Reframed Tech Series

Climate resilience & deep retrofits

#Reframed

June 10, 2020

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Leading Canada's transition to clean energy

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Reframed Tech Series

Moderator

Ghazal Ebrahimi

Senior analyst, Pembina Institute

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Agenda

1. Opening remarks
2. Introductions
3. Presentations
4. Q&A
5. Upcoming opportunity

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Note to attendees

This webinar is being recorded. The video will be published online and shared with all registrants.

Introducing the Reframed Initiative

The Reframed Initiative is working with designers, builders, owners, financiers, and policy-makers to scale up deep retrofits.

Together, we can address the housing crunch and climate emergency.

LEARN MORE: pembina.org/reframed

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Deep retrofits are:

- **Healthy:** cleaner air, improved comfort
- **Resilient:** ready for extreme weather and earthquakes
- **Low-carbon:** use renewable energy and carbon smart materials

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Let’s scale up solutions that:

- Keep rent affordable
- Minimize disruption to tenants
- Return value to owners and investors

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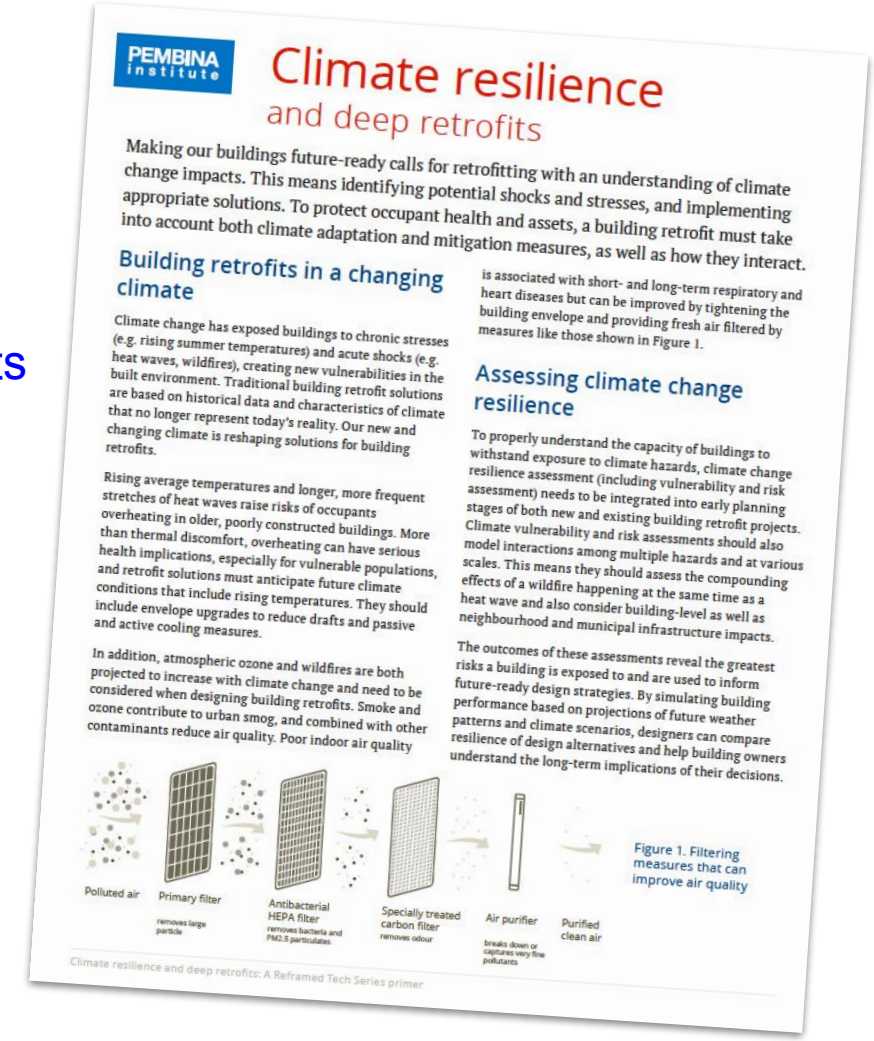
New primer

DOWNLOAD:
pembina.org/pub/climate-resilient-retrofits



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Climate resilience and deep retrofits

Making our buildings future-ready calls for retrofitting with an understanding of climate change impacts. This means identifying potential shocks and stresses, and implementing appropriate solutions. To protect occupant health and assets, a building retrofit must take into account both climate adaptation and mitigation measures, as well as how they interact.

Building retrofits in a changing climate

Climate change has exposed buildings to chronic stresses (e.g. rising summer temperatures) and acute shocks (e.g. heat waves, wildfires), creating new vulnerabilities in the built environment. Traditional building retrofit solutions are based on historical data and characteristics of climate that no longer represent today's reality. Our new and changing climate is reshaping solutions for building retrofits.

Rising average temperatures and longer, more frequent stretches of heat waves raise risks of occupants overheating in older, poorly constructed buildings. More than thermal discomfort, overheating can have serious health implications, especially for vulnerable populations, and retrofit solutions must anticipate future climate conditions that include rising temperatures. They should include envelope upgrades to reduce drafts and passive and active cooling measures.

In addition, atmospheric ozone and wildfires are both projected to increase with climate change and need to be considered when designing building retrofits. Smoke and ozone contribute to urban smog, and combined with other contaminants reduce air quality. Poor indoor air quality is associated with short- and long-term respiratory and heart diseases but can be improved by tightening the building envelope and providing fresh air filtered by measures like those shown in Figure 1.

