FRANKSTON CITY COUNCIL

COUNCIL MEETING
SUPPORTING INFORMATION

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Meeting Date: 6 June 2022

Attachment: C

Version: Final (Updated)
Date: 28 March 2022

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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HIP V. HYPE

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HIP V. HYPE

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

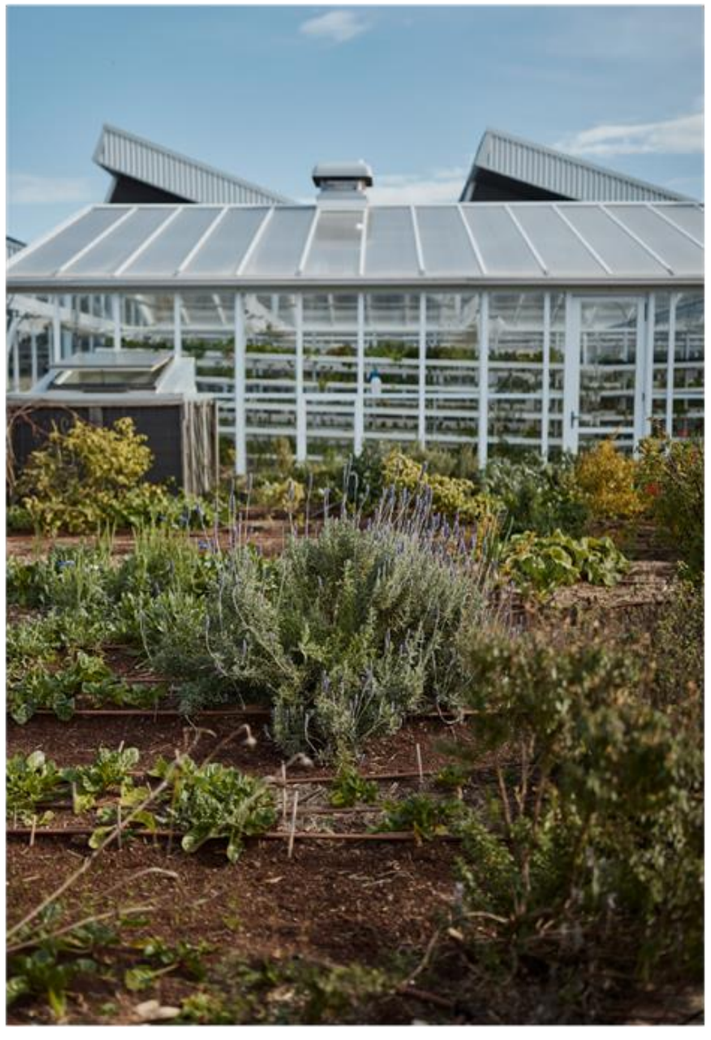
The purpose of this report is to present the outcomes of the above research, which when combined with the outputs of Part B and Part C, represent a robust evidence base to support further development of the proposed planning scheme amendment.

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

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.

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".

Operational Energy

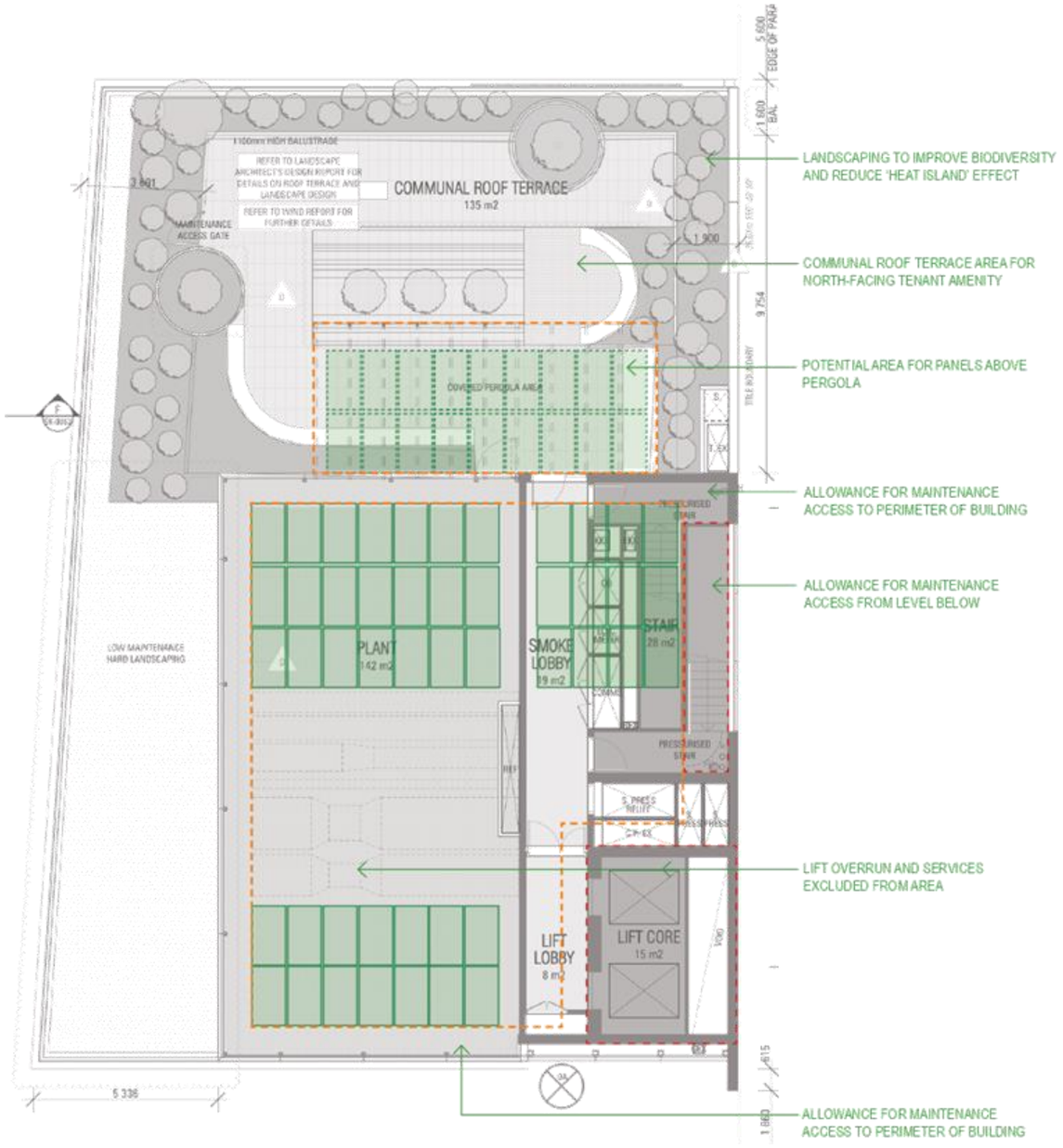


Diagram demonstrating potential solar photovoltaic capacity for the rooftop of an office case study. The image demonstrates 19.5kWp of solar. Image by JCB Architects

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.

Operational Energy

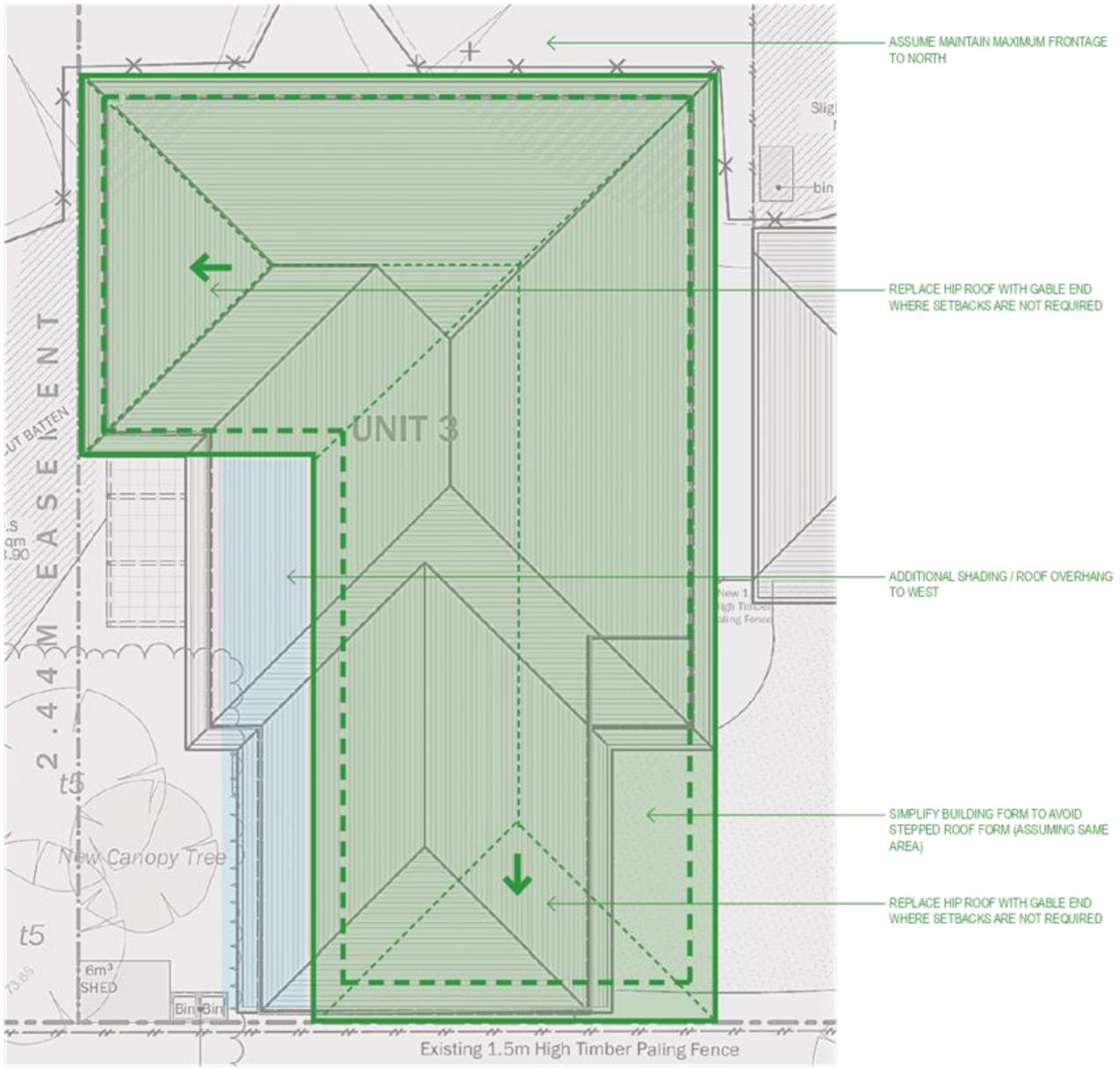


Diagram demonstrating the possibilities for simplification of a single dwelling pitched roof to increase opportunities for solar photovoltaic panels.
Image by JCB Architects

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

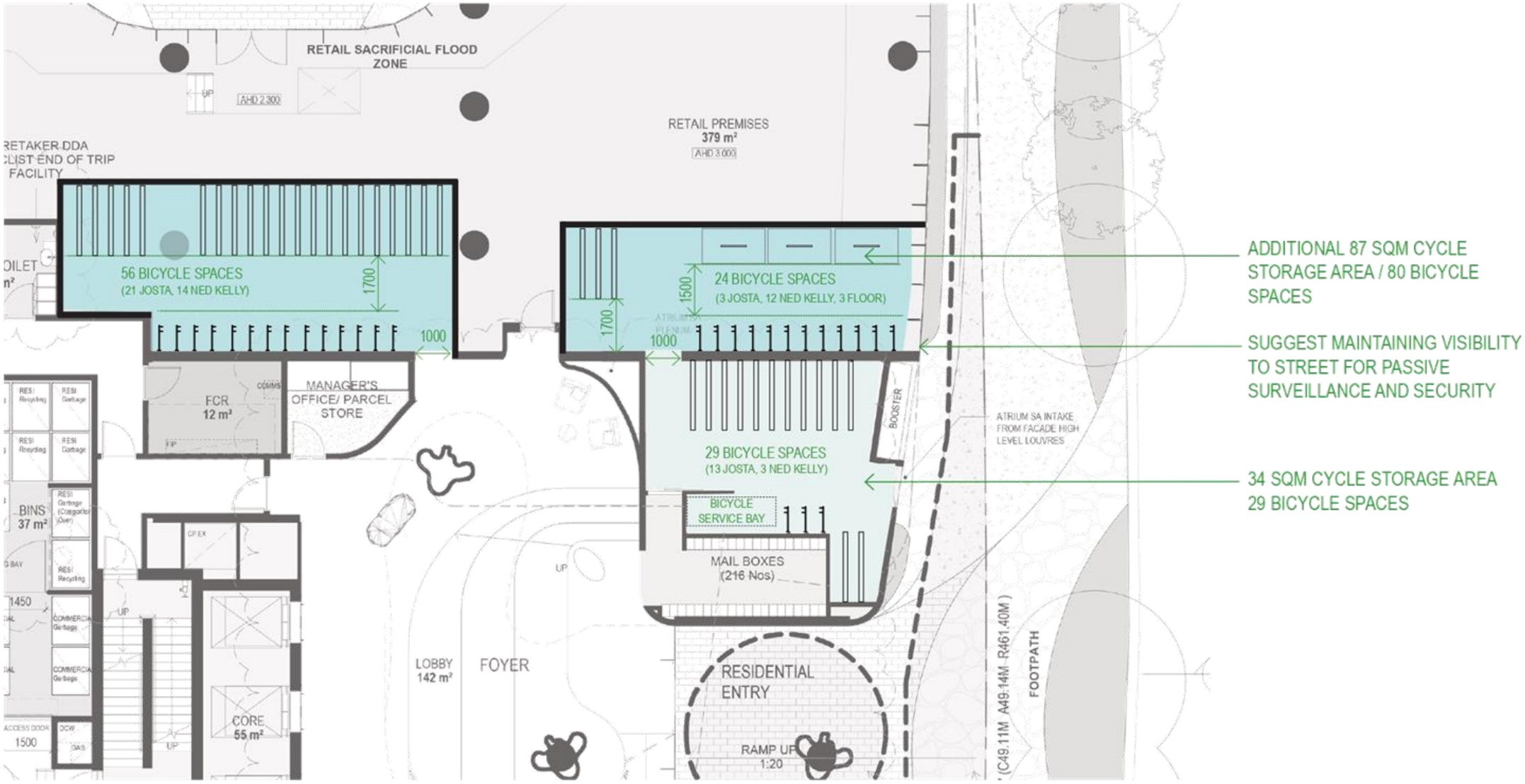


Diagram highlighting the impact of the bicycle parking standards as a suite of measures for a mixed use development. Image by JCB Architects
Note: The following storage types have been utilised - two tier system (Josta), hanging rack (Ned Kelly) and hoop (floor).

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)

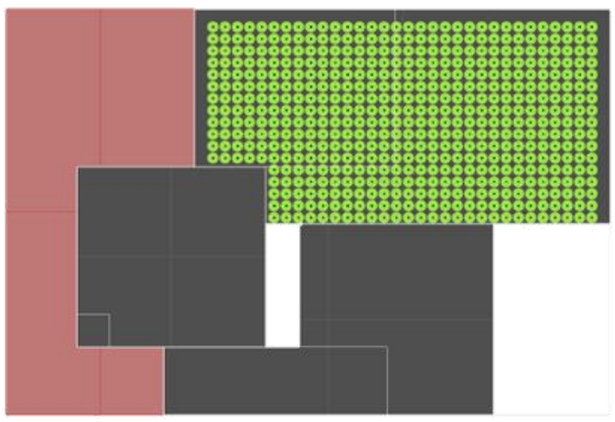
STANDARD	DESIGN IMPACT	CAPITAL COST IMPACT	BENEFITS	RECOMMENDATION
S42 Buildings must achieve a daylight level of minimum 200 lux for at least half of daylit hours each day to at least half the area of every habitable room and regularly occupied space.	The impact of this standard as written will be varied 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.

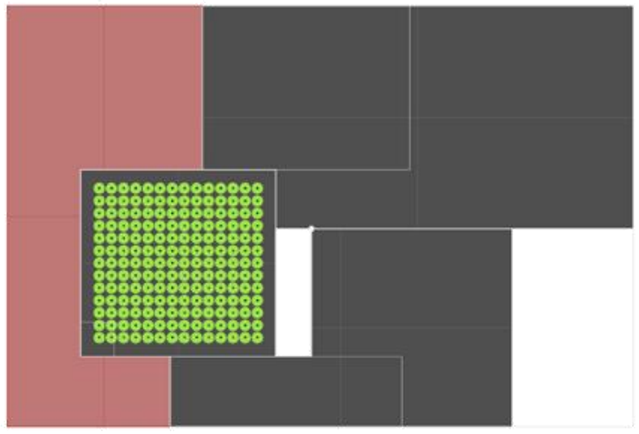
Indoor Environment Quality (IEQ)

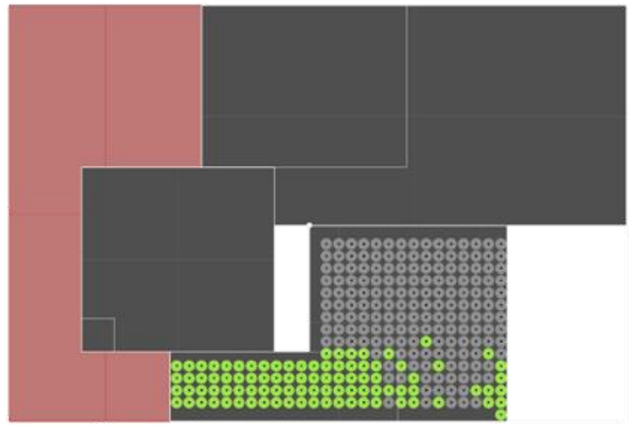
PROPOSED ELEVATED STANDARD 1

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%).

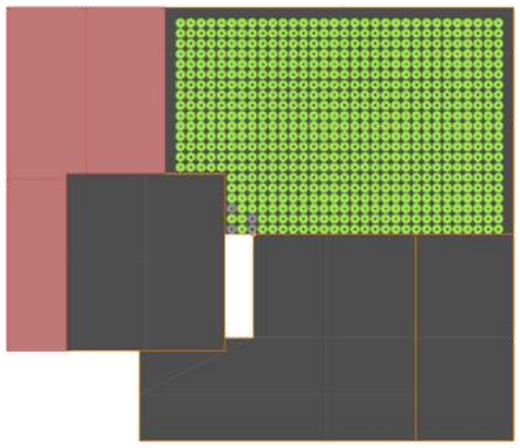
Refer to Appendix C for full daylight modelling results.

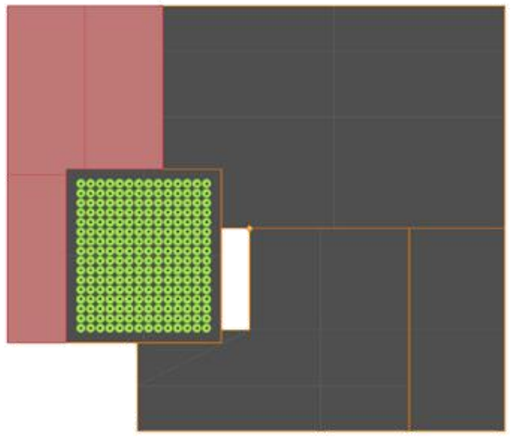


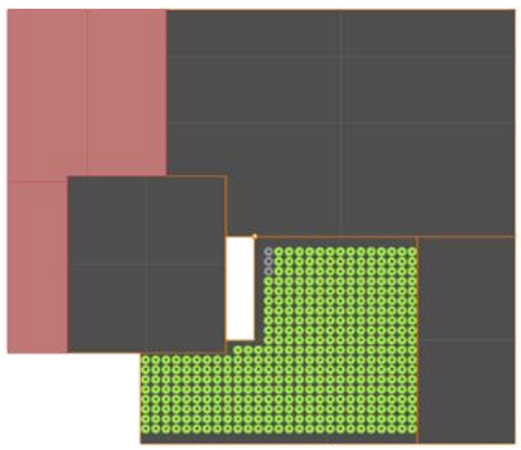




Original apartment layout







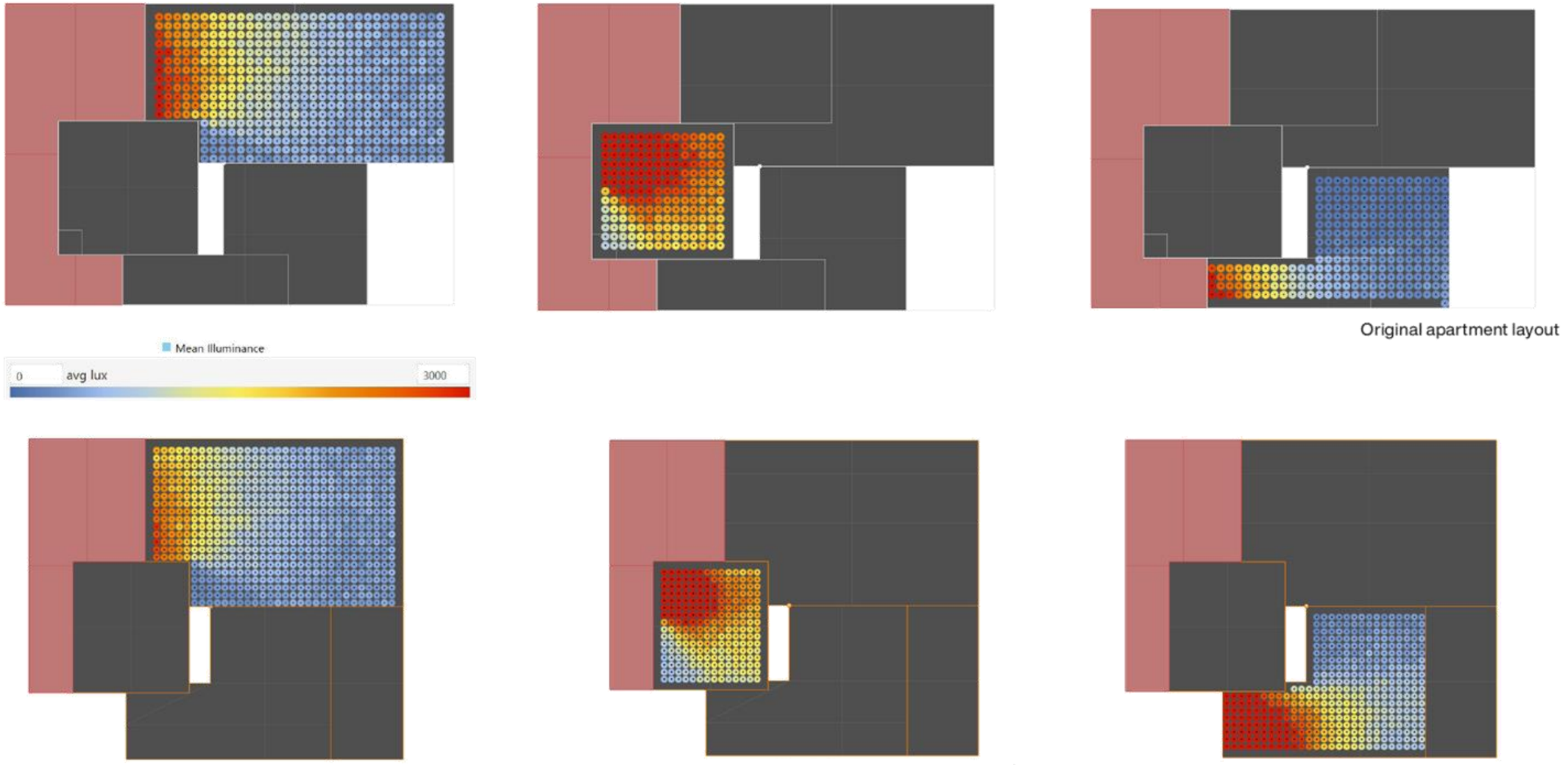
Optimised apartment layout (improved apertures to rooms; balcony cut out to second bedroom aligned to Better Apartment Design Standards (BADS))

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)

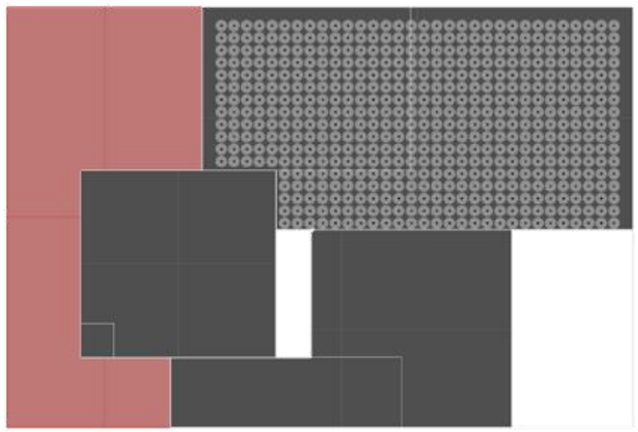
STANDARD	DESIGN IMPACT	CAPITAL COST IMPACT	BENEFITS	RECOMMENDATION
S44 Buildings should achieve direct sunlight to all primary living areas for 2 hours on June 21 to at least 1.5 m deep into the room from glazing.	The design impact of this standard as written would rule out the development of any southern-only 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.

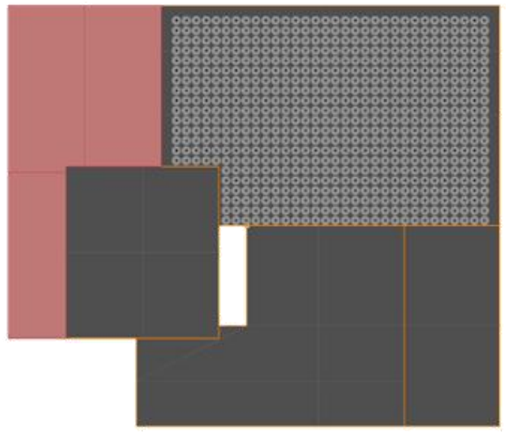
Indoor Environment Quality (IEQ)

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.

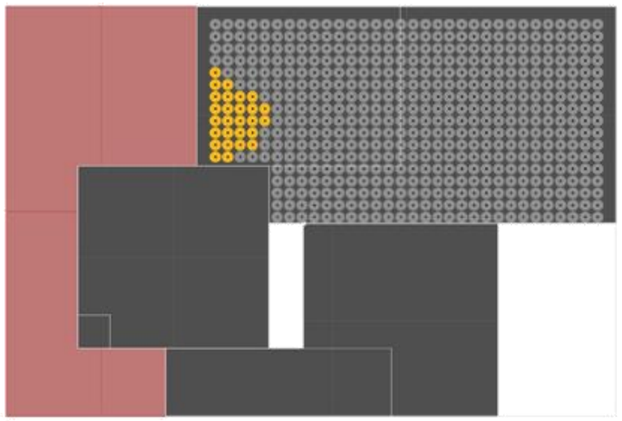




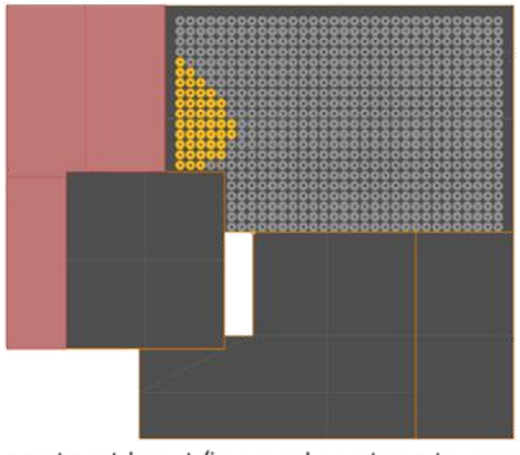
ADJUSTED ELEVATED STANDARD 3

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 CO2e 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

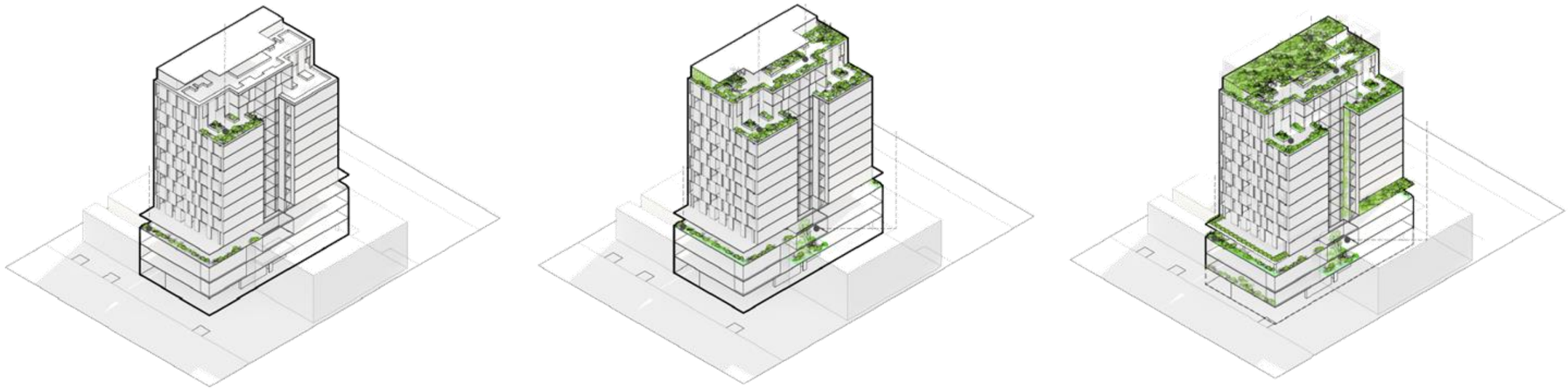
This theme focuses on increasing the amount of green infrastructure to provide a range of ecosystem service benefits, and reducing the contribution of the built environment to the urban heat island effect.

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.

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

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.

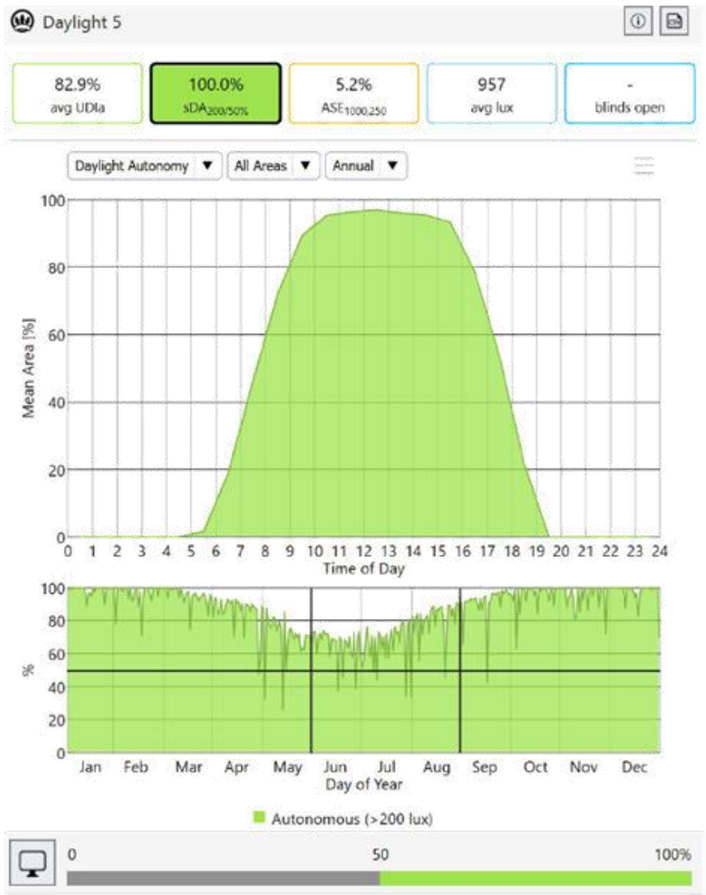
ITEM	COST ($)	PER	SOURCE / REFERENCE
Dishwasher: 3 Star	799	unit	https://www.thegoodguys.com.au/bosch-stainless-steel-freestanding-dishwasher-sms40e08au
Dishwasher: 4 Star	1049	unit	https://www.thegoodguys.com.au/bosch-60cm-freestanding-dishwasher--sms4hvi01a
Dishwasher: 5 Star	1299	unit	https://www.thegoodguys.com.au/bosch-60cm-freestanding-dishwasher-sms6hai01a
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

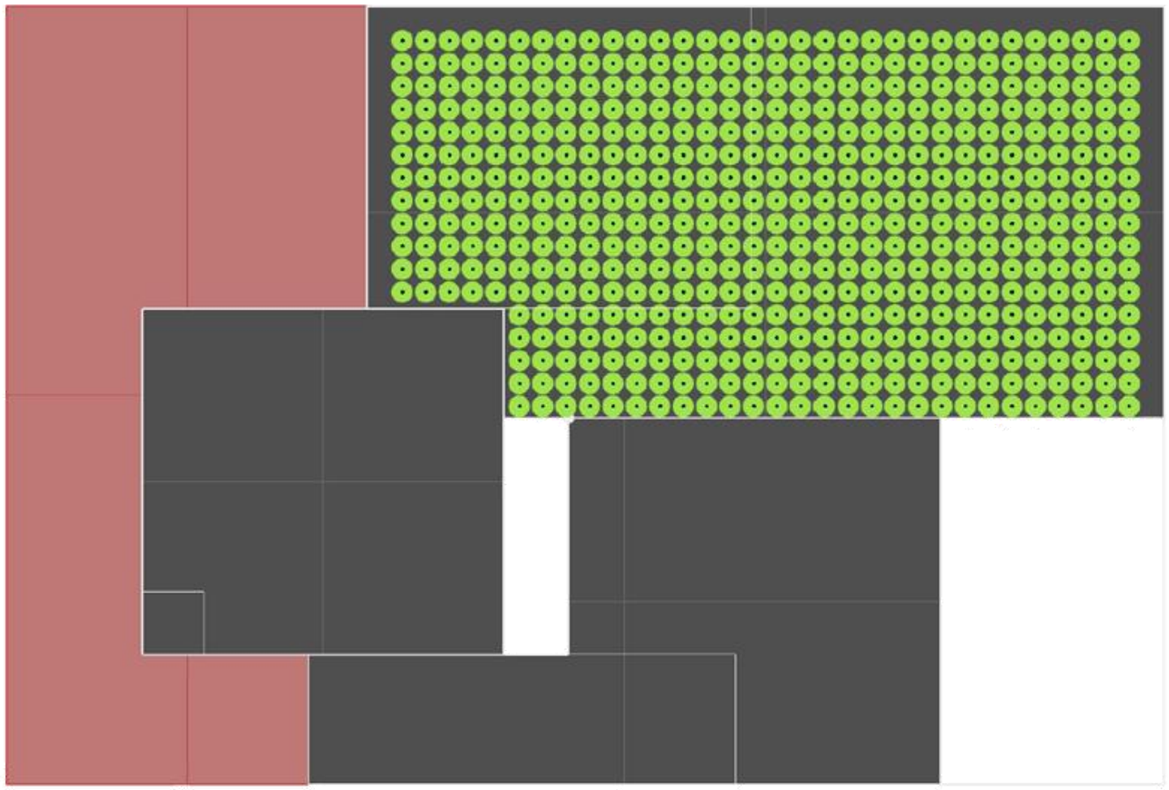
Appendix C

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

HIP V. HYPE

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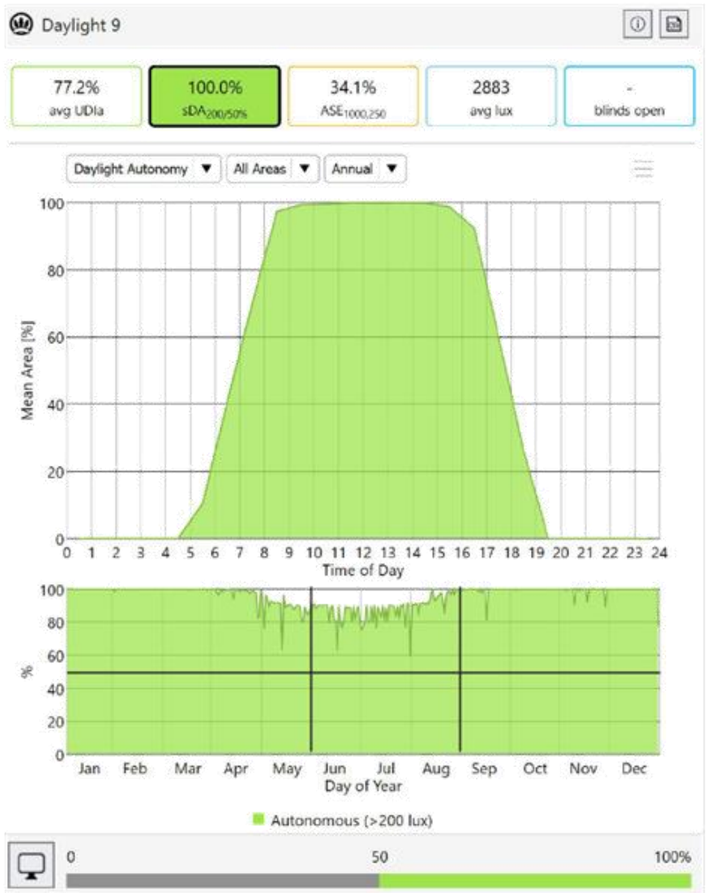

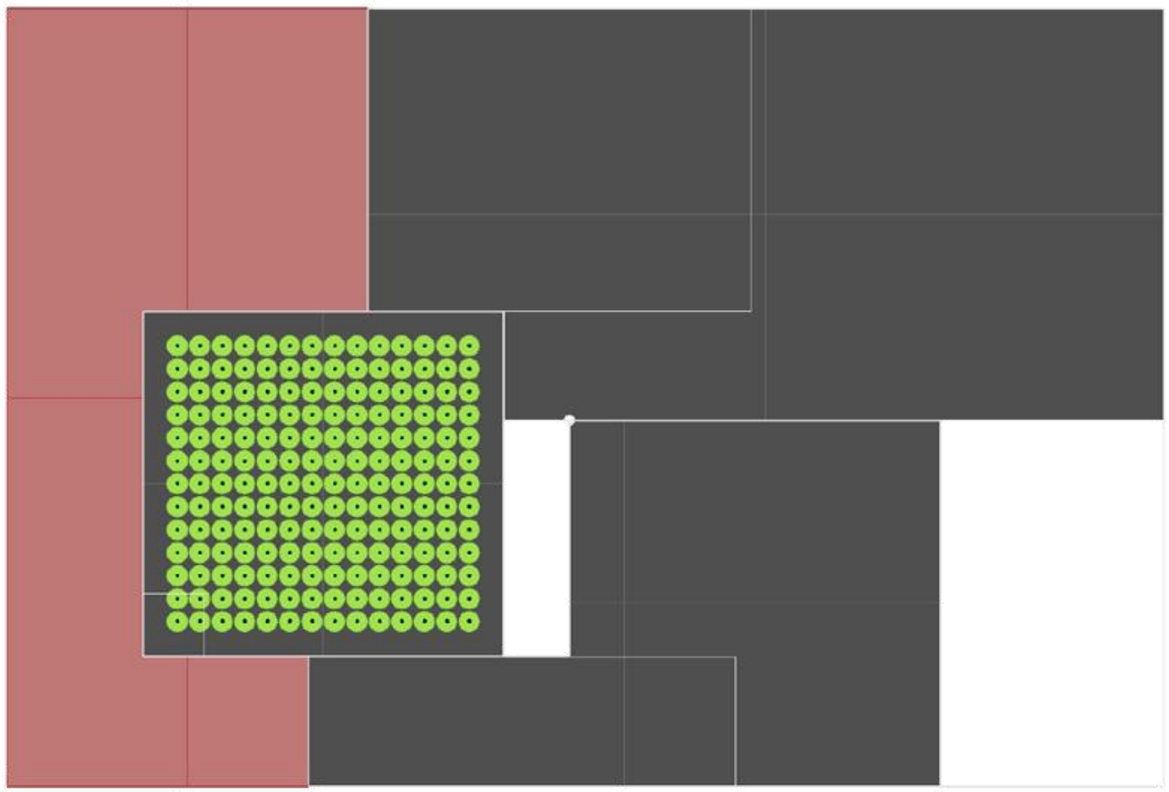

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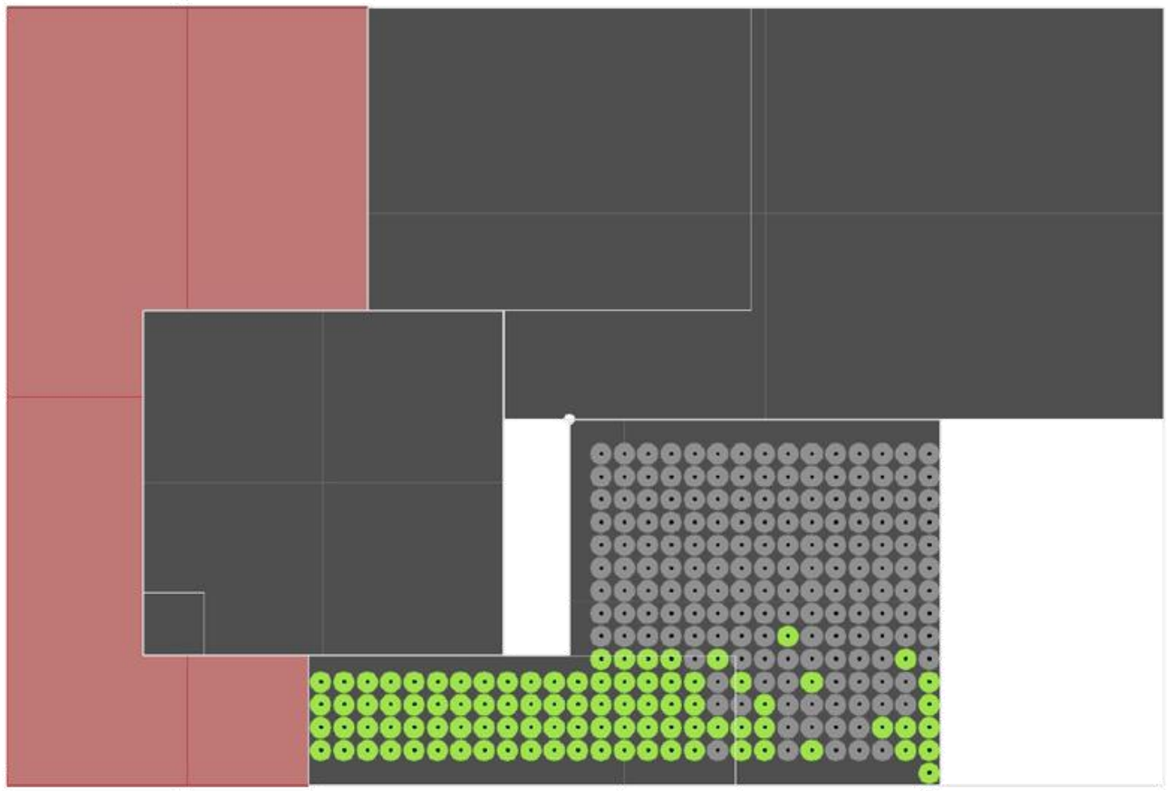

