TECHNOFORM

H1 Energy Efficiency Analysis

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Executive summary

This report provides a cost analysis and energy performance evaluation of five design strategies to optimise building energy efficiency while considering cost implications. The report uses H1 AS1 Schedule Method for deemed to satisfy results, H1 AS1 Calculation Method for heat loss results and H1 Verification Method to determine heating and cooling load results. The findings reveal each strategy's distinct cost and energy performance metrics, enabling stakeholders to make informed decisions.

Design Strategy	Building Cost Change (%)	Heat Loss Change (%)	Heating & Cooling Load Change (%)	Viability
DTS Post-2023	Baseline	Baseline	**Baseline**	Baseline
H1 Pre-2023	-8.74	34.46	**39.76**	Poor Energy Efficiency
DS1	7.56	-7.6	**-4.44**	Viable
DS2	3.63	11.55	**-6.66**	Unviable
DS3	16.07	-1.95	**-36.99**	Mixed Results
DS4	-4.05	-0.72	**-26.72**	Best Balance
DS5	-6.21	0.25	**-6.14**	Most Cost-Effective

Table 1 Design strategy building cost, heat loss change and heating & cooling load change outcomes from analysis

Transition from H1 Pre-2023 to H1 Post-2023 lowest building cost (walls, floor, roof and windows only)	Cost ($)
Lowest building cost increase (DS5)	$2,846
Building cost (including builder's margin & GST)(DS5)	$3,927

Table 2 Base building cost increase – H1 Pre-2023 compared to lowest cost increase design strategy 5

The section " Design Strategies" outlines DS 1, 2, 3, 4, and 5.

This analysis emphasises the importance of balancing cost and energy efficiency when choosing building design strategies. DS4 is the best option, providing an ideal cost and energy performance blend. However, DS5, despite slightly increased heat loss, proves to be the most cost-effective choice.

H1 Pre-2023 reveals significant energy efficiency issues, emphasising the importance of maintaining current H1 guidelines. The shift to DS5 (H1 Post-2023) results in a minimal cost increase of only $2,846, much lower than previous estimates, creating an opportunity for stakeholders to embrace energy-efficient measures affordably.

It is important to note that overheating is unlikely due to increased insulation but rather from design flaws such as insufficient shading and ventilation. Decision-makers should prioritise energy-efficient strategies that meet budget and performance goals, foster sustainable practices, and lead to long-term savings, reinforcing the critical message.

Glossary

Calculation Method	An approach to determine building code clause H1 energy efficiency by assessing each building's specific characteristics and energy consumption, allowing for customised solutions.
Climate Zones	Designations of geographical areas differentiated by climate, affecting building design and energy requirements.
Conditioned floor area ("CFA")	The sum of areas in conditioned space, including basements and intermediate levels, is measured from the exterior faces of walls or the centre line of interior walls, excluding covered walkways, open-roofed areas, porches, terraces, steps, chimneys, and roof overhangs.
Combined (kWh/m²)	The total energy consumption for heating and cooling per square meter, often used to evaluate energy efficiency in building designs.
Cost	The costs quoted are from YourQS Ltd schedules and exclude; GST, contractors margin and preliminary and general costs.
Deemed-to-Satisfy ("DTS")	A standard or method that simplifies building compliance by adhering to predefined criteria or solutions.
Design Navigator	This is an online tool. The website offers tools that help the designer with simple but otherwise time-consuming design tasks, such as floor, wall, and roof R-value calculations, H1 compliance, and an external moisture risk matrix. The aim is to make design work more accessible.
Design Strategy (DS1, DS2, DS3, DS4, DS5)	Five different design strategies to reduce construction costs while maintaining or improving energy efficiency standards.
Dwangs (or Nogs)	Horizontal bracing members in a timber frame wall which are used to increase rigidity.
Energy Plus	EnergyPlus is the Department of Energy's open-source, state-of-the-art whole-building energy simulation engine.
Floor Area (m²)	The total usable space within the boundaries of a building, measured in square meters.
g-value	Also known as the solar factor, this measurement indicates how much solar energy passes through a glazing system into a building. It includes the directly transmitted solar energy and the heat absorbed by the glass that is subsequently re-radiated inside. The value ranges from 0 to 1, where a higher number means more solar heat is transferred indoors.
Glazed Door	A door composed of at least one pane of glass, allowing natural light to flow through while providing exterior access or views.
Glazing U-cog	The U-factor unit of measure for the centre-of-glass U-factor refers to the window glazing, excluding the frame. (see Ug).
Heat Loss (W/K)	The rate heat escapes from a building, measured in watts per degree Kelvin. Lower values indicate better insulation.
H1/AS1	A specific building performance clause that sets minimum energy efficiency requirements for insulation and glazing in different building parts.
H1/VM1	A specific building verification method that provides for efficient energy use and sets physical conditions for energy performance for housing and other buildings with a floor area of occupied space no more than 300m2.
Modelling Method	A compliance approach using advanced simulation tools to predict a building's energy performance under various scenarios.
Percentage Decrease (kWh/m²)	This metric shows the reduction in energy use per square meter compared to a reference or baseline.
psi value (W/m·K)	This value refers to the "thermal transmittance" or "thermal bridging" value, often denoted as "Ψ" (psi). It quantifies the heat transfer through specific linear building components, such as frames, joints, or connections, where insulation does not fully mitigate heat loss.
R-Value (m²K°/W)	A measure of thermal resistance indicating the insulation effectiveness of a material. Higher R-values suggest better insulation properties.

Reference Building	A standard or model used as a baseline for comparison in energy efficiency assessments.
Reference Schedule Method	A detailed account providing reference criteria or standards for building energy assessments.
Schedule Method	A compliance approach that relies on predefined standards and values, generally simplifying the process of meeting building regulations.
Slab on Ground Floor R-value	The measure of thermal resistance for concrete slab floors in direct contact with the ground.
Solar Heat Gain Coefficient (SHGC)	The ratio of solar radiation admitted through the glazing compared to the total solar radiation incident. Lower SHGC values are preferred in hot climates.
Speckel	An online sustainable design platform that allows engineers and architects to demonstrate building compliance using the Energy Plus modelling engine (see Energy Plus).
System R-value	The thermal resistance of a complete element, such as a window, considering all components, not just the frame material.
Thermal Bridging	Thermal bridging occurs when a highly conductive material, such as metal or concrete, allows heat to flow more quickly than the surrounding insulating materials. This phenomenon creates “bridges” of heat loss, ultimately reducing a building’s overall thermal performance.
Thermally Broken	Aluminium thermally broken windows and doors with Technoform thermal breaks using PA66GF25. This glass-fibre-reinforced polyamide enhances thermal insulation by reducing heat transfer between interior and exterior profiles.
Thermally broken Treated Floor Area (“TFA”)	In building thermal modelling, treated floor area refers to the total floor area of a building that is actively conditioned for heating and cooling purposes, excluding internal walls, doors, stairs, and unusable spaces.
Ug	The thermal transmittance or U-value of a glazing unit, specifically for double glazing measured at the centre of the glass. It measures the heat transfer rate through the glazing and is expressed in watts per square meter kelvin (W/m^2K). (see Glazing U-cog).
Verification Method (VM)	A New Zealand Building Code verification method is a way to show compliance with the Code’s performance requirements.
Wall Area (m^2)	The total surface area of the exterior or interior walls, measured in square meters.
Wall R-Value ($m^2K°/W$)	The measure of thermal resistance of a wall structure, indicating its effectiveness in insulating a building.
Window Energy Efficiency Rating System (“WEERS”)	A system that calculates and rates the energy efficiency of windows and glazing products based on performance metrics.
Window-to-Wall Ratio (%)	The proportion of window area to wall area, expressed as a percentage, influencing daylighting and thermal performance of a building.

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Acknowledgements

We thank Speckel, Architectural Profiles Ltd, Architectural Glass Products, Altus Window Systems, Comfortech Building Performance Solutions, FMI Building Innovation, Metro Performance Glass, Omega Windows and Doors and YourQS Ltd for contributing to this analysis. The data and expertise provided have greatly enriched the quality of the results. Thank you for your support and collaboration. Design Navigator and Speckel online tools were used extensively in this analysis.

Disclaimer

This report has been prepared with the utmost care and diligence to analyse energy efficiency in compliance with H1/AS1 standards using schedule, calculation, and modelling methods. However, Technoform Bautec Asia Pacific makes no representations or warranties of any kind, express or implied, about the completeness, accuracy, reliability, suitability, or availability of the content of this report for any purpose. Therefore, any reliance on such information is strictly at your own risk.

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Peer review

We sincerely thank Darren O’Dea, co-founder of Speckel, for his invaluable contribution as a peer reviewer for this analysis. His thorough evaluation and insightful feedback significantly enhanced the quality and depth of our work. Darren’s expertise and perspective provided scrutiny and understanding crucial in refining our findings, ensuring their accuracy and relevance to the industry.

Scope of works

The scope of work for an analysis comparing energy efficiency and costs using the H1/AS1 Schedule, Calculation, or Modelling methods for determining R-values for Model House 1, which is a residential dwelling under 300m^2 includes:

Data Collection and Analysis: Gather and analyse data on R-value requirements and performance outcomes for each method (Schedule, Calculation, Modelling) across BRANZ Model House 1, roof, walls, floor, windows, and doors.

Cost Assessment: Evaluate the costs associated with each method for the roof, floor, walls and windows, including material costs, installation, labour, and any additional expenses related to achieving compliance with minimum R-values.

Energy Performance Evaluation: Assess each method's energy efficiency outcomes, considering heating and cooling loads as prescribed in H1 VM1.

Modelling and Simulation: Use the H1 VM1 Modelling method to conduct simulations to project long-term energy performance over the building's lifecycle.

Regulatory Compliance Review: Ensure all methods are evaluated against current New Zealand Building Code standards, ensuring findings align with legal requirements for energy efficiency.

Recommendations and Reporting: Develop evidence-based recommendations that inform best practices for choosing R-value determination methods, emphasising the benefits for economics and energy efficiency.

Goal of works

The goal of undertaking an analysis comparing energy efficiency and costs between the H1/AS1 Schedule, Calculation, or Modelling methods for determining R-values in residential dwellings under 300m^2 is to:

Evaluate Cost-Effectiveness: Assess the financial implications of each method to determine which provides optimal energy efficiency at the lowest cost. This includes examining upfront material costs, long-term energy savings, and potential impacts on construction budgets.

Optimise Energy Efficiency: Identify which evaluation method (H1 schedule, calculation, or modelling methods) best achieves the desired balance between adequate insulation (R-values) and overall energy performance. This involves determining how each approach affects heating and cooling demands.

Understand Method Suitability: This includes evaluating the schedule, calculation, and modelling methods to adapt to unique site conditions and specific architectural features.

Inform Decision-Making: Provide data-backed insights to assist builders, architects, and policymakers decide which H1 energy efficiency compliance method to employ, balancing regulatory compliance with practical and economic considerations.

By evaluating these factors, the analysis recommends the most advantageous approach for determining R-values, enhancing energy efficiency and economic viability in residential construction projects.

Assumptions and limitations

This analysis uses the Schedule Method as per the Reference building from H1 Energy Efficiency Acceptable Solution H1/AS1 and Verification Method 1 for energy efficiency for all housing and buildings up to 300 m2 to establish the criteria for comparison. This analysis uses the BRANZ Model House 1, with the garage removed from the analysis as it is deemed an uninhabited space.

The analysis has been undertaken using Climate Zone 1 only; other climate zones, as specified in H1/AS1, will have different outcomes and have not been included in this analysis. The building will be deemed compliant with the Calculation Method if its heat loss is less than or equal to the Reference building's heat loss.

When conducting an analysis using only Model House 1, with a single cladding type in one climate zone, the following limitations occur:

Limited Generalisability: The findings may not represent other house designs, cladding types, or climate zones. This limits the ability to generalise the results to other settings or building configurations.

Lack of Variability in Cladding: Using just one cladding type can restrict understanding of how different exterior materials influence energy efficiency and cost-effectiveness, potentially overlooking optimal combinations for other scenarios.

Single Climate Zone Focus: This analysis won't capture how diverse weather conditions and regional temperature variations affect each R-value determination method's performance and cost implications by focusing on only one climate zone.

NIWA weather files: This analysis used previous weather data from the National Institute of Water and Atmospheric Research ("NIWA") to evaluate building energy performance. Using older NIWA weather files may not accurately reflect current climate conditions, potentially underestimating energy demands and risks.

Inflexibility to Design Variations: Results based on a single model house do not account for variations in architectural design, such as different floor plans or building orientations, which can significantly influence energy performance.

Potential Bias in Results: The choice of Model House 1 may favour one method over others, potentially skewing results to suggest one method is superior when different designs yield different outcomes.

Narrow Scope of Applicability: The conclusions drawn apply only to the specific houses and conditions tested, limiting their usefulness for broader policy recommendations or diverse construction projects.

Insufficient Lifecycle Data: Insights gained may only partially encompass long-term maintenance, durability, or lifecycle costs related to different methods and materials, particularly if the selected model has unique attributes.

Exclusion of User Preferences and Behaviours: The analysis does not account for occupant behaviours; however, an assumed "operability" of windows is set at 30%, impacting energy outcomes.

Construction R-values: The construction R-values of all walls include the effects of thermal bridging, which are calculated in accordance with NZ 4214:2006 or stated values.

