework objective of improving health and wellbeing outcomes for occupants -
1	*Do you agree with each of the listed IEQ parameters in the table below being included?* *Please tell us the reason for your choice and/or any supporting evidence on which you have based your answer.*
2	*Do you agree with each of the listed IEQ settings (or approach to settings) in the table below?* *Please tell us the reason for your choice and/or any supporting evidence on which you have based your answer.*

IEQ parameter	**Setting**	**Parameter – Agree/Disagree**	**Setting or approach – Agree/Disagree**
Air temperature – minimum	20°C		
Air temperature – maximum	25°C		
Relative Humidity (RH)	40 – 60 %		
CO_2 concentration	Upper Limit setting to be determined		
Ventilation	Rates for balanced supply of outdoor air and extract of indoor air being developed.		
Temperature Factor (f_{Rsi})	Minimum values to be determined for each climate zone.		

3	*Are there any additional IEQ parameters that should be included?*
4	*Are ventilation rates a suitable proxy for CO_2 concentration, Relative Humidity (RH) and Indoor Air Quality (IAQ) alone or are other parameters or measures required?*

SECTION 4: THANK YOU

Thank you for taking the time to provide valuable insights into the development of this methodology. MBIE and Building System Performance are committed to working proactively together to tackle the complex problem that climate change presents for the sector. If you have any other feedback, please do let us know.

REFERENCES

[i] Jack, M., Stephenson, J., Anderson, B., 2021, Decarbonising NZ's energy system through demand-side intervention, Submission to CCC Advice Consultation – 26 March 2021.
Jack, M., Mirfin, A., Ben Anderson, B., 2020, Quantifying the potential of ultra-efficient houses to reduce seasonal electricity demand and enable greater renewable supply, Otago

[ii] Note: the primary research on annual heating demand vs peak heating load is in the context of the international Passive House standard and houses (i.e., what are considered Small Buildings in this Framework). This is not because Passive House is being proposed, but because it is a science-based, voluntary standard with some similar metrics and with a considerable body of published research associated with it.

Grant, N., Clarke, A., Jarvis, A., 2021 Heating load as a design target revisited

Forde, J., Hopfe, C., McLeod R., Evins, R., 2019, Temporal optimization for affordable and resilient Passivhaus dwellings in the social housing sector, Building Energy Research Group, Loughborough University, UK

Bere, J., 2011, Cost effective solutions to social housing – comparing the differences between certification by annual heat demand and by peak load, Passive House Institute, Darmstadt

Bere, J., 2011, Cost effective solutions to social housing – comparing the differences between certification by annual heat demand and by peak load, Passive House Institute, Darmstadt

Bere, J., Godinho, S., Dina, D., Ridley, I., 2014, Building Performance Evaluation, Domestic Buildings Phase 2 – Final Report, Technology Strategy Board, UK.

[iii] Jack, M., Mirfin, A., Ben Anderson, B., 2020, Quantifying the potential of ultra-efficient houses to reduce seasonal electricity demand and enable greater renewable supply, Otago