Assessing climate change resilience

To properly understand the capacity of buildings to withstand exposure to climate hazards, climate change resilience assessment (including vulnerability and risk assessment) needs to be integrated into early planning stages of both new and existing building retrofit projects. Climate vulnerability and risk assessments should also model interactions among multiple hazards and at various scales. This means they should assess the compounding effects of a wildfire happening at the same time as a heat wave and also consider building-level as well as neighbourhood and municipal infrastructure impacts.

The outcomes of these assessments reveal the greatest risks a building is exposed to and are used to inform future-ready design strategies. By simulating building performance based on projections of future weather patterns and climate scenarios, designers can compare resilience of design alternatives and help building owners understand the long-term implications of their decisions.

Figure 1. Filtering measures that can improve air quality

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Panellist

Ilana Judah

Architect and MSc student,
Institute for Resources,
Environment and Sustainability,
University of British Columbia

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Panellist

Greg Allen

Senior associate, Rivercourt Engineering

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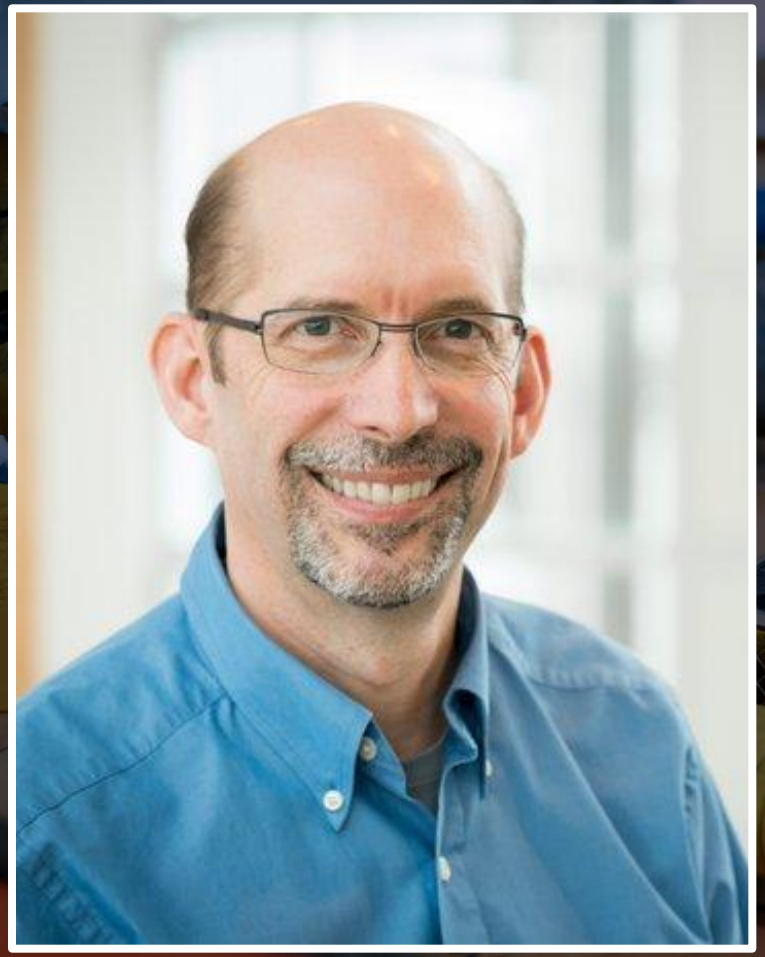

Panellist

Ralph Wells

Community energy manager, University of British Columbia

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Panellist

Alex Hutton

Energy manager, Provincial Health Services Authority

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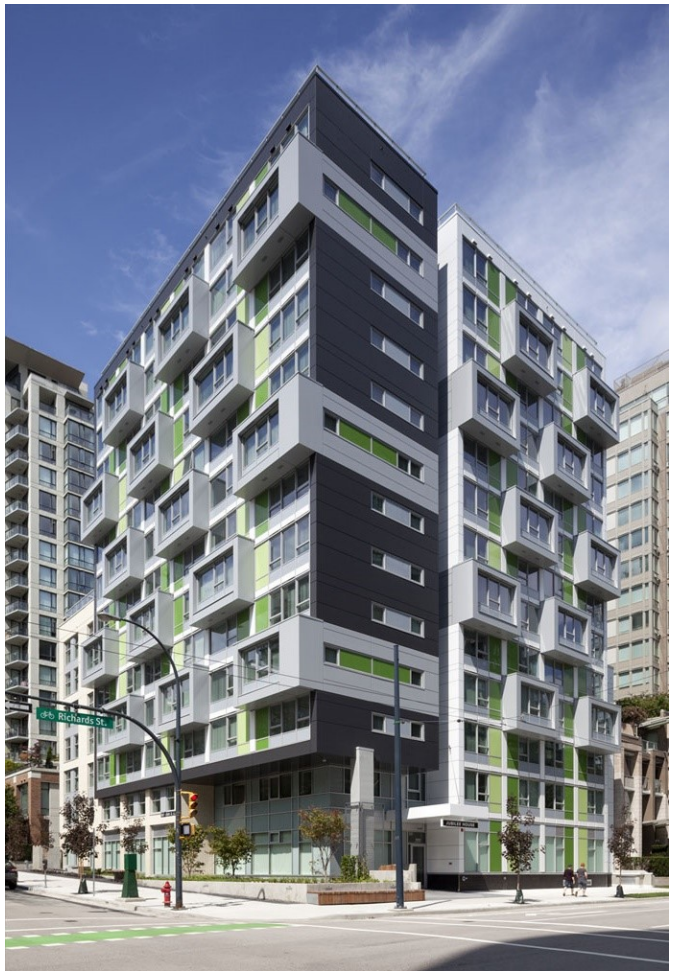
Adaptive mitigation

