BUILDING
PERFORMANCE

Operational Efficiency Assessment: Technical Methodology

Building for climate change programme

MINISTRY OF BUSINESS,
INNOVATION & EMPLOYMENT
HĪKINA WHAKATUTUKI

Te Kāwanatanga o Aotearoa
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Ministry of Business, Innovation and Employment (MBIE)

Hīkina Whakatutuki – Lifting to make successful

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Overview of this document

This document sets out a proposed methodology for assessing the operational efficiency of new buildings in Aotearoa New Zealand.

This technical methodology provides an approach:

- to assess a building's predicted operational efficiency using default values for Indoor Environmental Quality (IEQ) levels and modelled energy use
- to the IEQ parameters that are in scope, and where appropriate, suggest suitable limits or ranges for IEQ parameters for modelling purposes
- for calculations to carrying out an operational efficiency assessment.

This technical methodology does not:

- prescribe any requirements for new or existing buildings
- specify final technical settings for IEQ parameters
- monitor or set requirements for the way occupants actually use a building
- specify how a building's modelled performance must be verified
- prescribe requirements to ensure all building work results in buildings that are safe, healthy and durable.

Using this document

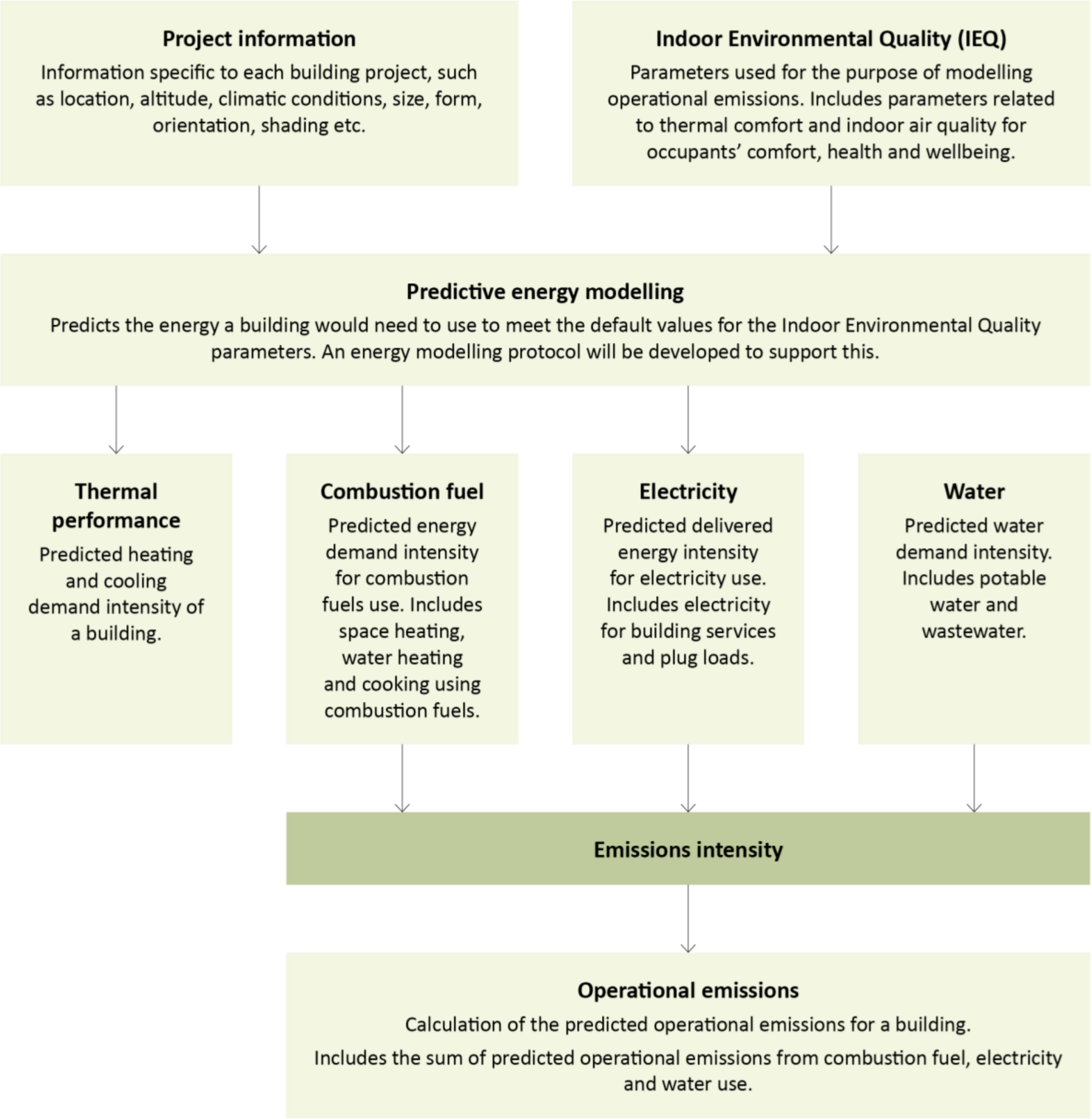
The main intended audience for the technical methodology is people carrying out operational efficiency assessments and those who may wish to carry out these assessments in the future. Over time, other resources and digital tools based on this technical methodology may be available for other building sector participants, such as homeowners.

Designers and modellers should be familiar with each aspect of this document if they are to use the technical methodology.

Building practitioners and building consent authorities whose work relates to operational efficiency assessments should familiarise themselves with:

- pages 4-5, for an overview of the technical methodology and the high-level calculations used
- pages 27-28, to understand proposed principles for reporting the results of assessments.

Figure 1: Technical methodology overview



Project information

Information specific to each building project, such as location, altitude, climatic conditions, size, form, orientation, shading etc.

Indoor Environmental Quality (IEQ)

Parameters used for the purpose of modelling operational emissions. Includes parameters related to thermal comfort and indoor air quality for occupants' comfort, health and wellbeing.

Predictive energy modelling

Predicts the energy a building would need to use to meet the default values for the Indoor Environmental Quality parameters. An energy modelling protocol will be developed to support this.

Thermal performance

Predicted heating and cooling demand intensity of a building.

Combustion fuel

Predicted energy demand intensity for combustion fuels use. Includes space heating, water heating and cooking using combustion fuels.

Electricity

Predicted delivered energy intensity for electricity use. Includes electricity for building services and plug loads.

Water

Predicted water demand intensity. Includes potable water and wastewater.

Emissions intensity

Operational emissions

Calculation of the predicted operational emissions for a building.

Includes the sum of predicted operational emissions from combustion fuel, electricity and water use.

Table 1: Calculating total predicted operational emissions intensity

Total operational emissions intensity	=	**Combustion fuel emissions intensity**	+	**Electricity emissions intensity**	+	**Water emissions intensity**

Combustion fuel emissions	=	**Combustion fuel emissions*** Annual emissions intensity (kgCO$_2$-e/m^2/yr)						
Annual emissions intensity (kgCO$_2$-e/m^2/yr)		**Space heating**	=	Annual space heating demand	÷	Combustion appliance efficiency	x	Fuel emissions factor
		Water heating	=	Annual water heating demand	÷	Combustion appliance efficiency	x	Fuel emissions factor
		Cooking	=	Annual cooking energy demand	÷	Combustion appliance efficiency	x	Fuel emissions factor

**Only applies if combustion fuels are intended to be used for space heating, water heating or cooking*

Electricity emissions	=	**Emissions factor** (kgCO$_2$-e/kWh)	x	**Electricity use**** Annual delivered intensity (kWh/m^2/yr)		
Annual emissions intensity (kgCO$_2$-e/m^2/yr)				**Building services**	=	Annual building services delivered intensity to be determined by energy modelling
				Plug loads	=	Annual plug loads delivered intensity to be determined by energy modelling

*** Including any electricity used for space heating, water heating or cooking*

Water emissions	=	**Emissions factor** (kgCO$_2$-e/m^3)	x	**Water use** Annual demand intensity (m^3/m^2/yr)		
Annual emissions intensity (kgCO$_2$-e/m^2/yr)				**Potable water**	=	Calculation to be determined
				Wastewater	=	Calculation to be determined

Definitions

Carbon dioxide equivalent (or CO_2-e): a measure of the global warming caused by all greenhouse gases released by a specific activity. In addition to Carbon Dioxide (CO_2), it includes the impacts of other greenhouse gases, which are typically less significant than the impact of CO_2 but are included for completeness.