Slab-on-ground condition is only assumed when:

1. The combined density of the floor is greater than 1400 kg/m^3, and
2. The boundary condition is Ground Contact.

Floors other than slab-on-ground conditions and materials are only assumed when the model boundary condition is set to External. When adopted within a design, the R-value of floors other than slab-on-ground construction is either nominated or calculated. When calculated, the methods prescribed in CIBSE Guide A (Section 3.5) are provided as a proxy, as Verification Method H1/VM1 doesn't cite a method for this flooring type.

Floors and R-Values: When designing a building model, different types of floors are considered only if the boundary condition is set to "External." For floors that aren't slab-on-ground, their R-value (a thermal resistance measure) can be specified directly or calculated. If calculated, CIBSE Guide A offers a method as the official guidelines don't specify one for these floors.

Heat Capacity and Density: When creating a model in Speckel, the heat capacity (amount of heat the material can hold) is kept constant, but the assumed material density changes based on whether the material is considered Lightweight, Moderate, or Heavyweight. These factors influence the simulation results since they are crucial in modelling and are consistently considered by the Energy Plus simulation tool.

Recognising these limitations and constraints is essential for contextualising the findings and making cautious interpretations or recommendations based on the analysis. Expanding the scope to include varied conditions would provide a more comprehensive understanding of each method's implications. Also, refer to the section on further research to understand how this analysis could be taken further.

Introduction

The New Zealand Building Code's H1 AS1 and VM1 documents are pivotal in guiding energy efficiency for nationwide residential and small building constructions. This analysis aims to help homeowners, builders, and architects grasp the importance of H1, focusing on energy efficiency and sustainability alongside improved cost mitigation strategies to meet contemporary environmental standards.

H1 Energy Efficiency, AS1 and VM1 represent buildings smaller than 300m2 and are dedicated to ensuring energy efficiency by setting building envelope thermal performance requirements. Complying with an Acceptable Solutionor Verification Method is complying with that part of the Building Code. Other options for establishing compliance are listed in section 19 of the Building Act. This clause ensures homes are comfortable, cost-efficient, and environmentally friendly.

Recently, the Honourable Chris Penk, Minister for Building and Construction, initiated discussions about reversing the revisions to H1 implemented in November 2022 to lower construction costs. However, no evidence suggests such rollbacks would reduce housing costs. Instead, they could diminish building performance and heighten long-term health risks for occupants due to poorly insulated homes.

New research conducted by New Zealand Certified Builders ("NZCB") and industry partners such as EBOSS has alleviated concerns that the updated H1 insulation standards significantly raise building costs. The study revealed that these standards add only around $2,200 to $10,609, rather than the $40,000 to $50,000 some have claimed. The research employed the standard 'Schedule Method' and the more precise 'Calculation Method' to evaluate costs (Duder, 2024). NZCB Chief Executive Malcolm Fleming emphasised that using the H1/AS1 Calculation Method can substantially cut costs, supporting a shift towards more energy-efficient homes with minimal financial burden.

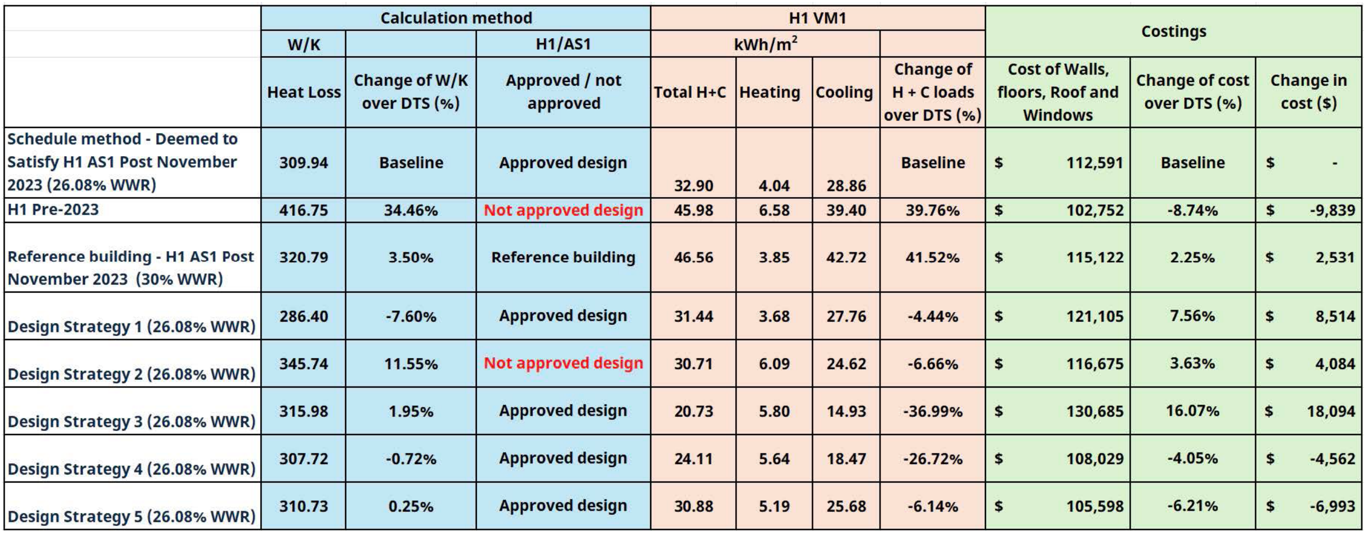
The findings counter Minister Chris Penk's proposal to roll back these standards, advocating instead for their maintenance to provide homeowners with warmer, healthier homes at a modest cost increase. Technoform concurs with the NZ Certified Builders but attributes overheating issues not to over-insulation but to building design.

Technoform conducted this analysis to develop alternative design strategies to better understand energy efficiency issues. These strategies aim to uphold enhanced building performance standards while effectively managing costs. Whether or not the rollback occurs, the New Zealand Building Code H1/AS1 remains essential for sustaining high energy efficiency standards in building construction, ensuring long-term economic and health benefits. While reducing construction costs is necessary, it should not compromise building performance and occupant health.

This analysis explores the impact of the H1/AS1 Schedule Method on cost and energy performance compared to calculation and modelling methods, offering alternative design strategies. By finding the right balance, New Zealand can continue to construct energy-efficient, comfortable, and affordable homes without sacrificing quality.

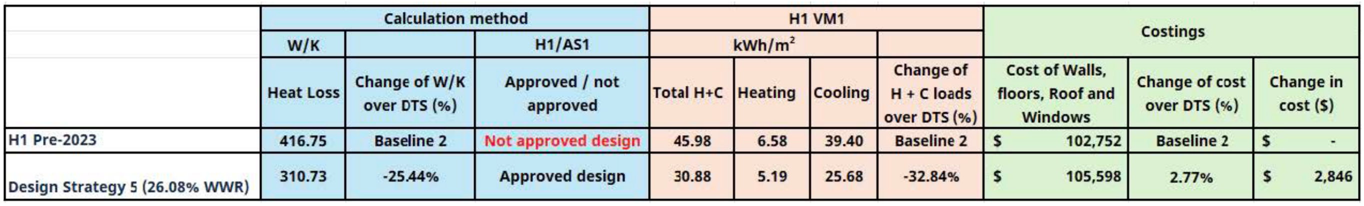
High-level results

The design strategies evolved as the analysis progressed. Initially, DS1 and DS2 aimed to reduce heat loss without increasing costs compared to the Baseline. However, DS2 did not pass the H1 AS1 Calculation Method. Therefore, DS3 was created; however, DS3 led to a significant increase in costs. To address these issues, DS4 was developed to enhance window performance and understand if there were cost and energy-saving improvements. Then, DS5 was created to explore the potential benefits of reducing costs.



	Calculation method			H1 VM1				Costings		
	W/K		H1/AS1	kWh/m^2						
	Heat Loss	Change of W/K over DTS (%)	Approved / not approved	Total H+C	Heating	Cooling	Change of H + C loads over DTS (%)	Cost of Walls, floors, Roof and Windows	Change of cost over DTS (%)	Change in cost ($)
Schedule method - Deemed to Satisfy H1 AS1 Post November 2023 (26.08% WWR)	309.94	Baseline	Approved design	32.90	4.04	28.86	Baseline	$ 112,591	Baseline	$ -
H1 Pre-2023	416.75	34.46%	Not approved design	45.98	6.58	39.40	39.76%	$ 102,752	-8.74%	$ -9,839
Reference building - H1 AS1 Post November 2023 (30% WWR)	320.79	3.50%	Reference building	46.56	3.85	42.72	41.52%	$ 115,122	2.25%	$ 2,531
Design Strategy 1 (26.08% WWR)	286.40	-7.60%	Approved design	31.44	3.68	27.76	-4.44%	$ 121,105	7.56%	$ 8,514
Design Strategy 2 (26.08% WWR)	345.74	11.55%	Not approved design	30.71	6.09	24.62	-6.66%	$ 116,675	3.63%	$ 4,084
Design Strategy 3 (26.08% WWR)	315.98	1.95%	Approved design	20.73	5.80	14.93	-36.99%	$ 130,685	16.07%	$ 18,094
Design Strategy 4 (26.08% WWR)	307.72	-0.72%	Approved design	24.11	5.64	18.47	-26.72%	$ 108,029	-4.05%	$ -4,562
Design Strategy 5 (26.08% WWR)	310.73	0.25%	Approved design	30.88	5.19	25.68	-6.14%	$ 105,598	-6.21%	$ -6,993

Table 3 Current H1, AS1, Schedule method compared against H1 pre-2023, reference building, and design strategies 1, 2, 3, 4, & 5



	Calculation method			H1 VM1				Costings		
	W/K		H1/AS1	kWh/m^2						
	Heat Loss	Change of W/K over DTS (%)	Approved / not approved	Total H+C	Heating	Cooling	Change of H + C loads over DTS (%)	Cost of Walls, floors, Roof and Windows	Change of cost over DTS (%)	Change in cost ($)
H1 Pre-2023	416.75	Baseline 2	Not approved design	45.98	6.58	39.40	Baseline 2	$ 102,752	Baseline 2	$ -
Design Strategy 5 (26.08% WWR)	310.73	-25.44%	Approved design	30.88	5.19	25.68	-32.84%	$ 105,598	2.77%	$ 2,846

Table 4 H1 pre-2023 schedule method compared against H1 pre-2023 design strategy 5

Conclusions

Refer to section "Design Strategies" for details of what is contained in each strategy.

Energy Efficiency H1 pre-2023: The data for H1 pre-2023 show building cost decrease of 8.74% compared to the baseline, with a 34.46% increase in heat loss and a 39.76% increase in heating and cooling loads. Pre-2023 demonstrates that the current H1 AS1 solutions are not as costly as previously stated. Also, H1 pre-2023 shows extremely high heat loss and heating and cooling loads, demonstrating poor energy efficiency (refer to Table 3).

Design Strategy 1: DS1 exhibits a 7.56% increase in building cost compared to the baseline, with a 7.60% decrease in heat loss and a 4.44% decrease in heating and cooling loads. DS1 is an example that shows that the Acceptable Solution, H1 AS1 Calculation Method, and H1 VM1 for thermal modelling are not comparable or compatible (refer to Table 3).

Design Strategy 2: DS2 shows a 3.63% increase in costs compared to the baseline, with an 11.55% increase in heat loss and a 6.66% decrease in heating and cooling loads. DS2 is an example that shows that non-insulated concrete slab floors are not cost-effective and that the benefits perceived via H1 VM1 are not demonstrated in the H1 AS1 Calculation Method. DS2 failed the Calculation Method and was not considered a viable strategy (refer to Table 3).

Design Strategy 3: DS3 represents the most significant building cost increase of 16.07% compared to the baseline, with a 1.95% increase in heat loss and a 36.99% decrease in the heating and cooling loads. DS3 is an example that shows that simply increasing wall insulation is not a cost-effective strategy. The Calculation Method shows minimal heat loss improvements, but the modelling method significantly improved energy efficiency performance. For this strategy, long-term energy costs should be weighed against the upfront insulation improvement costs (refer to Table 3).

Design Strategy 4: DS4 demonstrates a 4.05% building cost reduction compared to the baseline, with a 0.72% reduction in heat loss and a 26.72% decrease in heating and cooling loads. DS4 is a viable option for balanced, budget-conscious projects and demonstrates that using the correct window R-value with high-performing glazing is cost-effective and beneficial. However, using the Calculation Method alone would not prove the benefits (refer to Table 3).

Design Strategy 5: DS5 stands out as the most cost-effective solution, with a 6.21% reduction in building costs compared to the baseline, a 0.25% increase in heat loss, and a 6.14% reduction in heating and cooling loads. DS5 is the most cost-effective option, demonstrating that using the correct window R-value with moderately well-performing glazing is a cost-effective strategy (refer to Table 3).

Affordable compliance with advanced window technology: To minimise the increase in building cost from H1 pre-2023 to the current Building Code Clause H1, designers can use H1 VM1 to balance the performance cost trade-offs of the building elements. By using higher-performing windows and doors and optimising the insulation of roof/walls/floor (DS5), a slight cost increase of $2,846 is achievable compared to unsubstantiated claims of a $40,000 to $50,000 increase. The same design strategy (DS5) will reduce the heating and cooling loads by 32.84% compared to H1 pre-2023, which is deemed-to-satisfy. These results can be achieved using readily available building elements and advanced window system technology from WGANZ members in New Zealand (refer to Table 4).