A framework for assessing synergies, conflicts, opportunities and trade-offs between climate change mitigation and adaptation in urban neighborhoods

Ilana Judah AIA, OAQ, LEED AP BD+C, CPHD
Institute for Resources Environment and Sustainability
The University of British Columbia



The New Jubilee House (GBL Architects, 2016)

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Faculty of Science

Research Problem & Question

Some adaptation solutions have **negative consequences** for mitigation, while some mitigation strategies put populations at risk during extreme weather events or even slow-onset changes.

Not considering **interactions** between climate mitigation and adaptation strategies can result in unnecessary redundancy, additional costs, unintended risks, and missed opportunities.

(NYC Department of Environmental Protection, 2015)

(Tadashi Ono, 2018)

Research Problem & Question

Some adaptation solutions have **negative consequences** for mitigation, while some mitigation strategies put populations at risk during extreme weather events or even slow-onset changes.

Not considering **interactions** between climate mitigation and adaptation strategies can result in unnecessary redundancy, additional costs, unintended risks, and missed opportunities.

How can the design process for multifamily buildings in urban neighbourhoods effectively integrate both climate mitigation and adaptation considerations?

(NYC Department of Environmental Protection, 2015)

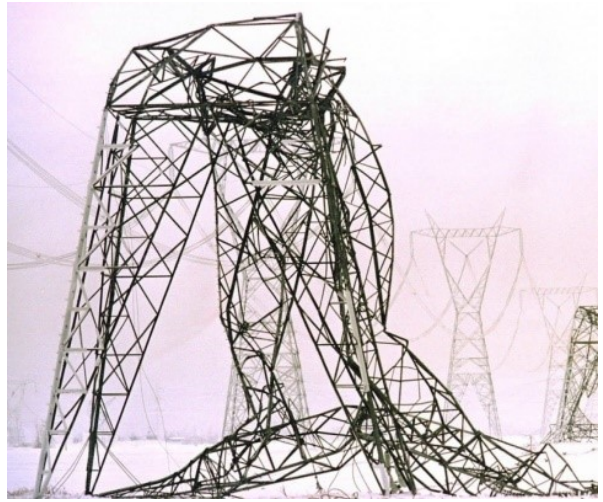
(Tadashi Ono, 2018)

Need for a Multi-Scalar Approach

Some adaptation solutions are most appropriately implemented at the **neighborhood scale**, and can be specifically tailored to it.
(Uda & Kennedy, 2015)

Need to consider potential cascading effects beyond the control of neighborhoods and advocate for **multi-scalar** assessment.
(Kwok et al., 2018)

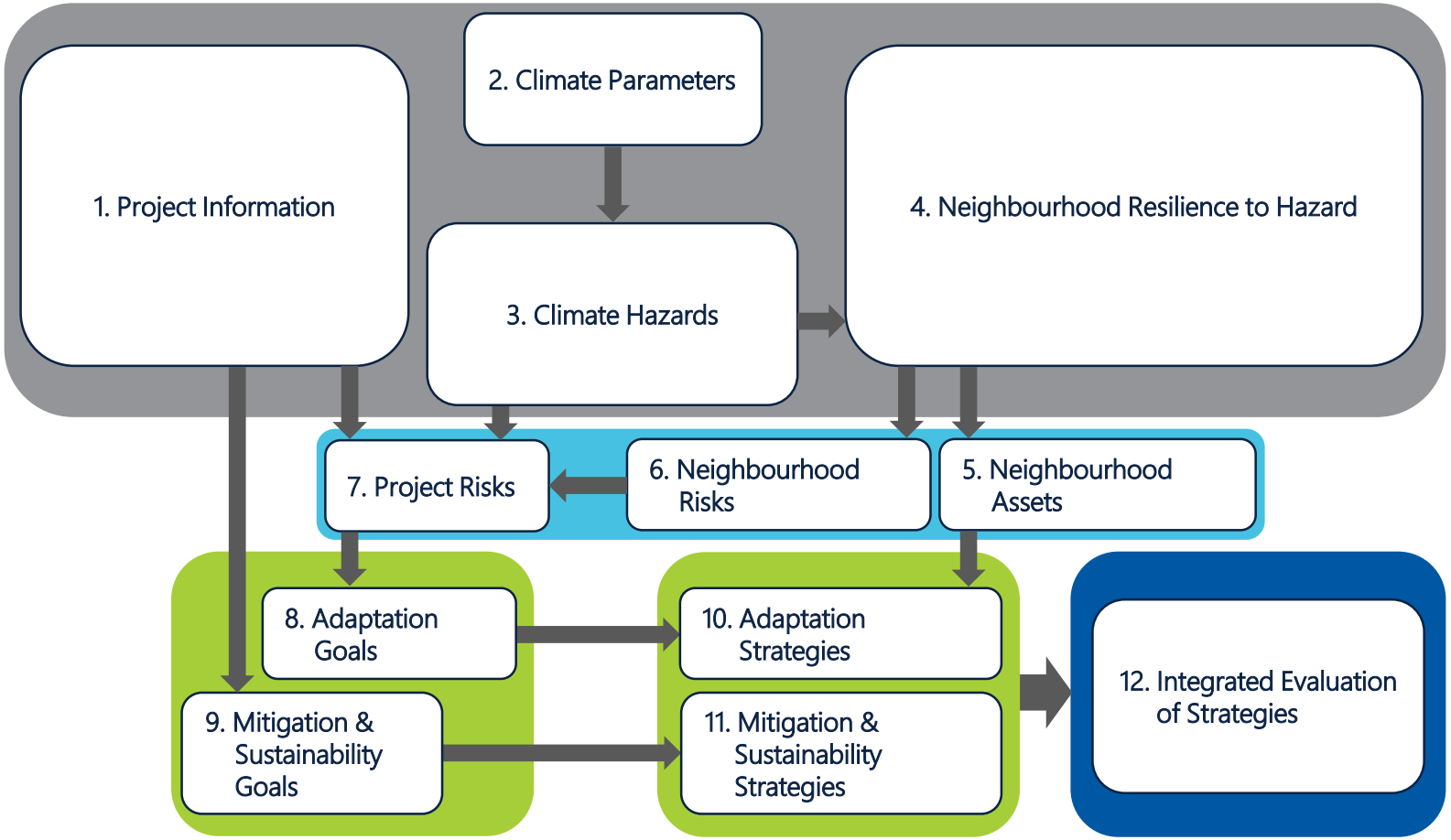
Key **infrastructure functions** are as important, if not more so, as the reparability of building components. (Kurth et al., 2019)