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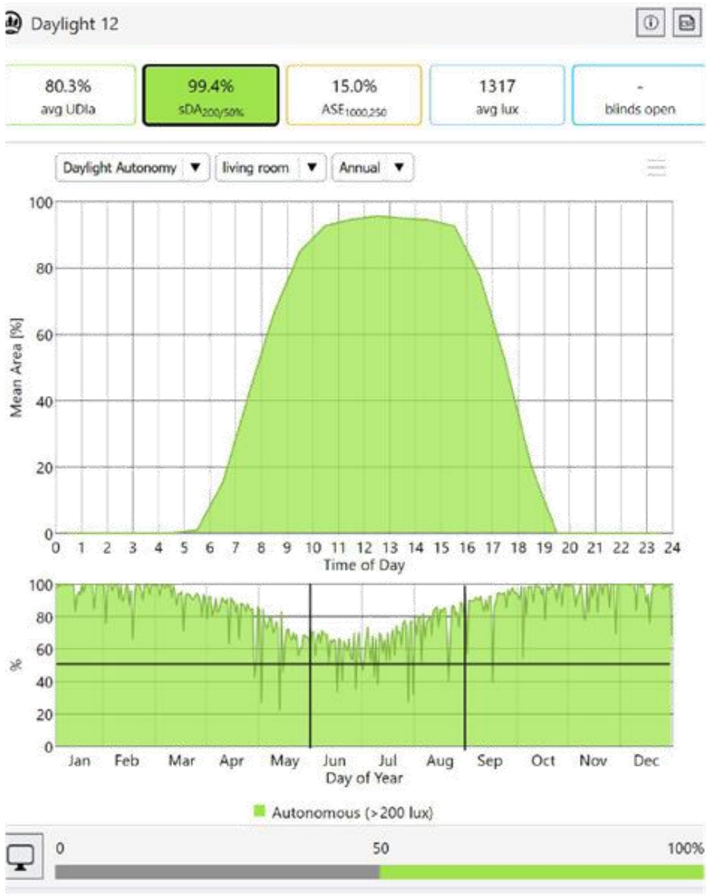

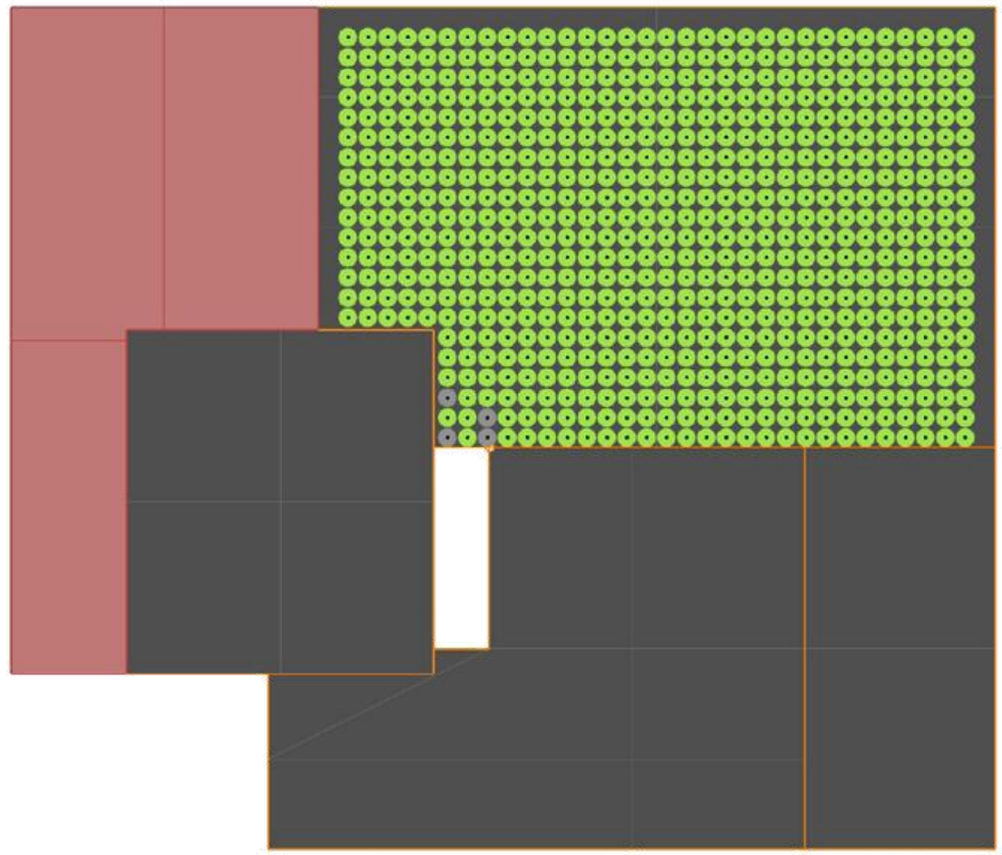

Optimised apartment layout (improved apertures to rooms; balcony cut out to second bedroom aligned to Better Apartments Design Standards (BADS))

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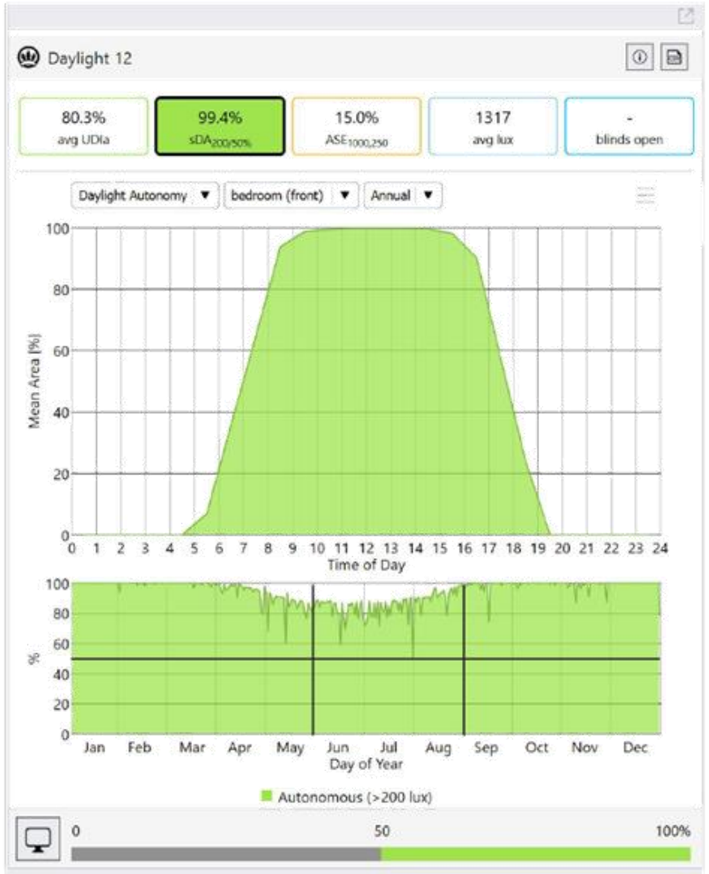

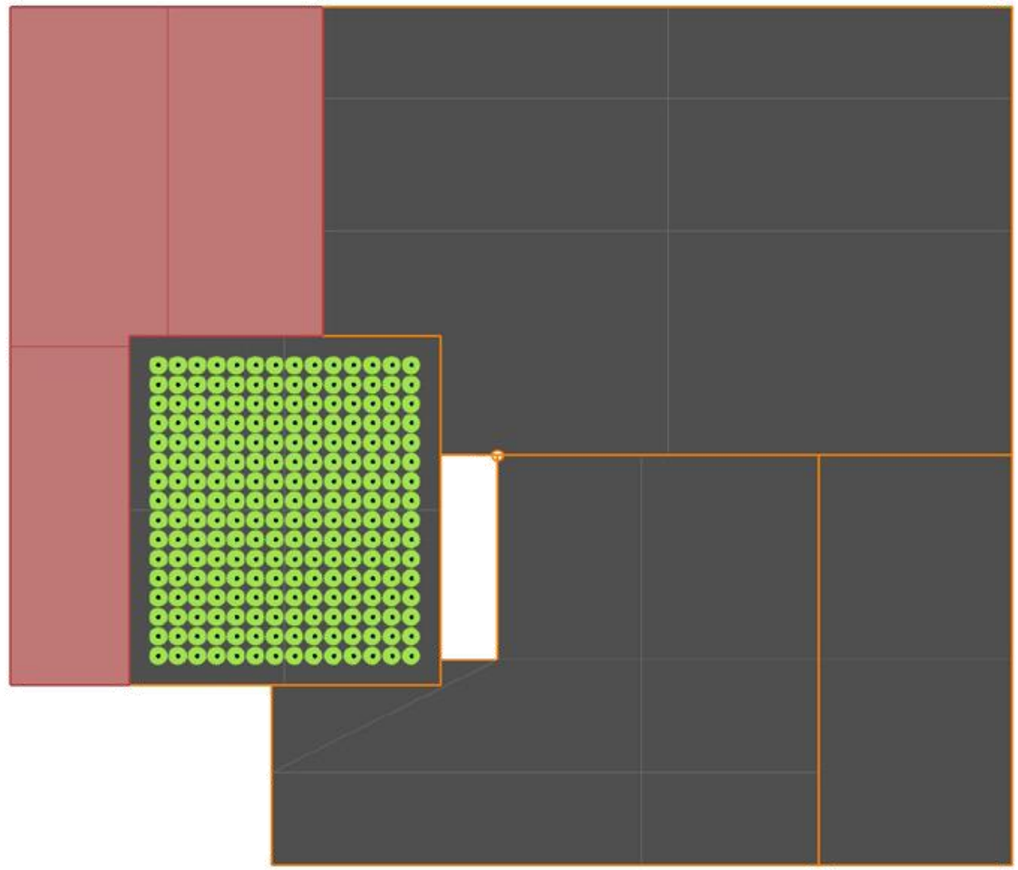

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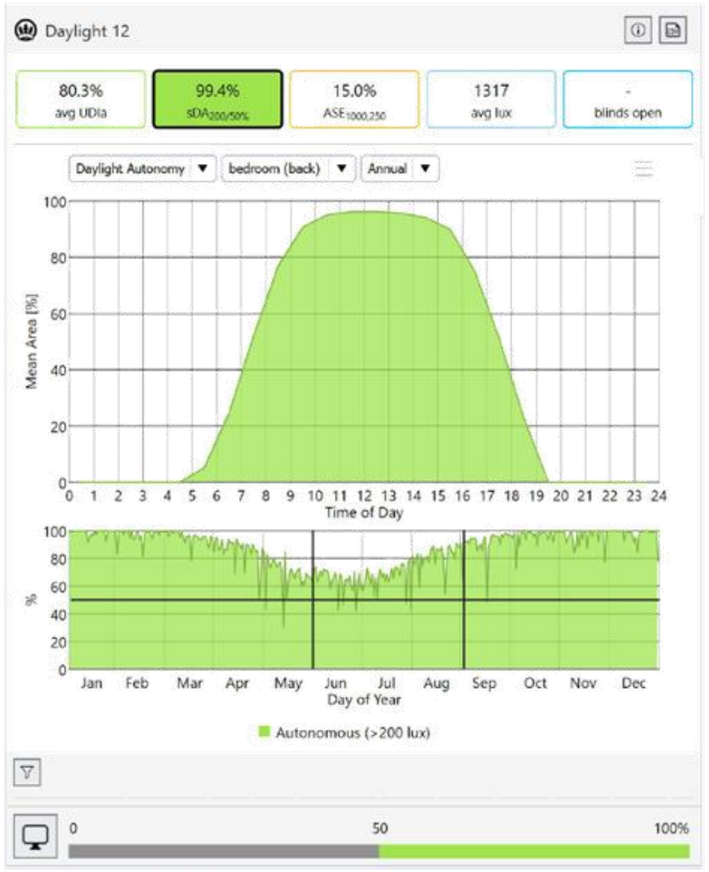

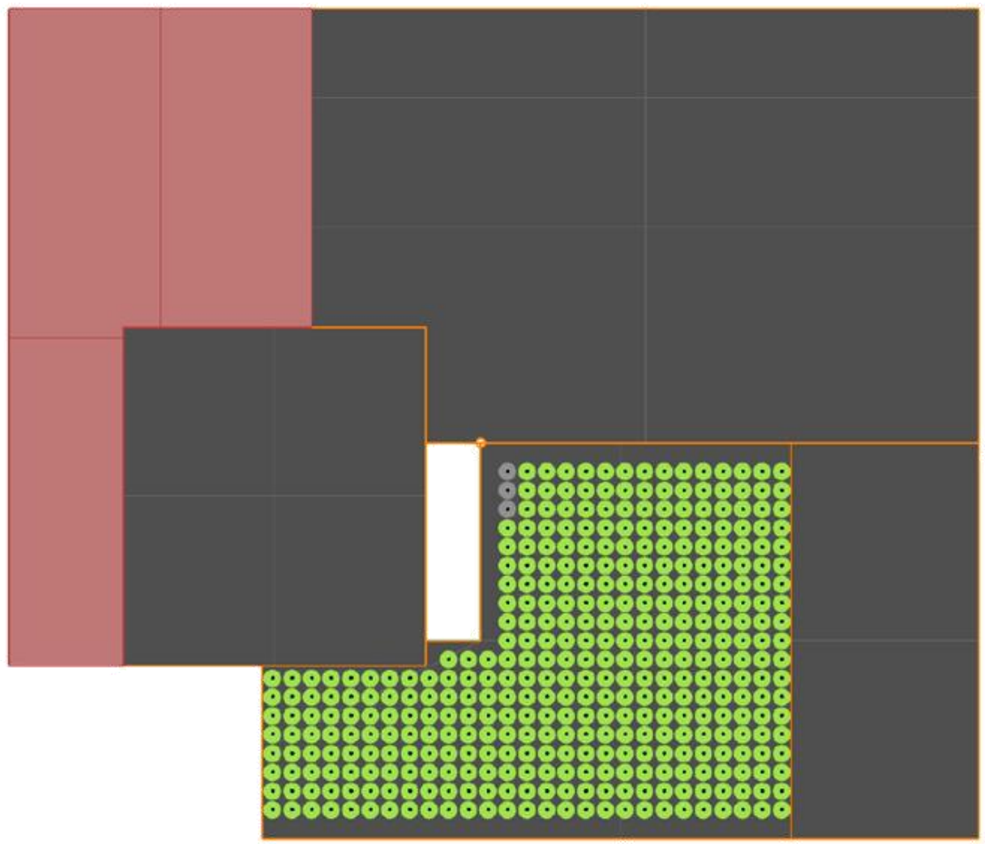

Optimised apartment layout (improved apertures to rooms; balcony cut out to second bedroom aligned to BADS)

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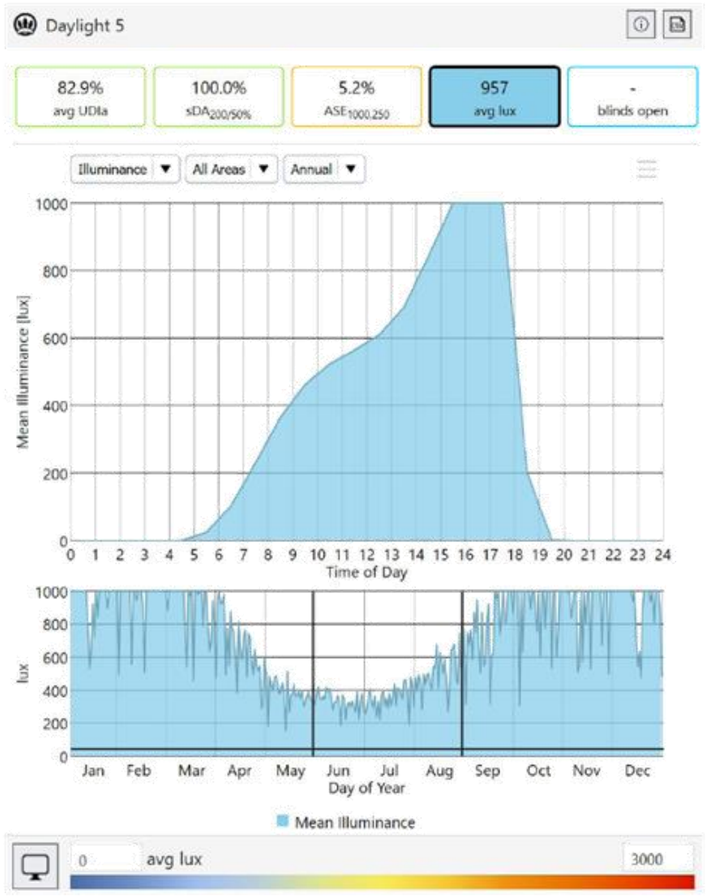
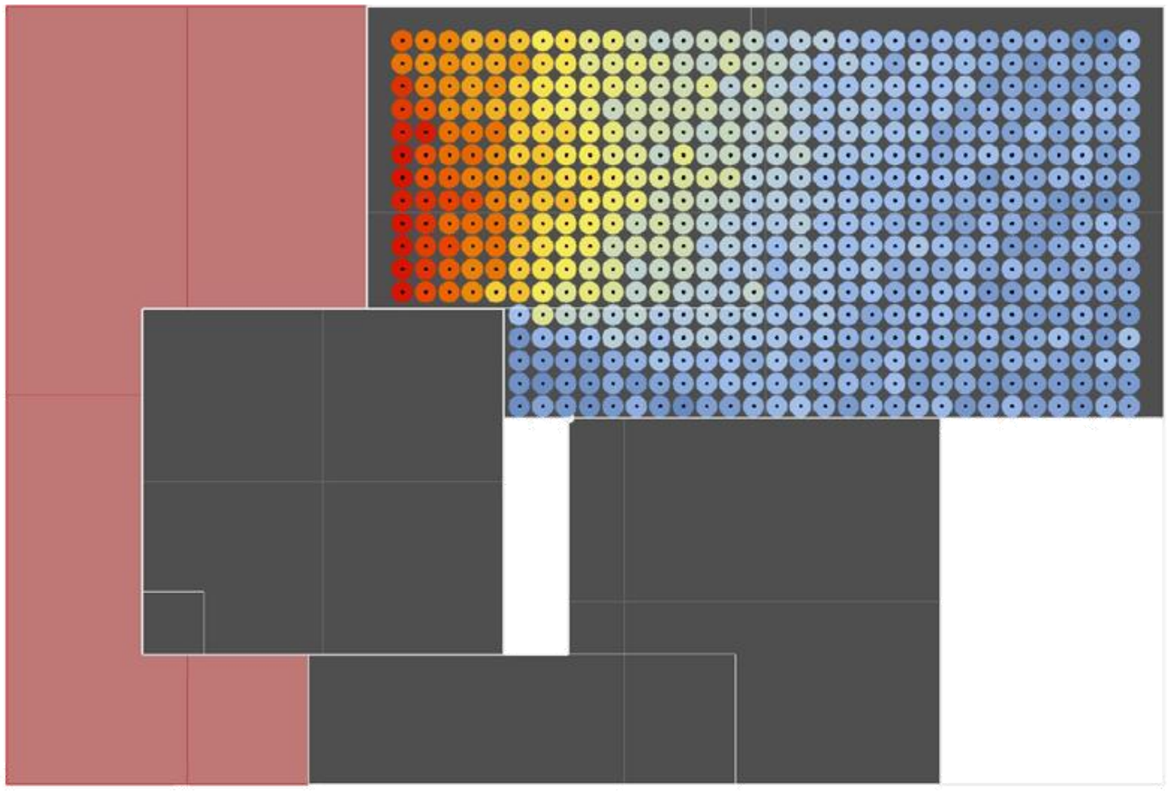
Daylight Illuminance

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





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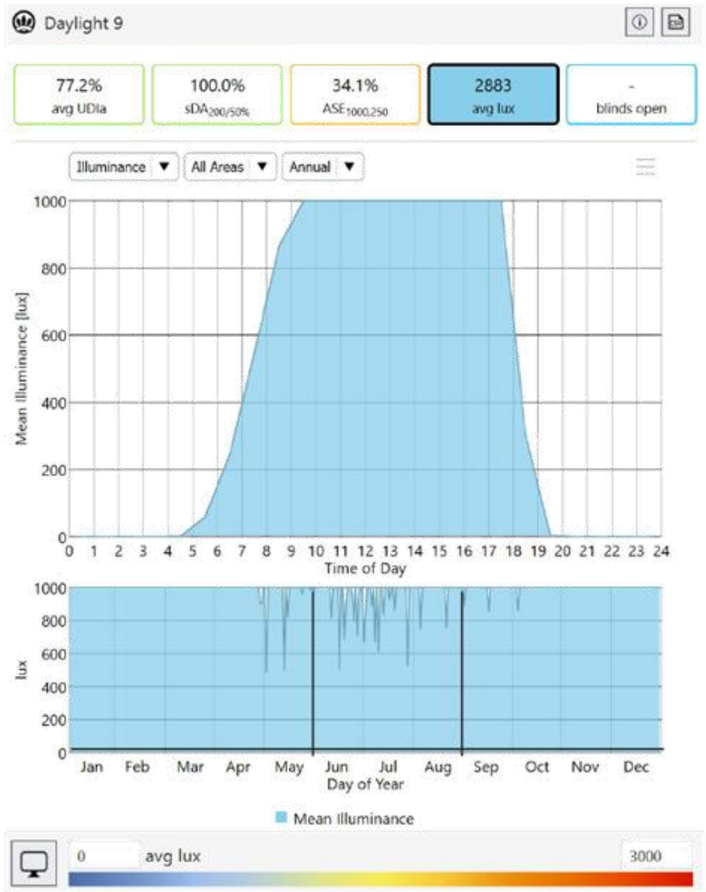

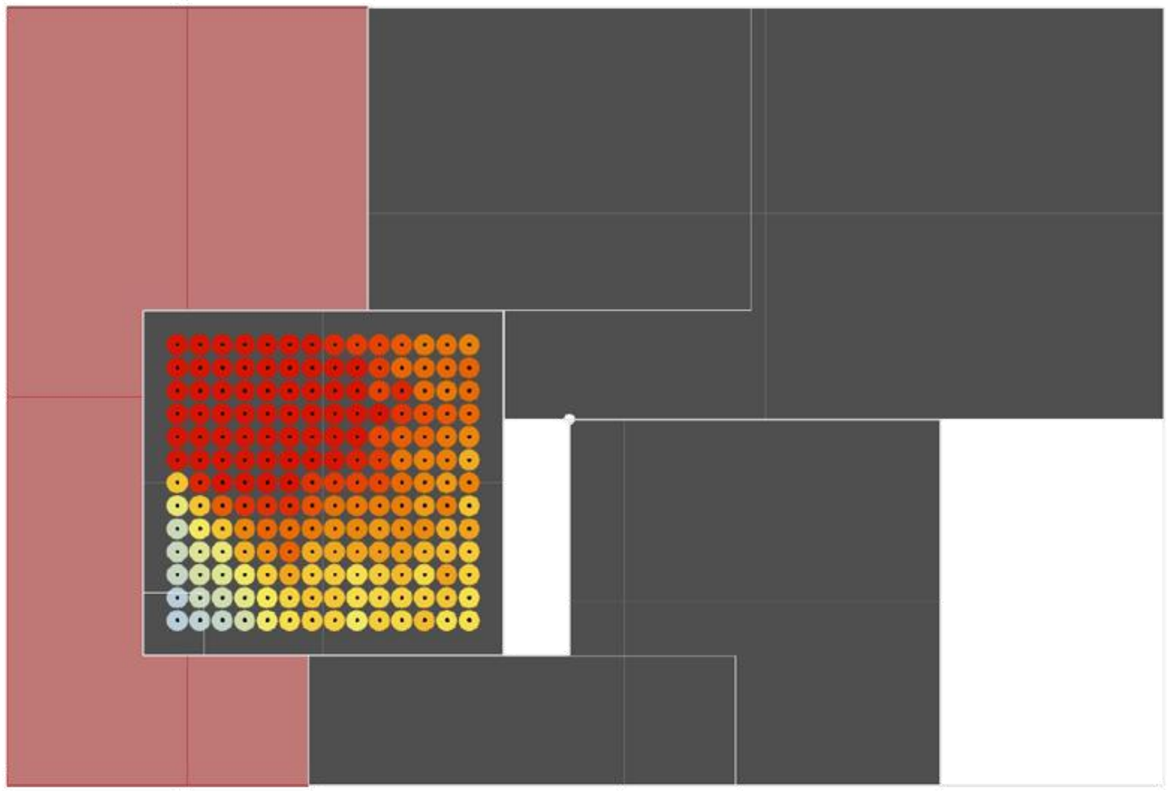

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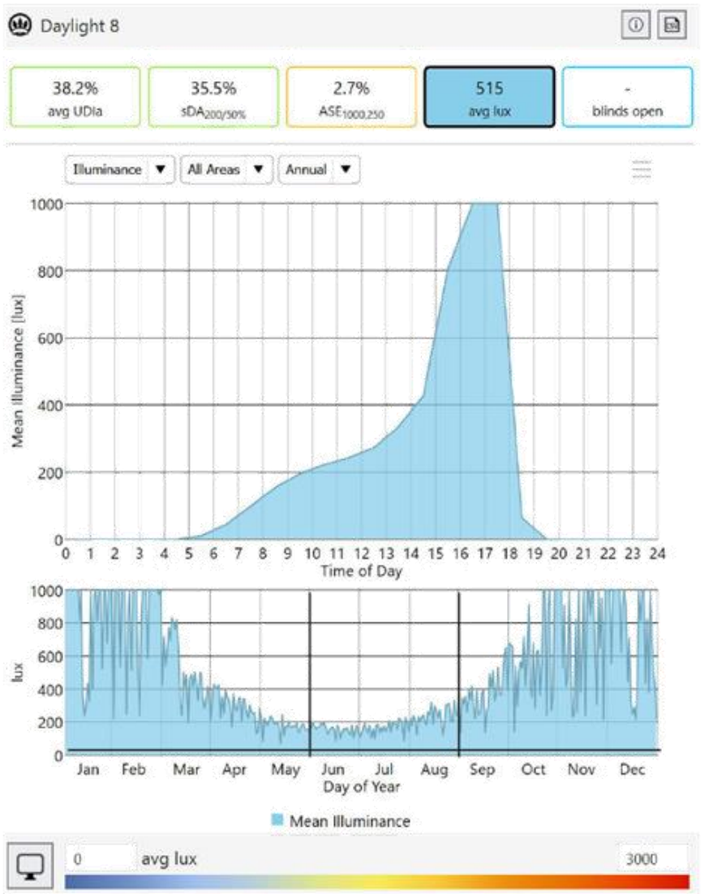

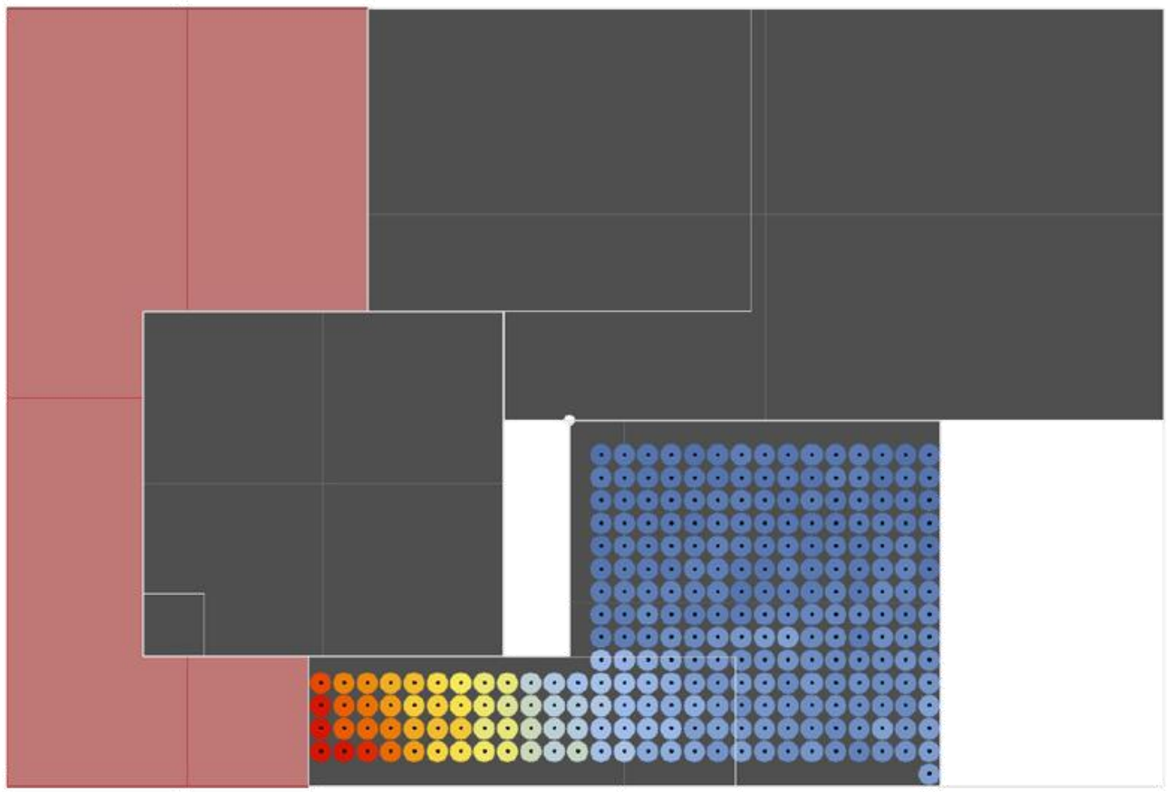

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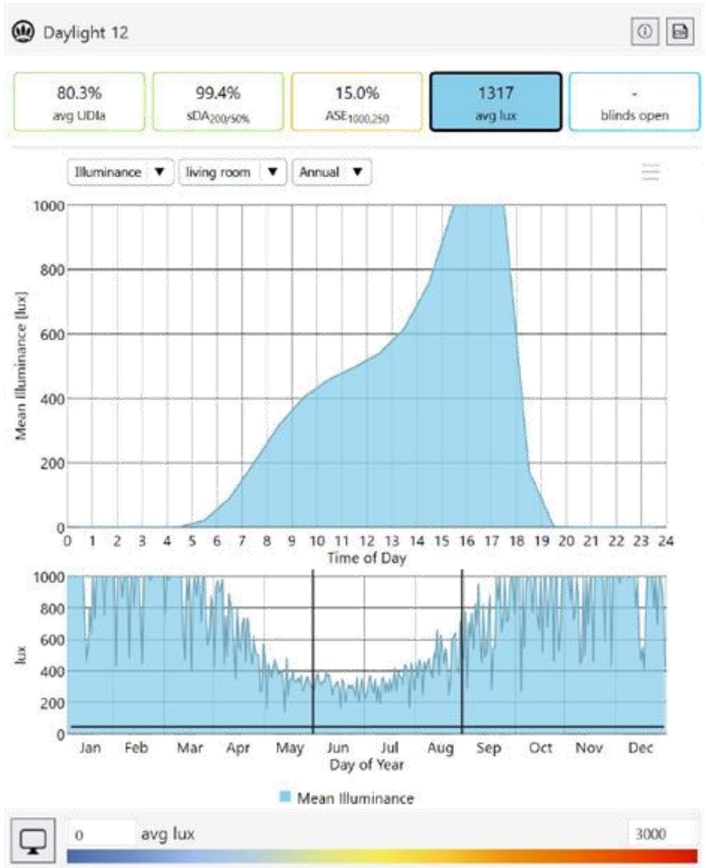

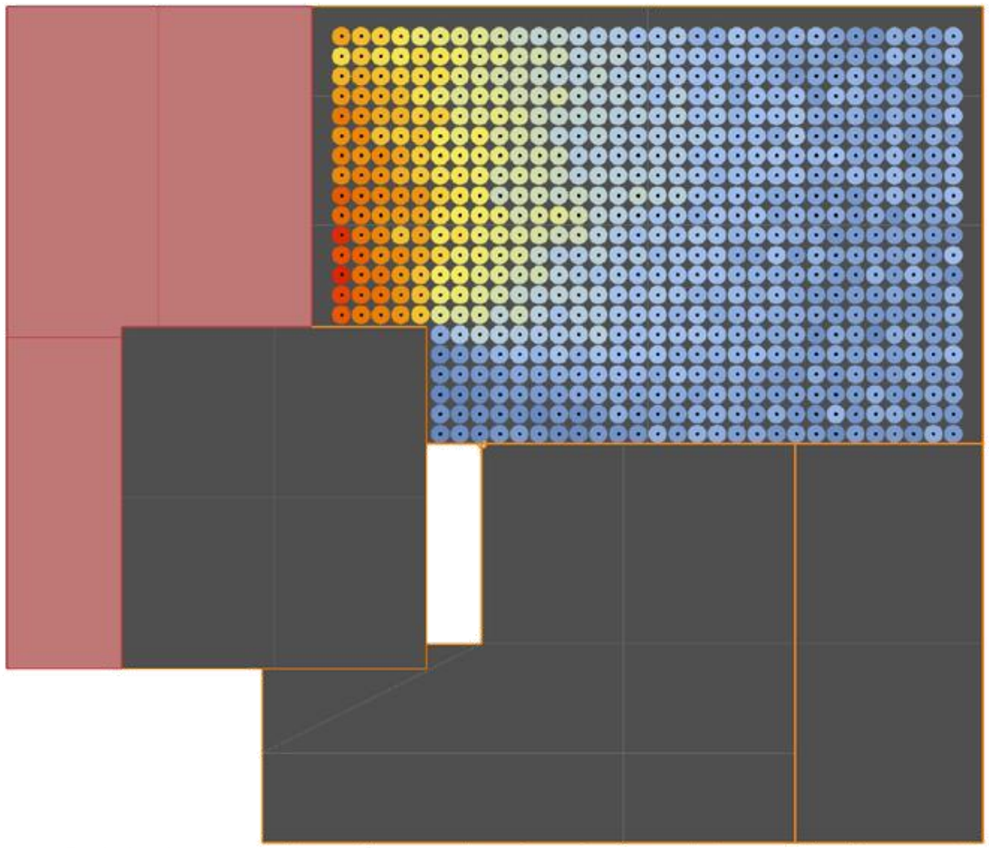

Optimised apartment layout (improved apertures to rooms; balcony cut out to second bedroom aligned to BADS)

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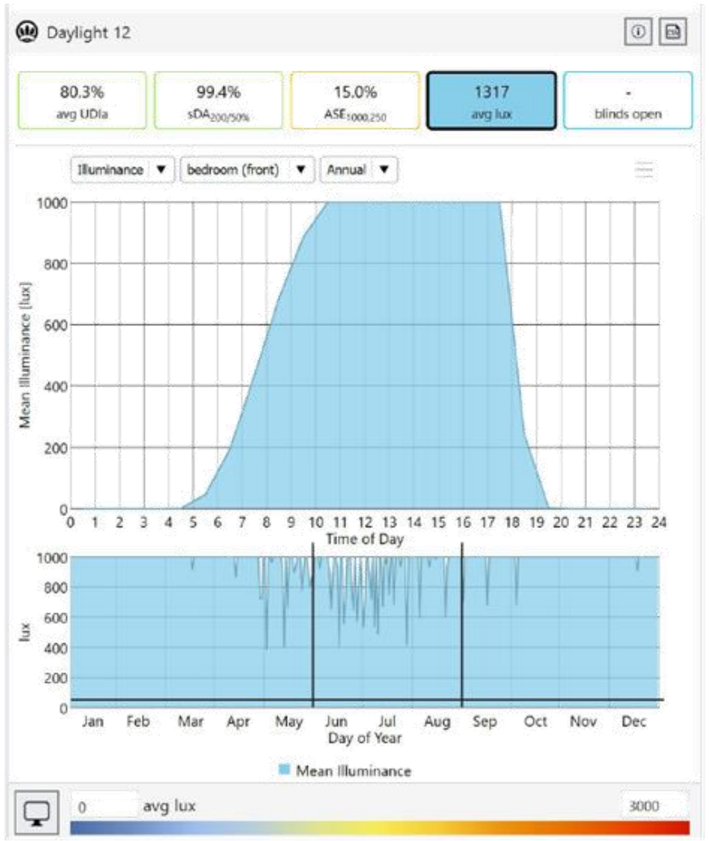

