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Sustainability Planning Scheme Amendment - Background Research

Part A. Technical ESD and Development Feasibility

Municipal Association of Victoria on behalf of the Council Alliance for a Sustainable Built Environment

HIP V. HYPE

WHO WE ARE

HIP V. HYPE Sustainability provides advice that is commercially grounded, yet ambitious. We pursue exceptional outcomes that are socially, economically and environmentally sustainable and enable action across government, institutions and organisations.

We seek to partner with those who are willing to think strategically to achieve better. We lead, collaborate and support others to deliver impact and build Better Cities and Regions, Better Buildings, and Better Businesses.

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We respectfully acknowledge that every project enabled or assisted by HIP V. HYPE in Australia exists on traditional Aboriginal lands which have been sustained for thousands of years.

We honour their ongoing connection to these lands, and seek to respectfully acknowledge the Traditional Custodians in our work.

Climate Active Carbon Neutral ORGANISATION

HIP V. HYPE Sustainability Pty Ltd is a Climate Active certified carbon neutral business.

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Introduction

For approximately 20 years local government in Victoria has been leading both voluntary and policy led approaches to sustainable design assessment in the planning process. This leadership is built on community expectation, their role as a responsible authority and the urgency to act on critical environmental challenges such as climate change.

Both planning and building processes have a role in evolving and elevating best practice to deliver a sustainable built environment. The Council Alliance for a Sustainable Built Environment (CASBE) is an alliance of Victorian councils committed to the creation of a sustainable built environment within and beyond their municipalities with a focus on the planning process as the lever for delivering more climate and environmentally responsive development.

CASBE provides a supportive environment for councils and seek to enable the development industry to achieve better buildings through consultative, informative relationships. In this work CASBE is acting on behalf of 31 member councils to develop an evidence base to support new planning policy. CASBE is auspiced by the Municipal Association of Victoria and is the owner and manager of the Built Environment Sustainability Scorecard (BESS), a key tool for demonstrating environmentally sustainable design (ESD) credentials at the site scale, at the planning stage.

POLICY CONTEXT

The evolution of planning policy and its relation to delivering sustainability outcomes in the built environment is long and complex. Whilst there is some State planning policy support for sustainability outcomes, much of the environmental sustainability planning policy development has been developed through local policy. In 2013 the City of Melbourne developed a local policy; Clause 22.19 - Energy, Water, Waste Efficiency. In 2015, 6 local councils collaborated on a planning scheme amendment for a local ESD policy. Almost identical ESD policies are now in place in over 20 municipal planning schemes.

City of Melbourne is now progressing an update and a broadening of their own local policy, and CASBE (supported by 31 councils) is progressing a new policy which would replace the existing ESD policy in some Councils and introduce an ESD assessment approach to others. The policy update is required to respond to evolving best practice and to reflect the increased urgency in response to climate change.

SCOPE

CASBE has commissioned background research in three parts:

- Part A. Technical ESD and Development Feasibility
- Part B. Planning Advice
- Part C. Economic Benefit Cost Analysis

A consultant team comprising Hansen Partnership, Frontier Economics and HIP V. HYPE Sustainability has been appointed to undertake the background research. This report responds to Part A of the brief. HIP V. HYPE have been supported in responding to Part A by Jackson Clements Burrows (JCB) Architects.

CASBE has developed policy objectives and standards to a working draft stage to support the project. All parts of the project are focused on testing these objectives and standards and developing evidence to justify their inclusion in the planning scheme.

The scope of Part A is as follows:

Task 1 – Design Response

This task involves the development of design responses which meet agreed objectives and standards for 8 building typologies. The design responses build on case studies drawn from councils who are supporting the research, some of whom have a local ESD policy in place and others who rely on State policy or other locally specific provisions for assessing ESD at the planning stage.

Task 2 – Technical Feasibility

This task includes the analysis of technical feasibility of these design responses.

Task 3 – Development Feasibility (Financial Viability)

This task presents an itemised development feasibility of each standard, including cost variations where applicable and benefits (including financial) that are applicable to each standard.

Task 4 – Prepare a summary of recommendations

This task includes a summary of recommendations, including any variations or recommendations for removal of any standards and their justification.

The method applied to the above scope is detailed in Section 2 of this report.

Introduction

PURPOSE OF REPORT

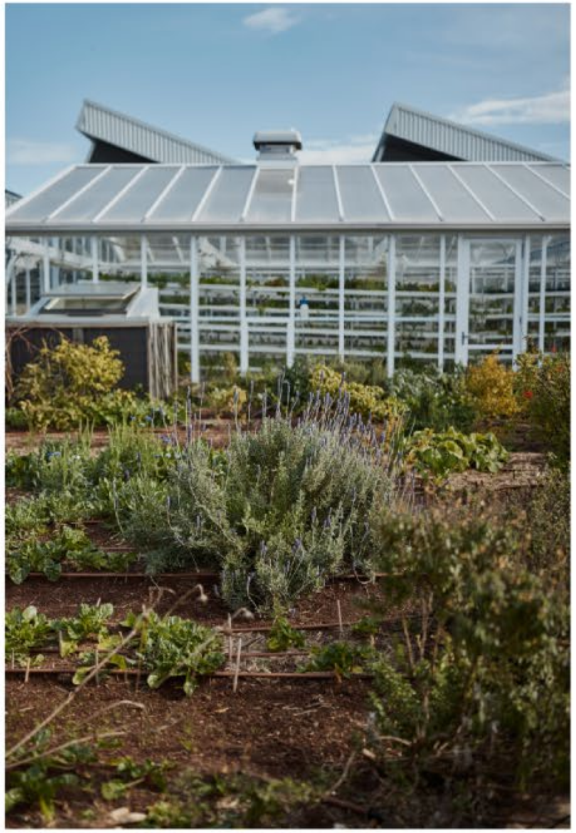
The purpose of this report is to present the outcomes of the above research, which when combined with the outputs of Part B and Part C, represent a robust evidence base to support further development of the proposed planning scheme amendment.

The report allows the planning scheme amendment process to consider likely impacts of the proposed policy from a technical feasibility and financial viability perspective, recognising that the benefits of ESD standards accrue to a range of stakeholders in the development process.

STRUCTURE OF REPORT

The report is structured as follows:

1. Executive Summary
2. Introduction (this section)
3. Method (detailing the approach to the meeting the requirements of the project)
4. Technical Feasibility and Financial Viability (detailing the results of the two critical research components across each ESD category)
5. Conclusions (key findings and further research)
6. Appendices



Rooftop garden and solar photovoltaic panels at Burwood Brickworks. Photography by Kim Landy

Method

The approach to the project for this technical and development feasibility research has centred on applying a range of proposed standards across six ESD categories or themes to real world case studies. Appropriate design responses to meet the standards were developed and their impact documented.

This section of the report outlines the method applied to the project.

CASE STUDY SELECTION

To ensure the proposed elevated standards were assessed against a diverse and representative sample of developments, HV.H worked with the CASBE and its network of councils to identify suitable case studies. These case studies were selected to satisfy the typology criteria (below), provide a diversity of localities and local policy contexts. 'Middle of the road' examples were sought to ensure that the case studies chosen were representative of standard responses to existing policy settings. Sufficient documentation of the endorsed developments was also a consideration.

For each typology, two case studies were sourced which represented councils with local ESD policies (from the 2015 and subsequent amendments) and councils without.

For the single dwelling typology, only one case study was sourced as this typology does not commonly have a local ESD policy applied. Note that some non-ESD policy case studies for Inner Urban and Suburban councils included ESD Statements and/or assessments against the Built Environment Sustainability Scorecard (BESS) which highlights the voluntary uptake of such objectives and tools despite a lack of local planning policy.

The councils of Melbourne, Port Phillip, Stonnington, Yarra, Darebin and Moreland were considered Inner Urban, all other metropolitan Councils considered Suburban and all councils outside the metropolitan boundary considered Regional.

TYPOLOGY	INNER URBAN	SUBURBAN	REGIONAL
(RES1) Large residential mixed-use development >50 apartments and small retail	ESD Policy	Non-ESD Policy	
(NON-RES 1) Large non-residential >2,000 m2 GFA office development	ESD Policy	Non-ESD Policy	
(NON-RES 2) Large industrial >2,000 m2		ESD Policy	Non-ESD Policy
(RES 2) Small multi-dwelling residential <3 dwellings		ESD Policy	Non-ESD Policy
(RES 3) Small multi-dwelling residential >5 dwellings but < 10 dwellings	ESD Policy	Non-ESD Policy	
(RES 4) Small residential apartment building >10 dwellings but <50 dwellings		ESD Policy Non-ESD Policy	
(NON-RES 3) Small non-residential office and retail <2,000 m2	ESD Policy		Non-ESD Policy
(RES 5) Single dwelling and/or residential extensions greater than 50 m2		Non-ESD Policy	

Matrix detailing the eight typologies, the case study locality type and the local ESD policy context.

Method

DOCUMENTATION

The proposed standards (which were sourced from work developed to working draft stage by CASBE) were reviewed by HV.H against the case study documentation including plans, ESD Statements and BESS assessments, and these base case design responses documented. Where documentation was not sufficient to determine the base case design response, assumptions were based on the BESS benchmarks, policy or regulatory settings and/or using the response of the other base case for the same typology.

To allow for standardisation of results across both case studies and the alternative, the second base case was 'scaled' using built form of one case study (the case study with a local ESD policy). This involved using the built form parameters of the first case study such as site area, gross floor area and dwelling number but applying the design responses of the second case study. This provided for a consistent basis for comparison. This was particularly relevant for initiatives that were directly informed by the scale of the built form such as bicycle parking, where total parking numbers were not comparable and a parking ratio applied to the selected built form allowed for equivalence.

ALTERNATIVE DESIGN RESPONSES AND TECHNICAL FEASIBILITY

Following the documentation of the base case designs, alternative design responses which satisfied the proposed standards were developed by HV.H for all standards (with the exception of those that had been ruled out by through preliminary assessment by Hansen Partnership). These responses included specifications or a built form response, and aimed to clearly communicate the change required to meet the proposed standards as the key input into the cost benefit analysis.

For those initiatives which had a built form response, these were discussed at a series of design workshops attended by HV.H Sustainability, HV.H Projects and JCB Architects. The implications of the standards were tested to ensure that any built form response was cost-effective and technically feasible.

BENEFITS EVALUATION

A range of benefits associated with the alternative design responses were evaluated by HV.H including quantitative benefits such an operational energy, operational water and landfill diversion. Qualitative benefits were also noted such as carbon reduction, thermal comfort improvements and ecosystem services benefits.

Operational energy (HVAC and hot water) and water benefits (potable water reduction for interior uses and irrigation) were quantified using the BESS calculators. Other figures such as total energy use, construction and organic waste generation, and embodied carbon of concrete were quantified using industry benchmarks and average figures. Refer to appendices for further detail of sources and calculations methodology.

These benefits were communicated to Frontier Economics for incorporation into the cost-benefit analysis.

Electric vehicle charging station at The Cape development.
Photography by Kim Landy

Method

FINANCIAL VIABILITY

Through the analysis, HV.H provided preliminary feedback on the proposed standards to Hansen where the costs and/or yield loss were considered prohibitive. Such examples include requiring a separate line of travel for cyclists in basement car parking.

The capital cost of design responses was quantified for standards where the alternative response was different to the base case and the alternate response incurred either a cost or saving. These capital costs were communicated to Frontier Economics for incorporation into the cost-benefit analysis.

The costs were derived from a range of sources according to the following hierarchy:

- Rawlinsons Australian Construction Handbook (note that the 2020 version was used as this was considered less likely to be impacted by fluctuations in the market during the COVID pandemic)
- Suppliers (written and verbal quotations) and product listings
- Industry reports
- Consultancies with industry expertise

Refer to appendices for full list of costs and sources.

STANDARDS RECOMMENDATIONS

Insights from the above analysis informed advice from HV.H to Hansen as to whether a proposed standard should be excluded or modified to ensure improved financial and technical feasibility. Such examples include some required rates of on-site solar photovoltaic generation not being achievable, or reducing the prescriptive approach of non-residential ventilation standards.

COST-BENEFIT ANALYSIS INTEGRATION

Discussions between HV.H and Frontier Economics ensured that the capital costs and quantitative and qualitative benefits HV.H documented were appropriate and could be integrated into the cost benefit framework. These costs and benefits from the technical and financial analysis were incorporated by Frontier into the cost-benefit analysis.

REPORTING

The above activities, outputs and insights are summarised within this report. Key findings, limitations and next steps are detailed for use by the Municipal Association of Victoria as part of the future Sustainability Planning Scheme Amendment.

Note that as work of different expertise streams (e.g. ESD and planning) was undertaken in parallel, there are some differences in wording and distribution of draft standards across different ESD categories as these have evolved over time. This report has aligned category theme wording as best as possible with the planning report, and a summary of the relationship between ESD categories as defined in the planning report has been included as an appendix for reference.

Urban greenery in Elwood. Photography by Adam Gibson

Technical Feasibility and Financial Viability

This section of the report outlines the results of technical feasibility and financial viability testing of proposed objectives and standards.

ESD CATEGORIES

This report is based on six ESD categories as follows:

- Operational Energy
- Sustainable Transport
- Integrated Water Management
- Indoor Environment Quality (IEQ)
- Circular Economy
- Green Infrastructure

Note that the above categories were based on an early restructured categorisation by Hansen Partnership which removed the 'Climate Resilience' theme and redistributed standards initially under that theme. The 'Climate Resilience' theme was reintroduced as part of subsequent planning advice after the ESD analysis was undertaken, while the 'Circular Economy' category was split into two called 'Waste and Resource Recovery and 'Embodied Emissions' (see Appendix D).

In this section of the report, results are presented for each category in turn, drawing on analysis relating to both technical and financial impacts of proposed standards.

The results are presented in table format. The tables have adopted the same structure as the early set of restructured standards presented by Hansen. The standards tested in this analysis were also from the early restructure by Hansen, with wording largely unaltered at that stage. Subsequent rewording by Hansen was reviewed by HV.H to ensure the intent of both versions was similar and that the technical analysis would not be impacted.

The table sets out the following in relation to each standard:

- Standard (description)
- Nested standard (this applies only when the standard differs between typologies)

Then with reference to base cases (Local policy, State policy)

- Design Impact (including variations between typologies)
- Cost impacts (by typology)
- Benefits (by typology)
- Recommendation

Our advice in the recommendations is either to retain a standard in its current form, to modify a standard or to remove the standard altogether. In the case that a standard is recommended for removal either by Hansen or HV.H, the standard is noted as:

- Appropriate as a guideline (e.g. Guidelines for Sustainable Building Design)
- Appropriate for incorporation in future updates to the BESS
- Requiring further testing and analysis to determine potential pathway
- Is inappropriate to be addressed through any of the above mechanisms.

Where a standard is recommended to be modified, this feedback has been incorporated by Hansen into the planning advice Following the tabulated analysis a summary is provided for each category.

Construction site of townhouse development.
Photography by Sunlyt Studios

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Operational Energy

This theme focuses on energy efficiency, on-site renewable energy generation and energy supply, with the aim of achieving net zero operational carbon.

Rooftop solar photovoltaic panels at Burwood Brickworks. Photography by Kim Landy

Operational Energy

STANDARD	DESIGN IMPACT	CAPITAL COST IMPACT	BENEFITS	RECOMMENDATION
S1 A Net-zero carbon performance from all operational energy use must be achieved through a combination of measures	There is no design impact as this standard is met by a range of other standards (e.g. S2, S6, S8)	N/A	N/A	We recommend that the standard be removed and reinstated as an objective only as other standards deliver energy efficiency, prohibit fossil fuels, deliver on-site renewable energy generation and require off-site renewable energy purchasing.
S2 No natural gas or other onsite fossil fuel consumption is permitted (*continued on next page)	Design / technical impact is generally negligible with the exception of very large buildings. No design responses created insurmountable issues with technical feasibility. In regard to hot water provision, in larger residential typologies, the most likely design response to meet the standard is a centralised electric hot water heat pump, which has a reasonably significant impact on roof plant spatial allocation (but does not result in a reduction of any residential space). Design responses for all other typologies 'swap out' gas instantaneous or storage hot water systems for either electric heat pumps (smaller residential) and electric instantaneous (non-residential).	The cost impact varies. The electric alternative generally has a higher capital cost than the gas alternative, with the exception of the electric instantaneous which is marginally favourable in terms of capital cost. Whilst not included in our analysis of costs, where the infrastructure associated with gas is avoided altogether further cost reductions are available. In certain circumstances, electricity peak demand may trigger a contribution to network infrastructure (such as a transformer upgrade). There is an avoided future cost of retrofit (would be required to meet State and National carbon reduction targets).	All electric alternatives with the exception of electric instaneous offer an operational energy and corresponding cost saving. Smaller residential typologies also offer the benefit of avoiding a supply charge for gas. Electric alternatives can further reduce carbon impact when matched with on-site renewable energy or completely remove operational energy emissions if there is a renewable electricity contract in place. Gas alternatives lock in fossil fuel dependence and do not allow for zero carbon in operation without offsets. Excluding natural gas also better aligns inclusion of demand management systems with potential future income There is also greater certainty around achieving zero net emissions given the future emissions intensity of the electricity and gas networks are not locked in for the life of a building. Whilst carbon associated with grid electricity will decrease with clear policy and trend, for gas networks this is much less clear.	The standard has strong justification based on a range of benefits and manageable cost impacts. We recommend the standard be discretionary to allow for the very limited range of uses (e.g. commercial kitchens and industrial uses with high thermal loads) where further industry transition is required before a mandatory control can be introduced. This discetion should be applied in very limited circumstances. We recommend that the proposed Guidelines for Sustainable Building Design apply discretion for electric instanteous systems for taller residential buildings and non-residential buildings.

Operational Energy

STANDARD	DESIGN IMPACT	CAPITAL COST IMPACT	BENEFITS	RECOMMENDATION
S2 No natural gas or other onsite fossil fuel consumption is permitted (*continued from previous page)	The design response for all typologies for cooking was electric induction. For many of the typologies, induction was already specified. Induction cooking is now common in residential development (estimated to be approximately 25% of applications in City of Yarra in 2021) and no design responses created insurmountable issues with technical feasibility, however may contribute to peak electrical demand for the building. Food and beverage (commercial kitchen scale) may present some challenges from a market acceptance perspective.	The cost impact is approximately 25% at the dwelling level, but maybe partially offset by reducing piping costs from central gas supply.	Electric induction cooking is: _More efficient than gas cooking offering an operational energy saving _Safer than gas cooking _Able to be matched with renewable energy _Avoid health (air quality) impacts associated with indoor gas combustion	See above.
S4 Residential (Class 1 & 2) and Aged Care (Class 3) only Residential developments should achieve an average 7 Star NatHERS	The design impact of meeting the proposed standard varies according to strategies employed and can be achieved using a variety of methods including passive solar design changes (orientation, window size, window placement, shading) or specification improvements (window performance, insulation).	No capital cost is incurred as the proposed standard is already recommended to be included in the proposed changes to National Construction Code (NCC) in 2022. If this does not occur it is highly likely that the Victorian government will take the step to 7-star themselves.	The heating and cooling energy consumption benefit of moving from 6 star to 7 star NatHERS is approximately 28% reduction in predicted energy use per m2. This benefit has not been incorporated in the cost benefit analysis, because the increase in thermal performance will likely be required through a building permit requirement in the short term. A health and wellbeing benefit would also be delivered related to the improvement in thermal performance.	We recommend that the standard be retained for completeness, but removed from the proposed planning scheme amendment if the proposed 7 star NCC 2022 standards (or Victorian variation) are confirmed. We recommend that aged care (Class 3) not be included as NatHERS is not an appropriate measure for this development type. We recommend that evidence from the following report be used to support the evidence base if the proposed NCC 2022 changes are not adopted as drafted.
S5 Residential and aged care only Provide external natural clothes drying facilities that does not impact open space area or visual amenity	The design impact of meeting the proposed standard is restricted to amenity and visual obstruction issues. Many owners corporation rules still prohibit hanging clothes on balconies where they can be seen by other residents, but a range of flexible solutions are now available that nest drying clothes in behind the balustrade and also allow for the space to be usable for recreation when not in use. In an aged care setting, the impact is similar. Note that some planning overlays or restrictions on title prohibit clothes lines being visible from frontage.	Capital cost is negligible, so has not been sourced.	Benefits relate to operational energy savings, as outdoor drying avoids the use of clothes dryers but have not been quantified.	We recommend that the standard be retained in its current form, but more consultation occur with the aged care sector to ensure that guidelines for implementation do not impact private open space amenity. We recommend that the term open space be clarified (private open space versus public open space).

Operational Energy

STANDARD	DESIGN IMPACT	CAPITAL COST IMPACT	BENEFITS	RECOMMENDATION
S6 Maximise onsite renewable energy generation to meet or exceed predicted annual energy use: Medium density only A 3kW minimum capacity solar photovoltaic (PV) system must be installed for each 1-2 bedroom dwelling and an additional 1.0kW per bedroom for each bedroom there-after. The electrical system should be designed to maximise on-site consumption of renewably generated electricity (i.e. minimizing grid export).	The design impact of solar PV for smaller residential typologies (single dwellings and town houses) is minimal, with roof spaces generally with adequate space provision to meet the standard.	Capital cost impact is now less than $1,000 per kWp at this scale.	Solar energy generation offsets on site consumption of electricity creating an operational saving (with a return on investment of generally less than 5 years). There is a corresponding carbon reduction benefit.	We recommend retaining the standard, based on strong financial benefit to the occupant, but allowing some discretion, when there is conflicting roof space with an alternative use which has environmental or social benefit or when existing or an approved building will overshadow the roofspace. If roofspace is restricted, Building Integrated Photovoltaic (BIPV) Panels could be considered as an appropriate strategy to achieve the required solar PV capacity, however, should not be required. We believe this standard could apply to single dwellings as well as medium density.
S6 Maximise onsite renewable energy generation to meet or exceed predicted annual energy use: Apartments only Provide a solar PV system with a capacity of at least 25W per square meters of the development's site coverage, OR 1kW per dwelling. *Capacity of solar PV system: kW = Site coverage (m2) x 25 (W/m2) / 1000(W/kW). The system should be designed to optimise use of on-site generated electricity	The design impact of meeting the proposed standard for apartments is significant, especially for larger buildings. Based on the largest of the case studies (RES 1), a 38kWp system would be required to meet the proposed standard, however our analysis indicates that only 16kWp is achievable (with additional pergola shading structures to support panels over some communal terrace areas), based on rooftop capacity.	Capital cost based on industry standards remains below $1,000 per kWp, but may be higher in certain circumstances.	Benefits are as above for all solar PV standards.	We recommend modifying the standard to account for discretion in circumstances where the amount of unencumbered roof space is not available to meet the standard. Whilst the standard could be modified in many ways, we consider that because the standard is unable to be met only when there are significant competing roof top uses, that the standard could be reworded as discretionary ie that buildings **should** provide the benchmark solar PV capacity. We recommend that proposed Guidelines for Sustainable Building Design should outline specific (narrow) circumstances where discretion may be required such as competing beneficial roof uses and existing or known future overshadowing. Standard S7 would drive optimisation of roof capacity to ensure the best available space for solar PV. Where apartments are a mixed use building (e.g. have ground floor retail), the standard for the predominant use in the development should apply.