(Robert Laberge AFP, 1998)

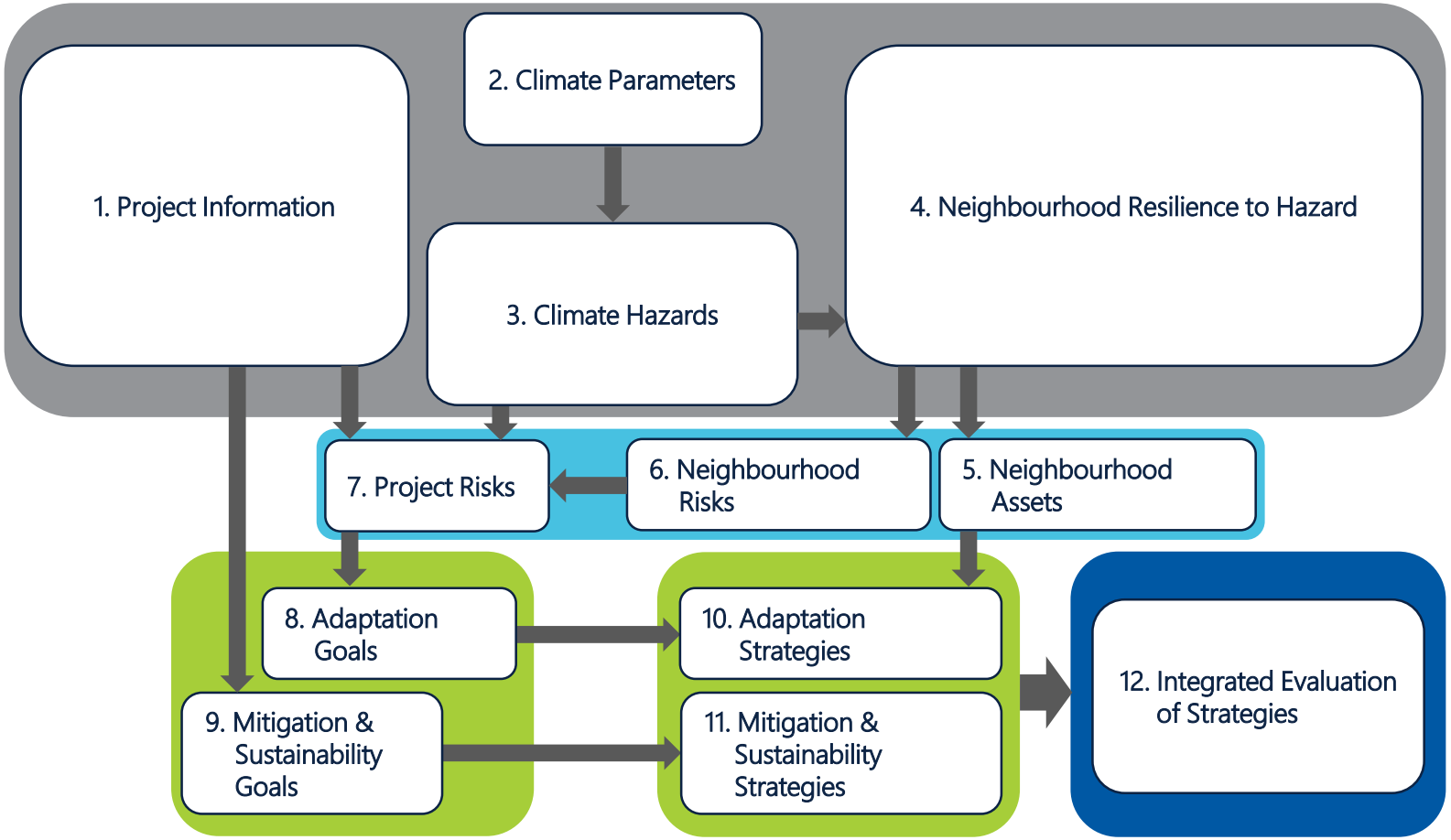
(NYC Planning, 2016)