Analysis

- Total Floor area: 223.78 m2
- Conditioned floor area: 195m2
- Treated floor area: 182m2
- Wall area: 120.41 m2
- Window and glazed door area (including garage): 50.07 m2
- The garage is considered an unconditioned space for this project and is not included in this study.
- Window-to-wall ratio (excluding garage): 26.08%

Figure 1 Model House 1 rendered view

Figure 2 Rendered floor plan of Model House 1

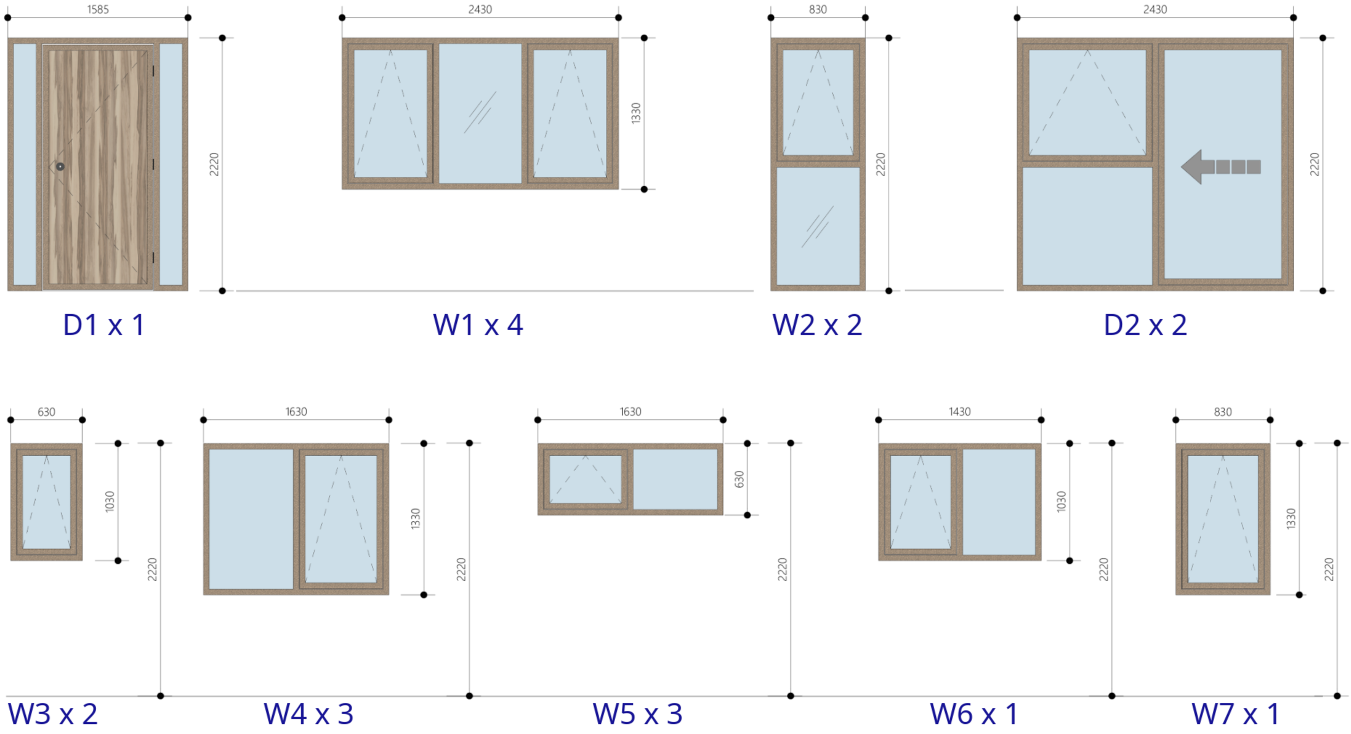


Figure 3 Window schedule of Model House 1

Design strategies

The following design strategies have accounted for thermal bridging, by using the "isothermal planes" method, the same method as used in NZS4214:2006.

SCHEDULE METHOD – DEEMED TO SATISFY H1 AS1 POST NOVEMBER 2023

Element	Construction R-value	U-value	Specification
Roof	6.73		R7.0 Pink Batts Superbatt®
Floor	1.50		Table F.1.2.2B: Construction R-values for concrete raft foundation floors without insulation, where the external walls do not have masonry veneer cladding
Wall	2.06		90mm studs @ 600mm, dwangs @ 800mm R2.2 batt
Windows	0.46		Industry-standard residential aluminium thermally broken suite with Low-E double glazing (26.08% WWR)
U-cog 2		1.3	Low-E1 glazing with a SHGC of 0.56

DESIGN STRATEGY H1 PRE 2023

Element	R value	U-value	Specification
Roof	3.60		R3.6 Fibreglass
Floor	1.50		Concrete raft foundation floors without insulation
Wall	1.74		R1.8 Batts 90mm studs @600 dwangs @800mm Rusticated Pine
Windows	0.26		Cold Aluminium Non-thermally broken clear double-glazed (26.08% WWR)
U-cog 1		2.8	Clear double glazing with a SHGC of 0.77

Table 5 design strategies for H1 Pre-2023 and Schedule Method deemed to satisfy

REFERENCE BUILDING H1 AS1 POST NOVEMBER 2023

Element	R value	U-value	Specification
Roof	6.73		R7.0 Pink Batts Superbatt®
Floor	1.50		Table F.1.2.2B: Construction R-values for concrete raft foundation floors without insulation, where the external walls do not have masonry veneer cladding
Wall	2.06		90mm studs @ 600mm, dwangs @ 800mm R2.2 batt
Windows	0.46		Industry-standard residential aluminium thermally broken suite with Low-E1 double glazing adjusted to 30% glazing WWR
U-cog 2		1.3	Low-E1 double glazing with a SHGC of 0.56

DESIGN STRATEGY 1 – INCREASE WALL R VALUE BY 83%, USE INDUSTRY STANDARD WINDOW INCREASING R VALUE BY 13%, SHGC DECREASED BY 9%

Element	R value	U-value	Specification
Roof	4.56		Superbatt® R4.5
Floor	1.50		Table F.1.2.2B: Construction R-values for concrete raft foundation floors without insulation, where the external walls do not have masonry veneer cladding
Wall	3.79		90mm studs @ 600mm centres no dwangs, R2.8 batt, strapping 45mm x 70mm with R1.3 batt
Windows	0.52		Industry-standard residential aluminium thermally broken suite with Low-E2 double glazing (26.08% WWR)
U-cog 3		1.1	Low-E2 double glazing with a SHGC of 0.51

Table 6 design strategies for Reference Building, and design strategies 1

DESIGN STRATEGY 2 – DECREASE FLOOR R VALUE BY 20%, USE INDUSTRY STANDARD WINDOW INCREASING R VALUE BY 13%, DECREASE SHGC BY 9%

Element	R value	U-value	Specification
Roof	4.56		Superbatt® R4.5
Floor	1.20		Table F.1.2.2F Construction R-values for slab floors without insulation, where external walls do not have masonry veneer
Wall	2.06		90mm studs @ 600mm, dwangs @ 800mm R2.2 batt
Windows	0.52		Industry-standard residential aluminium thermally broken suite with Low-E2 double glazing (26.08% WWR)
U-cog 3		1.1	Low-E2 double glazing with a SHGC of 0.51

DESIGN STRATEGY 3 – INCREASE WALL R VALUE BY 83%, USE INDUSTRY STANDARD WINDOW INCREASING R VALUE BY 17%, DECREASE SHGC BY 30%

Element	R value	U-value	Specification
Roof	4.56		Superbatt® R4.5
Floor	1.20		Table F.1.2.2F Construction R-values for slab floors without insulation, where external walls do not have masonry veneer
Wall	3.79		90mm studs @ 600mm centres no dwangs, R2.8 batt, strapping 45mm x 70mm with R1.3 batt
Windows	0.54		Industry-standard residential aluminium thermally broken suite with Low-E2 double glazing (26.08% WWR)
U-cog 4		1.0	Low-E3 double glazing with a SHGC of 0.39

Table 7 design strategies for design strategies 2 & 3

DESIGN STRATEGY 4 – INCREASE WALL R VALUE BY 4%, USE INDUSTRY STANDARD WINDOW INCREASING R VALUE BY 17%, DECREASE SHGC BY 30%

Element	R value	U-value	Specification
Roof	4.56		Superbatt® R4.5
Floor	1.50		Table F.1.2.2B: Construction R-values for concrete raft foundation floors without insulation, where the external walls do not have masonry veneer cladding
Wall	2.15		90mm studs @ 600mm, no dwangs R2.2 batt
Windows	0.54		Industry-standard residential aluminium thermally broken suite with Low-E3 double glazing (26.08% WWR)
U-cog 4		1.0	Low-E3 double glazing with a SHGC of 0.39

DESIGN STRATEGY 5 – INCREASE WALL R VALUE BY 4%, USE INDUSTRY STANDARD WINDOW INCREASING R VALUE BY 13%, SHGC DECREASED BY 9%

Element	R value	U-value	Specification
Roof	4.56		Superbatt® R4.5
Floor	1.50		Table F.1.2.2B: Construction R-values for concrete raft foundation floors without insulation, where the external walls do not have masonry veneer cladding
Wall	2.15		90mm studs @ 600mm, no dwangs R2.2 batt
Windows	0.52		Industry-standard residential aluminium thermally broken suite with Low-E2 double glazing (26.08% WWR)
U-cog 3		1.1	Low-E2 double glazing with a SHGC of 0.51

Table 8 design strategies for design strategies 4 & 5

Glazing types

Element	U-value	Specification	SHGC	% change
U-cog 1	2.8	Clear double glazing	0.77	38%
U-cog 2	1.3	Low-E1 double glazing	0.56	Baseline
U-cog 3	1.1	Low-E2 double glazing	0.51	-9%
U-cog 4	1.0	Low-E3 double glazing	0.39	-30%

Table 9 U-cog glazing types

In-depth results

Heat Loss

	Calculation Method H1 AS1	
Scenario	Heat Loss (W/K)	Approved/not approved
Schedule Method - Deemed to Satisfy H1 AS1 Post November 2023	309.94	Approved design
Design Strategy H1 Pre 2023	416.75	Not approved design
Reference building H1 AS1 Post November 2023	323.03	Reference building
Design Strategy 1	286.40	Approved design
Design Strategy 2	345.74	Not approved design
Design Strategy 3	315.98	Approved design
Design Strategy 4	307.72	Approved design
Design Strategy 5	310.73	Approved design

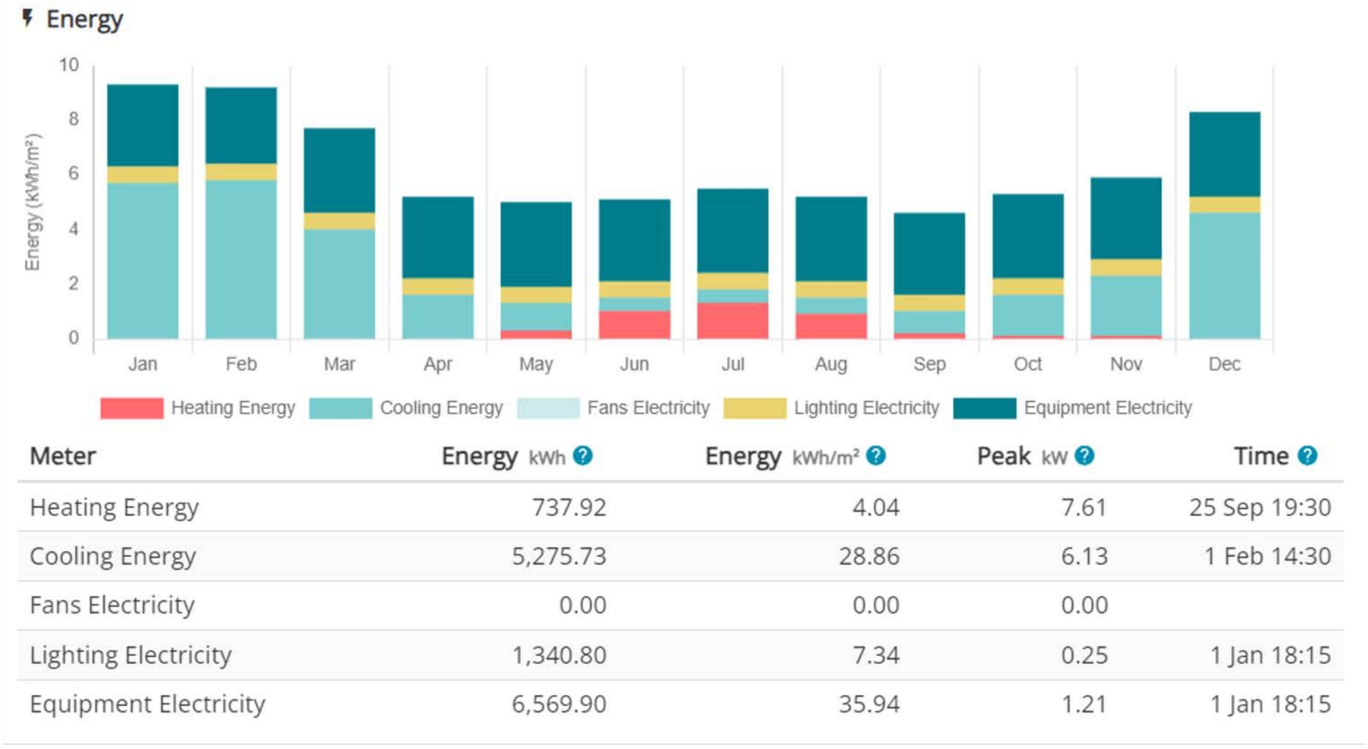
Table 10 Heat loss results for H1 Pre-2023, Schedule Method deemed to satisfy, reference building, and design strategies 1, 2, 3, 4, & 5