Coefficient of Performance (COP): The coefficient of performance or COP of a heat pump, refrigerator or air conditioning system is a ratio of useful heating or cooling provided (to meet the heating/cooling demand) to the electricity input required (delivered energy.) Higher COPs equate to higher efficiency and lower energy consumption.

Delivered energy: the amount of energy modelled/calculated to be supplied to meet the demand that accounts for the efficiency of the appliances/fittings used. For electricity, typically this is the amount that passes through the meter at the building.

For example, if the heating demand is 15 kWh/m^2/yr and a heat pump with a COP of 2.5 is used, the delivered electricity will be 15/2.5= 6 kWh/m2/yr. If an electric panel or fan heater is used (COP of 1), the delivered electricity will be 15/1= 15 kWh/m^2/yr (i.e., the same as the demand).

Direct emissions: (Greenhouse Gas) emissions that come from sources that are within, on or directly connected to the building, typically from combustion fuels.

Greenhouse gases: gases that trap heat in the earth's atmosphere, contributing to global warming. The most prevalent ones are Carbon Dioxide (CO_2), Methane (CH_4), Nitrous Oxide (N_2O), and fluorinated gases (such as CFCs, HCFCs, HFCs etc. found in refrigerants).

Heating (or cooling) demand: the annual amount of heating (or cooling) energy (measured in kilowatt-hours, kWh) modelled/calculated to be required to maintain a building at a defined indoor temperature range and comfort level.

Heating (or cooling) load: the instantaneous amount of power (measured in watts, W) modelled/calculated to be required to maintain a building at a defined indoor temperature range and comfort level.

Indirect emissions: (Greenhouse Gas) emissions that come from the generation of purchased electricity and the treatment and transport of water that are used in the operation of the building. These emissions physically occur where electricity is generated, or the water is treated and pumped. But as the electricity and water is used in the operation of the building, the emissions are associated with the building.

Indoor environmental quality (IEQ): the quality of a building's indoor environment related to the health and wellbeing of the occupants. IEQ is determined by many factors, including air temperature, surface temperature air movement, CO_2 concentrations, humidity, daylight, acoustics etc.

Definitions (continued)

Infiltration: unintentional and uncontrolled air movement through the building envelope elements and junctions, distinct from intentional and controlled ventilation. Infiltration is also referred to as “airtightness” or “permeability”.

Intensity (emissions): a measure of emissions per square meter of usable floor area within a building per annum. Typically, in $kgCO_2$-e/m^2/yr.

Intensity (energy use): a measure of energy demand or use per square meter of usable floor area within a building per annum. Typically, in kWh/m^2/yr. Sometimes referred to as energy use intensity (EUI).

Large buildings: for the purpose of this document, “large buildings” refers to buildings other than housing that are 300 m^2 or larger.

Occupancy: the number of people and the periods of time that they use a building based on the building type at the time the assessment is undertaken. For some building types, default occupancy values will be provided by MBIE in the energy modelling protocol.

Operational emissions: carbon emissions attributable to the operation of buildings – essentially the use of energy (for heating, cooling, hot water, lighting, ventilation, appliances etc.) and water, that directly and indirectly cause emissions of greenhouse gases.

Operational efficiency: a measure of how much energy and water is modelled or calculated to be needed to operate a building to maintain a defined indoor environmental quality (temperature, air quality, etc).

Small buildings: for the purpose of this document “small buildings” refers to housing and buildings other than housing less than 300 m^2.

Temperature factor: a constant, construction-specific value, that is independent of the temperature difference between indoors and outdoors. It indicates the likelihood of low surface temperatures, condensation and mould risk at thermal bridging locations in the building envelope.

Useable floor area: this will be defined as part of the energy modelling protocol.

Background

Aotearoa New Zealand has committed to achieving net zero greenhouse gas emissions, excluding biogenic methane, by 2050.

Government's approach to begin reducing emissions in the building and construction sector has been laid out in the first Emissions Reduction Plan, released in May 2022.

The Building for Climate Change programme has been established to reduce emissions from the building and construction sector and to prepare our buildings for the ongoing effects of climate change, such as rising temperatures and increased rainfall.

By 2050, the Building for Climate Change programme is aiming for Aotearoa New Zealand's building-related emissions to be near zero while providing healthy places to work and live for present and future generations, and for our homes and buildings are resilient to the impacts of climate change and meet people's social and cultural needs.

Introducing regulatory requirements for buildings' operational efficiency may be a key part of the approach. The programme sets a strategic direction that encourages transformational change:

> *To meet Aotearoa New Zealand's climate change goals, we will be setting bold targets. Incremental change is not enough to get Aotearoa New Zealand where it needs to be. Strong action may be unsettling, but we need to drive the innovation and action New Zealanders expect to see from the Sector. The targets will focus on delivering ambitious improvements to operational efficiency as well as significantly reducing material and construction emissions*[1].

This technical methodology is one of the resources that MBIE is providing to ensure the building sector has the information required to manage and minimise climate risk of new and existing buildings.

A technical methodology for assessing the operational efficiency of buildings

In August 2020, MBIE consulted on two high-level frameworks to provide a pathway to meeting the above climate change goals in the building and construction sector. These frameworks related to the following areas:

- Transforming the operational efficiency of buildings.
- Reducing the whole-of-life embodied carbon emissions for buildings.

During consultation, the sector requested a better understanding of the technical methodology that would underpin the frameworks. MBIE has prepared this document to provide a technical methodology for assessing the operational efficiency of our buildings.

This document aims to set out what we mean by operational efficiency and how this is intended to be calculated. It is intended to be read in conjunction with other key documents that set out how the frameworks can be used to meet climate change goals for the building and construction sector, in particular:

- The **strategic direction** of the programme is set out in the following document:
    - *Building for Climate Change: Transforming the Building and Construction Sector to reduce emissions and improve climate resilience* (July 2020)

- The **high-level frameworks** that signalled the Building for Climate Change programme intentions for reducing building-related emissions are:
    - *Transforming Operational Efficiency* (August 2020)
    - *Whole-of-Life Embodied Carbon Emissions Reduction* (August 2020)

- The **technical methodologies** that set out methods for assessing buildings to help achieve the aims of the high-level frameworks are:
    - *Whole-of-Life Embodied Carbon Assessment: Technical Methodology* (April 2022)

Purpose of this document

This document is intended to:

- set out a technical methodology for assessing the operational efficiency of new buildings in Aotearoa New Zealand
- support any future consultation on regulatory proposals to implement the Transforming Operational Efficiency framework, by proposing what operational efficiency calculations are intended to look like
- introduce the concept of operational efficiency assessments to those not familiar with them
- enable early adopters to use a consistent technical methodology before regulatory requirements are developed.