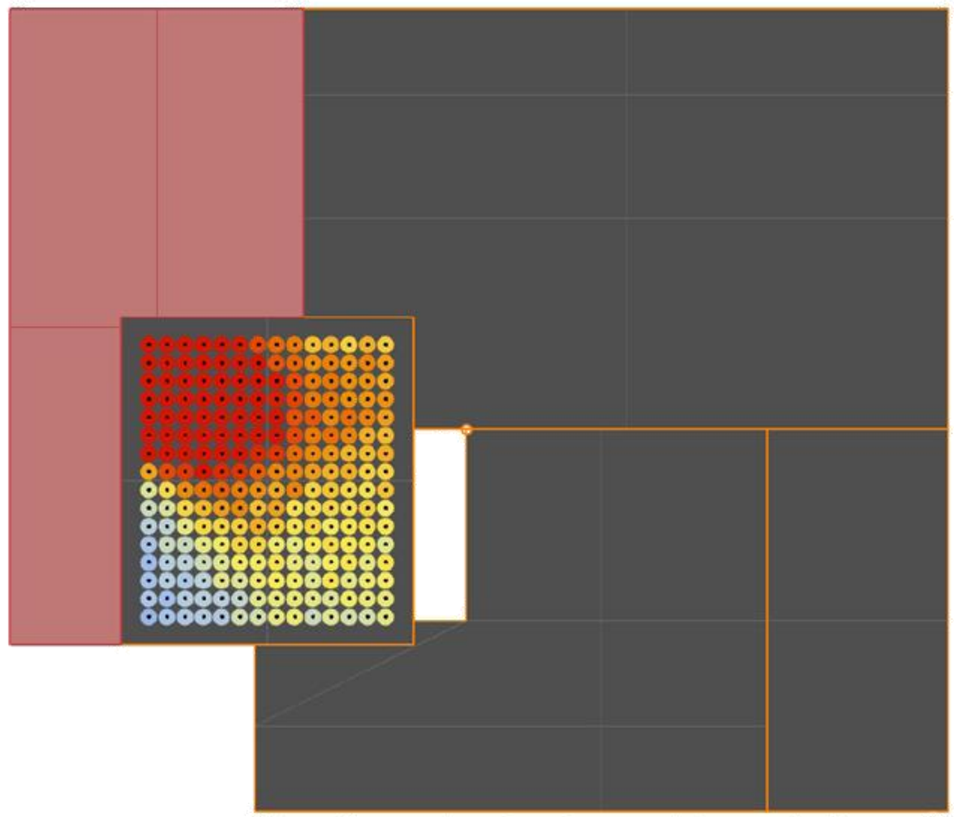

Optimised apartment layout (improved apertures to rooms; balcony cut out to second bedroom aligned to BADS)

HIP V. HYPE

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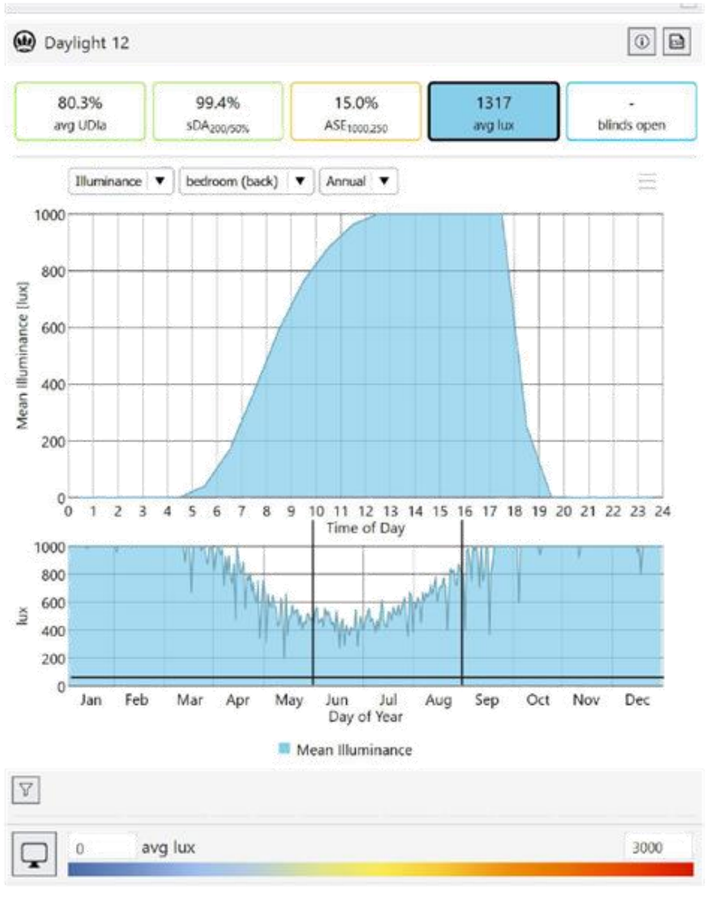
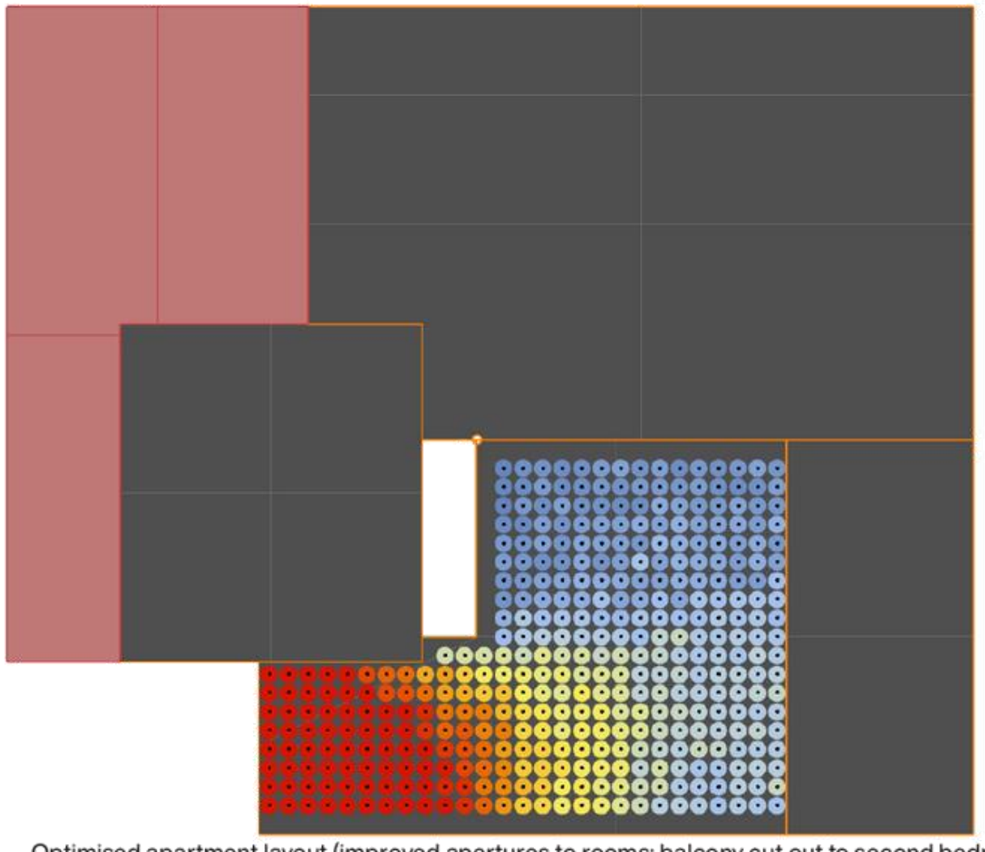


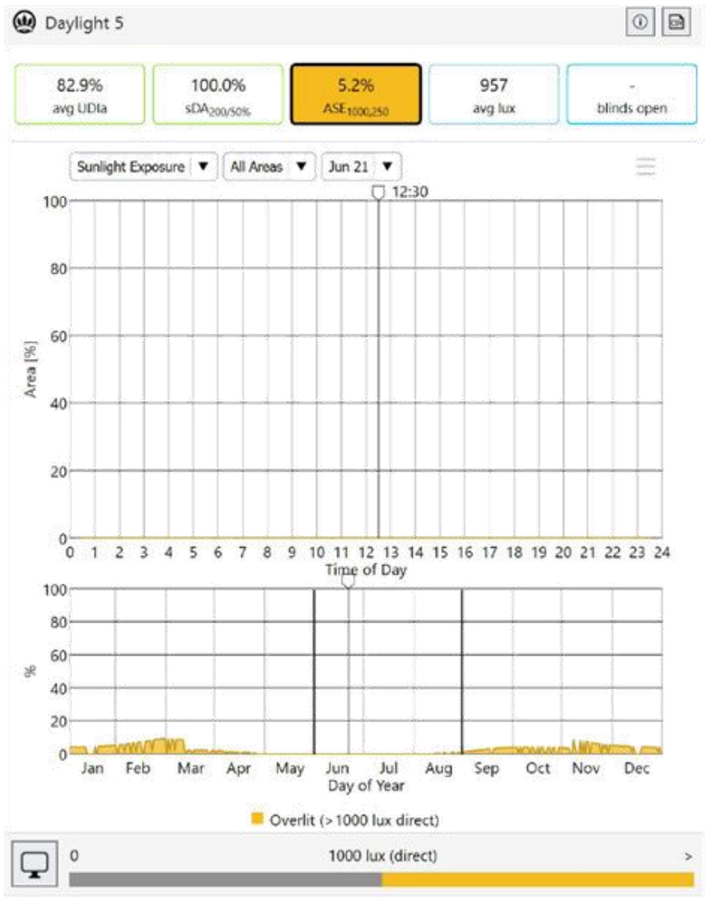


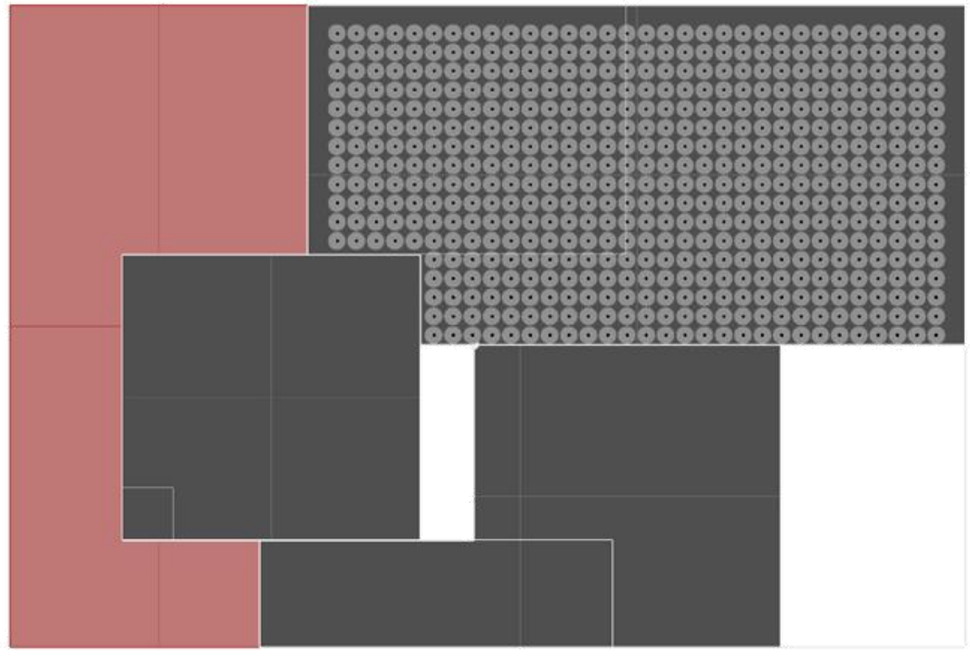
Optimised apartment layout (improved apertures to rooms; balcony cut out to second bedroom aligned to BADS)

HIP V. HYPE

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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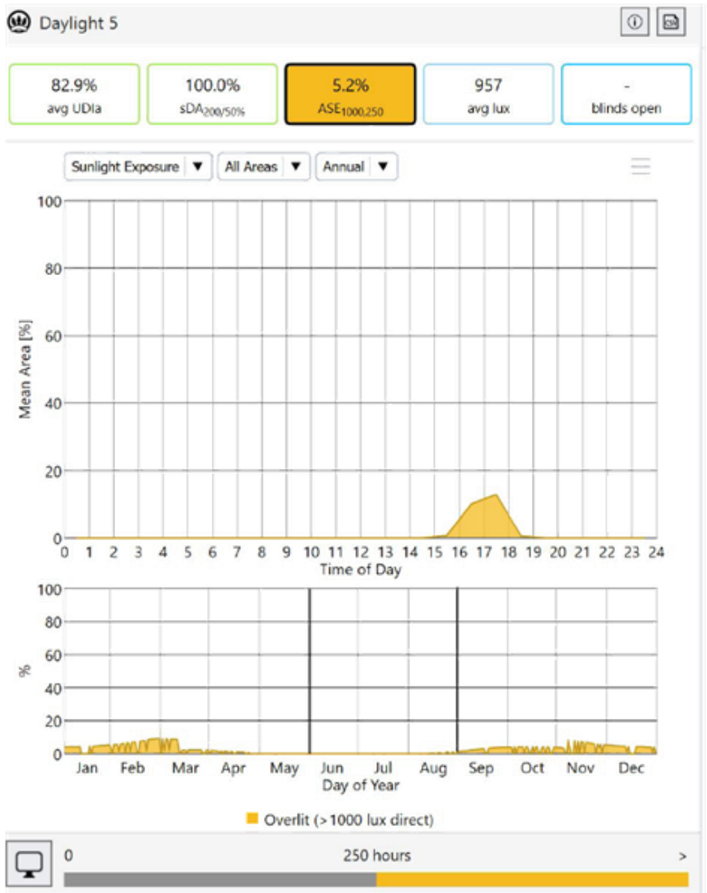

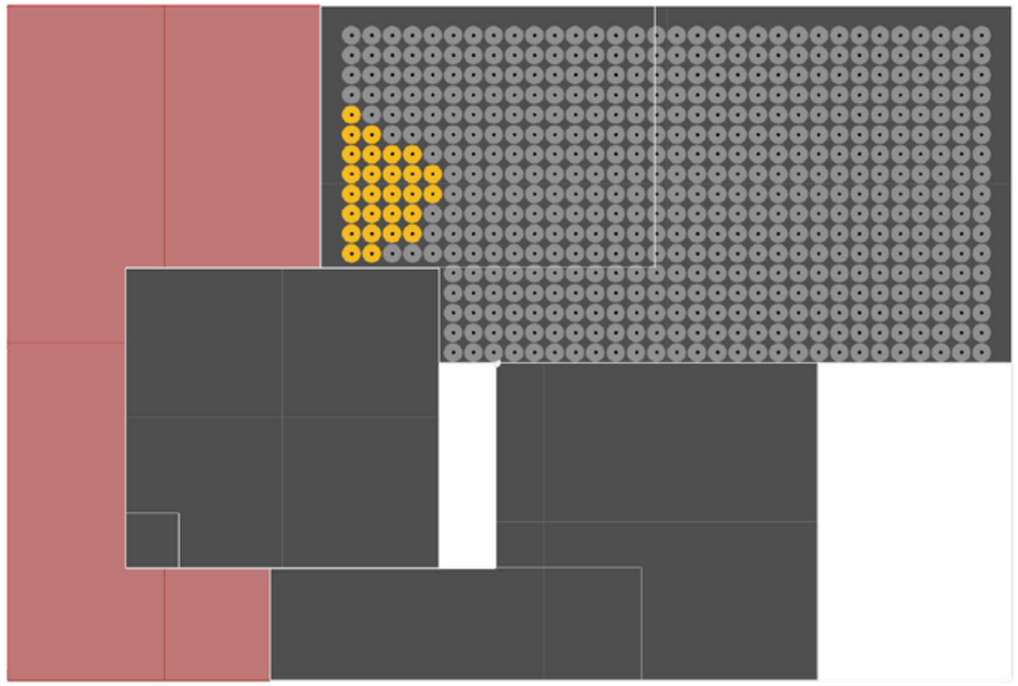

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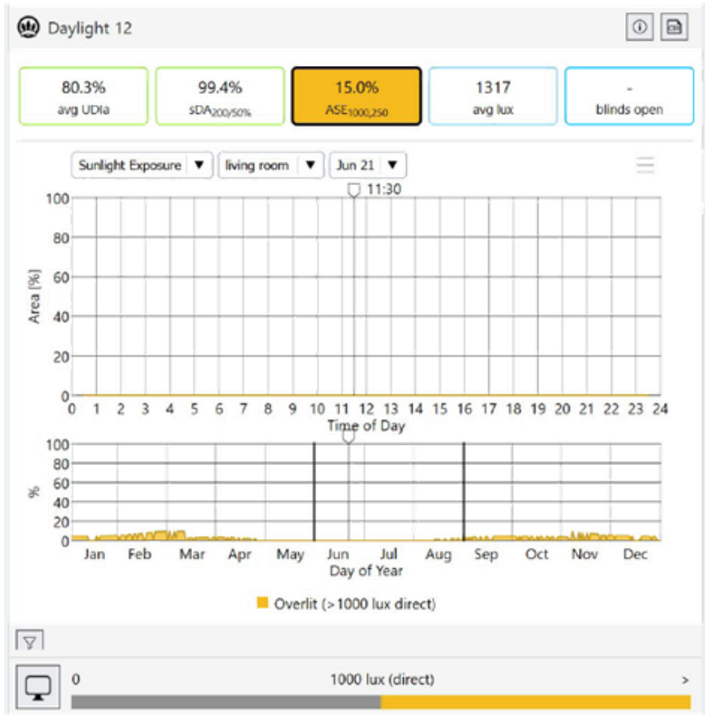

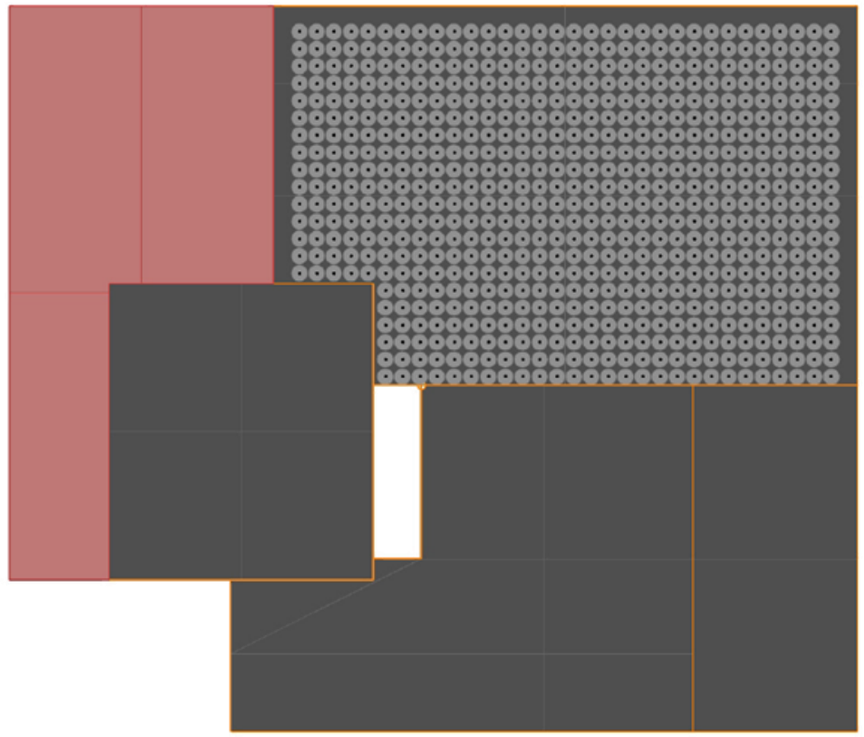

Optimised apartment layout (improved apertures to rooms; balcony cut out to second bedroom aligned to BADS)

HIP V. HYPE

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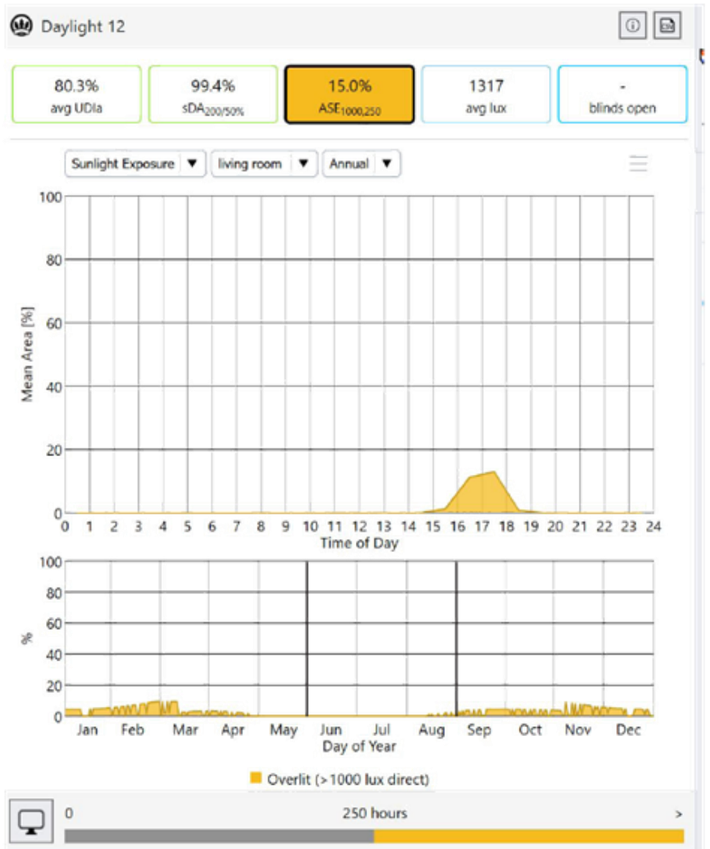

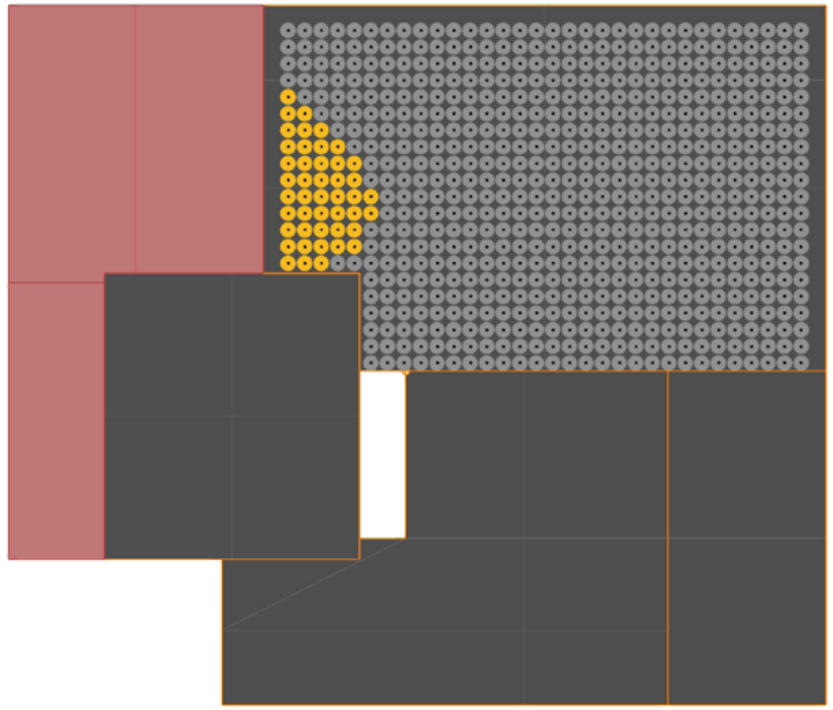

Optimised apartment layout (improved apertures to rooms; balcony cut out to second bedroom aligned to BADS)

HIP V. HYPE

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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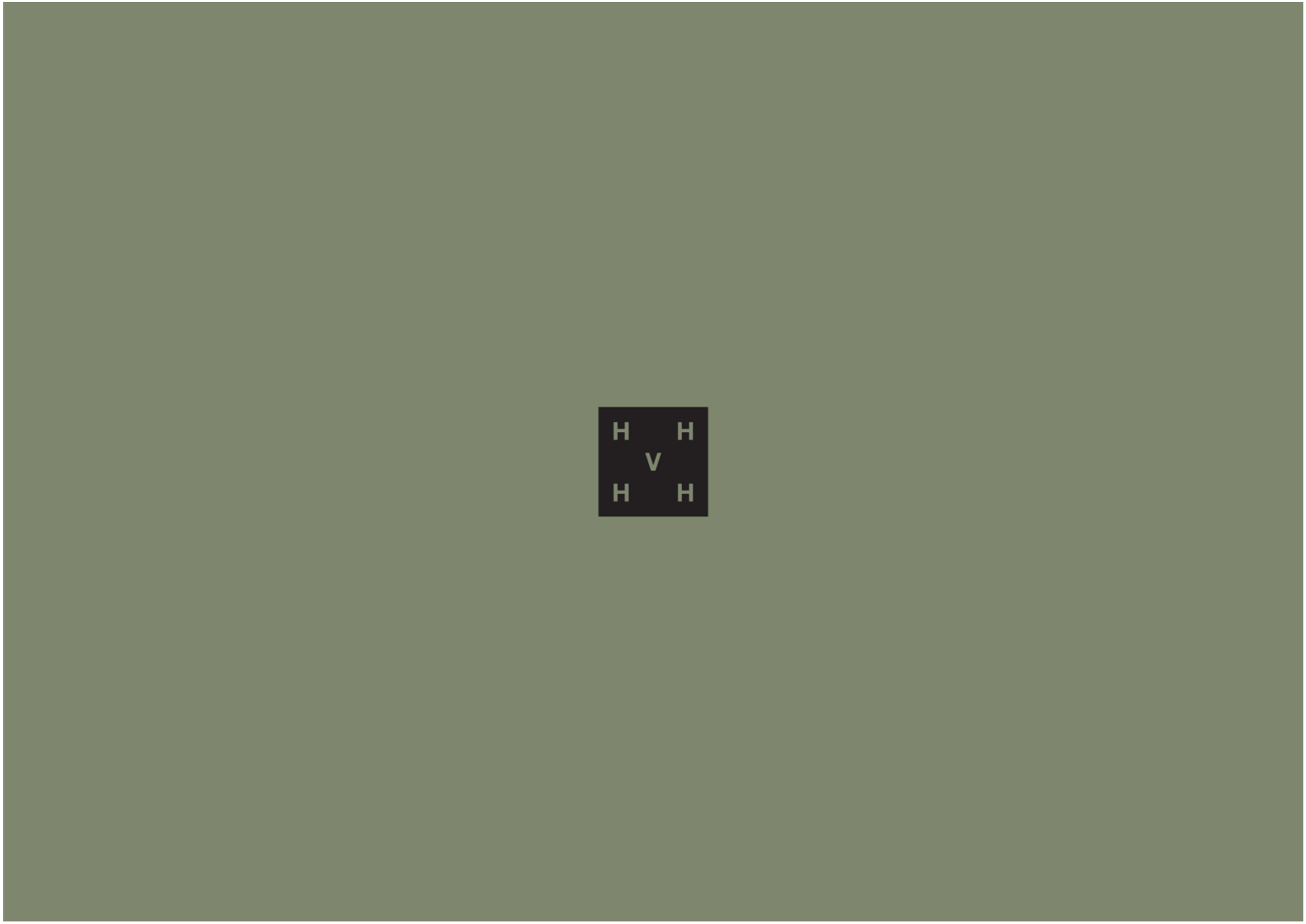
HIP V. HYPE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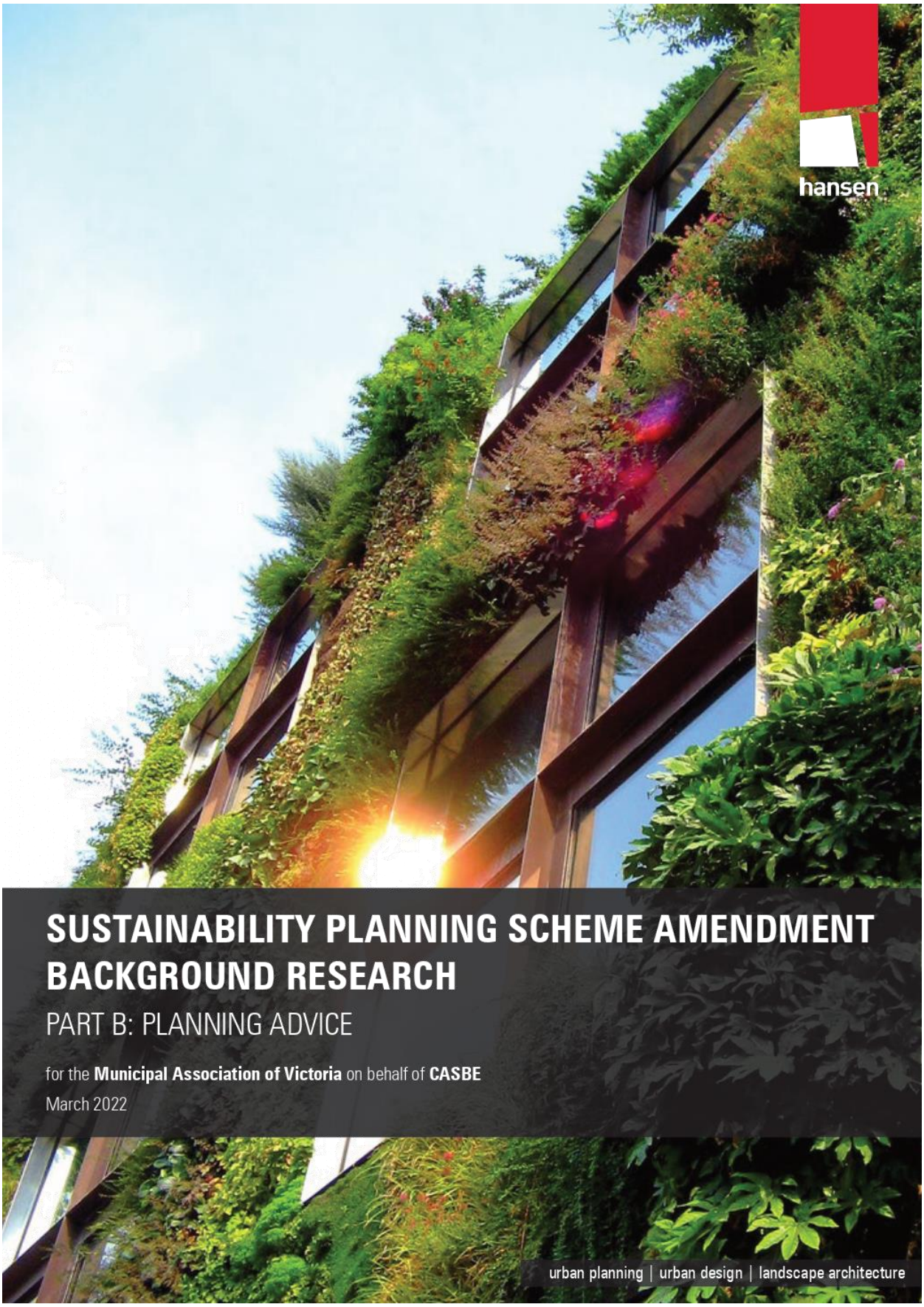
Consideration of City Planning Reports

ELEVATING ENVIRONMENTALLY SUSTAINABLE DEVELOPMENT (ESD) TARGETS PLANNING POLICY PROJECT: STAGE 2 PLANNING SCHEME AMENDMENT

Part B - Hansen Partnership - Elevating ESD Targets Planning report (Final)

Meeting Date: 6 June 2022

Attachment: D



SUSTAINABILITY PLANNING SCHEME AMENDMENT BACKGROUND RESEARCH

PART B: PLANNING ADVICE

for the **Municipal Association of Victoria** on behalf of **CASBE**

March 2022

urban planning | urban design | landscape architecture

CONTENTS

1.0 INTRODUCTION

Hansen Partnership, Hip V Hype and Frontier Economics have been engaged to provide advice on a range of draft ESD standards proposed for inclusion in the planning schemes of a growing number of participating councils. These standards represent an 'elevation' of existing standards currently found in the local policies of 20 of Victoria's councils.

A total of 31 Victorian councils are involved in the 'Elevating Environmentally Sustainable Development (ESD) Targets Planning Policy Amendment' project (the project), indicating the increasing awareness of the importance of planning in delivering ESD. It also signals the importance that planning plays in the ability of local governments to act in response to their communities concerns, expressed through various declarations associated with the climate emergency.

Hansen's role has been to review the proposed standards and recommend adjustments, and to provide advice on related questions of implementation. HIP V. HYPE undertook an assessment of the technical and financial implications of the Standards (Component A), and Frontier Economics considered undertook a cost benefit analysis (Component C).

This report contains two key sections - the first documents the outcomes of a review of draft standards provided to the project group, bringing together input from not only Hansen, but also technical advice and feedback from stakeholders. The second component of this report responds to a series of questions related to how those Standards could, or should, be implemented through Victoria's planning system, before the report concludes with a series of recommendations.

Hansen Partnership Pty Ltd 3

2.0 PEER REVIEW OF STANDARDS

Hansen have undertaken a thorough review of the proposed Standards. The outcome of this review and associated discussion is contained in this section of the report.

The review process comprised a number of stages:

- Initial review and identification of matters which were not appropriate for implementation through a planning scheme. Some of these were identified as more appropriate as guidelines, some were identified as duplicating other standards, and others were not matters that are suitably addressed through a planning scheme, for example:

  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.
- A workshop was then held with members of the client group who had been involved in a 'strategic working group', developing the Standards in their early phases. Through this process, the intent behind particular Standards was discussed and additional Standards resolved for removal, modification or consolidation were identified.
- Hansen then undertook a more thorough review of the Standards considering the following:
  - The likely implementation mechanism and therefore the appropriate 'framing' of the Objectives and Standards.
  - Existing content within planning schemes, and content proposed through current reforms.
  - Opportunities for simplification and clarification.
  - The ability for planners to assess the proposed Standards and the ways in which they might do so.
- Following this, the Standards were further updated on the basis of advice prepared as part of Component A of this project which examined the technical feasibility and viability of the proposed Standards. Where technical challenges were identified with respect to implementing and embedding relevant standards, corresponding adjustments were made to address this.
- The Standards were also tested with a number of stakeholder groups, such as ESD practitioners and peak industry bodies.

The updated Objectives and Standards are included on the following pages, followed by identification of Standards which are recommended to not be pursued further as part of this project.

There are a number of matters to note:

- The Objectives and Standards have been arranged thematically. However, these themes have been adjusted from those originally proposed. The rationale for these adjustments is outlined in the highlight box opposite.
- While the particular requirements of development have been retained as 'Standards', it is noted that these may require further translation once the preferred implementation mechanism has been confirmed and DELWP preferences ascertained. For example - it may be that more specific Performance Measures and Criteria are preferred, or Requirements and Guidelines. See Implementation into Planning Schemes for further details.

THEMES

ENERGY

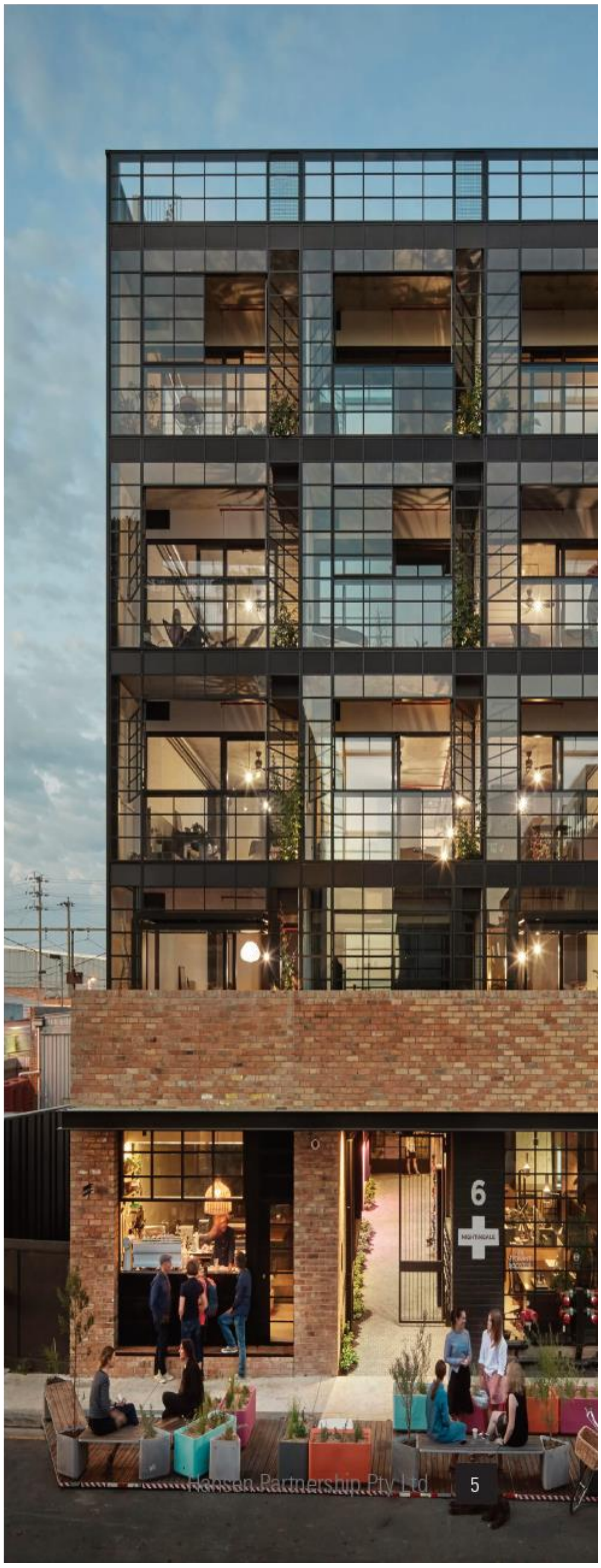
This theme has been split into Operational Energy and Embodied Carbon. This allows for the splitting of objectives related to these two matters. The introduction of a new Embodied Carbon theme allows for an increased emphasis on this and to provide a logical 'home' for Standards which are seeking to achieve objectives related to this. While most of the Standards in this theme are not quantitative or specific, it provides the opportunity for later updates as consideration of embodied carbon becomes more resolved.

GREEN INFRASTRUCTURE

This theme replaces Urban Ecology. While urban ecology is important, as a theme it fails to appropriately encompass the range of matters addressed under this heading and is perhaps more aligned with specific 'biodiversity' outcomes which are often situated in other parts of the scheme. Green Infrastructure allows a greater focus on health and wellbeing considerations alongside biodiversity outcomes.

WASTE & RESOURCE RECOVERY

While this theme was originally identified as Waste, Materials & the Circular Economy, much of the content related to materials has been moved to the Embodied Carbon theme. While the Objectives of this theme certainly relate to the development of a circular economy, it is considered that the Standards proposed under this relate primarily to waste and resource recovery rather than the broader circular economy and so a thematic heading which reflects that provides greater clarity.



2.1 THE OBJECTIVES AND STANDARDS

The table is broken into relevant themes, and for each a series of Objectives are detailed. Below these the revised Standards are included. These have been subject to a rigorous process of review and testing with stakeholders but should be subject to a further round of review prior to any exhibition of a Planning Scheme Amendment

For each theme, the relevant Objectives which the Standard is intended to deliver is identified, along with some commentary as to how the standards would be assessed through the proposed process. It is important that all the Standards are practical in terms of how they can be assessed by any decision-maker and also that they do not impose unreasonable burdens on applicants. These should be read in conjunction with the discussion at Section 2.3 on application requirements and supporting material.

THEME: OPERATIONAL ENERGY

Objectives

.1 To ensure new development achieves net zero carbon emissions from operational energy use.
.2 To support the inclusion of renewable energy generation and ensure a transition to renewable energy sources.
.3 To ensure higher levels of energy efficiency and reduce pressure on energy networks.
.4 To support effective energy load management and storage.
.5 To support development that demonstrates innovation in the delivery of carbon positive emission outcomes.

Standards	Assessment process	Objectives
S1 All development should be designed to reflect the following hierarchy in achieving net zero carbon performance from all operational energy use: 1. Design buildings to be all electric; 2. Design building orientation, envelope and openings to increase energy efficiency; 3. Selection of energy efficient systems, equiptment and appliances; 4. Onsite generation of renewable energy; 5. Purchase of offsite renewable energy.	As part proposed Sustainability Management Plan (SMP) templates (see Section 2.3) a 'checklist' could be included which, on completion, provides the planner or other decision-maker with a clear understanding of the order and steps taken by the applicant to meet the Standard.	1, 2, 3, 4, 5.

