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Social Ecological Economic Development Studies (SEEDS) Sustainability Program

Student Research Report

Policy and Process Considerations for Enhanced Resilience

A review of best practices and stakeholder perspectives to refine UBC's Residential Environmental Assessment Program (REAP)

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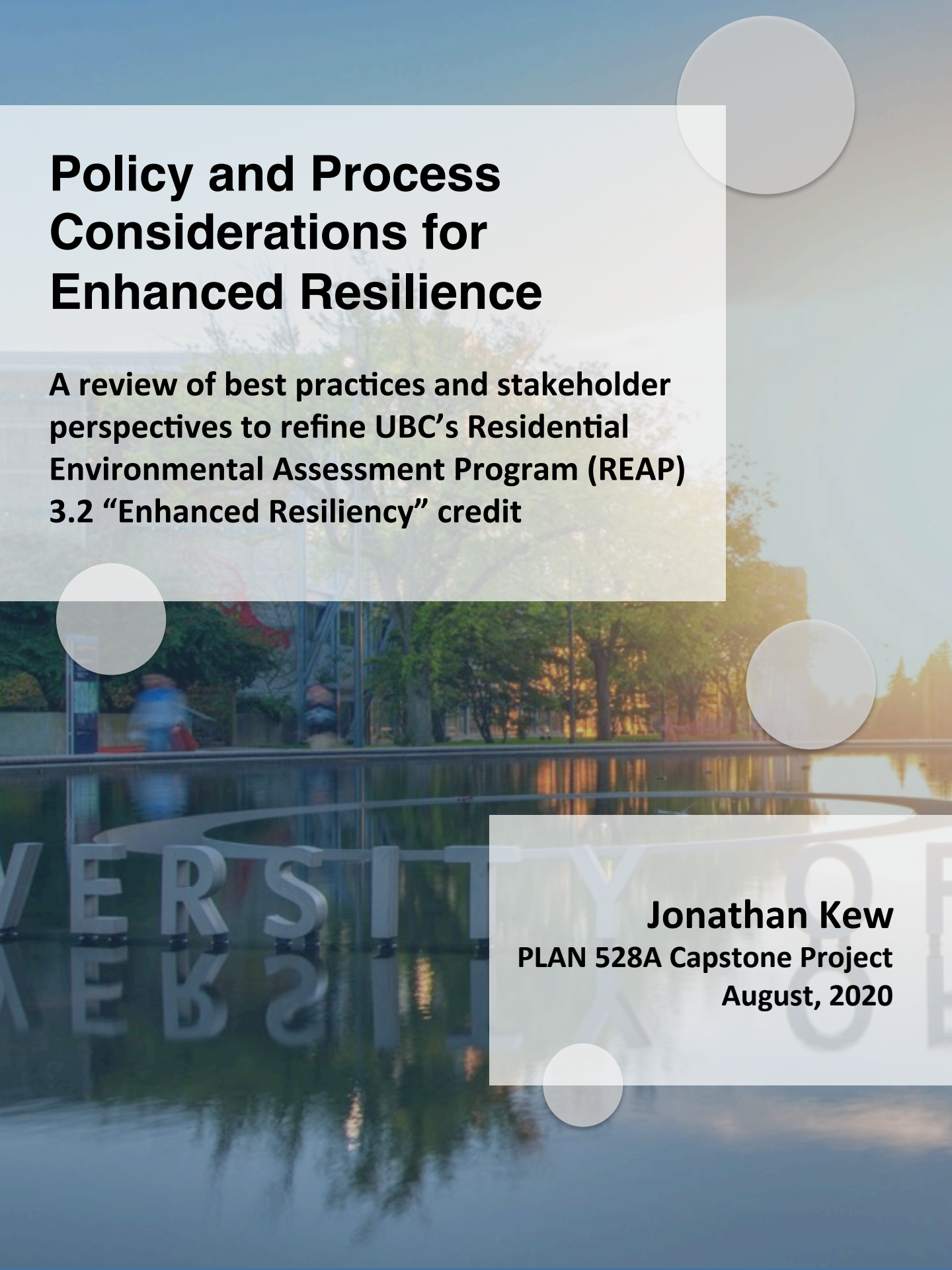

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UBC SEEDS Sustainability Program
Student Research Report

Policy and Process Considerations for Enhanced Resilience: A review of best practices and stakeholder perspectives to refine UBC's Residential Environmental Assessment Program (REAP) 3.2 "Enhanced Resiliency" credit

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Unceded Territory of xʷməθkʷəy̓əm (Musqueam) First Nation
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EXECUTIVE SUMMARY

The newest iteration of UBC's green-building rating system, REAP 3.2, will be the first to implement credits for resilience and climate adaptation. As REAP 3.2's Enhanced Resiliency credit references the BC Housing Mobilizing, Building and Advancing Resilience (MBAR) papers on strategies for climate-driven chronic stressors, this project entailed a literature review and interviews with four MBAR stakeholders, to determine whether the credits are aligned with expert perspectives.

With respect to findings, the interviewees generally agreed that REAP 3.2's Climate Adaptation category and Enhanced Resiliency credit represents a step in the right direction. But without an internal process at UBC to weigh, scale, or split the MBAR strategies into prerequisite and optional components, some stakeholders believed the credit would be less effective. Most stakeholders emphasized the importance of a deliberate facilitation process to align stakeholder goals, and to determine appropriate strategies for each development collaboratively. Models like the Integrated Building, Adaptation and Mitigation Assessment (IBAMA) framework are emerging as potential tools to structure an inclusive and comprehensive process for weighing climate mitigation and adaptation strategies.

REAP 3.2 does have some gaps. For instance, the current Climate Adaptation prerequisites do not cover all best practices emergency preparedness. Disease transmission and seismic resilience were identified as the major stressor gaps in the Enhanced Resiliency credit. The former is going to be added as a primer to the MBAR series soon, making it easy to integrate into the existing Enhanced Resiliency credit. More substantive earthquake resilience represents a more prohibitive cost, but was identified by multiple stakeholders and in the literature as the predominant gap in the provincial discussion. Other building rating systems provide credits for advocacy and education on-behalf of more rigorous earthquake codes, and this could represent an opportunity for UBC to advance the conversation.

Gaps in industry knowledge include the lack of a provincial resilient building database, a lack of post-occupancy analysis, and the need for more consideration of community resilience. UBC's neighbourhoods, with many non-English speaking residents, would be a valuable site to pilot multi-lingual programming. Each stressor also represents an opportunity for UBC to encourage design strategies that fulfill multiple sustainability goals.

There are more findings dispersed throughout this report. Altogether, based on the literature and input from MBAR stakeholders, REAP 3.2's Enhanced Resiliency credit and the Climate Adaptation category represent a sound approach to begin advancing resilient design at UBC. The primary challenge is in the disparate cost and effectiveness of the MBAR primer strategies, which is compounded by a lack of industry convergence on the best strategies. Whether UBC is able to weigh the strategies in-advance of the debut of REAP 3.2 or not, a deliberate facilitation process to identify the best strategies for each new development is recommended.

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TABLE OF CONTENTS

1.0 INTRODUCTION

1. BACKGROUND
2. INTENTION, SCOPE, METHODOLOGY

1.1 Background

Our climate is transforming. At the local scale, it is projected that buildings and neighbourhoods in the Lower Mainland will face more extreme precipitation events, drier summers, and shifting ecosystem conditions that will overload existing civic infrastructures (Metro Vancouver, 2016).

As a consequence of these changes, resilience, climate adaptation, and mitigation have taken on precedence in the sustainability conversation. The IPCC defines resilience as "the ability of a system and its component parts to anticipate, absorb, accommodate, or recover from the effects of a hazardous event in a timely and efficient manner, including through ensuring the preservation, restoration, or improvement of its essential basic structures and functions" (IPCC, 2012, p. 556) In the context of green building, this means developing structures and communities that can manage and bounce back from changing and emergency conditions, such that no one is pushed past their ability to cope.

At the provincial level, BC Housing has recently launched their Mobilizing and Building Resilience Program (MBAR) to connect stakeholders around the province for the enhancement of resilience policy and technology. As part of their programming, MBAR have launched a series of design discussion primers. These primers are intended as conversation-starting documents to identify strategies for a variety of climate-driven chronic stressors. UBC's own rating system, the Residential Environmental Assessment Program (REAP), will introduce a new Climate Adaptation category that includes a credit for Enhanced Resiliency. Based on the accessibility and breadth of the MBAR primers, they have been adopted as a reference in the current draft of REAP 3.2. Specifically, the Enhanced Resiliency credit will award points based on the adoption of strategies from the primers on Air Quality, Fire, Heat Waves, and Power Outages and Emergencies.

With the emergence of resilience policy at UBC, and the utilization of the MBAR primers, this project represents a moment to check-in with MBAR stakeholders on the utilization of the primers, and review of best practices in building resilience. By doing this, the project may support UBC in its goal to maximize resilience in a locally appropriate and cost-effective fashion through the REAP tool — while also providing feedback on overall resilience efforts at UBC.

1.2 Intention, Scope, Methodology

This project is being completed to fulfill the capstone requirements of UBC's School of Community and Regional Planning's Master of Community and Regional Planner program. The project was scoped and coordinated through the UBC SEEDS Sustainability Program, with the primary clients being Penny Martyn and John Madden of UBC Sustainability and Engineering. The purpose of this project is to support UBC Campus + Community Planning and UBC Sustainability and Engineering in refining the proposed "Enhanced Resiliency" in REAP 3.2,

and to provide best practices and insight from resilient building stakeholders on the best practices for resilience building at UBC more generally. This is being done in the context of BC Housing's MBAR program, which acts as an incubator for resilient building knowledge and partnerships. As a major owner in the Lower Mainland, with a mandate to advance research, UBC's contributions to resilient development will be a component in the success of the MBAR program.

The literature review was conducted from the broad to specific level, with major guiding documents such as Rashmin Sorithaya's "Resilience and its Applicability to the UBC Building Context" (2019), Ted Kesik's "MURB Design Guide" (2017), and the MBAR design document primers (2020) providing numerous leads. The interviews were conducted with a qualitative journalistic methodology, as the purpose was to gain a deeper understanding of key stakeholders perspectives. Because the focus was on a small number of interviewees, as opposed to a statistically significant representation of research participants, iterative analysis was not employed.

This project was conducted during an expedited 3-credit timeline. The project kick-off took place on July 2nd, with the academic portion of this project concluding on August 28th. This project will also entail a presentation to stakeholders in September, and additional touches on the report for upload to the SEEDS Sustainability Program library.

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Interviews were held with:

Wilma Leung, Senior Manager, BC Housing

Lisa Westerhoff, Principal, Integral Group

Jennifer Cutbill, Principal, Lateral Agency

Ashleigh Fischer, Project Performance Specialist, ZGF Architects

This report is divided into these following sections:

Section 1.0 provides an introduction to the project and its methodology.

Section 2.0 comments on the institutional context of this project.

Section 3.0 details the findings and best practices that emerge from the research.

Section 4.0 provides a list of recommendations.

Section 5.0 provides a summary, list of limitations, next-steps for follow-up research, and a bibliography.

The appendix contains the MBAR Design Discussion Primers for reference.

2.0 PLANNING CONTEXT

1. PROVINCIAL STRESSORS
2. MBAR DESIGN DOCUMENT PRIMERS
3. UBC GREEN BUILDING ACTION PLAN
4. STADIUM NEIGHBOURHOOD PLAN
5. RESIDENTIAL ENVIRONMENTAL ASSESSMENT PROGRAM

This section will provide a brief overview of the provincial resilience stressors, the BC Housing MBAR program, UBC's Green Building Action Plan (GBAP), REAP, and UBC Stadium Neighbourhood.

2.1 Provincial Stressors

Rashmin Sorithaya's "Resilience and its Applicability to the UBC Building Context" (2019) collects a comprehensive set of stressors, priorities, and guiding principles from across the Lower Mainland (Figure 1). These reports rely on provincial climate projections for a range of future trajectories (Metro Vancouver, 2016). As a recent and comprehensive rendering of issues relevant to the Lower Mainland, the table below may be used as a snapshot of many of the resilience challenges UBC must also consider. The key takeaway is that resilience encompasses many vulnerabilities and opportunities across the spectrum of environmental, economic, and social sustainability. Many of the best practices that emerge from this report are based on the processes that are necessary to identify co-benefits, trade-offs, and priorities that can maximize resilience in a cost-effective fashion.

2.2 MBAR Design Document Primers

Mobilizing, Building, and Advancing Resilience (MBAR) is a new program launched by BC Housing in 2019 to act as an incubator of resilient building pilots and partnerships. In-collaboration with Integral Group, MBAR has developed a series of design discussion primers for nine climate-driven chronic stressors: Air Quality, Chronic Stressors, Fire, Flood Events, Heat Waves, Power Outages and Emergencies, Seismic Events, Severe Storms, and Wildfires. These primers will be referenced throughout this document, and are meant to be conversation starters to ensure that a broad range of considerations are made for any development or retrofit (Leung, personal communication, 2020).

Each primer provides strategies in design and engineering, operation and administration, or community support. All primers feature a description of the subject stressor, and some primers feature a section noting potential design conflicts. Each strategy is awarded a score for cost and impact, and aligned with a particular breakdown in the built-environment (for instance, a strategy could be designed to address "Fire at the Urban Interface" and "Severe Storms"). Although there will be updates to the primers on a rolling basis, there are no plans to order the primers according to a hierarchy or for specific typologies (Leung, personal communication, 2020).
Because of the breadth and accessibility of these primers, and their relevance to the provincial resilience context, four of them have been adopted by UBC for use in REAP 3.2. REAP 3.2 is the first system to utilize the primers in a more formal fashion. This report provides perspectives from stakeholders involved in the production of the MBAR primers regarding REAP 3.2.

Please find the MBAR primers current referenced in REAP 3.2 copied into this project's Appendix for reference.

Resilient Strategy for Vancouver City	
Key Shocks	• Earthquakes • Coastal and riverine flooding • Forest fires / Air quality • Extreme weather and temperatures • Oil spills • Public health emergencies- Opioid crises • Infrastructure failure and disruption • Hazardous materials • Residential fires
Key Stressors	• Affordability • Aging population • Debt and low wages • Food security • Homelessness • Gender inequity • Lack of diversity in decision-making • Poverty • Racism • Social isolation • Increasing demand and aging civic facilities • Aging buildings • Water system and resources • Climate change • Food system resilience • Regional infrastructure and supply chains
Guiding Principles	• Reconciliation • Equity and intersectionality • Sustainability • Recovery • Reciprocity

Figure 1. Key stressors and priorities identified by the City of Vancouver. UBC has its own system of plans and policies with reference to climate adaptation and mitigation — but this figure by Rashmin Sorithaya represents the breadth of shocks and stressors across environmental, economic, and social domains. (from Sorithaya, 2019, p. 15).

2.3 UBC Green Building Action Plan

UBC's Green Building Action Plan (GBAP) directs the sustainability initiatives integrated throughout the university's operations in the context of building regulation, development, and administration: according to themes in Energy, Water, Quality, Materials & Resources, Climate Adaptation, Health & Wellbeing, Biodiversity, and Place & Experience. In-addition, the GBAP also foregrounds its capacity for leveraging faculty, staff, and student expertise to advance sustainability solutions for the wider community. The GBAP outlines tools and targets which it uses to achieve objectives. Current actions include the development of a Resiliency Initiative that would fulfill best practices in providing a multi-disciplinary and centralized hub for resilience at UBC (Sorathiya, 2019, p. 26). The GBAP incorporates a 2050 Ready Plan for climate mitigation and adaptation. The GBAP also administers the UBC Integrated Design Process that outlines the logistics for development at UBC (Figure 3). Recommendations for REAP 3.2 will be applied to the context to Integrated Design Process, so that may be more actionable.

2.4 Stadium Neighbourhood Plan

The development of REAP 3.2 is in-tandem with the finalization of the Stadium Neighbourhood Plan. Stadium Neighbourhood is UBC's newest residential subdivision, and represents the first neighbourhood at UBC to foreground resilience as a core value. The plan concept identifies five lots for high-rise towers of 20 to 32 stories, with townhouses arranged on the podium of the tower. The west-side of the plan, adjacent to the Botanical Gardens, will provide several lots for wood-frame MURBs of 6 to 8 stories. These represent a mix of high and low-rise typologies, for which REAP 3.2 must be suitable. As the plan remains under-development, considerations for the situation of critical infrastructures and responsibilities at the building or site scale will be valuable for this project's recommendations.