Status of this document

This document represents MBIE's thinking to date on what is intended to form the basis of a technical methodology to assess the operational efficiency of buildings. This is intended to support consultation with the sector on future regulatory changes, which could include requirements to report and then meet caps on the operational efficiency of buildings in Aotearoa New Zealand. These potential changes would represent a transformation of the current regulatory approach and will be developed in consultation with the sector and the public.

This technical methodology will be subject to change as regulatory proposals related to the operational efficiency of buildings are developed and consulted on.

In 2021, MBIE consulted with a targeted group of technical experts in Aotearoa New Zealand and abroad on aspects of the operational efficiency technical methodology. Feedback from experts on the technical methodology provided strong direction on the approach the technical methodology should take and has been incorporated into this document.

Objectives and principles

The primary objective of this document is to establish a consistent method of assessing the operational efficiency of new buildings in Aotearoa New Zealand. It has the ultimate aim of significantly improving operational efficiency and occupant health and well-being outcomes while significantly reducing operational emissions of new buildings in Aotearoa New Zealand.

Table 2: The four key principles that have guided the formation of the technical methodology

CONSISTENT Using the technical methodology provides consistent assessments of operational efficiency, so results 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.
ACCESSIBLE AND UNDERSTANDABLE Assessments are simple and clear to understand by users across all areas of the sector, supporting carbon literacy.	**OUTCOME-DRIVEN** Results of assessments lead to more operationally efficient buildings with reduced operational emissions, improved indoor environment quality and improved occupant health and wellbeing outcomes.

Intended stages of the building process

This technical methodology is intended to be used at any stage of the design and construction process for a new building.

Operational efficiency assessments have the biggest impact on operational emissions and indoor environmental quality outcomes when undertaken in the early design and concept stages. Design choices made at this stage can lock-in many aspects of building performance for the lifetime of the building, unless substantial upgrades (which are likely to be more costly and may be more carbon intensive) are undertaken later. For instance, at the design stage it is much easier to make changes to insulation levels to reduce heating demand than it is during construction when many other parameters are already fixed. Other aspects like orientation are impossible to change once a building is complete.

While this technical methodology is primarily intended to be used at the design stage, it can also be used at other stages of the building life cycle (e.g., during operation by using actual monitored energy use data rather than predictive energy modelling). For example, this could help to assess and establish ways to improve the operational efficiency of a building to support decisions on potential alterations.

The Building for Climate Change programme intends to require energy performance ratings during the use stage of large commercial, public, industrial and multi-unit residential buildings[1]. Further work on energy performance ratings will address how they relate to the operational efficiency technical methodology.

Building type and size

This technical methodology is intended to apply to any building, or part of a building, that has a thermal envelope (insulated walls, floor, roof, windows and doors) and uses energy to maintain indoor environmental quality for human occupancy, regardless of building type, classification, or size. The technical methodology is intended to provide a level of consistency regardless of which modelling tool is used.

A separate technical methodology may also be developed for the operational efficiency of buildings, or parts of buildings, that do not have a thermal envelope.

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[1] Minister of Building and Construction (December 2022). *Building Act changes put the environment at the heart of how we build* [Press release]. https://www.beehive.govt.nz/release/building-act-changes-put-environment-heart-how-we-build

Operational efficiency technical methodology

Overview

The proposed technical methodology uses the results of predictive energy modelling to assess the predicted operational efficiency of a building.

Energy modelling predicts the energy use and thermal performance of a building using:

- information specific to each project, such as building size and site-specific climate information
- Indoor Environmental Quality (IEQ) parameters, such as air temperature, ventilation rates and humidity. The technical methodology sets default values for some of these parameters, used for the purpose of energy modelling.

Based on this modelling, the building's operational emissions intensity is then calculated for energy from combustion fuels and electricity and water demand. Calculating the operational emissions from the energy and water needed to operate a building to maintain a defined indoor environmental quality gives the building's predicted operational efficiency.

Finally, the technical methodology sets out a proposed format for reporting the results of the operational efficiency assessments.

The technical methodology is described in more detail below.

Project information

Information specific to each building project will be required in order to model the thermal performance and energy use figures for the project. For example:

- building size
- location
- climate
- geometry
- building orientation
- thermal envelope specification
- building services specifications

The proposed energy modelling protocol will set out the required project information in more detail.

Indoor environmental quality

Indoor Environmental Quality (IEQ) at a glance

The indoor environmental quality (IEQ) section of the technical methodology sets out default values for parameters used for the purpose of modelling operational emissions. The parameters relate to achieving intended comfort, health and wellbeing outcomes for occupants in the following areas:

- **Thermal comfort:** air temperatures; temperature factor; infiltration; relative humidity
- **Indoor Air Quality:** ventilation rates; CO_2 concentration

Indoor Environmental Quality (IEQ) parameters will help demonstrate whether the building is predicted to be capable of achieving the intended comfort, health and wellbeing outcomes for occupants, in conjunction with improved operational efficiency.

The parameters have been selected to be both useful for energy modelling and practically able to be measured, including during and after construction if desired.

Using an IEQ parameter in practice – ventilation rate example

Ventilation rate is the main parameter used in this technical methodology to determine indoor air quality. Ventilation rate refers to air movement into and out of a building to provide fresh air for the occupants, which also happens to transport heat with it.

This technical methodology will, when finalised, specify the ventilation rate that should be used as a default for the purpose of modelling a building's operation to achieve the intended comfort, health and wellbeing outcomes. Energy modelling will take into account the specified ventilation rate when calculating the building's predicted energy efficiency. Predicted emissions can then be calculated based on this. The ventilation rate could be verified in the completed building if required.

The technical methodology uses current international standards and expectations for IEQ parameters that relate to energy efficient buildings where relevant. The primary standard referenced is Building Standard *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*. This was developed in relation to the European "Energy Performance of Buildings Directive" 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.

EN 16798-1:2019 – Energy performance of buildings contains categories for the level of indoor environmental quality expected:

- Category IEQ I is a building with a high level of indoor environment quality expected. This would tend to be selected for occupants with special needs (children, elderly, persons with disabilities etc.)
- Category IEQ II is a typical building with a medium level of indoor environmental quality expected. This would tend to be selected for most building occupants.

The following IEQ parameters are in scope for this technical methodology. In practice, there is some overlap between these categories (for example, relative humidity contributes to both thermal comfort and indoor air quality).

- Thermal Comfort: air temperatures, temperature factor, infiltration, and relative humidity
- Indoor Air Quality: ventilation rates, CO_2 concentration.

IEQ parameters not in scope for this technical methodology:

- Daylight
- Acoustic comfort.

The technical methodology is based on typical buildings occupied by people and, as such, somewhat generalised. Settings specific to some building types may be provided in the energy modelling protocol. There may also be exceptions for buildings with specialist IEQ requirements such as museum buildings, hospitals and swimming pools.

INDOOR ENVIRONMENTAL QUALITY – THERMAL COMFORT

The typical measure of thermal comfort is the operative temperature, which includes ambient air temperature, radiant temperature of surfaces, and draughts[2]. The technical methodology approaches this by setting default values for the purpose of modelling for the following elements:

- minimum air temperature
- maximum air temperature
- a temperature factor requirement which determines minimum performance requirements for some radiant surface temperatures
- infiltration limits
- a relative humidity acceptable range.

Other aspects of indoor environmental quality, such as ventilation rates, also contribute to thermal comfort outcomes. Ventilation rates are discussed in more detail under the indoor air quality section of this technical methodology.