Standards	Assessment process	Objectives
S2 All new development should be designed to avoid consumption of natural gas or other onsite fossil fuels.	This can be clearly identified in the SMP and on relevant plans, including the proposed Sustainability Response Plan. The Guidelines document will provide 'helpful hints' as to ways to overcome common issues with gas. The Guidelines should also include a clear list of uses for which discretion may be warranted from this standard, and any associated parameters. It is noted that advocacy for corresponding changes to the VPPs to address the issue of gas providers as Determining Authority for some permit applications will also need to be pursued.	1
S3 All development should be designed to reflect the following hierarchy in achieving net zero carbon emissions from all operational energy use: 1. Design buildings to be all electric; 2. Design building orientation, envelope and openings to increase energy efficiency; 3. Selection of energy efficient systems, equipment and appliances; 4. Onsite generation of renewable energy; 5. Purchase of offsite renewable energy.	This would be assessed through review of built form as shown on plans, and also as articulated through the SMP. Appropriate design responses would vary dependant on context, but examples of common best practice could be provided through the Guidelines.	3
S4 All development should be designed to minimise energy use including: • Provision of clotheslines to allow natural drying of clothes and bedlinen, that do not impact the amenity of external secluded private open space, or internal room function. • Provision of appropriate energy management systems (such as load management) to support use of renewable energy generated onsite and efficient energy consumption throughout the day.	Clothes drying areas would be marked on plans allowing for easy assessment and SMP would contain details of any proposed energy management systems as part of documentation. Guidelines again, could provide details as to common and cost effective forms of energy management for different typologies.	3, 4
S5 All residential developments should achieve an average 7 Star NatHERS rating.	Relevant NatHERs modelling reports would be incorporated into the SMP. Note: it is anticipated that this Standard will be removed following delivery of Victorias commitment to pursuing this standard through updates to the building regulations.	1, 3, 4

Standards	Assessment process	Objectives
S6 All development should maximise potential utilisation of solar energy and where appropriate, wind, through the following measures: • Ensuring electrical systems are designed to optimise the onsite consumption of generated electricity. • Optimising roof form, pitch and orientation for photovoltaic arrays and/or solar air or water heating. • Minimising shading and obstructions. • Designing for appropriate roof structure to accommodate and access equipment. • Consider spatial requirements for future renewable energy storage or other energy management systems.	The SMP would provide detail on measures proposed, and the Guidelines would provide certainty as to what matters might need to be specified in terms of electrical systems for different typologies. Plans, including the Sustainability Response Plan, could detail roof characteristics allow for assessment, and again, the Guidelines could clearly articulate appropriate responses in different contexts. Where relevant and if load management or storage is suggested to be part of the response, relevant notations and definition of spatial requirements on plans could be sought.	1, 2, 4

<table>
<tr><th>Standards</th><th>Assessment process</th><th>Objectives</th></tr>
<tr><td>S7
All developments should provide the following minimum requirements for onsite renewable energy generation:
<table><tr><th>DEVELOPMENT</th><th>REQUIREMENT</th></tr><tr><td>Single dwelling, Two or more dwellings on a lot (multi-dwellings other than apartments)</td><td>A 3kW minimum capacity solar photovoltaic (PV) system should be installed for each 1-2 bedroom dwelling and an additional 1.0kW per bedroom for each bedroom there-after.</td></tr><tr><td>Apartment development</td><td>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.</td></tr><tr><td>Office, Retail, Other non-residential</td><td>Provide a solar PV system with a capacity of at least 25W per square meters of the development's site coverage.</td></tr><tr><td>Industrial & Warehouse</td><td>A solar PV system that is:
Sized to meet the energy needs of the building(s) services (lighting, air-conditioning, industrial processes). When no industrial process is proposed, minimum 1.5kW per tenancy plus 1kW for every 150m2 of gross floor area must be provided,
OR Where an energy intensive industrial process is likely, maximised based on the available unencumbered roof area.</td></tr></table></td><td>The solar PV proposed would be shown on the plans and detailed in the SMP, allowing for easy assessment against the Standard. There will clearly be some instances where there is a need for discretion in the application of this Standard, including where roofs are already overshadowed (where the application of such a requirement would be unreasonable) or where a better overall sustainability outcome is generated through a combination of measures proposed for the site which results in this Standard not being appropriate.
In order to ensure transparency, situations where discretion would always lead to the Standard not being applied should be clearly outlined in the Guidelines or suitable wording added to the Standard. Other situations where discretion may be exercised could be identified though case study examples but should not be specifically listed within the Guidelines. Where relevant these matters could be integrated into decision guidelines.</td><td>1, 2</td></tr>
<tr><td>S8
All residual operational energy should be 100% renewable, purchased through government accredited off-site Green Power, power purchasing agreement or similar.</td><td>See Section 3.7 for more in depth discussion of how this Standard could be implemented and assessed.</td><td>1</td></tr>
</table>

THEME: EMBODIED CARBON

Objectives

.1 To encourage development that considers the lifecycle impacts of resource use and supports lower carbon emissions.

Standards	Assessment process	Objectives
S9 Development should reduce the impact of embodied carbon emissions in materials used through a combination of the following measures: • Reusing all, or part, of existing buildings. • Use of reclaimed or repurposed materials where appropriate. • Use of new materials with a recycled content. • Identifying opportunities to substitute high impact materials, such as concrete or steel, with materials with lower embodied carbon. • Selecting materials from sources which have undertaken offsetting of any carbon emissions.	The SMP would provide detail on measures proposed by the applicant to meet this Standard. The template could be structured to identify opportunities, which the applicant could confirm if they have taken up or not. Guidelines could provide guidance as to the reductions that would be considered reasonable and the circumstances where discretion would be anticipated.	1
S10 Development should demonstrate consideration of the potential for future adaptation and / or alternate uses where relevant, in the design of buildings.	This could be detailed in the SMP, where a template could provide a checklist of measures that have been considered in response to the Standard. The relevant section of the Guidelines could provide best practice case study examples.	1
S11 Development should contribute to the reduction in future embodied carbon through careful material selection, including: • Utilising materials that are durable, reducing need for replacement. • Utilising materials and construction methods which facilitate future recycling of materials. • Considering the application of 'design for disassembly' principles.	Materials and finishes specifications are anticipated to be provided as per standard application requirements. This would allow assessment against the first and second dot point. Similarly to the above, the SMP template could provide a checklist against matters which have been considered by the applicant in responding to the Standard. Guidelines again could provide locally relevant case studies and ideas that could be considered by applicants.	1

THEME: SUSTAINABLE TRANSPORT

Objectives

.1 To ensure development supports sustainable and equitable transport patterns through the provision of transport infrastructure that prioritises active transport.
.2 To support and encourage zero emissions transport.
.3 To support development that is designed to encourage behavioural changes to reduce transport related emissions and congestion.
.4 To ensure that development is designed to accommodate the expected increase in use of lower emission modes of transport through the provision of infrastructure that is efficient and can adapt to meet changing needs and innovations in transport technology.

Standards	Assessment process	Objectives
S12 All development should provide the following rates of bicycle parking:	Bicycle parking areas and proposed numbers should be included on relevant plans. They should also be detailed with the relevant SMP (see recommendation for consolidation of current Green Travel Plan requirements with a single SMP). SMP template could contain an adjustable table with the relevant uses so applicants can just add in relevant floor areas and identify numbers of bicycle parking spaces provided, with justification for any reduction required. This template could also allow for the easy identification of the number of 'other' types of bicycle parking provided (i.e cargo bikes, electric bikes spaces with charging etc).	1, 2, 4

DEVELOPMENT	REQUIREMENT
New residential development	A minimum of one secure undercover bicycle space per dwelling. Where a lesser provision of bicycle parking is proposed, development should demonstrate how additional space (i.e. car parking spaces) could be repurposed for bicycle parking should demand arise. A minimum of one visitor bicycle space per 4 dwelling.
New retail development	A minimum of one secure undercover employee bicycle parking space per 100 sqm net leasable area. Visitor bicycle spaces equal to at least 5% of the peak visitors capacity.
New development associated with a Place of Assembly	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.
New office development	A minimum of one secure undercover staff bicycle parking space per 100 sqm net leasable area of office. A minimum of one visitor space per 500 sqm net leasable area of office.
For all other non-residential uses	Provide bicycle parking equal to at least 10% of regular occupants.

Standards	Assessment process	Objectives
S13 All non-residential developments should provide: • One shower for the first 5 employee bicycle spaces, plus 1 to each 10 employee bicycle spaces thereafter. • Personal lockers are to be provided with each bicycle space required if 10 or more employee bicycle spaces are provided. • If more than 30 bicycle spaces are required, then a change room should be provided with direct access to each shower. The change room may be a combined shower and change room.	As above, this could be included as a table to fill out in any SMP template, and should be marked on relevant plans.	1, 2, 4
S14 All bicycle parking facilities should be designed for convenient access, including: • Locating the majority of bicycle parking facilities for occupants at ground level, where this does not compromise other relevant objectives. • For bicycle parking not at ground level, providing the majority within 10 meters of vertical pedestrian access ways (i.e. lifts, stairs). • Providing safe access to bicycle parking facilities in basement carparks via a separate line of travel or by clearly signalling cycle priority through surface treatments and to facilities accessed via lanes by providing suitable lighting and surveillance. • Ensuring any lifts used to access bicycle parking areas are at least 1800mm deep. • Ensuring at least 20% of residential bicycle parking facilities are of a type which support equitable access through a combination of well-spaced ground level facilities to support ease of use and provision of parking spaces to accommodate a diverse range of bicycles (such as cargo bikes or three wheeled bikes).	Details of how the design has considered easy access could be documented in the SMP, with relevant content included on plans. The Guidelines should include examples of application types for which dot points relating to ground floor locations and separate lines of travel may not be appropriate. As with previous Standards, where decision guidelines etc are used, these matters could be addressed there.	1, 2, 4

<table>
<tr><th>Standards</th><th>Assessment process</th><th>Objectives</th></tr>
<tr><td>S15
All development should be designed to support the use of electric vehicles through the provision of:
<table><tr><th>DEVELOPMENT</th><th>REQUIREMENT</th></tr><tr><td>Single dwellings / Two or more dwellings on a lot</td><td>Appropriate infrastructure and cabling to support at least moderate speed, efficient EV charging (without the EV charger unit) in each garage/ carport.</td></tr><tr><td>Apartment development</td><td>Electrical capacity capable of supporting the provision of an appropriate moderate speed, efficient EV charging outlet to all car parking spaces.
Appropriate EV infrastructure and cabling must be provided to ensure peak demand is managed for example, distribution boards, power use metering systems, scalable load management systems, and cable trays or conduit installation.</td></tr><tr><td>Non-residential development under 5,000 sqm gross floor area</td><td>Electrical capacity capable of supporting the provision of an appropriate moderate speed, efficient EV charging outlet to 20% of all staff car parking spaces (or a minimum of one space).
Appropriate EV infrastructure and cabling must be provided to ensure peak demand is managed, for example, distribution boards, power use metering systems, scalable load management systems, and cable trays or conduit installation.</td></tr><tr><td>Non-residential development over 5,000 sqm gross floor area</td><td>Installed EV charging infrastructure complete with chargers and signage to 5% of all car parking spaces.
Electrical capacity capable of supporting the provision of an appropriate moderate speed, efficient EV charging outlet to 20% of all staff car parking spaces (or a minimum of one space).
Appropriate EV infrastructure and cabling must be provided to ensure peak demand is managed for example, distribution use metering systems, scalable load management systems, and cable trays or conduit installation.</td></tr></table></td><td>SMPs will contain a section which includes details of EV provisions proposed on site. The template could be set up to allow easy assessment against the Standards. Location of relevant infrastructure should also be shown on relevant plans.</td><td>2, 3, 4, 5</td></tr>
</table>

Standards	Assessment process	Objectives
S16 All car parking facilities should be designed to support the charging of shared or visitor vehicles through: • The provision of a minimum of one EV enabled shared parking space if visitor or shared parking spaces are proposed. • Locating shared EV charging space(s) in highly visible, priority locations. • Providing clear signage indicating that EV charging is available at the shared space(s).	As with above this information could detailed in the EV section of the SMP through use of a template model, and through the inclusion of relevant spatial details on the plans.	2,3,4,5
S17 All car parking facilities should be designed to support the charging of motorcycle, moped, electric bicycle or scooters through: • Providing electrical capacity for appropriate charging outlets at the parking / storage area. • Providing a general power outlet for every six vehicle parking spaces to support charging.	As above.	2, 3, 4
S18 All development should be designed to support modal shift to more sustainable forms of transport through: • Locating low and zero emission vehicles in a prominent, accessible locations within parking facilities. • Designing car parking facilities to be adaptable to other uses. • Adopting flexibility in the allocation of car parking spaces to facilitate adaptable uses or transfer of ownership.	SMP template could provide a section where applicant can outline steps they have taken to support modal shift which may include measures beyond those identified in the Standard. Where items included in the Standard have not been pursued by the applicant the expectation would be the rationale for this is documented in the SMP also.	1, 2, 4 ,5

THEME: INTEGRATED WATER MANAGEMENT

Objectives

.1 To support development that minimises total operating potable water use.
.2 To support development that reduces the amount of stormwater runoff on site, and improves its quality of stormwater, and impacts for stormwater that leaves a development.
.3 To ensure development considers and addresses the impact of future climate conditions in the management of water resources.
.4 To encourage development that supports innovation in the use and reuse of water

Standards	Assessment process	Objectives
S19 All development should be designed to reduce potable water use on site by at least 30% in interior and irrigation uses, in comparison to an equivalent standard development, with use of roof harvested rainwater supply prioritised in the delivery of reductions.	SMP template would include an area where the water use of the 'equivalent standard development' would be recorded (in line with definition and Guideline content). The anticipated usage based on measures which would also be outlined could then be recorded, allowing an easy assessment of the reduction in use anticipated to be achieved by the development. A breakdown of where the reductions have been achieved could also be provided.	1, 4
S20 Design developments to use water resources efficiently through a range of measures, including; • Collection of rainwater from above ground catchments, and appropriate filtering for on-site use for toilet flushing as a minimum, and additional uses such as laundry, irrigation, wash down facilities, etc. • Capture of fire-test water for on-site reuse • Collection of stormwater for on-site reuse • Considering opportunities for onsite recycling of wastewater through the installation of approved greywater or blackwater systems • Reducing potable water use for irrigation by selection of drought tolerant landscaping, design for passive irrigation, and selection of efficient irrigation systems where needed • Connecting to a precinct scale Class A recycled water source if available and technically feasible (including a third pipe connection to all non-potable sources). • Providing water efficient fixtures, fittings and equipment.	Measures taken to achieve water efficiency will vary from site to site, but should be documented in the SMP. The SMP could include all measures identified in the Standard to ensure direct response to these key opportunities but would also allow for other measures to be identified.	1, 3, 4
S21 Reduce the volume and flow of stormwater discharging from the site by appropriate on-site detention and on-site retention strategies, consistent with catchment scale IWM objectives and targets.	This would be demonstrated through use of tools such as STORM / MUSIC as is currently the case. The results would be included in the SMP.	2
S22 Improve the quality of stormwater discharging from the site by meeting best practice urban stormwater standards.	This would be demonstrated through use of tools such as STORM / MUSIC as is currently the case. The results would be included in the SMP.	2

THEME: GREEN INFRASTRUCTURE

Objectives

.1 To deliver development that protects existing landscape values on and adjoining the development site, including canopy, vegetation, and habitat for biodiversity.
.2 To deliver development that increases vegetation, particularly indigenous and native vegetation, and enhances existing landscape values, connects biodiversity corridors and increases the resilience of ecosystems.
.3 To ensure landscaping proposed as part of development will be resilient to future climate conditions and supports integrated water management and energy efficiency outcomes.
.4 To support development that increases amenity, improves connections to surrounding natural landscapes and supports health and wellbeing.
.5 To encourage development that provides opportunities for on-site food production.

Standards	Assessment process	Objectives
S23 All new development should achieve a Green Factor score of 0.55 (0.25 for industrial and warehouse uses) OR A minimum of at least 40% of the total site coverage area (20% for Industrial or Warehouse) must comprise green cover (external landscaping) that delivers at least one of the following: • A minimum of 65% of the required green cover area 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 arrangement comprising native and / or indigenous species which provides habitat for native fauna. • Green cover which is located to provide maximum benefit in relation to the 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.	If using the Green Factor Tool (GFT), the final score report which is generated would be provided allowing the Standard to be easily assessed. If alternate measures are proposed to meet the Standard then this would be documented on the relevant plans, including planting schedules. Guidelines would be needed to provide additional detail as to the parameters of how the alternate pathway would be assessed (i.e. lower levels are up to three storeys etc).	1, 2, 3, 5

S24 Green infrastructure should: • Support the creation of complex and biodiverse habitat. • Provide a layered approach, incorporating both understory and canopy planting. • Provide either native, indigenous and/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. • Ensure species selection is appropriate to address expected future climate conditions.	As per some earlier standards, a 'checkbox' approach within the SMP template could provide an easy mechanism for assessment.	1, 2, 3, 5
S25 Siting of buildings should seek to retain existing mature canopy trees (excluding invasive species) or significant areas of other green cover which contribute to biodiversity corridors and habitat.	Existing trees would be shown on plans. Any removal of mature canopy trees would need to be justified as part of any application. Guidelines would make clear the parameters what appropriate responses may be in different circumstances. This could addresses approaches based on preferred densities, location of trees on lots etc. If trees are proposed for removal an arborists report would form part of application requirements.	1, 2, 3
S26 Development should ensure appropriate measures are integrated to support the establishment and ongoing maintenance of landscaping	Review of landscape plans and any associated material should detail proposed measures (noting crossover with IWM requirements).	5

THEME: CLIMATE RESILIENCE

Objectives

.1 To improve the resilience of the built environment to climate change related hazards and natural disasters.
.2 To deliver development that reduces the urban heat island effect.

Standards	Assessment process	Objectives
S27 New development should demonstrate that future climate impacts have been considered and addressed in any design response.	Applicants would be required to prepare a Sustainability Response Plan, similar to existing Design Response Plans, which identify the future climate impacts. Impacts would be as per State of the Climate reports. This plan would summarise impacts and then identify proposed responses which would be outlined in more detail in SMPs. Guidelines could provide further information of the impacts that would need to be considered and what potential responses could include.	1, 2

S28
Provide at least 75% of the development's total site area with a combination of the following elements to reduce the impact of the urban heat island effect:
• Green infrastructure.
• Roof and shading structures with cooling colours and finishes that have a solar reflectance index (SRI) of:
  • For roofing with less than 15 degree pitch, a SRI of at least 80.
  • For roofing with a pitch of greater than 15 degrees, a SRI of at least 40
• Water features or pools.
• Hardscaping materials with SRI of minimum 40.
	The total 75% area would be documented on the Sustainability Response Plan, allowing for easy assessment as per current documentation of permeability requirements under ResCode.	1,2

S29 Pedestrian pathways should be designed with thermal comfort in mind. This includes incorporating landscaping (tree canopy and other vegetation), shading and covered structures.	Plans would allow easy assessment of whether pedestrian paths incorporate responses to urban heat.	1,2

THEME: INDOOR ENVIRONMENTAL QUALITY

Objectives

.1 To support development that achieves safe and healthy indoor environments, specifically addressing:
- Thermal comfort
- Thermal safety
- Access to clean, fresh air
- Access to daylight and sunlight
- Harmful indoor air pollutants

.2 To deliver development that considers the impact of future climate conditions on indoor environment quality.

<table>
<tr><th>Standards</th><th>Assessment process</th><th>Objectives</th></tr>
<tr><td>S30
Buildings should be designed to be able to provide appropriate levels of thermal comfort without reliance on mechanical heating and cooling systems, as follows:
<table>
<tr><th>DEVELOPMENT</th><th>REQUIREMENT</th></tr>
<tr><td>Single dwellings
Two or more dwellings on a lot</td><td>All habitable rooms should be cross ventilated.</td></tr>
<tr><td>Apartment development
Residential Buildings</td><td>60% of all apartments should be effectively naturally ventilated, either via cross ventilation, single-sided ventilation or a combination
At least 40% of apartments on every floor to be cross ventilated</td></tr>
<tr><td>Non-Residential development</td><td>All regular use areas of non-residential spaces should be effectively naturally ventilated; or commensurate mechanical measures provided.</td></tr>
</table></td><td>Plans should document proposed flow paths allowing for assessment of ventilation. Guidelines should make definitions of cross and single side ventilation clear.</td><td>1</td></tr>
<tr><td>S31
Buildings should achieve a daylight level across the entirety of every habitable room of 100 lux and of 50 lux across the entirety of any other regularly occupied space.</td><td>Proposed lux levels should be documented in the SMP. For larger and more complex development, application requirements would include specialist reporting.</td><td>1</td></tr>
<tr><td>S32
Internal spaces in buildings should utilise natural light to minimise the use of artificial lighting during daylight hours, unless the proposed use of the room is contrary to the provision of glazing.</td><td>Standard application plans such as elevations would be used to assess this Standard.</td><td>1</td></tr>
</table>

S33 Primary living areas of at least 70% of all dwellings in a development should achieve direct sunlight for 2 hours on the 21st day of June to at least 1.5m deep into the room through glazing.	Extent of sunlight through glazing could be documented on plans. Guidelines could show how this should be demonstrated, and detail considerations in calculating solar access. For larger and more complex development, application requirements would include specialist reporting.	1
S34 Development should include openable external windows to circulation corridors and lift lobbies to facilitate natural ventilation for residential development below six storeys.	Plans notate openable windows.	1, 2
S35 Development should use materials which are low toxicity in manufacture and use, and that do not cause harm to people or ecosystems.	Guidelines would list materials to be avoided and cross references could occur with Materials and Finishes specification.	1

THEME: WASTE & RESOURCE RECOVERY		
Objectives		
.1 To facilitate development that supports functional waste recovery and management. .2 To enable the continuous improvement of sustainable waste management and resource recovery		
Standards	**Assessment process**	**Objectives**

S36
Development should include:
• Adequate waste and recycling infrastructure to manage the waste demand of the development in a sustainable manner and to support recycling, such as an appropriate number of bins, waste chutes, and cleaning facilities.
• Waste and recycling infrastructure and enclosures which are:
  • Adequately ventilated.
  • Integrated into the design of the development.
  • Located and designed for convenient access by occupants and made easily accessible to people with limited mobility
  • Signposted to support recycling and reuse.
• Adequate facilities or arrangements for bin washing.
	A Waste Management Plan would be required as part of application requirements for applications other than single dwellings, and a template will assist easy assessment against aspects of the Standards.	1

S37 Development should be designed to facilitate: • Collection, separation and storage, and where appropriate, opportunities for on-site management of food waste through composting or other waste recovery as appropriate. • Collection, storage, and reuse of garden waste, including opportunities for on-site treatment, where appropriate, or off-site removal for reprocessing. • Collection and storage of glass recycling • Collection and storage of containers under any Container Deposit Scheme as appropriate for the proposed use and scale. • The provision of adequate circulation space on site to allow waste and recycling collection vehicles to enter and leave the site without reversing. • Waste and recycling separation, storage and collection designed and managed in accordance with an approved Waste Management Plan, if required by the responsible authority. • For apartment development, the provision of space for communal storage of additional waste streams including E waste, hard waste and textiles.	A Waste Management Plan would be required as part of application requirements for applications other than single dwellings, and a template will assist easy assessment against aspects of the Standards.	1
S38 An application should demonstrate through the provision of a Construction / Demolition Waste Management Plan, if required by the Responsible Authority, that all practical and feasible practices and activities to minimise waste and increase resource recovery will be implemented.	The required CMP, and associated template would support assessment.	1

2.1.1 OTHER STANDARDS

It is noted that a number of other Standards were initially proposed as part of this amendment. Some of these initial Standards will inform updates to BESS (CASBE's sustainability rating tool) or relevant Guidelines, while others may form part of a future planning scheme amendment when further work has been undertaken.

The Standards which were not pursued at this point in time related to:

ENERGY

- Improvements on NCC for commercial energy efficiency.
- Glazing specifications.
- Airtightness requirements.
- Penetration points in insulation.
- Appliance and system efficiency requirements.
- Electric heat pump minimum standards.
- Illumination power density of internal lighting.
- Provision of electric cooktops.
- Basement car park ventilation.
- Installation and specification of HVAC systems.
- Specific controls for energy management.
- Preparation of an EV management plan.
- Discretionary fast charging points.
- Reduction in vehicle crossover lengths.
- Efficient fixtures, appliances and fittings.

INTEGRATED WATER MANAGEMENT

- Increased permeability requirement.
- Reduction in flood impact on site and in associated context.
- Modelling of flood impacts.
- Ensuring environmental safety and human health in reuse of water.

GREEN INFRASTRUCTURE

- Retention of soil profiles.
- Provision of composting and soil conditioning.
- Provision of uncontaminated top soil.
- Landscape measures compliance reporting.
- Shared urban ecology space (including food production) requirements.
- Water supply and taps to balconies.

CLIMATE RESILIENCE

- Strengthening local community resilience.
- Blackout refuge requirements.

INDOOR ENVIRONMENTAL QUALITY

- Internal room temperature minimum and maximums for habitable rooms.
- Workplace heating requirements.
- Provision of double glazing.
- Heating and cooling load densities of habitable rooms.
- Higher provision of daylight levels to specified proportion of habitable rooms.
- Winter sun access to primary private open space.
- Provision of layered views from habitable rooms.
- Distance between fixed points of occupation (i.e desks) and glazing.
- Pollutant emissions of engineered wood, carpet, paint and sealants and other materials.
- Olfactory comfort in non-residential development,
- Land use directives for development within proximity of main roads truck routes and diesel train corridors and other sources of pollution.
- Specific technical requirements for development within proximity of main roads truck routes and diesel train corridors.

WASTE & RESOURCE RECOVERY

- Onsite reuse of materials.
- Private waste contractor resource diversion.
- Onsite versus street collection of waste and street space allocation.
- Internal waste storage space (dwellings).
- Provision of charity donation bins.
- Waste capacity for peak demand times.
- Odour impacts of waste collection vehicles.

2.2 ASSOCIATED MATTERS

2.2.1 DEFINITIONS

While planning should always be drafted in plain English, in the case of ESD, this can often mean including reference to specific elements, for example "green infrastructure" or "Solar Reflectance Index (SRI)". It is important that there is a consistent understanding of these terms.

There are two options for including definitions. They could be included within the provision itself (which is standard practice) or they could be included in a Glossary which is an Incorporated Document within the schemes. If further consideration or legal advice suggests only a small number of terms would require statutory weight then the definitions could be included within the provision. If however, there are a large number of terms requiring definition with statutory weight, then the Incorporated Document is the preferred approach as it is considered that most of the terms are unlikely to require an 'explanation' for most users of the scheme. Specific definitions are relevant only when a Councils definition of them (for example) as included in the proposed Policy Document) is challenged in a legal setting. In that scenario, the statutory weight accorded to a definition included as an Incorporated Document becomes important. If agreed State definitions are introduced through Clause 73 then these definitions may not be required.

Terminology included within the proposed Standards which may benefit from definition include:

- Net zero carbon performance
- Operational energy use
- Residual carbon emissions
- Embodied carbon
- Green infrastructure
- Green cover
- Solar Reflectance Index (SRI)
- Net Leasable Area (NLA)
- Available unencumbered roof area
- Peak visitor capacity
- Regular occupants
- Total site area
- EV ready
- Mature canopy trees
- Regularly occupied spaces

2.2.2 INFORMATION REQUIREMENTS

The review also identified other considerations and associated requirements which may be needed to support planners, and other relevant officers or decision-makers, in assessing the various Standards.

Generally speaking, it is considered that the *content* required to undertake an assessment against these Standards is likely to be similar across all scale and types of development. What is likely to differ is the *scope and level of detail of information* provided under relevant themes.

New format Local Policy does not allow for the identification of application requirements. Consistent with the *Planning and Building Approvals Process Review* undertaken in 2019 by Better Regulation Victoria, application requirements should be identified by councils external to planning schemes.

While this approach is supported, it is also important to ensure that it is clear to applicants what information is required to allow decision-makers to assess their proposal against relevant Standards. This need is reflected in proposed changes to ResCode (*Improving the operation of ResCode*, 2021) which retains the Information Requirements against the various Standards contained within those Clauses. If such a model is adopted then relevant requirements should be integrated into the provision.

While relevant documents such as Sustainability Management Plans (SMPs) are sometimes provided only as Permit Conditions, it is considered that in delivering these Standards, councils will need additional information to be able to efficiently assess the Standards. Upfront provision of such documents also signals the importance of integrating their content with the overarching design of any development, rather than ESD measures being an 'add-on'.

There are significant opportunities to streamline the required information pertaining to other parts of the scheme (for instance Water Sensitive Urban Design / Integrated Water Management requirements) into a single document, reducing complexity and avoiding contradictions. Well-considered structuring of a shared templates for participating councils will also significantly improve consistency and transparency for applicants in required ESD information.

Developing templates will not only support council staff in ensuring that the 'right' information is provided upfront, reducing the need for Requests for Further Information, but will also assist applicants (particularly those who may not be frequent users of the planning system) in understanding what material needs to be provided and what council will be considering during any assessment phase.

Sustainability Management Plan

As noted earlier, this is a key document and should be seen as an 'automatic' requirement similar to the requirement for an Urban Context Report for apartment development. A refresh of these key documents as part of this process is suggested. This would allow the development of a consistent template, and also make clear the level of expectation in terms of content for differing scales of development. A Practice Note on the preparation of an SMP would also be of benefit.

Sustainability Response Plan

In addition to the more detailed SMP, it is suggested that all development should include within their set of plans a 'Sustainability Response Plan', modelled on the current Design Response required under ResCode - with a focus on responding to existing and future environmental conditions rather than neighbourhood character. This would not be a replacement for the more detailed SMP or the inclusion of relevant elements on other plans, but a way of bringing upfront acknowledgement of the climatic and other environmental conditions to which the design of any building should be responding to. It would provide a summary of key elements of the design response relevant to sustainability on a single plan.

In addition, a number of other reports are likely to be required to allow assessment. These are discussed briefly below:

- A **Waste Management Plan** (WMP) which deals with how operational waste will be managed on the site should be required for all development, other than single dwellings or two dwellings on a lot. As part of reducing complexity and ensuring the burden on applicants is not unreasonable, templates for smaller scale development should be considered to allow applicants to provide this information without the need to employ specialist waste experts. This 'template' could also be used to convey 'best practice' to applicants and educate them in effective ways of managing their waste. For larger scale developments more typical WMPs would still be required, with relevant updates and endorsement to follow as part of any issue of permit, as per current practice.
- In addition to operational waste, construction (and in relevant cases where a permit is triggered, demolition) waste is also a key source of landfill. While some targets proposed have sought specific landfill diversion targets etc, the diversity of areas covered by the councils affiliated with these Standards means a flexible approach is more appropriate. Permit Conditions now often require **Construction Management Plans** for larger scale development and similar application requirements are embedded in other parts of the scheme (i.e. requirement that the application describes how the site will be managed prior to and during construction periods at Clause 53.18) - such requirements could be integrated with this requirement, and this integration communicated through Application Requirement guidelines. Similar to the approach proposed to WMPs it is suggested that a template for the management of construction waste, including tips for best practice could also be adopted.
- Although again, increasingly standard practice, it will be important that a **Landscape Plan**, and associated maintenance plan for larger scale development is also submitted with any applications. See discussion on Guideline Material for more detail.

Finally, it should be made clear through any Application Requirement guidelines that all relevant ESD content should be shown spatially on plans where relevant to ensure they are carried through all stages of the construction process. As part of a 'support package' for implementation of any amendment, Application Requirement guidelines could be prepared which could be used by all councils who apply the seek to integrate the Elevated ESD Standards in their schemes.

2.2.3 PERMIT CONDITIONS

As outlined in Section 3.7 of this report, Permit Conditions will be critical in ensuring objectives for net zero operational energy. The proposed requirement for Sustainability Certificates at Construction and Operational stages would need to be included as Permit Conditions.

There are also a number of other matters which would need to be addressed as Permit Conditions to effectively implement the proposed Standards. While many of these are already applied by some councils, again, a consistent approach across all councils applying the Elevated ESD Standards would be highly beneficial.

Other matters to be addressed by Permit Conditions would include:

- Endorsement of the SMP (including EV management and also IWM) prior to construction commencing.
- Endorsement of the Construction / Demolition management plan (if required) prior to construction commencing.
- Endorsement of the WMP prior to construction commencing.
- Endorsement of Landscape Plan/s and associated Maintenance Plan (if required) prior to construction commencing.
- Endorsement of any Green Travel Plan, if relevant and not integrated into the SMP.

2.2.4 GUIDELINE MATERIAL

As noted in the Peer Review of the Standards, a number of the initial standards and some of the more 'technical' details are suggested for inclusion in a document which sits outside planning schemes.

A **Guidelines for Sustainable Building Design** document is recommended which could be used consistently by all councils who apply the Elevated ESD Standards, and could be included as a Background Document in relevant schemes. This could provide more explicit technical information, appropriate alternatives for responding to performance criteria, and real life case studies. Its inclusion as a Background Document may provide the flexibility for it to be included (similar to the Best Practice Environmental Management Guidelines) in a manner which allows it to be updated over time as technology changes (i.e "or as updated"), ensuring the technical recommendations are consistent with any contemporary best practice.

These Guidelines could provide not only clear direction as to options for delivering the Standards, but could also clearly articulate expectations at different scales of development. This confusion about expectations from different councils is a key issue for applicants, as a lack of understanding of what may be expected in the 'ESD' space can act as a significant barrier. Guidelines can assist with breaking down this barrier. Importantly, the Guidelines should be structured and drafted to directly relate to the content within the schemes which would be assessed through any approval process.

Areas relevant to the proposed Standards which could benefit from coverage in any guidelines include:

- SMP content, outlining expectations of a SMP and the level of detail required for different development. This could then link directly to different thematic headings where common issues, helpful tips and best practice case studies are documented.
- Landscape plans & maintenance plans, in particular requirements at different scales and references to other key resources (such as the City of Melbourne Green our City resources).
- Best practice case studies of construction waste management.
- Guidelines for designing for adaptation or 'design for disassembly' for different typologies.
- How to maximise available roof space for solar and options for managing competing space requirements.
- Expectations around EV infrastructure, including addressing tricky issues like how EV infrastructure might be integrated with car stackers.
- Guidelines for ventilation, across all typologies and tips for addressing common issues.

3.0 IMPLEMENTATION CONSIDERATIONS

This part of the report addresses a number of specific questions posed in the project brief. They include the following:

Advise on what proportion of technical information can be contained within the draft objectives and standards, and what proportion would be better located elsewhere..

Advise on how other external references such as incorporated documents, background documents and reference tools could be utilised to deliver the best format and structure.

Review proposed staged triggers for the planning scheme amendment. Consider the value of this as a tool for implementing the more ambitious and challenging aspects of the proposed objectives and standards.

Consider whether these staged triggers could be exhibited and published as part of one planning scheme amendment, rather than a series of amendments.

To assist the analysis, consider the proposed planning mechanisms in context of the eight development typologies included below to ensure an adequate cross section of development typologies across Victoria are represented to demonstrate net community benefit of sustainable resilient built environments.

Advise on suitable application documentation, such as Sustainability Management Plan (SMP) being suitable for initial development application and assessment.

Advise on suitable operational evidence and reporting options, by referring to previously completed legal advice from Maddocks and consider how best to administer new provisions notably the operational aspects of the zero-carbon performance standard including ongoing operational purchasing of renewable energy, by considering the following;

i. Use of SMP and planning permit conditions to set ESD performance standards, including new zero carbon standards.

ii. Use of s173 agreements, Owners' Corporation Rules, Tenancy agreements or other devices to require renewable energy purchasing for the life of the building.

iii. Use of Implementation Reports, similar to Operational Waste Management Plans,

iv. Other alternative reporting, submission or assessment mechanisms as necessary.

3.1 TECHNICAL INFORMATION WITHIN OBJECTIVES AND STANDARDS

A question posed in the brief was to:

Advise on what proportion of technical information can be contained within the draft objectives and standards, and what proportion would be better located elsewhere.

The initial draft of the elevated standards circulated with the brief contained considerable detailed technical information and reference to technical requirements and standards. Examples include:

- *Buildings must be designed, constructed and tested to achieve a maximum air permeability of 5 m3/hr.m2 when tested at 50 Pa.*
- *Electric heat pump hot water must have a COP of at least 3.0 at winter design conditions or within 85% of most efficient system available.*
- *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.*

It also included reference to some sustainability assessment tools such as the Green Factor Tool and NatHERS.

Planning is the first stage of the approvals process for the construction buildings. Initially the planning process dealt with basic issues concerning the use and the development of land (i.e. the construction of buildings and works). In relation to buildings, it focussed on the basics of siting, form and design, and the impacts of buildings on their surrounds.

The building system deals with more detailed technical information that sets minimum requirements for safety, health, amenity and energy efficiency in the design and construction of new buildings.

Over time, increasingly more detailed and technical information has been incorporated into planning schemes. This is largely because the building process focusses on minimum standards whereas the planning process provides the opportunity to implement higher than minimum standards. This is particularly relevant in relation to sustainability standards.

The outcome is that additional technical expertise and specialised tools are required to assess planning permit applications. Sustainability engineers and other more specialised areas of expertise, and documents that relate specifically to sustainability, such as Sustainable Design Assessments and Sustainability Management Plans, are now required as part of the planning permit application and assessment process.

The proposed elevated ESD Standards contain considerable additional technical information in relation to requirements to be met for sustainable buildings. In deciding on the type of technical information appropriate to include in planning policies and controls, the following principles should be applied:

- The information must assist in realising a planning objective.
- The information must assist in determining whether a development meets stated objectives or requirements contained in a planning control.
- The information must be from a verified and legitimate source that is recognised by the planning system.
- The information must be understood and be capable of being measured, applied and assessed by professionals that are commonly involved in assessing planning permit applications, both within local government and the development industry.
- Should not replicate standards included in other legislation.

It is considered appropriate for technical information that complies with the above principles to be included in objectives and standards in any provisions proposed to be included in planning schemes.

3.2 USE OF EXTERNAL AND OTHER DOCUMENTS

The project brief seeks advice on:

> *… how other external references such as incorporated documents, background documents and reference tools could be used to deliver the best format and structure.*

3.2.1 DOCUMENTS REFERRED TO IN THE VPPS

Planning Practice Note 13 Incorporated and Background Documents explains the role of external documents in planning schemes. Two options exist in relation to referencing external documents in schemes:

- Incorporated documents.
- Background documents.

Incorporated documents

Incorporated documents are documents that are essential to the function of planning schemes. Incorporated documents form part of planning schemes. They carry the same weight as other parts of the scheme. An incorporated document can only be changed by a planning scheme amendment. It can include planning controls and requirements and can trigger the need for a planning permit.

An incorporated document must be listed in Clause 72.04 of the VPPs, which provides a list of all documents that are incorporated into a scheme.

There is a strong preference as part of the planning reform process underway in Victoria, to simplify and streamline planning provisions. The aim is for all planning requirements to be included within planning schemes rather than in incorporated documents, wherever possible.

Principles for including technical details in the VPPs

- Must assist in realising a planning objective.
- Must assist in determining if a development meets stated objectives or requirements.
- Must be from a verified and legitimate source.
- Must be understood and be capable of being measured, applied and assessed by professionals involved in assessing planning permit applications.
- Should not replicate standards included in other legislation.

It is not considered necessary to include an incorporated document into the VPPs to implement the proposed Standards as part of this project. All relevant provisions related to elevated ESD Standards for sustainable buildings can be included in appropriate controls within the framework provided by the VPPs, such as particular provisions. See also discussion on Definitions (at Section 2.2.1) which identifies one potential use of an Incorporated document that may be considered.

Background documents

Background documents are documents that are referred to in planning schemes but which are not actually part of schemes.

They are documents that may provide useful background advice to applicants or that assist in understanding planning scheme requirements, why particular requirements are included in the planning scheme, substantiate issues or provide background to specific decision guidelines in local planning policies or schedules. The substantive planning elements of background documents are generally included within the planning scheme itself.

Background documents must be listed in Clause 72.08 of the VPPs. As set out in that clause a background document is one that may:

- Have informed the preparation of, or an amendment to, the planning scheme;
- Provide information to explain the context within which a provision has been framed; or
- Assist the understanding of the planning scheme.

The key documents and key tools that are referred to in any proposed planning provision included in the VPPs as part of this project, will need to be listed as background documents. An example of this might be the proposed *Guidelines for Sustainable Building Design*.

3.2.2 SUSTAINABILITY TOOLS

The proposed elevated ESD Standards include reference to external tools and other published standards such as:

- NatHERS – The National House Energy Rating Scheme, which measures the energy efficiency of dwellings.
- The Green Factor Tool, developed by the City of Melbourne (currently in a voluntary pilot phase) to deliver green infrastructure in line with international best practice.

It is commonplace for planning schemes to refer to external tools to be used in the assessment of planning permit applications. Tools that are presently commonly referred to in planning schemes include:

- NatHERS.
- Green Star.
- The Built Environment Sustainability Scorecard (BESS) tool.
- STORM and MUSIC – Calculators used to model stormwater treatments for small subdivisions (STORM) and more complex projects (MUSIC).