Operational Energy

STANDARD	DESIGN IMPACT	CAPITAL COST IMPACT	BENEFITS	RECOMMENDATION
S6 Maximise onsite renewable energy generation to meet or exceed predicted annual energy use: Industrial & warehouse only All roofs must be structurally designed to be able to accommodate full PV coverage, excluding areas set aside for plant equipment or areas significantly shaded by other structures	The design impact of meeting this standard has not been tested as the existing structural load of the case studies was not able to be determined. However, we note that one case study planned to engage an engineer at building permit application stage to ensure the structural design allowed for the future installation of solar panels. Imposing a standard across a whole building is somewhat problematic, as in the vast majority of situations an industrial building would have a significantly larger roof than is required to match energy consumption with solar. Distribution network businesses routinely limit the size or export limit solar PV installation in business parks and industrial estates to ensure network issues don't occur. This would mean the roof is designed with capacity that is never needed. Portal frames are a highly cost effective solution and increasing loading would require changes to design.	Not able to be determined as it is not clear whether the base cases would have required alteration.	The benefit is that the structure allows for additional solar PV to be retrofitted at a future date, therefore reducing the retrofit cost of reinforcing a structure. This increases the feasibility of new solar being able to be accommodated.	We recommend engaging a structural engineer to provide targeted advice on the load requirements of an industrial roof to support solar PV to clarify differences with current NCC minimum requirements (including those proposed under NCC 2022) or standard designs. Depending on this advice, we caution applying a blanket structural improvement across the the whole industrial roof space unless the impact / cost is minimal. This is because the vast majority of industrial roofs will not be used for this future purpose. The embodied carbon of additional structural steel should also be accounted for in this decision. We recommend awaiting the outcome of the NCC 2022 provisions before confirming a decision.

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Operational Energy

STANDARD	DESIGN IMPACT	CAPITAL COST IMPACT	BENEFITS	RECOMMENDATION
S6 Maximise onsite renewable energy generation to meet or exceed predicted annual energy use: Industrial & warehouse only Include a solar PV system that is: - Sized to meet the energy needs of the building(s) services (lightning, air- conditioning, industrial processes); or - Maximized based on the available roof area; or - When no industrial process is proposed, minimum 1.5kW per tenancy plus 1kW for every 150m2 of gross floor area must be provided. The system should be designed to optimise use of on-site generated electricity.	The design impact of meeting this standard is negligible (subject to structural requirements above), as industrial roofs have expansive, flat roof space which can accommodate solar PV capacity without significant design implications. Generally speaking however, buildings do not always have a confirmed tenant when they are developed, so whether or not an industrial tenant has an energy intensive industrial process may not be known. The standard which would apply when no industrial process is proposed represents approximately 10% of available roof space. We note that in the case that a number of industrial buildings are co-located, that export of solar PV generation (which would occur on the weekends where occupation is low and equipment is not in operation) may cause localised network impacts and may have to be limited.	Capital cost based on industry standards remains below $1,000 per kWp, not including any cost impact to increased structural capacity required to facilitate a solar PV system.	As above.	We recommend the standard be retained, but modified to encourage increased solar PV system sizes, where the roof can support the additional load and where an energy intensive industrial process is likely.
S6 Maximise onsite renewable energy generation to meet or exceed predicted annual energy use: Office, educational buildings, health facilities, aged care, student accommodation, commercial and other non-residential buildings Should install onsite renewable energy generation up to or exceeding predicted annual energy consumption	The design impact of meeting the proposed standard for non-residential buildings is significant, especially for larger buildings. Based on one of the non-residential case studies, a system of over 100kWp would be required, but the roof capacity based on some conservative assumptions will only account for 19kWp. Refer to the diagram on the following page. Alternatively, if applying a rate of 25W per square metre of the development's site coverage (similar to the apartments standard), the case study rooftops would have sufficient space to meet such a requirement.	Capital cost based on industry standards remains below $1,000 per kWp, but may be higher in certain circumstances.	Benefits are as above for all solar PV standards.	We recommend that the standard be modified for consistency with the apartment standard. An updated standard could reference "a solar PV system with a capacity of at least 25W per square meters of the development's site coverage".

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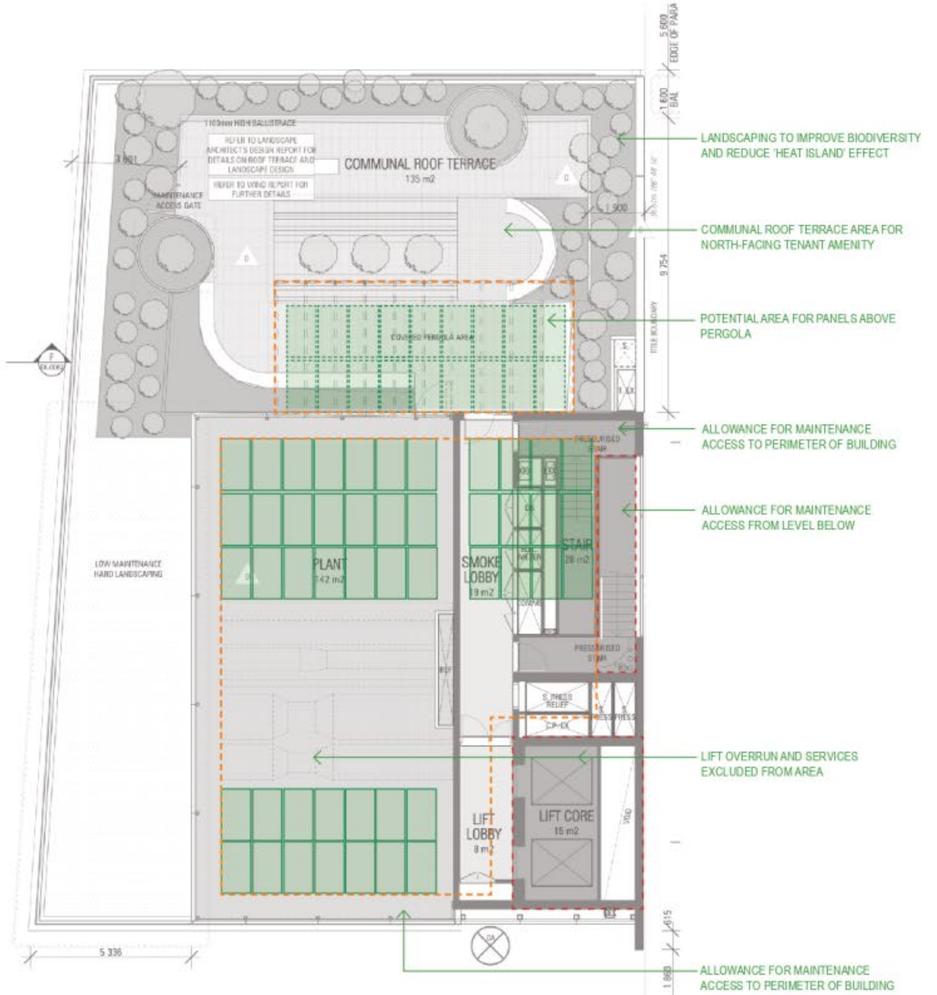

Diagram demonstrating potential solar photovoltaic capacity for the rooftop of an office case study. The image demonstrates 19.5kWp of solar. Image by JCB Architects

Operational Energy

STANDARD	DESIGN IMPACT	CAPITAL COST IMPACT	BENEFITS	RECOMMENDATION
S7 Maximise the opportunity to generate solar electricity on all roofs by: designing roof structures to accommodate solar PV arrays, minimise shading and obstructions, optimise roof pitch and orientation. The system should be designed to optimise use of on-site generated electricity	The design impact of the standard is confined to the smaller residential typologies where roof structures can be more complex. There are no major technical issues associated with maximising the opportunity, however a simplification of some roof lines will be required to meet the standard and deliver the solar PV target in Standard S6. Refer to the diagram on the following page.	No capital cost impact is expected, and in some circumstances may reduce the cost of the roof structure.	The benefit is documented in relation to Standard S6, however there may be an additional opportunity for dematerialisation and reduced waste if roof structures are simplified.	We recommend that the standard be retained in its current form, and that Guidelines for Sustainable Building Design provide guidance for architects and designers looking to maximise viable zones for solar rooftops.
S8 All residual operational energy to be 100% renewable purchased through offsite Green Power, power purchasing agreement or similar	There are no design impacts related to this standard.	No capital costs, but a minor Operational Expenditure (OPEX) impact which is being addressed through the cost benefit analysis.	Benefit is significant in terms of carbon reduction. When delivered in combination with S2 this standard delivers zero carbon for stationary energy for a building's operation (generally its largest emissions impact).	We recommend retention of the standard, based on the very high impact. Part B of this project further examines how operational energy management can be implemented though a planning mechanism.
S9 Design to enable for future renewable energy battery storage including space allocation	Design and technical feasibility was investigated for smaller residential typologies and industrial typologies only. The reason technical feasibility was restricted to these typologies / uses is that in all other circumstances, on-site renewable energy is unlikely to deliver a surplus of energy that would prompt the future inclusion of battery storage. Single dwellings and town houses had space in garages that could be reallocated to support battery storage and industrial buildings has significant space to support battery storage if it was financially viable at a future date.	No capital cost impact as no new space allocation required.	There is no quantifiable energy or financial benefit accruing from space allocation for future battery storage.	We recommend that the standard be removed in its current form, with the principle of future proofing embedded in a generalised standard which allows for future upgrades (but does not pick battery storage as a winner). Single dwellings and townhouses have garage storage space that can otherwise be converted and industrial buildings have ample space opportunity that can be reallocated. We also consider that EV integration may mean that batteries at the household level are not routinely specified or retrofitted in the numbers that were anticipated several years ago, so creating space specifically for them is not required. We do not recommend inclusion in Guidelines for Sustainable Building Design or BESS.

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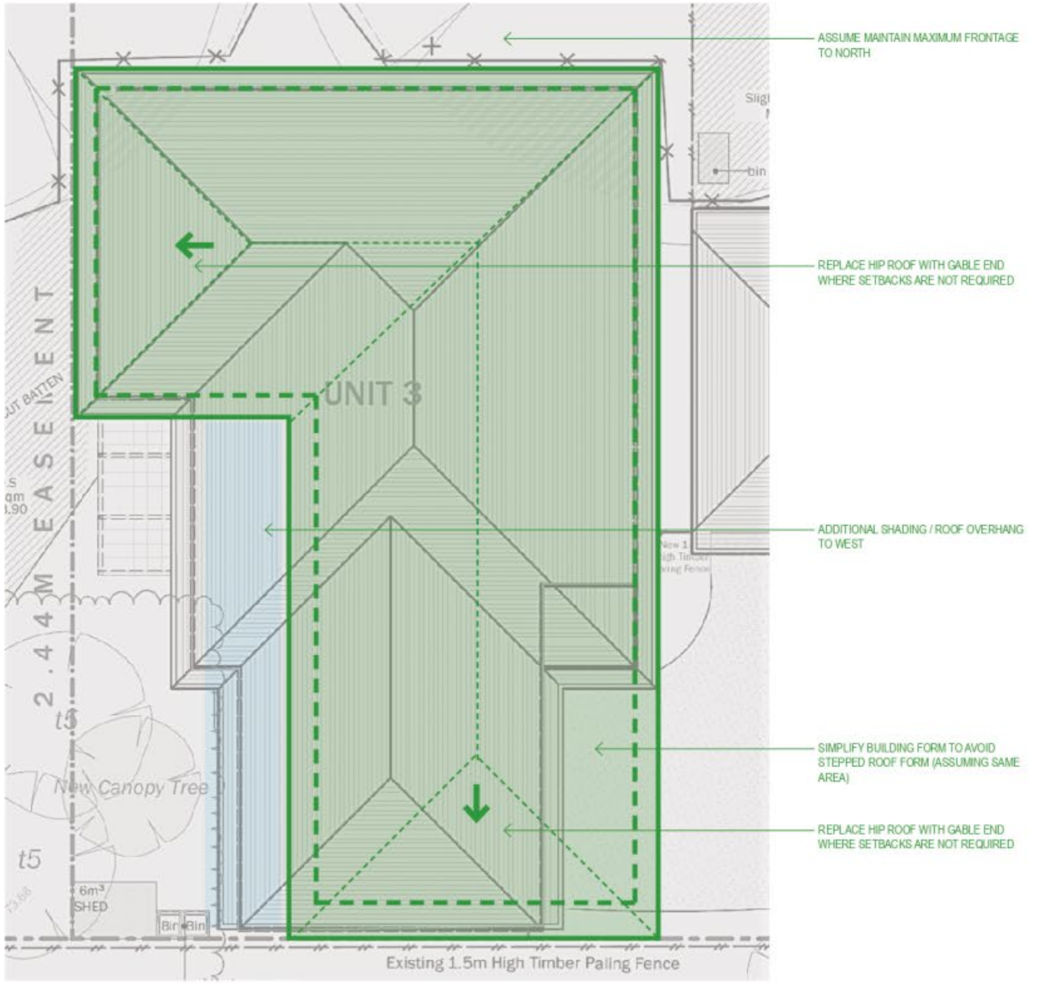


Diagram demonstrating the possibilities for simplification of a single dwelling pitched roof to increase opportunities for solar photovoltaic panels.
Image by JCB Architects

Operational Energy

The following standards were not included in the analysis as they were either flagged for removal due to planning advice or the impact, costs and benefits were addressed in similar standards. Note that some standards may not have been fully analysed but are still included in the previous tables as there was relevant commentary to document.

STANDARD	REASON FOR EXCLUSION FROM ANALYSIS
S3 Provide effective shading to glazed surfaces of conditioned spaces exposed to summer sun	Refer to Standard S38.
S10 Select materials that minimise carbon emissions, and offset these emissions onsite or through a verified carbon offset scheme	Refer to Standard S58.
All non-residential developments should exceed National Construction Code Building Code of Australia Volume One Section J or Volume 2 Part 2.6 Energy Efficiency building fabric and thermal performance requirements by in excess of 10 per cent	Although this was not originally proposed to be a standard and therefore has not been analysed, we note there is not an energy efficiency standard driving efficiency beyond NCC 2019. We feel this is appropriate due to step change in increased efficiency requirements from NCC 2016 to 2019 but consider that BESS may want to be updated periodically to reward performance above NCC minimum requirements outside the planning policy.

Sustainable Transport

This theme focuses on facilitating increased active transport with the aim of reducing private vehicle trips, and setting the condition to ensure a smooth transition for the future uptake of electric vehicles.

Ground level bicycle parking area at Nightingale 2 apartment development. Photography by Jake Roden

Sustainable Transport

STANDARD	DESIGN IMPACT	CAPITAL COST IMPACT	BENEFITS	RECOMMENDATION
S11 Developments should provide the following rates of bicycle parking and associated facilities: New residential development • A minimum of one secure undercover bicycle space per dwelling • A minimum of one visitor bicycle space per 4 dwellings	The design impact in relation to increased bicycle parking provision is complex. This standard relates to the provision of the bicycle parking infrastructure and the associated space allocation. The impact on space allocation is estimated at 1m2 per park (e.g hanging rack), however in some cases this can be reduced by two-tier bicycle storage options (e.g. Josta), but this requires minimum 2.6m floor to ceiling clearance so is only able to be used at ground level or where basement car parking is more generous than standard. Implementation of the infrastructure solutions is straight forward, subject to the space allocation being made. For residential development the impact is confined to apartments. Townhouses and single dwellings have more flexible storage options. The diagram on the following page graphically highlights the impact of the bicycle parking standards as a suite. From a design perspective the additional bicycle parking space does not pose technical issues, but represents either a loss in yield from other uses (e.g. car parking or retail if at ground floor level) or an additional space allocation which comes at an additional construction cost.	The capital cost impact related to infrastructure ranges between $410 and $1,640 per space depending on the solution. The capital cost of the additional space is estimated at $1,630 per sqm.	Benefits related to additional bike parking provision are also complex. A theoretical approach would see the extra bicycle parking provision motivate a change in behaviour (travel mode) for residents and workers. This would have a flow on benefit of reducing private vehicle transport (which causes carbon emissions and congestion) and increasing health and wellbeing related to additional exercise as a result of active transport. Whilst there is confidence that the impact exists, modelling the benefit is complex as outlined in the Cost Benefit Analysis.	We recommend that the standard be modified to allow for discretion in circumstances where the medium to long term expected take up of bike parking spaces is less than the proposed 1:1 dwelling rate. In these circumstances, the project should outline how additional space (nominally car parking) could be repurposed for bicycle parking as demand rises and reliance on private vehicle ownership declines.
S11 Developments should provide the following rates of bicycle parking and associated facilities: New retail development • A minimum of one secure undercover employee bicycle parking space per 100 sqm Net Lettable Area (NLA). • Provide visitors bicycle spaces equal to at least 5% of the peak visitors capacity	For retail development, the issues are consistent to those in residential apartments, but in all non-residential case studies, the standard proposed is close to or already being met.	As per above.	As per above.	We recommend that the standard be retained as the expected impact to space allocation and infrastructure costs is minimal, based on only a minor gap (if at all) between business as usual provision and the level proposed under the standards. Further work could explore a higher rate for locations with a strong cycling culture.

Sustainable Transport

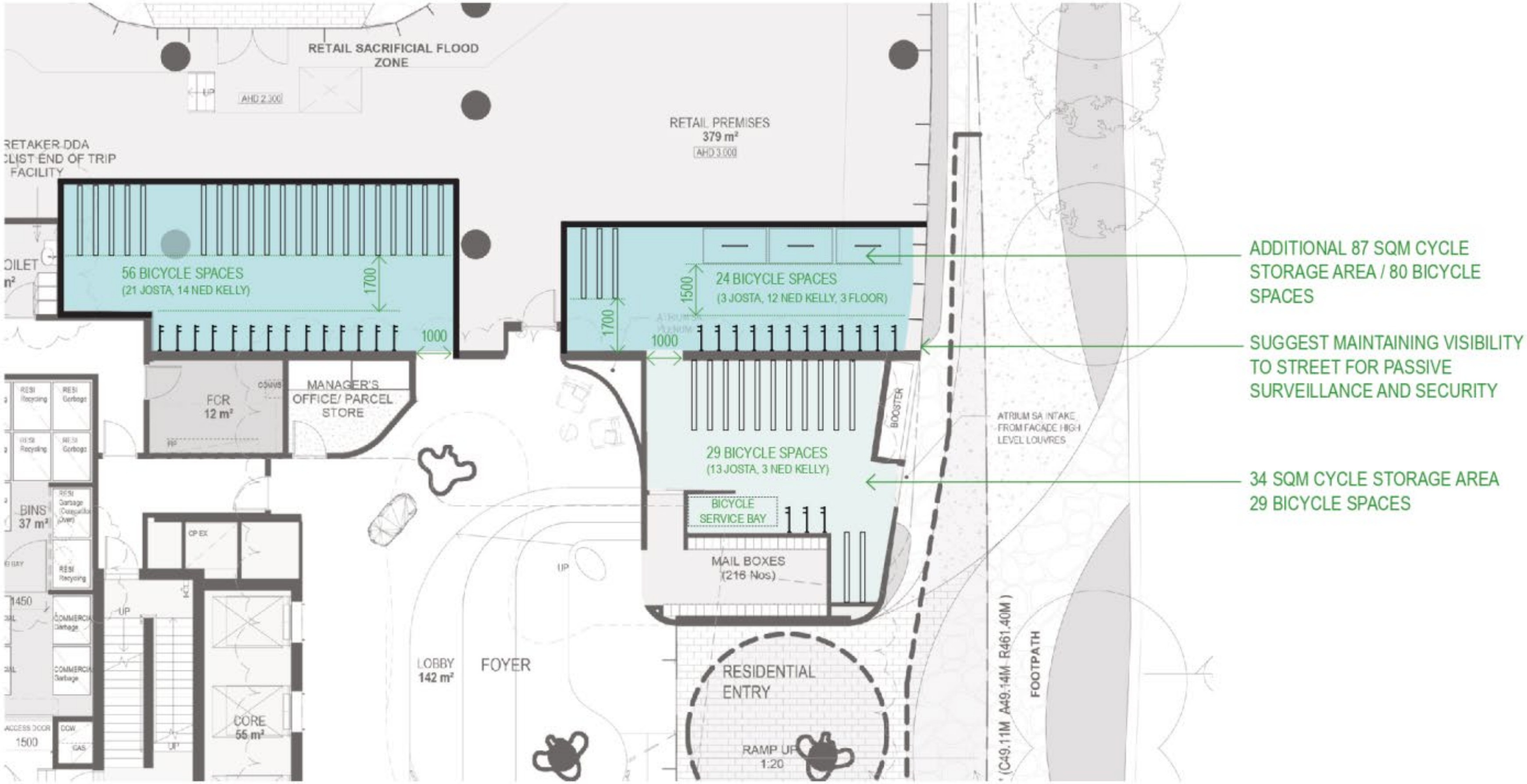


Diagram highlighting the impact of the bicycle parking standards as a suite of measures for a mixed use development. Image by JCB Architects
Note: The following storage types have been utilised - two tier system (Josta), hanging rack (Ned Kelly) and hoop (floor).

Sustainable Transport

STANDARD	DESIGN IMPACT	CAPITAL COST IMPACT	BENEFITS	RECOMMENDATION
S11 Developments should provide the following rates of bicycle parking and associated facilities: New development associated with a Place of Assembly, Office or Education use • A minimum of one secure undercover staff bicycle parking space per 100 sqm NLA of office • A minimum of one visitor space per 500 sqm NLA of office • A minimum of 2 secure staff bicycle spaces per 1500 sqm of a place of assembly • A minimum of four visitor spaces for the first 1500 sqm and 2 additional spaces for every 1500 sqm thereafter for place of assembly? • A minimum of one secure staff bicycle parking space per ten employees of education centres • A minimum of one per five students of education centres	For place of assembly, office or educational development, the issues are consistent to those in retail and residential apartments, but in all non-residential case studies, the standard proposed is close to or already being met.	As per above.	As per above.	Recommendation is as per the retail standard.
S11 Developments should provide the following rates of bicycle parking and associated facilities: For all other non-residential • Provide bicycle parking equal to at least 10% of regular occupants	The design impact of this standard is similar to other non-residential bicycle standards.	As per above.	As per above.	Recommendation is as per the retail standard.
S12 Bicycle parking – non-residential facilities One shower for the first 5 employee bicycle spaces, plus 1 to each 10 employee bicycle spaces thereafter should also be provided. If 10 or more employee bicycle spaces are required, personal lockers are to be provided with each bicycle space required. If more than 30 bicycle spaces are required, then a change room must be provided with direct access to each shower. The change room may be a combined shower and change room.	This standard is linked to S11, and can therefore result in requirements greater than Clause 52.34. However, the design impact for increased wet areas was negligible for the case study design responses. Additional space for locker provision is required but has a relatively small footprint.	The capital cost impact of the standard is minor as increased area for showers (the most expensive component of the standard) was negligible for the case studies. Space provision and capital cost per locker is minimal.	As per bicycle parking, with the infrastructure provision (in this context to change and shower) workers are more likely to ride to work. Whilst there is confidence that the impact exists, modelling the benefit is complex as outlined in the Cost Benefit Analysis.	We recommend that the standard be retained as the expected impact to space allocation and infrastructure costs is minimal. Inclusion of locker provision makes the provision of EOT facilities more comprehensive.