Air Temperature – minimum: 20°C

Setting a minimum air temperature for the purpose of modelling will enable modelling to predict a building's ability to maintain a thermally comfortable indoor environment while also meeting any minimum energy efficiency requirements.

It is intended that the minimum air temperature used as a modelling input in this technical methodology will be based on maintaining comfort levels, rather than solely aiming to achieve health outcomes.

The technical methodology therefore sets a minimum air temperature of 20°C. This temperature is consistent with the minimum temperatures for comfort recommended by BRANZ (20-25°C)[3], ASHRAE (20-28°C)[4] and *EN 16798-1:2019 – Energy performance of buildings*.

This minimum temperature for comfort (20°C) differs from the World Health Organisation's recommend minimum temperature for health (18°C), which is currently used in the Residential Tenancies (Healthy Homes Standards) Regulations 2019.

The minimum air temperature of 20°C for comfort will be used for Category II buildings (typical buildings) as defined in *EN 16798-1:2019 – Energy performance of buildings.* Buildings in a different category may require a different minimum air temperature for modelling purposes.

Air Temperature – maximum: 25°C

The technical methodology sets a maximum air temperature of 25°C for modelling purposes. This is the overheating threshold and the cooling set point to be used for modelling/calculating cooling, in accordance with the winter maximum temperature requirements in *EN 16798-1:2019 – Energy performance of buildings*.

The maximum air temperature is intended to be used for modelling individual dwellings, apartments or office floors contained within a single building. Large buildings may need additional modelling to account for greater complexity in calculating overheating.

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[2] Designing Buildings (March 2023). *Operative temperature*. https://www.designingbuildings.co.uk/wiki/Operative_temperature

[3] BRANZ (2010) *SR221 Energy use in New Zealand households - final HEEP report*. https://www.branz.co.nz/pubs/research-reports/sr221/

[4] ASHRAE 55:2017 Thermal Environmental Conditions for Human Occupancy considers 20-28°C (67-82°F) comfortable.

ASHRAE (July 2020). *ANSI/ASHRAE Addendum d to ANSI/ASHRAE Standard 55-2017, Thermal Environmental Conditions for Human Occupancy*. https://www.ashrae.org/file%20library/technical%20resources/standards%20and%20guidelines/standards%20addenda/55_2017_d_20200731.pdf

There are two approaches to the maximum air temperature:

- Overheating: where active cooling is not included, 25°C is the overheating threshold. Any period of time above this is considered as overheating. There will be an allowable overheating frequency, dependent on the building type and occupancy.
- Cooling: where mechanical cooling is included, this means that buildings will need to be designed and constructed to be capable of maintaining a maximum indoor air temperature of 25°C at all times with an annual cooling demand that does not exceed any thermal performance requirements.

While both approaches are presented neutrally in this technical methodology, residential buildings that are designed to have a low frequency of overheating would avoid the need for mechanical cooling and may therefore lead to improved operational efficiency outcomes.

The maximum air temperature of 25°C will be used for *EN 16798-1:2019 – Energy performance of buildings* Category II buildings (typical buildings). Buildings in a different category may require a different maximum air temperature for modelling purposes.

Temperature factor (fRsi) – minimums to be set

The temperature factor is a constant, construction-specific value, that is independent of the temperature difference between indoors and outdoors. It indicates the likelihood of low surface temperatures, condensation and mould risk at thermal bridging locations in the building envelope (for example, where a floor and external wall meet).

Maintaining internal surface temperatures that are close to the internal air temperature is important for occupant comfort (operative temperature). It provides protection against condensation risk and mould, which is important for health and wellbeing outcomes, and can also improve construction durability.

Acceptable fRsi values ensure comfort and mould risk are addressed, but are not an input for energy modelling. Thermal bridge details may also need to have the heat loss assessed or modelled to provide inputs for energy modelling (such as the PSI-value of linear thermal bridges.)

A minimum temperature factor will be set for each climate zone. In the meantime, fRsi settings that are already used in the sector, such as Passive House or New Zealand Green Building Council settings, may be considered.

The temperature factor for modelling purposes is to be calculated in accordance with *ISO 13788:2012 Hygrothermal performance of building components and building elements — Internal surface temperature to avoid critical surface humidity and interstitial condensation — Calculation methods*.

Infiltration – limits to be set

Infiltration is unintentional and uncontrolled air movement through the building envelope elements and junctions, distinct from intentional and controlled ventilation. Infiltration is also referred to as “airtightness” or “permeability”.

Minimising uncontrolled draughts that impact on IEQ is important for occupant comfort (operative temperature) and health and wellbeing outcomes. In addition to causing discomfort, uncontrolled air leakage (draughts) through the building envelope carries heat and moisture which increases condensation and mould risk. Infiltration can also cause heat loss that reduces operational efficiency.

Infiltration limits will be a necessary input for energy modelling/calculations to assess the thermal performance of a building. The infiltration limit will be set in air leakage volume (m^3) per hour, per building envelope area (m^2) measured at 50 pascals (averaged pressurisation and depressurisation) in accordance with *AS/NZS ISO 9972:2015 Thermal performance of buildings – Determination of air permeability of buildings – Fan pressurization method*, or a modified method based on this standard.

Relative Humidity (RH) – acceptable range

Relative humidity measures water vapor in the air, relative to the air temperature. Indoor relative humidity is important for comfort, health and wellbeing. The comfort and health range for people is generally considered to be 40 – 60 per cent or sometimes 30 – 70 per cent.

Ventilation rates will be set as a proxy for relative humidity. That is, for a building that has the correct air temperature range and ventilation rates, it can be assumed that the indoor air will be in the comfortable range of relative humidity for the majority of the time.

Absolute humidity also measures water vapor in the air, but is not relative to the air temperature. For the purposes of energy modelling following this technical methodology, the maximum level for absolute humidity is 12 g/kg the majority of the time. This is equivalent to 70 per cent relative humidity at 20°C and 50 per cent relative humidity at 25°C.

In terms of health and wellbeing:

- when relative humidity is above 55 per cent asthma and other respiratory diseases (like pneumonia or the flu) get worse
- when relative humidity is below 45 per cent people may get dry or itchy skin and conditions like eczema get worse.[5]
- when relative humidity is higher than 60 per cent there is an increased condensation risk and higher than 65 per cent can increase the likelihood of microbial growth[6]
- a lower relative humidity limit of 40 per cent offers better protection against viruses such as COVID-19 than 30 per cent does[7].

The maritime climate in many parts of Aotearoa New Zealand results in a reasonably high outdoor relative humidity a lot of the time. Therefore, it is expected that indoor relative humidity will sometimes be higher than 60 per cent, unless indoor relative humidity is actively controlled.

However, as buildings move to well-controlled building envelopes with effective ventilation, frequent active humidification or dehumidification of internal air is not expected to be necessary in most buildings to achieve a comfortable relative humidity range.

Some specific building types may require different relative humidity settings, for example, where documents or taonga are stored or displayed.

INDOOR ENVIRONMENTAL QUALITY – INDOOR AIR QUALITY

Indoor air quality is an important part of IEQ and ensuring occupant comfort and good health and wellbeing outcomes. Ventilation, the critical factor for indoor air quality, also has a significant impact on operational efficiency as it impacts on the annual heating and cooling demand and building services energy use. As such, it is an important parameter for energy modelling/calculations for operational efficiency.

While there are many factors that could be included in indoor air quality, the scope of this technical methodology is limited to ventilation rates, CO_2 concentration, and relative humidity. The technical methodology uses ventilation rates as a proxy to address all of these.