Application of external sustainability tools in planning schemes has been considered and supported by Planning Panels Victoria in a number of key panel hearings in relation to planning scheme amendments:

- Environmentally Efficient Design Local Policies, Planning Panels Victoria 2014
- Fishermans Bend Planning Review, Planning Panels Victoria, 2018

In both cases the committees / panels supported reference to various sustainability tools within planning policies in planning schemes. The amendments have since been approved.

Various approaches have been used to reference tools in existing planning schemes:

- Some tools are listed as reference documents (i.e. Melbourne Planning Scheme, Clause 22.19-7, Port Phillip Planning Scheme Clause 22.13-6, Manningham Planning Scheme, Clause 22.21-6).
- In some cases they are 'defined' in local policies (i.e Melbourne Clause 22.19.8).
- In others that are included as policy guidelines (i.e. Moreland).

None of the documents mentioned above are presently listed as background documents in Clause 74.08 of those planning schemes. This is probably because the schemes were amended prior to the VPPs being reformatted as a consequence of Amendment VC148.

It will be necessary to list any sustainability tool directly referred to in any proposed planning provisions within the actual provision and also in Clause 74.08 of the VPPs.

In the case of the Green Factor Tool, it is noted that current testing is underway to ensure it broader applicability beyond an inner city context. It will also be important to provide a level of transparency in the content of any tool referenced in the planning scheme. This may be addressed through a current review of governance arrangements, but alternatively the relevant Standard could include a 'date' thereby ensuring that any change to the tool from that identified time would require a planning scheme amendment to carry statutory weight. This would ensure relevant 'checks and balances' are in place.

Principles for including references to external tools in the VPPs

- It will be necessary to list any sustainability tools referred to in the planning provisions as a background document
- Any tool would need to be transparent in relation to the content against which any application would be assessed.

While considering the use of external tools it is pertinent to also note some further work which could be undertaken in this area. While current practice to refer to a variety of tools that can be used to support assessments has many benefits, there is the potential for a more streamlined approach to the use of external tools which would be beneficial.

Given the role that CASBE plays in leading both this amendment project and in the governance of the BESS tool, the benefits of more widespread use of that tool is noted. While this is happening to a degree naturally due to the ease of use and the alignment of the tools with requirements of existing Local ESD policies, it should be encouraged. If possible, further liaison should occur with the State government around issues of governance and responsibilities for maintenance. These discussions around governance of external tools will also likely be important in generating support at State level for tools such as the Green factor Tool.

There may also be benefit in some clearer articulation of the different tools currently referenced in planning schemes and their role through a Planning Practice Note. This could provide clarity for planners, many of whom may benefit from a greater understanding of, for example, what NatHERS does, as opposed to more holistic tools such as BESS or Green Star. Such a note may also allow for the identification of preferred tools, while leaving open the opportunity to utilise other tools where appropriate.

3.3 PLANNING PRACTICE NOTES

Planning Practice Notes give advice about how to prepare, apply and use planning provisions contained in planning schemes.

A wide range of planning practice notes that have been prepared by DELWP for a wide range of issues. They generally relate to statewide issues.

No planning practice note has been prepared to date that explains the sustainability initiatives that presently exist in planning schemes and how such matters are to be taken into account in the assessment of planning permit applications.

Benefit would exist in the Department preparing a planning practice note in relation to sustainable buildings. The practice note could:

- Explain the policy context and justification for sustainability requirements for buildings.
- Explain the relationship between the proposed statewide building sustainability requirements and the elevated sustainability standards proposed to be included in planning schemes as a consequence of this project.

3.4 SUSTAINABILITY GUIDELINES

The initial list of elevated ESD Standards generated by the client, upon which this project is based, was extensive. It included many initiatives that were not appropriate to be included in a planning provision as Objectives or Standards but which were good design ideas to improve the sustainability of buildings.

Merit exists preparing a separate detailed document called *Guidelines for Sustainable Building Design*. That document could be listed as a background document in the VPPs and / or referenced in the proposed particular provisions recommended to be included into the VPPs as part of this project.

The guidelines would provide additional sustainability advice and guidance beyond that contained in the particular provision itself. It could operate in a similar fashion to the *Urban Design Guidelines for Victoria* which were prepared by DELWP and which are a reference document in all planning schemes through the state.

3.5 PERMIT TRIGGERS

Generally the VPPs provide the opportunity to impose requirements on development that needs a planning permit. The VPPs do not generally provide the opportunity for standards to be imposed on development that does not require a planning permit. Exceptions to this do exist. It is not recommended that an exception be pursued for the purpose of implementing sustainable building standards. The preferred approach to apply sustainability standards to developments that do not require a planning permit would be:

- Via the National Construction Code.
- Via public education and a voluntary approach. The design guidelines referred to in the previous section could be made available to the general community, builders and designers.

Planning permits are required for most buildings and works undertaken in most zones. Noticeable exceptions include:

- Single dwellings on standard size lots (i.e. 300 to 500 sqm or more).
- Public buildings in public use zones such as universities, hospitals, local government building etc, on land that is zoned for public purposes.

3.5.1 ZONES AND OVERLAY TRIGGERS

The requirement for a planning permit for buildings and works arises from the VPPs provisions from either:

- Zone controls.
- Overlay controls.
- A particular provision.

In situations where a planning permit is not required for buildings and works by zone controls, an overlay may trigger the need for a permit. When an application under an overlay is being assessed, it is only assessed against the purpose for which the overlay has been introduced. For example:

- A single dwelling in a residential zone does not require a planning permit.
- However a planning permit is required because the land is covered by a heritage overlay.
- The only matters that can be taken into account in assessing the application, are heritage matters.
- The fact that a heritage overlay triggers the need for a planning permit, would not enable sustainability requirements contained in a particular provision to be imposed.

3.5.2 VICSMART

VicSmart is a fast track process for assessing planning permit applications that are triggered by other requirements of the VPPs – either zone or overlay requirements. VicSmart provisions do not trigger the need for planning permits in their own right.

One of the features of the VicSmart process is that the matters to be taken into account when assessing a planning permit application, are limited to only those specified for that type of application (i.e. decision guidelines). Sustainability requirements contained in a particular provision, could only be taken into consideration in assessing a VicSmart application, if they were specified as a VicSmart decision guideline for that class of application in the scheme (either as a standard requirement or as a local requirement).

Most development that has been identified for assessment via the VicSmart process, is smaller types of development or extensions. In most cases, it would not be necessary to specify that sustainability considerations need to be taken into account for VicSmart applications.

Under VicSmart a council officer cannot ask for more information than the planning scheme requires. A council can only consider a local planning policy where it is included in the decision guidelines for a VicSmart class of application and included in the planning scheme.

Under the VicSmart process there is an application requirement for buildings and works pathway for a written statement describing whether the proposed buildings and works meet *"Any development requirement specified in the zone or the schedule to the zone"*. There are requirements to meet certain clauses of ResCode but energy efficiency, for example, is not one of these.

A DDO would also trigger assessment under VicSmart (and therefore not allow for consideration of local policy) in any commercial zone or a Special Use, Comprehensive Development, Capital City, Docklands, Priority Development or Activity Centre Zone up to $500k or in an industrial zone up to $1million

For land in a Design and Development Overlay, a written description of the proposal including *"how the proposal responds to the design objectives specified in a schedule to the overlay"* and *"how the proposal meets the requirements specified in a schedule to the overlay"*.

There is no explicit reference under VicSmart requirements that reference the need to comply with any particular provisions.

3.6 BUILDING TYPOLOGIES

The brief sought advice in relation to the types and scale of development that might be used as a basis for staging:

> *To assist the analysis, please consider the proposed planning mechanisms in context of the eight development typologies included below to ensure an adequate cross section of development typologies across Victoria are represented to demonstrate net community benefit of sustainable resilient built environments.*

The suggested typologies and scales referenced in the brief included the following:

Typology
i. Large residential mixed use development > 50 apartments and small retail
ii. Large non-residential > 2000sqm GFA office development
iii. Large industrial > 2000sqm
iv. Small multi-dwelling residential < 3 dwellings
v. Small multi-dwelling residential > 5 dwellings but less than < 10 dwellings
vi. Small residential apartment building < 10 dwellings but > 20 dwellings
vii. Small non-residential office and retail > 2000sqm
viii. Single dwelling and/or residential extensions

Another suggestion was included as part of the documentation of initial draft Standards, also attached to the brief. These differed slightly and were as follows:

Typology
Residential: 100 or more dwellings Non-residential: > 5000sqm new floor space
Residential: 50 or more dwellings Non-residential: > 3000sqm new floor space
Residential: 20 or more dwellings Non-residential: > 2000sqm new floor space
Residential: 2 or more dwellings Non-residential: > 200sqm new floor space

Building typologies shown in the first table above, categorise buildings by three land use types:

- Residential
- Non-residential
- Industrial

For non-residential and industrial development only one category was suggested, for larger developments of more than 2,000 sqm. No category was suggested for smaller developments of less than 2,000 sqm. It is noted that existing local policies for sustainable buildings in planning schemes, commonly apply to non-residential buildings of less than 2,000 sqm, often down to 50 sqm in area (i.e. Moreland, Port Phillip etc.) Local policies in the Melbourne Planning Scheme relate to offices of all sizes, although lesser standards apply to smaller offices.

There is a need for a consistent approach to classifying building typologies. Typologies used for sustainability standards should closely align with land use definitions and building types used throughout the VPPs. The VPPs define land uses and group (or nest) similar uses together in nesting diagrams contained in Clause 73.43 of the VPPs. This grouping of land uses is an effective way to categorising different groups of land uses to which the elevated ESD Standards can be applied. The recommended approach is outlined in the following table. The table:

- Lists all of the land use 'nesting groups' identified in Clause 73.04 of the VPPs.
- Identifies those groups appropriate to be subject to sustainable building guidelines.
- Identifies categories of uses with each group, where appropriate. This only relates to residential development.
- Groups together 'nesting groups' that have similar built form characteristics.
- Lists the names of the building typologies recommended to be used for the purpose of this project.
- Identifies scales of development (i.e. small or large) for typologies where it is appropriate to do so.

A number of "nesting groups" are identified in the table as not needing sustainability standards. They are generally land uses that do not rely on buildings for the use of the land. Where some buildings are required in association with the use (i.e. an office, a restaurant, a workshop, storage building etc), Standards applicable to those particular activities should be applied to those buildings. The typologies to which the elevated ESD Standards applied is likely to require further refinement during any implementation phase, particularly considering non-metropolitan contexts.

Nesting groups	Are standards needed?	Categories within group	Similar groups	Recommended building typologies	Size classification (where relevant)	
					Small	Large
Accommodation	Yes	Single dwelling		**Single dwelling**		
		Multi-dwellings – other than apartments		**Multi-dwellings – other than apartments**	10 or less	More than 10
		Multi-dwellings - apartments		**Multi-dwellings – apartments**		
		Other accommodation i.e. corrective institution, residential aged care facility, residential building, residential village, retirement village		**Accommodation (other than dwellings)**		
Agriculture	No					
Education centre	Yes		Hospital	**Institutional** – includes education centre and hospitals	1,000 sqm or less	Greater than 1.000 sqm
Industry	Yes		Warehouse	**Industry and warehouse** – includes storage		
Leisure and recreation	Yes		Place of assembly Transport terminal			
Earth and energy resource industry	No					
Office	Yes		Shop			
Place of assembly	Yes		Leisure and recreation Transport Terminal	**Place of assembly and other gathering places** – includes Place of assembly, Leisure and recreation, Transport terminal	1,000 sqm or less	Greater than 1,000 sqm
Recreational and boat facility	No					

Nesting groups	Are standards needed?	Categories within group	Similar groups	Recommended building typologies	Size classification (where relevant)	
					Small	Large
Retail premises – other than shop	Yes		Retail premise - shop Office	**Retail premises and offices**	1,000 sqm or less	Greater than 1,000 sqm
Retail premises – shop	Yes		Retail premises – other than shop Office			
Transport terminal	Yes		Place of assembly Leisure and recreation			
Utility installation	No					
Warehouse	Yes		Industry			
Energy generation	No					

Table 1: Assessment of typologies

3.7 NET ZERO CARBON

A key objective of the elevated ESD Standards is to achieve net zero carbon emissions during the operational stage of buildings. If this is to be sought through the issue of the planning permit there are a number of important considerations. Any requirement of a planning permit condition / or a Sustainability Management Plan must be able to be monitored and enforced by council for it to have effect.

There are four stages of the development cycle: Design, Construction, Operation and Demolition. Planning generally deals with the first two stages – design and construction. It also deals with the third stage to a more limited degree. Permits can contain conditions that regulate the future use of the land such as hours of operation, patron numbers, compliance with EPA requirements etc.

The question is whether an objective for net zero operational carbon is appropriate or necessary to include in the elevated sustainability standards. Given this is a key objective and a strong case can be made for the built environment to deliver net zero buildings and for the role of the planning system in this, the critical question becomes, how can it be monitored and applied?

It is noted that planning regulation to ensure that new development does not contribute to increased carbon emissions is only one part of jigsaw in the current transition phase. However, planning controls are important in an efficient transition as it is well understood that embedding appropriate responses at a planning stage results in more considered and integrated responses.

One of the matters required to be taken into account by Ministerial Direction 11 – Strategic Assessment of Amendments, is the administrative burden an amendment will place on a responsible authority:

- To monitor compliance with a permit condition that required ongoing carbon emissions to be met during the operational life of a building would likely require either regular inspections from Council enforcement officers or a self-reporting mechanism like a certificate of compliance lodged by owners or tenants of the building.
- To be effective throughout the operational life of building, this would need to be done on an ongoing basis. While some typologies or developers may chose a pathway such as NABERS which includes monitoring of operational energy use, for most development, ongoing monitoring would place an unreasonable administrative burden on Councils.

It is therefore considered that the need for one certificate of compliance upon occupation of a building (i.e. within 12 months), would be sufficient to demonstrate that the requirements of a permit condition had been complied with, at least in the short term. Such a requirement is less likely to impose an unreasonable administrative burden on a Council. The process for issue of this operational certificate may also be able to be undertaken by a consolidated resource (i.e through funding of a compliance program via CASBE).

In addition, given the complexity and the varying interpretations of associated terms, statutory definition of net zero operational emissions must be included in any amendment. Any other relevant terms such as green power or offsets should also be included.

Any process for documenting and demonstrating compliance should be documented in the proposed Guidelines so this is clear to applicants. This should include the various 'options' that would be considered acceptable in demonstrating to Council the achievement of relevant standards (such as through external tools such as NABERS or GreenStar).

For applicants the process could look as follows:

1. Document proposed approach to delivery of zero carbon in the SMP, including anticipated energy efficiency, proposed onsite energy generation and proposed approach to delivery of green power (e.g. through a power purchase agreement, Section 173, GreenStar certification or other).
2. Permit conditions would be applied and updated SMP endorsed as part of the planning permit process.
3. If applicable, S173 applied (CASBE should consider development of a 'standard' S173 for consistent application) if this option is used.
4. At construction completion, an *'ESD compliance certificate: construction'* would be issued. This certificate could be issued either by Council or by a consolidated resource funded through CASBE for those councils without sufficient internal resources. Where relevant external certification could be used. This would confirm that all the proposed steps to deliver net zero outlined in the SMP had been delivered. A standard assessment template / process should be developed by CASBE.

5. At a certain timeframe post occupancy a second certificate *'ESD compliance certificate: occupation'* would be issued. This should only occur one time, nominally 1 year post occupation. This certificate would focus on ensuring that required operational aspects of the SMP has been delivered, including relevant greenpower or purchase arrangements.

This last step has been subject to further legal advice as to how any operational compliance would operate in respect the strata titled or multi-tenancy development, where the operational components of energy use may fall outside the control of any landowner to whom the planning permit would apply. The legality of the proposed approach and applicable responsibilities has been confirmed through this advice.

Given net zero can be achieved through the purchase of GreenPower etc, without major changes to building fabric, there remains avenues to achieve compliance with the net zero objective even in a post-construction phase. Consideration should be given to the wording of permit conditions to ensure that councils can seek alternative approaches to the delivery of net zero objectives if constructed development precludes any approach which formed part of original planning approvals.

The process for assessing and issuing 'compliance' certificates should be documented to ensure this occurs in a consistent manner across all councils. This could be modelled on, or build on, the Residential Energy Efficiency Scorecard program to ensure compatibility with other programs and with NatHERS. Any process must be designed in a manner which integrates with existing processes to avoid creating additional burdens. As noted, where compliance monitoring is required at construction and operational stages, consideration should be given to whether this can be absorbed within existing regulatory processes of participating councils or through RBS processes or if a more effective approach may be through shared central or regional resources to undertake this work. It is recommended that a monitoring and review system be implemented so that common issues and levels of compliance can be tracked and processes improved or adjusted if needed.

3.8 IMPLEMENTATION INTO PLANNING SCHEMES

A question in the brief was to:

Provide advice on the best format and location for the zero carbon and elevated sustainability outcomes in the Victorian planning scheme.

Initial policy work has indicated that a preferred location would be for a new local schedule for a new Victorian Particular Provision (VPP), from the ESD Roadmap or other (e.g. Existing or new Particular Provision addressing ESD objectives). This relies on an appropriate VPP being in place. This also assumes that any State drafted VPP changes will be of a lower standard to what is drafted as part of this project. Review and assess this position and consider whether there is another suitable place in the planning scheme that may have higher value. See DEWLP discussion paper for detail on ESD Roadmap.

Before the new VPPs are finalised, the draft planning scheme amendment is currently formatted as a Design and Development Overlay for entire municipalities. Analyse whether this is viable over all zones and land uses across the range of local government areas contained within the participating councils.

The Advisory Committee that considered the amendments exhibited by Councils in 2014, considered options as to how the provisions should be implemented. It considered the following five options:

- Incorporated document.
- Local planning policy framework.
- Amended existing particular provisions – i.e. Clause 55, 56, 58 etc.
- A new particular provision.
- Design and Development Overlays.

The committee noted that each option had advantages and disadvantages, and may to appropriate in different circumstances. However, it did not form an opinion on the most appropriate option, as the amendments before it proposed local policies.

The Table 2 on the following pages includes an updated review of options to include elevated ESD Standards into the VPPs.

A new particular provision in Clause 53 of the VPPs is considered the most appropriate way to introduce elevated ESD Standards for buildings into the VPPs. A new particular provision is considered a superior option to a DDO.

A new particular provision would work in the following way:

- It would be a freestanding Clause that would include all operational provisions required to implement the elevated ESD Standards in the one clause in the VPPs.
- This Clause would appear in planning schemes in Victoria, where a council had adopted the Clause for its municipality.
- The provision would include a list of municipalities to which the provision applies.
- Those municipalities that choose to adopt the Standards would amend their planning schemes to add the name of their municipality to the list.
- Any local policies regarding sustainable buildings already contained in municipal planning schemes would need to be reviewed and potentially deleted as part of the amendment, to avoid duplation and inconsistencies between existing policies and the new particular provision.
- If the state government introduced a separate statewide policy for sustainable buildings at a later date, both provisions could apply in a municipality. If a contradiction existed between two controls the accepted practice is that the more stringent control applies.
- There would be no need to amend other clauses that may apply to existing uses (such as Clause 55, Clause 56, Clause 58 etc).

A new particular provision in the VPPs is the most appropriate way in which to introduce elevated standards for sustainable buildings

Location in the VPPs	Comments
Local Planning Policy	Similar to the way existing sustainability requirements are implemented into many municipal schemes. A policy has less statutory weight than a requirement that is contained within a planning control, such as a DDO or a particular provision. A policy cannot be applied as a mandatory requirement or include mandatory standards. Conflicting policies need to be balanced in regard to net community benefit and sustainability. This may lead to policies for sustainable buildings being given lesser weight than other policies in some circumstances. An aim of this project is to move beyond the current policy approach and to give greater statutory weight to elevated sustainability requirements. Application requirements, definitions and decision guidelines cannot be included in Local Policy the new PPF format
Design and Development Overlay	A municipal wide DDO would be a mechanism that could be used to introduce elevated sustainability standards into planning schemes. DDOs can introduce planning permit triggers for buildings and works into a planning scheme that may not presently require a permit under other provisions of a planning scheme. Both discretionary and mandatory requirements can be included in a DDO. A municipal wide DDO could be crafted to relate to all land uses within a municipality, or to different uses in different parts of a municipality. The opportunity would exist to apply different DDOs to different zones or localities within a municipality, if there was a benefit in doing so i.e. Central City Zone, industrial zones, residential zones etc. The structure and set sections of a DDO schedule are not ideal and do not provide enough flexibility to achieve what is intended from the elevated targets (i.e. bicycle parking rates could not be included). DDOs are generally designed to apply to specific locations within a municipality and are not the preferred tool for a requirement that applies across a whole municipality.
Particular Provision	A particular provision would be an appropriate mechanism by which to introduce elevated sustainability standards into planning schemes. Generally, particular provisions are statewide provisions. They usually apply to a particular issue or to a particular type of use or development across the state, often regardless of the zoning of the land. Other than in a few situations where schedules exist, there is no opportunity for a local council / or groups of local Council's to introduce a new particular provision into the VPPs. However, with the consent of DELWP, it would be possible to introduce elevated ESD as a new particular provision into Clause 53 of the VPPs (i.e. General Requirements and Performance Standards). This would involve preparing a particular provision that contained a clause that stated which municipality the provision applied to. As additional municipalities adopt the elevated sustainability standards, a simple amendment would be made to the VPPs to add the name of those municipalities to the list of municipalities to which the provision applies. Greater flexibility exists in the structure of a particular provision than a schedule to a DDO, as the contents and structure of schedules to DDOs are set out in a Ministerial Direction regarding the Form and Content of Planning Schemes. This is not the case in relation to particular provisions. This approach could be presented to DELWP as a provision that will apply across the state, but only in those municipalities that choose to adopt the provision, technically meeting the test of being a statewide provision. Some flexibility could be included in the scheme for municipal variations and for staged implementation with municipalities, by the inclusion of a schedule to the provision if deemed necessary.

Location in the VPPs	Comments
All standards in the one place in the planning scheme or spread throughout the scheme.	Preferably, elevated sustainability standards should be embedded into relevant existing provisions contained in the VPPs for particular uses or issues in a fully integrated way (i.e. Clause 52.34 Bicycle Facilities; Clause 53.18 Stormwater in Urban Areas; Clause 55 Multi dwellings; Clause 58 Apartments etc). This would remove the potential for duplication and contradictory standards between different clauses of the planning scheme and would be a better overall approach. This approach would only be possible where standard statewide provisions are introduced into the VPPs that apply to all municipalities from the outset. Such an amendment could include a thorough review other aspects of the VPPs that also relate to sustainability, and make consequent changes to those clauses to achieve a fully integrated outcome. This approach would not be practicable where elevated sustainability standards are being introduced at the municipal level, as proposed by this project. It would not be practical to amend other statewide provisions of the planning scheme (i.e. Clause 55 and 58) to include sustainability standards that only applied in specified municipalities. The most practical approach to include elevated standards for specified municipalities, is for all standards to be included in the one place in the VPPs, either a single particular provision (preferable) or alternatively a schedule to a DDO. This may result in some duplication and conflict between provisions that already exist in other clauses of planning schemes. However, such an outcome is justified in the short to medium term, until elevated standards eventually become statewide standards and any duplication is removed. This approach has been supported by Planning Panels Victoria in relation to Amendment C278 to the Melbourne Planning Scheme. That amendment introduced new mandatory overshadowing controls for parks throughout the municipality. Those controls contradicted numerous other specific overshadowing controls contained in numerous other schedules to DDOs throughout Melbourne. Where two contradictory controls exist, the planning principle is that the most stringent control applies.
Special Control Overlay	Inconsistent with the stated purpose of the overlay.
Incorporated document	Technically, elevated sustainability standards could be presented in a single document that sits outside the planning scheme but which is incorporated into the planning scheme by a planning scheme amendment. An incorporated document is read as if it is part of the planning scheme and it can include planning permit triggers and both discretionary and mandatory requirements. There is a strong preference within DELWP for planning provisions to be included in the VPPs, rather than to be included in separate free standing document, wherever possible.

Table 2: Potential implementation options

3.9 ALIGNMENT WITH STATE GOVERNMENT'S APPROACH TO SUSTAINABILITY STANDARDS

It is understood that the state government is preparing statewide standards for sustainable buildings that are likely to be included as a particular provision in the VPPs. These provisions are likely to be based on lesser targets and a lesser number of matters than the elevated targets advanced as part of this project.

This does not present an impediment to the introduction of elevated standards that can be applied in those municipalities that choose to adopt them in their planning schemes.

As far back as 2007, when one of the first reports was prepared that investigated the role of sustainability requirements for buildings in planning schemes in Victoria, it was noted that there is a valid role for local government to encourage and to trial best practice sustainability standards in municipal planning schemes. The observation was made that municipal planning schemes provide a legitimate vehicle to implement new best practice requirements, ahead of the introduction of more widespread statewide planning requirements, or ultimately requirements that might eventually be included in the National Construction Code.

Figure 1: Interaction between standards in the planning and buildings systems in Victoria

Elevated municipal targets would work in conjunction with proposed state government targets as follows:

- The elevated targets would only apply in those municipalities listed in the particular provision.
- Upon the introduction of statewide provisions by the state government, those provisions would apply in those municipalities that had chosen to adopt the elevated standards.
- In municipalities in which both sets of provisions apply, the established planning principle is that the most stringent control prevails.
- In municipalities in which only the statewide provisions applies, those provision would apply with no reference to the elevated standards.
- Over time as the elevated standards become more widely applied in more municipalities, the ambition would be that the state government would adopt the elevated standards as statewide provisions.
- In the longer term, the opportunity may exist for all or many of the standards to be adopted as requirements of the National Construction Code. This would remove the burden of requiring and assessing compliance with the standards as part of the planning process.

The advisory committee that considered a number of amendments exhibited by Council's in 2013 to concurrently implement local planning policies sustainable buildings into planning schemes, discussed the appropriateness of including local provisions for sustainable buildings in schemes, as distinct from statewide provisions. The committee supported the approach, commenting as follows:

- A statewide approach would be the most effective way to implement sustainability outcomes into planning schemes.
- In the absence of a statewide approach it is appropriate for Councils to develop local policies for sustainable buildings.
- It would be a concern if Councils adopted different approaches between municipalities.
- Until statewide policies are prepared, it is appropriate for municipalities to include a local policy in their planning schemes.
- Even if a statewide policy is introduced, local policies may still be appropriate where municipalities seek to raise the bar either in specific locations, or where the community has higher sustainability expectations.

- There would be merit in including a sunset clause in any local policies introduced. That would enable the review of the policies in light of any statewide approach introduced. If the policies duplicated the statewide approach it would be appropriate for the local policies to be deleted. However, if the local policies went further than the statewide approach, the policies could be refined to delete areas of duplication and retain those elements that are higher than the state wide provisions.

The above comments clearly envisage a role of local sustainability standards that are higher than statewide targets. Whilst the comments were made in relation to local policies into schemes, it is considered they are also relevant to standards in planning controls, rather than policy.

3.9.2 WHERE MIGHT DUPLICATION OCCUR?

While the previous section of the report discusses the broad parameters of alignment with State level ESD standards, it is noted that as part of the second stage of the delivery of the ESD Roadmap (now scheduled for mid 2022) also identifies areas where specific Standards are being developed. The development of specific State level ESD standards means it will be important to assess any duplication or key differences to properly integrate the two processes.

Areas where specific State level standards are proposed include the following. The table includes relevant cross-references to proposed 'local' Standards:

ESD Roadmap areas of interest	Standard
Residential:	
Improved guidance on passive design including building and subdivision orientation	**S3**
Support for generation and deployment of renewable and distributed energy systems	**S1, S6, S7**
Updated development standards to minimise overshadowing	**S6**
Clearer guidance on assessing 'unreasonable' overshadowing of rooftop solar panels	**N/A**
Investigate measures to support 'solar ready' building design to support future installation of rooftop solar systems	**S7**
Enhance planning system guidance to support implementation of the 2018 stormwater reforms	**S20, S21, S22, S23**
Review measures to support water efficiency/ use of alternative water sources	**S20, S21**
Update of standards for apartments and developments of two or more dwellings on lot to include key elements from Sustainability Victoria's Better Practice Guide for Waste Management and Recycling in Multi-unit Developments	**S37, S38**
Encourage assessment of opportunities for subdivision infrastructure to facilitate small scale recycling and resource recovery technologies (e.g. reverse vending machines)	**N/A**
Investigate design measures to support new multi-unit developments being EV ready	**S17**
Review bicycle space allocation requirements and end of trip facility standards of clause 52.34	**S14**
Consideration of development interaction with strategic cycling corridors	**N/A**
Review planning policy, tools and guidance to support sustainable and active transport outcomes for land use development	**S13, S14, S15, S16**
Suite of planning measures to support retaining and increasing urban tree cover as further developed through the forthcoming planning response to cooling and greening	**S24, S25, S26**
Guidance and new planning standards to reduce urban heat exposure (in addition to tree canopy cover), including cool paving and surfaces, shade devices and water sensitive urban design	**S29**

Extend apartment noise design standards to other residential developments and other noise sensitive land uses	**Local Standard not pursued**
Implement siting and design standards to reduce impacts of air and noise pollution from transport corridors on building occupants	**Local Standard not pursued**
Commercial & Industrial	
Support for generation and deployment of renewable and distributed energy systems	**S1, S6, S7**
Enhance planning system guidance to support implementation of the 2018 stormwater reforms (e.g. advice on treatment options to meet planning standards)	**Guide only**
Review how to support VicSmart processes to improve assessment of stormwater management	**N/A**
Adopt minimum requirements to support effective management, separation and storage of waste and recycling	**S37, S38**
Encourage assessment of opportunities for subdivision infrastructure to facilitate small scale recycling and resource recovery technologies (e.g. bio-digestion unit in commercial precinct)	**N/A**
Investigate design measures to support new developments being EV ready	**S13, S17, S18, S19**
Investigate measures to support new industrial developments being designed to be EV ready, where appropriate	**S17**
Suite of planning measures to support retaining and increasing urban tree cover as further developed through the forthcoming planning response to cooling and greening*	**S24, S25, S26**
Consideration of measures to support urban biodiversity	**S24, S25, S26**
Guidance and new planning standards to reduce urban heat exposure (in addition to tree canopy cover), including cool paving and surfaces, shade devices and water sensitive urban design ^	**S29**
Implement noise and air pollution siting and design standards for sensitive land uses	**Local Standard not pursued**

Table 3: Alignment with ESD Roadmap

3.9.3 OTHER REFORM CONSIDERATIONS

In addition to any alignment of Standard with comparable Standard, in light of ongoing programs of planning reform (see https://reform.planning.vic.gov.au/) it is important to also acknowledge any potential influences on recommendations which may arise.

In particular the following is noted:

- The introduction and potential expansion of the VicSmart program, which includes specification of application requirements, what can be assessed by any decision-maker and a shorter timeframe for assessment. See Section 3.5.2 for more in depth discussion of VicSmart implications
- Introduction of other streamlined planning pathways for particular types of development (such as State Significant projects etc which include similar restrictions on matters which inform any assessment of permits. In some cases this may include the turning off of other VPPs.
- Introduction of new decision-makers for some precincts or areas, meaning in some cases, local government may not be the decision-maker for applications.
- Reforms to ResCode provisions to align with future digitalisation of the system and introduction of new code assessment pathways. As part of the implementation of SMART planning objectives around digitisation, there is clear intention to deliver increased clarity to the planning system to allow some aspects to be easily assessed as part of a 'code' that increases clarity for applicants that if they commit to certain performance measures they can have greater confidence in the approval process and reduction in assessment timeframes can be achieved.

3.10 STAGING IMPLEMENTATION

The project brief seeks advice on the following matters:

Review proposed staged triggers for the planning scheme amendment. Consider the value of this as a tool for implementing the more ambitious and challenging aspects of these proposed objectives and standards.

Consider whether staged triggers could be exhibited and published as part of one planning scheme amendment, rather than a series of amendments.

To assist the analysis, consider the proposed planning mechanisms in context of the eight development typologies included below to ensure an adequate cross section of development typologies across Victoria are represented to demonstrate net community benefit of sustainable resilient built environments.

3.10.1 A STAGED APPROACH

A staged approach to the implementation of elevated ESD Standards may be easier to gain approval from the State government, as it provides the ability to progressively introduce new standards into planning schemes over time.

However, it is recommended that the full suite of proposed elevated ESD Standards should be presented to the State Government. The package should be seen as an indication of the preferred level of building sustainability standards sought to be included in planning schemes and any changes to the proposed suite of Standards should be tested through a transparent and independent Panel process. It should be presented as the benchmark to be pursued by local government preferably also by state government. This process would also ensure the development industry and the community are aware of local government ambitions for sustainable buildings in Victoria.

If the package of standards is to be introduced in stages, the aim should be to pare back the full suite of Standards, in a number of progressive steps, with each step based on minimising the disbenefits to the community of retreating from the full suite of Standards.

Options for staging the introduction of sustainability provisions

Immediate implementation of the full package of elevated ESD Standards is the preferred approach. The need to progress to a zero net carbon built environment is urgent. After a decade of debate, a staged implementation plan would result in further greenhouse gas emissions from the built environment and more buildings which may require expensive retrofitting. The elevated ESD Standards proposed are an important component in slowing climate change, which has been highlighted by the UN as critically important in the next eight years.

While the following are not considered to apply, it should be acknowledged that there is a potential rationale that may suggest a staged approach to implementation including matters such as:

- Potential political impacts of concerns from the community and the development industry about perceived additional costs and regulations, particularly around housing affordability.
- The need to give to the development industry 'time' to adapt to new requirements.
- If the complexity of assessing the benefits of some Standards makes the justification for more ambitious requirements less clear.
- To enable the time to build up resources and implement capacity building to support implementation of the Standards through assessment of planning permit applications.

However, in relation to 'staging, it must be acknowledged that the proposal to introduce elevated ESD Standards as a particular provision into the planning scheme will be a form of staged implementation in itself:

- A number of municipalities already have policies for sustainable buildings in their planning schemes. This project is advancing those existing policies, giving them greater statutory weight by making them planning requirements rather than just planning policy, and by including elevated targets and a wider range of considerations.
- The new particular provision would only apply to those municipalities that amend their planning schemes to apply the particular provision. This would result in a gradual increase (i.e. a staged implementation) in the number of municipalities that apply the provisions over time.

It is considered that the need to allow for time for adaptation is of less relevance than if an entirely new suite of controls was proposed.

If the Standards were not implemented as a single package as recommended, the following alternative approaches exist to staging the implementation of provisions:

- A transition period.
- A two tiered system.
- By theme.
- By location.
- By building use / size of development.

Transition period

This option would involve:

- The particular provision being included in the VPPs in its entirety.
- The provision being worded to the effect that "This provision will not come into effect until 1 year (or an alternative time to be determined) after the approval date. Until that time a responsible authority and planning permit applicant may agree to apply the requirements of this provision in part or in full."
- During the 'transition period' councils could seek to implement the provisions with the 'co-operation' of planning permit applicants.

This approach would lend itself to introducing the full package of requirements into the planning scheme at the outset. This would enable the development industry and community to become aware of the elevated ESD Standards and adapt to them prior to them becoming mandatory controls.

Two tier system

This option would involve wording the particular provisions to set out two different levels of standards. For example:

- Standard requirements – Standards that are based on lesser targets or a lesser number of items than included in the full package.
- Preferred requirements - The full list of elevated ESD Standards ultimately sought to be applied by the proposed particular provision.

The particular provision would be worded to say that the 'standard requirements' apply for a specified period i.e. one year. After that period the 'preferred requirements' would apply and the standard requirements would become redundant. The provision could be worded so that the transition period applies from the 'approval date' at which each municipality amends its planning scheme to make the provisions apply to that municipality.

The consultant team has not identified which standards fall within each category. This would need to be further considered and determined by the project working group.

By theme

The proposed standards are framed around the following themes:

- Operational Energy
- Embodied Carbon
- Sustainable Transport
- Integrated water management
- Green Infrastructure
- Climate resilience
- Indoor environmental quality
- Waste and resource recovery

Implementation could be staged by theme. Those themes that are considered more critical to the issue of climate change, more consistent with existing state planning policies and those that have a higher level of strategic justification could be implemented first. Requirements in relation to other themes could be implemented over time, as State government policies evolve to provide a higher level of strategic justification for the inclusion of additional requirements into planning schemes.

Themes or standards for which there is presently insufficient supporting information to enable standards to be prepared and assessed, should be deferred from inclusion in the amendment until those matters are rectified.

By location

This option involves staging the implementation of the particular provisions for different regions within the state. Logical regions include:

- Metropolitan Melbourne.
- Municipalities comprising Victoria's main regional centres i.e. Greater Geelong, Greater Ballarat, Greater Bendigo and Latrobe City.
- The 'rest of the state'.

The particular provision could be worded so it initially only applies to municipalities within specified parts of the state i.e. metropolitan Melbourne and the municipalities of Greater Geelong, Greater Ballarat, Greater Bendigo, Latrobe Valley and Greater Shepparton. Municipalities within those parts of the state would still need to decide to amend their individual planning schemes before the provisions would apply.

Application of the elevated ESD Standards to metropolitan Melbourne and major regional cities would maximise the community benefit of the amendment, as those locations accommodate the vast majority of the state's population and the majority of new building development.

By building use and scale

The existing approach to sustainable building policies contained in a number of planning schemes, commonly applies to different land uses (i.e. residential or non-residential) and has different requirements and assessment pathways for buildings of different scales (i.e. number of dwellings or floor area).

The elevated provisions recommended as part of this project have been specifically designed to be applicable to all urban land uses and to developments of all sizes. Accordingly, there is no technical need for implementation of the provisions to be staged based on the use of the building or the scale of the development.

In linking staged implementation to different type of buildings, the aim should be to ensure that Stage 1 applies to those building types that are most commonly constructed throughout Victoria.

It can be assumed that the value of building approvals for different types of buildings, equates to the floor area of buildings constructed, which equates to the sustainability benefits that would accrue by applying sustainability standards to those types of buildings. The following table (Table 4) summarises the value of building approvals in Victoria as at March 2020. That date has been used to avoid the impacts of Covid on the building industry. It shows the total value of construction works by building use. The building typologies that experienced the greatest value of approvals in the calendar year up to March 2020 were, in order of priority:

- Domestic (single dwellings - by far the highest value)
- Commercial
- Public buildings
- Retail
- Residential (apartments and other)
- Industrial

If a staged approach based on building typologies was to proceed, maximum sustainability benefits would be realised by applying the elevated ESD Standards based on the priorities listed above. Given that detached dwellings (i.e. domestic) do not generally require a planning permit, the greatest benefits would be achieved by a staged approach that commenced with commercial buildings (i.e. offices) and public buildings. However, at a municipal level the proportion of investment in different types of buildings varies considerably, depending on whether municipalities contain large activity centres or industrial precincts. For this reason, the first stage of sustainability standards should also be applied to residential developments (other than single dwellings).

FINANCIAL YEAR TO DATE

Period	Current Financial Year		Previous Financial Year		Analysis	
	July 2019 to March 2020		July 2018 to March 2019		% Changes	
Building Use	**No. of Permits**	**CoW $M**	**No. of Permits**	**CoW $M**	**No. of Permits**	**CoW $M**
Domestic	63,848	17,900.65	68,486	18,449.07	(6.77%)	(2.97%)
Residential	582	1,134.83	580	1,224.53	0.34%	(7.33%)
Commercial	5,007	4,686.67	5,466	4,607.79	(8.40%)	1.71%
Retail	3,170	1,476.41	3,322	1,610.62	(4.58%)	(8.33%)
Industrial	1,030	822.76	961	612.59	7.18%	34.31%
Hospital/Healthcare	344	404.51	410	663.58	(16.10%)	(39.04%)
Public Buildings	2,975	2,613.29	3,116	2,369.91	(4.53%)	10.27%
Total	**76,956**	**29,039.11**	**82,341**	**29,538.09**	**(6.54%)**	**(1.69%)**

Table 4: Summary of number and value of building approvals by building use as at March 2020, Victorian Building Authority

Note: CoW stand for 'cost of works'

3.11 CAN STAGED TRIGGERS BE PART OF ONE AMENDMENT

The brief sought advice on whether the staged triggers could be exhibited and published as part of one planning scheme amendment, rather than a series of amendments.