Building Energy

	H1 VM1		
	kWh/m2		
Scenario	Total	Space heating load	Space cooling load
Schedule Method - Deemed to Satisfy H1 AS1 Post November 2023	32.90	4.04	28.86
Design Strategy H1 pre-2023	45.98	6.58	39.40
Reference building H1 AS1 Post November 2023	46.56	3.85	42.72
Design Strategy 1	31.44	3.68	27.76
Design Strategy 2	30.71	6.09	24.62
Design Strategy 3	20.73	5.80	14.93
Design Strategy 4	24.11	5.64	18.47
Design Strategy 5	30.88	5.19	25.68

Table 11 heat and cooling load results for H1 Pre-2023, Schedule Method deemed to satisfy, reference building, and design strategies 1, 2, 3, 4, & 5

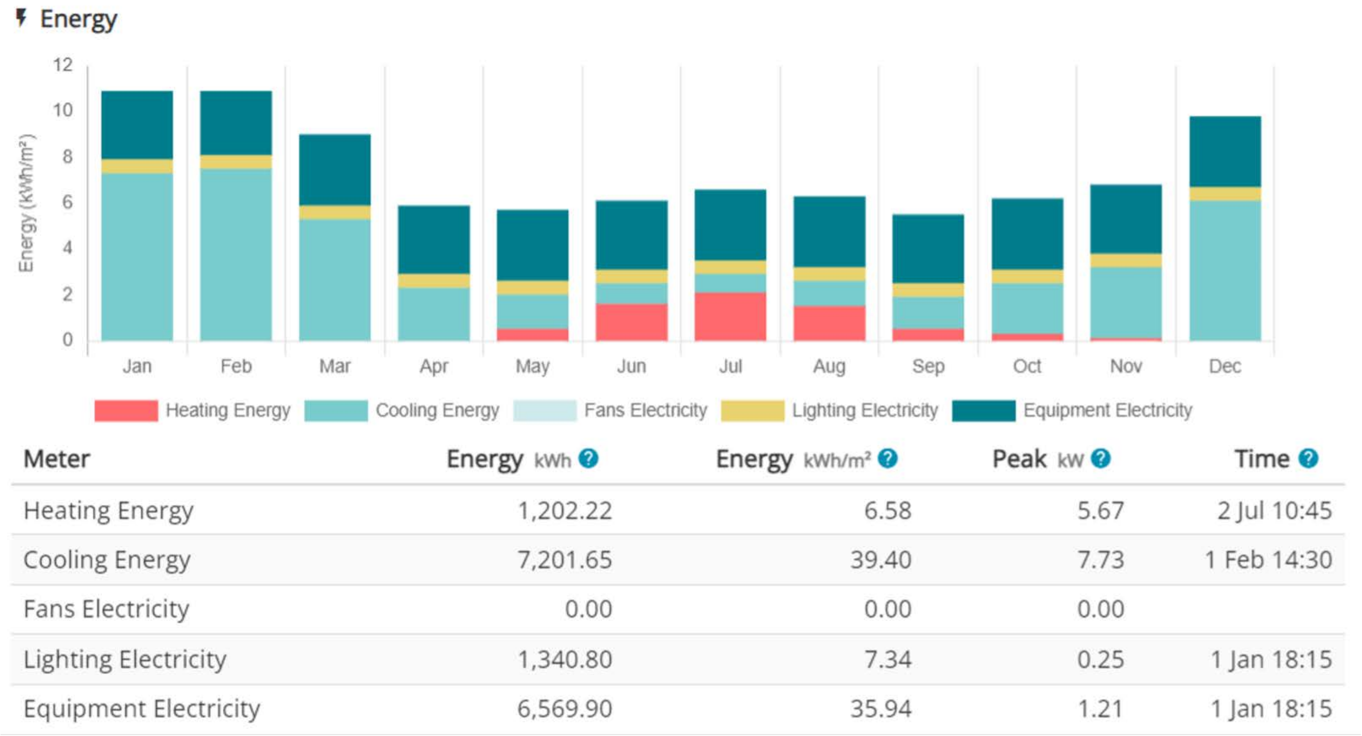
Schedule Method deemed to satisfy energy chart



Meter	Energy kWh	Energy kWh/m^2	Peak kW	Time
Heating Energy	737.92	4.04	7.61	25 Sep 19:30
Cooling Energy	5,275.73	28.86	6.13	1 Feb 14:30
Fans Electricity	0.00	0.00	0.00	
Lighting Electricity	1,340.80	7.34	0.25	1 Jan 18:15
Equipment Electricity	6,569.90	35.94	1.21	1 Jan 18:15

Figure 4 Design Strategy Schedule Method, DTS heating, cooling, equipment and lighting energy chart

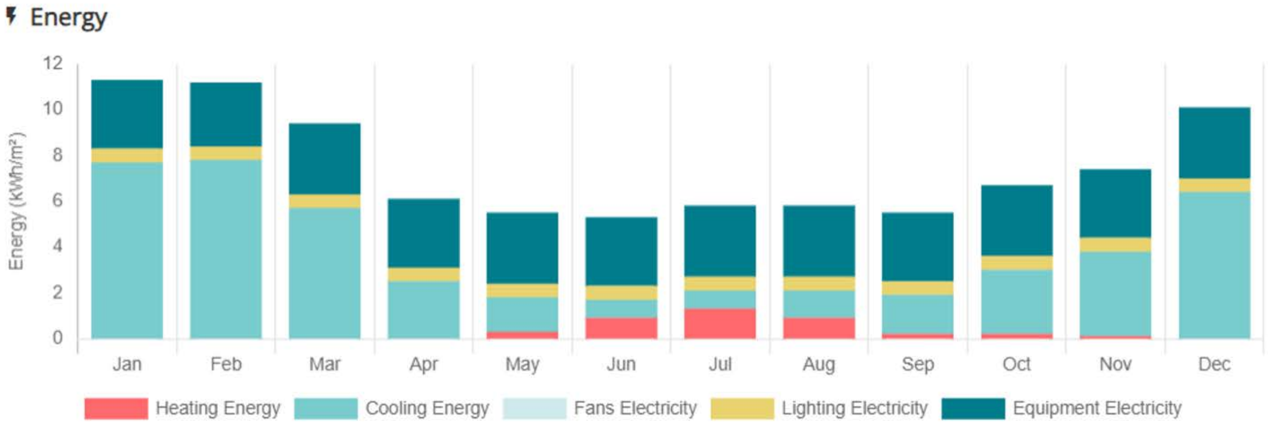
H1 Pre-2023 energy chart



Meter	Energy kWh	Energy kWh/m^2	Peak kW	Time
Heating Energy	1,202.22	6.58	5.67	2 Jul 10:45
Cooling Energy	7,201.65	39.40	7.73	1 Feb 14:30
Fans Electricity	0.00	0.00	0.00	
Lighting Electricity	1,340.80	7.34	0.25	1 Jan 18:15
Equipment Electricity	6,569.90	35.94	1.21	1 Jan 18:15

Figure 5 Design Strategy H1 pre-2023, heating, cooling, equipment and lighting energy chart

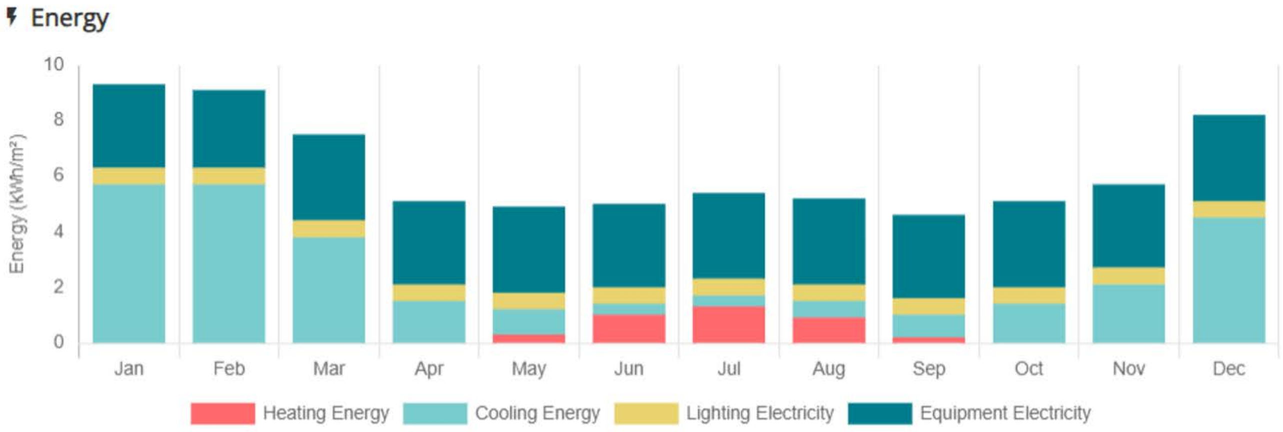
Reference building energy chart



Meter	Energy kWh	Energy kWh/m^2	Peak kW	Time
Heating Energy	702.82	3.85	9.92	25 Aug 18:30
Cooling Energy	7,807.61	42.72	7.77	1 Feb 14:30
Fans Electricity	0.00	0.00	0.00	
Lighting Electricity	1,340.80	7.34	0.25	1 Jan 18:15
Equipment Electricity	6,569.90	35.94	1.21	1 Jan 18:15

Figure 6 Design Strategy Reference Building, heating, cooling, equipment and lighting energy chart

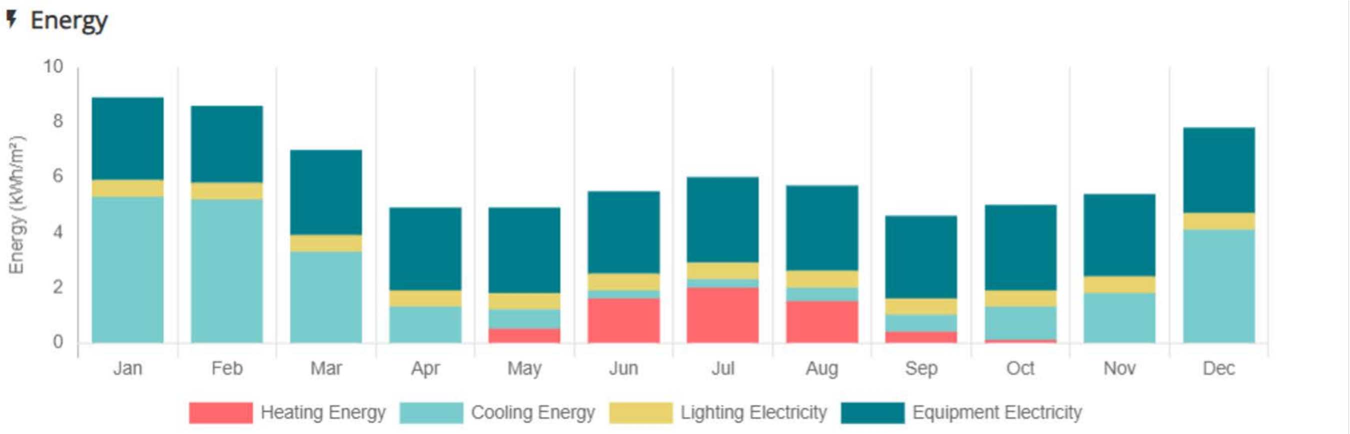
Design strategy 1 energy chart



Meter	Energy kWh	Energy kWh/m^2	Peak kW	Time
Heating Energy	672.38	3.68	2.66	27 Jun 07:30
Cooling Energy	5,074.26	27.76	5.67	1 Feb 14:30
Lighting Electricity	1,340.80	7.34	0.25	1 Jan 18:15
Equipment Electricity	6,569.90	35.94	1.21	1 Jan 18:15

Figure 7 Design Strategy 1, heating, cooling, equipment and lighting energy chart

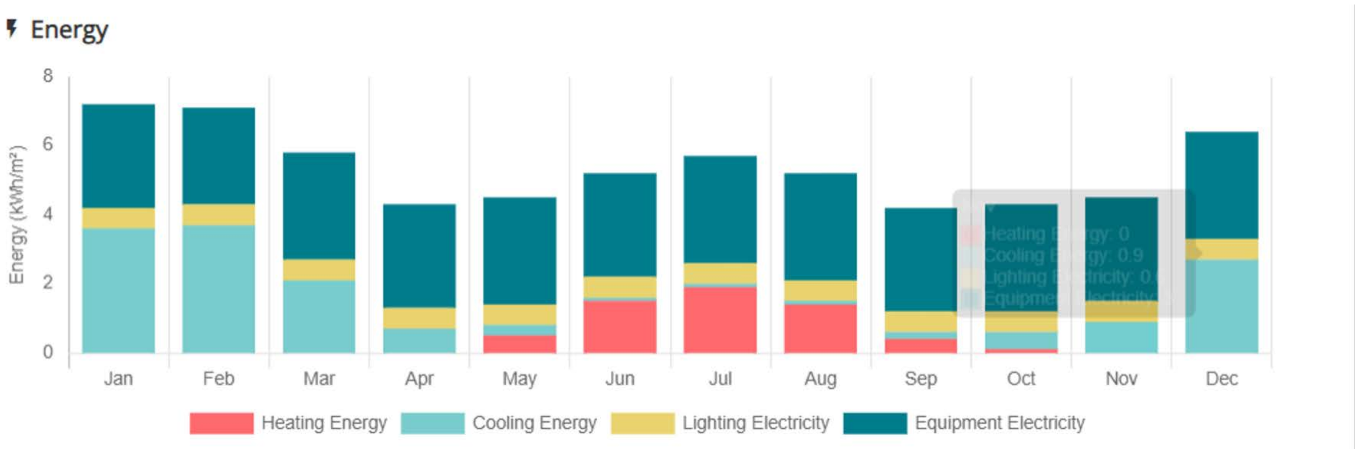
Design strategy 2, energy chart



Meter	Energy kWh	Energy kWh/m²	Peak kW	Time
Heating Energy	1,112.52	6.09	3.15	27 Jun 07:30
Cooling Energy	4,500.59	24.62	5.60	1 Feb 14:30
Lighting Electricity	1,340.80	7.34	0.25	1 Jan 18:15
Equipment Electricity	6,569.90	35.94	1.21	1 Jan 18:15