Ventilation rates – requirements to be set

Ventilation rates will be set in accordance with Building Standard *EN 16798-1:2019 – Energy performance of buildings* requirements for Category II buildings in general, to be used for modelling/calculating thermal performance. The specific rates that apply to building types and occupancies will be developed as part of future work.

Ventilation rates are a critical input for predicting indoor air quality and to calculate the heat loss and gain from air exchange between inside and outside when modelling/calculating thermal performance and building services energy use.

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[5] NIWA. *Air Aware - Good Indoor Air Quality Guide* https://niwa.co.nz/sites/niwa.co.nz/files/Air%20Aware%20Good%20Indoor%20Air%20Quality%20Guide.pdf

[6] ASHRAE (2019). *ANSI/ASHRAE Standard 62.1-2019, Ventilation and Acceptable Indoor Air Quality*.

[7] For example: Coronavirus SARS-CoV-2 spreads more indoors at low humidity.

Ajit Ahlawat, Alfred Wiedensohler, Sumit Kumar Mishra (2020). An Overview on the Role of Relative Humidity in Airborne Transmission of SARS-CoV-2 in Indoor Environments. Aerosol and Air Quality Research. https://doi.org/10.4209/aaqr.2020.06.0302

Ventilation could be provided by windows ('natural ventilation'), continuous mechanical extract ventilation (with dedicated provisions for make-up air) or balanced mechanical ventilation with heat recovery. Modelling is to be based on providing 100 per cent fresh air ventilation, without relying on recirculation (although recirculation may be used for other purposes such as heating and cooling).

Ventilation rates will be set at a level that takes into account relative humidity and occupant comfort levels.

- **Relative humidity.** High ventilation rates can remove too much internal moisture, reducing relative humidity too low, particularly in cooler climates. Ventilation rates will not be set too high so as to conflict with relative humidity requirements.
- **Air speed.** High air speed in habitable spaces, including from excessive ventilation rates, can cause discomfort. For the purposes of energy modelling following this technical methodology, the maximum air speed is 0.1 metres per second in accordance with *ISO 7730:2005 – Ergonomics of the Thermal Environment*.

CO_2 concentration – upper limit

The intention of the technical methodology is to maintain indoor CO_2 concentration below 1200 parts per million (ppm) the majority of the time.

EN 16798-1:2019 – Energy performance of buildings has a default requirement for Category II buildings of 800 ppm above outdoor CO_2 concentration, which is currently 400-420 ppm. However, the settings for this may vary depending on the building type and occupancy. For example, for schools, the settings may need to consider the interaction between this technical methodology and the CO_2 concentration requirements in the Ministry of Education's Indoor Air Quality and Thermal Comfort guidelines.

As noted in the previously, ventilation rates will be set as a proxy for CO_2 concentration. That is, for a building that has the correct air temperature range and ventilation rates modelled, it can be assumed that the predicted indoor CO_2 concentration will be maintained below the limit for the majority of the time.

Indoor CO_2 concentration has an impact on comfort, health and wellbeing. CO_2 concentration levels around 1500 ppm can cause discomfort and above this limit can start to have health impacts such as headaches or tiredness. Even higher levels[8] can cause dizziness, sleepiness or even trigger attacks for people with asthma.

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[8] Worksafe Workplace Exposure Standards limit CO_2 concentration time weighted average exposure to 5000 ppm.

Worksafe (June 2022). *Workplace exposure standards and biological exposure indices*. https://www.worksafe.govt.nz/topic-and-industry/monitoring/exposure-standards-and-biological-exposure-indices/

Predictive modelling

Assessing the operational efficiency of a building will require predicting the building's thermal performance and expected energy use. This technical methodology uses predictive modelling to achieve this. The results of this modelling will be used to assess the predicted operational emissions of buildings using the calculations in this technical methodology.

The predictive modelling will be carried out in accordance with an energy modelling protocol which is needed to fully describe the modelling settings to be used for consistency. MBIE intends to develop this modelling protocol in consultation with technical experts in the sector

Thermal performance assessments

Calculating thermal performance at a glance

The thermal performance assessments section of the technical methodology sets out an approach to calculating the predicted thermal performance of a building in terms of annual heating and cooling demand. The predicted thermal performance of a building is calculated by taking into account predicted heat gains and heat losses for the building.

- **Heat gains:** sun; internal sources
- **Heat losses:** thermal envelope, thermal bridging, ventilation, air leakage

CALCULATING THERMAL PERFORMANCE

Purpose and scope

Space heating and cooling, which are largely determined by the thermal performance of a building, account for around a third of household and commercial office energy use[9].

The purpose of predicting thermal performance is to drive the design, specification and construction of thermally efficient buildings in order to reduce energy use for heating and cooling and ensure indoor environmental quality requirements are met. This can also reduce peak demand on the electricity grid, the emissions associated with meeting peak demand with non-renewable energy[10] and the need for additional electricity infrastructure.

Good thermal performance means less energy is needed to maintain the required indoor environmental qualities, promoting good occupant health and wellbeing outcomes regardless of their financial means.

To improve thermal performance, designers will increasingly need to holistically consider building orientation, efficient building form, effective shading, sufficient insulation, efficient glazing, passive cooling measures, limiting infiltration, limiting thermal bridging and efficient ventilation systems with high efficiency heat recovery. Energy modelling will play a critical role in the design process.

The following elements are included in the scope of calculating/modelling the predicted annual heating demand and cooling demand in order to meet any thermal performance requirements:

- Project information
    - location, altitude and climatic conditions
    - building form, orientation, and shading
- Heat gains from
    - the sun
    - internal sources (people, equipment, appliances etc)
- Heat losses from
    - the thermal envelope including floor, walls, roof, windows, doors etc.
    - thermal bridging
    - ventilation
    - uncontrolled air leakage

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[9] BRANZ (2010) *SR221 Energy use in New Zealand households - final Household Energy End-use Project (HEEP) report.* https://www.branz.co.nz/pubs/research-reports/sr221/

BRANZ (2014) *SR297/1 Building Energy End-use Study (BEES)*. https://www.branz.co.nz/environment-zero-carbon-research/bees/publications-and-presentations/

[10] Jack, M., Mirfin, A., Anderson, B. (November 2021). *The role of highly energy-efficient dwellings in enabling 100% renewable electricity*, Energy Policy Volume 158. https://doi.org/10.1016/j.enpol.2021.112565

As building energy efficiency improves, the energy modelling for thermal performance becomes more sensitive to the accuracy of the climate data. The climate varies significantly across Aotearoa New Zealand, sometimes even within relatively close geographic proximity. The energy modelling will use climate data and modelling files for 18 climates zones (19 including the Chatham Islands) that were developed by NIWA[11]. Climate files for the predicted future climate are currently being developed by NIWA. Future work will consider how these can be utilised, so buildings are designed to be resilient to the changing climate.

Calculation approach

Predicting the annual heating and cooling demand is a complex calculation to account for the building design, specification, location, and climate, and will be determined by energy modelling.

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[11] Liley, B., Shiona, H., Sturman, J., Wratt, D. (2008). Typical Meteorological Years for the New Zealand Home Energy Rating Scheme. Prepared for the Energy Efficiency and Conservation Authority. NIWA Client Report: LAU2008-01-JBL. NIWA, Omakau, New Zealand.

Operational emissions assessments

Calculating operational emissions at a glance

The operational emissions assessments section of the technical methodology sets out an approach to calculating the predicted operational emissions for a building from different emissions sources. Total operational emissions are calculated by adding together the predicted emissions from combustion fuel, electricity and water use.