Maddocks Lawyers addressed this issue in its advice which the consultant team has reviewed. Maddocks did not see any impediment to introducing staged permit triggers into planning schemes by way of different commencement dates for different types (and scales) of development.

3.12 RECOMMENDED APPROACH TO STAGING

The level of detail DELWP is likely to allow in any amendment will likely be a political decision. It is likely to be based on the Department's opinion about the degree that municipal sustainability standards can vary from proposed State standards, if at all. As a consequence it is not possible to recommend a definitive approach to staging at this time. However, it is recommended the following approach should be followed to resolving this issue:

- **Pursue the full suite of standards in their entirety as a starting point.** This is because there is an imperative to improve the sustainability of buildings to the highest degree possible, as soon as possible. The initial draft amendment should express the preferred optimal outcome. This will establish a starting position as the basis for discussion with the Department. It will also provide an end point to aim for, if the full suite of provisions are included in any initial amendment supported by the Department.
- **Staging of the standards should only be considered if the Department will not accept the full suite of standards.** The approach to staging that results, will depend on the variables that the department if prepared to accept.
- **Minimising the sustainability disbenefits to the community** of a staged withdrawal from the full suite of standards, should be the key guiding principle in any discussions with the Department about staging. The starting point should be the full suite of standards. Any withdrawal from that starting point, should be based on adjusting those variables that have the least impact on net sustainability outcomes, until a position of agreement is reached with the department.

It is recommended that the discussion process with the department proceeds on the following basis:

- Priority 1 – **Implement the full suite of standards** (i.e. the preferred requirements) to all building types and make the particular provision available for all municipalities across the state to adopt.
- Priority 2 – Implement the preferred standards but **vary the municipalities** that can adopt the particular provision, based on the following order of priority:
  - Municipalities in metropolitan Melbourne.
  - Municipalities containing larger regional cities: Greater Geelong, Greater Bendigo, Greater Ballarat, Latrobe, Greater Shepparton.
  - Municipalities containing major regional towns.
  - All other municipalities.
- Priority 3 – As for Priority 2 but vary the standards to only implement the **standard requirements** identified and not the preferred standards.
- Priority 4 – As for Priority 3 but only apply the standards to **larger buildings / developments**.
- Priority 5 – As for Priority 3 but limit the **type of buildings** the standards apply to, based on an agreed order of priority linked to scale of impact.

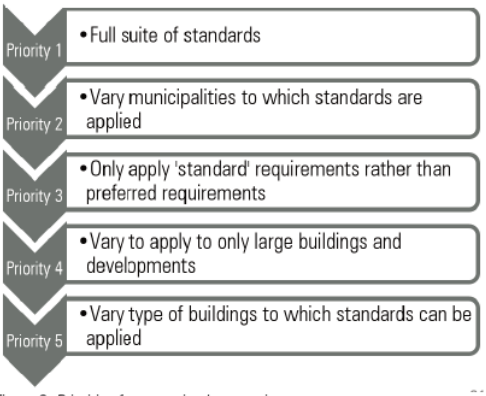


Figure 2: Priorities for stage implementation

3.11 APPLICATION REQUIREMENTS AND ASSESSMENT DETAILS

The project brief requested a response to the following questions

Advise on suitable application documentation, such as Sustainability Management Plan (SMP) being suitable for initial development application and assessment.

Advise on suitable operational evidence and reporting options, by referring to previously completed legal advice from Maddocks and consider how best to administer new provisions notably the operational aspects of the zero-carbon performance standard including ongoing operational purchasing of renewable energy, by considering the following:

i. Use of SMP and planning permit conditions to set ESD performance standards, including new zero carbon standards.

ii. Use of s173 agreements, Owners' Corporation Rules, Tenancy agreements or other devices to require renewable energy purchasing for the life of the building.

iii. Use of Implementation Reports, similar to Operational Waste Management Plans,

iv. Other alternative reporting, submission or assessment mechanisms as necessary.

Whilst there is some variation between different municipalities, existing policies regarding sustainable buildings contained in planning schemes generally refer to two key documents:

- A Sustainability Design Assessment (SDA) for small scale developments – provides a simple assessment that can generally be prepared by a specialist.
- A Sustainability Management Plan (SMP) – provides a more detailed assessment of a development that generally needs to be prepared by a specialist consultant.

These documents have an established place in the planning permit process that is generally accepted by the industry and by planning practitioners. It is appropriate that the use of these documents continue in any approach recommended as part of this project. However, given the aim of the project to include higher standards of sustainability into planning scheme than in the past, the use of more basic Sustainability Design Assessment is unlikely to be appropriate in assessing applications under the proposed new planning provisions.

Sustainability is relevant at four stages of the development process of buildings:

- Permit application stage – To ensure that the design of a building complies with all relevant sustainability policies and requirements contained in a planning scheme.
- Construction stage – To confirm that all sustainability initiatives required to include in a development have actually been built into the development.
- Ongoing operation stage – To confirm that a building is being operated in accordance with any requirements included in the initial sustainability management plan, which are relevant to the ongoing operation of a building.
- Demolition stage – To confirm waste minimisation and maximisation of the reuse of buildings materials.

Maddocks Lawyers were asked to provide advice in relation to the legality of requiring sustainability management plans or the like, at each of these three stages of the process. Their advice was that it is possible to require management plans or like at each stage, provided that the need for such was clearly expressed as a requirement in the planning provisions to be included in planning schemes. If the requirement for such documents is contained in a planning control, the documents that can only be prepared after a planning permit has been issued, can be required either by a planning permit condition or a Section 173 Agreement.

While Section 2.2.1 of this report addresses proposed application requirements, the following discussion addresses the questions contained in the brief more specifically.

3.11.1 SUSTAINABILITY MANAGEMENT PLAN

A Sustainability Management Plan (SMP) should be required to be lodged with a planning permit application. The plan should address sustainability requirements at the permit application, construction and operational stages of a development.

If the plan lodged with a planning permit application is not adequate, either a request for further information can be made to rectify the deficiencies, before a planning permit application is assessed, or a condition can be placed on a permit requiring changes to the SMP before it is endorsed as part of the approved planning permit.

3.11.2 CERTIFICATES OF COMPLIANCE

This section of the report details with the issue of certificates of compliance at the construction stage and during the operational stage of a building's lifecycle.

The relevance of and the need for certificates of compliance for operational aspects of buildings was discuss in Section 2 of this report. This section further discusses the issue, assuming that a one-off certificate of compliance is are required.

The documents required to be submitted at the construction phase and operation phase of a development are not management plans as such, which set out what needs to be done to make a development comply with the sustainability requirements contained in the planning scheme. Rather, they are documents that confirm that the requirements of the endorsed sustainability management plan are met. Accordingly, they should be referred to as certificates of compliance rather than management plans. They could be referred to as follows:

- Sustainability Certificate – Construction
- Sustainability Certificate – Operation

In relation to a Sustainability Certificate – Operation, a question is, when and how often should such as certificate be required. It is considered that an operations certificate should only be required once, 12 months after the occupation of a development. To require a certificate on an ongoing basis would impose an excessive administrative burden on both Council and the owner / body corporate of a development.

Whilst Maddock's advice was that a condition could be included on a planning permit requiring an operation certificate to be provided at some time after a building had been occupied, there are practical issues. Who is responsible for providing such a certificate once a development has been strata subdivided and an owners corporation and multiple owners exist? There may be an ability to seek a certificate from the owners corporation that relates to the communal areas it is responsible for. However it would be impractical and an administrative burden to require certifications from multiple owners of dwellings within a large development. This matter needs to be clarified by further legal opinion.

The following actions are required in response to the question of application requirements and compliance with requirements at the construction and operation stage of a development:

- Include a requirement in the planning scheme (if appropriate based on mechanism) or in any Application Requirement guidelines that a Sustainability Management Plan must be submitted with a planning permit application.
- Include a requirement in the planning scheme that a *Sustainability Certificate – Construction* must be submitted to the satisfaction of the responsible authority upon completion or within 6 months of the occupation of a building. That certificate is to demonstrate that all requirements of the Sustainability Management Plan relevant at the construction stage of a development are complied with.
- Include a requirement in the planning scheme that a *Sustainability Certificate – Operation* is required to be submitted to the satisfaction of the responsible authority within 12 months of the occupation of a building. That certificate is to demonstrate that all requirement of the Sustainability Management Plan relevant to the ongoing operation of the building are complied with (subject to further legal opinion).

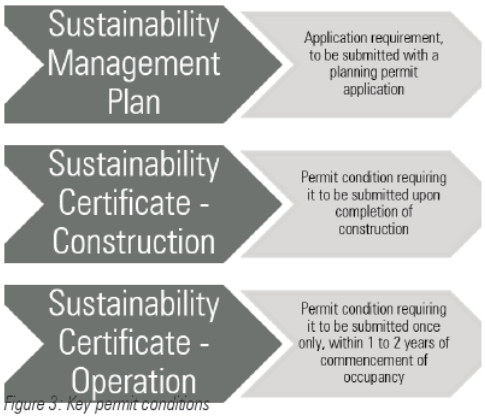


Figure 3: Key permit conditions

4.0 SUMMARY RECOMMENDATIONS

As outlined above, the following key recommendations are suggested:

- That a new Particular Provision be prepared and incorporated into the planning schemes of relevant councils that includes the elevated ESD standards. The new Particular Provision would include the following characteristics.
    - Mandatory objectives, with associated Standards (or performance measures and criteria) which would be applied as relevant to ascertain delivery of the Objectives.
    - Provision would only to those municipalities who 'opt in' to the elevated standards and amend their schemes to include the provision. State guidelines on ESD would be applied through proposed changes (to clauses 54, 55 and 58, as well as the new particular provision for commercial and industrial uses) and would apply to all other municipalities.
    - Provisions would include relevant definitions if a small number required (i.e net zero operational carbon).
    - Inclusion of a specific 'date-stamped' reference to the Green Factor Tool to ensure certainty. Resolution of external governance issues may mean this is not required.
- Further work may be undertaken to adjust existing proposed Standards to be suitably framed as performance 'measures' (i.e where specific metrics have been identified) and criteria (where a range of measure may be appropriate) consistent with proposed reforms to particular provisions. This would also allow clear identification of the information required to support assessment of the relevant performance measure / criteria. However, this should not occur until there is a greater degree of certainty as to that proposed reform.
- Further work would also be required to confirm participating Councils expectations regarding the inclusion of typologies as proposed in the current Standards.
- A consistent set of Application Requirements should be developed, along with relevant templates, in particular a standard Sustainability Management Plan template, to support applicants in preparing application material. These templates would also assist in ensuring consistent responses across the various municipalities.
- A consistent set of Permit Conditions should be developed to deliver Standards (i.e. sustainability certificates).
- A *Guidelines for Sustainable Building Design* document be prepared that could be used consistently by all councils who apply the elevated ESD standards, and would be included as a Background Document in relevant schemes. This should provide more explicit technical information where relevant, appropriate alternatives for responding to Objectives where Standards cannot be met, and real life examples.
- Background documents could be included in any local strategies contained in the Planning Policy Framework which address ESD and underpin the application of the particular provision.
- A consistent set of Definitions should also be incorporated into relevant planning schemes. If a small number then integration within provision is recommended, if large then consideration of Glossary as Incorporated Document should be considered. Ideally definitions should be consistent across State and included at Clause 73 General Terms.

4.1 RATIONALE AND BENEFITS OF THIS APPROACH

As clearly articulated by DELWP (for example, in relation to neighbourhood character as part of ResCode reforms) Local Policy should not be used as a planning control, nor is it mandatory. What this means is that for Local Government to have any certainty about the delivery of ESD outcomes through their planning schemes, a Local Policy is no longer appropriate, unless it is drafted in a manner which is directly contradictory to instruction contained within the Practitioners Guide prepared by the Department. The approach to the delivery of ESD Standards recommended in this report offers a number of benefits, including:

- Provides certainty to Local Government about the standard of design responses that will be delivered through their planning schemes.
- Provides a mechanism to ensure that actions proposed through the any development approval process are delivered.
- Provides a much greater level of transparency and certainty to the development community as to what is required to meet policy Objectives.

- Provides the opportunity for a much greater level of consistency in requirements and assessment of ESD across the municipalities to which the Standards would apply.
- Provides a framework within the planning scheme for future changes in response to new evidence, and the flexibility for robustly tested standards to be migrated to Statewide provisions if appetite for change increases at a State level.
- Allows for other municipalities to join the 'elevated' ESD group if and when their council and community supports such a move.
- Fills key gaps in the delivery of ESD outcomes prior to any more widespread changes to building regulations.

It is noted particularly, that in current processes, many of the elements addressed through the proposed Standards are already considered and delivered through Permit Conditions under existing Local Policies. The consideration of these matters through Permit Conditions occurs without any legislated timeframes and without clear guidance. In many ways, while these targets represent an 'elevation' of existing targets, and certainly bring new aspects such as Climate Resilience, Green Infrastructure and net zero outcomes into greater focus they are, in fact, also streamlining an existing process in many ways. They do this by bringing consideration and agreement about relevant ESD matters upfront in the process, and integrating them with broader consideration of the appropriateness of any application.

4.2 ALTERNATE PATHWAYS

While the preferred option for the integration of these Standards has been clearly articulated, it must be acknowledged that there is the possibility of some resistance at a State level to some of the underlying rationale behind what is proposed through any amendment seeking to introduce more stringent and elevated ESD Standards applied to participating municipalities, rather than Statewide.

It is acknowledged that the approach taken by this amendment and sought by the participating councils, in some ways, represents a shift from business as usual. It seeks to position the planning scheme as the 'front line' in the critical transition to net zero across all sectors, while other systems lag in the delivery of appropriate responses to the current climate emergency. This is however, more accurately characterised as an 'evolution' of the role planning schemes already play in ensuring that aspects of sustainable design are embedded from the earliest stages of the development process.

Careful consideration has been needed to ensure that the proposed Standards act in a complementary way to other regulations. While it is considered that the right 'balance' has been identified, other options must also be considered, not least due to the preferred option requiring State level commitment to a new provision prior to any amendment gaining authorisation for exhibition.

The alternate pathways and the implications of these are therefore explored in Figure 4 on the following page.

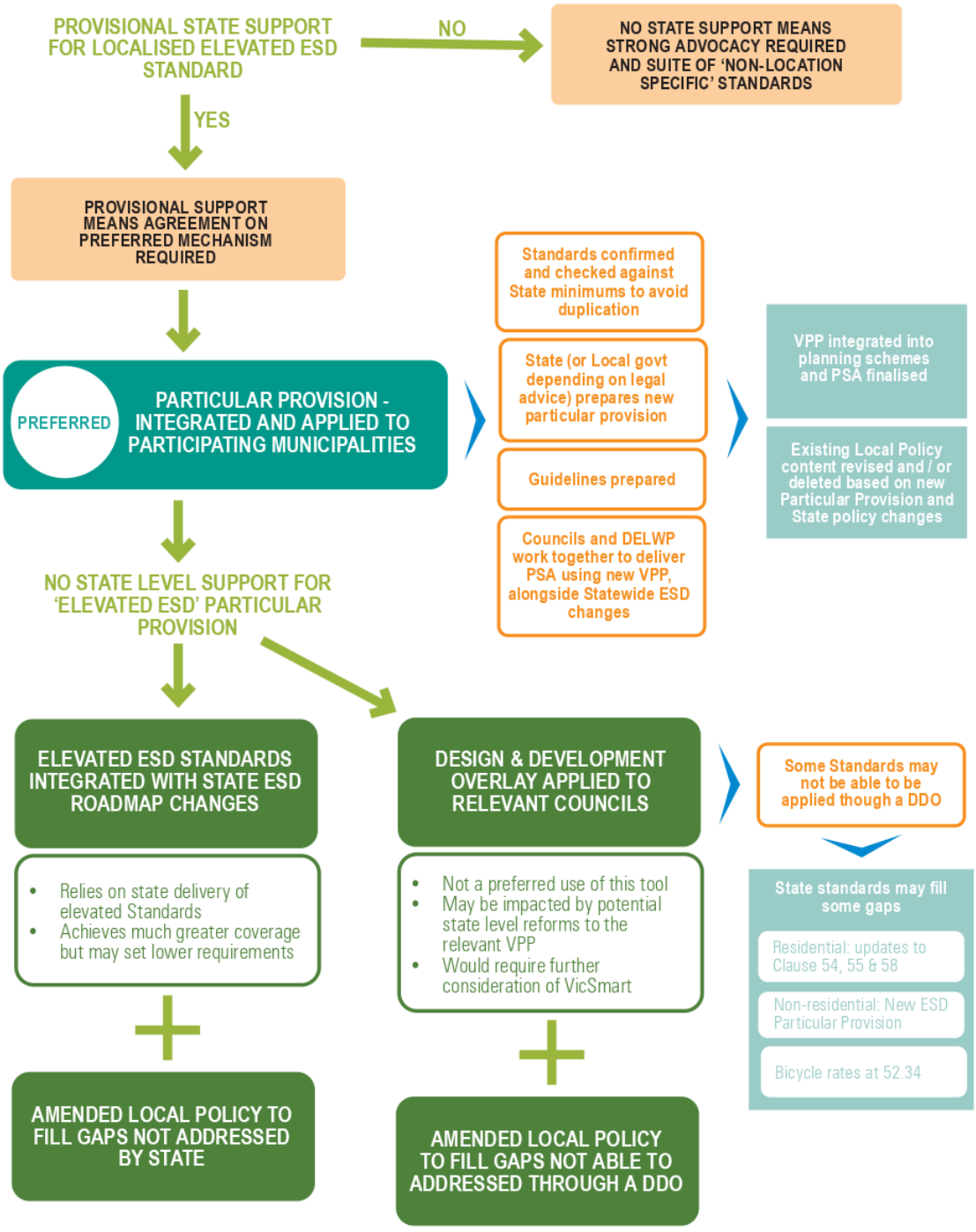


Figure 4: Alternate implementation pathways

Consideration of City Planning Reports

ELEVATING ENVIRONMENTALLY SUSTAINABLE DEVELOPMENT (ESD) TARGETS PLANNING POLICY PROJECT: STAGE 2 PLANNING SCHEME AMENDMENT

Part C - Frontier Economics - Elevating ESD Targets CBA Report (Final)

Meeting Date: 6 June 2022

Attachment: E

frontier economics

Sustainability Planning Scheme Amendment – Cost-Benefit Analysis

A report for the Municipal Association of Victoria on behalf of CASBE | 28 March 2022

Disclaimer

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1 Introduction

1.1 About this report

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. CASBE's focus is on seeking better sustainability outcomes in the built environment using the planning permit application process. CASBE is auspiced by the Municipal Association of Victoria (MAV). MAV is the peak body for local government in Victoria.

MAV, on behalf of CASBE, has sought expert advice to enable the development of a planning scheme amendment, with a range of new elevated standards of sustainability in buildings.

The purpose of the elevated standards is to ensure that new buildings and significant alterations and additions are planned and designed in a manner which mitigates and adapts to climate change, protects the natural environment, reduces resource consumption and supports the health and wellbeing of future occupants.

This report presents the results of the cost-benefit analysis of the proposed elevated standards. As outlined further in this report, it builds on other workstreams in the project including planning advice and technical and development feasibility. Further information on the standards is provided in the reports for these workstreams.

1.2 The case for change

There are numerous benefits and performance improvements that arise from more sustainable buildings. These include operational cost savings from improved energy and water efficiency, and higher-quality building outputs. Improved indoor environment quality has been shown to improve health outcomes and employee productivity.[1] More sustainable buildings can also help to manage climate, regulatory, or other environmental risks.

Despite these potential benefits, there are several market failures that inhibit new developments from achieving more sustainable outcomes. These include:

- **Information asymmetry** – a lack of information by purchasers or renters on the sustainability performance of buildings. In particular, building qualities like efficiency and indoor environment quality are difficult to detect and verify prior to purchase or lease. When buyers and sellers do not have perfect information, it can lead to inefficient outcomes

[1] For example the following articles discuss various productivity and health benefits from improved indoor environment quality, https://theconversation.com/research-shows-if-you-improve-the-air-quality-at-work-you-improve-productivity-76695; https://v2.wellcertified.com/health-safety/en/air%20and%20water%20quality%20management; https://www.researchgate.net/publication/273746860_Costs_and_benefits_of_IEQ_improvements_in_LEED_office_buildings

- **Negative externalities** - negative externalities may mean that suboptimal decisions are made in the absence of intervention. For example for energy consumption, energy prices that do not fully reflect the economic cost of consuming energy (including the cost of greenhouse gas emissions) can lead to overconsumption of energy. There are similar issues related to the embedded carbon in construction materials.

  Negative externalities mean that energy consumption is higher than economically efficient levels and there is under-investment in energy efficiency.

- **Principal-agent problems** - where builders or designers do not share the objectives of those purchasing new homes (for example to minimise energy bills)

These problems and market failures suggest a form of policy response or intervention may be needed.

2 Methodology

2.1 Overview of Cost-Benefit Analysis

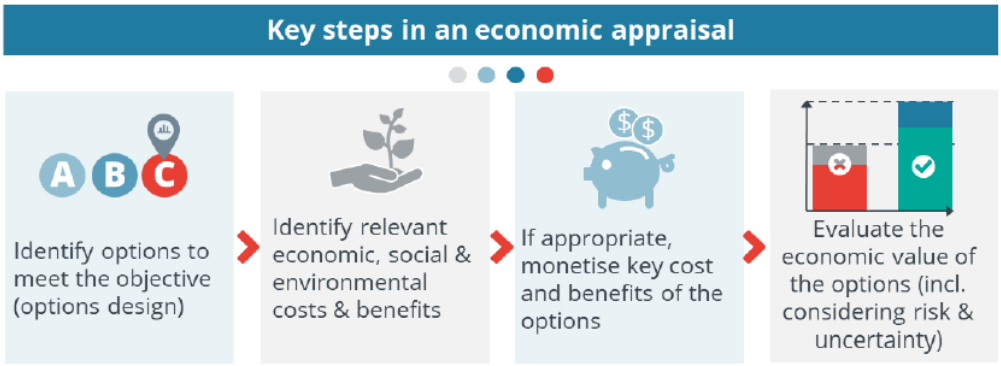
A cost-benefit analysis (CBA) provides a robust framework to assess the impacts of an intervention. A CBA is an assessment tool that compares the costs associated with a potential intervention with the benefits. The analysis is incremental in that it looks at additional costs and benefits over and above a "business as usual" scenario (the base case). The process is shown in

Figure 1 below and involves:

- **Step #1:** Identifying the appropriate Base Case and alternative interventions options (for comparison against the base case)
- **Step #2:** Identifying the range of relevant, incremental economic, social, and environmental costs and benefits of the options
- **Step #3:** Quantifying and monetising (where appropriate) a subset of the incremental economic, social and environmental costs and benefits

Step #4: Undertaking a CBA of the incremental economic value of the options (including considering risk and uncertainty using sensitivity analysis)

Figure 1: CBA process



Source: Frontier Economics.

While a CBA is an economic analysis, it looks to value economic, environmental and social impacts. The focus of a CBA is on 'real resource' changes from the point of view of society. That is to say, the focus is on incremental changes in scarce resources (labour, material, natural capital etc.) from the point of view of Victorian society. Financial transactions (such as the purchase of land or the payment of a levy) which make one party better off and another worse off are "transfers" which are excluded from a CBA as they result in no change for society.

Importantly for this analysis, property value uplift is not a real resource impact. Rather this is a financial benefit for a property owner. However, a number of the factors driving the higher property value – lower ongoing utility costs and improved amenity benefits etc. are captured in this analysis.

2.2 How this CBA fits with other workstreams and typologies assessed

This CBA builds on the planning and environmentally sustainable development (ESD) components of the elevating ESD targets project. As outlined in **Figure 2**, the planning advice refined the Sustainability Planning Scheme Amendment standards, the technical ESD component then estimated the costs and impacts associated with the design response for the standards and then this CBA values and profiles impacts based on available data and evidence.

Figure 2: Overarching project process

Source: Frontier Economics

In line with the case study typologies developed in the project, this CBA analyses eight building typologies across a range of locations (ie. inner urban, suburban and regional). For each typology the analysis compares the costs and benefits of an option or *intervention case* (with the Sustainability Planning Scheme Amendment) against two base cases (one for councils with an existing ESD Policy and another for councils that do not have an existing ESD Policy).[2] These typologies and base cases are outlined in **Table 1** and are hereafter referred to as scenarios. These scenarios align with those analysed across the project as a whole.

[2] The exception here is the RES 5 typology which only has a single base case (a council with no existing ESD policy).

Table 1: Typologies and base cases included in the analysis.

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	

Source: Frontier Economics

2.3 Impacts

The next step in the CBA process (following the identification of a range of potential options) is to identify the range of incremental economic, social and environmental costs and benefits that accrue to the local and broader Victorian communities, compared to the Base case.

The proposed Sustainability Planning Scheme Amendment (the application of which is the difference between our options and the Base Case) covers a broad range of changes to building requirements across the broad themes of:

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

Note that the themes above were based on an early categorisation which removed 'Climate Resilience' and redistributed standards under that theme. This theme has now been reintroduced. In this report, results have not been reported separately for climate resilience however to avoid any doubt, the costs and benefits related to climate resilience are still included as part of other themes. In addition, the 'Circular Economy' category was split into two called 'Waste and Resource Recovery and 'Embodied Emissions'. More information is contained in the Technical ESD report.

Figure 3: Overview of key cost and benefit themes considered in this analysis

Source: Frontier Economics

The breadth of these themes leads to a broad range of potential impacts. To ensure that this CBA takes a robust approach to analysing these broad impacts, a three-stage approach was taken:

1. Logic mapping exercise undertaken to identify ultimate impacts that should be assessed by category (as opposed to an intermediate implication). The logic mapping process drew on our expertise across these key themes and a range of Australian literature (See Appendix C for more detail). The logic maps started from the theme objective, identified implications and then key impacts.
2. Longlist of potential impacts developed by drawing on the logic mapping exercise.
3. Further research undertaken to identify which outcomes can be quantified and those which should be considered qualitatively (See Appendix C for more detail).

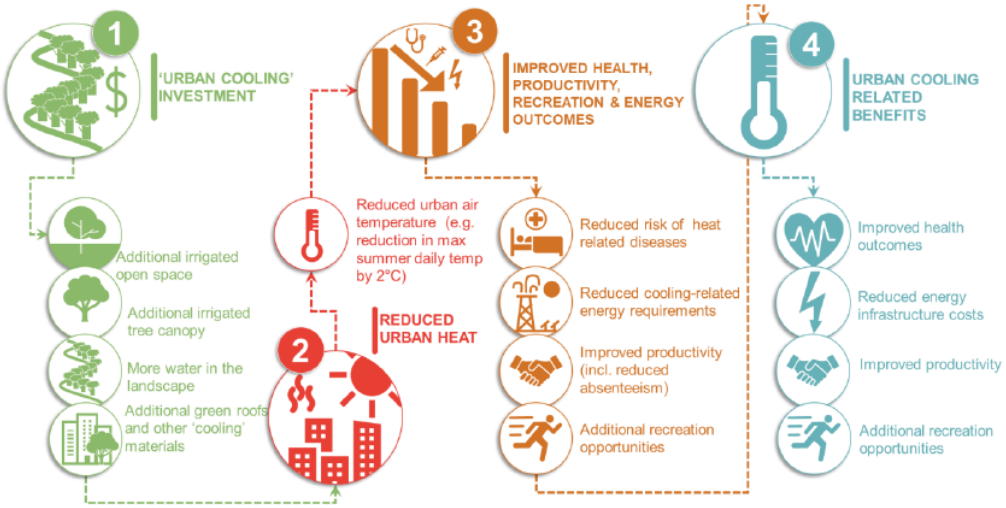
Our logic mapping and potential impacts is shown below in **Table 2**. Importantly, it is the end outcome that are being identified and, if appropriate, valued in the CBA (where possible) as opposed to the initial step in the causal chain or the overall objective.

In the discussion below, we elaborate on a logic mapping approach for urban heat. As shown in **Figure 4**, investment to manage urban heat (including investment in irrigated open space and tree canopy, water in the landscape and other cooling-materials such as green roofs) can reduce the urban air temperature (e.g. reducing the max summer daily temperature), providing economic, environmental and social (or liveability-related) benefits to the community.[3] This includes:

[3] See for example Sydney Water Corporation (2017), Cooling Western Sydney A strategic study on the role of water in mitigating urban heat in Western Sydney; CRCWSC (2016), Impacts of Water Sensitive Urban Design Solutions on Human Thermal Comfort. Available at: https://watersensitivecities.org.au/wp-content/uploads/2016/07/TMR_B3-1_WSUD_thermal_comfort_no2.pdf; Kabisch, N., et al. (2017). "The health benefits of nature-based solutions to urbanization challenges for children and the elderly–A systematic review." Environmental Research 159: 362-373.

- **Reductions in the risk of heat-related diseases** –While urban heat is rarely listed as the cause of death, various studies have found that increased heat levels lead to increased risk of death or disease, especially amongst the most vulnerable in the community: the very young and elderly. [4] A reduction in urban heat can reduce the risk of heat-related diseases, reducing the number of heat-related deaths and the use of health services (reducing the total cost of treatment).
- **Reductions in cooling-related energy requirements –** reduced cooling demand as a result of reduced urban heat, can reduce the generation and network energy infrastructure requirements required to meet future demand. This in turn, defers the operation and augmentation of energy generation and network infrastructure, reducing the future cost of providing the energy infrastructure.
- **Improvement in productivity**– reduced urban heat can lead to improvements in productivity, including reduced absenteeism, which may result from reduced heat stress on the community (for example, reductions in the incidence of disturbed sleep or cancelled workdays due to excess heat).
- **Additional recreation opportunities in the summer** – reduced urban heat can lead to increased participation in active and passive recreation in the summer (in addition to the increased recreation opportunities arising from increased availability of open space).

Figure 4: Link between green infrastructure and urban cooling-related benefits



Source: Frontier Economics

The impacts in the table below are in addition to the incremental upfront and ongoing costs to meet the revised standard (i.e. less any costs under the base case). Note that the impacts that are in **bold** text are those that we have been able to quantify and ultimately, monetise, as discussed in the following section.

[4] See for example, Center for Disease Control and Prevention (2006), Heat Island Impacts. Available at: https://www.epa.gov/heat-islands/heat-island-impacts#3>(viewed January 2018).

Table 2: Logic mapping

Theme	Objectives	Implication	Potential impacts
Operational energy	Net zero operational carbon	• No natural gas or onsite fossil fuel consumption • Maximise onsite renewable energy generation • All residual energy to be 100% renewable purchased through Green Power or similar	• **Reduce GHG emissions arising from reduced grid-based energy demand** • **Reduced energy use, avoiding energy fuel costs and deferring the need for energy network investment**
Sustainable transport	Reduce private vehicle trips, support a smooth transition for the future uptake of electric vehicles (EV)	• Provide for bicycle parking (increase likelihood of residents and workers riding bikes) • Provide EV charger outlets • Shared space EV charging	• Increased active transport and resulting reduction in inactivity-related health benefits / avoided costs arising from increased use of bicycles • Increased uptake of EVs leading to reduced GHG emissions and increased electricity use
Integrated water management	Reduce potable water consumption and improve the quality of stormwater discharging from site	• Provide efficient fitting, fixtures and appliances • Provide for rainwater harvesting (rainwater tanks)	• **Reduced potable water use deferring water network investment** • Reduced stormwater discharge leading to reduced impact of nitrogen and suspended solids. This can lead to improvements in the health of waterways and surrounding ecology. • **Value of recovered organic waste (less cost of recovery)**

Theme	Objectives	Implication	Potential impacts
Indoor Environment Quality	Improve the comfort of building occupants including internal temperatures, air quality and daylight access	• Improved external shading • Improved ventilation • Improved daylight	• Improved productivity • Health benefits from improved air quality inside buildings • Staff health & retention in non-residential buildings • Health benefits from increased natural light
Circular Economy	Improve rates of resource recovery, encourage the use of materials with recycled content as an alternative to virgin material	• Provide a Construction and Demolition Waste Management Plan that sets a landfill diversion target • Utilise low maintenance, durable, reusable, repairable and recyclable building materials	• **Avoided operational costs of landfill and avoided landfill externalities (disamenity)** • **Value of recycled materials less costs of transport/processing**
Green infrastructure	Increase the amount of green infrastructure (such as tree canopy, green roofs and open space) to provide a range of ecosystem service benefits, reduce the contribution of the built environment to the urban heat island effect	• All new developments to meet target Green Factor score • Improved green cover (leading to reduced urban heat island effect)	• Reductions in the urban heat-related diseases • Improved productivity • Reductions in cooling-related energy requirements • Improved biodiversity outcomes • Additional recreation opportunities in the summer

Source: Frontier Economics

2.4 Approach to valuing costs and benefits

The aim in economic evaluation is to value very different measures of impact in consistent monetary terms to enable a comparison of a range of economic, environmental and social (or liveability-related) outcomes.

As discussed above, this analysis has sought to, where possible, monetise key costs and benefits where there is an incremental difference in 'real resource' outcomes between the base case and the intervention case.

Many of these impacts can be considered market impacts as the prices of goods or services are observable in markets. Other impacts, such as the environmental or social impacts (or avoided impacts) can be considered non-market impacts.[5]. Where the incremental costs and benefits have been monetised, these are shown in bold in **Table 2**.

In some circumstances, there was not sufficient data to establish a quantitative causal link or attach a defensible monetary value to the incremental difference between outcomes of the interventions (such as the benefits of IEQ and GI). Where the incremental costs and benefits have been unable to be monetised to include in the CBA in a quantitative way, these are shown un-bolded in **Table 2** and have been qualitatively assessed in **Table 4**.

Consistent with best practice and the Victorian Department of Treasury and Finance Guidelines our analysis has:

- **Drawn upon the best available information**, including information provided by Hip V. Hype on incremental costs and impacts of interventions
- **Focused on impacts in the state of Victoria,** consistent with Victorian Treasury Guidelines. This has involved:
  - including impacts that accrue to people in the local and broader Victorian community
  - excluding impacts that accrue to the Australian (such as wider economic impacts) and international communities.
- **Used accepted and relevant methodologies for monetising key costs and benefits**, including the use of benefit transfer techniques (where appropriate) which draw upon existing literature reflecting the willingness to pay or preferences of a similar community for a similar change in outcome. Recognising the potential limitations of benefit transfer, the approach taken in the CBA adopts – as much as is practicable – a range of studies (mainly in VIC) (see Box 1).

[5] As a price cannot be observed and other methods must be used to derive a monetary value.

Box 1: Overview of valuation approaches

There is a range of techniques available to monetise non-monetary economic, social and environmental outcomes. These include primary monetisation approaches (such as market-based and survey-based techniques) and secondary approaches, such as benefit transfer:

- **Primary approaches:** use original data from the project site or context to derive a monetary value for some quantified change in outcomes caused by a green infrastructure intervention. There are two broad categories of primary approaches:
  - **Market-based or surrogate market-based techniques –** uses market prices or people's behaviour in a similar or related market to infer the value of outcomes.
  - **Survey Based -** uses surveys that ask people their willingness to pay to value outcomes.
- **Secondary approaches, such as benefit-transfer,** takes values from a pre-existing study, project, or piece of research (i.e. the 'study site') and applies it to a new project, or context (i.e. the 'policy site'). Judgement is required to determine whether results from a previous study are appropriate to use. In addition to scrutinising the quality of the original study needs to ensure there are no technical weaknesses or biases, important preconditions for benefit transfer include:
  - the impact being valued must be essentially the same (e.g. improved thermal comfort)
  - the base case and extent of change should be similar
  - the affected populations should be similar

Given primary research was outside the scope of this analysis (and can be costly and time consuming), we have primarily considered benefit transfer.

Source: Frontier Economics

The following sections provide further detail on our approach to valuing key costs and benefits.

2.4.1 Data for costs and impacts

The CBA takes cost and impact data from the technical ESD analysis undertaken by Hip V. Hype. This data includes:

- upfront incremental capital costs to meet revised standards
- operational energy and water savings incremental to the base case
- avoided waste to landfill
- reduced embodied carbon
- estimated useful life of assets.

Further information on these costs and impacts is provided in the Hip V. Hype report.

2.4.2 Benefit data

Quantified benefits

To value benefits, we have drawn on robust valuation benchmarks as outlined in **Table 3**, with further information provided at Appendix B.

Table 3: CBA valuation benchmarks

Benefit category	Valuation approach
Greenhouse gas (GHG) emission reduction	Our valuation includes the following steps: • applying the estimated reduction in gas and electricity consumption (obtained from ESD technical workstream) • forecasting emission intensity factors for Victoria during the evaluation period (see Appendix B) • converting reduced gas and electricity consumption into reduced GHG emissions using forecast emission intensity factors • multiplying the reduced emissions by a social cost of carbon ($75/tonne CO2-e) – Frontier Economics estimate of the economic costs, or damages, of emitting one additional tonne of GHG into the atmosphere.
Reduced energy use (electricity & gas)	We have estimated the resource cost savings associated with reduced electricity and gas consumption, including reduced network and wholesale costs: • For electricity network costs, we have based our estimates on published values for the long-run marginal cost (LRMC) from Victorian electricity network distribution businesses ($0.01/kWh). • For deferred gas network costs, we have adopted an estimate of $4.50/GJ based on a recent Consultation RIS undertaken by ACIL Allen • For electricity wholesale costs, we have assumed a flat $70/MWh (Frontier Economics estimate/assumption) • For gas wholesale costs, we have used price forecasts from the Australian Energy Market Operator's 2022 Integrated System Plan (based on new entrant combined cycle gas turbine generator prices) (see Appendix B) See Appendix B for further discussion on why we have not applied a retail bill (representing financial savings) in our approach.

Benefit category	Valuation approach
Avoided health costs of electricity generation	Electricity generation produces air pollution containing particulate matter, nitrogen oxides, sulphur dioxide, as well as other emissions. These can cause health problems such as respiratory illness and can also affect local economies. We estimated the health benefits of avoided coal and gas-fired electricity at $1.78/MWh. See Appendix B for information.
Reduced potable water use	Our valuation approach involves: • applying the estimated reduction in potable water use (in megalitres) (obtained from ESD technical workstream) • multiplying the reduction in potable water use by the estimated LRMC of water supply based on the value advised by Melbourne Water ($2,450/ML).
Reduced embodied carbon	Estimates of reduced embodied carbon obtained from the ESD technical workstream were multiplied by the social cost of carbon discussed above.
Reduced waste to landfill/value of recovered materials	Estimates of reduced construction and demolition waste to landfill (tonnes) were multiplied by the full economic cost of landfill and the net value of recovered materials. This approach provides an estimate of the avoided cost of landfill and value of recovered materials of $125/tonne. See Appendix B for information.
Recovery of organic waste	Estimates of organic waste recovered, obtained from the ESD technical workstream, were multiplied by an average value added for organic waste. To estimate the average value added for organic waste we used data from Australian Organics Recycling Association's publication 'Australian Organics Recycling Industry Capacity Assessment: 2020-21'. This approach provides an estimate of the value added by additional organic waste recovered of $93/tonne.
Residual value	Some assets have a useful life that is greater than the analysis period of the CBA. The residual value is the estimated value of assets at the end of the appraisal period, representing the expected value in continuing use. We calculate residual value as the present value of future benefits.

Source: Frontier Economics

We note that our approach is consistent with advice provided by HoustonKemp to the Australian Government for cost-benefit analysis for residential building energy efficiency (**Box 2**).

Box 2: Guidelines for residential building regulatory impact assessment

HoustonKemp were engaged by the Department of the Environment and Energy to develop a robust methodology for evaluating the benefits and costs of possible future increases in the stringency of the energy efficiency provisions in the National Construction Code (NCC).

Our valuation approach outlined in **Table 3** is in line with HoustonKemp's recommendations, including that:

- benefits of reduced energy use be estimated based on LRMC estimates and wholesale market prices where available
- benefits of reduced GHG emissions be based on forecast emission intensity factors and GHG abatement costs
- health, safety and amenity benefits be dealt with qualitatively (unless they can be readily quantified)

Our analysis is also consistent with HoustonKemp's base case description, and recommended evaluation timeframe of at least 20 years (outlined below).