Sustainable Transport

STANDARD	DESIGN IMPACT	CAPITAL COST IMPACT	BENEFITS	RECOMMENDATION
S13 Bicycle Parking - Convenience. All bicycle parking facilities must be convenient and accessible, and: • Locating the majority of bicycle parking facilities for residents at ground level • For any other bicycle parking, providing this within 10 meters of vertical pedestrian access ways (ie lifts, stairs) • Providing access to bicycle parking facilities in basement carparks via a separate line of travel to vehicles and pedestrians • Ensuring any lifts used to access to bicycle parking areas are at least 1800mm deep • Ensuring at least 20% of residents bicycle parking facilities are ground level or horizontal type racks to ensure equitable access	The design impact of some elements of the proposed standard is very significant as outlined below. Locating the majority of bicycle parking at ground level (i.e. ground floor) may in some circumstances have a negative impact on activation of retail space, however with the exception of one typology the case studies had already prioritised ground floor bike parking access. To provide bicycle parking within 10m of vertical pedestrian access was tested in detail in relation to the RES 1 case study. The result of meeting the standard is that the corners of the building become underutilised space as they are unsuitable for car parking access. Space closer to lift cores would need to be reallocated to bicycle parking which has a positive outcome for cycling access, but will mean additional basement needs to be constructed to maintain car parking rates (although a partial waiver may be possible). The requirement for a separate line of travel for cyclists has a major impact on the efficiency of basement car parks. This would increase car park aisle widths by approximately 1m and decrease the efficiency of the basement car park significantly. Both other elements of the standard have only minor design impacts and do not impact technical feasibility. Note that storage stacker or supported lift parking systems can be utilised to improve accessibility for parking not on the floor.	From a development feasibility perspective, the loss of potential retail space to provide bicycle parking at grade actually provides a construction cost benefit (basement per sqm costs are lower), but there is lost revenue on this space, which would exceed the revenue associated with the equivalent space allocation in a basement. This is explored more in the Cost Benefit Analysis. The impact of the 10m maximum distance to bicycle parking and the separate line of travel on cost would require the construction of significant additional basement area. The construction cost per sqm of basement area is $1630 per sqm. By way of example if 2 additional car spaces and 20m of dedicated (separate) line of travel was required the impact would be in the order of $114,000 with no financial return. Other cost impacts (lift size and ground level preference) were not quantified as the majority met the standard already.	As per bicycle parking and end of trip facilities, the improved infrastructure location means residents and workers are more likely to ride. Whilst there is confidence that the impact exists, modelling the benefit is complex as outlined in the Cost Benefit Analysis.	We recommend that the standard be modified to remove the requirement for the separate line of travel, the spatial implication will add major cost to a basement. We instead recommend that surface treatments be used to afford cyclists priority without increasing car park aisle width. We recommend that the standard relating to no more than 10m access to vertical pedestrian access ways be modified to require the majority of basement bike parking to be within this distance. We further recommend that the standard relating to ground level/ floor for the majority be discretionary to allow for performance solutions that provide a good outcome without the majority of bike parking being at ground level. Modification of the language for the 20% standard is recommended to remove confusion with ground floor of the building (our interpretation is that it means close to the ground rather than the ground level of the building). Equitable access facilities should address not only the proximity of racks to the ground but also the spatial allocation for different bicycle types (e.g. recumbent bicycles). This can be detailed in Guidelines. We recommend this standard be modified to encourage design that can see particularly non-residential car space reallocated to bicycle parking over time.
S15 Preparation of an EV Management Plan.	There is no design impact based on the preparation of an EV Management Plan.	The capital cost is restricted to the cost of the consultancy as infrastructure costed elsewhere.	Benefit is derived from improved management of EV charging, however this is not quantified.	We recommend that planning advice from Hansen be referred to relating to whether an additional plan specifically for managing EV's is appropriate.

Sustainable Transport

STANDARD	DESIGN IMPACT	CAPITAL COST IMPACT	BENEFITS	RECOMMENDATION
S16 The proposed location of EV charger outlets and units demonstrated on the plans: Medium density only Infrastructure and cabling (without the EV charger unit) is to be provided for each garage, to support a minimum Level 2 (Mode 3) 7kW 32Amp EV car charging.	The design impact of this standard is negligible, it does not require any additional space allocation and from a technical perspective is achievable using standard electrical contractors.	The cost impact of the standard is approximately $500 per dwelling.	There are no immediate benefits, however the existence of the infrastructure will reduce a potential barrier to EV uptake and avoid a more costly retrofit cost in the future. There is an indirect carbon benefit, based on the higher likelihood of replacement of a internal combustion vehicle with electric vehicle (higher efficiency and lower carbon emissions).	We recommend that the intent of the standard be retained, but the standard be modified to remove the prescriptive guidance on capacity, instead ensuring that the standard provides clarity that increased capacity for moderate speed (Level 2) and efficient charging (beyond a standard General Power Outlet) is required to support EV chargers being easily installed in the future. We support the prescriptive wording as current best practice, but consider it is more appropriate in the proposed Guideline for Sustainable Building Design.
S16 The proposed location of EV charger outlets and units demonstrated on the plans: Apartments only Required Capacity Electrical infrastructure capable of supplying: ▪ 12kWh of energy for charging during off peak periods; and ▪ A minimum Level 2 (Mode 3) 7kW, 32Amp single phase EV charging outlets to all residential car parking spaces.	As per above, the design impact of this standard is negligible, it does not require significant additional space allocation and from a technical perspective can be designed by electrical engineers.	The cost impact of the standard is approximately $869 per car space.	As per above.	As per above
S16 The proposed location of EV charger outlets and units demonstrated on the plans: Apartments only EV infrastructure and cabling must be provided and may include, for example, distribution boards, power use metering systems, scalable load management systems, and cable trays or conduit installation.	The design impact of this standard is moderate (including a spatial allocation for distribution boards), but the approach is technically feasible as a method of future proofing the building. Based on direct feedback from HV.H projects, there are specific issues that need to be resolved for car stackers and further industry learning needs to take place for electrical engineers and within the electricity network businesses to design and deliver scalable load management systems that provide confidence that peak demand on a building will not be exceeded, additionally that the expectation of EV drivers that they will be always 100% charged at 7am may need to be challenged.	Costs included in above.	The benefit is an extension of the above. The scaleable load management system, will allow for increases in peak electricity demand to be avoided, but further advocacy and stakeholder engagement is required to ensure that risk averse responses do not add to significant cost implications.	We recommend that the standard should be retained, as the avoided cost of future retrofit is significant and the complexity of governance arrangements of owners corporations may make a retrofit very challenging. We recommend the standard be strengthened to ensure that load management is employed to manage any network peak demand issues (s14). Potential rewording could be "...must be provided to ensure peak demand is managed and may include...". We recommend that the Guideline for Sustainable Building Design note the specific issues with car stackers.

Sustainable Transport

STANDARD	DESIGN IMPACT	CAPITAL COST IMPACT	BENEFITS	RECOMMENDATION
S16 The proposed location of EV charger outlets and units demonstrated on the plans: Non-Residential EV Charging 20% of carparking spaces in office, educational centres, places of assembly, retail and all other non- residential development types must meet all the requirements of the apartment criteria above, (or a minimum of one space).	As per above, the design impact of this standard is negligible, it does not require significant additional space allocation and from a technical perspective can be designed by electrical engineers.	The cost impact of the standard is approximately $869 per car space.	As per medium density and apartments standard.	As per medium density and apartments standard. The standard should effectively require 20% of spaces to have undertaken the pre-work to support future electric vehicle charging, even if charging is not fitted at the time of build.
S16 The proposed location of EV charger outlets and units demonstrated on the plans: Non-Residential EV Charging 5,000 sqm trigger - 5% of car spaces must have installed EV charging infrastructure complete with chargers and signage	The design impact of meeting this standard is simply an extension of delivering the capacity under the proposed standard above.	Capital cost impact is $2,200 for charging infrastructure per space.	The availability of EV Charging builds confidence in EV purchase. This has operational savings for the consumer and results indirectly in reduced carbon emissions.	The standard is recommended to be retained. It is consistent with a Green Star standard that has been in place for some time and allows for at least some Day 1 provision to support uptake of EV's as potential fleet vehicles or similar.
S17 Shared Space EV Charging •Where one or more visitor/shared parking spaces are provided in a development a minimum of one enabled EV charging unit(s) is required to be installed at a shared parking space. •Communal EV charging space(s) should be located in highly visible, priority locations, to encouraged EV uptake. •Clear signage indicating that EV charging is available at the shared space(s).	The design impact of this standard is negligible and technically there are no implementation issues (there is widespread adoption)	Capital cost impact is $2,200 for charging infrastructure to support one shared space.	The availability of EV Charging builds confidence in EV purchase. This has operational savings for the consumer and results indirectly in reduced carbon emissions.	The standard should be clarified to define shared, visitor and communal as the standard appears to use the terms interchangably. The intent is supported, and the cost impact is low, but further work is required to refine the land uses or typologies that would benefit from the standard and should reasonably be asked to provide the infrastructure.
S19 Motor cycle, moped, electric bicycle or scooter parking •Where space is provided for motor cycle, moped, bicycle or scooter parking a 10 or 15 A charging outlets is to be provided at the parking/storage area. •A charging outlet is to be provided for every six vehicle parking spaces to facilitate charging of electric bicycles, scooters, mopeds or motorcycles.	The design impact of this standard is negligible and technically there are no implementation issues (there is widespread adoption)	The capital cost is negligible, so has not been quantified.	As per bicycle parking and end of trip facilities, the improved infrastructure location means residents and workers are more likely to ride. Whilst there is confidence that the impact exists, modelling the benefit is complex as outlined in the Cost Benefit Analysis.	The standard should be modified to delete the first dot point (as the specification is too detailed for a planning scheme) and these are standard General Power Outlet in any case.

Sustainable Transport

STANDARD	DESIGN IMPACT	CAPITAL COST IMPACT	BENEFITS	RECOMMENDATION
S20 Parking Facilities • Parking facilities for these low and zero emission vehicles should be located in a prominent, accessible location to encourage their easy access for use on short trips, ahead of higher emission and less space efficient vehicles.	The design impact of this standard is negligible as there is no additional space allocation required, simply a reallocation of existing car parking to prioritise the most sustainable private vehicle options	There is no capital cost implication.	The availability of EV prioritised car parking builds confidence in EV purchase. This has operational savings for the consumer and results indirectly in reduced carbon emissions.	The standard should be retained in its current form.

The following standards were not included in the analysis as they were either flagged for removal due to planning advice or the impact, costs and benefits were addressed in similar standards. Note that some standards may not have been fully analysed but are still included in the previous tables as there was relevant commentary to document.

STANDARD	REASON FOR EXCLUSION FROM ANALYSIS
S14 EV charging infrastructure must ensure that peak energy demand is managed to minimise the impact to the electricity supply network.	The impact of this standard is addressed through S16 as the scalable load management system is the principal design response. We have recommended that management of peak energy demand be included in S16.
S18 Rapid/Fast EV Charging The provision of fast charging spaces is not to be mandated but is to be a decision of developer.	This standard was flagged for removal by Hansen in a preliminary review of the standards, and was therefore not measured. This is a suitable consideration for Guidelines for Sustainable Building Design.
S21 Reducing crossover length, minimising cross-fall in pedestrian areas and maintaining sightlines at entry/egress of developments	This standard was flagged for removal by Hansen in a preliminary review of the standards, and was therefore not measured. This is a suitable consideration for Guidelines for Sustainable Building Design.

Integrated Water Management

This theme focuses on the reduction of potable water consumption through efficiency measures and use of non-potable water sources, and the improving the quality of stormwater discharging from site.

Rainwater tank in rear garden of dwelling at The Cape development. Photography by Kim Landy

Integrated Water Management

STANDARD	DESIGN IMPACT	CAPITAL COST IMPACT	BENEFITS	RECOMMENDATION
S22 Reduce the total design amount of potable use on site by at least 30% in comparison to an equivalent standard development	Design impact is delivered through other standards. Note that the potable water reduction has been considered for interior uses and irrigation only.	N/A	N/A	We recommend that the standard be retained to drive potable water reduction outcomes while allowing the flexibility to decide how those reductions are achieved. Such a standard supports a performance based approach rather than a prescriptive approach which may not be suitable to all developments. The standard should be modified to clarify which potable water uses are to be assessed as part of the percentage reduction (e.g. only interior uses and irrigation, supported by rainwater reuse). Note that the analysis showed many cases studies already achieved >30% reduction for interior uses and irrigation support by rainwater reuse, and alternative design responses had the potential to further reduce potable water use above the minimum 30%. While further research could be undertaken to determine whether a more ambitious percentage reduction target is feasible, stakeholder consultation flagged that pursuit of a target greater than 30% could have amenity impacts for occupants and queried how far the role of the building sector should go in reducing potable water use compared to sectors with higher usage and greater opportunity. CASBE will need to define 'equivalent standard development'.
S23 Provide efficient fittings, fixtures, appliances and equipment including heating, cooling and ventilation (HVAC) systems and re-use of fire safety system test water	The design impact is negligible and an appropriate design response is achieved through specifications. Such specifications were used as a potable water reduction strategy to meet Standard S22. Note that in all cases the potable water reduction target of 30% in Standard S22 was either already achieved in the base case or achieved through improved efficiencies to one or more fittings, fixtures and/or appliances.	Capital cost impact is negligible for fixtures and fittings, and approximate 50% premium on water efficient appliances.	High efficiency fixtures, fittings and appliances result in an operational water saving. Note that further potable water reductions are possible for the alternative design responses as any improved efficiencies were only undertaken with the aim of achieving at least a 30% reduction.	We recommend that the standard be removed as a standalone standard but strategies listed under Standard S22. The specification of high efficiency fixtures, fittings and appliances must be considered as part of a suite of strategies to achieve potable water reduction. Specific mention of water efficiency (and strategies such as efficient fittings for example) should be included in Standard S22 as a means to achieve potable water reduction. Further detail on strategies to reduce potable water consumption can be included in Guidelines for Sustainable Building Design.

Integrated Water Management

STANDARD	DESIGN IMPACT	CAPITAL COST IMPACT	BENEFITS	RECOMMENDATION
S24 Provide onsite stormwater collection from suitable roof rainwater harvesting areas with reuse to toilets as a minimum and additional uses such as laundry, irrigation, external wash down facilities and hot water systems.	The design impact of providing onsite stormwater collection is negligible as all but two case studies included rainwater tanks. As the case studies with the built forms selected for a standardised analysis already had a spatial allocation for rainwater tank/s, there was no spatial implication for the two case studies requiring a tank. More broadly, apartment buildings and office high-rises where space is limited would be impacted most, however for most typologies a rainwater tank is the preferred method of meeting the Best Practice Environmental Management (BPEM) Guidelines. Optimising rainwater tank capacity based on the available collection catchment and reuse demand early in the design process can ensure a suitably sized location is provided for any tank/s.	Capital cost impact for a rainwater tank can range from $1,000-4,500, depending on the tank capacity.	Inclusion of rainwater tanks result in an operational water saving, largely through reuse in toilet flushing and irrigation. Use of rainwater tanks also helps deliver improvements to stormwater quality. Improved resilience during intense rainfall events.	We note that rainwater tanks are potentially commonly undersized in the absence of specific policy lever relating to tanks and potable water reduction. This is due to tank capacity often being driven by stormwater quality objectives, which may not result in optimised rainwater reuse. We recommend this standard be retained but slightly modified to include reference to maximising tank capacity aligned to reuse potential, not just size to achieve compliance with stormwater quality requirements. The inclusion of rainwater tanks is a cost effective way to provide multiple benefits relating to resource efficiency and environmental protection. We also recommend this standard highlight the need for filtration from rainwater harvested surfaces.
S25 Connect to a precinct scale Class A recycled water source if available and technically feasible including a third pipe connection to all non-potable sources	The design impact of meeting this standard has been thoroughly tested through several strategic planning processes (such as Fishermans Bend), where the business case for provision of third pipe is highly dependent on mandated connection to the service.	Not measured.	Benefit of potable water reduction.	We consider this standard is likely redundant in most circumstances where there is opportunity to connect to a recycled water supply because it would generally be mandated by a separate planning instrument. We support its inclusion not as a standalone standard but as a potential strategy under a suite of measures in the standard for efficient water use.
S26 Consider alternative uses such as approved greywater and blackwater systems installed on site	The design impact of meeting this standard has not been tested as it is a consideration rather than a requirement.	Not measured as only a consideration.	Benefit of potable water reduction.	We recommend retaining but modifying the standard to sit as a potential strategy for using water resources efficiently. Additionally, it could be included in the proposed Guidelines for Sustainable Building Design (with specific reference to the regional contexts which may not be sewered).

Integrated Water Management

STANDARD	DESIGN IMPACT	CAPITAL COST IMPACT	BENEFITS	RECOMMENDATION
S27 Provide landscaping irrigation that is connected to non-potable sources	The design impact of providing landscape irrigation connected to non-potable sources varies depending on the location of the landscaping. Most case studies already had connections and those without did not require a connection to achieve the potable water reduction target of Standard S22. Irrigation connected to non-potable sources should be considered as part of a suite of potable water reduction strategies, and may only be employed where the amount of harvested rainwater exceeds other all year round reuse demands such as toilet flushing, or where landscaping and associated irrigation is closer to the point of collection than some toilets. This approach can ensure efficiencies for hydraulic services within a development (e.g. avoid unnecessarily pumping water from the basement to a roof garden when it can be reused on lower levels).	Not measured as costs are highly variable based on the location of landscaping relative to the non-potable water source.	Benefit of potable water reduction.	We recommend that the standard be removed, instead clarifying in S22 the types of demand reduction strategies that should contribute to the standard being met. The specification of landscaping irrigation connections to non-potable water sources should be considered one option of a suite of strategies to achieve potable water reduction, but should not be a mandatory strategy. Developments should achieve the 30% reduction in potable water use of Standard S22 through water efficiency and reuse measures, however, there should be the flexibility to achieve the 30% reduction without landscape irrigation connected to non-potable sources. This allows a contextual approach to potable water reduction for individual developments, and can avoid irrigation connections and associated pumps which don't achieve added benefit (e.g. if no rainwater leftover from toilet flushing to be used for irrigation, the hydraulic infrastructure is redundant). The inclusion of irrigation as part of the 30% reduction target may require some further work to determine what would be a suitable benchmark for irrigation in an 'equivalent standard development', with a methodology created to determine this for each assessment. If this isn't pursued, then a separate standard targeting water efficient landscaping without a target may be appropriate. Note that BESS does currently reward rainwater reuse for irrigation under Credit Water 1.1. Further detail on strategies to reduce potable water consumption can be included in Guidelines for Sustainable Building Design.
S28 Consider landscaping that is drought tolerant and considers xeriscape design principles	The design impact is negligible as it is specification in the landscape design.	Cost neutral design specification.	Specification of drought tolerant species or use of xerispace design principles can help to reduce potable water demand.	We recommend that the standard be modified to be strengthened in language (but remain discretionary) and be less specific (e.g. remove xeriscape design principles) and focus more broadly on landscape design which reduces potable water consumption. Guidance materials (e.g. BESS Tool Notes and the proposed Guideline for Sustainable Building Design) can detail strategies to reduce water use in landscape design.

Integrated Water Management

STANDARD	DESIGN IMPACT	CAPITAL COST IMPACT	BENEFITS	RECOMMENDATION
S29 Reduce the volume and flow of stormwater from discharging from the site by appropriate on-site detention and on-site retention strategies	The design impact of meeting this standard has not been tested as the impact was not able to be quantified and is more commonly addressed through engineering requirements during planning. Note that the use of rainwater tanks under Standard S24 is considered an on-site retention strategies and would contribute to the aim of reducing the volume and flow of stormwater discharged from site.	Not measured.	Operational water benefit from rainwater reuse and stormwater quality improvement from reduced flows off-site.	We recommend that the standard be retained with the intent of generally reducing volume and flow of stormwater. Further work would need to be undertaken for the standard to be linked to an explicit reduction target.
S30 Improve the quality of stormwater discharging from the site by meeting best practice urban stormwater standards	The design impact of improving stormwater quality is negligible as addressing this is commonplace. All case studies achieved the best practice urban stormwater standards (or where detail was insufficient were assumed to as per requirements of Clause 53.18). Stormwater quality can be improved through a range of strategies including maximising pervious surfaces, rainwater tanks, water sensitive urban design measures (e.g. raingardens) or stormwater offset contributions (e.g. Melbourne Water or local council schemes). Such strategies are routinely utilised by industry.	No capital cost is incurred as the proposed standard is addressed by existing planning provisions.	Stormwater quality improvements in line with the Best Practice Environment Management Guidelines (BPEM) standards.	We recommend that the standard be retained to further support existing planning provisions relating to stormwater management while also ensuring an integrated approach to water management is taken. Refer to planning advice as to whether inclusion of such a standard is a duplication of State provisions.
S31 Provide at least 30% of the site with pervious surfaces	This standard was flagged for removal by Hansen in a preliminary review of the standards, and was therefore not measured.	N/A	N/A	We recommend that the standard be removed as the percentage target is not suitable for all typologies. Further exploration could be undertaken to determine whether a suitable permeability-related standard could be adopted, supporting additional integrated water management objectives. The principle of maximising pervious surfaces can be highlighted in Guidelines for Sustainable Building Design.
S32 Reduce the impact of flooding and the urban heat island effect on the direct site and its associated context	The design impact of this standard has not been tested as it is achieved either through measures of other standards (e.g. Standards S83) or existing planning mechanisms (e.g. Land Subject to Inundation Overlay).	Not measured.	Not measured.	We recommend that the standard be removed as it is a duplication of another standard and addressed through other planning mechanisms such as overlays.

Integrated Water Management

STANDARD	DESIGN IMPACT	CAPITAL COST IMPACT	BENEFITS	RECOMMENDATION
S33 Improve the resilience of the design by modelling and demonstrating a response to future specified future flood modelling that considers impacts from climate change such as flooding, intense storm events, sea level rise, storm surge and drought	The design impact of responses to future climate impacts has not been measured as such measures are highly contextual to individual developments due to factors such as location and associated hazards. Due to the site-specific nature, the creation of design responses for the case studies is not beneficial as the impact cannot be easily extrapolated across other developments within the same typology.	Capital cost resulting from integrating climate risk assessment recommendations into the design are not able to be determined. Consultancy cost of approximately $15,000 if a formal Climate Risk Assessment aligned with Australian Standards / Green Star Buildings is required.	Long-term benefits associated with future-proofing a development from predicted climate impacts are tangible. Example benefits include reduced rate of material replacement.	We recommend that the standard be modified to address future climate impacts broadly. The standard would however need to be supported by guidance (Guidelines for Sustainable Building Design) as to what is considered an appropriate response from a planning applicant, as the approach to consideration of future climate impacts could range from a simple statement of design responses to a formal climate risk assessment.
S34 Ensuring the environmental safety and protection of human health through - onsite water collection, treatment, filtration, and usage, especially potable water use and irrigation on productive food gardens	This standard was flagged for removal by Hansen in a preliminary review of the standards, and was therefore not evaluated.	N/A	N/A	We recommend that the standard be removed and addressed through S24. The concerns about public health implications from rainwater reuse (reference to appropriate filtration) should be included in any rainwater reuse standard.

Indoor Environment Quality (IEQ)

This theme focuses on improving the comfort of building occupants including internal temperatures, air quality and daylight access.