Integrated Building Adaptation & Mitigation Assessment (IBAMA) Framework



Integrated Building Adaptation & Mitigation Assessment (IBAMA) Framework

A. GATHER INFORMATION



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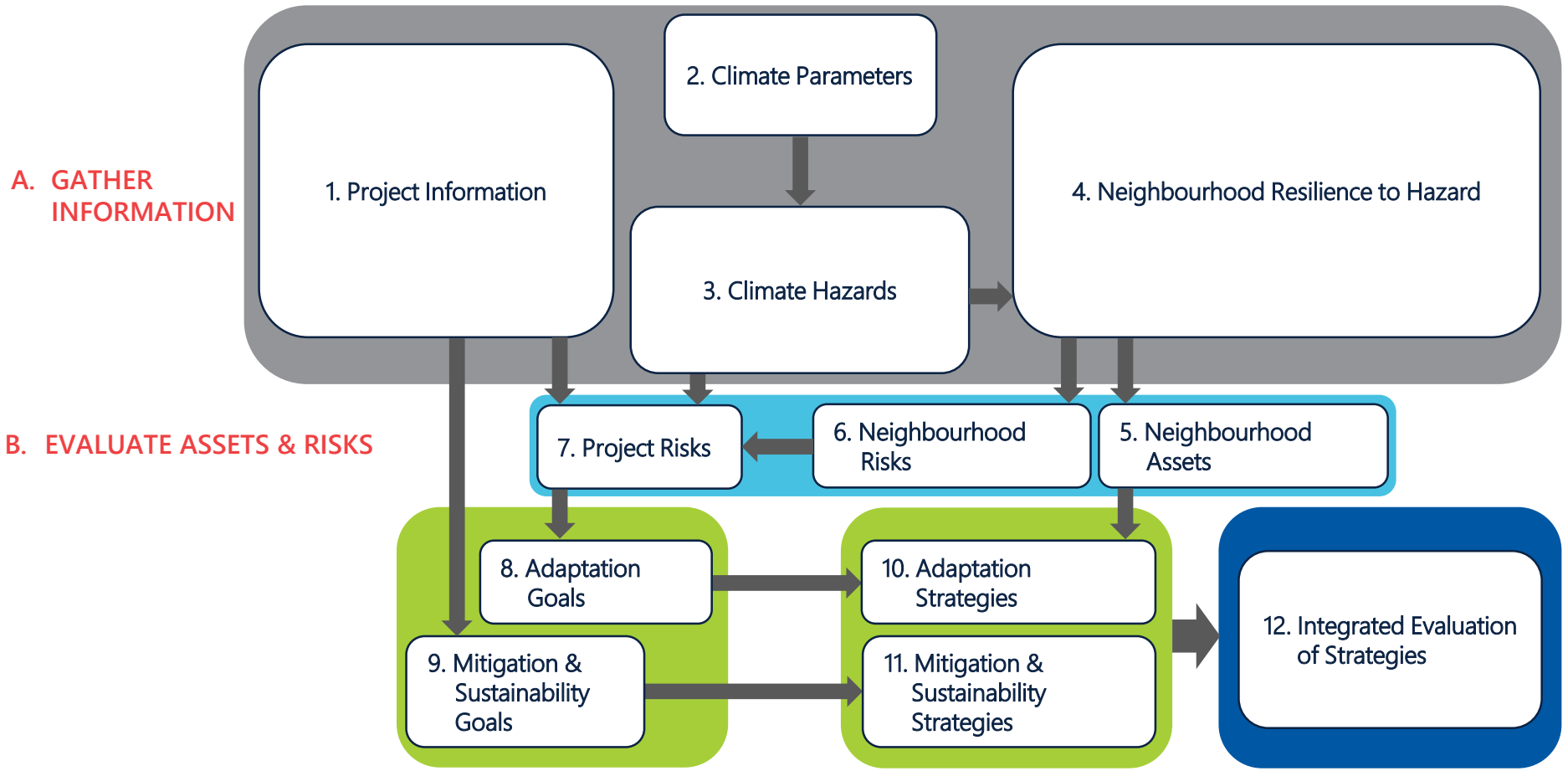