- **Combustion fuel:** space heating; water heating; and cooking (only energy use from combustion fuel sources)
- **Electricity:** building services that use electricity as an energy source; plug loads
- **Water:** potable water; wastewater

Purpose and scope

Assessing a building's predicted direct and indirect operational emissions enables people using the technical methodology to understand and reduce them.

Operational emissions in scope of this technical methodology includes emissions from:

- **Combustion fuel:** space heating; water heating; and cooking that use combustion fuel as an energy source
- **Electricity:** building services using electricity as an energy source; plug loads
- **Water:** potable water; wastewater

Emissions factors

Electricity and water emissions are indirect and therefore the electricity and water use figures must be multiplied by an emissions factor to be converted to CO_2-e emissions. The emissions factor is a measure of how many kg of CO_2-e are emitted for every kilowatt hour (kWh) of energy used and cubic meter (m^3) of water used.

The electricity emissions factor will account for grid average generation emissions and transmission and distribution loss emissions. It may also account for the whole of life emissions associated with the electricity grid.

The water emissions factor will account for both potable water supply and wastewater removal and treatment.

Possible sources for emissions factors include:

- Ministry for the Environment emissions factor tables that cover fossil fuels, electricity and water
- Building Research Association of New Zealand (BRANZ) electricity emissions factors for Life Cycle Assessments of buildings[12]. BRANZ factors are based on MBIE future electricity demand and generation scenarios[13] and other sources and account for the lifecycle impact of the electricity grid. They are arguably more representative of the true emissions of electricity use. Factors from the "Environmental" scenario from the Consequential Model is recommended by BRANZ for Life Cycle Assessment purposes.

Emissions factors for energy and water emissions may change over time. For example, as less fossil fuel or geothermal energy is used to power the national electricity grid, the electricity emissions factor can be expected to reduce.

Combustion fuels also have emissions factors. However, as the emissions are direct from the combustion, the emissions factors relate to the fuel type and are not expected to change over time.

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[12] BRANZ (December 2021). *New Zealand grid environmental factors (module B6)*. https://www.branz.co.nz/environment-zero-carbon-research/framework/data/

[13] MBIE (July 2019). *Electricity Demand and Generation Scenarios (EDGS)*. https://www.mbie.govt.nz/building-and-energy/energy-and-natural-resources/energy-statistics-and-modelling/energy-modelling/electricity-demand-and-generation-scenarios/

Future work

MBIE will determine which emissions factors are to be used. Once the Framework is implemented, MBIE may update these periodically. This could be through the New Zealand Building Code update process, when any Framework caps change or when otherwise determined by MBIE. Emissions factors for fully off-grid buildings will also be considered.

Reference area for calculations

To support comparisons between buildings, emissions are calculated per square metre.

When determining the area of a building for the purposes of calculating emissions, the reference area to be used is the useable floor area of the building.

Calculation approach

Operational emissions are calculated by adding up the total emissions from combustion fuel use, electricity use and water use. Table 7 below provides an overview of how these components are calculated. These components are set out in more detail in the calculating operational emissions section.

Table 3: Calculating total operational emissions intensity

Total operational emissions	=	Combustion fuel emissions	+	Electricity emissions	+	Water emissions
Annual emissions intensity ($kgCO_2$-e/m^2/yr)		Annual emissions intensity ($kgCO_2$-e/m^2/yr)		Annual emissions intensity ($kgCO_2$-e/m^2/yr)		Annual emissions intensity ($kgCO_2$-e/m^2/yr)

CALCULATING OPERATIONAL EMISSIONS – COMBUSTION FUEL

Purpose and scope

The purpose of this component is to assess emissions from the combustion of all fossil fuels (including coal and reticulated/piped and bottled fossil gas) and combustion of biomass (including wood and liquid biofuels) for the operation of buildings.

The combustion fuel component is made up of three sub-components: space heating, water heating and cooking. The total combustion fuel emissions are calculated by adding these three sub-components together.

Only emissions from the combustion of fossil fuels are included in the combustion fuel component. The emissions from any space heating, water heating or cooking that use electricity as an energy source are included in the calculations for the electricity component (under building services).

Combustion fuel uses for other purposes (e.g., industrial processes which may take place within buildings) are outside the scope of this technical methodology as they do not directly relate to the operation of buildings.

The CO_2 emitted from the combustion of biomass (including biofuels) is biogenic, meaning it equates to the CO_2 absorbed by the feedstock during its lifespan. This means the CO_2 portion of the combustion emissions of biomass is considered as carbon neutral. However, there are also Methane (CH_4) and Nitrous oxide (N_2O) emissions from the combustion that need to be accounted for as CO_2-equivalent emissions[14].

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[14] Ministry for the Environment (August 2022). *Measuring emissions: A guide for organisations: 2022 detailed guide*. https://environment.govt.nz/publications/measuring-emissions-a-guide-for-organisations-2022-detailed-guide/

Calculation approach

The formulae below are how the operational emissions from the component parts of combustion fuels are to be calculated.

Annual space and water heating demand intensity will be determined by energy modelling.

Annual cooking energy demand intensity will be calculated using settings based on building type, size and occupancy.

Table 4: Total predicted combustion fuel emissions intensity

Total Annual Emissions Intensity	=	**Space heating emissions**	+	**Water heating emissions**	+	**Cooking emissions**
(kgCO$_2$-e/m^2/yr)		(kgCO$_2$-e/m^2/yr)		(kgCO$_2$-e/m^2/yr)		(kgCO$_2$-e/m^2/yr)

Table 5: Predicted space heating emissions intensity

Annual Emissions Intensity	=	**Annual space heating demand intensity**	÷	**Combustion appliance efficiency**	x	**Fuel Emissions factor**
(kgCO$_2$-e/m^2/yr)		(kWh/m^2/yr)		%		(kgCO$_2$-e/kWh)

Table 6: Predicted water heating emissions intensity

Annual Emissions Intensity	=	**Annual water heating demand intensity**	÷	**Combustion appliance efficiency**	x	**Fuel Emissions factor**
(kgCO$_2$-e/m^2/yr)		(kWh/m^2/yr)		%		(kgCO$_2$-e/kWh)

Table 7: Predicted cooking emissions intensity

Annual Emissions Intensity	=	**Annual cooking energy demand intensity**	÷	**Combustion appliance efficiency**	x	**Fuel Emissions factor**
(kgCO$_2$-e/m^2/yr)		(kWh/m^2/yr)		%		(kgCO$_2$-e/kWh)

CALCULATING OPERATIONAL EMISSIONS – ELECTRICITY

Electricity – Overview

Purpose and scope

The purpose of this component is to calculate the predicted electricity used in buildings. Any regulatory requirements related to limiting emissions will aim to reduce the indirect operational emissions associated with electricity generation and distribution.

The electricity component is made up of two sub-components: electricity predicted to be used for building services and electricity predicted to be used for plug-loads. The total predicted electricity use is calculated by adding these two sub-components together.

Renewable electricity generation

At this stage, it is not intended that on-site renewable energy generation can be used to ‘offset’ greater energy demand from less efficient building designs. This is intended to support the design of energy efficient buildings that can maintain a healthy and comfortable indoor environment without using large amounts of energy, regardless of the source of that energy. Therefore, for the purpose of calculating emissions in this technical methodology, on-site renewable electricity generation is treated the same as electricity supplied from the grid.

There are a number of complexities that would be needed to be worked through to account for lower emissions from on-site renewable energy generation. This includes determining the percentage of self-consumption of energy from on-site renewable sources, which may change depending on the supply of wind or sunlight at different times of the day or year, or on-site battery capacity to store renewable energy. It also includes establishing lifecycle emission factors for electricity generated by on-site renewable technologies.