Natural light in Bendigo Hospital. Photography by Peter Clarke

Indoor Environment Quality (IEQ)

STANDARD	DESIGN IMPACT	CAPITAL COST IMPACT	BENEFITS	RECOMMENDATION
S35 No habitable rooms should have internal temperature greater than 21 degrees continuous for 72 hours, demonstrated through NatHERS modelling in free-running mode	This standard was flagged for removal by Hansen in a preliminary review of the standards, and was therefore not measured in detail. We do note however that when a NatHERS FirstRate file for an 8.2 Star dwelling was interrogated it did not meet the standard.	Not measured.	Not quantified.	We recommend that the standard as currently written be removed, consistent with Hansen's advice. However, we support the intent of the standard so suggest further work to refine the wording and the temperature and time range. We suggest including a reporting requirement in BESS which doesn't impact assessments scoring, but allows for the gathering of an evidence base.
S37 Ventilation standard: Apartments only Apartment buildings should have all apartments effectively naturally ventilated, either via cross ventilation, single-sided ventilation or a combination	The design impact of meeting this standard is significant for some apartment buildings (however only one apartment case study was impacted). Whilst the standard does not prescribe specific depths that would meet single sided ventilation standards or breeze paths that would meet cross ventilation standards, the tool notes for the BESS tool provide guidance as outlined below: _Single sided ventilation - Maximum permissible depth of room 5m (separated openings high and low or split across the width of the room/facade, each 5% of the floor area are preferred) _Cross flow ventilation - Breeze path length less than 15m measured between ventilation openings and around internal walls, obstructions & partitions (note no more than 1 door between openings and that openings must be on opposite or adjacent walls) The most significant impact is where apartments are loaded off each side of a central corridor, but have living room and kitchen depths of greater than 5m. The standard structure of these apartments (see below) does not allow for the standard to be met without significant redesign, to introduce new external facades to the built form. This could have multiple impacts, including increasing the length of external walls (with a thermal performance impact that needs to be managed), a major loss of yield and complicating the building structure (apartment buildings of this type are often built on a standard 8.4m grid which allows for walls between apartments to sit directly above car parking pylons separated by 3 car spaces). Mechanical ventilation solutions which can preserve energy recovery, better control air quality and condensation as air tightness increases may be preferable in a wide variety of contexts.	The capital cost impact of the standard is highly variable depending on the base case design. Whilst there is no standard response, in the case of RES 1 CS2 one design response, focusing on the built form on the western edge of the site (image below) would be to delete Apartment 101 to externalise the access to all apartments (via an open walkway). The capital cost impact would actually be positive (approximately $300K per 100m2 apartment) but the lost revenue (in relation to the dwelling sale) would potentially be three-fold in the context that administration, land values etc remain constant. If redesigned from the 'ground up' then design responses to meet the proposed standard may result in a reduced yield impact.	The benefit of the standard is to deliver improved health and wellbeing outcomes and assist in delivering passive cooling (delivering an improvement to thermal performance).	We recommend that the standard be modified to allow discretion for demonstrated performance of mechanical solutions to ventilation where there may be other advantages including controlling energy losses, filtering air on high pollen days and controlling condensation as air tightness increase. We do not consider that the standard as written is appropriate unless BESS guidelines for definition of single sided ventilation are relaxed. We recommend as an alternative to retain the current benchmark of 60% natural ventilation as it also promotes other positive outcomes, but this would reduce the detrimental impact on development feasibility, supported by a minimum cross ventilation outcome for each floor.

Indoor Environment Quality (IEQ)

STANDARD	DESIGN IMPACT	CAPITAL COST IMPACT	BENEFITS	RECOMMENDATION
S37 Ventilation standard: Detached houses and townhouses All habitable rooms of detached houses and townhouses should be cross ventilated.	The standard does have some impact on design of dwellings, but design responses to meet the standard are generally speaking modest. In the examples studied design responses included replacement of fixed windows with operable, and introducing additional windows. Note that three study rooms of a town house case study could not achieve cross flow ventilation due to only having one external face (rooms adjoined neighbouring dwellings or garage).	Cost impact related to the replacing fixed with operable windows (an impact of approximately $90 per sqm) and replacement of facade with operable glazing (an impact which varies with the construction material it replaces).	Benefits are as per the apartment standard.	We recommend the standard be retained as only small, low cost modifications were required to meet the standard, however, clarity is needed as to whether home offices / studies would be required to meet the standard.
S37 Ventilation standard: All regular use areas of non-residential spaces should be effectively naturally ventilated; or provided with 50% greater outdoor air than the minimum required by AS1668:2012; or have CO2 concentrations maintained below 800 ppm.	The design impact of this standard is significant and may have unintended consequences. The impact would be from a larger mechanical ventilation system - an increase in fan size and power, and also increased duct sizes resulting in spatial implications such as larger risers in the building and larger footprints in plant rooms. Energy requirements would be increased. Whilst this plant room impact is minor it will impact the net lettable area from a developer perspective. The standard also prescribes a specific solution to improved ventilation when alternatives such as Heat Recovery Ventilation may be preferable.	Cost impact related to the standard would depend on the individual building context and was unable to quantified in a way that conclusions could be accurately drawn from the results.	Benefits are as per the apartment and townhouse standard. An additional benefit relates to worker productivity.	We recommend that the standard be modified to maintain the goal of natural ventilation but keep open mechanical design solutions for increased ventilation, especially those that do not have an energy implication. The intent of the PPM standard is supported, however we note that the detail required to model this outcome would not generally be known at the planning stage.
S38 Buildings should achieve effective external shading to west, north and east facing glazing and skylights.	The design impact of this standard is significant. Required responses range from external awning solutions for smaller residential typologies to vertical fins and horizontal eaves for larger residential and non-residential developments. There are no major technical issues as a wide range of solutions exist to suit a variety of contexts. For the RES 1 case study, the alternative design response proposed an optimised glazing to wall ratio, with a height reduction in east and west glazing from 2.7m to 2m (changed to spandrel construction) to avoid excessive heat gain while reducing the shading costs associated with a larger amount glazing.	The capital cost impact of shading is significant. The implication for a single residential dwelling was $9,000 and in the large residential case study this was over $3,500 per dwelling. The modelled cost impact was based on retaining the same amount of glass and shading it except for RES 1. With a reduction of 25% on east and west facades the impact was significantly reduced ($3,570 per dwelling in additional cost, but with an additional saving of approximately $500 per dwelling through the conversion of glazing to a spandrel facade).	Benefits include a thermal performance (energy saving) benefit related to reduced cooling loads (with a related peak demand improvement) as well as improved health and wellbeing outcomes. The average NatHERS improvement attributed to externally shaded windows is in the order of 0.2 Stars (or 10 mj/m2 per year)	We recommend that the standard be modified to broaden the design strategies for managing excessive heat gain that the shading is attempting to address. This will allow for a wider range of solutions to be deployed and potentially reduce the cost associated with controlling excessive heat gain. Alternatives include; reducing east and west glazing ratios, spandrels, balconies with wing wall protection etc. This could be integrated with other passive design principles). The updated standard by Hansen allows for the flexibility in approach to reducing heat gain.

Indoor Environment Quality (IEQ)

STANDARD	DESIGN IMPACT	CAPITAL COST IMPACT	BENEFITS	RECOMMENDATION
S39 Buildings should have at least double glazing with improved frames to all habitable rooms and nominated areas OR All dwellings to have PMV between -1 and +1 for 95% of areas of each space for 98% of annual hours of operation (NCC2019 for NABERS, Green Star and JV3 is - 1 to +1)	The design impact of the standard varies with respect to the base case, but in almost all contexts double glazing was already specified. The design impact of the double glazing component of the standard is therefore negligible in the residential context. The predicted mean vote (PMV) component of the standard is problematic, principally because the information required to model it accurately is often not available at the planning stage and not often used for residential developments.	The cost impact of double glazing over single glazing was not measured as in all but one base cases (of 9) double glazing was already specified.	Double glazing and PMV optimisation both produce a thermal comfort benefit and drive improved thermal performance and therefore both an energy saving and a health and wellbeing outcome. As all but one base cases had specified double glazing already, the operational savings and health benefits associated with the standard were not calculated.	We recommend that the standard be removed, as the inclusion of double glazing will (in the circumstances it is not already routinely delivered) be driven through the adoption of the proposed 7 star NatHERS standard through NCC 2022 (or otherwise through this proposed policy). Double glazing is supported as one of several strategies to improve thermal performance. The PMV standard may be appropriate to reference in Guidelines for Sustainable Building Design. Double glazing can be highlighted in Guidelines for Sustainable Building Design as a key strategy to improve thermal performance and comfort.
S40 All habitable rooms should have annual heating load density under 150% of dwelling annual heating load density.	The impact of this standard was tested using a FirstRate file for an 8.2 Star dwelling. It was determined that the lower the density figures of a dwelling, the more easily this results in non-compliance with the standard. This may have the unintended consequence of penalising high-performing dwellings (i.e. those with low loads).	The cost impact was not measured as initial testing of technical feasibility determined the standard should be removed.	Intended benefit of the standard is to avoid isolated thermal comfort issues in individual rooms.	We recommend that the standard be removed as it is likely to have the unintended consequence of penalising high-performing dwellings. If the intent of the standard is to be pursued, the standard would need further investigation to establish an appropriate metric rather than a percentage ratio related to annual dwelling heating load density. An alternative metric to be explored is maximum heating and cooling loads for individual rooms. We suggest including a reporting requirement in BESS which doesn't impact scoring, but allows for the gathering of an evidence base.

Indoor Environment Quality (IEQ)

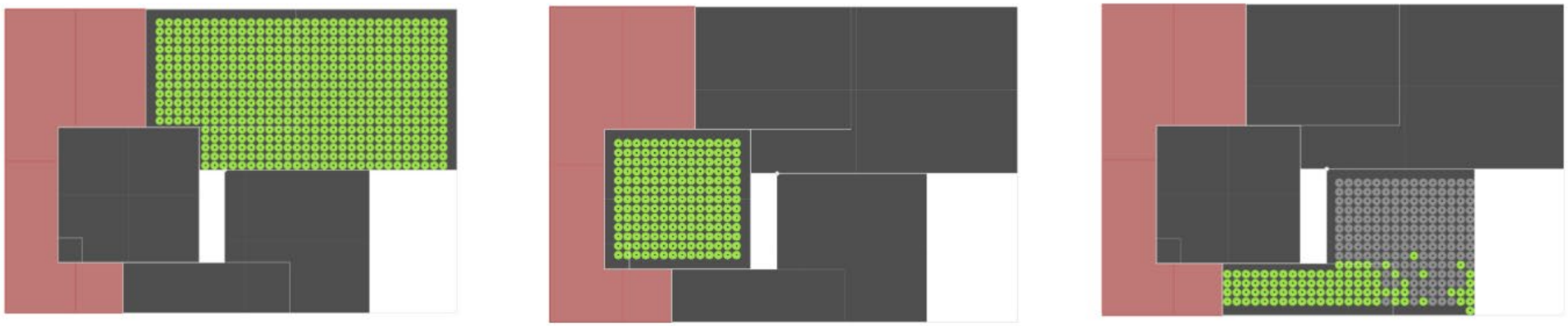
STANDARD	DESIGN IMPACT	CAPITAL COST IMPACT	BENEFITS	RECOMMENDATION
S42 Buildings must achieve a daylight level of minimum 200 lux for at least half of daylit hours each day to at least half the area of every habitable room and regularly occupied space.	The impact of this standard as written will be varied across different typologies of the built environment. For residential apartment buildings, specific design restrictions on habitable room depth, building orientation, setbacks, building separation and glazing visible light transmittance specifications will be necessary. The impost of this standard on bedrooms (as currently written) is considered impractical, given the usage patterns in bedrooms is generally aligned with non-daylit hours. It would require both bedrooms to have nearly full aperture directly to daylight or to a shallow balcony, which would mean that dwellings would need to exceed the standard 8.4m apartment grid. This would mean that 2 bedroom apartments would need to be in excess of 80 sqm to accommodate the standard which would significantly impact affordability. Refer to daylight modelling outputs on following page.	The capital cost impact is that two bedroom dwellings would need to be much bigger (impacting affordability) or significantly shallower which would impact yield and have a flow on benefit for affordability.	The benefit (over current standards) is primarily restricted to improved daylight amenity for second bedrooms, where a 'battle axe' arrangement restricts daylight amenity. More broadly, evidence exists relating to minimum daylight levels for occupant health (e.g. base levels of circadian rhythm). Further detail can be found in the report 'Health impacts of daylight in buildings' prepared by UTS for MAV / CASBE / DELWP.	We recommend modifying the standard based on the impact to development feasibility. The ethics of daylight access are complex and whilst we consider that people who spend significant time during the day in bedrooms should be afforded an improved daylight outcome, we consider that a broad application of this standard to ensure good daylight access to a second bedroom is outweighed by the impact on development feasibility (and the flow on impact to affordability) in its current form. We would support a revised standard which averaged the 200 lux daylight level over the winter period rather than each (every) day over the whole year. Alternatively, further testing could be undertaken for the standard as is currently written but with a modified period of time (e.g. 2 hours rather than half of daylit hours). This testing could occur through the daylight scope separately commissioned by CASBE.
S43 Building must achieve a daylight level across the entirety of every habitable room and regularly occupied space of minimum 50 lux or 100 lux depending on the space type (refer to detailed daylight criteria table).	The design impacts of this standard is considered minimal, given the low levels of lux requirements across habitable rooms. This standard is generally in alignment with the current BESS Daylight Factor levels however the increase to 100% creates additional challenges if applied in a residential setting. If the 50 lux level is applied to habitable rooms of dwellings, then all rooms which meet standard S42 will pass this standard already. Refer to daylight modelling outputs on following pages.	The capital cost impact of the standard is not significant, however yield would be impacted due to increased building separation / setbacks if a standard higher than 50 lux was applied in a residential setting.	The benefit delivers improved daylight amenity for both living areas and bedrooms..	We recommend reviewing the standard further through the daylight scope separately commissioned by CASBE. On the basis of the results in this case study the standard appears redundant for residential applications. We also recommend that a standard to minimise use of artificial light may be appropriate.

Indoor Environment Quality (IEQ)

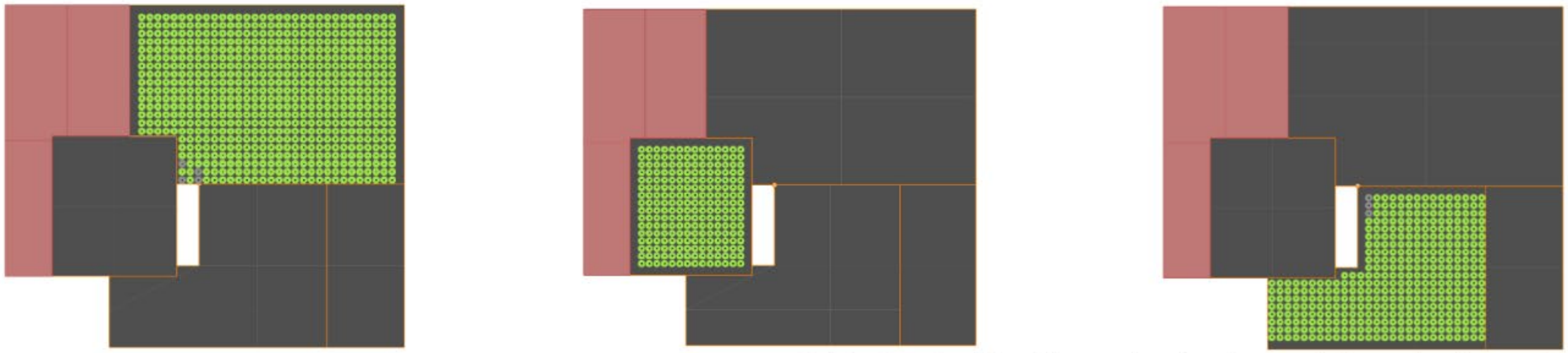
PROPOSED ELEVATED STANDARD 1

Buildings must achieve a daylight level of minimum 200 lux for at least half of daylit hours each day to at least half the area of every habitable room and regularly occupied space. (sDA200,50%).

Refer to Appendix C for full daylight modelling results.



Original apartment layout



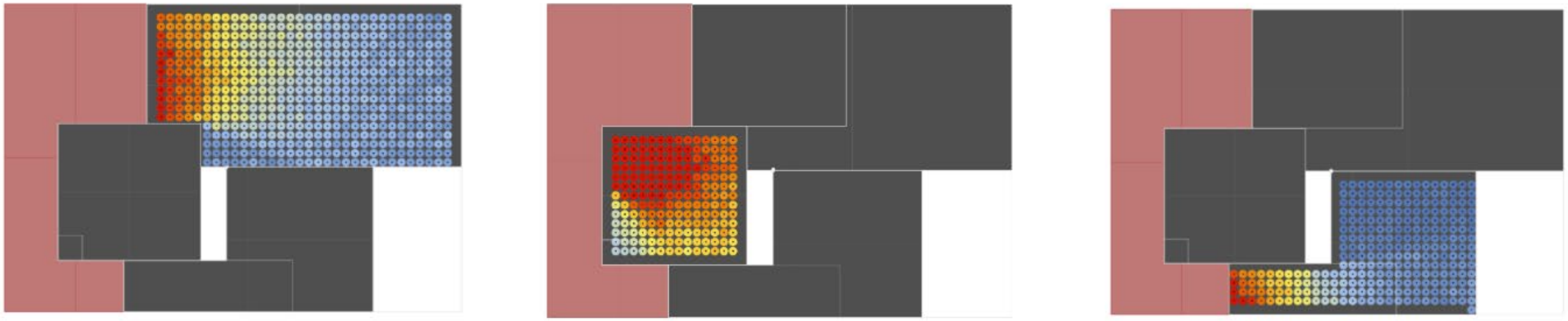
Optimised apartment layout (improved apertures to rooms; balcony cut out to second bedroom aligned to Better Apartment Design Standards (BADS))

Indoor Environment Quality (IEQ)

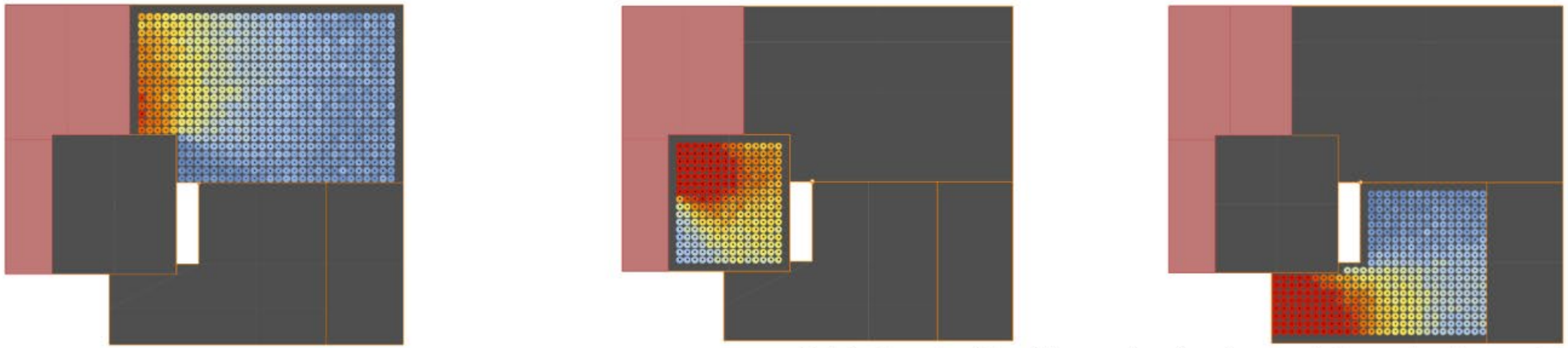
PROPOSED ELEVATED STANDARD 2

Building must achieve a daylight level across the entirety of every habitable room and regularly occupied space of minimum 50 lux depending on the space type.

Refer to Appendix C for full daylight modelling results.



Original apartment layout



Optimised apartment layout (improved apertures to rooms; balcony cut out to second bedroom aligned to BADS

Indoor Environment Quality (IEQ)

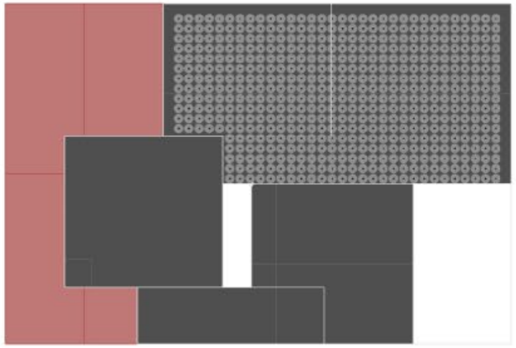
STANDARD	DESIGN IMPACT	CAPITAL COST IMPACT	BENEFITS	RECOMMENDATION
S44 Buildings should achieve direct sunlight to all primary living areas for 2 hours on June 21 to at least 1.5 m deep into the room from glazing.	The design impact of this standard as written would rule out the development of any southern-only aspect dwellings. Primary living areas would be required to face either north, east or west in order to have the potential to receive direct sunlight for at least 2 hours. The testing undertaken found that where a wing wall is present on the north side of an east or west facing dwelling with an adjacent living space that the standard could not be met without reducing the depth of the balcony (impacting outdoor amenity) the length of the wing wall considerably, or adjusting its height (which might impact privacy and structural integrity). Refer to daylight modelling outputs on following page.	The capital cost impact of the standard is not significant, however as written, the standard is not possible to meet for buildings with south facing aspects.	Amenity is improved when dwellings have direct access to sunlight.	We recommend that at a minimum the standard be modified by targeting a reduced number of compliant living rooms as it is not practical for a large development (in particular a large east-west site) to totally avoid a south facing aspect for some living areas. Further testing is required through the dedicated scope commissioned by CASBE to test multiple design iterations beyond a single case study condition (which would include testing a 70%, 75% and 80% threshold). We also query the use of the winter solstice (June 21) .We suggest that the an average over winter months (June-August) is more appropriate. We support a sunlight standard being pursued, but further work beyond our scope is required.
S46 Buildings should have all habitable rooms and frequently occupied spaces provided with glazing to the outside. An exception can be made where external views and daylighting are contrary to the nature and role of the activity in the space (e.g. cinemas).	The design impact of this standard is negligible as in all cases the residential typologies already met the standard.	No cost impact.	The benefit is related to amenity, but as all base cases already meet the standard no benefit can be quantified.	We recommend that the standard be retained, pending a review by Hansen as to whether the standard duplicates other planning policy or building regulations.

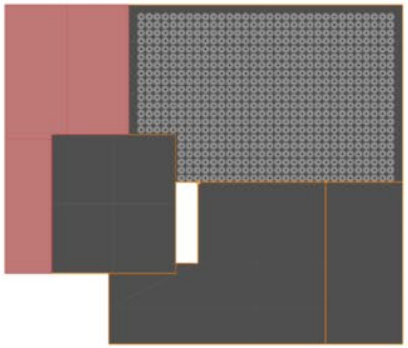
Indoor Environment Quality (IEQ)

PROPOSED ELEVATED STANDARD 3

Buildings should achieve direct sunlight to all primary living areas for 2 hours on June 21 to at least 1.5 m deep into the room from glazing.

Refer to Appendix C for full daylight modelling results.

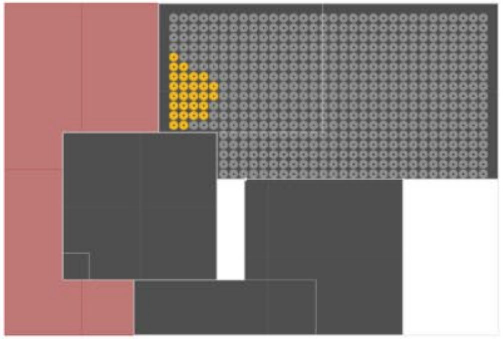




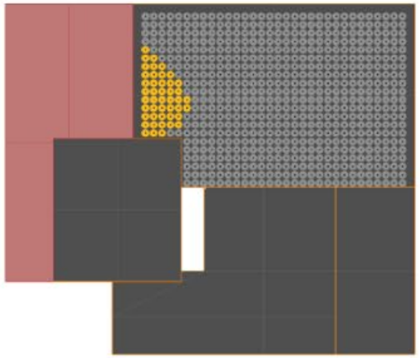
ADJUSTED ELEVATED STANDARD 3

Buildings should achieve direct sunlight to all primary living areas for 2 hours to at least 1.5 m deep into the room from glazing.

This demonstrates that only when averaged over the whole year does this type of apartment layout come close to meeting the standard.