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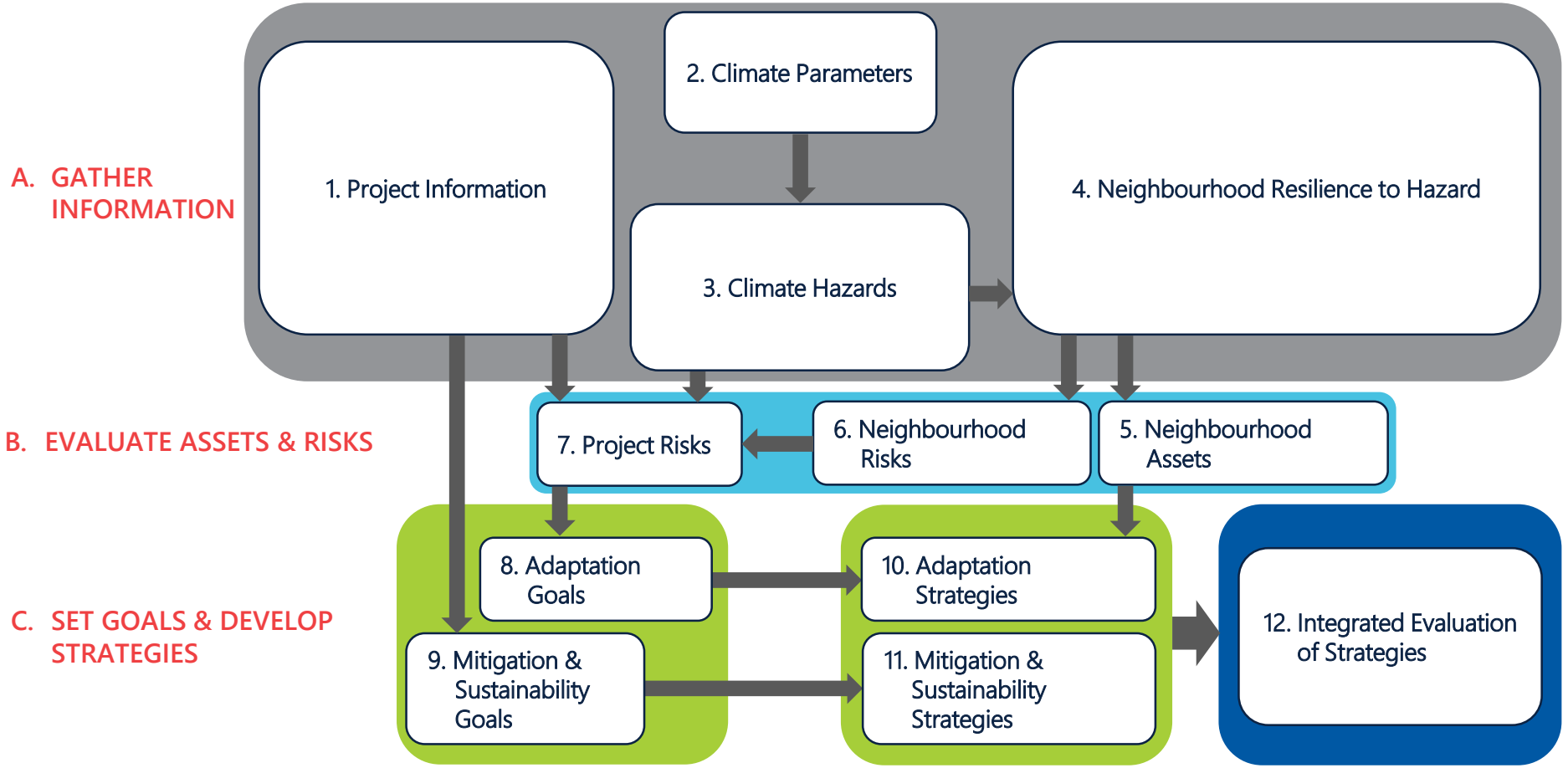

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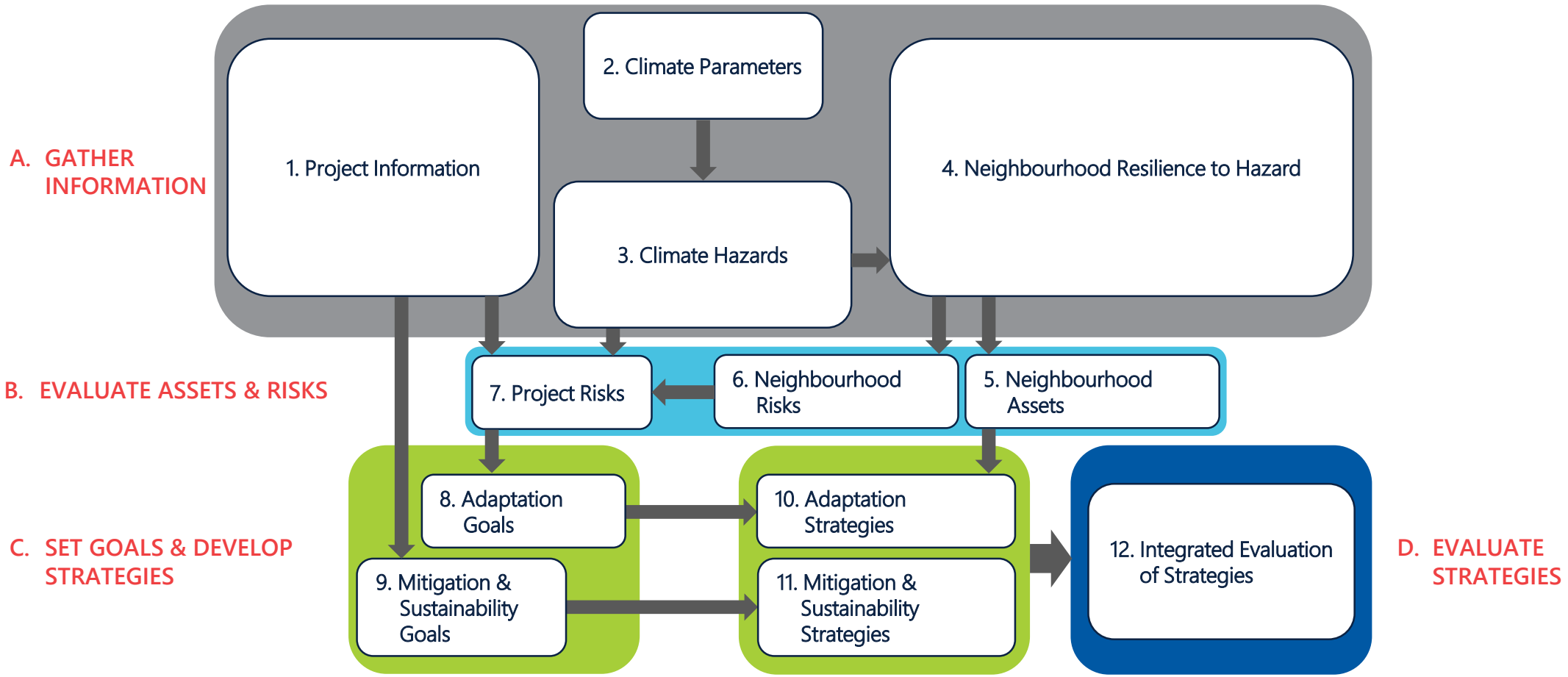