Figure 8 Design Strategy 2, heating, cooling, equipment and lighting energy chart

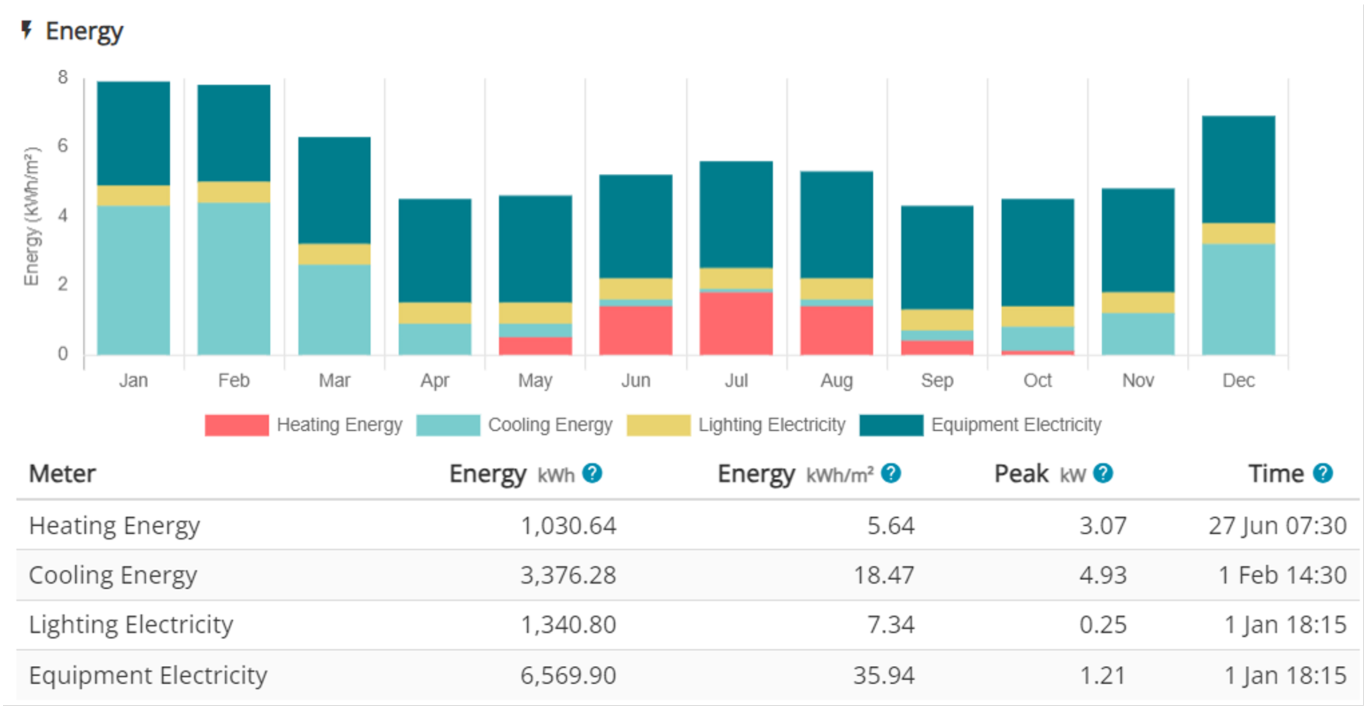
Design strategy 3, energy chart



Meter	Energy kWh	Energy kWh/m²	Peak kW	Time
Heating Energy	1,059.78	5.80	2.90	27 Jun 07:30
Cooling Energy	2,729.00	14.93	4.37	1 Feb 14:30
Lighting Electricity	1,340.80	7.34	0.25	1 Jan 18:15
Equipment Electricity	6,569.90	35.94	1.21	1 Jan 18:15

Figure 9 Design Strategy 3, heating, cooling, equipment and lighting energy chart

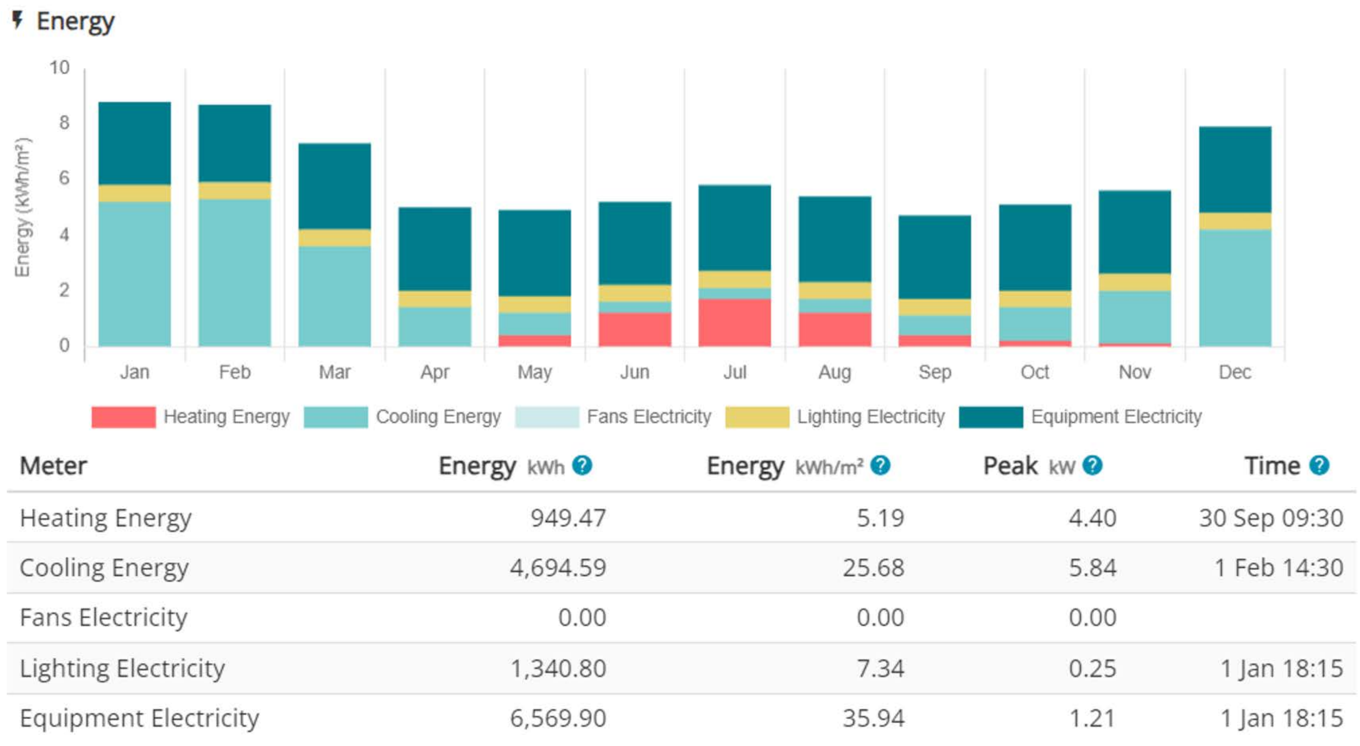
Design strategy 4, energy chart



Meter	Energy kWh	Energy kWh/m²	Peak kW	Time
Heating Energy	1,030.64	5.64	3.07	27 Jun 07:30
Cooling Energy	3,376.28	18.47	4.93	1 Feb 14:30
Lighting Electricity	1,340.80	7.34	0.25	1 Jan 18:15
Equipment Electricity	6,569.90	35.94	1.21	1 Jan 18:15

Figure 10 Design Strategy 4, heating, cooling, equipment and lighting energy chart

Design strategy 5, energy chart



Meter	Energy kWh	Energy kWh/m²	Peak kW	Time
Heating Energy	949.47	5.19	4.40	30 Sep 09:30
Cooling Energy	4,694.59	25.68	5.84	1 Feb 14:30
Fans Electricity	0.00	0.00	0.00	
Lighting Electricity	1,340.80	7.34	0.25	1 Jan 18:15
Equipment Electricity	6,569.90	35.94	1.21	1 Jan 18:15

Figure 11 Design Strategy 5, heating, cooling, equipment and lighting energy chart

Itemised costings

The following costings were undertaken with the services of Your QS. A complete cost breakdown is available; however, only the roof, floor, wall, and window costs have been used in this analysis.

DESIGN STRATEGY H1 PRE-2023

Element	R value	Specification	DTS Pre-2023
Roof	3.6	R3.6 Fibreglass	3,977
Floor	1.5	Concrete raft foundation floors without insulation	45,400
Wall	1.74	R1.8 Batts 90mm studs @600 dwangs @800 Rusticated Pine	31,944
Windows	0.26	Cold Aluminium Non-thermally broken clear double glazing (26.08% WWR)	21,429
			$ 102,752

SCHEDULE METHOD – DEEMED TO SATISFY H1 AS1 POST NOVEMBER 2023

Element	R value	Specification	DTS
Roof	6.73	R7.0 Pink Batts Superbatt®	7,876
Floor	1.5	Table F.1.2.2B: Construction R-values for concrete raft foundation floors without insulation, where the external walls do not have masonry veneer cladding	45,400
Wall	2.06	90mm studs @ 600mm, dwangs @ 800mm R2.2 batt	32,145
Windows	0.46	Industry-standard residential aluminium thermally broken suite with Low-E1 double glazing (26.08% WWR)	27,169
			$ 112,590

Table 12 Wall, Floor, Roof and Window Costings for Pre-2023 and DTS

REFERENCE BUILDING H1 AS1 POST NOVEMBER 2023

Element	R value	Specification	Reference
Roof	6.73	R7.0 Pink Batts Superbatt®	7,876
Floor	1.5	Table F.1.2.2B: Construction R-values for concrete raft foundation floors without insulation, where the external walls do not have masonry veneer cladding	45,401
Wall	2.06	90mm studs @ 600mm, dwangs @ 800mm R2.2 batt	32,109
Windows	0.46	Industry-standard residential aluminium thermally broken suite with Low-E1 double glazing windows adjusted to 30% glazing.	29,736
			$ 115,122

DESIGN STRATEGY 1 – INCREASE WALL BY INSULATION BY 83%, USE INDUSTRY STD WINDOWS INCREASING R VALUE BY 13%, SHGC DECREASED BY 9%

Element	R value	Specification	Design Strategy 1
Roof	4.56	Superbatt® R4.5	4,846
Floor	1.5	Table F.1.2.2B: Construction R-values for concrete raft foundation floors without insulation, where the external walls do not have masonry veneer cladding	45,401
Wall	3.79	90mm studs @ 600mm centres no dwangs, R2.8 batt, strapping 45mm x 70mm with R1.3 batt	43,688
Windows	0.52	Industry-standard residential aluminium thermally broken suite with Low-E2 double glazing (26.08% WWR)	27,169
			$ 121,105

Table 13 Wall, Floor, Roof and Window Costings for Reference Building, and Design Strategy 1

DESIGN STRATEGY 2 – DECREASE FLOOR R VALUE BY 20%, USE INDUSTRY STD WINDOWS INCREASING R VALUE BY 13%, DECREASE SHGC BY 9%

Element	R value	Specification	Design Strategy 2
Roof	4.56	Superbatt® R4.5	4,846
Floor	1.2	Table F.1.2.2F Construction R-values for slab floors without insulation, where external walls do not have masonry veneer	52,550
Wall	2.06	90mm studs @ 600mm, dwangs @ 800mm R2.2 batt	32,109
Windows	0.52	Industry-standard residential aluminium thermally broken suite with Low-E2 double glazing (26.08% WWR)	27,169
			$116,675

DESIGN STRATEGY 3 – INCREASE WALL R VALUE BY 83%, USE INDUSTRY STD WINDOWS INCREASING R VALUE BY 17%, DECREASE SHGC BY 30%

Element	R value	Specification	Design Strategy 3
Roof	4.56	Superbatt® R4.5	4,846
Floor	1.2	Table F.1.2.2F Construction R-values for slab floors without insulation, where external walls do not have masonry veneer	52,550
Wall	3.79	90mm studs @ 600mm centres no dwangs, R2.8 batt, strapping 45mm x 70mm with R1.3 batt	43,688
Windows	0.54	Industry-standard residential aluminium thermally broken suite with Low-E3 double glazing (26.08% WWR)	29,600
			$130,685

Table 14 Wall, Floor, Roof and Window Costings Design Strategy 2 & 3

DESIGN STRATEGY 4 – INCREASED WALL R VALUE BY 4%, USE INDUSTRY STD WINDOW R VALUE BY 13%, DECREASE SHGC BY 30%

Element	R value	Specification	Design Strategy 4
Roof	4.56	Superbatt® R4.5	4,846
Floor	1.5	Table F.1.2.2B: Construction R-values for concrete raft foundation floors without insulation, where the external walls do not have masonry veneer cladding	45,401
Wall	2.15	90mm studs @ 600mm, no dwangs R2.2 batt	28,181
Windows	0.54	Industry-standard residential aluminium thermally broken suite with Low-E3 double glazing (26.08% WWR)	29,601
			$108,029

DESIGN STRATEGY 5 – INCREASED WALL R VALUE BY 4%, USE INDUSTRY STD WINDOWS INCRREASING R VALUE BY 13%, SHGC DECREASED BY 9%

Element	R value	Specification	Design Strategy 5
Roof	4.56	Superbatt® R4.5	4,846
Floor	1.5	Table F.1.2.2B: Construction R-values for concrete raft foundation floors without insulation, where the external walls do not have masonry veneer cladding	45,401
Wall	2.15	90mm studs @ 600mm, no dwangs R2.2 batt	28,181
Windows	0.52	Industry-standard residential aluminium thermally broken suite with Low-E2 double glazing (26.08% WWR)	27,169
			$105,598

Table 15 Wall, Floor, Roof and Window Costings Design Strategy 4 & 5

Discussion

WEERS - Window Energy Efficiency Rating System

The Window & Glass Association of New Zealand ("WGANZ") developed the window energy efficiency rating system ("WEERS"). WEERS offers an on-the-fly calculation of your project's R-value averaged across your specific project's house lot of windows and doors.