Original apartment layout



Optimised apartment layout (improved apertures to rooms; balcony cut out to second bedroom aligned to BADS

Indoor Environment Quality (IEQ)

STANDARD	DESIGN IMPACT	CAPITAL COST IMPACT	BENEFITS	RECOMMENDATION
S56 Buildings should include openable external windows to circulation corridors and lift lobbies to facilitate natural ventilation and daylight.	The design impact of this standard is constrained to Class 2 (apartment) buildings. The most significant impact is where apartments are loaded off each side of a central corridor and the corridor is fully enclosed within the building footprint. We note that for level above approximately 5 storeys that natural ventilation to corridors may not be the best solution due to wind issues, and as outlined in relation to dwelling ventilation, mechanical systems may have better performance outcomes. A secondary issue is natural ventilation of corridors requires walls onto the corridor to be treated as external spaces from a thermal performance perspective, increasing the insulation requirements to meet the same modelled outcome. Depending on the floor layout, meeting the standard may impact on yield (in one of the base cases, approximately 16 sqm per level).	The capital cost impact may actually be positive (as to meet the standard requires a reduction in building footprint). By way of example the loss of 16m2 of residential space could save up approximately $50K in construction cost, but would represent a loss in yield of well in excess of double that value (depending on location). Administration costs, land costs, preliminaries etc would all remain relatively constant. There is also a cost impact to increase thermal fabric of the walls abutting the corridor space.	The benefit of the standard is to deliver improved amenity outcomes (reduced odours, improved health etc).	We recommend that the standard be modified to account for mechanical ventilation solutions which may be more appropriate for non-residential buildings and taller residential buildings, as well as delivering a range of other benefits (thermal performance etc). We consider that the daylight component of the standard be retained. We recommend that a standard clarify which building typologies it would be applicable to (hospitals, aged care, some office typologies etc all have central corridors but it appears the standard has been drafted with primary reference to apartment buildings) and have regard to wind issues in taller builings.

The following standards were not included in the analysis as they were either flagged for removal due to planning advice or the impact, costs and benefits were addressed in similar standards. Note that some standards may not have been fully analysed but are still included in the previous tables as there was relevant commentary to document.

STANDARD	REASON FOR EXCLUSION FROM ANALYSIS
No habitable rooms should have internal temperature less than 16 degrees continuous for 72 hours, demonstrated through NatHERS modelling in free-running mode.	Refer to Standard S35.
All habitable rooms should have annual cooling load density under 150% of dwelling annual cooling load density.	Refer to Standard S40.
Buildings should achieve winter sun access to all proposed primary private open spaces. At least 50% or 9 m2, whichever is the lesser, of the primary private open space should receive a minimum of two hours of sunlight between 9 am and 3 pm on 21 June.	This standard was flagged for removal by Hansen in a preliminary review of the standards, and was therefore not evaluated. We consider that other planning scheme instruments are preferable to an ESD policy for ensuring outdoor amenity.
Buildings should have all habitable rooms and frequently occupied spaces provided with a layered view comprising 3 distinct layers: sky (background), landscape (middle ground) and ground (foreground)	This standard was flagged for removal by Hansen in a preliminary review of the standards, and was therefore not evaluated. We consider this an appropriate objective to be included in Guidelines for Sustainable Building Design.
Buildings should have a maximum horizontal distance from a fixed point of occupation (e.g. sales desk, retail checkout, office desk, work station) to the external glazing of 8 m.	This standard was flagged for removal by Hansen in a preliminary review of the standards, and was therefore not evaluated. We consider that this information is not available at the planning stage and so it not appropriate to be included within the proposed Guideline for Sustainable Design.

Indoor Environment Quality (IEQ)

STANDARD	REASON FOR EXCLUSION FROM ANALYSIS
All paints, sealants and adhesives should meet the maximum total indoor pollutant emissions limits as set out in most current GECA, Global GreenTag GreenRate, Green Star or WELL standards.	This standard was flagged for removal by Hansen in a preliminary review of the standards, and was therefore not evaluated. We consider this as an appropriate standard to be included in Guidelines for Sustainable Building Design.
100% of relevant products should meet the maximum total indoor pollutant emission limits	This standard was flagged for removal by Hansen in a preliminary review of the standards, and was therefore not evaluated. We consider that this information is not available at the planning stage and so it not appropriate to be included within the proposed Guideline for Sustainable Design.
All carpets should meet the maximum total indoor pollutant emissions limits as set out in most current GECA, Global GreenTag GreenRate, Carpet Institute Australia Environmental Classification Scheme Level 2, Green Star or WELL standards.	This standard was flagged for removal by Hansen in a preliminary review of the standards, and was therefore not evaluated. We consider this as an appropriate standard to be included in Guidelines for Sustainable Building Design.
All engineered wood should meet the maximum total indoor pollutant emissions limits as set out in most current GECA, Global GreenTag GreenRate, Green Star or WELL standards.	This standard was flagged for removal by Hansen in a preliminary review of the standards, and was therefore not evaluated. We consider that this information is not available at the planning stage and so it not appropriate to be included within the proposed Guideline for Sustainable Design.
Non-residential only Internal smell and odour control for olfactory comfort - use negative pressurisation, self-closing doors or area separation (e.g. via corridors, air-lock) to prevent migration from bathrooms, kitchens, dining areas and pantries to workspaces (WELL credit).	This standard was flagged for removal by Hansen in a preliminary review of the standards, and was therefore not evaluated. We consider that this information is not available at the planning stage and so it not appropriate to be included within the proposed Guideline for Sustainable Design.
Where the development is within 150m of main roads, truck routes and rail corridors carrying diesel trains: •Sensitive use facilities are not supported within this zone. Acceptable indoor air quality may be achieved through HEPA or MERV16 filters, however acceptable open space air quality is not deemed to be achievable. •All other development types within this zone should include all outdoor air supply filtered through HEPA or MERV16 filter system. Development to include air pollution monitoring system including PM1, PM2.5 and PM10 levels.	This standard was flagged for removal by Hansen in a preliminary review of the standards, and was therefore not evaluated. We consider that an ESD policy is not the appropriate mechanism for ensuring air pollution standards and buffer distances for sensitive uses.
Where the development is within 500m of main roads, truck routes and rail corridors carrying diesel trains: •All development types within this zone (including sensitive use types) should include all outdoor air supply filtered through HEPA filter system. •Development to include air pollution monitoring system including PM1, PM2.5 and PM10 levels.	This standard was flagged for removal by Hansen in a preliminary review of the standards, and was therefore not measured. We consider that an ESD policy is not the appropriate mechanism for ensuring air pollution standards and buffer distances for sensitive uses.

Circular Economy

This theme focuses on improving rates of resource recovery during both construction and operation, and closing the loop by encouraging the use of materials with recycled content as an alternative to virgin materials.

Public waste receptacle with disposal points for multiple streams at Burwood Brickworks. Photography by Kim Landy

Circular Economy

STANDARD	DESIGN IMPACT	CAPITAL COST IMPACT	BENEFITS	RECOMMENDATION
S57 Provide a Construction and Demolition Waste Management Plan that sets a landfill diversion target by demonstrating practices and activities in line with minimising waste and increasing resource recovery.	There are no design impacts related to this standard as it is an operational practice.	Capital cost impact is not measurable as waste disposal services do not commonly offer an option of 'all waste to landfill' and an option of 'XX% waste diverted from landfill'. This is further compounded as the rates of different service providers vary as they are dependent on factors such as proximity to a construction site and whether a provider operates its own recycling processing facility or has arrangements with another party, therefore making comparison across providers problematic. Note that there is no cost impact for an increased percentage of diversion (e.g. no cost premium for a recovery rate of 70% versus rate of 80%).	Significant benefits from increased resource recovery/landfill diversion. Volume of waste diverted from landfill largely dependent on the typology.	We recommend that the standard be retained but modified to include a minimum 80% landfill diversion target for construction and demolition waste. This will help to achieve consistent responses to the standard and ambitious but achievable resource recovery rates.
S58 Utilise low maintenance, durable, reusable, repairable and recyclable building materials. S59 Utilise materials that include a high recycled content. S60 Utilise low embodied energy, water and carbon through informed responsible procurement and product stewardship measures. S61 Avoid materials which are low toxicity in manufacture and use, and that may cause harm to people, the ecosystem and other biodiversity	The design impact is varied depending on the strategies used and extent to which this standard is addressed. The selection of more sustainable materials would be achieved through specifications which prioritise alternatives over business-as-usual materials. As materials selection options are highly varied, we applied one consistent example which is generally accepted by industry and easily quantified - the specification of concrete with cement replacements (supplementary cementitious materials) over a standard concrete mix. This applied as a standard design response for the case study alternatives.	Capital cost premium of a concrete with supplementary cementitious materials is approximately $10/m3.	For the example of concrete with supplementary cementitious materials: Resoure recovery benefit from the reuse of a waste product/by-product (fly ash). Carbon benefit from replacement of carbon intensive materials (cement).	We recommend that the standard be modified to consolidate multiple draft standards relating to materials selection, and focus the revised standard on use of recycled content materials and materials with low embodied carbon. Guidance such as BESS tool notes and the proposed Guideline for Sustainable Building Design is required to communicate what strategies are considered adequate to meet the standard. Low toxicity may be appropriate as a standalone IEQ standard.
S62 Utilise materials that are locally sourced and supplied, supported by relevant chain of custody or third-party verification process.	This standard was flagged for removal by Hansen in a preliminary review of the standards, and was therefore not measured.	N/A	N/A	We recommend that although this standard has been flagged for removal, the principle of local sourcing can be included under standards relating to reducing (travel related) embodied emissions.

Circular Economy

STANDARD	DESIGN IMPACT	CAPITAL COST IMPACT	BENEFITS	RECOMMENDATION
S63 General Collection and Management Enable the separation and collection of resources from all current waste and recycling streams and provide spatial allocation for future waste and recovery streams.	The design impact of meeting this standard relates to the ability of a development to cater for the disposal and collection of a variety of waste streams. At a minimum, all case studies provided space for both general waste and recycling, with some also providing space for organics, glass and hard waste recovery. An increase in waste streams collected (e.g. glass recycling & FOGO) may result in the need for increased spatial allocations, however, this is not a given as some developments may respond with a range of measures to avoid requiring additional floor space dedicated to resource recovery (e.g. increase collection frequency, use of compactors/crushers).	Cost implication has not been measured, as this will be a result of State policy rather than this standard directly.	Carbon benefit due to avoided CO_2e emissions of organics in landfill. Note that the amount calculated for the CBA assumes that occupant behaviour results in full diversion of organics from landfill if appropriate infrastructure is present and collection services are available.	This standard should be retained but modified to be an overarching waste collection and management standard where elements of other standards can be consolidated into. Note that part of the role of the standard is to reinforce State policy direction of the near future (i.e. Recycling Victoria), particularly waste stream diversification. We recommend that apartment developments consider additional waste streams such as textiles and e-waste.
S66 Individual/ Localised Management Developments should include dedicated areas of adequate internal storage space within each dwelling to enable the separation and storage of waste, recyclables and food and organic waste.	The design impact of meeting this standard is negligible. Dedicated internal storage space within dwellings for waste management was not ordinarily evident in the case studies but adequate collection systems can easily be integrated into existing/standard storage space (e.g. a 600mm x 600mm area).	Capital cost is none/negligible.	Potential to improve waste separation at the source and improve resource recovery.	We recommend that this standard be consolidated into a broader/ overarching standard relating to waste collection and management.
S67 Consolidated/ Centralised Management Developments should include dedicated facilities for the collection, separation and storage of waste and recyclables; which are: – Adequate in size, durable, waterproof and blend- in with the development. – Adequately ventilated. – Accommodating similar transfer passages for all waste and recycling streams – Located and designed for convenient access including for people with limited mobility – Include appropriate signage and labelling	The design impact of meeting this standard is negligible as consolidated/centralised management is commonplace across the majority of typologies (e.g. a central waste storage room in a basement).	Capital cost is none/negligible.	Potential to improve waste separation at the point of disposal and improve resource recovery.	We recommend that although the intent of the standard is supported it should be consolidated into a broader/overarching standard relating to waste collection and management.

Circular Economy

STANDARD	DESIGN IMPACT	CAPITAL COST IMPACT	BENEFITS	RECOMMENDATION
S68 Consolidated/ Centralised Management Developments should include dedicated areas for the collection, storage and reuse of food and garden organics, including opportunities for on-site treatment, where appropriate, or off-site removal for reprocessing	Refer to Standard S63	N/A	N/A	We recommend that this standard be consolidated into a broader/ overarching standard relating to waste collection and management.
S69 Consolidated/ Centralised Management Developments should include adequate facilities for bin washing.	The design impact of meeting this standard is varied due to the options available for bin washing. One option may be on-site infrastructure in the waste collection area (e.g. a tap and floor waste), which some case studies did include. However, some developments may opt for bin cleaning by a mobile cleaning vehicle (i.e. hooks bins up to the back of the truck, washes out and returns to storage space). The latter option would not require on-site infrastructure, only space for the temporary parking of a washing vehicle which could be the same as any on-site collection space.	Cost implication has not been measured as the differing strategies range from capital costs (e.g. taps - negligible cost) to operational costs (e.g. arrangement for in-truck washing).	Improved amenity for occupants due to a cleaner waste disposal area.	We recommend that this standard be modified to clarify that 'facilities' does not necessarily mean on-site infrastructure such as taps and floor waste is required. While such infrastructure can be encouraged, the modificiation allows flexibility for other approaches to bin washing.
S70 Collection Points and Access Developments should include adequate circulation to allow waste and recycling collection vehicles to enter and leave the site without reversing.	This standard was flagged for removal by Hansen in a preliminary review of the standards, and was therefore not measured. Note that the design impact of requiring vehicle circulation on-site that allows entry and exit without reversing is significant. This objective is often already sought for by Councils however is largely not evident or practical in the case studies reviewed. For many smaller sites such as inner city apartment and office developments, this is either impractical or would have a large spatial implication.	N/A	N/A	N/A
S73 Materials Encourage development to include a framework for ease of repair, design disassembly and resource recovery for future renovations and demolition.	This standard was flagged for removal by Hansen in a preliminary review of the standards, and was therefore not measured.	N/A	N/A	We recommend that although this standard has been flagged for removal, designing for disassembly and future recyclability could be incorporated elsewhere as a standard or in objectives.

Circular Economy

STANDARD	DESIGN IMPACT	CAPITAL COST IMPACT	BENEFITS	RECOMMENDATION
S75 Design Design adaptable buildings that enable transitional and alternative use.	The design impact of meeting this standard is varied given a range of strategies can be utilised to create adaptable buildings. Adaptive design responses apart from optimising floor-to-floor heights of above ground car parking levels are either highly contextual or not easily measured/ quantified. Therefore due to the site-specific nature, the creation of design responses for the case studies is not beneficial as the impact cannot be easily extrapolated across other developments within the same typology.	Capital cost implications are varied, depending on site-specific response. The example of optimised floor to floor heights results in an increased cost associated with a greater amount of external facade.	Long-term benefits associated with future-proofing a development. Main benefit is the reduced need to retrofit a building to suit a future alternative use.	We recommend that the standard be retained but supported by clear guidance (in Guidelines for Sustainable Building Design) detailing what measures are considered appropriate responses (e.g. specific floor to floor heights for above ground car parking; easily moved internal walls). This ensures the standard is consistently assessed against and provides certainty to applicants/developers.

The following standards were not included in the analysis as they were either flagged for removal due to planning advice or the impact, costs and benefits were addressed in similar standards. Note that some standards may not have been fully analysed but are still included in the previous tables as there was relevant commentary to document.

STANDARD	REASON FOR EXCLUSION FROM ANALYSIS
S64 General Collection and Management Waste and recycling separation, storage and collection must be designed and managed in accordance with a Waste Management Plan approved by the responsible authority and: – Meet best practice waste and recycling management guidelines – Provide capacity for periods of peak waste and recycling generation based on modelled estimates. – Consider shared waste and recycling disposal options – Minimize the impacts of odour, noise and hazards associated with waste collection vehicle movements.	This standard was flagged for simplification/consolidation with an overarching standard by Hansen in a preliminary review, and was therefore not evaluated.
S65 General Collection and Management Residential only Projects equal to or larger than 50 dwellings a charity donation bin must be provided and included in the management plan.	This standard was flagged for removal by Hansen in a preliminary review of the standards, and was therefore not evaluated. We consider this as an appropriate standard to be included in Guidelines for Sustainable Building Design.
S71 Collection Points and Access Prioritise on-site collection of waste and recycling as opposed to on-street collection, where applicable.	This standard was flagged for removal by Hansen in a preliminary review of the standards, and was therefore not measured. We consider this as an appropriate standard to be included in Guidelines for Sustainable Building Design, to the extent that this does not limit the waste streams available for collection.
S72 Private Contractors Consider, as relevant, that if a private waste contractor is required, that the handling and separation of various waste and recycling streams is facilitated ensuring that all resources are diverted from landfill.	This standard was flagged for removal by Hansen in a preliminary review of the standards, and was therefore not measured. We considerthat regardless of who collects waste, that the landfill diversion (as demonstrated through S63) is central to the approach. We refer to the planning advice as to the extent that this is covered through S63.
S74 Materials Encourage reduced product use where appropriate.	This standard was flagged for removal by Hansen in a preliminary review of the standards, and was therefore not measured. We consider dematerialisation should be addressed in proposed Guidelines for Sustainable Building Design.

Green Infrastructure

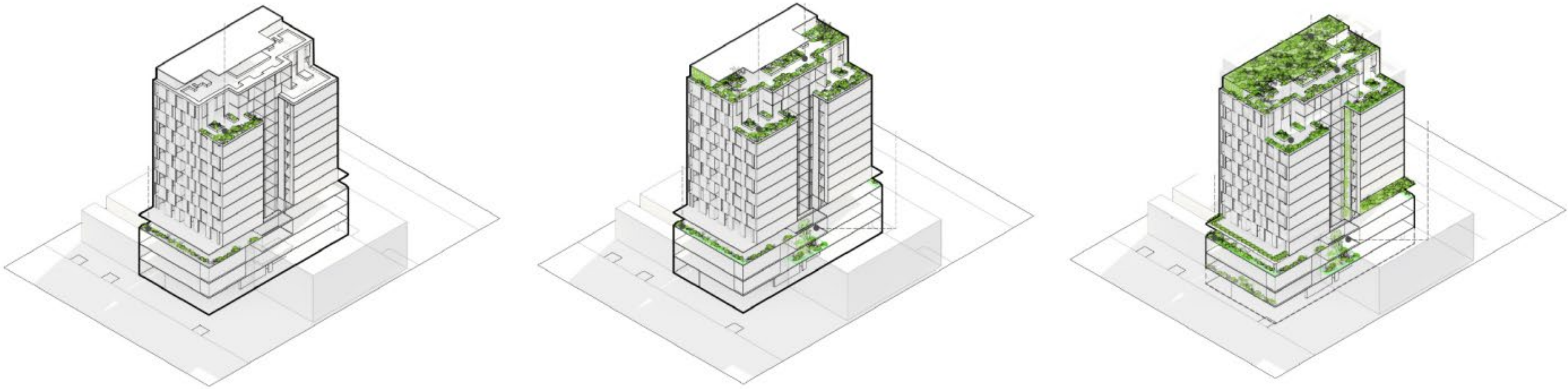
This theme focuses on increasing the amount of green infrastructure to provide a range of ecosystem service benefits, and reducing the contribution of the built environment to the urban heat island effect.

Landscaping on the rooftop of Nightingale 2 development. Photography by Rory Gardiner

Green Infrastructure

STANDARD	DESIGN IMPACT	CAPITAL COST IMPACT	BENEFITS	RECOMMENDATION
S76 All new development to meet a Green Factor score of (High= 0.55, Mid=0.4, Low=0.25) *Note: further work required to establish target score for different contexts OR provide green cover (external landscaping) as follows: Any alternate delivery of green cover must provide at least (high=40%, mid=30%, low=15% equivalence) of the total site coverage area as green cover comprising at least one of the following: • A minimum of 65% of the required green cover as new or existing canopy planting and a minimum of 35% as understory planting. Canopy planting and understory planting can overlap. • Species selection and associated planting scheme of native and / or indigenous species which provides valuable habitat for native fauna. • Green cover which is located to provide maximum benefit in relation of cooling of the adjoining public realm. Green walls or facades under this pathway must benefit the public realm and be on the lower levels of the building.	The design impact is variable depending on typology. Some case studies for detached dwellings already achieved the 40% cover due to the availability of ground level space for landscaping. However, the majority of case studies had green cover anywhere between 2% and 36%. In most cases, there was limited remaining ground level space for landscaping either due to the building footprint, car parking or existing landscaping. Therefore generally the design impact to achieve 40% cover is through the incorporation of vertical or on-structure landscaping (e.g. planters, climbers or green roofs). Exact green infrastructure design responses (e.g. determining where planters would be located) were not developed for each alternative design, as this would require an extensive assessment, and the design response based on the case study built form would not necessarily be able to be extrapolated to other built forms of the typology. However, different proportions of green infrastructure types were used for different typologies based on the building context and opportunity. Generally speaking, to achieve the required increase in green cover through vertical or on-structure landscaping, there would be some spatial implications to allow for sufficient growing medium (i.e. soil) and potentially some structural implications for green roofs and their associated weight loading. Note that extensive investigation was undertaken for the development of the Green Factor tool for the City of Melbourne, including testing the feasibility of the green cover targets on a range of typologies. This work found that meeting a 40% green cover target was feasible on all typologies with the exception of industrial, where larger hard stand areas and light weight roofs restricted outcomes. A 20% green cover target (or 0.25 Green Factor score) is considered appropriate for this land use.	Capital cost varies significantly between green infrastructure types. The following are approximate rates: $200/m2 - inground landscaping $1,640/m2 - planter $596/m2 - green facade $808/m2 - green roof This can represent an impact of in the order of 1% of the construction cost of the building if the 40% (high) green cover is targeted.	The incorporation of green infrastructure has a range of ecosystem service benefits including: 1. Urban Temperature Regulation (Cooling Effect) 2. Habitat for Biodiversity 3. Run Off Mitigation 4. Recreation 5. Place Values and Social Cohesion 6. Aesthetic Benefits 7. Food Supply	We recommend that the standard is retained as it supports a range of objectives relating to biodiversity, urban heat mitigation and stormwater runoff, while also supporting positive social outcomes. Note that as written the proposed standard states 'at least one of the following' for the alternative delivery of green cover. The original source of these requirements was the proposed Amendment C376 from City of Melbourne and may not specify 'at least one'. We recommend reviewing wording and determining whether any divergence from the wording of City of Melbourne is appropriate. Note that HV.H led the consultant team to develop the Green Factor tool but the tool is wholly owned by the City of Melbourne.