Figure 2. Concept birds-eye view of Stadium Neighbourhood (from Campus + Community Planning, 2020)

Phase	Step	Responsibility	Description
	Step 1: Site Selection	C&CP, Site Selection committee	Site review and recommendation which includes consideration of land use, utilities, transportation, sustainability, environmental assessment and adjacent impact.
Pre-Design	**Step 2: Design Brief Development**	C&CP	Staff develop a guiding framework and a set of design goals and strategies, reflecting the particular challenges and opportunities for the project.
	Board 1		
Schematic Design	**Step 3A: Preliminary Energy and Water Workshop**	Design Team	Based on preliminary energy analysis and water budget, coordinate a team meeting to brainstorm / assess potential strategies to achieve project goals. Consider: site conditions, massing and orientation, renewable energy potential, basic envelope attributes, lighting levels, thermal comfort ranges, process load needs, operational parameters and resilience to climate change.
	AUDP Pre-application		
	Step 3B: General Sustainability Workshop (technical)	Design Team	Facilitated team meeting to investigate integrated strategies that meet sustainability goals and which explore synergies among systems and components
	Development Permit Process: AUDP, DRC, public open house Board 2 DP		
Design Development	**Step 3C: Interactive Energy Workshop**	Design Team	Review potential energy savings strategies to inform and refine energy and envelope design relative to life cycle costs.
Construction Documents	**Step 4: Sustainability Reporting**	Design Team	Submit Sustainability Report which summarizes the cross cutting strategies used to achieve performance and process targets for each design brief goal
	Board 3 BP		
Construction/ Occupancy	**Step 5: Report Performance**	Design Team C&CP	Report broad sustainability outcomes from the project for inclusion in the Board 4 meeting minutes and for consideration by the Better Building Committee
	Board 4		

Figure 3. The June 2020 iteration of the UBC Integrated Design Process. Multiple recommendations for REAP 3.2 could be leveraged according to the existing timeline and expectations. This will build an understanding of the process at UBC among developers, and encourage more adherence to advancing resilient design.

2.5 RESIDENTIAL ENVIRONMENTAL ASSESMENT PROGRAM (REAP)

REAP is a green building rating system that UBC uses to ensure residential developments achieve certain standards and savings in categories such as energy, water, and wellbeing. REAP awards 'Gold' through 'Platinum Plus' statuses to developments based on achievement, with 'Gold' being the minimal award for approval. As a system, REAP shares many of the features of other building rating systems such as the Leadership in Environmental Energy and Design program (LEED). However, REAP is intended for use at UBC, and accommodates the campus's unique context. Because UBC controls institutional buildings and many of the capital assets in its neighbourhoods, it is able to provide resources at varying scales. LEED is often identified as being too prohibitive with respect to strategies that may not be relevant to a building's context, and REAP is more flexible in this context (Bahirat et al, 2007, p. 1).

REAP 3.2 has made several adjustments to the previous 3.1 and introduces a new Climate Adaptation category (Figure 4). To address climate-driven chronic stressors at UBC, this category introduces one prerequisite for development, and three credits to award points. The 2050 Climate Ready Thermal Comfort Modelling prerequisite mandates modelling for a range of future climates, and the Energy Efficient Design awards developers for design that will lower the Cooling Energy Demand Intensity given future heat projections. The On Site Backup Power credit awards developers for implementing backup power measures to mitigate the effects of a power outage.

The Enhanced Resiliency credit is meant to incentivize a range of strategies in-response to climate-driven, chronic stressors. Designs are awarded points on the basis of adoption of "appropriate design strategies" from the MBAR design discussion primers on Air Quality, Fire, Heat Waves, and Power Outages and Emergencies. How appropriate is defined has yet to be detailed, and there are concerns of less effective strategies being chosen, or critical strategies being overlooked.

Figure 4. REAP 3.2 Draft Climate Adaptation Category and Enhanced Resiliency Credit Copy. As with REAP 3.1, the final version of these credits will be extrapolated upon in the final REAP 3.2 guidebook.

Enhanced resiliency
Achieve appropriate design strategies from the Mobilizing Building Adaptation and Resilience (MBAR) discussion papers on "Air Quality", "Fire", "Heat waves" and "Power outages and emergencies". 10 different design strategies with at least 1 from each paper. — 1 point 15 different design strategies with at least 1 from each paper. — 2 points 20 different design strategies with at least 2 from each paper. — 3 points

Climate Adaptation (CA)		13
P1	2050 Climate Ready Thermal Comfort Modelling	
1.1	2050 Climate Ready Energy Efficient Design	7
1.2	Enhanced resiliency	3
1.3	On site backup power	3

3.0 FINDINGS

1. STRESSORS
2. SYSTEMS AND FRAMEWORKS
3. PROCESSES

This section provides findings from the literature review and interview components of the project. These findings are organized into three subsections: Stressors, Frameworks, and Processes. Stressors pertain to perspectives on effective design or approaches for pressing climate-driven chronic stressors. Systems and Frameworks pertains to other models for administering green building or framing resilience. The Processes sub-section pertains to best practices in institutional mechanisms, facilitation, and fostering change.

3.1 Stressors

Based on findings in the literature, interviews, and established by the current REAP 3.2 draft, a list of particular stressors worth emphasis arise. In-general, a systems approach to resilience with an appreciation of co-benefits and conflicts emerges as a major consideration. A common consideration is that any of these stressors may be addressed with strategies that achieve multiple goals. Shading can improve fire-resilience, while enhancing biodiversity and biomass. Spaces for refuge can also be community spaces, and house pilots for emergency preparedness or small-scale commercial jobs. But with respect to a suite of must-have strategies given UBC's context, the literature and interviews have less information. Multiple stakeholders referenced the lack of agreement in the development community regarding correct measures, and generally interviewees advocated taking a more contextual perspective. For a holistic and integrated approach, education and demand-side mechanisms have been identified as crucial components of a resilient building. New tools, such as digital information systems and community programs comprise new methods of communicating residential infrastructure to residents and operators (Pape-Salmon, 2015, p. 13).Emergency preparedness in-particular would benefit from application of community leadership and preparedness workshop models. Connections between centralized risk management and neighbourhood preparedness could be piloted at UBC. Ensuring feedback, education, and communication mechanisms are in-place will be a crucial component of ensuring the campus's operations are unified in the pursuit of integrated sustainability goals.

"If you look at many years ago, people would just think of housing as disposable like other products. We cannot afford that anymore, and we understand that we cannot just deal with one thing at a time." (Wilma Leung, personal communication, 2020)

3.1.1 Seismic Resilience

UBC is in the process of developing and implementing a seismic resilience plan, and has previously collaborated with ARUP to evaluate the campus's seismic resilience (ARUP, 2019). The biggest barrier to achieving progress is undoubtedly cost (Westerhoff, personal communication, 2020). Without a large shift in technology, governance, or financing, the ability to build above standard is limited.

This said, interviewees agreed that seismic resilience warrants much more attention. Although MBAR has dedicated a primer to the subject, seismic resilience is not captured in the primers selected for the Enhanced Resiliency credit. Compared to industry advancements on the American West Coast or Japan, there is a sense that local practitioners are lagging behind (Fischer, personal communication, 2020). This could be attributed to the lack of destructive earthquakes in the Pacific Northwest in living memory, whereas California and Japan have produced many contemporary case studies.

Peter Yaven's case studies suggest that modern designs are underperforming during seismic stress. In his white-paper on building performance in the aftermath of the Kyushu earthquake in Japan, he notes that although buildings were constructed with compliance to up-to-date seismic standards, a magnitude 7.0 earthquake produced surprising amounts of structural failure. Although this study primarily looks at wood-frame detached homes, this article does note the superior performance of older buildings with minimal glazing and few openings on the ground floor (Yanev, 2016). As such, there may be cause to interrogate modern design tendencies.

Multiple stakeholders recommended adding the MBAR primer on seismic resilience to the Enhanced Resiliency credit. While the cost makes many structural resilience strategies prohibitive, ARUP's REDi system provides examples of advocacy work that developers and designers can perform to receive points (2013, p. 37). In-terms of changing the culture with respect to seismic resilience, this may be an effective step forward.

> *"The giant elephant in the room is seismic resilience. We point to it as important, but the measures that are required to make a building fully seismically resilient above and beyond what the code requires are expensive and challenging. I would say that's one where as a community, as a society, we know what's coming but we're not really doing too much about it because it's really hard and expensive. That's one big one." (Lisa Westerhoff, personal communication, 2020)*

3.1.2 Disease Transmission

COVID-19 poses challenges for contemporary design tendencies that emphasize connectivity. Besides the 2020 pandemic, a changing climate may mean an uptick in infectious disease (World Health Organization, 2003, p. 16). This warrants more consideration of disease resilience. LEED has already developed a series of pilot credits to mitigate the risk of disease transmission and exposure. These credits are drawn from the American Institute of Architect's "Re-Occupancy Assessment Tool V3.0" (2020), and relate to re-occupancy assessments for re-entering your workplace, disinfection protocols, water management planning, and managing indoor air quality. With evidence emerging on the aerosol-spread of COVID-19 (Jiminez, 2020), superior HVAC filtration, efficient ventilation, and more CO2 monitoring to identify under-ventilatation, may be part of the building solution (Morawska et al, 2020). There are also emerging opportunities in home design. Examples of disease resilient design could include adaptable units, flexible floor plans, and work-from-home functionality to make quarantine less challenging (Alati, 2020).

The MBAR program will also be releasing a design discussion primer for disease transmission soon (Leung, personal communication, 2020). This represents an easy way of incorporating disease resilience into the existing Enhanced Resiliency credit, and ensuring that developers think proactively about a post COVID-19 world.

3.1.3 Heat Waves

The Climate Adaptation category in REAP 3.2 is proportioned towards future climate modelling and passive cooling. Additionally, adopting an adaptive and modular approach to overheating is prioritized in the university's 2050 Climate Ready mandate (GBAP, 2020). UBC is itself partnered with MBAR to pilot passive cooling innovations and technologies. This proportion reflects the industry and expert sentiment expressed in the literature and interviews. What has not emerged is a particular weighing of strategies. Although it is clear that passive cooling measures that have been adopted to-date for local LEED Platinum certified development — such as in the case of the AMS of UBC's Nest building — are insufficient (Wang, 2020).

What UBC can do above and beyond its current plans, may be in the development or implementation of a framework through which the campus can leverage all of its sustainability goals through cooling strategies at multiple scales. Green roofs and walls, increased vegetation, shade canopy, cool surfaces, and social activation are all interventions that can produce superior outcomes in biomass, carbon sequestration, and community connectivity (Lam et al, 2020). An effective framework and process should be able to broach these opportunities, while evaluating the trade-offs and co-benefits associated with various opportunities.

3.1.4 Power Outages and Emergencies

As the Stadium Neighbourhood plan develops, there will be more clarity on where institutional resources will be situated for emergencies, and what buildings should offer. This said, all the interviewees agreed that back-up power at the building scale corresponds to existing best practices.

In the case of a prolonged emergency, protocols and infrastructures for the safe disposal of human and non-human waste will be critical (Resilient Design Institution, 2013). Ensuring access to potable water or a gravity-fed water source is another best practice. These may be considerations best levelled at the neighbourhood plan scale, but UBC should otherwise consider making them mandatory through REAP 3.2. The rigour of UBC's emergency management protocols, and the potential of UBC residents to cope and adapt, also warrants consideration. Programming, social adaptiveness, and effective community engagement will be critical to ensure preparedness for an emergency scenario. Education, activation programs, and community initiatives may provide a good opportunity to relay feedback to UBC Safety & Risk Services. Systems such as RELi and REDi award points to developers for piloting these initiatives. With respect to the weight of various strategies, it is worth noting that several of the strategies in MBAR's primer on outages and emergencies are repeated through other primers, or represented by other credits in REAP. Weighing the credits can ensure the most relevant emergency strategies were required (Fischer, personal communication, 2020).

3.1.5 Wildfires and Air Quality

As with all stressors, wildfire resilience benefits from an integrated, systems approach (Smith et al, 2016, p. 130). UBC is already looking to leverage its institutional buildings as centralized locations to situate superior air-filtration systems (Lam et al, 2020), and this ought to be a consideration with respect to building requirements.

Pacific Spirit Park is known to UBC as a potential wildfire site, which means that windborne embers do pose a threat to UBC buildings. Vegetation setbacks and fire-resistant materials pose trade-offs in the loss of potential biomass, or materials more susceptible to other stressors. This is another case where having a trade-off and co-benefit framework for analysis of a new development would be beneficial.

Increasing wildfires also have consequences for local air-quality. Effective education and administrative controls will be necessary to ensure that buildings will be correctly sealed during problematic periods. When it comes to occupancy tools or management of HVAC systems, successful occupant use and renewal is dependent on accessibility (Kesik & O'Brien, 2015, p. 25). Digital occupant displays are one feature that developers could pilot to share the data on airborne impurities, informing occupants and building managers (Pape-Salmon, 2015, p. 13). These displays could also serve as an information source during emergencies. But given power outages, the best practice is to ensure analog resources remain available.

3.1.6 Community Resilience and Activation

Although the majority of the MBAR primer strategies correspond with the design or administration of buildings, many correspond to supporting the development of community connectivity. This reflects a recognition of the social component of climate adaptation and emergency management — or community resilience. In any disaster scenario, community cohesion and education will be an important component of a resilient and adaptive response. Much of the interviews with stakeholders concerned how to connect design with resilient communities.

The Happy Homes program provides a visual toolkit that outlines design strategies and interventions to encourage connectivity. When considering design interventions that promote connectivity through REAP, this guide provides a series of best practices and inspirational case studies.

The Hey Neighbour Collective is a project that aims to connect housing providers, researchers, governments, associations, and health authorities with pilots in community and social resilience throughout BC. The program is still in its initial round of pilots, but has completed a report summarizing its findings from the first pilot. Recommended methodologies include the development of communications support between RAs and managers, providing RAs with intentional relational approaches, the development of facilitation workshops, and grants for RAs to reduce the financial barriers to adoption of the role (Craig & Heng, 2018).

These considerations are relevant at UBC. UBC neighbourhoods tend to be multilingual, which means that programming and materials should reflect the media and languages in-use (Enterprise, 2015, p. 108). For instance, this means producing multilingual manuals and ensuring UBC is on WeChat.

Considerations for the social and economic dimension of resilience should factor in issues such as an increasing demographic of seniors, which will require building adaptations. And although this is a complex issue to leverage through REAP, UBC should consider on an ongoing basis how it can develop infrastructure that mitigates systemic disadvantages (Leung, personal communication, 2020).

"Some of the conversations around MBAR were the interface between more technical approaches to resilience and social resilience. As an example, it's one thing to have a certain size of back-up generator, but it's another to know your neighbours, to know Joe on the third floor is in a wheelchair, to have a plan in-place to be able to help him. UBC has a unique opportunity to test what it really means to complement and support a systems approach, and to design the tools that enable that." (Jennifer Cutbill, personal communication, 2020)

3.2 Frameworks and Systems

REAP is evaluated against other green building rating systems to ensure that it is in-step with current industry-thinking and advances. To evaluate what REAP may incorporate, or how new components could be structured, this project researched a number of other building and neighbourhood-scale systems. The selection of systems was based on a set identified through "Resilience and its Applicability to the UBC Context" project (Sorithaya, 2019), as that was the most recent report to evaluate which systems are worth application at UBC. Emerging standards such as the RELi 2.0 system represent more holistic, systems-level approaches to climate mitigation and adaptation — which UBC already has plans to apply (GBAP, 2018). This section will also provide some interviewee comments on the advantages or disadvantages of REAP in-comparison to other systems.

The balance of stressors will also be a key consideration for UBC. Should strategies for adapting to longer wildfire seasons weigh as much as strategies for adapting to emergency preparedness? It is also worth mentioning considering that multiple frameworks and systems separate measures for hazard assessment and emergency preparedness. Future iterations of REAP could also consider distinguishing these needs through separate credits.