WEERS provides a valuable framework for assessing and comparing window energy performance. Using this system to calculate actual window R-values and other performance metrics, stakeholders can enhance building energy efficiency, contributing to environmental sustainability and long-term financial savings. This comprehensive assessment is crucial for advancing energy-efficient designs and improving overall building performance.

Appendix B provides the Calculation Method for an industry-standard aluminium thermally broken suite. The window system R-value results reflect the average weighted house lot of MH1, using a glazing U-cog of 1.1 or 1.0. Several New Zealand window system suppliers, including Architectural Profiles Ltd, Altus Window Systems, FMI Building Innovation, and Omega Windows and Doors provided the R-value data. The data was then averaged across the different suppliers to create the standardised window R-value result used in this analysis.

This average weighted R-value ensures that the data used in this analysis comes from readily available aluminium thermally broken suites and low E glazing. Other WGANZ members providing aluminium thermally broken windows with a glazing U-cog of 1.1 or 1.0 can achieve similar results to this analysis.

Importance of Using WEERS for Calculating Window R-Values

The R-value measures thermal resistance. Traditionally, H1/AS1 energy efficiency clause uses table 2.1.2.2 to allocate generic R-values. WEERS provides a more comprehensive approach to evaluating window performance by providing:

Transparency and Standardisation: WEERS offers a standardised method for comparing different window products based on their energy performance. This transparency helps consumers make informed decisions.

Comprehensive Analysis: WEERS provides a more holistic view of a window's energy efficiency, unlike merely looking at the generic table from H1/AS1.

Informed Building Practices: Builders and architects can use WEERS to select the most appropriate windows for their designs and local climates, ultimately leading to more energy-efficient buildings and reduced energy costs. Asking your current window supplier to provide WEERS R-value ratings will help ensure industry uptake is higher than currently.

Supporting Energy Standards and Codes: With increasing energy codes and standards promoting higher efficiency in building materials, using a rigorous rating system like WEERS helps ensure compliance and promotes advancements in window technology.

Consumer Education and Awareness: By understanding WEERS, architects, designers, builders and homeowners can make better choices based on long-term energy savings and sustainability rather than just upfront costs.

Understanding SHGC and g-value for Glazing

Solar Heat Gain Coefficient (SHGC) and g-value are paramount in glazing discussions around energy efficiency within building regulations and window performance. New Zealand building code clause H1 Verification Method 1 (VM1) utilises the term SHGC for glazing. However, Jason Quinn from Sustainable Engineering recommends that using the SHGC value in cooling-dominated climates would underpredict cooling demand. Therefore, Jason recommends only using the g-value in energy modelling (Quinn, 2024).

The transition to using the g-value for glazing in New Zealand may be approaching. However, this analysis utilised the SHGC because of the H1 VM1 defaults. It is important to understand the similarities and differences between these two metrics, as well as their implications for energy efficiency calculations in New Zealand.

What is Solar Heat Gain Coefficient?

SHGC measures the amount of solar radiation that passes through the glazing and enters a building as heat. Expressed as a number between 0 and 1, the lower the SHGC, the less solar heat is gained. This metric is particularly relevant in warmer climates where reducing heat gain can lead to lower cooling demands and enhanced energy efficiency.

What is g-value?

The g-value, or solar factor, is another metric to assess the solar energy passing through glazing. It accounts for the total solar energy transmitted, absorbed, and re-radiated by the glazing system into the interior space. Like SHGC, the g-value is also calculated as a number between 0 and 1; however, it offers a more comprehensive look at the thermal performance of glazing, considering the effects of both direct solar gain and re-radiated heat.

Similarities between SHGC and g-value

Purpose: Both SHGC and g-value aim to quantify solar energy effects on buildings to inform energy efficiency calculations.

Energy Efficiency Focus: Each measure assists designers and builders in selecting appropriate glazing systems that minimise energy consumption while maximising comfort in residential and commercial structures.

Fractional Representation: Both metrics are expressed as values between 0 and 1, where lower values indicate less solar heat gain.

Differences between SHGC and g-value

Definition of Measurement: In New Zealand thermal modelling, SHGC measures the portion of solar radiation transmitted directly through the glazing. In contrast, the g-value encompasses direct transmission and the subsequent energy effects from absorbed solar energy, which may be re-radiated into the building.

Implications for Building Design: SHGC can lead to glazing choices that prioritise reducing solar heat gain, while the g-value may lead to considerations of how absorbed solar energy contributes to heating the building. This difference may result in varying choices depending on climate and building needs.

Regulatory Landscape: New Zealand's building regulations currently utilise SHGC under H1 VM1, but a possible shift towards the g-value reflects a growing recognition of the importance of total solar performance in achieving energy efficiency goals.

Future Outlook

As New Zealand considers the transition from SHGC to g-value for glazing assessments, it reflects a broader trend toward more integrated approaches to understanding building energy performance. While the timeline for this change remains uncertain, embracing the g-value will provide a more holistic understanding of solar energy dynamics within building environments, potentially leading to significant improvements in energy efficiency and building comfort.

For architects, builders, and energy assessors in New Zealand, staying informed about these metrics and their implications for energy efficiency is not just important, it's essential. This knowledge will help you comply with evolving standards and contribute to a more sustainable built environment, empowering you to make informed decisions that can have a significant impact.

While SHGC has served as the cornerstone for glazing performance assessments in New Zealand, the anticipated move towards the g-value is promising. This transition may offer enhanced insights into solar energy management, ultimately facilitating improved energy efficiency and building comfort nationwide, giving us hope for a more sustainable future.

Solar Heat Gain Coefficient in this analysis

The modelling undertaken in this analysis used glazing SHGC's between 0.77 and 0.39 and glazing U-cog between 2.8 and 1.0, which are the glass performance data for an AGP glass product range. However, WGANZ members in New Zealand should be able to match the U-cog and SHGC values used in this analysis.

A reduction in the SHGC delivered a significant drop in the cooling energy required for DS3 and DS4. The gains from an improved SGHC can only be recognised with thermal modelling, as the schedule and Calculation Method do not demonstrate the benefits of a reduction in SHGC.

The DTS model used a Low-E coating with a SHGC of 0.59 and a U-cog of 1.30, as per H1/AS1 table E1.1.1 a) double-pane, thermally improved Low-E/clear argon-filled double glazing. DS 1, 2, and 5 use a Low-E coating with a SHGC of 0.51 and a U-cog of 1.1. DS 3 and 4 use a Low-E coating with a SHGC of 0.39 and a U-cog of 1.0.

Use the right data

Overall, using floor, roof and wall tools such as Design Navigator and Speckel to obtain accurate R-values combined with actual window, door, and glass data empowers architects and designers with reliable information. The same applies when selecting glazing with either a SHGC or g-value. Know your values and use the right data because using the right data promotes better decision-making and sustainability in construction projects.

Further research

Further research could consider the thermal bridging of increased and decreased timber in walls, as BRANZ (2020) has indicated that wall framing in New Zealand has an average of 34% wall framing and could be as high as 50%.

Further research could include the psi value of installation for windows and the effect on the resultant R-value for an aluminium thermally broken window when installed.

During this analysis, questions about the validity of the default settings in H1 VM1 have been raised. Therefore, a study could be undertaken for MH1 using NZGBC EECHO and passive house PPHP tools to compare against H1 VM1 results.

The analysis could be more in-depth by considering different New Zealand climate zones to understand the similarities and differences in outcomes across the country.

To directly compare to this analysis undertaken in climate zone 1, the effects of different orientations and external shading devices could be undertaken for MH1 to understand the differences in energy efficiency against cost.

A recent update by NIWA for the New Zealand weather file means this analysis could be re-evaluated once Speckel incorporates the new weather file (Ministry of Building, Innovation and Employment, 2024).

References

Barnard, D. T., Eagles, A., Grimes, P. A., Howden-Chapman, P. P., Phipps, P. R., & Viggers, D. H. (2024, July 29). New Zealand's hard-won improvements to our Building Code must be retained: Here's why. Retrieved from Public Health Communication Centre Aotearoa: https://www.phcc.org.nz/briefing/new-zealands-hard-won-improvements-our-building-code-must-be-retained-heres-why

BRANZ. (2024, July 19). BRANZ reinforces support for higher energy efficiency standards. Retrieved from BRANZ: https://www.branz.co.nz/sector-leadership/branz-position-on-maintaining-higher-energy-efficiency-standards/

BRANZ. (2024, March). BU690 Thermal bridges in external wall framing (March 2024). Retrieved from BRANZ: https://d39d3mj7qio96p.cloudfront.net/media/documents/Bulletin690_Thermal_bridges_in_external_wall_framing_v2.pdf

Design Navigator. (2024, September 11). Construction R-value Calculator. Retrieved from Design Navigator: https://www.designnavigator.solutions/CRC.php

Duder, M. (2024, September 23). New H1 Insulation Standards Can Cost as Little as $2,200 Extra Using Calculation Method. Retrieved from Eboss: https://www.eboss.co.nz/detailed/building-industry-insight/h1-insulation-standards-cost-comparison

Hansard. (2024, July 24). Wednesday, 24 July 2024 - Volume 776, Question No. 7—Building and Construction. Retrieved from New Zealand Parliament: https://www.parliament.nz/en/pb/hansard-debates/rhr/combined/HansD_20240724_20240724

Ministry of Building, Innovation and Employment. (2024, November 25). Weather files for Aotearoa New Zealand. Retrieved from Building Performance: https://www.building.govt.nz/getting-started/climate-change-work-programme/resources/weather-files-aotearoa-new-zealand

Quinn, J. (2024, February 16). Don't cook your client by confusing g-value and SHGC. Retrieved from Sustainable Engineering Ltd: https://sustainableengineering.co.nz/dont-cook-your-client-by-confusing-g-value-and-shgc/#:~:text=Relevant%20ISO%20standards%20used%20in,on%20the%20glazing%20material%20properties.

Speckel. (2024, September 11). Energy, daylight, moisture and carbon - design better buildings. Retrieved from Speckel: https://www.speckel.io/

WGANZ. (2024, September 11). Guides, energy efficiency. Retrieved from Window and Glass Association of New Zealand: https://www.wganz.org.nz/wp-content/uploads/2020/11/Energy-Efficiency-Guide-1.pdf

Appendix A, Model House 1

- Overall area floor plan, no garage: 195.53m2
- Perimeter: 67.90m
- Area floor plan, compressed insulation (500mm): 32.95m2
- Area floor plan, non-compressed insulation: 162.97m2

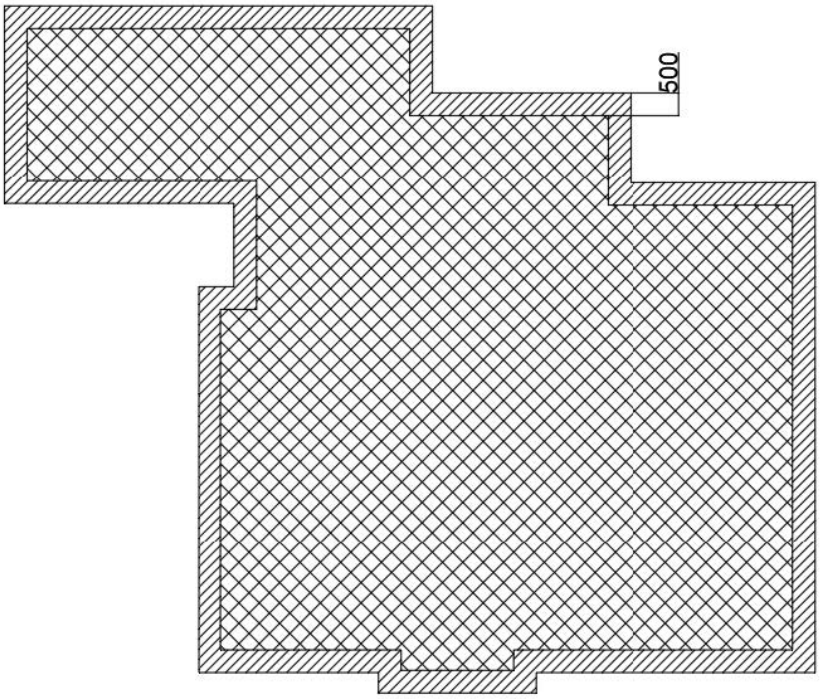


Figure 12 Model house 1, floor and roof area

Area compressed	32.95	m2		
Area not compressed	162.97	m2		
Area weighted roof R-value	**R4.5 Batt**	**R5.0 Batt**	**R6.0 Batt**	**R7.0 Batt**
R-value compressed	3.74	3.90	4.12	4.39
R-value not compressed	4.72	5.22	6.21	7.20
Area weighted Rvalue	4.56	5.00	5.86	6.73