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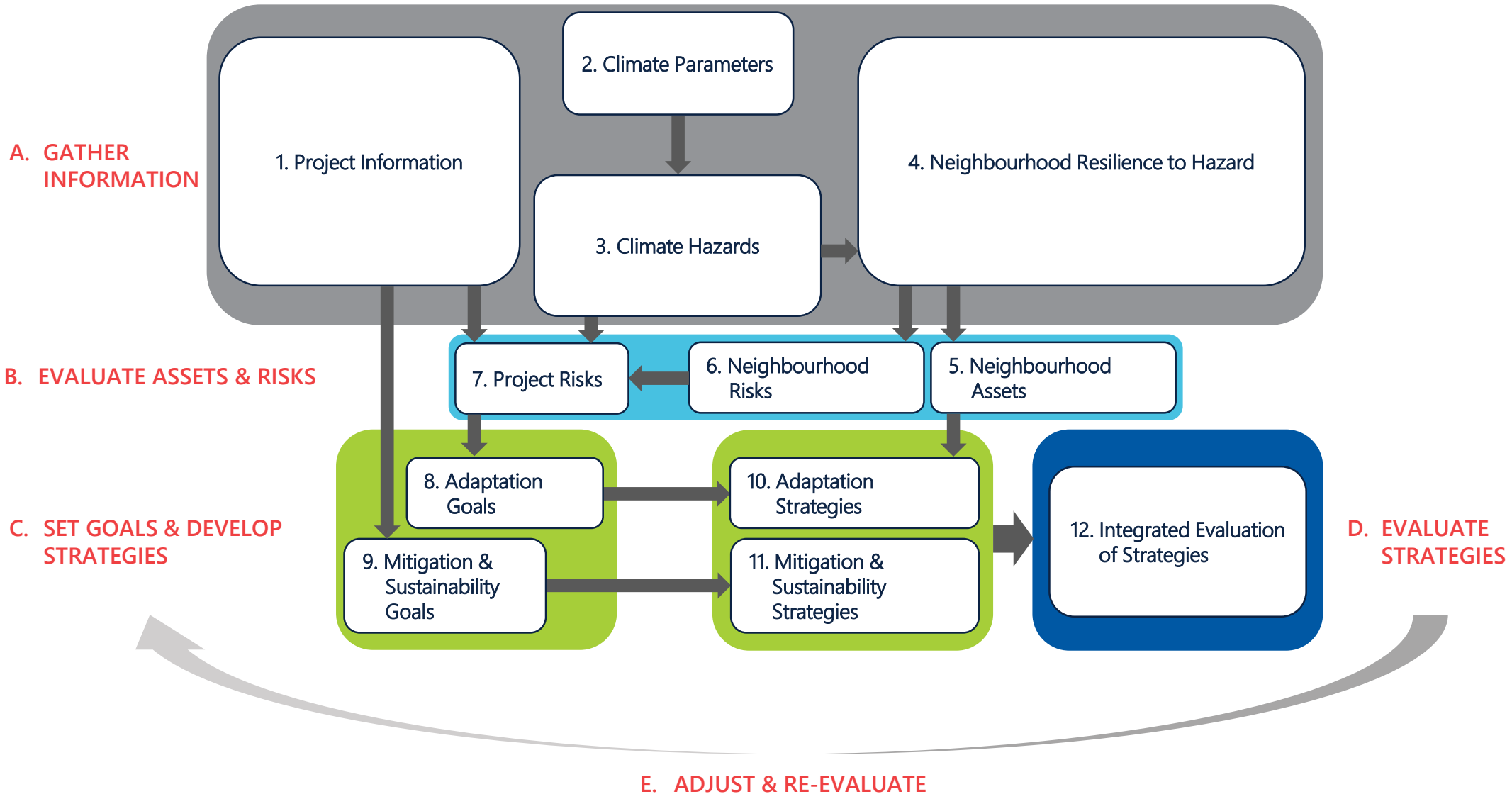