3.2.1 ARUP REDi System

As demonstrated by the previous section on seismic resilience, seismic resilience is a big gap in the provincial conversation. Given this emphasis that emerges from the interviews, it is worth reviewing the Resilience-based Earthquake Design Initiative (REDi) system, developed by ARUP's Advanced Technology and Research. The system is specifically meant to propose advances in resilience as opposed to basic occupant survival, and awards certifications based on a building's ability to assume "re-occupancy status, quick functional recovery, and low levels of direct financial loss" in-light of a major earthquake (Arup, 2013, p 10). UBC is already collaborating with REDi, and many of the challenges of seismic resilience lie in prohibitive costs. But notably, the REDi system does award developers for supporting the change-process. Specifically, the Advocacy for Resilience category provides points for structuring communications efforts with provincial and federal authorities, and lobbying for pilot projects to build up and beyond the existing code (Arup, 2013, p. 37). If a lack of urgency is one of the major barriers, then this could be an effective step to leverage through REAP 3.2. The REDi system also provides a framework for evaluation that is based on tiered requisites and considerations, as opposed to a point-based system. Based on the observation that performance-based requirements often work better than prescriptive requirements (Westerhoff, personal communication, 2020), REDi provides a sound means of measuring earthquake resilience, and may be inspirational for

other stressors as well. REDi also represents a system that codes strategies as mandatory or recommended — based on the level of achievement itself. In the systems explored through this project, this gated tier system seems like an especially promising model for emulation with the MBAR design document primers. UBC could use a similar, simplified model, to gate and grade levels of achievement in the Enhanced Resiliency credit.

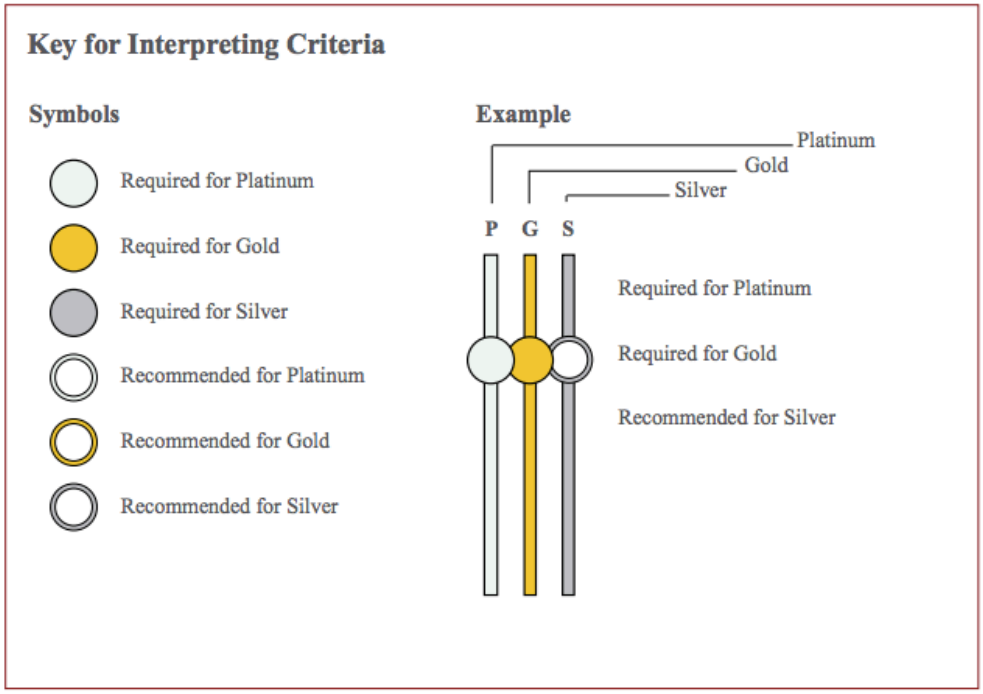
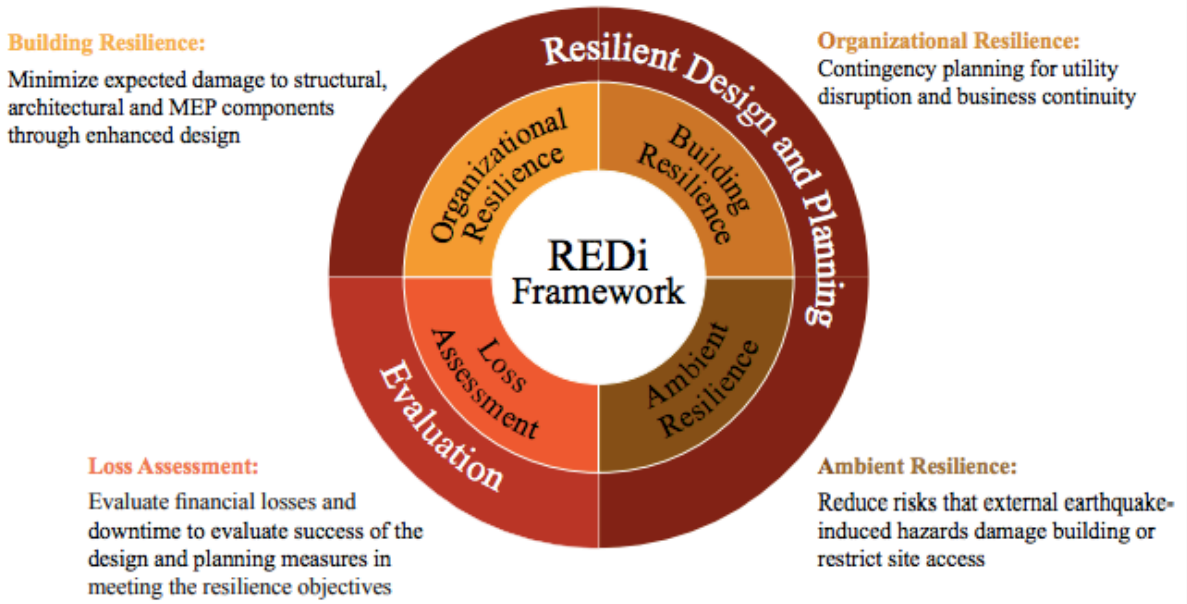


Figure 5 + 6. Key for Interpreting Criteria for the REDi System and model for seismic resilience performance requirements (from Arup, 2013, p. 8, 18). Both could be of inspiration for UBC to fine-tune MBAR strategies for the Enhanced Resiliency Credit.

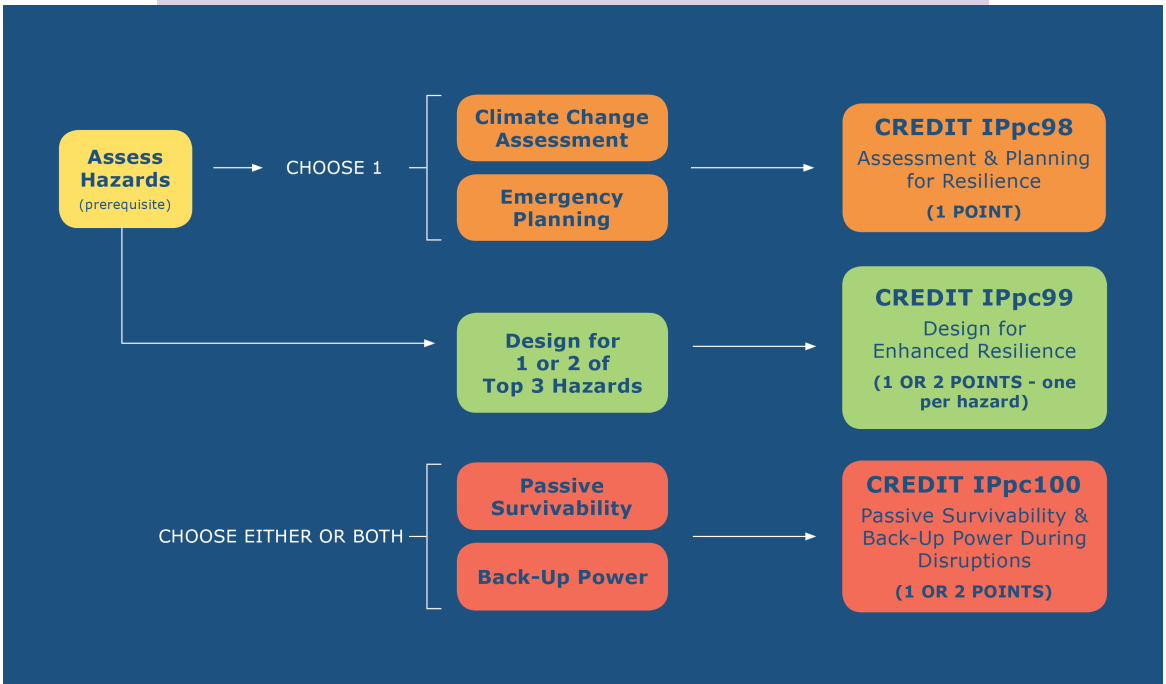


3.2.2 LEED Enhanced Resilience Pilot Credits

LEED, managed by the U.S. Green Building Council, represents one of the most commonplace green building rating systems, and provides a good corollary to REAP. The scale of the system is similar, and most of the credits and categories are transferable (Fischer, personal communication, 2020). With respect to resilience, LEED has been developing a series of pilot credits since 2015, with a focus on climate change and emergency preparedness assessments. Like REAP 3.2's Climate Adaption category, the major concerns correspond to advanced climate modelling and thermal resilience, hazard assessment and enhanced resilience strategies to address those hazards, and back-up power. One stakeholder recommended considering the Enhanced Resiliency credit as a prerequisite (Fischer, personal communication, 2020), and this would represent a leap ahead of the current LEED implementation.

Due to its popularity, there has been substantial adoption and criticism of LEED. A strengths, weaknesses, opportunities, and threats analysis for LEED v4.1 from Freitas & Zhang (2018) identifies many issues that are being addressed by UBC's actions with respect to REAP, or remain ongoing concerns. REAP is already a less bureaucratic and more accessible alternative to LEED (Bahirat et al, 2018, p. 3). But it also faces challenges in post-construction evaluation, limited ability to evaluate or measure all design features, and a lack of emphasis on user-experience or ability to track occupant and administrator feedback. These are issues identified throughout the interviews, and UBC should endeavour to ensure REAP is ahead of the curve in these respects.

Figure 7. A schematic showing the structure of the LEED pilot credits for resilient design (from Woodcock & Lemon, 2018).



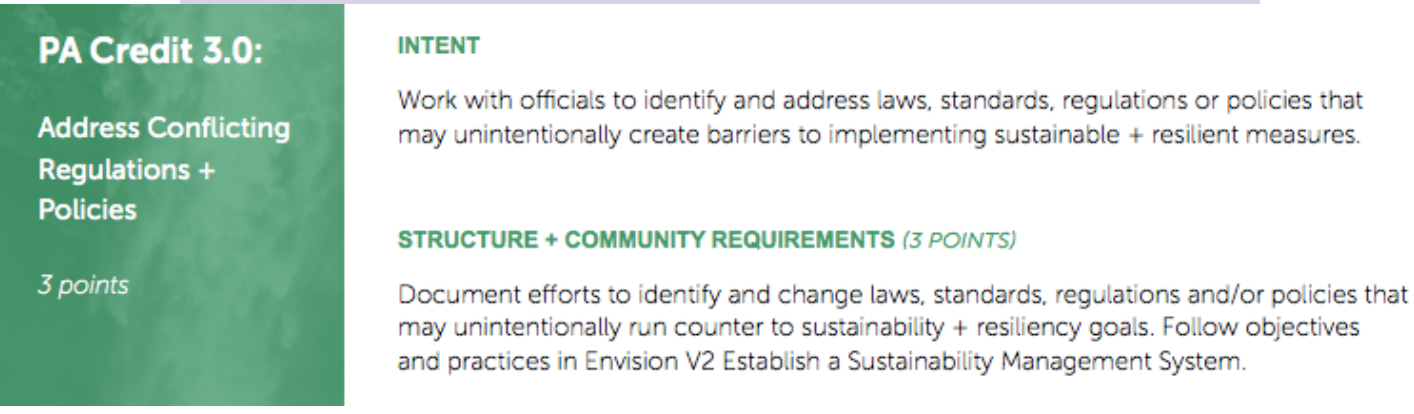
3.2.3 RELi 2.0 Rating Guidelines for Resilient Design + Construction

RELi is a notable, comprehensive system for measuring and monitoring building and community-scale resilience. The system shares credits with LEED, and is also administered by the U.S. Green Building Council. UBC has plans to research how the system could be integrated on-campus (GBAP, 2018), and it provides an interesting model for what a resilience framework at UBC could look like.

While RELi could supersede LEED as a system, many of its considerations would be more logically leveraged at the institutional level at UBC. This includes business-case assessments, control of invasive species, and enhancements to the local food supply-chains. It would be interesting to consider what infrastructure residential buildings should provide to advance these goals — such as commercial space that could support economic opportunities for young UBC residents, or more inclusionary consultation processes (Leung, 2020).

RELi also puts forward credits encouraging or requiring better reporting protocols that could be worth emulating in REAP. Credits in RELi 2.0 have a 'Structure + Community Requirement' component (Figure 8). These often entail stakeholder engagement, inclusion, programming, and documentation. Awarding credits for developing a project management documentation process to capture organizational policies, authorities, mechanisms, and business procedures — and for reporting post-occupancy performance data in comfort, serviceability, operational management, and physical systems — would help advance UBC's research mandate, and is of much interest to industry stakeholders (Leung, personal communication, 2020).

Figure 8. Example of RELi credit for "Panoramic Approach, demonstrating requirements for enhanced and more systematized documentation of process, barriers, and advocacy (from RELi, 2018, p. 6)



3.2.4 Integrated Building Adaptation and Mitigation Assessment Framework (IBAMA)

During the stakeholder interviews, a need for a framework and process to identify UBC's resilience priorities for any particular development was repeatedly identified. The IBAMA framework was specifically mentioned as one worth investigation. IBAMA, led by Ilana Judah in collaboration with BC Housing, aims to identify critical building and neighbourhood climatic challenges, gaps in development practices, and bridge the needs of mitigation and adaptation.

According to the IBAMA progress report (Judah & Chang, 2020), research and knowledge-sharing relating to these needs has been weak thus far, with adaptation being underrepresented. In the context of the Enhanced Resiliency credit, many of the strategies pertain to weatherization, or other design interventions to lessen the impact of projected stressors. An IBAMA framework will provide an integrated building adaptation and mitigation assessment framework to help stakeholders optimize mitigation and adaptation for development projects.

Important findings from the progress report also include the difficulty quantifying or qualifying adaptation needs and requirements, with a checklist/ credit format being insufficient. The research specifically highlights the importance of a "formal process or framework" for ensuring mitigation and adaptation needs are identified, defined at a degree of complexity suitable for the varied stakeholders. Tools should also be integrated into neighbourhood scale planning and programming processes. These are valuable insights for the ongoing development of REAP, Stadium Neighbourhood, and the formalization of a resilience process at UBC.

The complexity of these trade-offs, co-benefits, cascading uncertainties, and contrasting needs from stakeholders ought to be a part of the design process. With the Integrated Development Process lacking a hazard assessment stage, it may be more appropriate to fit these questions into the existing Sustainability workshop. As the IBAMA framework emerges, it might be an effective component of both the integrated design process and overall development of a resilience framework at UBC.

"This ability to add a filter of purpose, principles, and prioritization for the specific project, is so important. So it would be great if there was a way to insert in these systemic thinking approaches into the mechanistic toolbox, checklist framing method." (Jennifer Cutbill, personal communication, 2020)

3.3 Processes

Interviewees emphasized that tools such as REAP can only achieve optimal outcomes when there is a deliberate process led by the owner to align interests, provide sufficient information, weigh the trade-offs and co-benefits, and ensure varied stakeholders are represented. These institutional, communicative, and logistic needs are captured in this section. Facilitation relates to the process of engaging with stakeholders, guiding project development, the methodology for ensuring that UBC's resilience needs can be achieved through the Enhanced Resiliency credit. Logistics pertains to the need for transparency and communication relating to building-code changes at UBC. Research pertains to opportunities that UBC has to address gaps in the provincial industry's approach to resilience through the campus's staff, faculty, and student capacity. This section will conclude with comments on best practices in the use of the MBAR primers themselves.