Green Infrastructure



Greening scenarios for an example large residential typology. Business as usual scenario (left) showing a Green Factor score of 0.14, moderate greening scenario (centre) showing a Green Factor score of 0.55 and an optimised greening scenario (right) demonstrating a Green Factor score of 0.84. Images by SBLA

Green Infrastructure

STANDARD	DESIGN IMPACT	CAPITAL COST IMPACT	BENEFITS	RECOMMENDATION
S77 Existing mature canopy trees or vegetation which contributes to biodiversity corridors and habitat should be retained.	The design impact of this standard could be significant if applied to its full extent (i.e. all mature canopy trees retained without exception). For example, it was estimated from aerial imagery that one case study had removed approximately 80m2 of canopy to develop the full 1000m2 of the site. If this canopy was to be retained, this would have a significant impact on the yield potential of the multi-storey office development. Technical feasibility of the standard could not be evaluated due to lack of information and the highly variable nature of the impact from one development to the next. Approximately half of the case studies did not have sufficient or definitive information available to determine the presence of mature canopy prior to development, however, some sites it could be assumed based on the location (e.g. inner city) that there was no existing trees. A couple of case studies included commitments for the replacement of removed trees with equivalent vegetation. As the retention of canopy should be guided by multiple factors including the health and function of the trees (information which is site-specific and also not available for these case studies) and the role of Council local laws and planning overlays, no design responses were proposed which included the retention of any existing canopy. At a high level, retention of canopy should be encouraged however requires site-specific assessments to determining the value.	Not measured however would impact on development yield.	Benefits include habitat for biodiversity and urban cooling benefits.	We recommend the standard be modified to clarify the conditions which would need to be met for a mature canopy tree (regardless of whether it is native or exotic) to be either retained or removed as part of a development application. The retention of existing mature canopy trees or vegetation should be encouraged but may not always deliver the best outcome for a site. We consider that mature trees should be retained where possible. Note that there is a strong intersection with other planning mechanisms (e.g. overlays) and local laws for tree removal which will need to be considered during the planning approvals process. Tree removal often occurs separate from a buildings and works application, so we consider amendments to other policies may be a more appropriate mechanism for delivering the outcome sought.
S78 Developments should: – Retain existing soil profiles and conditions on site where possible. – Provide appropriate deep soil area to support the growth of canopy trees and vegetation to mature sizes. – Provide composting facilities and/or worm farms as appropriate to the scale of development – Incorporate effective soil conditioning (mulch, compost, manure, gypsum etc) – Ensure that imported topsoil is productive, free of contaminants, and of a high quality	This standard was flagged for removal by Hansen in a preliminary review of the standards, and was therefore not measured.	N/A	N/A	We recommend that although this standard has been flagged for removal, the principles could be detailed elsewhere (Guidelines for Sustainable Building Design).

Green Infrastructure

STANDARD	DESIGN IMPACT	CAPITAL COST IMPACT	BENEFITS	RECOMMENDATION
S79 Green cover proposed should: • Support the creation of complex and biodiverse habitat. • Provide a layered approach, incorporating both understory and canopy planting. • Provide either native, indigenous or climate change resilient exotic plants that provide resources for native fauna. • Support the creation of vegetation links between areas of high biodiversity through planting selection and design. • Consider appropriateness of species selected to expected future climate conditions.	The design impact of this standard is largely a change to the landscaping specification (species selection) and improvements to design (increased diversity of plant forms within the existing landscaped area). These impacts are considered to not impact technical feasibility.	Capital cost is none/negligible.	The main benefit is improved biodiversity outcomes, with secondary benefits such as aesthetic benefits and urban cooling.	We recommend the standard be retained to complement Standard S76 and support the achievement of biodiversity outcomes.
S83 Demonstrate that at least 75% of the development's total site area (building and landscape) comprises elements that reduce the impact of the urban heat island effect. These elements include: • Green infrastructure • Roof and shading structures with less than 15° pitch having SRI of minimum 80 and 40 for pitches of more than 15° • Solar panels • Hardscaping materials with SRI of minimum 40	The design impact to meet this standard is the specification of urban heat reducing materials. Several case studies were compliant with the standard, commonly through a combination of landscaping and a light coloured roof. Alternative design responses which satisfy the standard are easily achievable through consideration of surface colour.	Capital cost impact for lighter coloured metal and pavers is considered cost neutral. Capital cost premium of $24/m2 for concrete with white cement/ pigment.	Reduced urban heat resulting in more thermally comfortable environments for occupants and pedestrians.	We recommend that the standard be retained as it is an effective approach to achieving urban cooling outcomes in a manner which has a relatively low cost impact. We recommend solar panels be excluded from the calculation for increased consistency with the Green Star Buildings tool methodology.
S85 Utilise paving treatments which assist in cooling such as permeable paving or light-coloured aggregates, where applicable	The design impact of this standard specifically was not measured as it is considered a duplication of Standard S83.	Not measured.	N/A	We recommend this standard be removed and merged with Standard S83. A separate standard focusing on high pedestrian amenity (shade etc) may be appropriate.

HIP V. HYPE

Green Infrastructure

STANDARD	DESIGN IMPACT	CAPITAL COST IMPACT	BENEFITS	RECOMMENDATION
S87 Use materials that are resistant to extreme weather.	This standard was flagged for consolidation with another by Hansen in a preliminary review of the standards, and was therefore not measured.	N/A	N/A	We recommend this standard be removed and a materials focused standards incorporate a principle relating to durability as this is an important element of adaptive building design and supports local government as a decision maker in their climate related responsibilities under the Local Government Act. Material selection for extreme weather/hazards (e.g. fire) is often driven by building regulations, or would flow from risks identified during a climate risk assessment. Materials selection for all circumstances (e.g. current and future weather) can be considered as part of broader suite of objectives for materials.
S88 Incorporate cooling pathways and corridors to minimise urban heat and address heat health matters.	The design impact of the standard specifically was not measured as its objectives were considered to be addressed by other standards such as S76 and S83.	Not measured.	Quantified / addressed elsewhere.	We recommend this standard be retained to guide design which supports the greening outcomes of Standard S76.

The following standards were not included in the analysis as they were either flagged for removal due to planning advice or the impact, costs and benefits were addressed in similar standards. Note that some standards may not have been fully analysed but are still included in the previous tables as there was relevant commentary to document.

STANDARD	REASON FOR EXCLUSION FROM ANALYSIS
S80 Ensure shared urban ecology facilities are accessible for all users - at least the following amount of vegetated outdoor common space, including food production areas: • $1m^2$ for each of the first 50 occupants • Additional $0.5m^2$ for each occupant between 51 and 250 • Additional $0.25m^2$ for each occupant above 251.	This standard was flagged for removal by Hansen in a preliminary review of the standards, and was therefore not evaluated. We consider this is appropriate to be included in the proposed Guidelines for Sustainable Building Design. We note that the Green Factor Tool rewards accessible green space through the recreation and aesthetic benefits ecosystem service scoring, so caution should be exercised in rewarding meeting this standard in BESS (potential double counting).
S81 Assess the proposed development site against current and future climate related hazards and natural disasters.	This standard was flagged for removal by Hansen in a preliminary review of the standards, and was therefore not evaluated. Climate risk is addressed under Standard S33.
S82 Demonstrate that the development will be able to strengthen community climate resilience within its immediate or local context	This standard was flagged for removal by Hansen in a preliminary review of the standards, and was therefore not evaluated. We consider this could be included as an objective in Guidelines for Sustainable Building Design, with specific examples of how this could be achieved.
S84 Non-glazed façade materials exposed to summer sun must have an SRI of minimum 40	Refer to Standard S83 as design impact, costs and benefits are the same.
S86 Combine renewable energy with energy storage and smart energy management to provide resilience and enable 'refuge' from heat wave during power blackouts.	This standard was flagged for removal by Hansen in a preliminary review of the standards, and was therefore not evaluated. We consider this could be encouraged through the proposed Guidelines for Sustainable Building Design.

Conclusions

This section of the report summarises key findings, gaps, uncertainties and limitations and next steps.

KEY FINDINGS

The technical feasibility and financial viability analysis examined effective design responses to meeting proposed standards. This analysis had regard to technical and spatial implications of each standard, unless it had been ruled out through preliminary analysis by Hansen Partnership. Where the design response incurred a cost or benefit these were documented and then integrated where relevant with the cost benefit analysis.

The results of the analysis were mixed, with some standards being recommended to be retained in their current form, others modified and several standards recommended for removal altogether.

Taken at an aggregate level standards were recommended to be retained when technical impacts could be effectively managed, where cost impacts were either low or benefits high relative to the costs. Examples that met this criteria include solar PV for smaller residential typologies and bicycle parking rates for office buildings.

Standards were recommended for modification where the intent of the standard was appropriate for planning policy, but the standard could be improved to either address technical feasibility issues, address cost impacts or improve benefits. An example includes bicycle parking convenience where some elements of the standard were beneficial and other elements delivered an unreasonable yield impact relative to the benefit.

Standards were recommended for removal in circumstances where the level of prescription was more appropriate in a guideline, where technical issues can not be addressed through modification of the standard, or meeting the standard requires design responses which create an unreasonable cost impact or yield reduction relative to the benefit.

This process of analysis has resulted in standards being recommended for retention in largely their current form, a further number being recommended to be modified and others being recommended for removal.

The table on the following page outlined a summary of advice. We note that at the time of this analysis Part B and Part C of the project were yet to be completed and may recommend additional standards for removal / modification on planning and / or economic grounds.

Community interaction across private and public space.
Photography by Tess Kelly

HIP V. HYPE

Conclusions

THEME	KEY FINDINGS
OPERATIONAL ENERGY	Generally speaking the majority of standards were retained either in their present form or otherwise recommended to be modified to remove some of the prescriptive detail. Two of the solar standards were recommended to be modified significantly as they were found to not be technically feasible. Fuel switching and procurement of GreenPower were noted as being highly effective as reducing carbon emissions.
SUSTAINABLE TRANSPORT	Standards relating to the provision of bicycle parking were largely supported due the minimal expected cost for space allocation and infrastructure. Modifications to the bicycle parking convenience standard were suggested to avoid potentially significant impacts to basement and ground floor space. Electric vehicle standards were noted as important for future proofing buildings, however we recommended that the standards avoid prescriptive guidance and that a guideline which is updatable without the need for a planning scheme amendment is preferred.
INTEGRATED WATER MANAGEMENT	In the majority of cases the standards were already met by the case studies, for example the inclusion of rainwater tanks and the achievement of best practice stormwater quality standards were widespread. Overall the intentions for most standards were supported, however, some modifications were recommended to allow a flexible approach to achieving potable water reductions. It was noted that the potable water reduction target of 30% could be more ambitious, subject to further analysis.
INDOOR ENVIRONMENT QUALITY (IEQ)	Most standards were either suggested for modification or removal as they were better suited as guidance or were found to have significant development feasibility impacts. Preliminary testing determined standards for internal temperatures and heating and cooling loads were either not achievable or could have unintended consequences. Daylight modelling demonstrated significant challenges with meeting standards as written. It is noted that the intent of these standards is supported, but further work such as refining thresholds and metrics would be necessary for several standards before they would be suitable as a planning mechanism. In relation to daylight this work is understood to have been recently commissioned by CASBE.
CIRCULAR ECONOMY	A number of these standards are technically feasible and are seen in current developments. It is noted that standards relating to waste collection and management aim to strengthen the ability of Council's to achieve the outcomes they already seek. There is strong opportunity to drive the uptake of recycled content and durable materials, and the design of adaptable buildings, however these standards require additional guidance to provide clarity for both applicants and Councils.
GREEN INFRASTRUCTURE	A green cover target is a strong driver for increasing green infrastructure and achieving a range of ecosystem services benefits. While the retention of existing mature canopy trees should be encouraged, the intersection with local laws and existing planning mechanisms such as overlays should be considered, with these mechanisms possibly better able to deliver the outcome sought. A standard for cool surfaces and materials it is an effective approach to reducing urban heat in a manner which has a relatively low cost impact.

Conclusions

GAPS, UNCERTAINTIES AND LIMITATIONS

As noted in a number of sections of this report, whilst the qualitative analysis for the project has provided a number of insights into benefits accruing to individual standards, not all of these benefits are able to be quantified. The analysis in this report is limited to quantifying energy, water and landfill diversion benefits associated with standards. In some circumstances, even when there is a high level of confidence that a benefit exists there is not the evidence to quantify it and it has been excluded. The cost benefit analysis will quantify a greater range of economic benefits associated with meeting the proposed standards.

The analysis is also somewhat limited by the number of case studies able to be included in the study. Whilst every effort was made for the case studies to be representative of a broad range of typologies and development contexts, technical feasibility and financial viability impacts may be limited by the designs and specific context of the case studies. In addition, design responses were developed based on our professional development, architecture and sustainability experience. We acknowledge that design responses to meet the standards may be different in other contexts and development teams.

A third limitation are the costs. Whilst costs were sourced on the best available contemporary data, they will not be perfect. If costs change, so does the relationship between benefits and costs.

NEXT STEPS

This report is issued slightly ahead of Part B and Part C of the project. This allows those outputs to be informed by this report.

We anticipate that decisions on next steps will be made by CASBE on the basis of all reports, rather than this report alone.

If following the conclusion of all parts, a planning scheme amendment is pursued, we anticipate further work may be required to:

- Ensure that design responses are representative of the most cost effective industry response to the standard
- Update costs ahead of a planning panel (we have structured our analysis work to allow for this to be a seamless process)
- Enhance the quantitative analysis where new robust evidence becomes available as to benefits associated with particular design responses (and standards)
- Update the analysis if the proposed move to 7 stars NatHERS under NCC 2022 is not forthcoming
- Extend the analysis to additional case studies, if stakeholder consultation highlights a gap in those chosen
- Update this report to align ESD categories to the most up to date wording proposed as part of a planning scheme amendment.

Appendix A

The following details calculation methodologies and assumptions used to determine benefits used in the analysis.

EMBODIED CARBON

For the design response relating to recycled content materials, concrete with supplementary cementitious materials was used. In order to determine the amount of concrete in a building and embodied carbon reduction achieved through the design response, a number of calculations and assumptions were made.

Using an existing Life Cycle Assessment (LCA) for a mid-rise apartment building with concrete panel facade, two values of tonnes per m2 GFA were determined.

Building GFA	2,712m2
Concrete - precast	821 tonnes
Concrete - poured	3,059 tonnes
Concrete per GFA (precast and poured)	1.43 tonnes per m2
Concrete per GFA (poured only)	1.13 tonnes per m2

The figure of 1.43 tonnes per m2 GFA was then used to calculate the amount of concrete across case studies where concrete was a predominant material. For case studies where concrete was less prevalent (e.g. a curtain wall high rise development), the figure of 1.13 tonnes per m2 GFA was used.

Using the above values, the GFA for each case study and the below embodied carbon values from the EPiC database, embodied carbon (kg CO2e) reductions resulting from the design response of concrete with SCMs were calculated.

Concrete 40 MPa	497 kg CO2e per m3
Concrete 40 MPa - 30% fly ash	373 kg CO2e per m3

ORGANICS WASTE GENERATION

Organics generation was calculated primarily using Sustainability Victoria's Waste and Recycling Generation Rates Calculator. As this calculator does not calculate organics generation for non-residential developments (only garbage and recycling), a value of 26% was used to approximate the proportion of food waste generated by non-residential developments.

Although this figure is attributable to commercial and industrial waste in metropolitan Melbourne, as detailed by the Metropolitan Waste and Resource Recovery Group, it was deemed a suitable generalisation for all non-residential developments throughout Victoria.

CONSTRUCTION WASTE GENERATION

The generation of construction waste is highly dependent on the development typology and construction materials used. Limited information detailing specific figures which account for the above factors is available, therefore a general assumption was made.

Green Star Design & As Built v1.3 Credit 22 contains to pathways for diversion of construction waste from landfill. The Fixed Benchmark awards 1 point where <10kg of waste / m2 (GFA) goes to landfill. The Percentage Benchmark awards 1 point where 90% of construction waste is diverted from landfill.

To create an approximate total waste kg/m2, the figures of each benchmark required to achieve 1 point were assumed to be equivalent.

1 point achieved for waste kg/m2 (GFA) to landfill	<10kg
1 point achieved for waste % diverted from landfill	90%
Assumed total waste as a proportion of GFA	100kg per m2

Assuming a 90% diversion rate achieves only 10kg going to landfill, a generation rate of 100kg/m2 (GFA) was calculated.

TOTAL ENERGY USE

As the total predicted energy consumption was not always detailed in case study documentation, and is not calculated by BESS (focus is on HVAC and hot water), an average percentage breakdown in combination with known figures (e.g. HVAC) was used to calculate other energy uses and the total use. The following figures were sourced from the SDAPP Energy Efficiency Fact Sheet for residential developments.

Heating and cooling	60%
Water heating	20%
Appliances incl. TV & computer	10%
Cooking appliances	3%
Fridge and freezer	4%
Lighting	3%

The following figures were sourced from the Baseline Energy Consumption and Greenhouse Gas Emissions In Commercial Buildings in Australia Report for non-residential developments.

HVAC	18%
Lighting	37%
Equipment	31%
Hot water	3%
Other	11%

Appendix B

The following details the capital costs used in the analysis, the cost source and any relevant notes.

ITEM	COST ($)	PER	SOURCE / REFERENCE
Electric hot water system (localised instantaneous)	890	unit	Rawlinsons (p. 461)
Electric hot water system (central heat pump) - per dwelling / per 1000m2 non-res GFA	2,358	unit	Approximation based on high rise central heat pump figure (based on Dave Mahony advice)
Electric hot water system (central heat pump) - greater than 5 stories (e.g. 20 stories, >200 dwellings)	500,000	unit	HIP V. HYPE Better Buildings Lead Dave Mahony (advice for 212 dwelling apartment development)
Electric hot water system (individual heat pump e.g. townhouses & single dwelling)	4600	unit	Rawlinsons (p. 461)
Electric hot water system (electric boosted solar hot water)	6800	unit	Rawlinsons (p. 463)
Gas hot water system (localised instantaneous)	920	unit	Rawlinsons (p. 461)
Gas hot water system (central) - per dwelling / per 1000m2 non-res GFA	1,887	unit	Proportion of the high rise central heat pump figure (based on Dave Mahony advice)
Gas hot water system (central) - greater than 5 stories (e.g. 20 stories, >200 dwellings)	400,000	unit	Dave Mahony (advice for 212 dwelling apartment development)
Gas hot water system (storage)	3000	unit	Rawlinsons ($3000) - 410L
Gas cooktop	2,700	system	Rawlinsons (p. 681)
Induction cooktop	3,500	system	Rawlinsons (p. 681)
Solar PV system (residential)	939	kW	Average based on https://www.solarchoice.net.au/blog/solar-power-system-prices
Solar PV system (commercial)	985	kW	Average based on https://www.solarchoice.net.au/blog/solar-power-system-prices
Bicycle hoop (e.g. standard in ground)	410	hoop	Rawlinsons (p. 303)
Bicycle rack (e.g. Ned Kelly)	319	rack	Written quote (NJM Group, supplier of Ned Kelly racks)
Bicycle stacker (e.g. Arc, Josta, Cora)	1640	system	Written quote (Five At Heart, supplier of Arc stackers)
End-of-trip locker (two tier)	289	item	Rawlinsons (p. 307)
Electric vehicle capacity - infrastructure & cabling (medium density)	500	dwelling	Moreland City Council Low Emission Electric Vehicles Standard Report (2021) (p.108)
Electric vehicle capacity - infrastructure & cabling (apartment & non-residential)	869	parking space	Moreland City Council Low Emission Electric Vehicles Standard Report (2021) (p. 110)
Electric vehicle capacity - retrofit (medium density)	750	dwelling	Moreland City Council Low Emission Electric Vehicles Standard Report (2021) (p. 65)
Electric vehicle capacity - retrofit (apartment)	2,607	parking space	Moreland City Council Low Emission Electric Vehicles Standard Report (2021) (p. 66)
Electric vehicle charging units	2,200	system	Moreland City Council Low Emission Electric Vehicles Standard Report (2021), via Brendan Wheeler from EVSE

Appendix B

The following details the capital costs used in the analysis, the cost source and any relevant notes.

ITEM	COST ($)	PER	SOURCE / REFERENCE
Space allocation - Basement (e.g. car & bike parking space) - Construction	1,630	m2	Rawlinsons (p. 35)
Space allocation - Wet area (e.g. shower & changing space) - Construction	2,605	m2	Rawlinsons (p. 30)
Space allocation - Residential (townhouses) - Construction	2390	m2	Rawlinsons (p. 43)
Space allocation - Residential (apartments) - Construction	3270	m2	Rawlinsons (p. 43)
Space allocation - Covered walkway - Construction	1380	m2	Rawlinsons (p. 23)
Space allocation - Non-residential (retail) - Construction	2830	m2	Rawlinsons (p. 47)
Space allocation - Non-residential (office) - Construction	2600	m2	Rawlinsons (p. 33)
Space allocation - Non-residential (warehouse) - Construction	885	m2	Rawlinsons (p. 30)
Showerheads: 3 Star (>7.5 but <=9L/min)	No differential	unit	https://www.harveynorman.com.au/bathroom-tiles-renovations/bathroom-sink-tapware/shower-heads-arms/caroma/3+stars/993-1411
Showerheads: 4 Star (>6 but <=7.5L/min)	No differential	unit	https://www.harveynorman.com.au/caroma-urbane-ii-hand-shower-brushed-nickel.html
Showerheads: 4 Star (>4.5 but <=6L/min)	No differential	unit	https://www.harveynorman.com.au/caroma-luna-multifunction-hand-shower-brushed-nickel.html
Washing machine: 3 Star	800	unit	Approximation from available Harvey Norman products
Washing machine: 4 Star	749	unit	https://www.harveynorman.com.au/bosch-series-4-8kg-front-load-washing-machine.html
Washing machine: 5 Star	1200	unit	https://www.harveynorman.com.au/bosch-8kg-front-load-washing-machine-2.html
Toilets: 3 Star	No differential	unit	https://www.bunnings.com.au/estilo-wels-3-star-3-6l-min-pvc-link-p-trap-toilet-suite_p4821911 https://www.bunnings.com.au/stylus-wels-3-star-4l-min-allegro-link-toilet-suite_p4823156 https://www.bunnings.com.au/caroma-wels-3-star-4l-min-uniset-ii-connector-s-trap-toilet-suite_p4823150
Toilets: 4 Star	No differential	unit	https://www.reece.com.au/product/toilets-c469/toilet-suites-c705/base-link-toilet-suite-s-trap-with-seat-white-4-9503292 https://www.reece.com.au/product/toilets-c469/toilet-suites-c705/posh-solus-round-close-coupled-s-trap-toilet-9500993 https://www.reece.com.au/product/toilets-c469/toilet-suites-c705/american-standard-studio-round-close-coupled-9506994
Taps	No differential	unit	Approximation / comparison from of product listings from online suppliers

Appendix B

The following details the capital costs used in the analysis, the cost source and any relevant notes.