Source: Houston Kemp, Residential Buildings Regulatory Impact Statement Methodology – Report to the Department of Environment and Energy, 6 April 2017.

Non-monetised benefits

Critically, CBA does not require monetisation of all key costs and benefits. While we have aimed to value as many benefits as possible, some impacts are inherently difficult to quantify and value. This is particularly the case where impacts are not traded in markets, such as 'improved biodiversity outcomes', 'improved thermal comfort', or 'improved aesthetics'.

For impacts which do not have a robust valuation method, or do not have a clearly attributable incremental impact, they have been assessed qualitatively (**Table 4**). Qualitative assessment of impacts aligns with CBA guidance including the Victorian Department of Treasury and Finance.

To provide an indication of whether these benefits would alter the broad narrative of our results, we have included an assessment of materiality. In our discussion of the CBA results, we provide a break-even analysis to show how much unquantified benefits would need to be for scenarios to be equal to the incremental costs.

Table 4: Qualitative assessment

Incremental impacts	Most relevant theme	Materiality	Qualitative assessment (why we have not valued these impacts)
Ongoing cost to meet revised standards	All	Uncertain	Any change in ongoing cost will be dependent on the specific materials and products used in the Sustainability Planning Scheme Amendment option compared to the ESD policy or non-ESD policy base case. The technical ESD assessment haven't proposed specific materials in the design responses (except for recycled content concrete in the Circular Economy theme), which makes any assessment uncertain. At a high level, it is expected that some design responses would increase ongoing costs while others reduce ongoing costs and that the overall impact may not be material.
Health and wellbeing benefits from improved thermal comfort	Operational energy	Minor benefit	Increased thermal comfort can lead to a range of health and wellbeing benefits.[6] The impacts of increased thermal comfort would be expected to be highly context specific – both in terms of the location of the building and how the building is used (i.e. for residential typologies are residents working from home or out of the house 12 hours a day?). For scenarios where the base case has an existing ESD policy there is likely to be a small incremental impact as the base case provides a good level of thermal comfort. The incremental impact may be more for scenarios where the base case does not have an existing ESD policy.
Increased active transport / avoided costs through improved transport mode usage	Sustainable transport	Benefit with unclear materiality	CBA focuses on impacts which are attributable to the intervention. While improved bike access and storage would make active transport more appealing to building users, there are myriad factors which impact on mode choice decisions. As such, while the incremental impact is a benefit it is not possible to isolate the magnitude of this impact.
Increased uptake of EVs leading to reduced GHG	Sustainable transport	Minor impact	Similar to active transport, uptake of EVs is a complex decision with myriad factors including price of EVs, price of operating internal combustion engine vehicles and the

[6] For example - Ormandy, D. and Ezratty, V., *Thermal Discomfort and Health: Protecting the Susceptible from Excess Cold and Excess Heat in Housing*, 2015, https://warwick.ac.uk/fac/sci/med/research/hscience/sssh/publications/publications14/thermal.pdf

emissions and increased electricity use			range of EVs. As such, while the incremental impact of reducing vehicle-related emissions is a benefit it is not possible to isolate the exact magnitude of this impact.
Reduced volume of stormwater leading to reduced nitrogen and suspended solids	Integrated Water Management	No impact	The technical ESD assessment identifies that both ESD and non-ESD policy base cases include rainwater tanks for stormwater collection and meet the requirements for the quality of stormwater discharged from the site. Given this, it appears there is unlikely to be any incremental impact related to stormwater.
Health benefits from improved air quality inside buildings	Indoor Environment Quality	Benefit with unclear materiality	Increased natural ventilation should lead improved air quality which, in turn, leads to improved health outcomes.[7] The impacts would be highly context specific – both in terms of the location of the building and how the building is used. The incremental impact depends on the base case. For example, for RES 1 the ESD Policy base case includes 100% of apartments being naturally ventilated whereas the non-ESD Policy base case includes "some natural ventilation." In this example, there may not be an incremental impact on air quality when compared to the ESD Policy base case but there may be some incremental impact when compared to a non-ESD policy base case.
Staff health & retention for non-residential	Indoor Environment Quality	Benefit with unclear materiality	There is some evidence that improved indoor environment quality leads to improved staff health (fewer sick days) and improved staff retention.[8] The magnitude of the impact will be highly context dependent, particularly with respect to the base case. For example, in Non-RES 3 the ESD Policy base case includes natural ventilation and daylight requirements have been too location specific to be assessed by the technical ESD assessment.

7 For example - Al horr, Y., Arif, M., Kaushik, AK., Mazroei, A., Katafygiotou, M. and Elsarrag, E., *Occupant productivity and office indoor environment quality : a review of the literature*, 2016, https://usir.salford.ac.uk/id/eprint/39106/3/BAE-D-16-00533_final%20manuscript[1].pdf and Fisk, W., Health and productivity gains from better indoor environment and their relationship with building energy efficiency, 2000, https://www.annualreviews.org/doi/full/10.1146/annurev.energy.25.1.537

8 For example, REHVA, *Indoor Climate and Productivity in Offices: How to integrate productivity in life-cycle cost analysis of building services*, 2017, https://biblioteka.ktu.edu/wp-content/uploads/sites/38/2017/06/06_Productivity_2ed_protected.pdf. The International WELL Building Institute cite the following source for healthy buildings lowering staff turnover and burnout - Leiter M, Maslach C. Areas of Worklife Survey. Mindgarden. https://www.mindgarden.com/274-areas-of-worklife-survey.

Health benefits from increased natural light	Indoor Environment Quality	Benefit with unclear materiality	There is some evidence that improved natural light in buildings cause health benefits.[9] However, the daylight requirements have been too location specific to be assessed by the technical ESD assessment. As such the incremental impact is unclear.
Reduced risk of heat-related diseases	Green Infrastructure	Benefit with unclear materiality	A benefit of urban greening is reduced urban heat island which can reduce the risk of heat-related diseases.[10] This is typically a benefit which accrues with precinct or suburb level greening, rather than for an individual building. Given that the scale of this analysis is on individual building benefits, the incremental impact may be negligible.
Improved biodiversity	Green Infrastructure	Benefit with unclear materiality	Biodiversity benefits may arise from additional green cover being used to benefit fauna and flora. The nature of this benefit is likely to be highly context specific and similar to urban greening, would more likely occur with precinct/suburb level greening rather than for an individual building. Green infrastructure may also contribute to avoided costs to the extent that some councils can avoid costs of meeting canopy cover targets.

9 For example, Edwards, L. and Torcellini, P., *A Literature Review of the Effects of Natural Light on Building Occupants*, 2002, https://www.osti.gov/servlets/purl/15000841/

10 For example, U.S. Environmental Protection Agency (EPA), *Reduce Urban Heat Island Effect*, accessed from the U.S. EPA's website on 1 November 2021, https://www.epa.gov/green-infrastructure/reduce-urban-heat-island-effect

2.5 Overarching CBA parameters and sensitivities

As previously stated, the CBA assesses impacts over time. This requires an appraisal period to be defined and the application of a discount rate (to account for the time value of money where a dollar today is worth more than a dollar in future). To enable comparison of the costs and benefits over time, as shown in **Table 5** this analysis:

- Applies a 20-year appraisal period which aligns with a likely useful life of a number of the design responses required to align with the Sustainability Planning Scheme Amendment.
- Includes a residual value to capture the benefits and costs of the assets with lives beyond the modelling period - Some interventions (such as external shading) may have an asset value of more than 20 years. Where this is the case there has been liaison with the technical ESD workstream to identify a likely useful life in order to place a residual value on these assets at the end of the appraisal period. The residual value is included in the analysis as a benefit (see **Box 3**). This is a standard approach in best practice CBAs.
- Applies a discount rate of 7% per year, consistent with the Victorian Department of Treasury and Finance.

Table 5: Overarching parameters for the CBA

Input	Value
Price base	2021
Appraisal start date	1 Jan 2023
Project appraisal period	20 years
Appraisal end date	1 Jan 2043
Discount rate	7% per annum

Source: Frontier Economics

As with any CBA, there are a number of uncertainties relating to the analysis. Sensitivity analysis was undertaken to analyse how the CBA results change if key parameters change. For this analysis, the following sensitivities were tested:

- Low discount rate: 4% per annum
- High discount rate: 10% discount rate
- Low benefits: -50% on all valuation factors
- High benefits: +50% on all valuation factors
- Residual value for external shading and green cover

Box 3: Base case costs and residual values

Base case costs

As previously stated, CBA is incremental in that it looks at additional costs and benefits over and above a "business as usual" scenario (the base case). For example, in this analysis for the RES-1 typology both the ESD Policy and non-ESD Policy base cases include a cost for a gas-fired central hot water system while the Sustainability Planning Scheme Amendment option includes a cost for an electric central hot water system. That is to say, there are differing upfront costs associated with different design responses and the analysis captures the incremental cost. The one design response which is treated differently is EV chargers, which form part of the Sustainability Planning Scheme Amendment option. Rather than assuming no EV chargers in the ESD Policy and non-ESD Policy base cases, the CBA assumes that EV chargers are retrofitted in the base case in 2030 – a point in the future when EV take up would be expected to be higher.

Residual values

As stated above, the project appraisal period is 20 years. This is intended to largely align with the useful life of the design responses in the Sustainability Planning Scheme Amendment option. It is understood that some elements may have longer useful lives. These can be captured in CBA through a residual value. The Department of Treasury and Finance's Economic Evaluation states that residual value at the end of the appraisal period should be "the lower of (a) the replacement cost or (b) the present value of the future stream of net benefits at the arbitrary earlier end of the project." Focussing on the two key cost items in a number of scenarios (external shading and green cover), these items do not have benefits that have been valued in the CBA. Hence, following the Department of Treasury and Finance's guidance means that the residual value of external shading and green cover should be zero. To understand how sensitive the CBA is to this approach, a sensitivity scenario has been undertaken where external shading and green cover are assumed to have a 40 year useful life which results in 50% of their upfront cost being a residual value benefit at the end of the CBA appraisal period (as with all impacts this is then subjected to discounting to reach a present value).

Source: Frontier Economics drawing on documents including Department of Treasury and Finance (2013), Economic Evaluation for Business Cases Technical guidelines.

3 Cost-Benefit Analysis Results

3.1 Results – central scenarios

The next step in the CBA process is to undertake an evaluation of the incremental economic, social, and environmental value of the options. The incremental future costs and benefits are discounted using a social discount rate to a 'net present value' (NPV) and and Benefit-Cost Ratios (BCRs) where:

- **NPV>0 and BCR>1** indicates that the option results in a net benefit to the community relative to the Base Case (i.e. incremental benefits of the option exceed incremental costs).
- **NPV = 0 and BCR=1** indicates that the incremental benefit of the option exactly equals its incremental costs.
- **NPV < 0 and BCR<1** indicates that the option results in a net cost to the community relative to the Base Case (i.e. incremental costs of the option exceed incremental benefits).

The high-level results of the CBA are presented in **Table 6** and **Table 7**. The overall finding from the CBA is that across the different typologies there are negative NPVs and BCRs less than one.

In interpreting these results it is important to note that we were unable to quantify a number of benefits where the magnitude of these benefits is difficult to ascertain. This is particularly the case for benefits associated with the indoor environment quality (IEQ) and green infrastructure (GI) themes. In the sections below we undertake a break-even analysis to provide some guidance on the magnitude of potential benefits from these themes to produce a BCR of 1.

When the costs and benefits from the IEQ and green infrastructure themes are removed from the CBA, the BCRs across typologies are close to or greater than 1. We show these BCRs in the bottom rows of **Table 6** and **Table 7** and throughout this results section.

The NON-RES 1 typology under the ESD base case had the most favourable result with a BCR of 0.64, or 1.41 when IEQ and GI themes are excluded. The Non-RES 2 with ESD Policy base case has the lowest BCR (0.09) while RES 1 with ESD Policy base case has the lowest NPV (-$1.3m). For Non-RES 2 with ESD Policy base case this result is a combination of having low incremental benefits compared to the ESD Policy base case and also having high costs – with the Green Cover design response comprising $220k or 83% of total costs in this scenario. For RES 1 with ESD Policy base case there are also high costs (with the Green Cover and external shading design responses making up $1.4m or 61% of the cost). However, this scenario also has high benefits which total around $1m.

Comparing the results for the same typology with an ESD Policy base case to the corresponding non-ESD Policy base case, the benefits are generally higher in the non-ESD Policy base case scenarios. This makes sense as in these scenarios the Sustainability Planning Scheme Amendment options provides a bigger increment in outcomes compared to the base case. However, this bigger increment also tends to come with a higher cost. The overall impact is the BCRs for the non-ESD Policy base case are higher than the corresponding ESD Policy base case for 5 of the 7 typologies with two base cases tested.

Table 6: Cost-benefit analysis results – ESD Policy base case

Typology	RES 1	NON-RES 1	RES 2	NON-RES 2	RES 3	NON-RES 3	RES 4
TOTAL BENEFITS ($)	1,077,281	294,643	23,089	22,890	36,369	30,671	170,127
TOTAL COSTS ($)	2,382,798	458,493	46,929	264,994	154,698	156,212	334,398
NET PRESENT VALUES ($)	-1,305,517	-163,850	- 23,840	- 242,104	- 118,329	- 125,541	- 164,271
BENEFIT-COST RATIO	0.45	0.64	0.49	0.09	0.24	0.20	0.51
BENEFIT-COST RATIO (IEQ AND GI EXCLUDED AS BENEFITS UNQUANTIFIED)	1.15	1.41	0.80	0.85	0.84	2.55	1.09

Source: Frontier Economics

Table 7: Cost-benefit analysis results – Non-ESD Policy base case

Typology	RES 1	NON-RES 1	RES2	NON-RES 2	RES 3	NON-RES 3	RES 4	RES 5
TOTAL BENEFITS ($)	1,182,124	470,315	32,179	65,061	41,877	52,911	142,610	7,646
TOTAL COSTS ($)	2,451,244	945,133	97,072	364,096	146,298	202,220	255,213	20,086
NET PRESENT VALUES ($)	-1,269,121	-474,818	-64,893	-299,035	-104,421	-149,309	-112,603	-12,440
BENEFIT-COST RATIO	0.48	0.50	0.33	0.18	0.29	0.26	0.56	0.38
BENEFIT-COST RATIO (IEQ AND GI EXCLUDED AS BENEFITS UNQUANTIFIED)	1.11	1.94	1.01	1.24	1.28	0.93	0.75	0.75

Source: Frontier Economics

Table 8 presents a breakdown of the NPVs by theme for the best and worst performing scenarios (in terms of the benefit-cost ratio) under the central case. A complete set of NPVs by theme are presented in Appendix A.

For the best performing scenario (NON-RES 1, ESD Policy), the Operational Energy, and sustainable transport themes have positive NPVs while the remaining themes have negative NPVs. The key cost streams relate to external shading and green cover.

For the worst performing scenario (NON-RES 2, ESD Policy), Circular Economy has a positive NPV, the operational energy, Sustainable Transport and Indoor Environment Quality have a negative NPV and green infrastructure has a very negative NPV. The Green Cover cost is the driver of the very negative NPV for the green infrastructure theme. The key benefits in this scenario relate embodied carbon reduction.

Table 8: Breakdown of Net Present Value by theme for best and worst performing scenarios (in dollars)

Typology	Best performing NON-RES 1, ESD Policy base case	Worst performing NON-RES 2, ESD Policy base case
OPERATIONAL ENERGY NPV	95,222	-314
SUSTAINABLE TRANSPORT NPV	11,936	-9,537
INTEGRATED WATER MANAGEMENT NPV	- 15,000	
INDOOR ENVIRONMENT QUALITY (IEQ) NPV	- 84,850	-18,800
CIRCULAR ECONOMY NPV	- 6,301	5,875
GREEN INFRASTRUCTURE (GI) NPV	- 164,856	-219,328

3.2 Sensitivity results

Sensitivity analysis looks at how results change with different key assumptions. **Table 9** and **Table 10** present the sensitivity results for the best and worst performing scenarios (from a benefit-cost ratio). A complete set of sensitivity results are presented in Appendix A.

It is no surprise to see that the sensitivities with low discount rate and higher benefits improve the results. A low discount rate means that the benefits which accrue over time are less heavily discounted in the analysis, which makes the benefits look better when compared to costs which are incurred upfront. The high benefits simply inflate the valuation factors which also make the benefits look better when compared to the costs. The opposite effect occurs in the high discount rate and lower benefits.

Notably, for both the best and worst performing scenarios, interpretation of the results does not change in the different sensitivity analyses. That is to say, both have a negative NPV and BCR less than 1 in all the sensitivities.

Table 9: Sensitivity results – best performing scenario (NON-RES 1, ESD Policy base case)

	4% discount rate	10% discount rate	Lower benefits -50%	Higher benefits +50%	Residual values
TOTAL BENEFITS ($)	392,144	234,160	154,362	434,925	303,425
TOTAL COSTS ($)	512,383	424,191	372,029	544,956	458,493
NET PRESENT VALUES ($)	- 120,238	-190,031	- 217,667	-110,032	-155,068
BENEFIT-COST RATIO	0.77	0.55	0.41	0.80	0.66
BENEFIT-COST RATIO (IEQ & GI EXCLUDED)	1.49	1.34	1.26	1.47	1.41

Table 10: Sensitivity results – worst performing scenario (NON-RES 2, ESD Policy base case)

	4% discount rate	10% discount rate	Lower benefits -50%	Higher benefits +50%	Residual values
TOTAL BENEFITS ($)	33,205	16,932	12,165	33,616	31,994
TOTAL COSTS ($)	265,036	264,967	264,929	265,059	264,994
NET PRESENT VALUES ($)	-231,831	-248,035	-252,764	-231,443	-233,000
BENEFIT-COST RATIO	0.13	0.06	0.05	0.13	0.12
BENEFIT-COST RATIO (IEQ & GI EXCLUDED)	1.23	0.63	0.45	1.25	0.85

3.3 Break-even analysis

As discussed above, reductions in urban heat leading to reduced urban-heat related disease burden is a potential benefit of the scenarios assessed as part of this CBA, and in particular for the IEQ and GI themes. Mitigating the range of damaging effects of the urban heat island effect is a rising policy and broader sustainability priority in Victoria and across Australia.

While the urban heat island effect can negatively impact a range of outcomes valued by the community, arguably the most critical of these is the impact of soaring temperatures on human health. There is now strong scientific evidence that high temperatures and heatwaves are driving substantial costs on society by causing heat-related disease and death. There are also direct financial costs to the health system associated with this impact, such as the cost of ambulance call-outs and emergency department treatments to address heat-related illness.

This suggests there may be merit in exploring the potential for alternative building standards to contribute to limiting the UHI effect my promoting or mandating the use of materials that do not add to urban heat or can reduce ambient temperatures. As discussed in Box 4, if alternative building standards can drive reductions in peak temperatures on very hot days and during heatwaves, then this temperature reduction can be linked to reductions in heat-related deaths and reductions in costs to the health system.

Box 4: Valuing the health benefits associated with a reduction in urban heat

- The first step is to understand the extent to which alternative building designs, materials, or other urban typology interventions can drive reductions in peak urban temperatures on hot days and during heatwaves. First it must be shown that this causal link exists, and then the magnitude of the impact must be measured.
- The second step is to understand the relationship between each degree of temperature reduction on a very hot day, the prevalence of heat-related illness and death, *and* the assumed population characteristics of the intervention area (ie. in the community where the alternative urban typologies or building standards are applied)
- If we can reasonably and robustly:

1. assume that the urban typology intervention does drive reductions in temperature
2. understand how much temperature reduction is likely
3. assume that the surrounding population that experiences that temperature reduction is sufficiently large and sufficiently similar to the general population, then,

   we can link urban temperature reduction to reductions in heat-related illness and heat-related death, and then can place a monetary value on the avoided deaths and on the avoided costs to the health system.

Source: Frontier Economics

3.3.1 Findings of our break-even analysis

Given the availability of information, our analysis:

- assumes interventions are capable of driving down peak ambient temperature on very hot days and during heatwaves to a sufficient extent such that interventions can be causally linked to avoided heat-related deaths
- only considers scenarios that are likely to affect the population most vulnerable to heat-related illness and death – the elderly and the young
- is based on larger scale residential scenarios only
- assumes that, if scaled, the local population has the same age and disease burden characteristics as the general population
- accounts for uncertainty of scenario design and typology impact – including a 50% additional buffer around scenario costs to ensure potentially additional costs of urban cooling are not excluded
- calculates the total value of additional urban cooling benefits, including the avoided social cost of death and the avoided financial cost to the health system associated with ambulance call-outs and emergency department treatments, required to achieve a BCR of 1 or NPV of zero for each scenario. This assumes all impacts are incremental to the base case

As shown in **Table 13**, the break-even analysis indicates that changes under the IEQ and GI themes could deliver value to the community (i.e. incremental benefits outweigh incremental costs), if the investments assessed reduced the rate of urban-heat related deaths by between 0.07 and 1.5 people over the modelling period (depending on the scenario assessed).

Table 11: Results of breakeven analysis: Indicative incremental avoided deaths notionally required to reach a scenario BCR of 1

Scenario	Additional avoided deaths required over 20 year modelling period to achieve BCR of 1[11]	Monetised benefit[12]
RES 1 - Inner Urban ESD Policy	0.78 – 1.5	$1,305,517 - $2,496,916
RES 1 - Suburban Non-ESD Policy	0.76 – 1.5	$1,269,121 - $2,494,743
RES 4 - Suburban ESD Policy	0.10 – 0.2	$164,271 – $331,471
RES 4 - Suburban Non-ESD Policy	0.07 – 0.14	$112,603 - $240,210

Source: Frontier Economics.

[11] Figures assume each avoided death is incremental to the base case and that the profile of avoided deaths is constant over the 20 year modelling period

[12] In $2020-21, discounted at 7%

However, it should be noted that this analysis does not purport to identify whether the scenarios assessed are likely to reduce the burden of urban heat related diseases to this extent.

As discussed above, whether this outcome is achievable (i.e. whether the option could deliver value) will depend on a range of site-specific characteristics, such as the scale of the investment, the affected population – in some cases options may deliver a significant enough reduction in urban heat to deliver the required reduction in disease burden (and thus deliver benefit to the community), in others they may not.

While further site-specific analysis is required to identify whether these projects can deliver significant urban-heat related benefits to the community, given our experience applying this framework to projects elsewhere, we note that:

- These benefits are most likely to be realised in areas that already suffer from high temperatures – the UHI and the potential impact of alternative building materials or additional tree canopy for urban cooling is highly site specific and sensitive to microclimate, prevailing wind patterns, and a large range of other factors.
- The analysis draws on previous studies that considered the combination of changes to urban building materials *in combination with* very large-scale planting of broad-leaf urban canopy to drive reductions in temperature, rather than just the impact of alternative urban typologies alone.
- Benefits will only be realised at scale, for a number of key reasons:
    - Only very large developments are likely to be able to influence the ambient temperature – this cannot robustly be a consistent, ongoing impact attributed to a single (even large building). Sophisticated modelling can determine the extent to which quite a large development can reliably lower the peak temperature.
    - Benefits analysed rely on the statistical comparability of the local population assumed to benefit from (ie. live amongst) the alternative urban typologies/building standards and the general population both in terms of the age distribution and the burden of disease. The benefits therefore can only be considered achievable at the scale of an entire community and not any individual building or cluster of buildings.

4 Conclusion

4.1 Summary of key results

A key finding of this CBA for the Sustainability Planning Scheme Amendment is that the quantified costs exceeded the quantified benefits across each typology.

Importantly, the identified value of these options does not consider the broad range of unmonetised social and environmental impacts. Our breakeven analysis indicates that these projects may deliver value to the community (i.e. incremental benefits outweigh incremental costs) where sufficient scale is achieved.

4.2 Lessons and potential next steps

The key lessons from this project are:

- Overall, the size of benefits (especially those related to reducing disease burden) are likely to be more achievable for larger projects (i.e. scale matters). While a 1.5 person reduction in disease burden per building may appear like a small change, in practice, given overall disease burden, achieving this reduction on a building by building approach may be difficult.
- The size of the benefit in practice will be dependent on a range of site-specific characteristics, including population affected, urban temperature, whether there is pre-existing infrastructure (for example bicycle paths).
- Dollar benefits are likely to be higher when a larger population is involved. The primary driver of the difference between the case study results is the number of people that they affect.
- In considering which types of impacts to quantify, more effort should be expended on those impacts which are likely to be more significant given the circumstances of each case (e.g. urban heat effects in hot regions) and for which there is a sound evidence base.

Importantly, this analysis has been undertaken for a range of indicative projects, rather than for individual projects with site-specific characteristics. In practice, the value of these options is likely to vary significantly depending on the specific intervention and its location. As such there is likely to be value in undertaking further, place-based analysis to identify the value of individual projects. In considering the development of individual projects, key lessons from this project would suggest there is benefit in:

- Undertaking further research on the site-specific value of benefits. This could include site-specific analysis of the change in outcomes or a site-specific study of the community's willingness to pay for improvements in environmental and social outcomes (for example, the willingness to pay for improved biodiversity).
- Broadening the scale of the project - i.e rather than undertake an assessment of a development by development basis, broaden the assessment to development-wide or precinct-wide if possible.
- Focusing on areas where projects can make a large difference, for example, those where:
  - Urban heat is a large problem, so reductions in urban heat are likely to have a comparatively larger impact

- There is a large number vulnerable population (e.g. urban heat diseases impact the elderly and very young, and so reductions in urban heat diseases are most beneficial in areas with vulnerable populations)
- There are constraints in the supply of services, such as energy, water and waste (e.g. there isn't space for the next landfill, so deferring the need for the next landfill site is likely to be more beneficial, than in an area where there is significant space for landfill)

- Identifying the distribution of costs and benefits, to aid in the funding of these investments. It is important to recognise that quantification of benefits does not equate to funding for those investments. While broader benefits may present opportunities to generate additional funding, such projects will not be dependent on securing such funding.

A Detailed results

Net Present Value by theme

Table 12: Breakdown of Net Present Value by theme – ESD Policy base case (in dollars)

Typology	Note	RES 1	NON-RES 1	RES2	NON-RES 2	RES 3	NON-RES 3	RES 4
OPERATIONAL ENERGY NPV		88,506	95,222	-9,548	-314	-16,026	9,809	23,187
SUSTAINABLE TRANSPORT NPV		-37,841	11,936	1,149	-9,537	-1,230	4,265	6,060
INTEGRATED WATER MANAGEMENT NPV		-44,799	-15,000			734	1,405	1,359
INDOOR ENVIRONMENT QUALITY NPV	(No benefits quantified)	-929,187	-84,850	-17,904	-18,800	-1,910	-10,360	2,926
CIRCULAR ECONOMY NPV		133,325	-6,301	2,463	5,875	9,662	3,159	-17,283
GREEN INFRASTRUCTURE NPV	(No benefits quantified)	-515,520	-164,856		-219,328	-109,560	-133,820	-180,520

Table 13: Breakdown of Net Present Value by theme – Non-ESD Policy base case (in dollars)

Typology	Note	RES 1	NON-RES 1	RES2	NON-RES 2	RES 3	NON-RES 3	RES 4	RES 5
OPERATIONAL ENERGY NPV		109,704	118,864	-9,141	-5,004	-2,605	9,043	-8,508	-6,462
SUSTAINABLE TRANSPORT NPV		-265,744	5,160	-1,466	-5,614	-976	-6,213	13,492	8
INTEGRATED WATER MANAGEMENT NPV		-53,220	20,260	3,357	-5,499	2,967	-19,023	156	
INDOOR ENVIRONMENT QUALITY NPV	(No benefits quantified)	-929,187	-292,200	-19,808	-18,800	-1,910	-26,560	-24,674	-9,921
CIRCULAR ECONOMY NPV		323,887	83,954	7,565	28,810	9,662	12,504	-51,030	3,935
GREEN INFRASTRUCTURE NPV	(No benefits quantified)	-454,560	-410,856	-45,400	-292,928	-111,560	-119,060	-42,040	0

Sensitivity analysis

Table 14:Cost-benefit results for low discount rate sensitivities – ESD Policy base case (in dollars)

Typology	RES 1	NON-RES 1	RES2	NON-RES 2	RES 3	NON-RES 3	RES 4
TOTAL BENEFITS	1,587,383	392,144	33,551	33,205	45,447	41,334	235,152
TOTAL COSTS	2,502,678	512,383	46,929	265,036	154,698	159,192	355,324
NET PRESENT VALUES	-915,295	-120,238	-13,378	-231,831	-109,251	-117,857	-120,172
BENEFIT-COST RATIO	0.63	0.77	0.71	0.13	0.29	0.26	0.66
BENEFIT-COST RATIO (IEQ & GI EXCLUDED)	1.50	1.49	1.16	1.23	1.05	2.75	1.33

Table 15: Cost-benefit results for low discount rate sensitivities – Non-ESD Policy base case (in dollars)

Typology	RES 1	NON-RES 1	RES2	NON-RES 2	RES 3	NON-RES 3	RES 4	RES 5
TOTAL BENEFITS	1,644,524	590,136	40,311	65,074	53,658	65,723	192,559	7,495
TOTAL COSTS	2,562,107	1,008,945	97,072	364,681	146,298	217,668	289,622	20,086
NET PRESENT VALUES	-917,583	-418,809	-56,761	-299,607	-92,640	-151,945	-97,062	-12,591
BENEFIT-COST RATIO	0.64	0.58	0.42	0.18	0.37	0.30	0.66	0.37
BENEFIT-COST RATIO (IEQ & GI EXCLUDED)	1.40	1.93	1.27	1.23	1.63	0.91	0.86	0.74

Table 16: Cost-benefit results for high discount rate sensitivities – ESD Policy base case (in dollars)

Typology	RES 1	NON-RES 1	RES2	NON-RES 2	RES 3	NON-RES 3	RES 4
TOTAL BENEFITS	780,960	234,160	17,056	16,932	26,356	24,288	131,398
TOTAL COSTS	2,310,152	424,191	46,929	264,967	154,698	154,315	321,196
NET PRESENT VALUES	- 1,529,192	-190,031	-29,873	-248,035	-128,342	-130,027	-189,798
BENEFIT-COST RATIO	0.34	0.55	0.36	0.06	0.17	0.16	0.41
BENEFIT-COST RATIO (IEQ & GI EXCLUDED)	0.9	1.34	0.59	0.63	0.61	2.4	0.91

Table 17: Cost-benefit results for high discount rate sensitivities – Non-ESD Policy base case (in dollars)

Typology	RES 1	NON-RES 1	RES2	NON-RES 2	RES 3	NON-RES 3	RES 4	RES 5
TOTAL BENEFITS	914,800	354,087	23,424	44,082	30,347	37,993	112,154	5,354
TOTAL COSTS	2,383,835	905,070	97,072	363,767	146,298	193,259	234,182	20,086
NET PRESENT VALUES	-1,469,035	-550,983	-73,647	-319,685	-115,951	-155,266	-122,029	-14,732
BENEFIT-COST RATIO	0.38	0.39	0.24	0.12	0.21	0.20	0.48	0.27
BENEFIT-COST RATIO (IEQ & GI EXCLUDED)	0.91	1.75	0.74	0.85	0.92	0.8	0.66	0.53

Table 18: Cost-benefit results for high benefits – ESD Policy base case (in dollars)

Typology	RES 1	NON-RES 1	RES2	NON-RES 2	RES 3	NON-RES 3	RES 4
TOTAL BENEFITS	1,375,906	434,925	31,273	33,616	46,769	43,004	238,823
TOTAL COSTS	2,543,875	544,956	46,929	265,059	154,698	161,359	365,972
NET PRESENT VALUES	-1,167,969	-110,032	-15,656	-231,443	-107,929	-118,355	-127,149
BENEFIT-COST RATIO	0.54	0.80	0.67	0.13	0.30	0.27	0.65
BENEFIT-COST RATIO (IEQ & GI EXCLUDED)	1.25	1.47	1.08	1.25	1.08	2.5	1.27

Table 19: Cost-benefit results for high benefits – Non-ESD Policy base case (in dollars)

Typology	RES 1	NON-RES 1	RES2	NON-RES 2	RES 3	NON-RES 3	RES 4	RES 5
TOTAL BENEFITS	1,566,286	647,680	42,256	74,303	54,102	64,862	193,831	8,374
TOTAL COSTS	2,601,722	1,040,108	97,072	364,715	146,298	220,328	302,634	20,086
NET PRESENT VALUES	-1,035,436	-392,427	-54,816	-290,412	-92,196	-155,466	-108,803	-11,712
BENEFIT-COST RATIO	0.60	0.62	0.44	0.20	0.37	0.29	0.64	0.42
BENEFIT-COST RATIO (IEQ & GI EXCLUDED)	1.29	1.92	1.33	1.4	1.65	0.87	0.82	0.82

Table 20: Cost-benefit results for low benefits – ESD Policy base case (in dollars)

Typology	RES 1	NON-RES 1	RES2	NON-RES 2	RES 3	NON-RES 3	RES 4
TOTAL BENEFITS	778,655	154,362	14,904	12,165	19,823	18,337	101,431
TOTAL COSTS	2,221,721	372,029	46,929	264,929	154,698	151,065	302,825
NET PRESENT VALUES	-1,443,065	-217,667	-32,025	-252,764	-134,875	-132,728	-201,394
BENEFIT-COST RATIO	0.35	0.41	0.32	0.05	0.13	0.12	0.33
BENEFIT-COST RATIO (IEQ & GI EXCLUDED)	1.0	1.26	0.51	0.45	0.46	2.66	0.8

Table 21: Cost-benefit results for low benefits – Non-ESD Policy base case (in dollars)

Typology	RES 1	NON-RES 1	RES2	NON-RES 2	RES 3	NON-RES 3	RES 4	RES 5
TOTAL BENEFITS	797,962	237,222	16,822	29,363	23,506	31,425	91,388	3,884
TOTAL COSTS	2,300,767	850,158	97,072	363,477	146,298	184,113	207,792	20,086
NET PRESENT VALUES	-1,502,805	-612,936	-80,250	-334,114	-122,792	-152,688	-116,403	-16,202
BENEFIT-COST RATIO	0.35	0.28	0.17	0.08	0.16	0.17	0.44	0.19
BENEFIT-COST RATIO (IEQ & GI EXCLUDED)	0.87	1.61	0.53	0.57	0.72	0.82	0.64	0.38

Table 22: Cost-benefit results for residual values – ESD Policy base case (in dollars)

Typology	RES 1	NON-RES 1	RES2	NON-RES 2	RES 3	NON-RES 3	RES 4
TOTAL BENEFITS	1,132,234	303,425	23,705	31,994	37,484	35,523	177,028
TOTAL COSTS	2,382,798	458,493	46,929	264,994	154,698	156,212	334,398
NET PRESENT VALUES	-1,250,563	-155,068	-23,224	-233,000	-117,214	-120,689	-157,370
BENEFIT-COST RATIO	0.48	0.66	0.51	0.12	0.24	0.23	0.53
BENEFIT-COST RATIO (IEQ & GI EXCLUDED)	1.15	1.41	0.8	0.85	0.77	2.55	1.09

Table 23: Cost-benefit results for residual values – Non-ESD Policy base case (in dollars)

Typology	RES 1	NON-RES 1	RES2	NON-RES 2	RES 3	NON-RES 3	RES 4
TOTAL BENEFITS	1,234,747	468,564	31,890	63,750	43,069	53,051	145,272
TOTAL COSTS	2,451,244	945,133	97,072	364,096	146,298	202,220	255,213
NET PRESENT VALUES	-1,216,497	-476,569	-65,182	-300,346	-103,229	-149,170	-109,941
BENEFIT-COST RATIO	0.50	0.50	0.33	0.18	0.29	0.26	0.57
BENEFIT-COST RATIO (IEQ & GI EXCLUDED)	1.11	1.83	0.93	0.99	1.18	0.85	0.75

B More information on benefit valuation

This appendix providers further information on our approach to valuing benefits in the CBA.

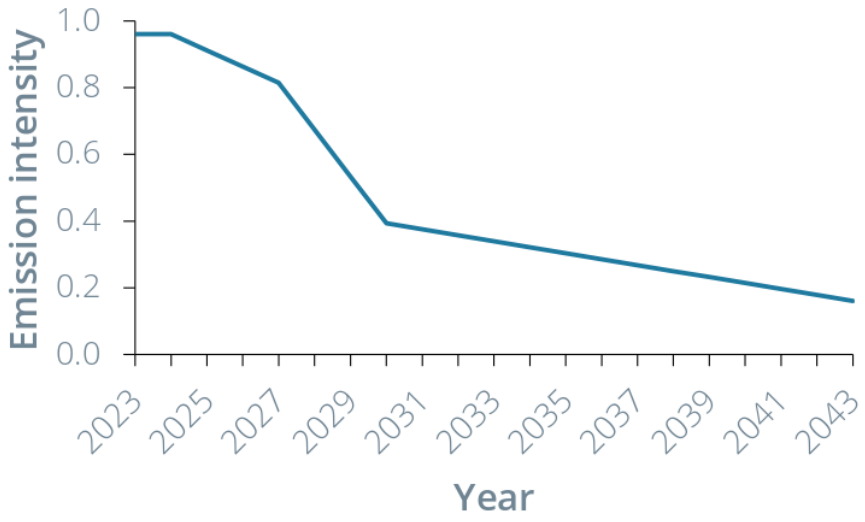
Avoided GHG emissions

Forecast emission intensity

As discussed in section 2.4, to estimate the value of avoided GHG emissions we have applied a forecast of the emission intensity of the Victorian electricity grid. The emission intensity of the grid is expected to fall over time as more renewable energy enters the market.

We have derived our forecasts from the Victorian Government's Victorian Energy Upgrades (VEU) program.[13] The VEU published forecast 10-year average emission intensity estimates. For example, the 10-year average emission intensity estimate for 2025 is 0.393 tonnes CO2-e/MWh. We have assumed this represents a reasonable point estimate for 2030. From 2030, we have assumed emission intensity tends towards zero in 2050 in line with the net zero commitment. Our forecast emission intensity is summarised in **Figure 5** below.

Figure 5: Forecast emission intensity (tCO2-e/MWh)



Source: Frontier Economics, based on Victorian Government commitments.

[13] See, https://engage.vic.gov.au/victorian-energy-upgrades/targets, accessed 29 October 2021.

Reduction in energy use

In valuing reduced energy consumption, it is sometimes considered that the value should be based on the reduction in retail electricity bills experienced by customers as a result of reduced consumption. However, this conflates economic benefits with distributional impacts. For instance, because many retail costs of energy are fixed (i.e. don't vary with the volume of energy consumed), reducing these costs for some customers results in them being redistributed to other customers.

Our approach to valuing benefits from reduced energy use is based on the estimated resource cost savings for society. These include:

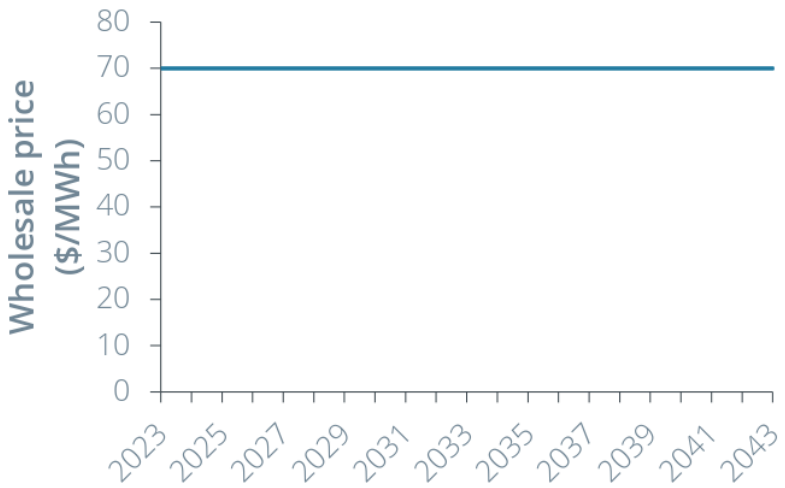
- variable costs avoided (estimated through wholesale market prices) and
- reduced capacity needed in the long run for electricity and gas network infrastructure.

Our approach is in line with guidance provided to the Australian Government for residential energy efficiency regulatory impact studies.[14]

Wholesale market prices

We have projected the wholesale electricity price will remain stable at $70/MWh ($0.07/kWh) as summarised **Figure 6**.