"It's more about the process: what are the steps you need to take to make sure your building is resilient to the key hazards of concern." (Lisa Westerhoff, personal communication, 2020)

3.3.1 Logistics

One issue that is repeated with reference to new building regulations at UBC is timeliness. Budget and timeframe uncertainty make developers more reluctant to adopt ambitious resilience strategies (Lam et al, 2020, p.8). Cutbill, Westerhoff, and Fischer emphasized the importance of ensuring clarity was available for what was expected long before the ground breaks on a project. In the context of REAP 3.2, this could mean ensuring that any facilitation of the Enhanced Resiliency credit takes place during the design permitting stage, as opposed to the run-up to construction. Currently there are a number of prospective plans and updates on the horizon. It would be advisable to publish a schedule that makes the rough timeline of these changes, along with notes on any considerations to be aware of, available to developers, designers, and contractors.

"You really need to do this at an earlier stage in the process for it to be more successful. And to have all those design team members aware of what the goals are that UBC has set for different building projects so they will be working on those from the get-go." (Lisa Westerhoff, personal communication, 2020)

3.3.2 Facilitation

From the four stakeholder interviews conducted, effective and inclusive facilitation emerged as a consistent need to align goals and bring structure to the Enhanced Resiliency credit. Perspectives on the need for a facilitated approach ranged from the benefits it would have in-terms of allowing for flexibility and encouraging developer innovation, ensuring that developers were in-alignment with the goals of UBC, opportunities to identify the contextual and site-specific needs for a specific development, and as an opportunity for UBC to push the resilience conversation forward while integrating feedback. As such, it would also be valuable to research and pilot a process that can be formally introduced in the Integrated Design Process, or as part of the work shops that are already mandated. Evaluative systems such as the aforementioned IBAMA framework or the Climate Resilience Principles (Climate Bonds Initiative, 2019) are worthwhile models, with the former emerging from another BC Housing collaboration.

Jennifer Cutbill in-particular identified several of the benefits that can emerge from a facilitated process with the aim of aligning goals, collaboratively identifying principles, and working from the core purpose of a project to enhance outcomes. Framing is critical, and can have cascading impacts on a project. Besides shifting interests in the project, framing can have dramatic outcomes in-terms of pro-formas — especially with reference to technology and strategies that contractors are unfamiliar with or perceive as a risk, and mark-up as a consequence.

> *"Before there is that consensus, my preference is to take a more bottom-up. What I mean by bottom-up is more facilitation: to provide all the information, look at each case, identify the opportunities and how we can maximize them." (Wilma Leung, personal communication, 2020)*

> *"Things like backflow preventers are a proxy for developers avoiding things they don't really understand, they're not seeing, or are perceived to not have any value. A lot of it is familiarity within the marketplace, but there's a bit of literacy involved. So the more that a team can build this literacy around what is important, why we're doing things, what is available: doing that in the early stages can make a lot of cost fall away, to the tune of millions of dollars." (Jennifer Cutbill, personal communication, 2020)*

3.3.3 Research

Gaps in technology, process, and data were identified as one of the major problems for resilience development in the provincial context. The MBAR program has emerged to help with these issues. For instance, if designers and developers have a consistent aversion to a particular strategy, then there ought to be a way for the community to understand these barriers. Mechanisms in systems such as RELi 2.0 help normalize the reporting process for developers.

The literature indicates a predominance of engineering frameworks in the resilience field, with more environmental and social perspectives being needed (Rajkovich, 2019). In-addition, post-occupancy analysis, analysis of the process of development, and qualitative analysis relating to experiences of sustainable buildings, or how sustainability programming is interpreted and implemented by occupants, is needed. Westerhoff's 2016 article, "Emerging narratives of a sustainable urban neighbourhood: The case of Vancouver's olympic village" examines how sustainability is interpreted and reproduced socially. UBC can also help advance this knowledge-gap. As mentioned previously, new emergency preparedness and social connectivity pilots are also emerging in the Lower Mainland, and it would make sense to test these in a UBC residential context.

3.3.4 Using the MBAR Primers

Interviewees had a number of perspectives on how best to use and showcase the MBAR primers. One stakeholder stated that most developers would be unfamiliar with the MBAR primers, and not interested in probing them (Fischer, personal communication, 2020). Having a design guide to situate the MBAR primers at UBC and to engage developers could be one solution

Stakeholders also expressed concern that the Enhanced Resiliency credit may provide too much discretion for developers and designers to adopt the easiest and least consequential strategies. Because the MBAR primers provide a comprehensive breadth of considerations, there are also strategies repeated between primers — and the credit ought to consider potential repetitions. Based on precedent experience, it was too easy to achieve Platinum accreditation on REAP projects, and innovation was not encouraged as a consequence (Fisher, 20 personal communication, 20).

In this sense, it may be worth separating Enhanced Resilience into prerequisite and optional tiers (if it is unfeasible to mandate the credit outright). An internal process of weighing, grading, or mandating strategies within the MBAR primers for use at UBC could accompany this process, and was encouraged by multiple stakeholders.

> *"So I think as a starting point it might be good, but at the same time, not all these strategies are created equally. So a designer could go for the lowest hanging fruit" (Lisa Westerhoff, personal communication, 2020)*

4.0 RECOMMENDATIONS

1. RECOMMENDATIONS

4.1 Recommendations

This section provides a list of recommendations for policy and process relating to the REAP 3.2 Enhanced Resiliency credit that have been derived from the research in this project. Recommendations are a list of actionable items that can be implemented in the immediate, or near-future. These could be potential changes to the REAP 3.2 credits, institutional and process-oriented changes, or new research initiatives and partnerships. Some of these recommendations are wholly complementary, others may be more suitable for a particular pathway or philosophy regarding the best application of the Enhanced Resiliency credit.

1. Consider an internal process to weigh and order the MBAR strategies for effectiveness at UBC

A weighing process for UBC to prioritize the most important and relevant strategies in the MBAR primers for use through REAP 3.2 is highly recommended. MBAR will not be doing this work themselves for the primers. Some interviewees also suggested that unfamiliarity with the primers means that consultants will target lower-cost strategies. By developing an order and weight for the strategies, UBC could ensure the most important strategies are mandated, provide a suite of options that are relatively equivalent and encourage more ambition.

2. Facilitation is key, consider adding a focus on resilience to the general sustainability workshop, and consider applying a Purpose, Process, and Principles framework

Some interviewees argued that the complexity of various sites and the lack of convergent opinions on the most impactful and cost-effective resilience strategies means that a prescriptive approach is not appropriate at the moment. This would make a more facilitated approach logical. But however the Enhanced Resiliency credit is leveraged, deliberate facilitation is crucial for the best outcomes. A facilitated approach would provide an educational function to ensure pro-formas are accurate and strategies are understood. It would help build consensus between multiple stakeholders on the importance of resilience. And it would provide flexibility and agency for the developer, while also giving UBC a chance to advocate for the key hazards, forward-thinking approaches, and the most optimal outcomes. An Enhanced Resiliency or Climate Adaptation workshop could be added to the Integrated Design Process for future projects; or existing workshops could be modified. Emerging models, such as the IBAMA framework, would also be valuable pilots in the pursuit of a facilitation framework that can weigh complex trade-offs, co-benefits, and concerns relevant to UBC's specific needs and stressors.

3. Consider more active publication of updates to UBC building policies, practices, and tools

Timeliness has been consistently identified as a major logistic concern through this and other UBC research projects. By publishing more frequently with respect to potential updates in UBC's building and planning policies, practices, and expectations, UBC can help assuage uncertainty in the development community, and ensure that critical pieces of infrastructure are not introduced too late in the development process.

4. Consider expanding the Enhanced Resiliency Credit to address COVID-19 and Disease

The consensus on the need to consider disease and pandemic resilience is moving fast. As other major green building rating systems have already developed pilot credits relating to design for disease transmission stressors, it is important that REAP 3.2 include some considerations as well. The easiest way to do this would by incorporating the upcoming primer that MBAR is developing for disease resilience into REAP 3.2's Enhanced Resiliency Credit. The co-benefits of designing for disease are emerging, and it is likely the market will want units that correspond to this need. With the extra weight this and the next recommendation imply, the Enhanced Resiliency category could be adjusted in value overall.

5. Consider expanding the Enhanced Resiliency Credit to incorporate MBAR's Seismic Events primer or more focus on earthquakes

Interviewees and the literature agree that BC is lagging behind with respect to advancing seismic resilience. UBC is more proactive through its partnership with ARUP, though costs are a challenge. But if provincial and industry attitudes are another major barrier, then credits in REDi that support developer education and advocacy to relevant governments for higher building codes may be worth emulating. In any case, adding seismic resilience to Enhanced Resiliency would be a step forward.

6. Consider splitting the Enhanced Resiliency Credit into tiers or making it partially prerequisite

To lead on resilience, it is worth considering mandating some elements of the Enhanced Resiliency credit. This could also be done in-tandem with a weighing process, to ensure that the strategies UBC absolutely wants are mandated and communicated clearly in-advance of any facilitation. For instance, instead of reading "10 different design strategies with at least 1 from each paper," this credit could direct that it be "10 different design strategies with at least 2 essential strategy from each paper." A weighing process at UBC could identify the low-cost and high-effectiveness strategies from the primer, and simply mandate them, with more ambitious strategies awarding points.

7. If the primers are to be used for REAP 3.2's Enhanced Resiliency credit, then consider weaving them into prospective Stadium Neighbourhood Design Guidelines

Co-benefits and trade-offs are UBC's major advantage when it comes to the development of resilience strategies for a variety of stressors. However, interviewees noted that developers would not be drawn to probe the MBAR primers too deeply. To ensure that resilience strategies are well-integrated into design at UBC and correspond to a breadth of sustainability goals, education and visualization would be ideal. One mechanism for this could be ensuring that the MBAR design strategies are represented in the design guide for Stadium Neighbourhood. This will help UBC with framing, ground the strategies, and get developers thinking about the trade-offs and co-benefits of any particular strategy in-advance.

8. Pursue a multilingual pilot for emergency preparedness; and evaluate feedback systems between new developments and UBC Safety & Risk Services to ensure UBC is emergency-ready

Social adaptiveness and community resilience were identified as core resilience needs by multiple interviewees. Pilots on relationship-building, emergency-preparedness, and protocols by organizations such as the Hey Neighbour Collective, provide precedents of interventions in multilingual neighbourhoods. A partnership with the Hey Neighbour Collective, the Happy Homes project, or with the UNA on one of their research initiatives, to launch a pilot in an existing UBC neighbourhood, would provide findings for developers and designers to begin considering in-advance of Stadium Neighbourhood's occupancy.

9. Utilize UBC's research capacity integrate research and to fill in resilient building knowledge gaps

Many opportunities for UBC to leverage its research capacity to advance industry goals were identified. Many of these research needs could be achieved through REAP 3.2 mechanisms, or as initiatives led by UBC departments. These opportunities include:

1. Providing feedback on the use of the MBAR primers to BC Housing to help iteratively update the primers.
2. Providing feedback and storytelling with respect to the entire development and change process at UBC.
3. Collaborating with MBAR on the development of a provincial data-set of resilient development.
4. Recruiting students to qualitatively and quantiatively evaluate the process of resilient development in Stadium Neighbourhood and UBC resident experiences of sustainability infrastructure.
5. Partnering with Hey Neighbour Collective or Happy City to identify pilot opportunities for inclusive emergency preparedness and community animation at UBC.

5.0 CONCLUSION

1. SUMMARY
2. LIMITATIONS
3. NEXT STEPS

The conclusion of this report provides a summary, an overview of this project's limitations, recommendations for ongoing research, and a bibliography.

5.1 Summary

REAP 3.2's Climate Adaptation category and Enhanced Resiliency credit represent steps forward for resilience at UBC. But for this credit to push the envelope, many processes and considerations are necessary. This may include an internal process to weigh and order the strategies within each MBAR primer, consideration of mandating particular strategies, and perhaps the elevation of stressors that are not currently included, such as seismic and disease resilience. This effort may also produce more refined systems of measurement for awarding Enhanced Resiliency points, rather than according to quantity.

Alterations to REAP should be applied in-recognition of UBC's unique governance and planning context, the flexibility of REAP, and the potential for REAP to be a front-end tool for integrated sustainability policy across the university. In any case, UBC should consider their facilitated process for identifying climate adaptation, mitigation, and resilience strategies. An elevated process can align stakeholder goals, incorporate multiple sets of expertise, and evaluate complex trade-offs and co-benefits. This facilitation process should also be supported with resources, guides, and case-studies, so that the MBAR primers may be a successful intervention, and not just a checklist.

With its research mandate and capacity, UBC has a powerful role to play in the advancement of the resilient building industry. A partnership with BC Housing to track and monitor MBAR pilots, case-studies, and developments across the campus would be an effective way of leveraging UBC's staff, students, and faculty to support knowledge and data at the provincial level. With its multilingual demographic-base, partnerships with the Hey Neighbour Collective could inform successful emergency preparedness development. Incorporating more research into the interaction between policies, processes, stakeholders, and development outcomes is being identified as a valuable intervention by other rating systems — and UBC has the capacity to engage in this work.

With its systems scale, UBC has a unique ability to showcase the best in resilient development, and demonstrate the co-benefits that climate adaptation and mitigation can provide. While design of the policy is crucial, ensuring that the processes for managing this activity is also of utmost necessity, and can lead to exemplary results.

5.2 Limitations

Time and capacity were the major limitations for this project. The accelerated schedule of the project, complicated by difficulties relating to COVID-19, meant that the data-gathering and production phases were accomplished in a relatively small period of time. As such, this report represents a comment on some — not all — of the best practices that should be applied to REAP 3.2.Much of the recommendations relate to the MBAR primers themselves and the need for an ordering and weighing process by UBC. Unfortunately, this project is unable to dive deep into providing recommendations of that granularity. The primary methodology of this project was based in literature reviews and the interviews — both modes in which UBC's unique context was not able to be fully investigated. To this effect, the interviewees avoided making strong recommendations about which strategies should or should not be incorporated. Generally, the perspective is that this should be a process led by UBC experts.

5.3 Next Steps

This project focused on a broad survey encompassing a variety of literature topics and the perspectives of a small set of MBAR stakeholders. However, based on the findings, a number of next-steps are possible. As previously mentioned, research could be conducted to produce a database of provincial projects, or piloting community resilience, or identifying barriers throughout UBC's neighbourhoods. Research could also be used to evaluate current development processes, and to develop a template for designers and developers to enhance feedback, reporting, and knowledge-sharing. As IBAMA and other frameworks for mitigation and adaptation develop, research could be conducted to determine how these frameworks may be mapped into the existing UBC Integrated Design Process. To enhance the emergency-preparedness dimension of the Enhanced Resiliency credit, a project could be done with UBC Safety & Risk Services to evaluate how the Integrated Design Process may feed into and enhance campus disaster resilience. And of course, there could be much research on the usage of the MBAR design primers, and the effectiveness of various strategies in the specific context of UBC, its development, and its neighbourhoods.

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APPENDIX

1. INTERVIEW TRANSCRIPTS
    i. WILMA LEUNG
    ii. LISA WESTERHOFF
    iii. JENNIFER CUTBILL
    iv. ASHLEIGH FISCHER
2. MBAR PRIMERS
    i. AIR QUALITY
    ii. HEAT WAVES
    iii. POWER OUTAGES AND EMERGENCIES
    iv. WILDFIRES

Interviews have been edited for clarity and length.

WILMA LEUNG

JK: May you introduce the BC Housing MBAR Program?

WL: The thinking behind MBAR is that for many years we have been tackling the building issues in bits and pieces. In the 90s we had the leaky condo crisis and there were building durability issues. The durability issues have become better understood since that time. And also, energy efficiency is not a new concept in Canada, it's been acknowledged for over 40 years. But we have been treating it as a speciality as opposed to something across the board. In BC we also have — in the next 30 years — a major chance of a very damaging earthquake. So we have to be prepared for that. And we all know the climate is changing. So we're preparing for that by investing in our buildings.