Table 16 Roof perimeter insulation ccompression calculation

Building slab area to perimeter ratio, H1/AS1, equation F.2

$$\text{Equation F.2:} \quad \text{slab area-to-perimeter ratio} = \frac{A_{\text{slab, external}}}{P_{\text{slab, external}}} - \frac{w}{2}$$

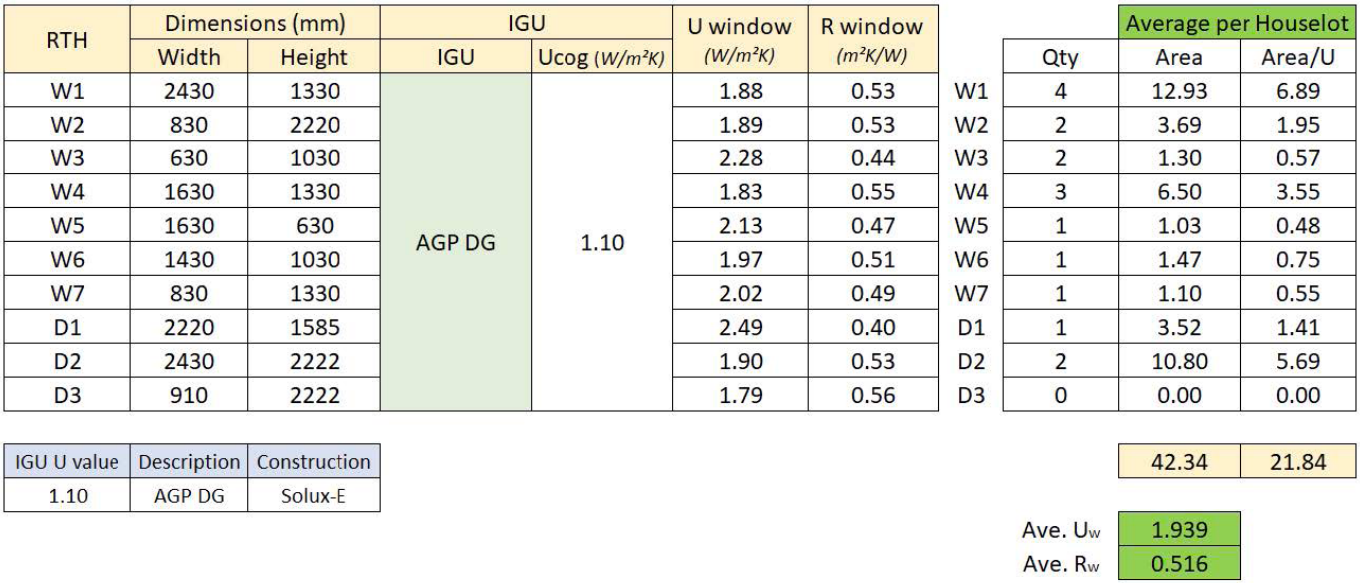
Figure 13 Reference house building slab area to perimeter ratio

Slab area	195.53	Refer to Appendix A, fig 17
Perimeter	67.9	Refer to Appendix A, fig 17
Depth of wall	0.143	Refer to Appendix C
SA -P Ratio	2.81	

Table 17 Building slab area to perimeter ratio, H1/AS1, equation F.2

Appendix B, WEERS calculations of Windows

Industry-standard residential aluminium thermally broken suite with Low-E2 double glazing (26.08% WWR)

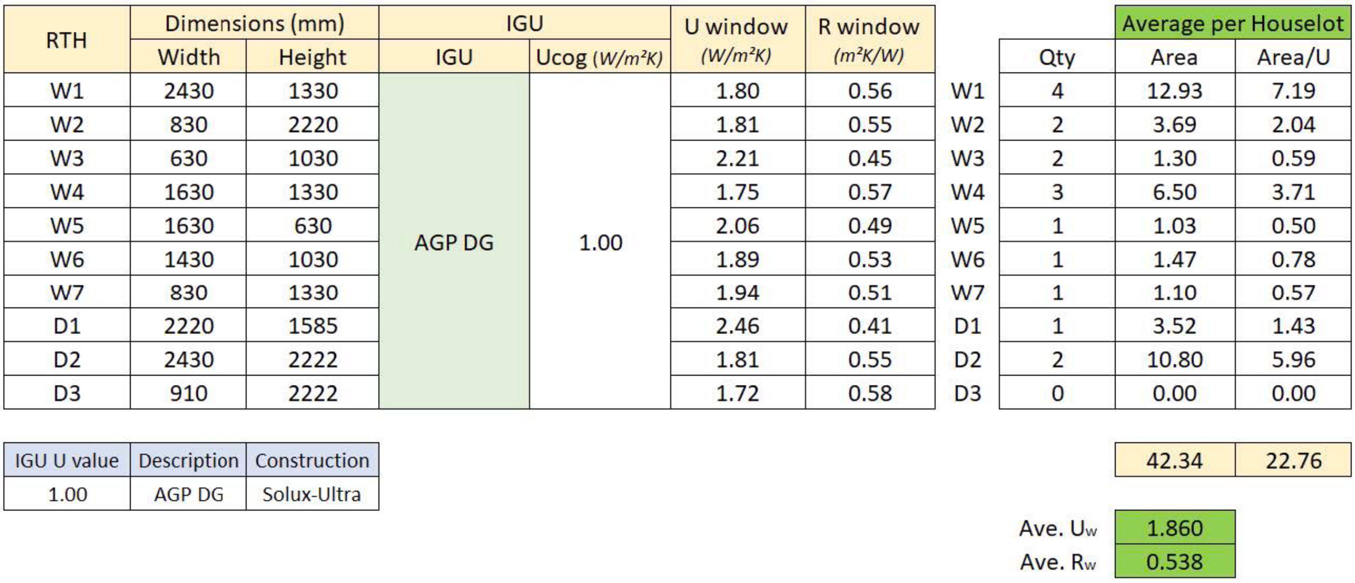


RTH	Dimensions (mm)		IGU		U window (W/m^{2}K)	R window (m^{2}K/W)			Average per Houselot	
	Width	Height	IGU	Ucog (W/m^{2}K)				Qty	Area	Area/U
W1	2430	1330	AGP DG	1.10	1.88	0.53	W1	4	12.93	6.89
W2	830	2220			1.89	0.53	W2	2	3.69	1.95
W3	630	1030			2.28	0.44	W3	2	1.30	0.57
W4	1630	1330			1.83	0.55	W4	3	6.50	3.55
W5	1630	630			2.13	0.47	W5	1	1.03	0.48
W6	1430	1030			1.97	0.51	W6	1	1.47	0.75
W7	830	1330			2.02	0.49	W7	1	1.10	0.55
D1	2220	1585			2.49	0.40	D1	1	3.52	1.41
D2	2430	2222			1.90	0.53	D2	2	10.80	5.69
D3	910	2222			1.79	0.56	D3	0	0.00	0.00
									42.34	21.84
								Ave. U_w	1.939	
								Ave. R_w	0.516	

IGU U value	Description	Construction
1.10	AGP DG	Solux-E

Table 18 Thermally broken windows and doors with Low-E2 double glazing, Ug 1.1, SHGC 0.51

Industry-standard residential aluminium thermally broken suite with Low-E3 double glazing (26.08% WWR)



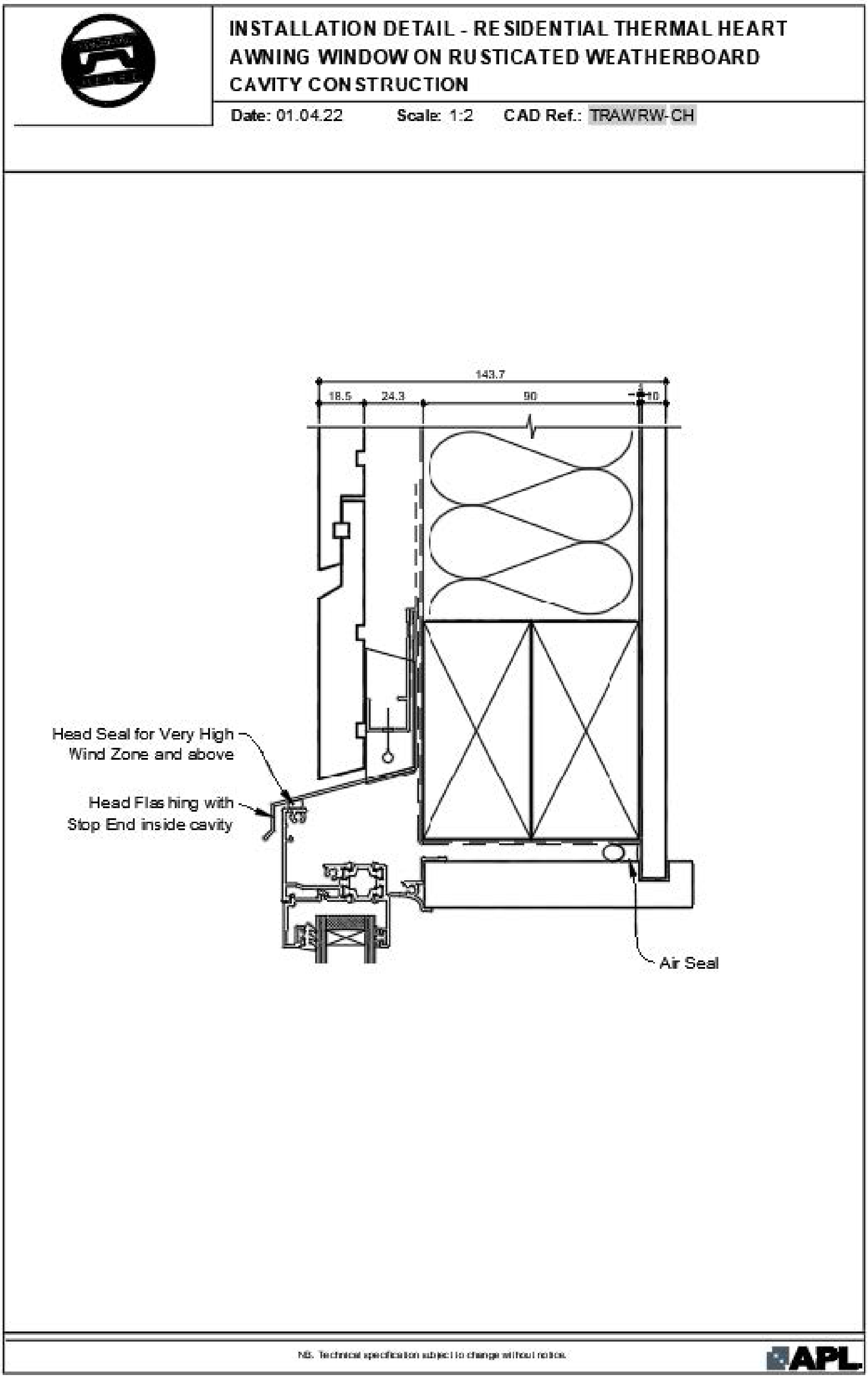
RTH	Dimensions (mm)		IGU		U window	R window			Average per Houselot	
	Width	Height	IGU	Ucog *(W/m²K)*	*(W/m²K)*	*(m²K/W)*		Qty	Area	Area/U
W1	2430	1330	AGP DG	1.00	1.80	0.56	W1	4	12.93	7.19
W2	830	2220			1.81	0.55	W2	2	3.69	2.04
W3	630	1030			2.21	0.45	W3	2	1.30	0.59
W4	1630	1330			1.75	0.57	W4	3	6.50	3.71
W5	1630	630			2.06	0.49	W5	1	1.03	0.50
W6	1430	1030			1.89	0.53	W6	1	1.47	0.78
W7	830	1330			1.94	0.51	W7	1	1.10	0.57
D1	2220	1585			2.46	0.41	D1	1	3.52	1.43
D2	2430	2222			1.81	0.55	D2	2	10.80	5.96
D3	910	2222			1.72	0.58	D3	0	0.00	0.00
									42.34	22.76

IGU U value	Description	Construction
1.00	AGP DG	Solux-Ultra

Ave. U_w	1.860
Ave. R_w	0.538

Table 19 Thermally broken windows and doors with Low-E3 double glazing, Ug 1.0, SHGC 0.39

Appendix C, Window installation, wall depth



INSTALLATION DETAIL - RESIDENTIAL THERMAL HEART
AWNING WINDOW ON RUSTICATED WEATHERBOARD
CAVITY CONSTRUCTION

Date: 01.04.22 Scale: 1:2 CAD Ref.: TRAWRW-CH

NB. Technical specification subject to change without notice.