Figure 6: Wholesale electricity price projection ($/MWh)



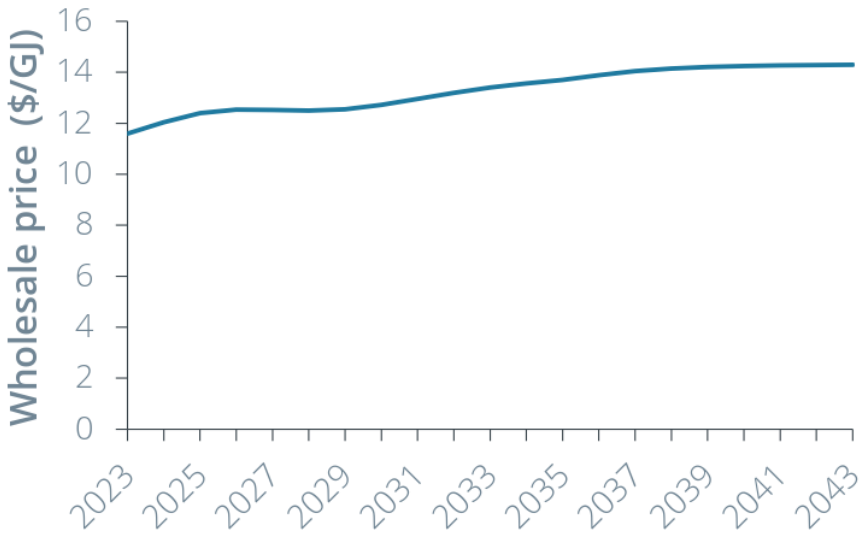
Source: Frontier Economics

Our forecast wholesale gas price is shown in **Figure 7** below. Our forecast derives from the Australian Energy Market Operators (AEMO's) 2022 Integrated System Plan (ISP). The ISP includes

[14] Houston Kemp, *Residential Buildings Regulatory Impact Statement Methodology – Report to the Department of Environment and Energy*, 6 April 2017, pp13-14.

a modelling assumptions workbook with generator fuel prices. We have applied prices for new combined cycle gas turbine (CCGT) generation in Victoria, as individual generator prices may reflect some view on their legacy contracts. We consider that CCGT is closer to the system profile for gas demand, compared to open cycle gas turbine (OCGT).

Figure 7: Wholesale gas price projections ($/GJ)



Source: AEMO, 2022 Integrated System Plan – Modelling assumptions workbook

Network costs

A reduction in energy use means that over the longer run investment in new generation capacity may be deferred or avoided. The change in costs as a consequence of small changes in electricity or gas consumption are known as the long run marginal costs (LRMC). LRMC is a forward-looking concept and amounts to a measure of the additional cost incurred as a result of a relatively small increase in output, assuming all factors of production are able to be varied.

Estimates of LRMC are available for electricity network businesses in Victoria as part of their Tariff Structure Statements.[15] We converted residential LRMC ($/kilowatt/pa) into a single rate LRMC by dividing by the number of hours in a year. This produced an estimate of around $0.01/kWh.

For deferred gas network costs, we have adopted an estimate of $4.50/GJ based on a recent Consultation RIS undertaken by ACIL Allen. This estimate is based on forecast capital expenditure on augmentations in the most recent revenue determinations for each gas distributor and the forecast growth in demand from new connections.

[15] For example, see https://jemena.com.au/documents/electricity/2021-2026_tariff-structure-statement.aspx

Avoided health costs of electricity generation

Electricity generation produces air pollution containing particulate matter, nitrogen oxides, sulphur dioxide, as well as other emissions. These can cause health problems such as respiratory illness and can also affect local economies.

We estimated the health benefits of reduced coal and gas-fired electricity using the studies referred to by ACIL Allen in the Consultation RIS for the National Construction Code 2022[16]. This resulted in avoided health damage costs of:

- $2.58/MWh for coal-fired generation
- $0.93/MWh for gas generation

We applied a weighted average of these values reflecting the share of coal (67.7%) and gas fired (4.5%) electricity generation in Victoria in 2020 ($1.78/MWh), declining over time as the rate as emission intensity discussed above.

Reduction in potable water use

We have valued reductions in potable water use brought about by elevated ESD standards based on LRMC. LRMC represents the cost of changing the capacity of a water supply system by building a permanent new supply source (such as a dam or a desalination plant). Water utilities use LRMC to decide if a water conservation activity is cheaper or more expensive than the cost of building a permanent augmentation to the water supply system. The LRMC applied in our analysis ($2,450/ML) is based on advice from Melbourne Water.

Avoided landfill / increased recycling

Estimates of reduced construction and demolition waste to landfill (tonnes) were multiplied by the full economic cost of landfill. To estimate the economic cost of landfill we:

- Reviewed published landfill gate fees for commercial and industrial waste and determined an indicative fee of $250/tonne (we placed more weight on metro rates given this is where most volume would be generated)
- Subtracted the current waste levy for industrial waste ($100/tonne) – average of metro and rural representing a financial transfer
- Added an estimate of externality costs of landfill representing visual disamenity ($1/tonne)[17]
- Subtracted an estimated recovery and processing cost for mixed concrete $43/tonne (including transport)[18]

16 ACIL Allen, National Construction Code 2022 Consultation Regulation Impact Statement for a proposal to increase residential building energy efficiency requirements, 20 September 2021, pp 90-21 https://acilallen.com.au/uploads/projects/377/ACILAllen_RISProposedNCC2022_2021.pdf

17 This estimate derives from the BDA Group, The full cost of landfill disposal in Australia, July 2009, see: https://www.awe.gov.au/sites/default/files/documents/landfill-cost.pdf

18 The estimate derives from Synergies Economic Consulting, Cost-benefit analysis of the implementation of landfill disposal bans in Queensland, November 2014, pp 27-29 https://www.synergies.com.au/wp-content/uploads/2019/09/cost-benefit-analysis-landfill-disposal-bans.pdf

- Added an estimated value of recovered materials for mixed concrete of $18/tonne)[19]

This approach provides an estimate of the avoided cost of landfill and value of recovered materials of $125/tonne.

[19] Ibid

C Literature review

Table 24: Literature review

Source	Topic	Key findings	Location
JONES, R. N., SYMONS, J. AND YOUNG, C. K. (2015) ASSESSING THE ECONOMIC VALUE OF GREEN INFRASTRUCTURE: GREEN PAPER. CLIMATE CHANGE WORKING PAPER NO. 24. VICTORIA INSTITUTE OF STRATEGIC ECONOMIC STUDIES, VICTORIA UNIVERSITY, MELBOURNE	Defining Green Infrastructure	Definitions of Green Infrastructure encompasses "blue" infrastructure, some definitions are linked to the functions of the Green infrastructure.	Australia, Victoria
	Value of Green Infrastructure	Non-use values are intangible values that have strong ethical component. They are important because once Green Infrastructure is removed, it is very hard to replace. Social benefits cover physical benefits (e.g. green infrastructure has been found to increase opportunities for recreation), social (e.g. green infrastructure has been found to reduce crime rates and improves patient recovery) and psychological and community-related benefits (e.g. green infrastructure has been found to enhance comfort).	Australia, Victoria
	Economic monetisation: Overview of methods	Some of the largest criticisms of individuals' willingness to pay approaches have come from behavioural economics. When asking what people would pay to gain, or not to lose or to gain a particular thing, Kahneman and Tversky, 1979, found that people valued the loss of something about twice as much as they valued obtaining the same thing. This was developed into prospect theory which states that people make decisions based on the potential value of losses and gains rather than the final outcome, and that people evaluate these losses and gains using certain heuristics, or rules of thumb.	Australia, Victoria

SYMONS, J., JONES, R.N., YOUNG, C.K. AND RASMUSSEN, B. (2015) ASSESSING THE ECONOMIC VALUE OF GREEN INFRASTRUCTURE: LITERATURE REVIEW. CLIMATE CHANGE WORKING PAPER NO 23. VICTORIA INSTITUTE OF STRATEGIC ECONOMIC STUDIES, VICTORIA UNIVERSITY, MELBOURNE	Economic monetisation: Applying these methods	Existing studies can be used (transferred) to estimate the economic value of changes stemming from other programmes or policies. In conducting an economic valuation with a benefits transfer, it is important to find the most appropriate studies to use in the benefits transfer exercise. However, the technique can also misjudge values by a factor of over 100% if not carried out with care (Rosenberger and Stanley, 2006).	Australia, Victoria
	Defining Green Infrastructure	There is no generally agreed definitions for Green Infrastructure. Some definitions are geared towards functionality of the Green Infrastructure and can be detailed to varying extents.	Australia, Victoria
	Value of Green Infrastructure	Identifies human well-being benefits as those arising from better access to green spaces increasing physical activity levels, increase in transport walking due land-use mix, better mental health due to regular contact with nature, etc. Environmental benefits include reductions in the urban heat island effect, carbon sequestration/storage and avoided emissions, air quality improvement, water cycle modification, flow control and flood reduction and water quality improvement and protection of Biodiversity (species diversity and population viability; habitat and corridors).	Australia, Victoria
	Economic monetisation: Applying these methods	A more sophisticated approach called the transfer function approach where the results from one study are adapted and modified to make it more suitable to another situation – for example making adjustments for location or socio-economic factors. However, the validity of the benefit transfer approach depends upon the rigour of the original study upon which it is based (ECOTEC, 2008) and the suitability of the target area for the transfer.	Australia, Victoria

BADIU, D., ET AL. (2019). "DISENTANGLING THE CONNECTIONS: A NETWORK ANALYSIS OF APPROACHES TO URBAN GREEN INFRASTRUCTURE"	Defining Green Infrastructure	Green Infrastructure definitions evolved over time from the concept of green spaces meant especially to improve the aesthetics of cities, before being associated with health and environmental benefits with the capacity to be connected and to provide several functions. Now, Green Infrastructure is part of larger concepts, such as ecosystem services and is a key element for providing a more healthier environment, for tackling challenges such as climate change, air pollution, water management and social injustice. The concepts associated with Green Infrastructure are determined by their relationship with society.	Global
WORLD HEALTH ORGANISATION (2016). "URBAN GREEN SPACES AND HEALTH: A REVIEW OF EVIDENCE"	Defining Green Infrastructure	There is no universally accepted definition of urban green space, with regard to its health and well-being impacts. Urban green spaces may include places with 'natural surfaces' or 'natural settings', but may also include specific types of urban greenery, such as street trees, and may also include 'blue space' which represents water elements ranging from ponds to coastal zones.	Global
	Value of Green Infrastructure	Green infrastructure can be associated with exposure to air pollutants, risk of allergies and asthma, exposure to pesticides and herbicides, exposure to disease vectors and zoonotic infections, accidental injuries, excessive exposure to UV radiation, vulnerability to crime. However, these detrimental effects are associated with poor maintenance of Green Infrastructure, and thus, can be reduced or prevented through proper planning, organisation and maintenance.	Global
TRANSPORT FOR NEW SOUTH WALES (TFNSW). "COST BENEFIT ANALYSIS GUIDE", (2019)	Benefit valuation: Valuation is more than monetisation of outcomes	Provides guidance on measuring benefits relating to active transport and environmental externalities. TfNSW publishes a set of economic parameters which reveals the estimated value of walking and cycling (in $/km) relating to various factors from accident cost to air pollution.	Australia, NSW

NSW HEALTH. "GUIDE TO COST BENEFIT ANALYSIS OF HEALTH CAPITAL PROJECTS", (2018)	Benefit valuation: Valuation is more than monetisation of outcomes	Prescribes guidance on measuring health benefits by service stream/scope and improvements in health outcomes, such as the use of the concept known as the disability-adjusted life year (DALY) to quantify health impact, as well as the valuing of health impact via reduced mortality or reduced morbidity.	Australia, NSW
NSW TREASURY. "GUIDE TO COST BENEFIT ANALYSIS", (2017)	Benefit valuation: Valuation is more than monetisation of outcomes	Sector-specific guidance on cost benefit analysis exists for coastal management, energy efficiency and mining and coal seam gas proposals.	Australia, NSW
UNITED STATES ENVIRONMENTAL PROTECTION AGENCY ENVIROATLAS 18; URBAN ATLAS IN THE EUROPEAN UNION, 2011	Defining Green Infrastructure	A narrower approach defines Green Infrastructure as "all vegetated land, including agriculture, lawns, forests, wetlands, and gardens. Barren land and impervious surfaces such as concrete and asphalt are excluded." This is similar to "public green areas used predominantly for recreation such as gardens, zoos, parks, and suburban natural areas and forests, or green areas bordered by urban areas that are managed or used for recreational purposes"	USA
GHOFRANI ET AL., "A COMPREHENSIVE REVIEW OF BLUE-GREEN INFRASTRUCTURE CONCEPTS", (2017); HAMMER ET AL., "CITIES AND GREEN. GROWTH: A CONCEPTUAL FRAMEWORK", (2011)	Defining Green Infrastructure	Many sources consider Green Infrastructure in conjunction with Blue Infrastructure as an interconnected network of natural and designed landscapes. This includes waterways, wetlands, wildlife habitats greenways, parks, working farms, forests, which provide multiple functions. This definition is also extended in cases to include cemeteries, squares and plazas, and pathways and greenways.	Australia

VICTORIA STATE GOVERNMENT. "A FRAMEWORK FOR PLACE-BASED APPROACHES", (2020)	Economic monetisation methods: Economic monetisation	The idea of a place-based understanding or approach is one that targets the specific circumstances of a place and engage local people as active participants in development and implementation, requiring government to share decision-making. Place-based approaches can complement the bigger picture of services and infrastructure. They engage with issues and opportunities that are driven by complex, intersecting local factors and require a cross-sectoral or long-term response.	Australia, Victoria
INFRASTRUCTURE AUSTRALIA. "PLANNING LIVEABLE CITIES", (2018)	Economic monetisation methods: Economic monetisation	Cities require a greater focus on the holistic needs of communities and places, rather than on the services provided by individual sectors. This is particularly true in precincts where growth is occurring rapidly. Governments should therefore develop 'place-based' planning frameworks to ensure that the full range of infrastructure communities require, across sectors, is considered when planning for growth.	Australia
LOOMIS, J., (2011) "WHAT'S TO KNOW ABOUT HYPOTHETICAL BIAS IN STATED PREFERENCE VALUATION STUDIES?" JOURNAL OF ECONOMIC SURVEYS, 25, 363-370	Economic monetisation: Overview of methods	Stated and revealed preferences methods may work in market-like situations, but they cannot readily be extended to public goods, where the gain/loss bias increases up to 3:1.	General

GSOTTBAUER AND VAN DEN BERGH, "ENVIRONMENTAL POLICY THEORY GIVEN BOUNDED RATIONALITY AND OTHER-REGARDING PREFERENCES", (2011)	Economic monetisation: Overview of methods	Provides a useful and comprehensive survey of behavioural economics and environmental regulation summarising many of these issues. One study that asked people for their willingness to pay for services in urban green spaces and also asked for their perceived gains in wellbeing found that the results were mutually consistent (Dallimer et al., 2014), suggesting that such methods can be reliable when assessing personal benefit.	General
GILES-CORTI, B., ET AL. (2005). "INCREASING WALKING: HOW IMPORTANT IS DISTANCE TO, ATTRACTIVENESS, AND SIZE OF PUBLIC OPEN SPACE?" AMERICAN JOURNAL OF PREVENTIVE MEDICINE 28(2): 169-176.	Improved natural environments and active recreation	Found that access to proximate and large public open space with attractive attributes such as trees, water features and bird life is associated with higher levels of walking. Individuals with 'very good access' to public open space were 2.05 times as likely to use than those with very poor access. Those who used POS were 2.66x as likely to achieve recommended levels of physical activity (30min for 5 days). While accessibility was not significantly associated with achieving overall sufficient levels of activity, those with very good access to attractive and large public open space were 1.24-1.5 times more likely to achieve high levels of walking.	Australia, WA, Perth

BALL, K., ET AL. (2001). "PERCEIVED ENVIRONMENTAL AESTHETICS AND CONVENIENCE AND COMPANY ARE ASSOCIATED WITH WALKING FOR EXERCISE AMONG AUSTRALIAN ADULTS." PREVENTIVE MEDICINE 33(5): 434-440.	Improved natural environments and physical activity	Those reporting a moderately aesthetic environment were 16% less likely, and those reporting a low aesthetic environment were 41% less likely to walk for exercise relative to high aesthetic. Similarly – for moderately convenient 16% less likely and low convenience were 36% less likely to walk for exercise	Australia, NSW
GRIGSBY-TOUSSAINT, D. S., ET AL. (2011). "WHERE THEY LIVE, HOW THEY PLAY: NEIGHBORHOOD GREENNESS AND OUTDOOR PHYSICAL ACTIVITY AMONG PRESCHOOLERS." INTERNATIONAL JOURNAL OF HEALTH GEOGRAPHICS 10(1): 66.	Improved natural environments and physical activity	Higher levels of neighbourhood greenness as measured by the Normalized Difference Vegetation Index (NDVI) was associated with higher levels of outdoor playing time among preschool-aged children in our sample. Specifically, a one unit increase in neighbourhood greenness increased a child's outdoor playing time by approximately 3 minutes.	USA, Chicago, Illinois

BARTON, J. AND M. ROGERSON (2017). "THE IMPORTANCE OF GREENSPACE FOR MENTAL HEALTH." BJPSYCH. INTERNATIONAL 14(4): 79-81.	Physical activity and health outcomes	Incorporating green spaces into building architecture, healthcare facilities, social care settings, homes and communities will encourage physical activity (PA), which may lead to greater social interaction and wellbeing. Extra weekly use of the natural environment for PA reduces the risk of poor mental health by 6%	United Kingdom
ZAPATA-DIOMEDI, B., ET AL. (2018). "A METHOD FOR THE INCLUSION OF PHYSICAL ACTIVITY-RELATED HEALTH BENEFITS IN COST-BENEFIT ANALYSIS OF BUILT ENVIRONMENT INITIATIVES." PREVENTIVE MEDICINE 106: 224-230.	Physical activity and health outcomes Health outcomes and economic outcomes	They estimated the change in population level of PA attributable to a change in the environment due to the intervention. Then, changes in population levels of PA were translated into monetary values. Improvements in neighbourhood environments conferred estimated annual physical activity related health benefit worth up to $70 per person. Improving neighbourhood walkability was estimated to be worth up to $30 and improvements in sidewalk availability up to $22 per adult resident. Value of physical activity health related benefits of walking and cycling is $0.98 and $0.62 per kilometre respectively.	Australia

MARSELLE, M. R., ET AL. (2013). "WALKING FOR WELL-BEING: ARE GROUP WALKS IN CERTAIN TYPES OF NATURAL ENVIRONMENTS BETTER FOR WELL-BEING THAN GROUP WALKS IN URBAN ENVIRONMENTS?" INTERNATIONAL JOURNAL OF ENVIRONMENTAL RESEARCH AND PUBLIC HEALTH 10(11): 5603-5628.	Exposure to green space and mental health outcomes	Walking participants who frequently attended in green corridor spaces (-2.81) recorded significantly lower stress scores than those who walked in urban space.	England
BERMAN, M. G., ET AL. (2012). "INTERACTING WITH NATURE IMPROVES COGNITION AND AFFECT FOR INDIVIDUALS WITH DEPRESSION." JOURNAL OF AFFECTIVE DISORDERS 140(3): 300-305.	Exposure to green space and mental health outcomes	Working-memory capacity and positive affect improved to a greater extent after the nature walk relative to the urban walk. Interestingly, these effects were not correlated, suggesting separable mechanisms.	USA, Michigan
GILL, S. E., ET AL. (2007). "ADAPTING CITIES FOR CLIMATE CHANGE: THE ROLE OF THE GREEN INFRASTRUCTURE." BUILT ENVIRONMENT 33(1): 115-133.	Improved natural environments and UHI effect	The magnitude of the urban heat island effect can vary across time and space as a result of meteorological, locational and urban characteristics.	Global

NGIA (2012). MITIGATING EXTREME SUMMER TEMPERATURES WITH VEGETATION, NURSERY PAPERS 5, NURSERY AND GARDEN INDUSTRY AUSTRALIA. AVAILABLE AT: <HTTPS://WWW.NGIA.COM.AU/ATTACHMENT?ACTION=DOWNLOAD&ATTACHMENT_ID=1451>	Improved natural environments and UHI effect	Suburban areas are predicted to be around 0.5 degrees Celsius (C) cooler than the CBD, while a relatively leafy suburban area may be around 0.7 degrees C cooler than the CBD. A parkland (such as grassland, shrub-land and sparse forest) or rural area may be around 1.5 to 2 degrees C cooler than the CBD. Doubling the CBD vegetation coverage may reduce 0.3 degrees C ASDM temperature.	Australia, VIC, Melbourne
ADAMS, M. P. AND P. L. SMITH (2014). "A SYSTEMATIC APPROACH TO MODEL THE INFLUENCE OF THE TYPE AND DENSITY OF VEGETATION COVER ON URBAN HEAT USING REMOTE SENSING." LANDSCAPE AND URBAN PLANNING 132: 47-54.	Improved natural environments and UHI effect	Found that overall, increasing tree cover reduces average surface temperatures more dramatically than mixed vegetation cover. In a combined model of vegetation and other environmental factors, increase in 1 foliage projection cover (% of area covered by trees) decreases LST by 0.113 degrees C.	Australia, NSW, Sydney

CRCWSC (2016), IMPACTS OF WATER SENSITIVE URBAN DESIGN SOLUTIONS ON HUMAN THERMAL COMFORT, <HTTPS://WATERSENSITIVECITIES.ORG.AU/WP-CONTENT/UPLOADS/2016/07/TMR_B3-1_WSUD_THERMAL_COMFORT_NO2.PDF>	Improved natural environments and UHI effect	Research found trees can lower the Urban Thermal Climate Index by up to 10 degrees C reducing heat stress from 'very strong' to 'strong'.	Australia
SUSCA, T., ET AL. (2011). "POSITIVE EFFECTS OF VEGETATION: URBAN HEAT ISLAND AND GREEN ROOFS." ENVIRONMENTAL POLLUTION 159(8-9): 2119-2126.	Improved natural environments and UHI effect	The study monitored the urban heat island in four areas of New York City and found an average of 2 degrees C difference of temperatures between the most and the least vegetated areas, ascribable to the substitution of vegetation with man-made building materials.	United States, New York City

BOWLER, D. E., ET AL. (2010). "URBAN GREENING TO COOL TOWNS AND CITIES: A SYSTEMATIC REVIEW OF THE EMPIRICAL EVIDENCE." LANDSCAPE AND URBAN PLANNING 97(3): 147-155..	Improved natural environments and UHI effect	The average temperature reduction in the day was 0.94 degrees C between the urban temperature and the park temperature.	Spain, Italy, Mexico, Japan, Taiwan, Singapore, Sweden, Botswana, USA, Germany, Israel, Russia, Canada, UK and Greece
OLIVEIRA, S., ET AL. (2011). "THE COOLING EFFECT OF GREEN SPACES AS A CONTRIBUTION TO THE MITIGATION OF URBAN HEAT: A CASE STUDY IN LISBON." BUILDING AND ENVIRONMENT 46(11): 2186-2194.	Improved natural environments and UHI effect	Park cool island (PCI) effect was a median 1.5 degrees C difference between the surrounding atmospheric environment and the garden (ranging from 1 - 2.6 degrees C).	Portugal, Lisbon

VOELKER, S., ET AL. (2013). "EVIDENCE FOR THE TEMPERATURE-MITIGATING CAPACITY OF URBAN BLUE SPACE—A HEALTH GEOGRAPHIC PERSPECTIVE." ERDKUNDE: 355-371.	Improved natural environments and UHI effect	Concluded that the bluespaces studied could provide a cooling effect of 2.5 K on average. Wetlands showed the strongest effect (ΔT=5.2 K, min=4.8 K, max=5.6 K, n=2) and ponds the least (ΔT=1.6 K, min=0.4 K, max=4.7 K, n=6). Rivers showed a ΔT of 2.1 K (min=0.6 K, max=4 K, n=8), the unspecified urban blue space type "water" 2.5 K (min=0.5 K, max=3.4 K, n=5).	Portugal, Japan, Germany, China, Canada
SUN, R. AND L. CHEN (2017). "EFFECTS OF GREEN SPACE DYNAMICS ON URBAN HEAT ISLANDS: MITIGATION AND DIVERSIFICATION." ECOSYSTEM SERVICES 23: 38-46.	Improved natural environments and UHI effect	When there was green expansion minor decreases in LST were recorded at -1.11degrees C to -0.67 degrees C. Major increases in LST were recorded in areas of green loss (1.64-2.21degrees C)	China, Beijing
GILL, S. E., ET AL. (2007). "ADAPTING CITIES FOR CLIMATE CHANGE: THE ROLE OF THE GREEN INFRASTRUCTURE." BUILT ENVIRONMENT 33(1): 115-133.	Improved natural environments and UHI effect	Using the conurbation of Greater Manchester, investigation found that green infrastructure, specifically green rooftops, reduced surface temperature by 6.6 degrees between 1961-1990, making it an effective strategy to keep surface temperatures below the baseline level. Less vegetated surface areas will decrease evaporative cooling, whilst an increase in vegetative surface sealing results in increased surface runoff.	United Kingdom

ADAMS, M. P. AND P. L. SMITH (2014). "A SYSTEMATIC APPROACH TO MODEL THE INFLUENCE OF THE TYPE AND DENSITY OF VEGETATION COVER ON URBAN HEAT USING REMOTE SENSING." LANDSCAPE AND URBAN PLANNING 132: 47-54.	Improved natural environments and UHI effect	Increasing tree covers reduces average surface temperature significantly more than mixed vegetation cover. If an area with no vegetation was to be replaced by a typical parkland, land surface temperature would be reduced by 3.48 degrees C	Australia, Sydney

NSW OFFICE OF ENVIRONMENT AND HERITAGE (2015). URBAN GREEN COVER IN NSW: TECHNICAL GUIDELINES, NSW GOVERNMENT. AVAILABLE AT: <HTTPS://CLIMATECHANGE.ENVIRONMENT.NSW.GOV.AU/-/MEDIA/NARCLIM/FILES/SECTION-4-PDFS/URBAN-GREEN-COVER-TECHNICAL-GUIDELINES.PDF?LA=EN&HASH=C7FCADABE417DD2DF67461F067463054D9408E2F>	Improved natural environments and UHI effect	Dark, impervious surfaces can absorb solar energy, causing the temperature of the city to rise as much as 10-20 degrees C higher than surrounding air temperatures. Every 10% increase in tree cover can reduce land surface temperatures by more than 1 degree Celsius. This means that a 14% increase in tree cover would offset this thermal loading effect	Australia, NSW

LOUGHNAN, M. E., ET AL. (2010). "THE EFFECTS OF SUMMER TEMPERATURE, AGE AND SOCIOECONOMIC CIRCUMSTANCE ON ACUTE MYOCARDIAL INFARCTION ADMISSIONS IN MELBOURNE, AUSTRALIA." INTERNATIONAL JOURNAL OF HEALTH GEOGRAPHICS 9(1): 41.	UHI effect and health outcomes	Positive association between AMI admission to hospital and age and socioeconomic inequality. Residents from highest or lowest socioeconomic standing more likely to be admitted for AMI; younger people most likely to be admitted.	Australia, Melbourne

PHUNG, D., ET AL. (2016). "AMBIENT TEMPERATURE AND RISK OF CARDIOVASCULAR HOSPITALIZATION: AN UPDATED SYSTEMATIC REVIEW AND META-ANALYSIS." SCIENCE OF THE TOTAL ENVIRONMENT 550: 1084-1102.	UHI effect and health outcomes	The pooled results suggest that for a change in temperature condition, the risk of cardiovascular hospitalization increased 2.8% for cold exposure, 2.2% for heatwave exposure, and 0.7% for an increase in diurnal temperature. No association was observed for heat exposure. Effects did change when incorporating variation of effect sizes: 7.8% for cold exposure, 1% for heat exposure, 6.1% for heatwave exposure, and 1.5% for an increase in diurnal temperature.	Germany, South Korea, Greece, UK, Taiwan, Australia, China, Portugal, Japan, USA, Vietnam, Mozambique, Czech Republic, Denmark, Thailand, Italy, Lithuania, Slovenia, France and Russia

MUELLER, N., ET AL. (2016). "URBAN AND TRANSPORT PLANNING RELATED EXPOSURES AND MORTALITY: A HEALTH IMPACT ASSESSMENT FOR CITIES." ENVIRONMENTAL HEALTH PERSPECTIVES 125(1): 89-96.	UHI effect and health outcomes	Reducing heat by 4 degrees prevents 376 deaths, increasing life expectancy by 34 days.	Barcelona, Spain
YE, X., ET AL. (2011). "AMBIENT TEMPERATURE AND MORBIDITY: A REVIEW OF EPIDEMIOLOGICAL EVIDENCE." ENVIRONMENTAL HEALTH PERSPECTIVES 120(1): 19-28.	UHI effect and health outcomes	The majority of studies reported a significant relationship between ambient temperature and total or cause-specific morbidities. However, there were some inconsistencies in the direction and magnitude of nonlinear lag effects. The majority of studies reported detrimental effects of heat on the same day or up to the following 3 days.	USA, Canada, Japan, Taiwan, Australia, Greece, Spain, South Korea, UK, Switzerland and Italy

XU, Z., ET AL. (2012). "IMPACT OF AMBIENT TEMPERATURE ON CHILDREN'S HEALTH: A SYSTEMATIC REVIEW." ENVIRONMENTAL RESEARCH 117: 120-131.	UHI effect and health outcomes	The existing literature indicates that very young children, especially children under one year of age, are particularly vulnerable to heat-related deaths. Hot and cold temperatures mainly affect cases of infectious diseases among children, including gastrointestinal diseases and respiratory diseases. Pediatric allergic diseases, like eczema, are also sensitive to temperature extremes. During heat waves, the incidences of renal disease, fever and electrolyte imbalance among children increase significantly.	Peru, Malta, Japan, Germany, UK, Bangladesh, Burkina Faso, Australia, Spain, Greece, Taiwan, USA, Cameroon and Singapore
CENTER FOR DISEASE CONTROL AND PREVENTION (2006), HEAT ISLAND IMPACTS, VIEWED JANUARY 2018, <HTTPS://WWW.EPA.GOV/HEAT-ISLANDS/HEAT-ISLAND-IMPACTS#3>	UHI effect and health outcomes	Estimates that from 1979–2003, excessive heat exposure contributed to more than 8,000 premature deaths in the United States	United States

KABISCH, N., ET AL. (2017). "THE HEALTH BENEFITS OF NATURE-BASED SOLUTIONS TO URBANIZATION CHALLENGES FOR CHILDREN AND THE ELDERLY–A SYSTEMATIC REVIEW." ENVIRONMENTAL RESEARCH 159: 362-373.	UHI effect and health outcomes	Kabisch, van den Bosch and Lafortezza (2017) found that urban trees and other vegetation provides cooling through shade and evaportranspiration, which reduce the impact of the UHI on hot summer days	Global
KJELLSTROM, T. AND H. J. WEAVER (2009). "CLIMATE CHANGE AND HEALTH: IMPACTS, VULNERABILITY, ADAPTATION AND MITIGATION." NEW SOUTH WALES PUBLIC HEALTH BULLETIN 20(2): 5-9.	UHI effect and health outcomes	Heat island effect contributes to greater heat exposure, which is positively associated with morbidity and mortality; mortality increases at temperatures above 28 degrees C, particularly amongst people 65+ years.	Australia, ACT

PERČIČ, S., ET AL. (2018). "NUMBER OF HEAT WAVE DEATHS BY DIAGNOSIS, SEX, AGE GROUPS, AND AREA, IN SLOVENIA, 2015 VS. 2003." INTERNATIONAL JOURNAL OF ENVIRONMENTAL RESEARCH AND PUBLIC HEALTH 15(1): 173.	UHI effect and health outcomes	People over 75 years and those with pre-existing acute circulatory diseases are most heavily impacted by heatwave. Risk factors of hypertension include being overweight and sedentary lifestyle. Older people with physiological cardiovascular impairment are more sensitive to heat waves	Slovenia
SMITH, K. R. AND P. J. ROEBBER (2011). "GREEN ROOF MITIGATION POTENTIAL FOR A PROXY FUTURE CLIMATE SCENARIO IN CHICAGO, ILLINOIS." JOURNAL OF APPLIED METEOROLOGY AND CLIMATOLOGY 50(3): 507-522.	UHI effect and urban environments	Widespread adoption of vegetated roofs could reduce localised temperatures up to 3 degrees C, but the effect is similar to other technologies (e.g. white roofs). The green roof approach also has several limitations including that the reduced temperature reduces natural circulation at the warmest times. Though this could reduce pollutants in the city, it also reduces natural cooling.	USA
ZANDER, K. K., ET AL. (2015). "HEAT STRESS CAUSES SUBSTANTIAL LABOUR PRODUCTIVITY LOSS IN AUSTRALIA." NATURE CLIMATE CHANGE 5(7): 647.	Health outcomes and economic outcomes	Estimated productivity may decrease by 11-27% in hot regions by 2080, and by 20% globally in hot months by 2050. Annual economic burden estimated to be US$6.2b for Australian workforce.	Australia

KJELLSTROM, T. AND H. J. WEAVER (2009). "CLIMATE CHANGE AND HEALTH: IMPACTS, VULNERABILITY, ADAPTATION AND MITIGATION." NEW SOUTH WALES PUBLIC HEALTH BULLETIN 20(2): 5-9.	Health outcomes and economic outcomes	Positive association between direct heat exposure and labourer's ability to carry out physical work, increased absenteeism and reduced labour productivity	Australia, ACT
GREEN BELT (2015). THE IMPACT OF GREEN SPACE ON HEAT AND AIR POLLUTION IN URBAN COMMUNITIES: A META-NARRATIVE SYSTEMATIC REVIEW. THE DAVID SUZUKI FOUNDATION. AVAILABLE AT: <HTTPS://DAVIDSUZUKI.ORG/WP-CONTENT/UPLOADS/2017/09/IMPACT-GREEN-SPACE-HEAT-AIR-POLLUTION-URBAN-COMMUNITIES.PDF>	Improved natural environments and UHI effect Improved natural environments and air quality	Among the identified studies on green space and air pollution, 92% reported pollution mitigating effects, Among studies on heat mitigation, 98% reported urban cooling effects associated with green space	USA, China, Japan, UK, Italy, Greece, Germany, Canada

VAN DEN BOSCH, M. AND Å. O. SANG (2017). "URBAN NATURAL ENVIRONMENTS AS NATURE-BASED SOLUTIONS FOR IMPROVED PUBLIC HEALTH–A SYSTEMATIC REVIEW OF REVIEWS." ENVIRONMENTAL RESEARCH 158: 373-384.	Improved natural environments and all health risk factors All health risk factors and health outcomes	Increase in natural green space accessibility strongly associated with increased physical activity, with greatest benefit being reduced cardio-vascular disease (CVD) risk and related mortality. Inconclusive association between obesity as an outcome of physical inactivity but strong evidence of association between obesity and CVD, and obesity and mental disorders. Strong association between physical activity and reduced levels of anger and sadness. Association between excess heat and disease susceptibility due to reduced 'adaptation capacity of human thermoregulation' (may exacerbate existing chronic conditions). Moderate to strong evidence of positive association between green space and all-cause mortality	Global
OFFICE OF BEST PRACTICE REGULATION (2014). BEST PRACTICE REGULATION GUIDANCE NOTE VALUE OF STATISTICAL LIFE. AUSTRALIAN GOVERNMENT DEPARTMENT OF THE PRIME MINISTER AND CABINET. AVAILABLE AT: <HTTPS://WWW.PMC.GOV.AU/SITES/DEFAULT/FILES/PUBLICATIONS/VALUE_OF_STATISTICAL_LIFE_GUIDANCE_NOTE.PDF >	Health outcomes and economic outcomes	WTP method is most appropriate for measuring the value of statistical life (reductions in the risk of physical harm). WTP involves identifying how much a consumer would pay for products that reduce/mitigate the risk of death or serious injury	Global

ABELSON, P. (2008). ESTABLISHING A MONETARY VALUE FOR LIVES SAVED: ISSUES AND CONTROVERSIES. OFFICE OF BEST PRACTICE REGULATION. AVAILABLE AT: <HTTPS://WWW.PMC.GOV.AU/SITES/DEFAULT/FILES/PUBLICATIONS/WORKING_PAPER_2_PETER_ABELSON.PDF>	Health outcomes and economic outcomes	VSL from studies ranged from A$3m to A$15m. Paper suggests that public agencies in Australia adopt a VSL of $3.5m for avoiding an immediate death of a healthy individual in middle age (about 50) or younger; a constant VLY of $151 000 which is independent of age; and age-specific VSLS for older persons equal to the present value of future VLYs of $151,000 discounted by 3% per annum.	Australia
ACCESS ECONOMICS (2007). THE HEALTH OF NATIONS: THE VALUE OF STATISTICAL LIFE. AUSTRALIAN SAFETY AND COMPENSATION COUNCIL. AVAILABLE AT: <HTTPS://WWW.SAFEWORKAUSTRALIA.GOV.AU/SYSTEM/FILES/DOCUMENTS/1702/THEHEALTHOFNATIONS_VALUE_STATISTICALLIFE_2008_PDF.PDF>	Health outcomes and economic outcomes	While VSL is somewhat flawed as a concept to capture the value of health life, WTP approach to valuing human life have been the focus of the literature in this area since the 1960s. Revealed preference studies are generally considered superior to stated preference methods in revealing WTP as they are based on real world empirical binding market transactions. A literature review suggests a mean VSL in Australia of $5.7m and a median of $2.9m.	Global

ORGANISATION FOR ECONOMIC COOPERATION & DEVELOPMENT 2012, THE VALUATION OF MORTALITY RISK, MORTALITY RISK VALUATION IN ENVIRONMENT, HEALTH AND TRANSPORT POLICIES, OECD PUBLISHING. AVAILABLE AT: <HTTP://WWW.OECD.ORG/ENVIRONMENT/MORTALITYRISKVALUATIONINENVIRONMENTHEALTHANDTRANSPORTPOLICIES.HTM>	Health outcomes and economic outcomes	While in some cases, a new primary valuation study, tailored for the specific policy in question, might be needed in order to carry out an appropriate CBA, in many situations benefit transfer (where VSL values that have been estimated in one context are– with appropriate adjustments – used in policy assessments in another context) will generally be less time- and resource-consuming. Average adult VSL for OECD countries ranges between US $1.5m-4.5m, with a base value of US $3m.	Global
VISCUSI, W. K. AND J. E. ALDY (2003). "THE VALUE OF A STATISTICAL LIFE: A CRITICAL REVIEW OF MARKET ESTIMATES THROUGHOUT THE WORLD." NATIONAL BUREAU OF ECONOMIC RESEARCH WORKING PAPER SERIES 9487.	Health outcomes and economic outcomes	Median value of VSL of prime-aged workers is $7m Income elasticity of VSL ranges from 0.5 to 0.6	USA

JORDAN. H, DUNT ET. AL (UNDATED). MEASURING THE COST OF HUMAN MORBIDITY AND MORTALITY FROM ZOONOTIC DISEASES. AUSTRALIAN CENTRE OF EXCELLENCE FOR RISK ANALYSIS. AUSTRALIA. AVAILABLE AT: <HTTPS://CEBRA.UNIMELB.EDU.AU/__DATA/ASSETS/PDF_FILE/0008/2220875/1002BOID1FR.PDF>	Health outcomes and economic outcomes	Must consider burden of disease as when measuring consequences of illness; must consider single or multi-criteria approach, use of data, time and resources available, contribution of modelling and equity consideration when measuring economic costs WTP method may be warranted if intangible costs are important. Review recommends use of Cost of Illness method to measure economic costs of human morbidity and mortality	Australia
MARKEVYCH, I., ET AL. (2017). "EXPLORING PATHWAYS LINKING GREENSPACE TO HEALTH: THEORETICAL AND METHODOLOGICAL GUIDANCE." ENVIRONMENTAL RESEARCH 158: 301-317.	Improved natural environments and health outcomes	Green spaces have 3 functions: reducing harm (air pollution, noise reduction, heat reduction), restoring capacities (attention and focus restoration) & building capacities (encouraging physical activity & facilitating social cohesion). These functions may lead to improving physical health & wellbeing (self-perceived health, higher birth weight, lower BMI, lower risk of depression and cardiovascular disease)	Global

Source: Frontier Economics

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