Now we are building buildings that are more durable, energy efficient, with more seismic resilience, and we are investing more. There are more bells and whistles and more technology in-general. The standard of construction is increasing. And the cost of construction is also getting higher, land prices as well.

Basically, for each square foot we are investing more, whether it is for sustainability, performance, or market aspiration. It's not a disposable thing anymore. If you look at many years ago, people would just think of housing as disposable like other products. We cannot afford that anymore, and we understand that we cannot just deal with one thing at a time.

Imagine dealing with the building envelope, and you remove the cladding, and replace it with new windows and new insulation so that they become more energy efficient. Later on you ask the team to work on seismic, you remove everything and try to make the building resilient. And then if you want to make it climate resilient, it's like 'ok let's do some shading.' So, we cannot just keep layering on. We have to look at things more holistically as a system, with solutions that serve multiple purposes.

That is something very important from what I have seen over many years. We cannot afford to deal with one issue at a time, we have to look at everything more together, and we have to design our buildings for future scenarios so that they will serve for years to come, and we do not find they are underperforming because we missed the opportunity to incorporate considerations when we were planning and designing the building

What has the feedback for MBAR been so far?

It's still at an early stage. The concept for MBAR is that we learn from doing. It's not like we have identified all the gaps and climate solutions and can promote the right path. We didn't approach it that way. The primers are so-called because they are there to prime the discussion. What we want is to work with people, building owners, or designers who are interested in addressing this issue. We work with them, identifying where the gaps and barriers are: whether it's a gap in the tools or a lack of future climate modelling. If we don't have a good tool or an easy guideline, then we can produce something like that. We work with engineers as well, and we complement each other's work. For instance, the industry, while they are trying to meet the energy step-code, might not realize the need to design for a future climate. So we produce guidelines and things like that to help them recognize that.

The most important part is that there are so many things to address. There are still a lot of gaps. So we cannot address them all at once. What we can do is work with different pilot projects and use that

opportunity to tell the story of the barriers. Some of the barriers are related to regulation or zoning policy. Sometimes zoning policy or planning regulations produce disincentives to build more resilience. So by working with pilot projects we are more able to identify barriers instead of accommodating them. We have to accommodate them with the first pilot, but we hope that by illustrating the harm that those barriers are creating, people will have the momentum to make the necessary changes. So that's part of what we hope to do with MBAR.

All these things vary from location to location, municipality to municipality. Different archetypes have different barriers or require different tools. As we work through this we will be better able to address them. We will need many partners working through multiple projects to build up the knowledge.

What process did MBAR use to develop the primers?

The development of the primers was the easiest part of MBAR. It's very much like other literature reviews, involving subject-matter experts. It's just a collection of what has been discussed in the past. And it's a little theoretical and conceptual, but we tried to include everything that would be relevant to prime the discussion so that people don't need to go everywhere to do the research themselves. The primers are easy to read and follow. It's not giving you the solution or a checklist. It's there purely as a discussion primer.

The Enhanced Resilience Credit awards points based on the quantity of strategies adopted by developers. Would this degree of discretion serve the credit's goals?

From my experience, if there is the opportunity, it's easier and more respectful of the different circumstances, implementation challenges, or the opportunities that each pilot project presents if we take a more bottom-up approach rather than a top-down approach. The top-down approach is very useful when we are in a mature stage. When the best methods are known and available, then you already have consensus.

I can't say whether this is more effective or not. But before there is that consensus, my preference is to take a more bottom-up approach and to make it a more facilitated approach. What I mean by bottom-up is more facilitation: to provide all the information, look at each case, identify the opportunities and how we can maximize them.

Of course, if you put it into a standard or a program, then that does not work. You have to define the levels. But if you look at it as providing incentives, or tiers, then that may be better. I hope to learn from UBC. You must be finding a way to deliberate and compare the different opportunities or requirements. MBAR hasn't done work to put the strategies in a hierarchy or give priority to them. We were just hoping to have the opportunity to work with people who are interested, help them achieve their goals, and identify the barriers.

And if there are any excuses, we hope the excuses can only be used once. [There's continuity], so if other people have used that excuse, and it can be pointed out that that's an excuse, it doesn't reflect very well. And then maybe at a more mature stage, when there are enough tools and everything is available to support the community, and there is also consensus, things can be more standardized. And when things are more standardized, you can introduce regulations and requirements.

The top-down approach at that point would be to bring in all the laggards or people who weren't there to try them out. We're not talking about the early adopters anymore. Then it will simplify things if we just tell them what to do. We will have consolidated things at that time. But at the beginning, we don't see any

convergence of design yet. So if you have a few pilots that address similar problems, and they all use this solution, then you start to see a convergence.

Just look at overheating: exterior shading, balconies, windows, envelope, unit layout within the building, whether you provide shared cooling throughout the building, and the mechanical system. The verdict is out on what is more effective.

On the other hand, things like flooding — because UBC is very specific with its sites, as opposed to having different geographic considerations around BC — should be able to be spelled out very easily. Things like seismic resilience should be spelled out very easily.

It's things that are more directly related to architectural design or things like that, things that could still allow people to experiment or find solutions. One of the things for us is social resilience. How do we design — especially with COVID, with people placing more emphasis on social distancing — more social cohesion and more community building? How do you design buildings that accommodate social distancing but where you can still promote social equity in the process?

Where are those opportunities to allow the designers to allow or incentive designers to do that? We really want to work on that. With COVID we have identified, for instance, that women, indigenous people, and youth have been disproportionately affected. I think that partly it is because they have been disadvantaged in the opportunities open to them, even before COVID. And COVID further constrained their opportunities.

This may not apply directly to UBC as a community, because UBC is a more privileged community. But at the same time, recognizing that UBC is more privileged is there something that it can do to acknowledge that. Can UBC help — not in a patronizing sense — by doing its part as UBC. To do UBC's share to address the issue and hopefully help the broader community as a whole to move to a more equitable future for all Canadians and people in BC. How do you do that part?

With MBAR, we haven't put a lot of focus in that area. But we feel that at the end of the day, as citizens, we should be addressing that need. With housing design, if it could support more social cohesion and support, then it may also reduce some disadvantage of some populations. Say women, if buildings are designed to support more sharing of child care, then maybe women can pursue more study or career opportunities that are more attractive. That can create more social equity.

And in the past there have been more youth employment opportunities, which enabled more self-determination. A paper route, or if there is some carwash opportunity, then they can get some pocket money. But if we don't have that because of technology migration, or there are concerns about safety, then children can become more dependent. That may not be healthy in the long run. If there's something in building design that can help address this, then we want to encourage it.

Similarly, the way we do things is important. When we develop a project, the process is often not accessible to Indigenous communities. It might not be part of your requirements right now, but because we live in BC, because UBC is on unceded territory, there are certain responsibilities to address it to the extent that we can, or to make a little bit of process.

What are models for advancing social adaptiveness that REAP can look to?

There are a lot of different things that can be done. We supported the Happy Cities project to prepare something called a Happy Home Toolkit. It's on their website. It addresses a bit of social cohesion, although

it needs revamping, especially because of COVID. Happy City are working with BC Housing to produce a social resilience metric and they have to consider COVID as well.

Also, I suggest you come back to BC Housing in a couple more weeks. We are working on a post-COVID design guide, and we are only just starting. We should be able to share this with you in a few weeks.

What kind of tracking mechanisms are you using to follow projects across the province?

We don't have one — other than reaching out to people. The only thing we have is doing interviews and documenting the story or the experience.

Is there a best way for UBC to use its particular governance structure to support the goals of MBAR?

I think it's about UBC sharing their process. It's not just the result, sometimes the results are very unfair. People have different resources, different circumstances. Results can be very inspiring, and I am sure that UBC can continue sharing results. But UBC has so many good brains and a diverse set of people from different disciplines.

My training for instance is in engineering. But I think it's important to recognize other dimensions; the equity dimension for instance. After all, we're different human beings. To really integrate as much as possible, then share the process, and share the learning. I'm trying to learn a lot from the Indigenous community, how they emphasize the importance of process. I hope we can integrate the process into this work because it's the only way we can work together as a community that includes everybody.

For MBAR, what we are trying to do, and have yet to do, is more storytelling. I think wherever possible, if we can work with building owners to share their story and their experiences, then that would be great.

MBAR seems like an iterative process — what is the timeline like for updates?

Yes, we are in the process of reviewing the primers and adding to the list of primers as well. So social resilience is one, and the other one will be on disease transmission. Infectious diseases are one of the impacts of climate change. We are working on those primers. If UBC wants to provide comment on these primers, BC Housing would be interested in the input.

JK: What jumps to mind with how REAP 3.2 utilizes the MBAR primers?

LW: MBAR is meant to provide a list of strategies that a designer or architect could consider in the design of a building, so it's not necessarily a checklist. It's more of a 'here are some best practices in resilience' to address particular hazards. And depending on the type of design, some or all of them, or a few of them, may be applicable or the best practice for that project.

That is the main thing that comes to mind based on having the credit be based on a number of strategies. Generally speaking, you could use [the primers in this way]. But, it should be acknowledged that not all strategies will apply to the projects necessarily. So in that way it shouldn't be a simple additive exercise. Because for a particular project it may not be suitable, in which case, a developer shouldn't be penalized for not having the full number of strategies. That said, the strategies are pretty broad. It's interesting; I don't think we ever thought that the primers would be translated into a checklist.

In the "Enhanced Resilience" credit, the points are awarded based on quantity of strategies adopted. So take the requirement for a single point out of three — 10 strategies adopted from four primers — does that seem reasonable?

That should not be challenging to achieve. Let me look at one of the primers to refresh my memory. These sheets are also going to be going through various updates over time.

Let's take Air Quality for example; you have "Ensure the air intake is away from local sources of air pollution." That is a very easy strategy to achieve, relatively speaking. It's not significantly costly, nor is it a huge measure. It has a relatively strong impact of reducing outdoor air pollutants. But it should be standard practice.

Another strategy within that category is "Use activated carbon filters or incorporate them into local HVAC systems" or "Ensure air filtration systems are HEPA ready or procure portable HEPA filters" or "Include cooling into HVAC design." That is a much more significant and much more impactful design decision, I would argue, than to make sure your intake is away from local air pollution.

So I think as a starting point it might be good, but at the same time, not all these strategies are created equally. So a design could go for the two lowest hanging fruits: like 'ok, we've introduced resilience into the air quality system.' Well, not really. So, that's something to consider. Again, some of them will be more relevant than others, and some will be more impactful than others. So I don't think they should all be treated equally necessarily.

That being the case, the credit does provide a lot of discretion relating to the adoption of strategies. Do you think that makes sense given the weight of specific strategies?

I would tweak that a little. How much should it be specific strategies versus how it should be a performance-based approach? So we can compare performance-based approaches versus prescriptive approaches. A prescriptive approach would be like: you have to have cooling, air-conditioning, in all of your buildings. Or you have to have a HEPA-ready HVAC system. That's a prescriptive requirement, which is very strong. But designers and building industry members often push back on it. Sometimes they just don't want

to do it. But the rationale for a performance-based approach is that you want to provide flexibility on how to achieve the goals that you want to set.

So you can say all buildings have to have cooling, and that's totally fine. But it may be more effective, cost-effective, and innovation inspiring if you instead require that the temperature in the unit has to stay below 25 degrees Celsius at all times. Is air-conditioning the way to achieve that? Maybe. Are there more cost-effective or desirable ways to achieve that? Maybe. It's not really a great example because I think cooling is something that needs to be put in all buildings, but there are other strategies where you could take the same argument.

Depending on where you are, is a HEPA filter necessary, or could you go for a lower filtration? It's about saying 'we want to make sure we have a standard of air quality to x limit,' which is a performance-based approach. Or do you want to have an approach where we say HEPA filters in all HVAC systems. One approach is setting a goal, you figure out how you achieve that goal, versus saying, 'here are the things to do, just do them.' There are strengths to both approaches.

But to answer a slightly different question to the one you asked, generally speaking the industry responds better to performance-based requirements. That allows them multiple pathways to achieve a desired outcome, as opposed to having to do x, y, and z.

What you actually need to do in practice is probably a combination thereof. Some should be performance based and some should be prescriptive. So UBC should probably figure out what their ultimate goals are, and which of these strategies are integral to achieving their goals, and which are more performance-based, less prescriptive, and allowing teams to figure out how to achieve those goals.

How will the MBAR primers be refined on an ongoing basis?

I think that these strategies, in my mind, should probably remain as best practices and conversation starters. But what we're trying to do now is develop something of a process of determining. And it may include some of these strategies too. But it's about more of the process: what are the steps you need to take to make sure your building is resilient to the key hazards of concern.

Infrastructure Canada has the Climate Lens program, through which they say perform a climate risk and vulnerability assessment for your design project. We've had to do this a few times for healthcare sector buildings. It's a process of identifying the climate projections for the site, the likely hazards and impacts it will face, and figuring out a way to say that these are the most important impacts that we should mitigate or avoid, and here are the design strategies that will mitigate those impacts. It's more of a process of taking stakeholders and design team members through to figure out the most important things, to identify the strategies that are best suited to address those concerns and risks.

So you would say it is more about having a facilitated approach?

I think so, and you could use these strategies as best practices to draw from. But it is more of a process-based, facilitated conversation. And there are methodologies that have been developed, so it's not that they have to come up with it on their own. We're trying to craft some kind of process with the Healthcare Sector now, and it would be mostly transferable to other building types.

You get the right expertise in the room and have the right process, and the primer can be used as fodder for discussion, not necessarily like a checklist of things you should do. That being said, if you said, if you said

'Lisa, give me the top five design features every building could incorporate,' I could probably do that. But it would immediately become challenging to be more specific about each case. There are always caveats.

In-terms of those kinds of best practices, are there obvious gaps in the current industry mindset?

I couldn't say off the top of my head. What I will say is: I don't know at what point the standard is applied during construction projects at UBC, but definitely the earlier that this process takes place, the better. Because then it can be integrated into building design as opposed to getting all the way down to the process and then suddenly actually we need HEPA filters or whatever. People would be like 'our duct work isn't sized for that, it changes the size of the units.' It has cascading effects on all the dimensions of the building.

So you really need to do this at an earlier stage in the process for it to be more successful. And to have all those design team members aware of what the goals are that UBC has set for different building projects so they will be working on those from the get-go.

Your research touches on post-occupancy evaluation of neighbourhoods — including Olympic Village — to determine how sustainable development is experienced and reproduced at the community level. Are there exemplary examples of connecting resilient design with social adaptiveness that you are following?

There are a couple of projects that I could point you to that are looking at just that. One of them is called Hey Neighbour (City of Vancouver program). They're very much focused on multi-unit residential building resilience, focusing on the social and community dimensions. It's a social-connectedness program with multiple partners including BC Healthy Communities, SFU, Vancouver, and a few different developers. So they developed a toolkit or a list of processes and practices designed to foster social-connectedness to improve social resilience. So I would say that's something UBC could explore as a starting piece.

The second thing is, UBC already has opportunities to foster social resilience well and above your standard residence because you already have a point of connection of it being a residence of members of a particular community. So there are all sorts of opportunities to foster different programs. Ultimately it's about designing a space, but also creating programs that go beyond design and into operations and management. Just allow and encourage people to connect to each other. It could be as simple as a posting board or more integrated program development.

I also know there's been research done at UBC on this very subject, and it came out of CIRS. I'd have to find it, but if you google UBC happiness research, stuff comes up. There are studies on wellbeing in different buildings on campus. So all the expertise you need to foster social connectedness and resilience exists within the campus research itself.

Regarding MBAR, what mechanisms currently exist for the community to evaluate where strategies are being implemented around the Lower Mainland?

We are tracking internally the pilots that come through the program. So as we add more pilots, we basically work with them to identify the strategies and we have a follow-up conversation or survey with them to figure out what you're actually implementing. That is ongoing somewhat informally. But we don't have a mechanism beyond the pilots themselves. We haven't expanded our reach outwards. The results will be released as research. But it's rolling and ongoing right now.

What are some of the gaps with respect to resilient design that are harder to broach in the industry right now?