As a starting point, and to encourage assessments without introducing these complexities, this technical methodology does not use a separate emissions factor for on-site renewable energy. However, the outcome that is being sought is that buildings are both as operationally efficient as possible and are operated with energy that is as clean as possible. Therefore, it proposes that on-site renewable generation capacity associated with the building is reported as part of the results (see Figure 2 on page 26). The technical methodology may in future be developed further to set out how renewable energy can be accounted for when assessing predicted emissions for buildings.

Electric vehicle (EV) charging

EV charging is excluded from the scope of predicted electricity use in this technical methodology. Emissions from electricity generated to charge EVs are not considered to be emissions related to the operation of a building.

Calculation approach

The formula below is how predicted electricity use is to be calculated.

Table 8: Total predicted electricity emissions intensity

Annual electricity emissions intensity	=	Annual Electricity Use Delivered Intensity	x	Emissions factor
(kgCO2-e/m^2/yr)		(kWh/m^2/yr)		(kgCO2-e/kWh)

Table 9: Total predicted electricity use

Annual Electricity Use Delivered Intensity	=	Annual Building Services Delivered Intensity	+	Annual Plug Loads Delivered Intensity
(kWh/m^2/yr)		(kWh/m^2/yr)		(kWh/m^2/yr)

Electricity – Building services

Purpose and scope

The purpose of this component is to calculate the predicted electricity used for building services including space heating and cooling, hot water, lighting, ventilation etc. which are the largest categories of household and commercial office energy use[15]. This contributes to the total predicted electricity use component of operational efficiency.

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[15] BRANZ (2010) *SR221 Energy use in New Zealand households - final Household Energy End-use Project (HEEP) report.* https://www.branz.co.nz/pubs/research-reports/sr221/

BRANZ (2014) *SR297/1 Building Energy End-use Study (BEES).* https://www.branz.co.nz/environment-zero-carbon-research/bees/publications-and-presentations/

The focus of the building services component is to drive the design, specification and construction of efficient electrical building services. This includes energy efficient system level design (e.g., short hot water pipe runs) as well as selection of efficient equipment (e.g., water heater and storage tank).

Both system-level and equipment-level approaches are needed. However, taking a systems design approach is most important as the systems design can lock-in aspects of building services efficiency for the lifetime of the building with long maintenance and replacement cycles. In contrast, specific items of equipment can be relatively easy to replace and upgrade as technology advances.

For small buildings, some aspects of building services will be calculated using default values based on the building type and occupancy. For example, electrical lighting in detached dwellings could be a default value. This level of detail will be developed further in the energy modelling protocol.

Any building services that use combustion fuel are not included in the calculation of predicted building services electricity, as they are already accounted for in combustion fuel calculations.

The following table sets out the scope of building services and equipment included in this sub-component:

Table 10: Scope of electricity building services

Service/Equipment	Small Buildings	Large Buildings
Space heating	Yes	Yes
Space cooling	Yes	Yes
Air conditioning / humidity control	Yes	Yes
Water heating	Yes	Yes
Ventilation (incl. supply, extract and recirculation equipment etc.)	Yes	Yes
Artificial lighting	Yes	Yes
Elevators and escalators	Yes	Yes
Auxiliary building services (pumps, fans)	Yes	Yes
Electrical signage	No	Yes
Security and alarm systems	No	Yes
Data & communications systems	No	Yes

The full scope of “auxiliary” building services will be developed further. This category is likely to include some services required for operating a building that may physically be located outside the building (e.g., a water bore pump) and other fixed services not covered by other categories (such as equipment for water features, pools or spas). It does not include elements already in other categories such as fans for ventilation.

External services on the project site, but not in or on the building, such as external lighting, signage, security systems and swimming pools are not included in the scope when calculating the building services electricity use.

Predicted building services electricity is based on the required delivered energy to meet the full modelled or calculated demand for all services/equipment set out in the scope table. Therefore, regardless of whether a building service is fixed to the building when constructed or will be provided as a plug-in appliance, it falls within the scope of building services, and not within plug loads. Where no fixed appliance is included, the delivered heating energy is to be treated as direct electric (COP=1). This is particularly relevant to space heating.

For example, a building with a very low heating demand may have no fixed heating appliances installed when it is built. Occupants could be expected to use plug-in heating appliances to maintain indoor environmental qualities and be comfortable. However, the calculated delivered energy required to meet the modelled/calculated space heating demand must still be included when calculating the predicted building services electricity use.

Calculation approach

Predicted annual building services electricity use is a complex calculation to account for all the services and equipment used, and the frequency of use, and will be determined by energy modelling.

Electricity – Plug loads

Purpose and scope

The purpose of this component is to ensure that most electricity uses in a building that can be reasonably predicted are included in the total predicted electricity use and therefore the predicted operational emissions. This prediction will be at a point in time, and will not attempt to forecast changes in electricity use over the building's expected lifespan.

Electricity use for building services and plug loads are separated out so efficient plug loads (which might change with occupants/tenants) are not "played-off" against inefficient building services. However, very efficient building services does allow flexibility for higher plug loads in the combined total for electricity use.

Plug loads are to be included based on what is intended to be used in the building by the owner, occupants and tenants when it will be first fully occupied.

For small buildings, default plug load values will be developed by MBIE and can be used to reduce the burden of work on designers, energy modellers and verifiers. As per *H1/VM1 – Energy Efficiency, 5th edition*, default values in the Passive House Planning Package (PHPP) or the New Zealand Green Building Council Energy and Carbon Calculator for Homes (ECCHO), may also be used where appropriate. It is intended that the process would simply be a matter of selecting which appliance/equipment types, and how many, are included in the building during the energy modelling process.

For large buildings, plug load values of the specified appliances/equipment are to be used in the energy modelling and the source/evidence provided. As the plug loads for large buildings are often not well defined at the design stage (e.g., they may depend on a commercial tenant that won't be involved until much later), further development of this is needed (e.g., potentially developing default values to apply based on the building classification).

The following table sets out the plug loads that are in scope:

Table 11: Scope of electricity plug loads

Appliance/Equipment	Small Buildings	Large Buildings
Oven, hob	Yes	Yes
Fridge, freezer	Yes	Yes
Dish washer	Yes	Yes
Washing machine	Yes	Yes
Dryer	Yes	Yes
TV	Yes	Yes
Audio visual	Yes	Yes
Computer (desktop, laptop)	Yes	Yes
Monitor	Yes	Yes
Printer	No	Yes
Photocopier	No	Yes
Any other electrical equipment used in the normal operation of the building by the owners, occupants and tenants.	Yes	Yes
Electric vehicle (EV) charging	No	No

Calculation approach

Predicted annual plug loads electricity use is a complex calculation to account for the majority of plug-in equipment and appliances used in buildings, and the frequency of use, and will be determined by energy modelling.

CALCULATING OPERATIONAL EMISSIONS – WATER

Background

There are operational emissions associated with the use of water in a building. Although water emissions can be relatively small compared to energy-related emissions, water emissions are included here for completeness.

When buildings are connected to the centralised water infrastructure, water-related emissions primarily come from the transport of water to and from the building, and from treatment of water at municipal facilities.

When buildings are not connected to centralised water infrastructure (off-grid), emissions primarily come from the treatment of water in on-site septic systems. The emissions from wastewater treatment in septic systems are different from those at municipal treatment facilities and can be accounted for using a different emissions factor.