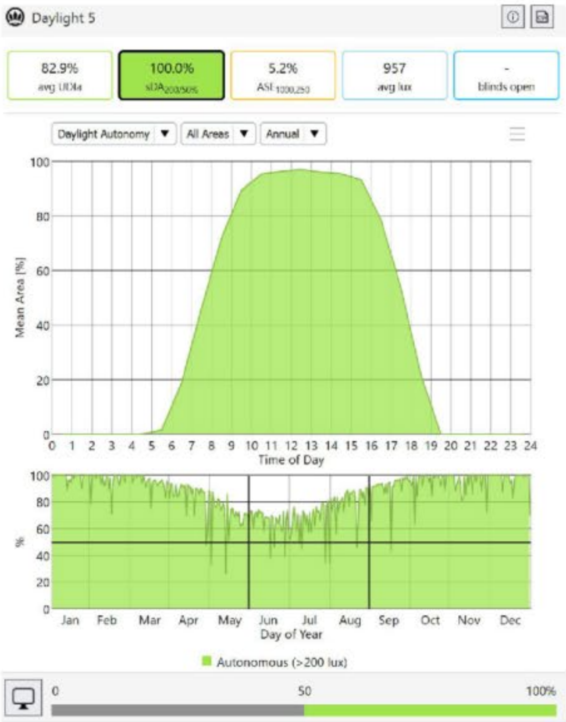
ITEM	COST ($)	PER	SOURCE / REFERENCE
Dishwasher: 3 Star	799	unit	https://www.thegoodguys.com.au/bosch-stainless-steel-freestanding-dishwasher-sms40e08au
Dishwasher: 4 Star	1049	unit	https://www.thegoodguys.com.au/bosch-60cm-freestanding-dishwasher--sms4hvi01a
Dishwasher: 5 Star	1299	unit	https://www.thegoodguys.com.au/bosch-60cm-freestanding-dishwasher-sms6hai01a
Rainwater tank - 5000L	1720	tank	https://www.tankworld.com.au/tanks-accessories-pumps/5000l-slimline-slr-2/
Rainwater tank - 32000L	4,390	tank	https://www.bluewatertanks.com.au/tanks/round-poly-tanks/32-000-litre-poly-water-tank/
Climate Risk Assessment	15,000	Report	HV.H
Glazing - double glazed fixed	439	m2	Rawlinsons (p. 363)
Glazing - double glazed operable	529	m2	Rawlinsons (p. 363)
Glazing - double glazed curtain wall component (additional to curtain wall framing)	385	m2	Rawlinsons (p. 366)
Facade - spandrel glass & insulation (additional to curtain wall framing)	228	m2	Rawlinsons (p. 366)
Facade - Face brick (total wall construction) (e.g. RES 2)	272	m2	Rawlinsons (p. 127)
Facade - Timber cladding (total wall construction) (e.g. RES 3)	147	m2	Rawlinsons (p. 129)
Facade - Precast concrete (total wall construction) (e.g. RES 4)	420	m2	Rawlinsons (p. 252)
Shading - fixed fins or louvres (e.g office)	400	m2	Rawlinsons (p. 387)
Shading - screens (on track) (e.g. apartments)	405	m2	Rawlinsons (p. 368)
Shading - fixed horizontal	370	m2	Rawlinsons (p. 387)
Shading - canvas awnings (townhouses & single dwellings)	320	m2	Rawlinsons (p. 387)
Roof - optimised design	Cost neutral / possible cost saving	dwelling	JCB Architects
Materials (low embodied) - 30% SCM concrete (cost premium)	10	m3	Holcim (verbal conversation) and Boral (written response)
Materials (high SRI) - white cement (e.g. RES 1)	24	m2	Rawlinsons (p. 252)
Green cover / landscaping - Planter	1,640	m2	City of Melbourne (average figure)
Green cover / landscaping - Green facade	596	m2	City of Melbourne (assumed 1m2 planter to every 5m2 of climber)
Green cover / landscaping - Green roof	808	m2	City of Melbourne
Green cover / landscaping - In ground only	200	m2	GLAS Landscape Architects

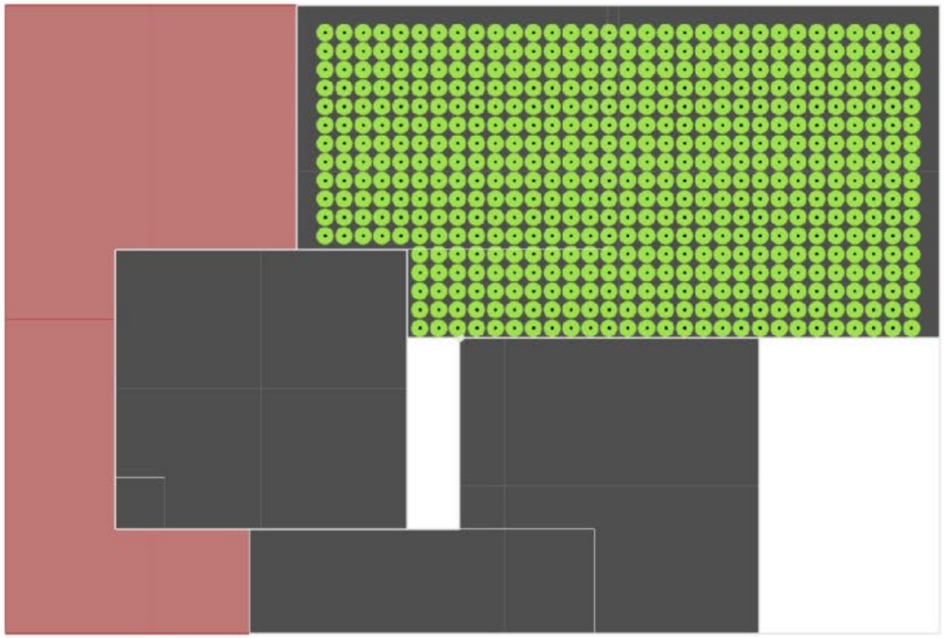
Appendix C

Spatial Daylight Autonomy

Buildings must achieve a daylight level of minimum 200 lux for at least half of daylit hours each day to at least half the area of every habitable room and regularly occupied space.

(sDA200,50%)





Original apartment layout

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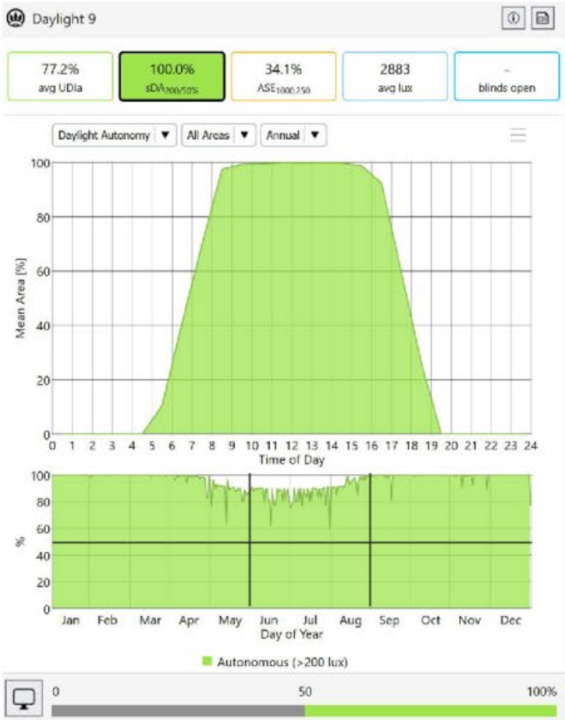

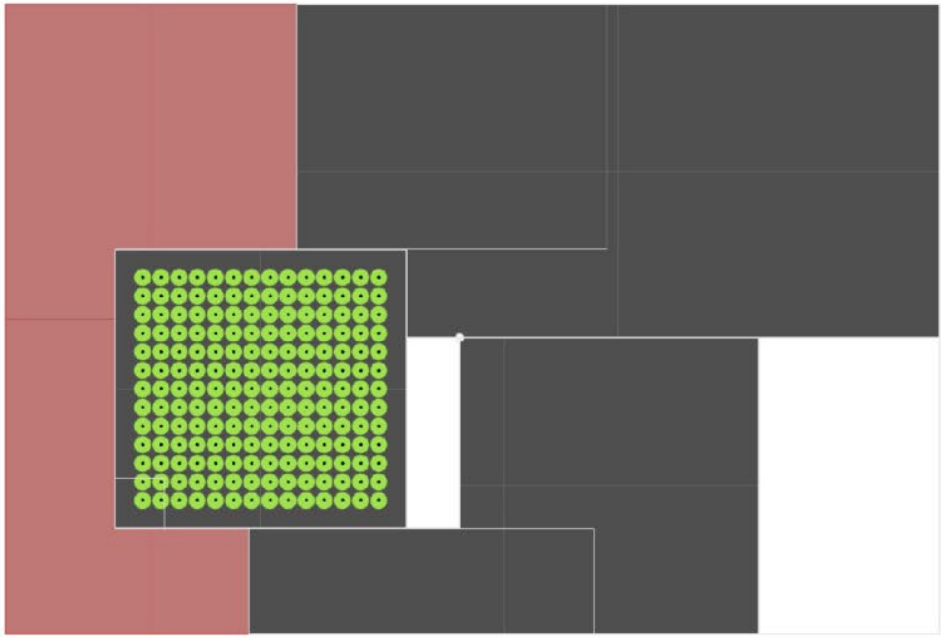

Original apartment layout

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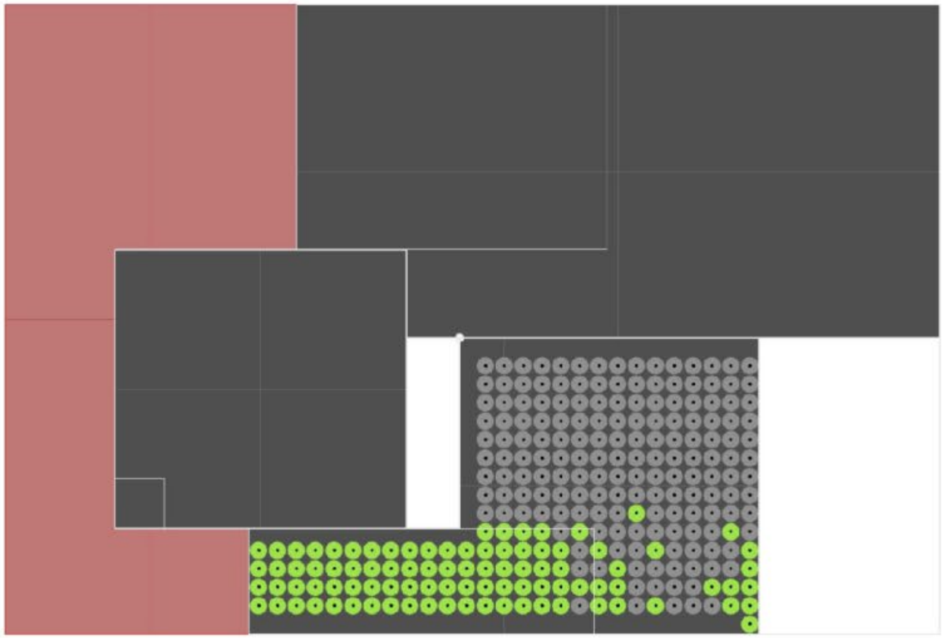

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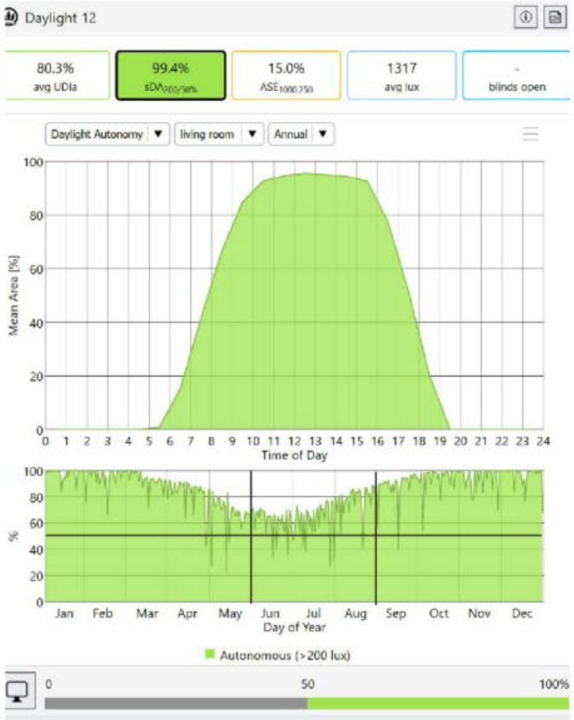

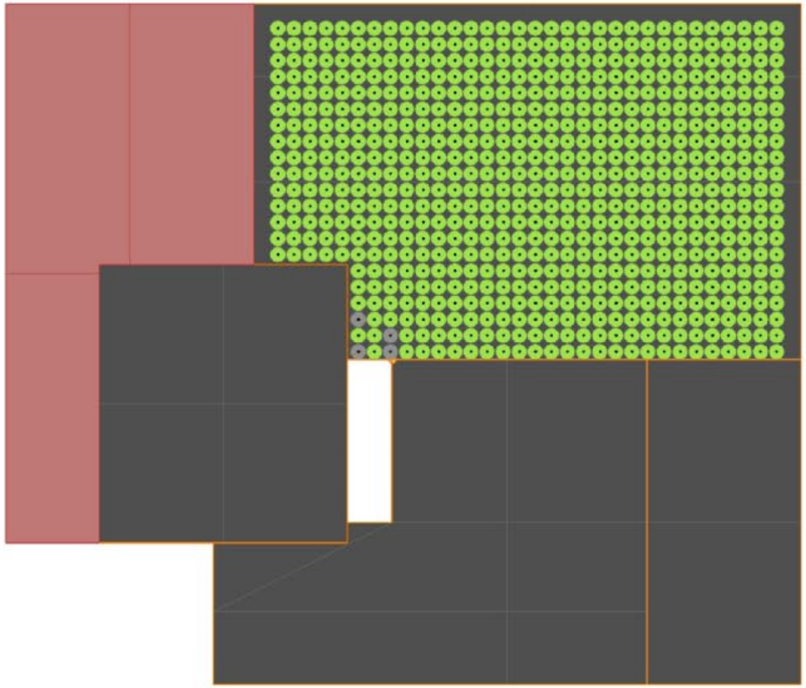

Optimised apartment layout (improved apertures to rooms; balcony cut out to second bedroom aligned to Better Apartments Design Standards (BADS))

Spatial Daylight Autonomy

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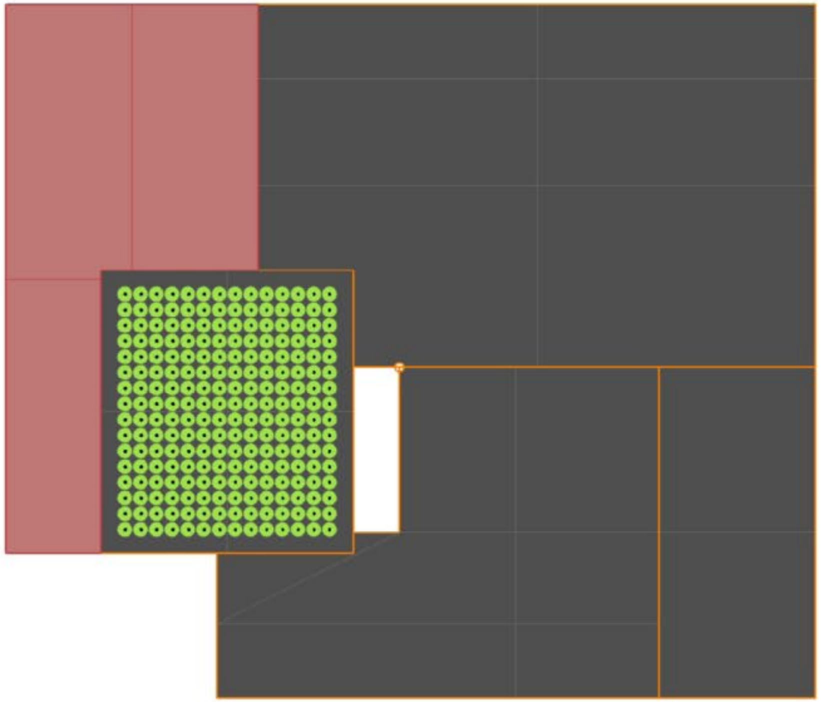

Optimised apartment layout (improved apertures to rooms; balcony cut out to second bedroom aligned to BADS)

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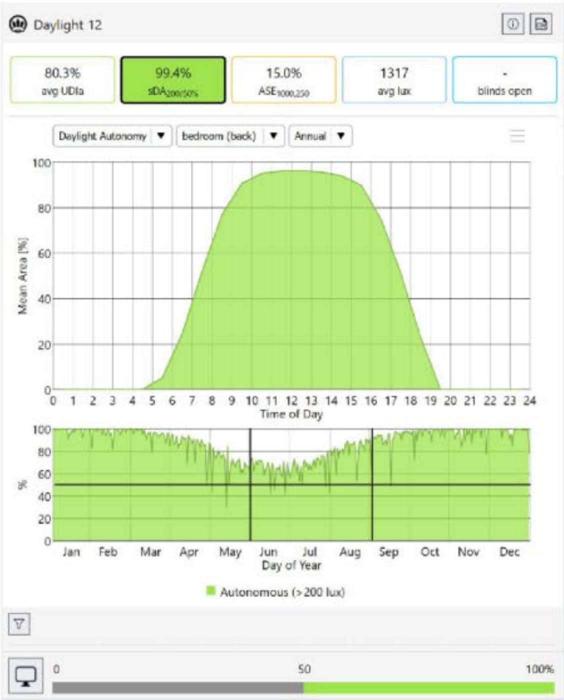
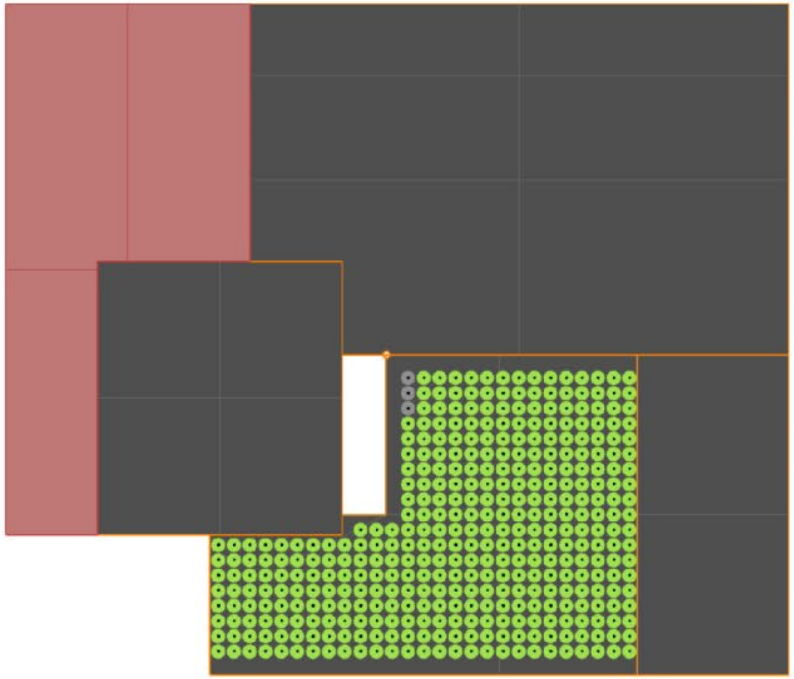


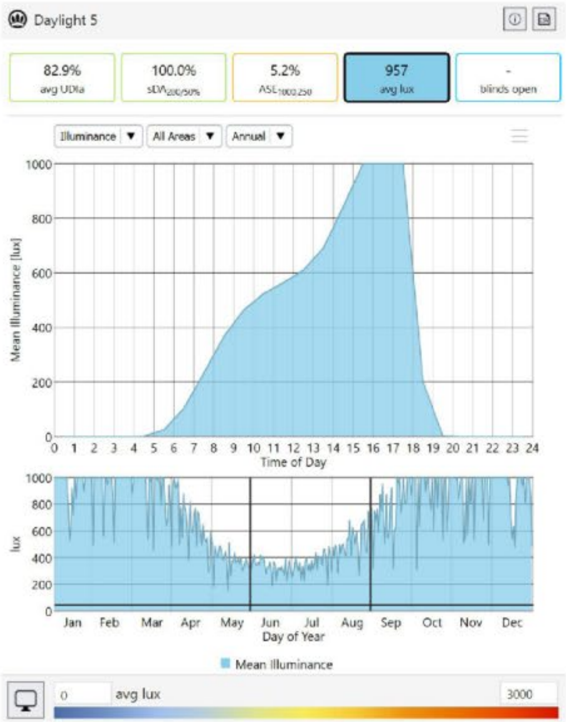


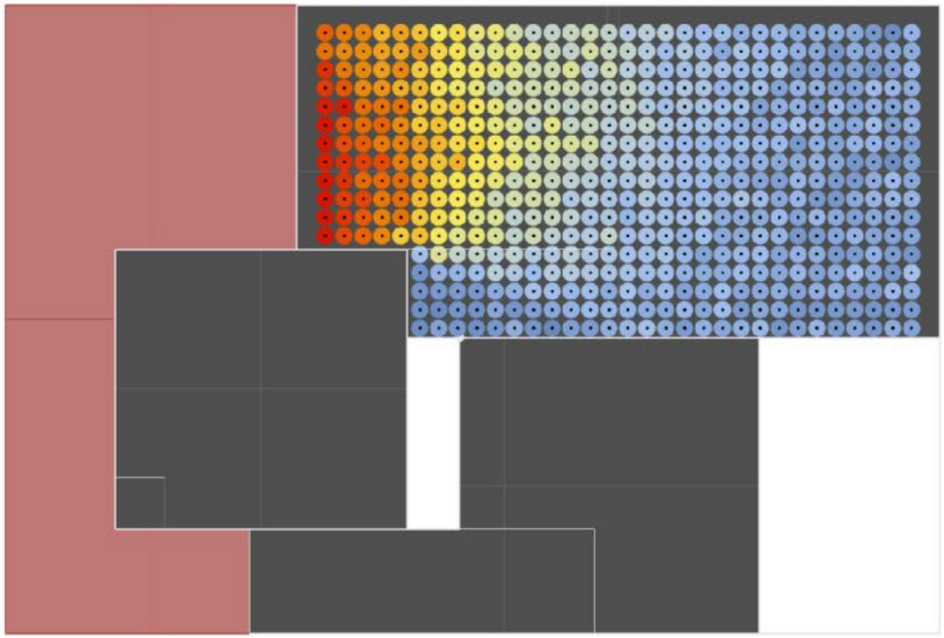
Optimised apartment layout (improved apertures to rooms; balcony cut out to second bedroom aligned to BADS)

Attachment 1: Technical ESD and Development Feasibility Report - (Final)

Daylight Illuminance

Building must achieve a daylight level across the entirety of every habitable room and regularly occupied space of minimum 50 lux.