Off the top of my head, the giant elephant in the room is seismic resilience. We point to it as important, but the measures that are required to make a building fully seismically resilient above and beyond what the code requires are expensive and challenging. So we often will bring it up in the pilots that you should look at seismic resilience, and here are all the major structural issues. Again, if you start earlier on in the program and process, it will be more cost-effective than going in later on. We can't have someone consider a more resilient structure if they're too far down the path. I would say that's one where as a community, as a society, we know what's coming but we're not really doing too much about it because it's really hard and expensive. That's one big one.

I think the community and social resilience piece is one that you've touched on that isn't always talked about, but it's really good to highlight it. I also think a big question to go into is how to make all the existing building stock resilient, but that might be beyond the scope of this project. We're trying to puzzle at the same question with carbon emissions. How do you make all our buildings right-now zero carbon? It's very hard and expensive, and the same issue goes with resilient buildings.

How can UBC best leverage its role in the development process to advance resilient design?

Certainly, making the community aware of what they're planning on requiring for construction. Being kept abreast of those changes and what they look like. And, because you mentioned it, tracking the number of buildings that have actually incorporated resilience measures and getting some sense of what were the barriers, what were the costs, what were the challenges in incorporating those strategies into the new building design would be useful. Because that's always what we're trying to get at: how can we make this business as usual? What are the obstacles that we can and should remove? Whether they are cost obstacles, policy obstacles, zoning, planning, all those different things. UBC is different in this way, but it would still be useful to have that information.

Do you have any final thoughts or comments on anything we've missed?

I've already made comments on the utility of the primers as a conversation-starter, but that's key to note. I think as a first step to building resilience, what REAP is introducing is good. Using 2050 modelling, thermal comfort, back-up power, and the enhanced resilience credit — this is a good starting point overall. The only other thing is taking a more procedural and process based approach to it, where you can allow for a bit more innovation and developing strategies in concert with the design team. But maybe these categories or credits allow for that as well. Overall I think it's great.

JENNIFER CUTBILL

Could you tell us a bit about your background and role with the MBAR primers?

I'm an alumnus from SALA at UBC, graduated about 10 years ago. My focus has always been on whole systems and adaptability. During the course of my professional career I focused on negative architecture and community engagement that focused on the underpinning systems and how we can affect more transformative change.

What is your role with MBAR?

I'm part of their advisory team, so that includes reviewing documents and participating in various workshops. I initially got involved through being the regional director of the BC-Yukon for the Royal Institute of Architecture of Canada. I was asked by Wilma Leung to write a letter-of-support for the MBAR program.

Could you tell us a bit about the MBAR primer development process?

We would be asked questions in a workshop, charette type format, half-day typically, on various issues. There would be summaries, and we as advisors would provide comments and insights. The real heavy lifting, for piloting the process, and the shape and form of the primers, was all Integral.

Would you say REAP 3.2's Enhanced Resiliency credit is an effective way of utilizing the primers?

When it comes to plugging in the primers, they already exist, and they're great tools. Zooming further out, one of the unique opportunities that UBC has in-terms of making the best use of the primers, shifting the needle, and enabling transformative approaches is the scale. The campus-wide scale allows UBC to operate at a systems scale.

Some of the conversations around MBAR were the interface between more technical approaches to resilience and "social resilience." As an example, it's one thing to have a certain size of back-up generator, but it's another to know your neighbours, to know Joe on the third floor is in a wheelchair, to have a plan in-place to be able to help him: finding ways to gauge the social resilience of the community. I don't have easy answers on how to do this. But UBC has a unique opportunity to test what it really means to complement and support a systems approach, and to design the tools that enable that.

A lot of it was about asking the right questions. There's the quantitative side of reducing your BUI and making sure you have back-up power for x number of hours. But it would also be interesting to see what types of questions you are asking, what stakeholders are in the room, and how can you leverage those larger scale synergies to reduce the cost of doing things at the building scale: be it for sharing energy, back-up power, a whole myriad of things.

There's the sense that a lot of the evaluation of success is based on the metrics of the completed building. Are there particular vulnerabilities that a lack of social adaptiveness can provoke?

I was reading a quote from one of the Directors of one of the Climate Portfolios at the World Health Organization, she said something like: 'if planning isn't to improve the health of people and place, what is it for?'

In that vein, when we're talking about resilience, mitigation, or adaptation, it's easy to get lost in the mechanistic mindset. But what we're talking about really, and UBC already has it in its mandate, is what it means to foster health, wellbeing, and place. It means a lot of things. Fostering daylight and views, determining where our heat comes from, how we encourage and allow for social connection, how we help take care of each other in case of emergency. How do we do this through a lens of equity and responsibility for people from different backgrounds, levels of abilities, and also in the context of local ecologies?

I don't have any specific answers. But in-terms of questions to be asking, it is interesting to think about how to build this into the framework. Otherwise it's very easy for those things to fall into the background after the first charette. I've too often seen that get shoved into a drawer, and detached entirely from the checklists that ultimately end up driving things. So I think finding a way to intrinsically embed those, will be a key success of this project and effort.

Do you have particular case studies of successes or precedents that you really look to in-terms of the implementation of social adaptiveness?

One example, most powerfully, were some of the core requirements for a project I was working on down in Memphis (the Crosstown Concourse) in the context of rife economic scarcity and racial strife. This is where process matters so much. And I think questions, in-addition to measuring, are so important through a process largely led by the client group. Questions like: what is the alignment with the community around health, how can we reframe the question around health and what does that mean; how do we connect with and support each other? It really embedded these core values within the DNA of the project and prompted everyone to examine what their role was to the contribution of health and community exchange. What contributions could not just minimize harm or reduction, but actually improve the health of the whole.

That process ended up providing things like the prioritization of wider stairs to accommodate social functions; more opportunities for unscripted engagement; the prioritization of active transportation within the building; partnerships with local farms and entrepreneurial programs for farm-to-work. So really it was this larger cascade.

It ended up being the largest LEED platinum, adaptive reuse building in the world at the time. But we never would've gotten there had we started with the LEED checklist. It was so important to ask those questions around health, wellbeing, and wellness. Because I think a lot of the social adaptiveness really comes from not only connections, but care for each other, and sharing a common purpose and common language around what everyone's striving for.

If there's some way to build into — what is essentially a front-end tool — something that gets people thinking outside of the checklist mindset and into a deeply rooted purpose around the potential of a place, of all of us here? Who else needs to be here when we're having these conversations? You can't exclude facilities managers or key community members. Who else needs to be involved? Then you have the more quantitative checklist and tools as an accountability framework. But it's more secondary to the higher-order questioning and alignment of purpose.

With respect to the MBAR primers, are you finding that there are resilience strategies that the industry is more or less inclined to develop?

A bit of it is context specific. I would say the biggest thing is that too often the questions and conversations happen too late. And everything costs more the later it happens. The projects with the most success and success measured in outcome, reduced friction, cost-saved, time-saved, is when these conversations are

embedded from the get-go. While that can seem simplistic, it too often doesn't happen. So making sure that that low-friction, or easy-to-address barrier, is addressed early.

I think a lot of it is based on familiarity. Maybe this is an unfair generalization for some, but typically developers see things through the lens of their pro formas, which are designed to operate as a cost-benefit decision-making rubric or matrix. It's a hard lens to work through. So this is an unfair characterization, but they'll sometimes gripe about anything that isn't status quo, because that's what their models are built for.

But the construction managers, builders, contractors, they're where the rubber hits the road because they'll say 'oh we can do this, it's no extra charge' versus 'we can never do this, it'll cost too much.' When builders don't know how hard it's going to be, they mark it up. And often things get marked up by double, or arbitrary factors, so what that means is that even if there are solutions in the market that don't actually cost more in-terms of hard capital dollars, because the solutions have the perception of increased risk or departure from what has always been done, they will cost more. So we see a big difference between those developers that want to be at the leading edge, who want to be doing more complex projects. They much more readily adopt things and then the price drops way down.

This is less of an issue at UBC because they attract the big players who want to impress. But that subjective, contextual matter really matters, otherwise as things become more accepted across the industry, the cost drops. So passive house was totally foreign and scary a few years ago, and now it's normalized. That being said, for a lot of mechanical sub trades: HOVs for example, people may have never heard of a certain supplier, they've only heard of one, and sole-sourcing isn't ok for many developers and clients. You run into a lot of funny issues like that. It's not that HOVs are hard or expensive, it's more that the culture makes them cost more and a lot of that comes from perceived risk rather than actual risk and cost

In-terms of specific examples — things like backflow preventers — people use that as a proxy for developers hawking at things they don't really understand or they're not seeing. So they are perceived to not have any value. A lot of it is familiarity within the marketplace, but also there's a bit of literacy involved. So the more that you as a team can build this literacy around what is important, why we're doing things, what is available — doing that in the early stages can make a lot of cost fall away, to the tune of millions of dollars.

In-terms of the make-up of the Enhanced Resilience credit, what do you think of the discretion it provides designers for the adoption of various strategies?

All contexts are unique. Depending on where you are on the campus there's more variation. So there is always this tension between the qualitative and the quantitative. So this ability to add a filter of purpose, principles, and prioritization for the specific project is so important. So it would be great if there were a way to — and maybe this is already embedded — way to shoehorn in these systemic thinking approaches into the mechanistic toolbox/checklist framing. Trying to get in there in a way that acknowledges and optimizes the specific challenges, opportunities, and other contextual considerations of each site.

So only having two points for any two is less relevant than having the two that matter most to the site and its considerations. It would be great if there were a way to filter that into the point-allocation matrix. So really with the checklist you're leveraging game theory to try and encourage the best results. And what are the best results, what does success look like? Well, no one cares about points. They're just a proxy for gamifying better results. So what is success? What does it actually mean? If it is about the health of people, place, and planet, just getting the most points in the most categories won't help anyone.

So maybe there's a way to tease it out, possibly as part of the prerequisites — 'have you done an assessment to rank in priority these four things' — or some other way to tease out that place-specific priority for each project. Because then you're going to get further with each project than if it was generic across the board. With each development there have to be those opportunities for effective consultation and developing that consensus.

There is also a disconnect we see in practice is the one between modeled and measured performance. In the living building challenge it has to be functioning after a year to see if it holds up. Again, looking at it through the lens of purpose, we want to ensure we're actually improving the health of people, place, and planet. We only know if we continue to monitor it and continue to build awareness and capability of those involved in the project and processes. Everyone involved, from facilities operations to the actual inhabitants. How do we know if what we're designing is actually working as it's intended?

And with the climate adaptation credit especially, that they're iterative and adaptive based on evolving knowledge. So ideally what you're doing with this tool not only reaches out to an earlier stage of questions and thinkings and engagement toolkit, but also extends out to post-occupancy engagement, monitoring, literacy building, and that kind of work to see if these things are working as intended.

Could you share more learnings from the Crosstown Concourse development?

That was a slightly different animal in that it wasn't in an academic development context. But there were campus players, and a number of them were health campus focused. The big lessons were working from the core purpose of the project, collaboratively identifying principles. I realize a lot of this sounds really simple, but it is so important. Collaboratively coming together around health. It was a real tipping point to have everybody embrace that this was about improving health. We got more stakeholders engaged, Methodist Health Church Centres, St. Jude Children's Research Hospital, big players in the American health context.

This changed the entire pro-forma for the project. All of this red ink got thrown out of the project because if this project is really to improve health, then we could do this, we could bring in this partner. By changing the process and the questions asked at the front end, it changed everything else. It changed the targets, the metrics. It changed the dollars ascribed to them. So it really opened my eyes to how important that process design is.

And there was one meeting where we were talking through the lens of LEED credits, and there was gaming in the negative sense of saying 'oh we could just do this in order to get this many points.' There was a radical departure between that and the conversations around 'oh this is about health, community interconnection, then we definitely have to collaborate with the local farmers' because this community was suffering from bottom rankings in-terms of healthy eating or health-literacy rates. So it really expanded what the project needed to be from a basic functional programming level, and everything beyond.

This is getting beyond how REAP might normally be used. But I think that's actually what we need. Because oftentimes we build things and get stuck in assuming that a lot of these decisions need to be made in a certain way or can only be made within a certain spectrum of options and constraints. Whereas if you let yourself think a little bit higher, and encourage the team to think a bit higher, and give them enough literacy — and this is where I think the primers are really great as well — well, they're primers.

The primers are great for getting everyone up to speed such that you can have these higher-order conversations. Because of the scale at UBC, I think you can really start to tap into higher-order synergies. Does each individual unit need its own cistern at a certain scale, or need a certain size backup generator, or

can it hold hands with whatever department building across the street which is only used during winter terms. It enables what the Living Building Challenge calls scale jumping. By leveraging the primers in an educational way, you can start to leverage the capital assets of the university so you can start doing more with less. And then that changes the pro formas the developers are working with. It's no longer a discussion between should we add two more inches of outboard insulation, or should we add sun shades; and now you have money to do both, or the form or the building can shift because you no longer need such a big community amenity room because you can use the space across the street.

Hopefully what these interviews can do is point towards a framework or a strategy for ensuring the activities and engagement and participation are a normalized part of the process; how do you think this can be reflected in REAP?

This conversation also makes me think of a conversation that was had at one of the MBAR meetings. It might have been related to the IBAMA Framework that Illana Judah was working on. She comes from being a high-profile sustainability director in New York. She left that in-order to pursue research in resilience, and she's been working at arms-length with Wilma at BC Housing on an integrated adaptation and mitigation framework that is very much about what questions to ask at what stage to better understand synergies and unintended consequences.

In was in a discussion with her that this idea of community resilience or social adaptiveness — this unfair burden that gets placed on developers to do all this systems scale recon. So there was talk around what is the role of municipalities for building up this kind of data, the percentages of vulnerable populations, proximity to locally grown food, additional water resources, places of refuge. How do you gather all of this?

UBC is uniquely poised to gather all of this data, to be a central hub for all of this knowledge. So you can alleviate a lot of the cost burden that resilience and all these systems normally entail by being this kind of library and seed-bank and mapping hub for all this information. This is both on the social resilience side and ecological function side, further removed from the REAP tool itself, but it's something I could imagine working powerfully in tandem and help the business case and process for developers and designers.

What would you say are the major industry gaps right now with respect to designing for resiliency?

I'm always thinking about measuring the capacity of teams and projects within just the narrow bounds of the project or team. But it's influenced by so many factors beyond and before that. So akin to contractors, things that don't actually cost more are being penned in as costing more because they're unfamiliar, so there's a risk factor or penalty assigned to that. So I think it's similar to the knowledge of teams and there are some fantastic and incredibly knowledgeable people in this region. The people at UBC are among the best of the best. But knowledge, or rather, context, is evolving so rapidly. And given that UBC is an academic context, I think there's huge potential to build on what's in the primers, to leverage REAP, and these broader goals and mandates of the university to really raise the awareness and capacity of practitioners.

So I could imagine some kind of educational program, and maybe it's in collaboration with SCARP, SALA, the students that are coming up with the hottest GIS or parametric modelling tools with the veterans in the industry who know how a lot of things work but don't necessarily have the agility or access to new tools and ways of thinking. There's something powerful there that UBC could do, and that impact could extend beyond what happens on campus to broader in the community. So in-terms of UBC as a leader and a living lab, I think there's some interesting potential there.

What is the ongoing refinement process for the MBAR primers?

There is a need to be constantly revising these, and to think about designing the process and the meta-level framework, to design the primers in a way that they are living and adaptive tools. I've been on the other end of this; I know how painful it is to do overhauls of things. The more you can design them to be lighter-weight or agile, easy to update on an ongoing basis, the better. It's always hard as a practitioner when you're all the way through design development, and then all of a sudden policy changes. So what are the ways that all of us, UBC specifically, can make those cycles more legible so people come to expect that 'oh, it's September, school's starting, so policy is going to be updated.' That makes it so much easier for people to be able to deal with change.

The ["Building a Better Canada"] investing in infrastructure reports written by the federal government talk about the biggest barriers to affordable housing being pre-development capacity: design, business-case modeling, financing, capital asset management, and then the access to data. And some of the biggest things to overcome are the inertia and the status quo. It's not that it's that much harder, but it's about changing the mindsets. I think that's part of what is so interesting about what UBC is doing — you're creating a tool that can allow you to not only measure things in certain ways, but to shift people's mindsets. So I think that's powerful and exciting.

Ashleigh Fischer

JK: What are your first impressions of the MBAR primers and how UBC is utilizing them?