This technical methodology sets out an approach to predicting water emissions based on the design of a building. It is not intended through this technical methodology to limit the use of water in buildings.

Purpose and scope

The purpose of this component is to account for predicted emissions from the use of water in a building. Both potable water (water entering the building) and wastewater (water exiting the building) are in scope.

On-site water pumping and transport is excluded from the calculation of water emissions, as the energy used to transport water onsite is already included where relevant in calculations of electricity (building services) emissions.

Heating of water is excluded from the calculation of water emissions, as it is already included where relevant in combustion fuel and electricity emissions calculations.

Calculation approach

Predicted water use annual intensity will be determined by calculating predicted potable water demand based on building type, size and occupancy. For some buildings, it may be appropriate to use default values based on one or more of these factors. This calculation will also be used as a proxy for the volume of wastewater exiting a building. While this is being developed, the sector is encouraged to use calculators already available (for example, from the New Zealand Green Building Council).

Total predicted emissions will be calculated by multiplying the potable water demand by an emissions factor that takes into account both potable water and wastewater. The emissions factor for this calculation is to be the sum of the potable water emissions factor and the wastewater emissions factor.

The potable water emissions factor and the wastewater emissions factor may be different depending on whether the water is sourced and/or treated onsite or using centralised water infrastructure.

The formula below is how water use is to be calculated.

Table 12: Total water emissions intensity

Annual water emissions intensity	=	**Potable water demand**	x	**Emissions factor**
($kgCO_2$-e/m^2/yr)		(m^3/m^2/yr)		($kgCO_2$-e/m^3)

Assessment results

Once operational efficiency assessments have been carried out, the results can be presented to inform design decisions, consumer choices, and assessments of whether the building will meet any potential future regulatory requirements. In the future, it is intended that these results will be reported and used to assess whether a building's predicted operational efficiency is within any caps set by regulations. Assessment results should cover each of the aspects outlined in this technical methodology:

- Indoor Environmental Quality parameters, including thermal comfort and indoor air quality
- predicted thermal performance, including project information, heat gains and heat losses
- predicted operational emissions, including fuel combustion, electricity use, and water use.

A range of audiences will be able to use the results of the operational efficiency assessments, including designers, builders, construction supply chain participants, and building owners. The outputs from an operational efficiency assessment will therefore need to be understood by different audiences with different levels of carbon and energy literacy.

PRINCIPLES FOR REPORTING ASSESSMENT RESULTS

To ensure assessments are accessible and lead to better outcomes, assessment results should meet the following principles:

- assessments are accessible to audiences with a low level of familiarity with operational efficiency
- the technical basis of the modelling/calculations, including assumptions made, and data sources used, can be traced and scrutinised
- the source information and results produced are presented in a consistent manner, so different buildings or construction methods can be readily compared.

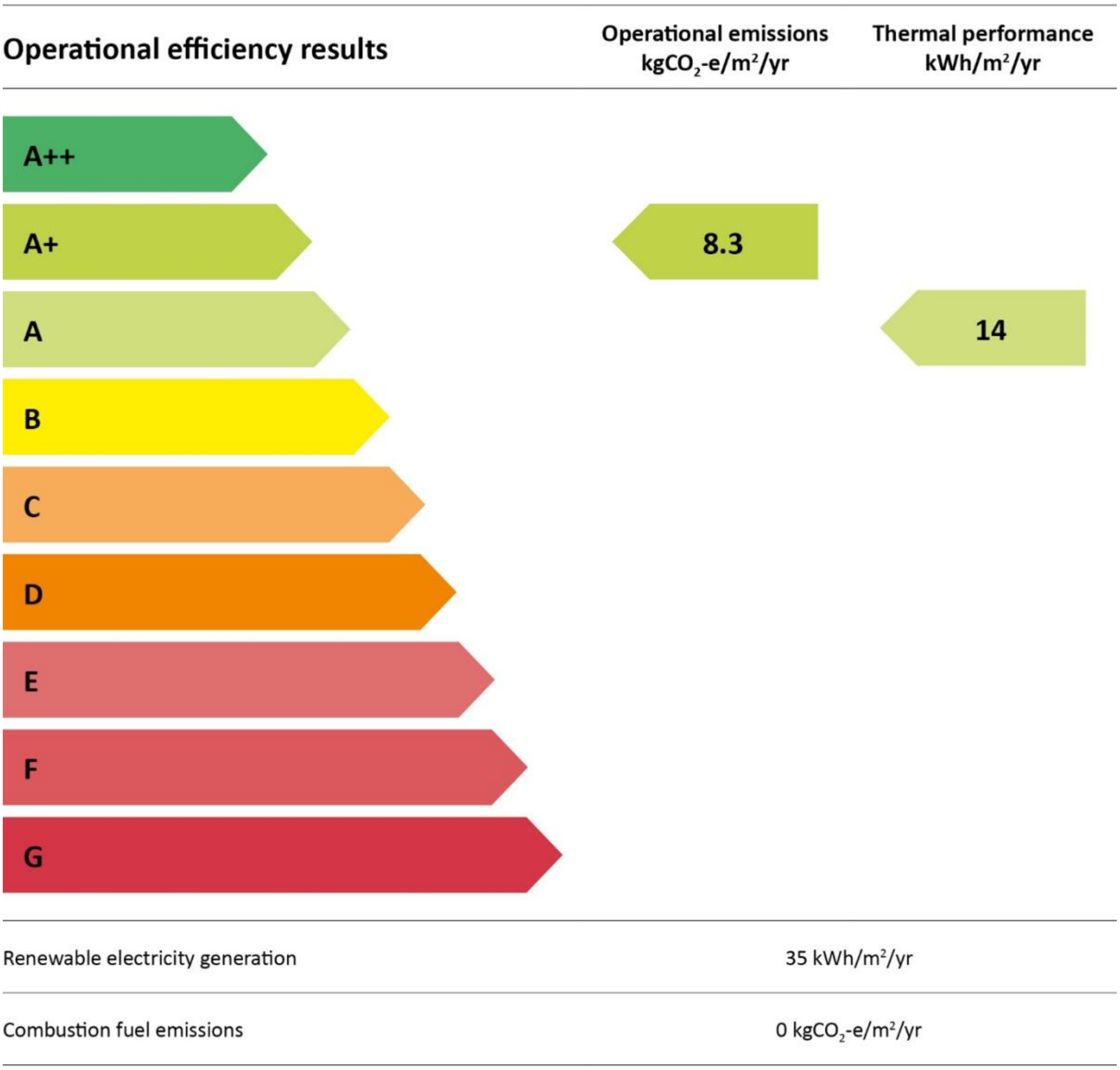
ASSESSMENT RESULT OUTPUTS

Assessments will present results in two different outputs:

- Non-technical output – providing a higher-level 'rating' that can be easily understood by a layperson, compared between buildings, used to improve performance in future, and used to improve the understanding of operational efficiency and carbon literacy in general across the sector. This could include graphical output comparable to Energy Performance Certificates (EPC) as used in other jurisdictions – see Figure 2 below for an illustrative example. The non-technical output could be similar to the output from proposed energy performance ratings which are proposed to display monitored actual energy use of a building, and will allow comparison between predicted and actual use.
- Technical output – including modelling parameters and inputs, calculations, data sources, references, specific numbers, etc. that are intended to provide detailed information to technical experts such that it could be peer reviewed if required and improve the quality of assessments over the longer term.

MBIE intends to provide further guidance on producing these outputs, such as template formats and example outputs. Figure 2 shows an example of a potential report format, which will be developed further.

Figure 2: Example non-technical graphical output for illustrative purposes



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