Original apartment layout

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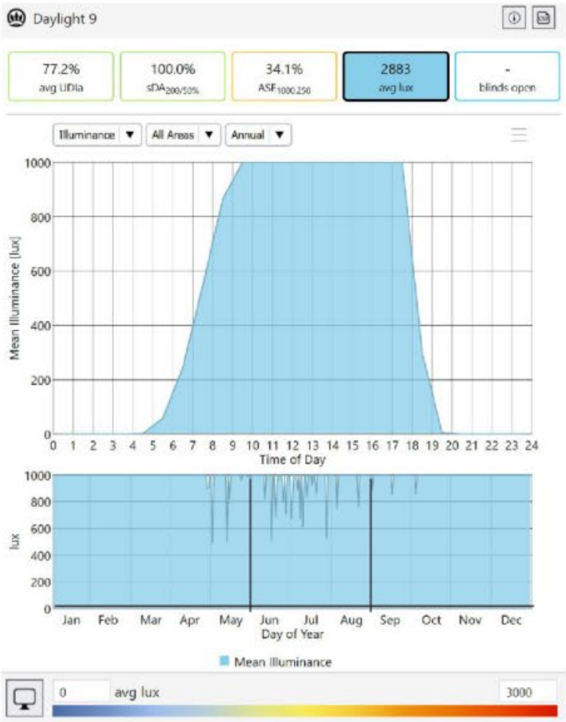

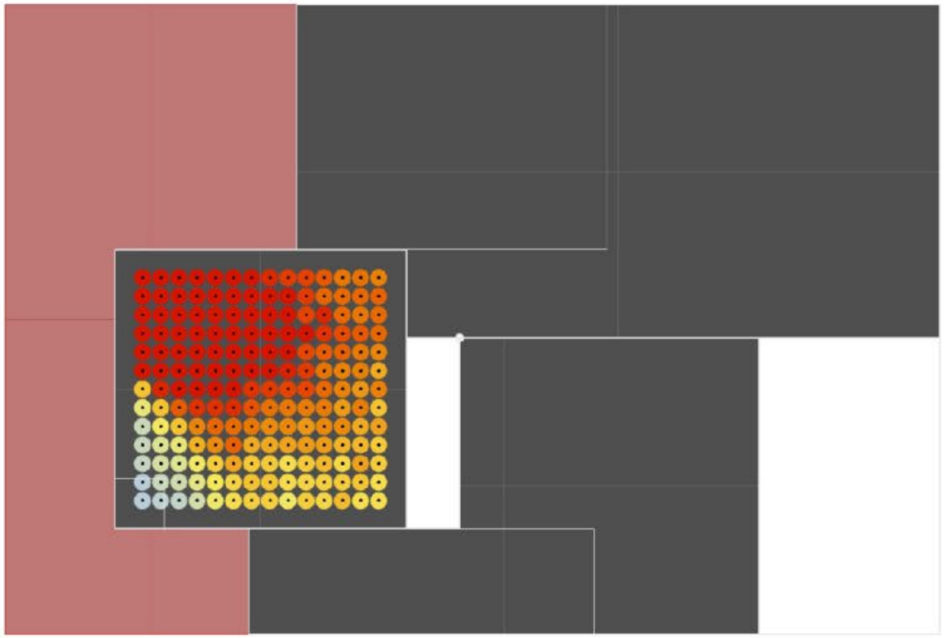

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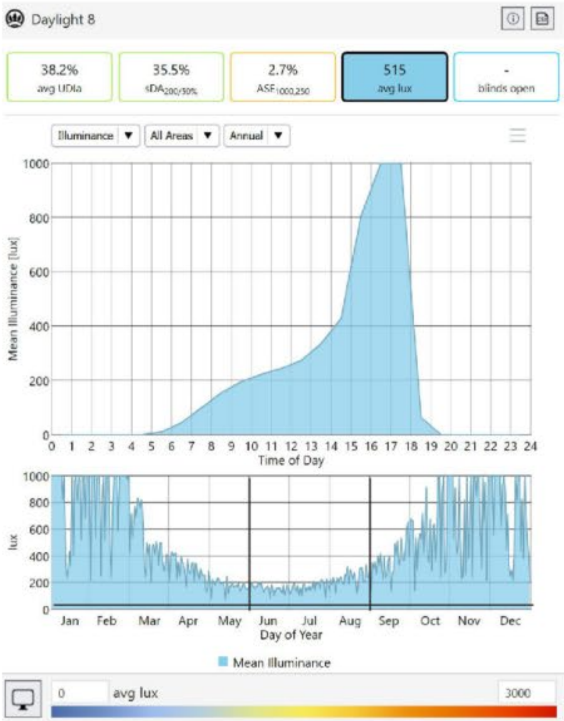

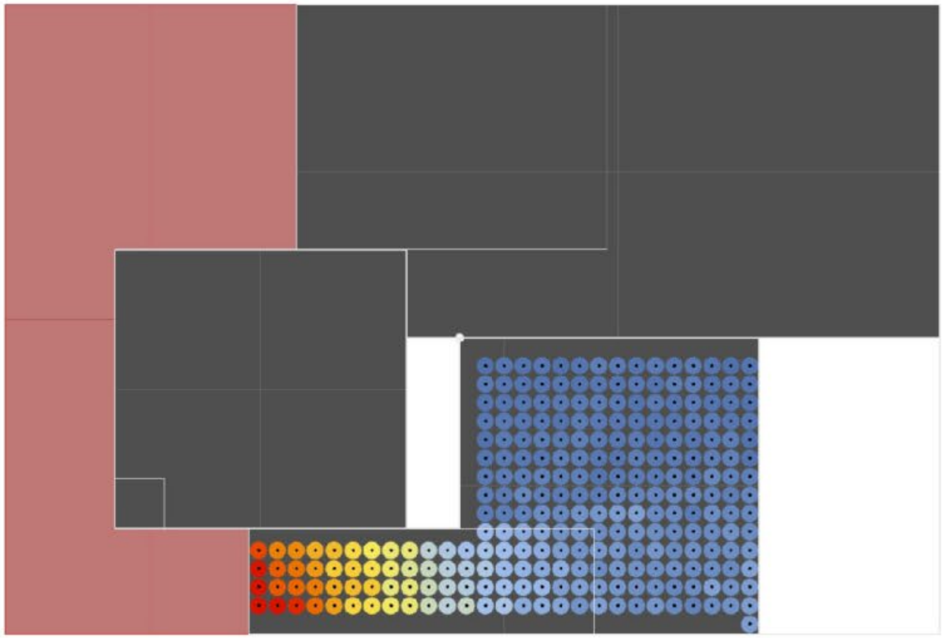

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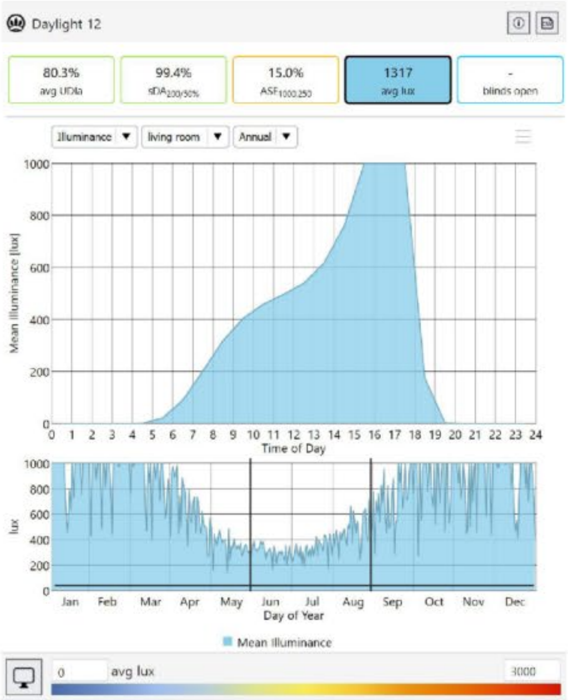

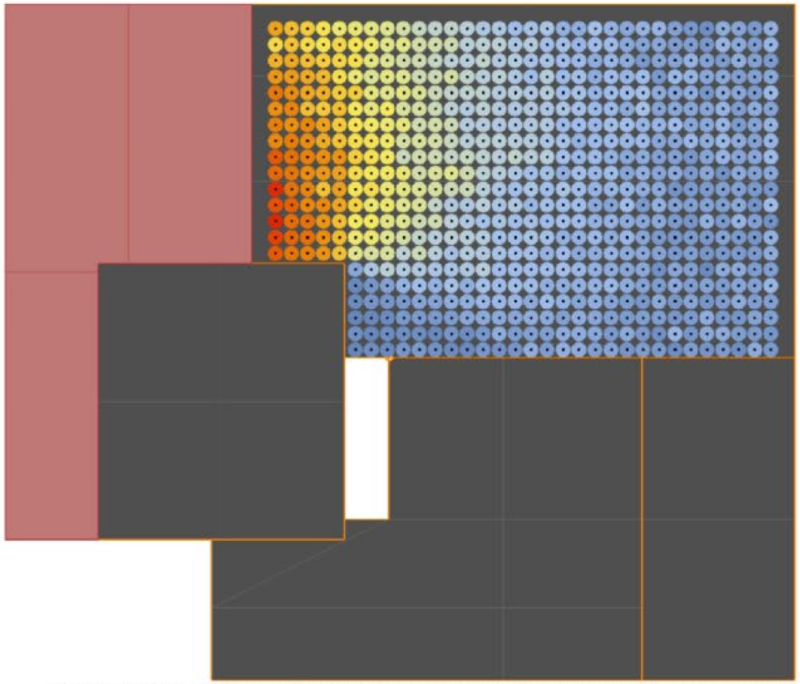

Optimised apartment layout (improved apertures to rooms; balcony cut out to second bedroom aligned to BADS)

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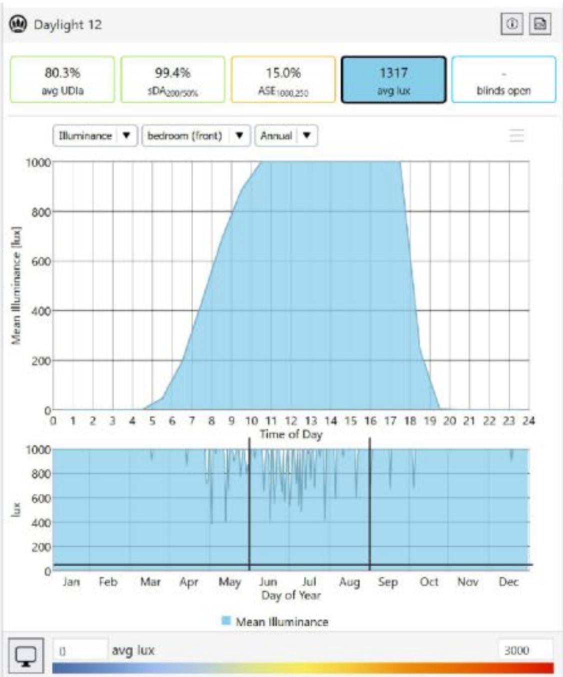

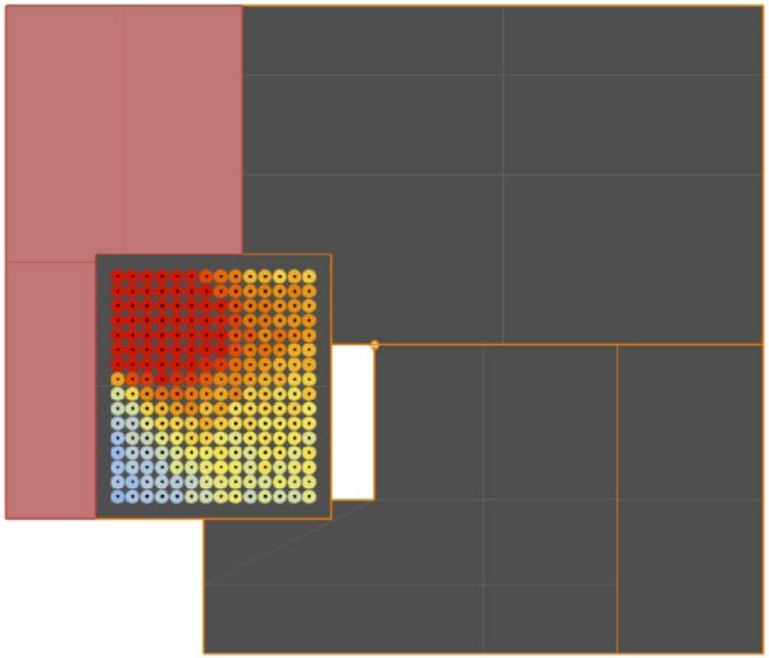

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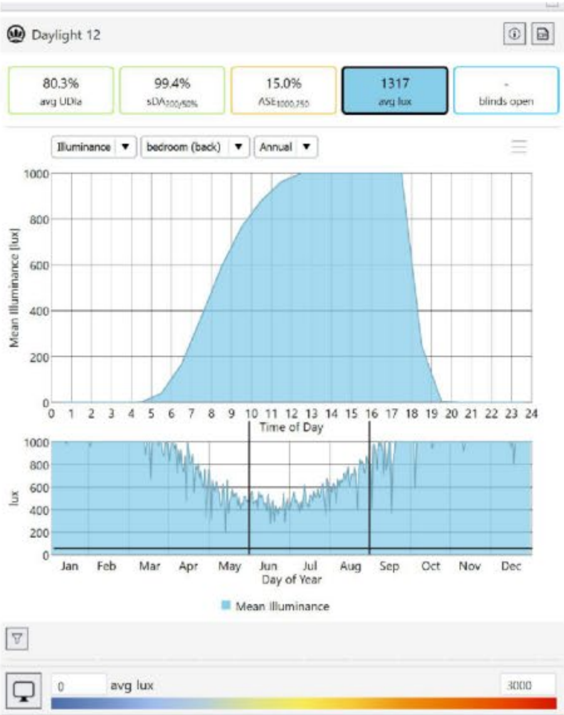
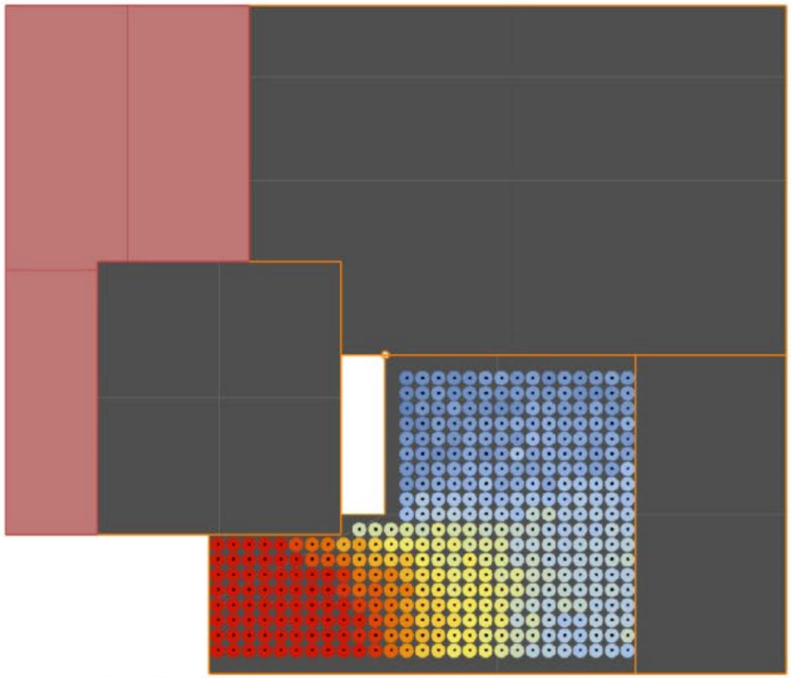
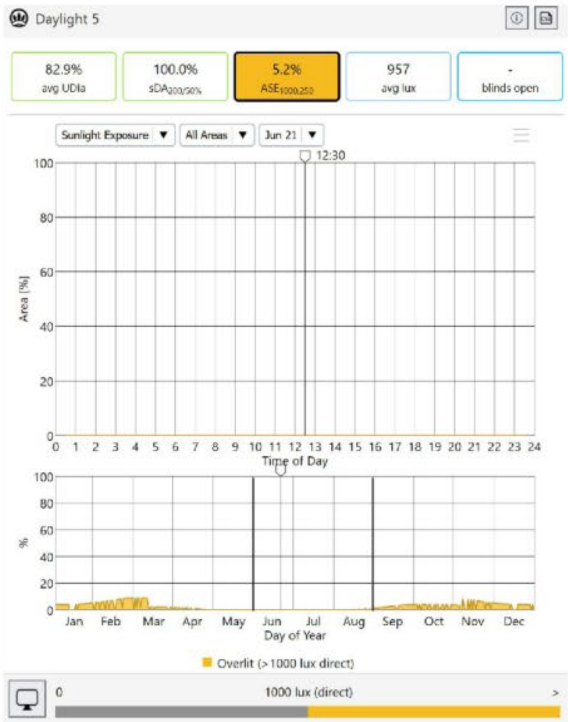


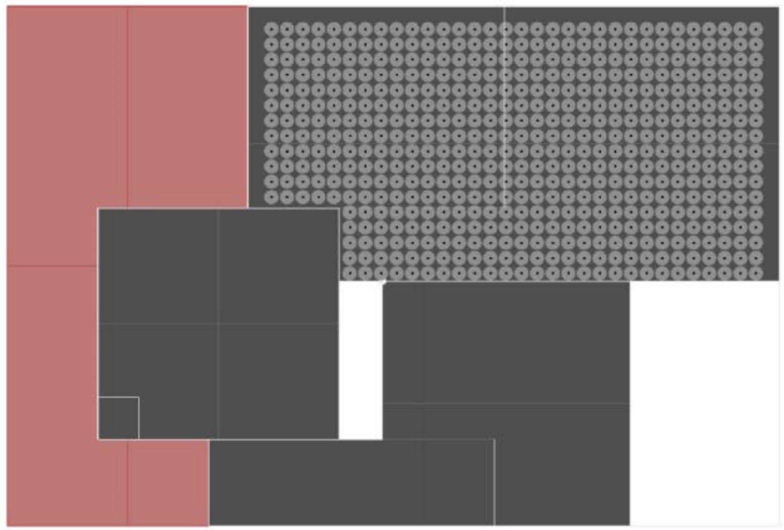


Optimised apartment layout (improved apertures to rooms; balcony cut out to second bedroom aligned to BADS)

Daylight Access

Buildings should achieve direct sunlight to all primary living areas for 2 hours on June 21 to at least 1.5 m deep into the room from glazing.





Original apartment layout

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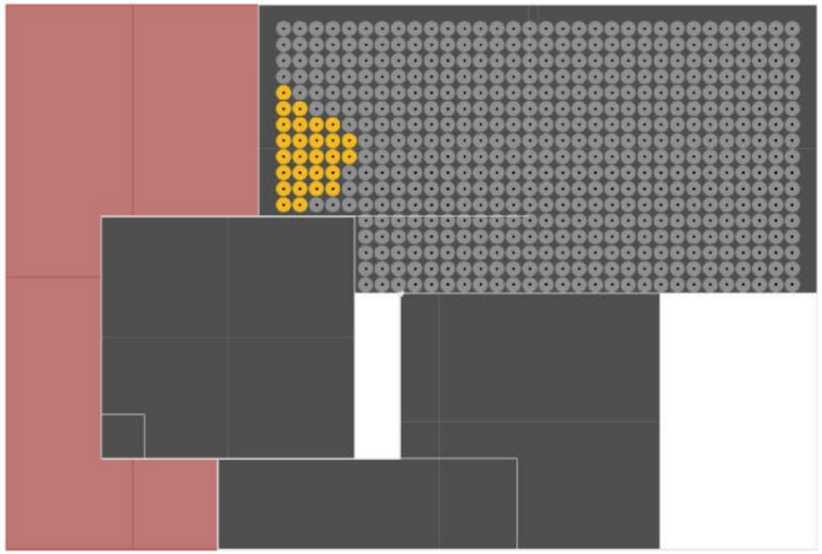

Original apartment layout

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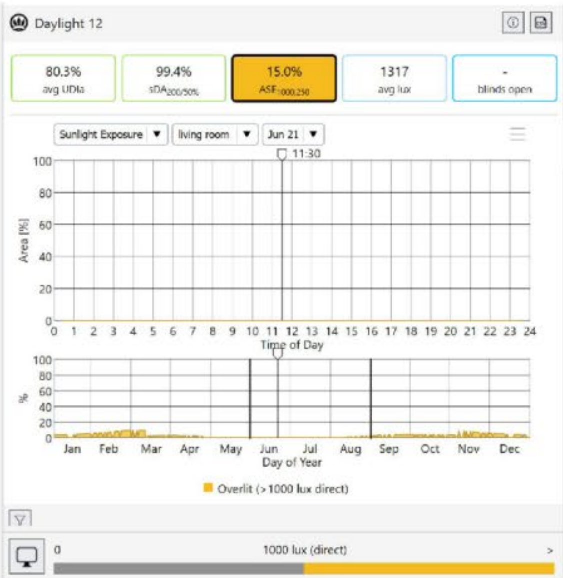

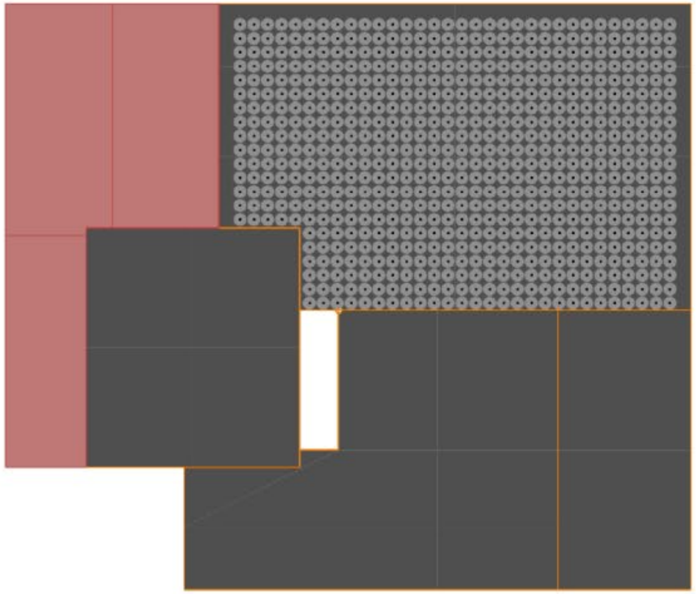

Optimised apartment layout (improved apertures to rooms; balcony cut out to second bedroom aligned to BADS)

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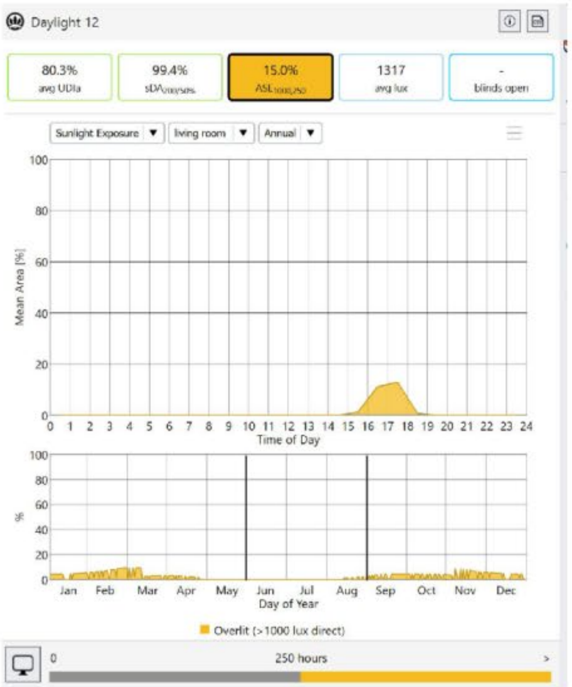

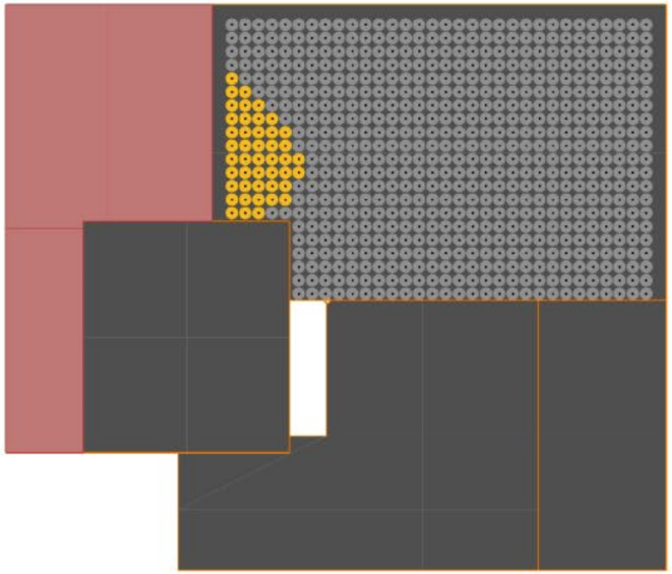

Optimised apartment layout (improved apertures to rooms; balcony cut out to second bedroom aligned to BADS)

Appendix D

The following seeks to highlight the evolution of category wording throughout the process of the ESD technical feasibility and the planning advice, and highlight where standards were redistributed from categories in the ESD report to different categories in the planning report.

CATEGORIES IN ESD REPORT	REVISED CATEGORIES IN PLANNING REPORT	SUMMARY OF STANDARDS REDISTRIBUTION INTO REVISED PLANNING REPORT CATEGORIES (IF APPLICABLE)
Operational Energy	Operational Energy	Standards redistributed to this category include those relating to: – External shading (from Indoor Environment Quality category)
Sustainable Transport	Sustainable Transport	
Integrated Water Management	Integrated Water Management	
Green Infrastructure	Green Infrastructure	
Indoor Environment Quality	Indoor Environment Quality	
Circular Economy	Waste and Resource Recovery Embodied Emissions	Standards redistributed between two new categories (Waste & Resource Recovery and Embodied Emissions)
	Climate Resilience	Standards redistributed to this new category include those relating to: – Urban heat reduction (from Green Infrastructure category) – Comfort of pedestrian pathways (from Green Infrastructure category) – Responding to future climate impacts (from Integrated Water Management category)

For additional information, questions unturned, collaboration opportunities and project enquiries please get in touch.

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