AF: I'm not super familiar yet, besides what has been shared through this project. With the four primers REAP is using, I would question as a starting point why seismic was left off of that. For instance, I'm from the states — my company has offices in LA, New York, DC, Seattle, and Portland — and they talk a lot about seismic prevention in California because that area has already had a lot of experience. We've done a lot of work in Japan and they talk about it a lot obviously. So we get a lot of questions to our offices in the Pacific Northwest asking why aren't we thinking about it more. So I would encourage UBC to add that to the list of primers to choose from as a starting point.

The other ones are quite good, and where most of our concerns would lie. The other thought is about the structure itself. If UBC could, instead of saying 10 different strategies with one from each paper, require more of a mix, or weigh them somehow. If UBC were to look at this list, or five primers per se, they could determine which of those have the most weight and are the most important. Because sometimes I find with these point systems, people will only target easy credits to get the points. And those easy credits may not be the most essential to the project, but they're easy to achieve. That would be my critique structurally.

What is your experience of the approach to resiliency in the industry currently?

The one that comes to mind immediately, in regards to climate, is overheating. What we're seeing with a lot of the passive house projects that have been developed over the last few years is that they're now dealing with overheating issues. We have to use future climate data, to look at the building's future environment. Part of the problem with current thermal and comfort modelling, is that they're using old data, back to the past 50 years when the world was much cooler. The way we do approach overheating preventitatively is typically by providing shading, or greater levels of cooling. Putting in an air conditioning system when residences in our climate would not typically do that.

Power outages and emergencies is also an interesting one. We're working on a healthcare project in West Vancouver, and talking about this quite a bit. With healthcare you're required to provide emergency generators, but on our site there's four to five buildings. So do we need four generators for each building? Or can we combine the buildings through a campus approach? One solution would be for the buildings to share a central energy plan, and that plan also provides for emergency power, and multiple generators to create redundancy. If one building goes down, and that goes to their generator, that building can use another building's generator. We're thinking about a range of situations that could happen in an emergency.

As far as air quality, it's hardest to look at future data, but you can model different air quality levels — interior and exterior. Fire is a bit more unpredictable. I do think it's important to focus on especially due to the increase of wildfires.

Other interviewees have identified seismic as the elephant in the room for the Lower Mainland industry. Would you agree with this assessment?

That is the response from our California colleagues. People in the northern regions are not as conscious because we haven't seen the results of the seismic disaster. We should be looking to places like California and Japan for case studies and what has worked and what hasn't worked.

A lot of problems, and what people aren't wanting to do, is because of expense. If they're looking at a university building, an old brick or masonry building, that would not be up to code currently. But people see the building's still standing, so why would they want to do this big multimillion dollar seismic upgrade when it's still there. It's something of which we should be more conscious.

With respect to the structure of the credit, there have been multiple perspectives on whether the credit should offer more or less discretion. What's your feeling on this, and how would you balance these two perspectives?

There's two sides to it definitely. A lot of times what I see with these certifications is that if you leave it too open-ended, it allows for people to chase the easiest strategies and credits. Rather than be super prescriptive, UBC could go through each of these strategies and suggest strategies or weigh them themselves for the most appropriate approaches at UBC.

If you look at each of these primer lists, there are a lot of strategies. So if you have five primers, that comes out to approximately 70 strategies to choose from. You have a big, open-ended, mixed bag. It's too open-ended for designers. It's nice to include the dollar sign and cost implementation. But what people will do first of all is go straight to the cheapest strategies.

Power outages and emergencies is a perfect example. "Provide natural lighting in common areas, operable windows, corridors and stairwells." That's pretty easy to do, pretty cheap. But how much is that going to help you in case of an emergency if it happens at night? So digging into it more and thinking about what strategies are actually valuable for the project is what I would advise UBC to do. They should more thoughtfully pick through each of these, and make it their own. Just as UBC adopted LEED credits for REAP, UBC should do something similar for the MBAR primers. There'd be a lot more value than using these as-is, and passing them off to the design teams.

Would you say you're seeing forward-thinking from the industry with respect to climate stressors, and new vulnerabilities, such as disease transmission?

From what I've been seeing from the organizations that write different standards, all of them across the board have come up with pilot credits that are addressing covid and other pandemic disease-related issues. Those organizations are typically forward thinking. I could see the rest of the industry following suit. It could impact code requirements, how municipalities deal with it.

As far as climate change, we've already seen our design teams and consultants approach climate change by looking at future data, and that was only for the purpose of thermal discomfort. That was only for the response of hot and unhappy occupants, not even necessarily whether our occupants are in an environment that could become dangerous because there's not enough ventilation. I think that all these buildings will need a full mechanical system overhaul by the end of all of this

How can UBC provide more education with respect to the primers for implementing them?

Again, I think that the list would be pretty good with the addition of the seismic primer. What I would encourage is outlining these a bit more in the credit language. Designers who may be looking at this credit don't typically don't want to dig into these things. Typically we have a REAP consultant who is well versed. They handle everything, and they don't always share everything with the design team. There's not as much of a conversation about the intricacies. So if UBC really wants people to think about these things, I think they should outline them more in the language of the credit. Maybe one way to do that would be to state actual strategies as examples.

I know you want to keep things general, and not get too wordy. But most people in the industry don't know about MBAR yet. I am up on it because I'm a sustainability specialist. But designers are juggling things with regard to code, planning regulations, city regulations. So the last thing they want to do is look at another set of documents and guidelines. But if it's already within the REAP guidelines, then they have no excuse.

Having done projects for UBC, are there improvements that can be made in-terms of UBC's process?

A lot of the project teams do not necessarily feel that REAP is strict enough to have a lot of weight. You're only required to meet REAP Gold. The project I'm coming off right now for instance met REAP Platinum by chance. We were not targeting it, but because we're a passive house project, the energy credits had enough weight to get us there. So it wasn't something on our mind. We already had a goal, and that goal was enough to satisfy REAP.

A lot of projects in the Lower Mainland hate LEED certification because it's been so forced on everybody over the last several decades. And that's interesting coming from the states, because we use LEED a lot to guide projects. If you want to be a LEED Platinum project, it takes a lot of work. We typically look at the certification credits with the client to sort through which ones bring value to the project. The client will say 'hey, we really want to focus on the energy component, or maybe we're really interested in water conversation and an integrated water strategy.' REAP doesn't have that weight in the sense that it's easier to achieve, so we're not having to look at what credits matter.

If UBC looks at where the university's priorities lie, that could help shape this — maybe raising the standards as well. Maybe we raise the bar so projects need to meet BC Energy Step Code 4 by minimum. Make the minimums stricter across the board.

Would it be worth making the Enhanced Resiliency credit a prerequisite?

Making it a prerequisite is pretty valid. Within this credit, maybe it's a prerequisite to include 10 different strategies. And I could guess just looking through the MBAR primers, that designers are probably doing at least 10 things anyway. So they shouldn't be awarded for that necessarily, they should just have to document their work. And then, you should grant credits for doing more than the average project.

Some would say there is still a lack of consensus on the best resiliency measures. Do you agree with this perspective?

I think that there's some level of consensus. When you provide an order of magnitude, as with the dollar signs in the primers, that's how we do things. It provides enough flexibility for consensus. But industry folks love to argue, and there's always a case for or against something. It is tough to put a weight on the strategies at an industry wide scale.

That being said, I think that the impact category in-terms of UBC, or Wesbrook specifically, is something that UBC could definitely look at and discuss. Because the way that MBAR has set this up is they've had to keep this really broad for a wide range of project typologies and a wide range of clients throughout the province. But UBC is looking at a very specific set of residences. It could be narrowed down and a consensus could be made. Structurally, for instance, would be something that's impact. For the rest of them, I think that they will follow the same principles. They're all residences, same clientele, same tenant base, more or less. So I think those things should be under consideration. And you wouldn't need to break it up by high-rise, mid-rise, low-rise.

In your experience, working with UBC, are there things they could be doing by implementing resilience infrastructure — say backup generators at the systems level — as opposed to the building level?

Well, UBC's current energy system needs work. The district energy system has been found to be inefficient, we've had to disconnect a project from it to meet our energy requirements for passive house. Reevaluating the energy for the projects is a good first step. But also if you're redoing the system, how can you incorporate campus-wide emergency power approaches? I'm not familiar with UBC's current strategy, but it's probably not necessarily to the level of a healthcare campus.

The clients are also interested in your perspective on the aftermarket surprises of recently developed buildings with resilience infrastructure, is there anything that's emerged?

Because resiliency is a newer topic, a lot of projects are not completed yet. It'll be interesting to keep an eye out over the next few years. That said, we did do the Campus Energy Plant project at Stanford, and that was a total systems overhaul. The goal there was energy efficiency and resiliency, and everything I've seen about that project has gotten fantastic feedback. The university is very happy, it's won awards and recognitions for the enhanced performance levels. So I think that revisiting these older systems and seeing how we can approve them across the board should be the primary goal.

Have you seen anything that's particularly interesting with respect to using design to foster connectiveness and wellbeing?

The examples that I have off-hand are more at a planning scale, or a neighbourhood scale. I would look into LEED for Neighbourhood Development (ND) certification. We've done a couple of LEED ND projects now, and we've seen that that certification has more weight than actual LEED certification because it does really address social interactions, community engagement, and community resiliency in the sense of how a neighbourhood is connected.

AIR QUALITY

Risks to Buildings, Occupant Safety & Environment

- Decreased outdoor and indoor air quality due to allergens (e.g. pollen)
- Risk of building-related and non-specific building-related illness
- Electrical system overload due to increased energy usage associated with ventilation and air conditioning systems
- Potential utility service interruption due to increased energy usage

Design Strategies

Strategy	Cost	Impact	Alignment
Select a minimum of double-paned tempered window and frames with an air barrier seal to provide greater air quality protection	$$	**	
Include mesh debris screens for gutters, eaves and vents to reduce accumulation of allergens	$	*	
Include mesh screens into operable windows to prevent and insects pests from entering occupied areas	$	***	
Ensure the building air intake is away from local sources of outdoor air pollution	$	***	
Exceed industry standards for ventilation to keep indoor air pollutants and carbon dioxide levels low. Consider including a carbon dioxide monitor to monitor ventilation needs	$$	***	
Use demand-controlled ventilation based on carbon dioxide levels to reduce the introduction of outdoor air beyond required air flow rates	$	**	
Ensure HVAC systems are HEPA ready and/or procure portable HEPA filters with carbon filters to be used during wildfire smoke events	$	**	
Use the highest rated filter possible in HVAC systems (minimum MERV 13, and ideally HEPA) in areas with poor local air quality, such as areas with high traffic, rail, port, or industrial activity	$$	***	
Activated carbon filters can be incorporated into HVAC systems in areas with poor local air quality to reduce exposure to outdoor gaseous contaminants (e.g. VOCs)	$$	**	
Consider ventilation systems that reduce humidity and prevent allergens, such as dust mites, mould, and pollen	$	**	
Include cooling in HVAC design to allow windows to be closed under conditions of poor air quality"	$$	***	
Connect cooling and ventilation systems in refuge areas to a source of back-up power	$$	**	
Ensure backup power to critical systems and areas to prevent system overload during high use of mechanical ventilation/cooling (i.e. when air quality is poor)	$$	*	
Eliminate infiltration of air from the parking garage into the building using air barriers and ventilation	$$	***	
Ensure sufficient ventilation in cooking areas to reduce particulate matter exposure	$	**	
Further reduce indoor particulate matter levels in small rooms for extreme air quality events, such as a building amenity space, through use of air cleaners equipped with high-efficiency particle air (HEPA) filters or electrostatic precipitators (EP)	$$	***	
Place equipment and furniture with air circulation, temperature control, and pollutant removal functions of the HVAC systems in mind	$	**	
Use building materials and furnishings that are low in volatile organic compounds	$	***	

(From Integral, 2020)

Sources of airborne contaminants from both inside and outside a building can have a serious impact on indoor air quality. Outdoor sources of contaminants include major roads, rail yards, industry, fireplaces and wildfire smoke events, while indoor sources of contaminants include off-gassing from building materials and furnishings, cooking, moisture, mould and pests. As the climate changes, climate scientists expect to see an increase in the number of wildfire smoke events and in the levels of summer ozone overall. Exposure to these contaminants have been linked to a number of short-term health effects such as fatigue, headaches, eye, nose and throat irritation, and impacts on cognitive function. Long-term health effects include respiratory diseases, cardiovascular disease and cancer. Emerging research shows association of poor air quality with birth outcomes, diabetes, obesity, mental health outcomes, cognitive development and cognitive decline. However, several measures can be taken to reduce exposure to poor air quality and improve occupant health and well-being.

Operations Strategies

Strategy	Cost	Impact	Alignment
Create a schedule to inspect, maintain and regularly replace high-efficiency air filtration media for all outdoor air building ventilation systems	$	*	
Improve access to local outdoor air quality data by installing displays in common areas of the building	$$	*	
Close building openings to temporarily reduce the intake of outdoor air during extreme events, including forest fires	$	***	
Keep relative humidity below 60% to control dust mites	$	**	
Develop a whole-building strategy to manage moisture and mould by reducing wet or damp areas, standing water, and condensation (minimizing attraction for mosquitos and other insects)	$	***	
Integrate indoor air quality concerns into purchasing decisions (e.g. building materials and furniture)	$	*	

Power Outages · Heat Waves · Fire at the Urban Interface · Severe Storms · Seismic Events

Relative Cost/ Cost Premium		
Low	Medium	High
$	$$	$$$

Relative Impact		
Low	Medium	High
*	**	***

Community Benefits

Consider the following strategies to help improve the resilience of the community overall:

- Educate building managers and occupants on measures to prevent exposure to and reduce impact of allergens, extreme air quality events, and traffic-related air pollution
- Provide refuge areas with excellent air filtration to create safe and healthy spaces for vulnerable community members during periods of extreme air quality advisories

Potential Design Conflicts

Take care and ensure resilient strategies do not exacerbate vulnerability and other risks

- Passive ventilation strategies that rely on natural air flow to cool and ventilate a building may exacerbate indoor air quality issues during times of poor air quality (e.g. forest fire smoke). Ensure buildings have back-up cooling and ventilation systems that allow for mechanical ventilation when necessary.