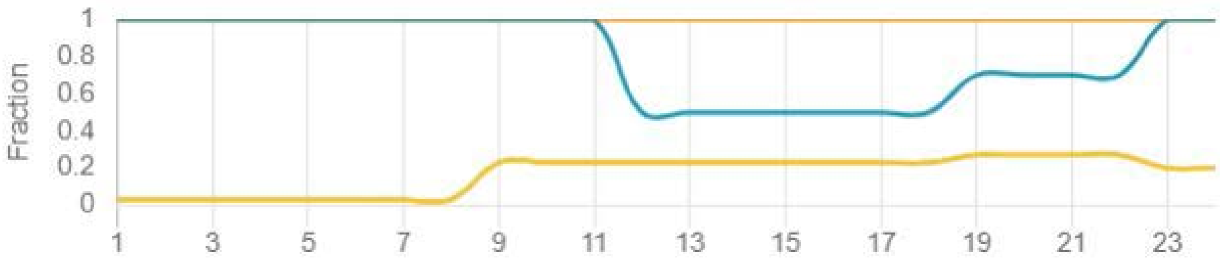
Figure 14 Wall thickness for floor slab calculations

Appendix D, H1 VM1 defaults

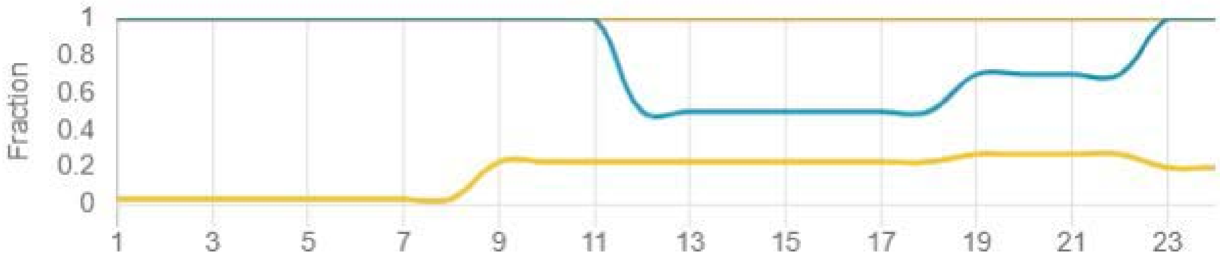
During this analysis, questions about the suitability of using the H1 VM1 defaults for thermal modelling were raised. The analysis employs all the defaults outlined in Appendix D. The modelling method involves comparing building energy use and continues to utilize H1 VM1, a verification method recognized as part of the building code. By using the same defaults across all design strategies, we ensure comparability of the results. Speckel, the software used for the analysis, has been tested against the ASHRAE Standard 140 procedure.

Schedule

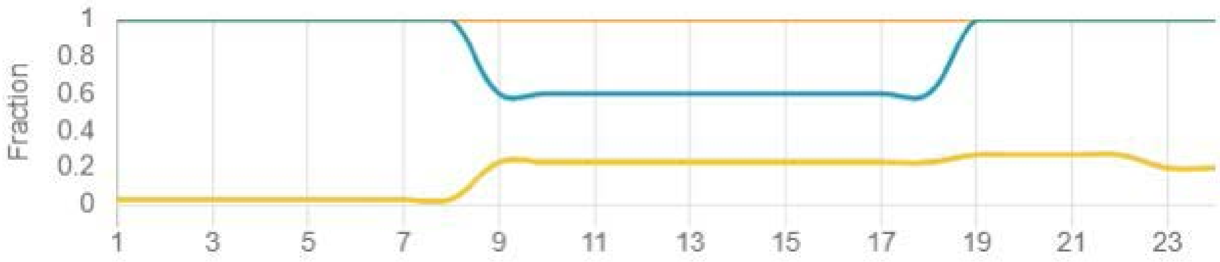
Saturday



Sunday

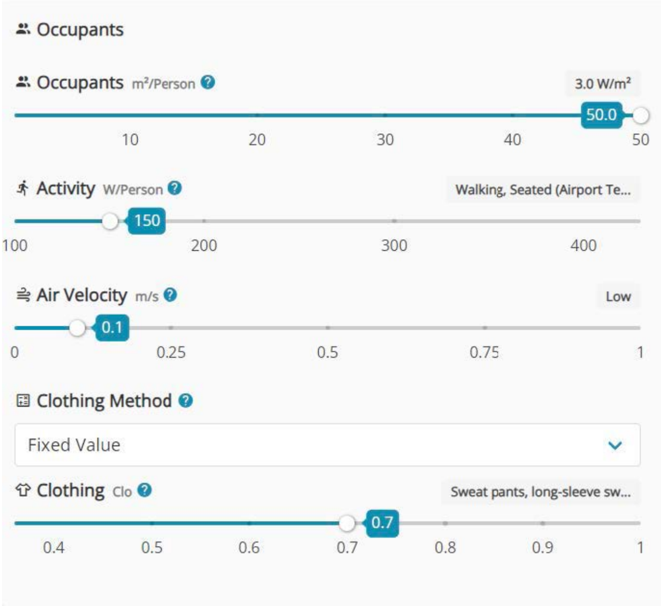


All Other Days



Schedules apply up to specified hour - e.g. '16' applies between 3:00pm and 4:00pm

Occupants



Occupants

Occupants m²/Person: 50.0 (3.0 W/m²)

Activity W/Person: 150 (Walking, Seated (Airport Te...)

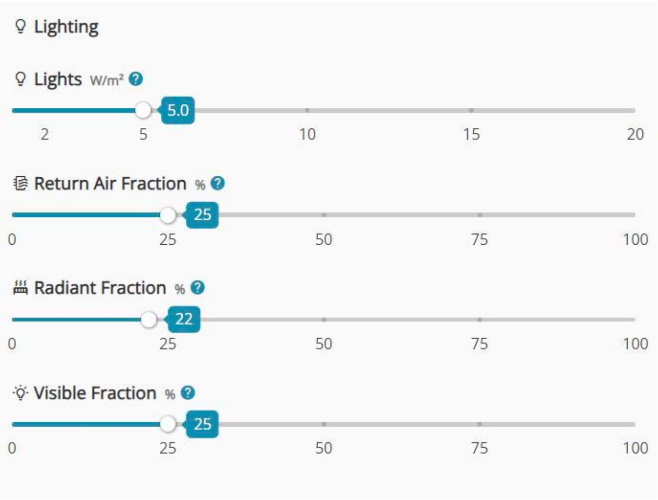
Air Velocity m/s: 0.1 (Low)

Clothing Method: Fixed Value

Clothing Clo: 0.7 (Sweat pants, long-sleeve sw...)

Figure 16 Occupants from H1 VM1 used in Speckel

Lighting loads



Lighting

Lights W/m²: 5.0

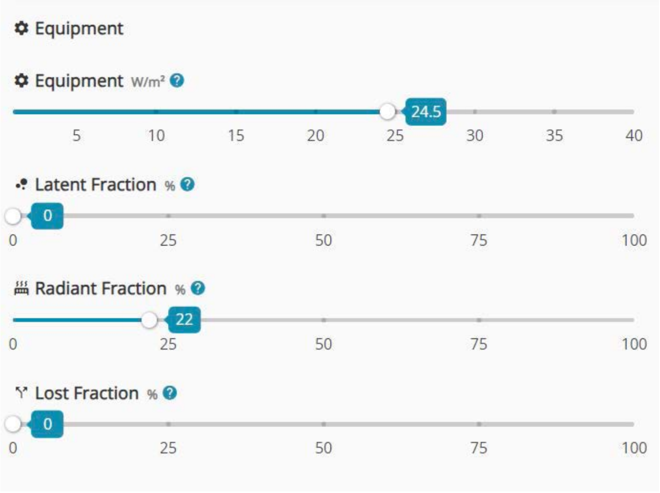
Return Air Fraction %: 25

Radiant Fraction %: 22

Visible Fraction %: 25

Figure 17 lighting loads from H1 VM1 used in Speckel

Equipment loads



Equipment

Equipment W/m²: 24.5

Latent Fraction %: 0

Radiant Fraction %: 22

Lost Fraction %: 0

Figure 18 lighting loads from H1 VM1 used in Speckel

Infiltration

Infiltration

Infiltration ACH: 0.35

Figure 19 infiltration, air changes per hour from H1 VM1 used in Speckel

Thermostat


Thermostat

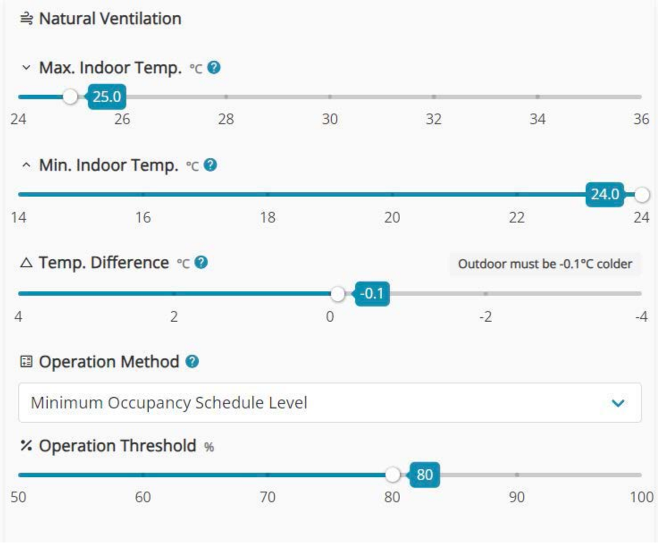
Cooling Setpoint °C 26.0

Heating Setpoint °C 18.0

Assigning setpoints outside of normal ranges (i.e. 18 to 26°C) can lead to HVAC sizing errors.

Figure 20 thermostat cooling and heating setpoints from H1 VM1 used in Speckel

Natural ventilation


Natural Ventilation

Max. Indoor Temp. °C 25.0

Min. Indoor Temp. °C 24.0

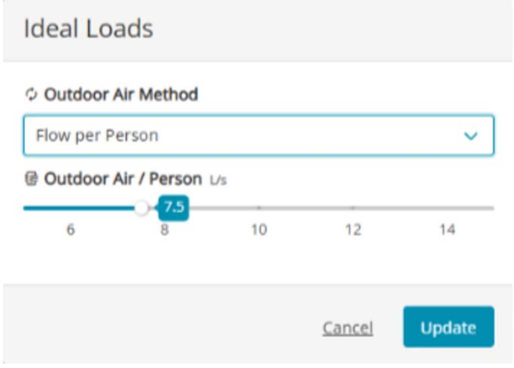
Temp. Difference °C -0.1

Outdoor must be -0.1°C colder

Operation Method: Minimum Occupancy Schedule Level

Operation Threshold % 80

Figure 21 natural ventilation including max and min indoor temperatures from H1 VM1 used in Speckel

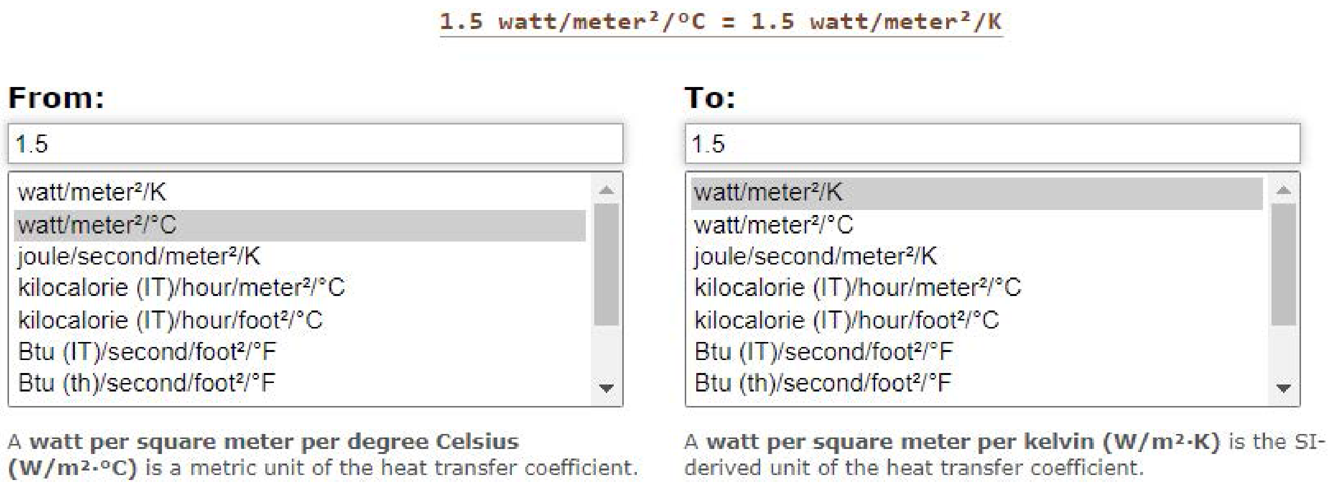

Ideal Loads

Outdoor Air Method: Flow per Person

Outdoor Air / Person L/s 7.5

Figure 22 HVAC ideal loads set at default used in Speckel

Appendix E, R-value conversion



1.5 watt/meter^2/°C = 1.5 watt/meter^2/K

From: 1.5

To: 1.5

A **watt per square meter per degree Celsius (W/m^2·°C)** is a metric unit of the heat transfer coefficient.

A **watt per square meter per kelvin (W/m^2·K)** is the SI-derived unit of the heat transfer coefficient.

Figure 23 R-value unit conversion chart, watt/meter2/Co vs watt/meter2/K

The units m^2°C/W (square meters degrees Celsius per watt) and m^{2}K/W (square meters Kelvin per watt) quantify thermal resistance in building materials, called R-values. These units represent the same physical quantity of thermal resistance because, in the context of temperature changes, the sizes of one degree Celsius and one Kelvin are identical.

When calculating a temperature difference, it's important to remember that both degrees Celsius and Kelvin have the same incremental value. This is because Kelvin is an absolute scale that increments identically to the Celsius scale. Therefore, the numerical values for temperature differences and, thus, for the thermal resistance remain unchanged between the two units, reinforcing the practical equivalence of m^2°C/W and m^{2}K/W.

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www.technoform.com

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