Additional Resources

- US Environmental Protection Agency: *Fundamentals of Indoor Air Quality in Buildings.*
- US Environmental Protection Agency: *Indoor airPLUS Program for Builders.*
- US Environmental Protection Agency: (2013) *Moisture Control Guidance for Building Design, Construction and Maintenance.*
- US Environmental Protection Agency: *Best Practices for Reducing Near-Road Pollution Exposure at Schools.*
- US Environmental Protection Agency: (2016) *Recommendations for Constructing Roadside Vegetation Barriers to Improve Near-Road Air Quality.*
- US Environmental Protection Agency: (2001) *Building Radon Out: A Step-by-Step Guide On How to Build Radon-Resistant Homes.*

INTEGRAL GROUP

BC HOUSING RESEARCH CENTRE

(From Integral, 2020)

HEAT WAVE

Risks to Buildings, Occupant Safety & Environment

- Overheating beyond typical comfort conditions
- Electrical system overload due to increased energy usage associated with ventilation and air conditioning systems
- Potential utility service interruption due to increased energy usage
- Decreased lighting and communications connectivity
- Risk of heat exhaustion or loss of life due to overheating, dehydration or hyperthermia
- Decreased outdoor and indoor air quality due to smog and associated risk to human health

Site Strategies

Strategy	Cost	Impact	Alignment
Identify and incorporate opportunities for cross ventilation during floorplan development to increase air flow without dependence on mechanical systems	$$	***	
Reduce parking areas and/or add shading or vegetation to reduce the heat island effect	$$	**	

Design Strategies

Strategy	Cost	Impact	Alignment
Conduct simulations to explore the thermal performance of individual suites and the building as a whole, focusing on window to wall ratio, window to floor area ratio, window thermal performance and solar heat gain coefficient, wall thermal performance, airtightness, shading, natural ventilation, stack effect and solar orientation	$$	***	
Use the latest climatic data for the modelling of thermal performance of the building and individual units	$	*	
Increase thermal mass performance of horizontal and vertical surfaces through the inclusion of exposed concrete floor slabs, exposed brick walls, natural stone tile; avoid carpeting and suspended ceilings	$$$	***	
Take advantage of thermal masses to allow for night-purging of heat from passive gains	$$	***	
Identify facades with highest potention for solar heat gains and optimize glazing accordingly (e.g. reduce ratio of glazing).	$	***	
Design horizontal and vertical external shading and external operable screens to reduce incoming solar heat gains along south, east, and west façades	$$$	***	
Use high performance insulation and glazing, including higher solar heat gain coefficient fenestration, and low-e coatings to reduce the rate of heat transfer through building structures, and reduce heating and cooling loads	$$	***	
Include operable windows throughout floorplan layout and common corridors to assist cross ventilation and night-purging of internal heat	$	**	
Incorporate operable windows in common corridors wherever security concerns do not pose a risk	$	**	
Locate amenity spaces in a north-facing area with operable windows (and high ceilings) to act as a cooling refuge area. Design for additional cooling capacity, connect to back-up power, and finish floors with exposed concrete or natural tile	$$	***	
Place deciduous vegetation along south, east and west façades to reduce solar heat gains	$	**	
Install outdoor water fixtures connected to a gravity-fed source in a location easily accessible to building occupants	$	**	
Use high albedo or "cool" roofing materials or vegetated roof systems to reduce internal heat gains	$	**	
Use light-coloured building materials to reduce envelope surface temperatures	$	*	
Include passive and mixed-mode ventilation strategies to cool internal spaces without dependence on active cooling systems	$$$	***	
Investigate opportunities to use solar energy technologies to power cooling systems or chillers	$$$	**	

(From Integral, 2020)

Heat waves are prolonged periods of abnormally hot weather that are often paired with high humidity in maritime climates such as the Pacific Northwest. What is considered a heat wave depends on the degree to which temperature exceed the normal temperature range for the area and season. Heat waves can be particularly intense in urban environments, as the number of heat-absorbing structures and buildings can act to increase overall temperature in what is known as the urban heat island effect. Heat waves are projected to increase in frequency and intensity as a result of climate change, and are projected to have adverse impacts on human health and well-being as risks of overheating increase. Building designers and operators should consider a range of strategies to reduce impacts to health and comfort of building occupants.

Design Strategies

Strategy	Cost	Impact	Alignment
Use high-efficiency lighting, equipment and appliances to reduce internal heat gains	$	*	
Place equipment and furniture with air circulation and temperature control in mind	$	**	

Operations Strategies

Strategy	Cost	Impact	Alignment
Ensure a minimum of 72 hours of fuel storage (natural gas) for power to refuge area and key services, including building pumps, fans, emergency lighting, and security systems	$$	***	
Establish operations and maintenance procedures and building management systems (BMS) to determine the level of cooling required in extreme heat events	$	**	
Ensure common areas' operable windows are opened at night to allow for circulation	$	*	
Educate occupants on practices to keep cool, including closing windows after noon and opening them at night	$	**	
Ensure building operators and occupants understand how to use thermal mass to mitigate temperature swings and optmize comfort	$	**	
Develop training programs to help staff to be able to identify symptoms of heat stress and associated health complications	$	**	

Power Outages · Air Quality · Fire at the Urban Interface · Severe Storms · Seismic Events

Relative Cost/ Cost Premium		
Low	Medium	High
$	$$	$$$

Relative Impact		
Low	Medium	High
*	**	***

Community Benefits

Consider the following strategies to help improve the resilience of the community overall:

- Provide a resilient potable water supply in site design to allow for universally accessible drinking water
- Design amenity rooms to act as cooling centres/refuge areas for at-risk community members (e.g. seniors) and a central location for emergency support and services
- Ensure refuge areas are designed to foster social connection, mental health, and overall cultural safety
- Increase tree canopies to help lower local temperatures and provide shading for community members
- Include public information in building common areas to educate on the common symptoms of health impacts from extreme heat
- Incorporate graywater recycling and rainwater cisterns for irrigation and plant drought tolerant species to conserve water during heat waves

Potential Design Conflicts

Take care and ensure resilient strategies do no exacerbate vulnerability and other risks

- Passive ventilation strategies that help cool buildings with fresh outdoor air can conflict with strategies used to reduce the impact of poor air air quality advisories. Ensure buildings have back-up cooling and ventilation systems that allow for mechanical ventilation when necessary.
- Increasing the thermal performance of vertical and horizontal surfaces through the use of concrete floor slabs may pose a risk to seismic resilience overall. Ensure concrete structures are appropriately designed to withstand seismic events.
- Ensure any vegetation used to shade building interiors are planted with fire risk in mind.

Additional Resources

- City of Vancouver. (2014) Extreme Heat Cool Buildings: A Review of Alternatives to Traditional Air Conditioning
- Government of British Columbia. Current Air Quality Data Map – Air Quality Health Index.
- Bureau de normalisation du Québec. Reducing the Urban Heat Island Effect

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BC HOUSING RESEARCH CENTRE

(From Integral, 2020)

POWER OUTAGES & EMERGENCIES

Risks to Buildings, Occupant Safety & Environment

- Reduced functionality of building heating & cooling systems compromises indoor thermal comfort
- Access to potable water and sanitary services cannot be guaranteed
- Decreased lighting and communications connectivity
- Decreased indoor air quality and associated risk to human health due to lack of ventilation, increased humidity, condensation, and mould
- Medical equipment may be inoperable, and medication requiring refrigeration may be threatened
- Vulnerable populations without extensive support networks may become temporarily homeless
- Carbon monoxide poisoning

Design Strategies

Strategy	Cost	Impact	Alignment
Provide natural lighting and operable windows in common areas, corridors, and stairwells	$	**	
Finish floors with exposed concrete or natural tile for added cooling during extreme heat events (thermal mass)	$	*	
Include passive and mixed-mode ventilation strategies to cool internal spaces without dependence on active cooling systems	$$	**	
Design mechanical and ventilation systems for both central control and/or on a per unit basis	$	**	
Consider the use of high energy efficiency or 'regenerative' elevators in building design	$$$	*	
Ensure building entry and exits can be operated manually	$	***	
Identify the appropriate size, form, and location of back-up power. Consider on-site renewable energy systems as a way to decentralize the building's energy supply	$	***	
Identify a building's critical load and necessary duration of back-up power. Ensure a minimum of 72 hours energy storage/backup energy is provided for critical systems, as well as water booster pumps, sump pumps, alarms and secury equipment, outlets for phone charging and medical equipment, wireless/telecomm services, lighting, refrigeration, and bathrooms.	$$$	***	
Integrate solar PV into shading devices and connect to ventilation and other critical systems	$$$	**	
Designate one or more easily accessible amenity rooms as refuge areas in a north-facing area of the building. Design the refuge area for additional cooling capacity/fans and operable windows.	$$	***	
Consider unit designs that allow for refuge within a home (e.g. one room that is resilient to extreme events)	$$	***	
Provide high efficiency (e.g. LED) emergency lighting in highly trafficked areas, and solar power lighting where possible	$	**	
Introduce rainwater or grey water harvesting as a source of non-potable water	$$$	***	
Install outdoor water fixtures connected to a gravity-fed source in a location easily accessible to building occupants	$	**	

Additional Resources

- Minimum Backup Power Guidelines for MURBs
- Enterprise Green Communities' Strategies for Multifamily Building Resilience
- Designing for ZNE and Passive Survivability
- Urban Green Council, Baby it's Cold Inside
- Enhancing the Livability and Resilience of Multi-Unit Residential Buildings (MURBs), MURB Design Guide

(From Integral, 2020)

A building's power supply may be interrupted for a number of reasons. Windstorms may knock out above-ground power lines, and heavy ice or snow may damage or break power lines. High demand for cooling during heat waves may overwhelm the grid, and flooding may down power lines or flood critical infrastructure such as transformer stations. As most buildings rely on active mechanical equipment to maintain appropriate ventilation rates and interior temperatures, power outages can have dramatic consequences. When paired with thermally inefficient enclosures, interior spaces can overheat due to solar gains and ventilation can become ineffective. Buildings with low thermal resilience become unsafe for occupants during power outages. Changes in climate expected for BC include extreme events and conditions, which may threaten energy supply to buildings and neighbourhoods.

Operations Strategies

Strategy	Cost	Impact	Alignment
Plan, rehearse, and identify necessary procedures (e.g. testing equipment, checking shelf life of stored provisions)	$	***	
Provide an emergency kit, including a backup lithium ion battery, food supplies, flashlights, medical supplies, an emergency radio, sources of entertainment, blankets, and other supplies	$$	***	
Establish a maintenance schedule for emergency power systems	$	**	
Design or connect to a building emergency communication system (e.g. SMS) with a back-up in the building (e.g. bulletin board in Refuge Area)	$	**	
Establish operations and maintenance procedures and building management systems (BMS) to include information about resources available to occupants during extended power outages	$	**	
Create an emergency management manual identifying key information and contacts. Develop procedures for temporary storage of sewage and waste	$	***	

Flood Events · Heat Waves · Fire at the Urban Interface · Severe Storms · Seismic Events · Air Quality

Relative Cost/ Cost Premium		
Low	Medium	High
$	$$	$$$

Relative Impact		
Low	Medium	High
*	**	***

Community Benefits

Consider the following strategies to help improve the resilience of the community overall:

- Provide a resilient potable water supply in site design to allow for universally accessible drinking water
- Design amenity rooms to act as refuge areas for at-risk community members (e.g. seniors) and a central location for emergency support and services
- Ensure refuge areas are designed to foster social connection, mental health, and overall cultural safety
- Build community connectivity through preparedness and other events (e.g. movie nights, block parties)
- Provide occupant education on refuge areas, evacuation measures, exit locations, etc. in multiple languages according to building occupancy
- Designate building or community members with first aid or other experience as emergency coordinators
- Ensure building and community members have access to key information and contact details
- Engage residents in a process of neighbour check-ins to address risks of isolation
- Conduct a sensitivity analysis for occupant demographics to identify key needs and critical services

Potential Design Conflicts

Take care and ensure resilient strategies do no exacerbate vulnerability and other risks

- Passive ventilation strategies that rely on natural air flow to cool and ventilate a building may exacerbate indoor air quality issues during times of poor air quality (e.g. forest fire smoke).

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(From Integral, 2020)

WILDFIRES

Risks to Buildings, Occupant Safety & Environment

- Damage to, or destruction of buildings
- Utility service interruption
- Potential loss of property and personal assets
- Decreased outdoor and indoor air quality and associated risk to human health
- Risk of human injury or loss of life through exposure to fire, smoke, and/or decreased air quality

Wildfir
grasse
combu
outsid
Interfa
quality

Site Strategies

Strategy	Cost	Impact	Alignment
Identify prevailing wind direction and airshed characteristics to determine direction of potential fires	$	***	
Conduct a full risk assessment, considering fuel types, building location relative to slope, and the nature of the structure	$$	***	
Maintain 10m setback from all combustible materials to create a natural firebreak. Increase this setback for structures or vegetation closest to the forest interface	$	***	
Install outdoor water fixtures (e.g. taps and sprinklers) connected to a gravity-fed source in a location easily accessible to building occupants	$	***	

Design Strategies

Strategy	Cost	Impact	Alignment
Include mesh debris screens (3 mm) in gutters, eaves and vents to reduce accumulation of flammable vegetation and limit areas exposed to sparks and embers	$	*	
Install a chimney spark arrestor to reduce release of sparks and embers to surrounding areas	$	*	
Select higher performance fire-retardant or -resistant siding materials (e.g. stucco, metal siding, brick, concrete and fibre cement)	$$	***	
Select fire-retardant roofing materials, such as metal, asphalt, clay and composite rubber tiles with Class A UL/ASTM rating – avoid green roofs for buildings at the wildland-urban interface	$$	***	
Use double-paned tempered windows and frames with an air barrier seal to provide greater air quality protection and heat resistance	$$	**	
Ensure building and garage entry doors are fire-rated and sealed with an air barrier	$	**	
Install high-efficiency air filtration media (MERV 11 or higher) for all outdoor air building ventilation systems to improve indoor air quality	$$	***	
Install air cleaners equipped with highest-efficiency particle air (HEPA) filters and activated carbon filters in refuge areas (e.g. amenity spaces)	$$$	***	
Make use of demand-controlled ventilation based on CO2 levels to reduce the introduction of outdoor air beyond required air flow rates.	$$$	**	
Install mechanical systems such as air source heat pumps that allow for cooling during fire events	$$	***	
Design a common building area to act as a cooling room or clean air refuge	$	***	
Connect cooling and ventilation systems in refuge areas to a source of back-up power.	$$	**	
Ensure a minimum of 72 hours of fuel storage for power to refuge area and key services, including building pumps, fans, emergency lighting, and security systems	$$	***	
Design building entry and exits that can be operated manually	$	***	

Power Outages & Emergencies · Air Quality · Flood Events · Severe Storms · Seismic Events · Heat Waves

Relative Cost/ Cost Premium

Low	Medium	High
$	$$	$$$

Relative Impact

Low	Medium	High
*	**	***

Operations Strategies

Community Benefits

Potential Design Conflicts

(From Integral, 2020)

Wildfires pose a serious threat to building safety. Risks occur when the close combustion of natural fuels (e.g. trees, grasses and shrubs) spread to human-made structures. Wildfires at the urban interface are made more complex because combustible building materials compound with out fuel sources. At the wildland-urban interface, fires can start either outside and spread to adjacent structures, or originate inside, then ignite vegetation and spread through the wilderness. Interface fires are projected to increase in severity and magnitude as a result of climate change, and can in turn lead to air quality advisories across the province. This sheet is intended to start conversations about mitigating these risks.

Operations Strategies

Strategy	Cost	Impact	Alignment
Trees should be set back 10m from all buildings and combustible materials	$	***	
Plant fire-resistant vegetation with moist, supple leaves and low sap or resin production	$	*	
Ensure planting groups are a minimum of 6m apart, and trees are a minimum 3m apart	$	*	
Prune lower branches within 6' (1.8m) of ground	$	*	
Regularly mow lawn areas and check roof, gutters, and eaves to remove flammable vegetation	$	*	
Inspect, maintain and replace high-efficiency air filtration media for all outdoor air building ventilation systems	$	**	
Close building openings to temporarily reduce the intake of outdoor air during extreme events	$	***	
Plan, rehearse, and identify preparedness procedures necessary to maintain a successful refuge area (e.g. testing equipment, checking shelf life of stored provisions)	$	*	
Provide occupant education on refuge areas, evacuation measures, exit locations, etc.	$	***	
Educate building maintenance staff in firefighting/resistance measures (e.g. operating sprinklers, wetting down surfaces, removing flammables)	$	***	
Provide sufficient personal protective equipment for building occupants, (e.g. N95 masks or N95 respirators) to minimize exposure to particulate matter	$	**	
Ensure personal cooling devices are available to building occupants (e.g. cooling blankets)	$	*	
Ensure there is adequate means for people who don't have cars or need assistance to evacuate the vicinity (e.g. public transportation or a carpool-evacuation plan)	$	*	
Ensure alternate egress routes are available and known to building occupants	$	**	

Community Benefits

Consider the following strategies to help improve the resilience of the community overall:

- Provide access to local outdoor air quality data and indoor CO2 levels via occupant displays
- Design amenity rooms to act as cooling centres/clean air refuge areas for at-risk community members (e.g. seniors) and a central location for emergency support and services
- Ensure refuge areas and common spaces are designed to foster social connection, mental health, and overall cultural safety
- Ensure building connection to community fire response plans (e.g. notification systems)

Potential Design Conflicts

Take care and ensure resilient strategies do no exacerbate vulnerability and other risks

- Vegetation setbacks may eliminate benefits associated with trees for shading and heat island reduction
- Consider the durability of siding materials to withstand storms, freeze/thaw and seismic events
- Consider the impact of roofing materials on the heat island effect
- Passive ventilation strategies that rely on natural air flow to cool and ventilate a building may exacerbate indoor air quality issues during times of poor air quality (e.g. forest fire smoke). Ensure buildings have back-up cooling and ventilation systems that allow for mechanical ventilation when necessary.

Additional Resources

- Government of BC: Current Air Quality Data Map – Air Quality Health Index
- Government of BC: FireSmart Homeowner's Manual
- Government of BC: FireSmart Your Property

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