Step 1 – Collecting Project Information

1. Project Information

General Information

Name
Address
Neighbourhood
Typology
Project Budget/sf
Utilities
Building Age
Retrofit Logistics Budget

Program Requirements

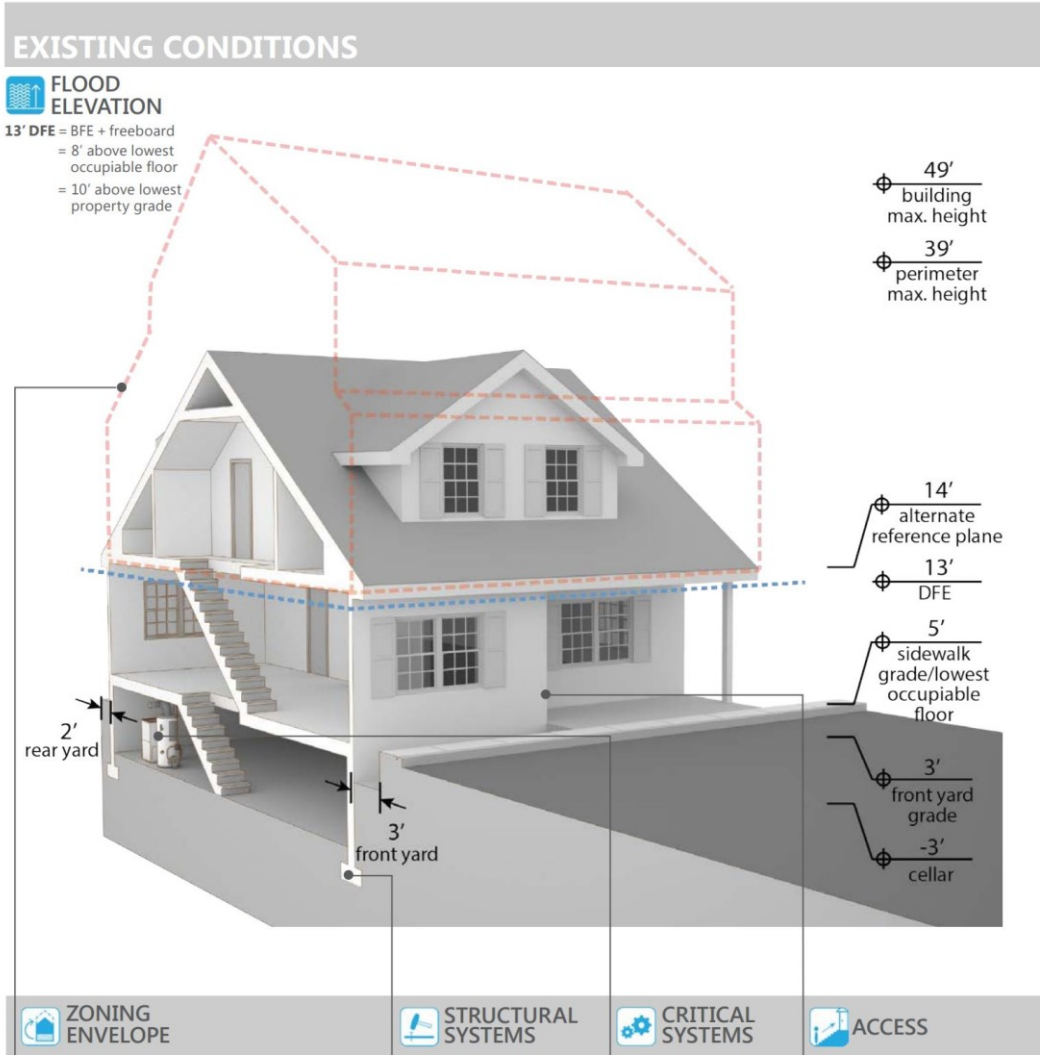
Project Program
OPR
Codes
Zoning Regulations
Costs & Budgets
Retrofit Logistics & Schedule

Location, Site & Building Features

Site Features
Infrastructure & Systems
Building Design Features
Existing Construction
Original Building Code

Demographics

Primary Age Group
Family Type
Income
Indigenous or Minority
Health
Official Language Speakers
Building Mgmt./Residents



(NYC Planning, 2014)

Steps 2 & 3 - Considering Climate Parameters & Hazards

2. Climate Parameters

Climate scenario
Structure & Enclosure Age & Lifespan
Systems Age & Lifespan
Infrastructure Age & Lifespan

3. Climate Hazards

Hazard 1 ⟷ **Cascading Impacts**

Hazard Type
Hazard Frequency
Hazard Duration
Hazard Intensity/Severity
Exposure of Occupants/ Asset
Affected Area

Cascading Impact 1

Hazard 2 ⟷ **Cascading Impacts**

	Past (mm)	RCP4.5				RCP2.6			
		2050s Percent Change (%)		2080s Percent Change (%)		2050s Percent Change (%)		2080s Percent Change (%)	
		Average	(Range)	Average	(Range)	Average	(Range)	Average	(Range)
Fall	580	6	(-1 to 19)	15	(0 to 27)	11	(-3 to 25)	12	(2 to 28)
Winter	683	9	(-2 to 22)	8	(-6 to 16)	6	(-6 to 15)	6	(1 to 11)
Spring	400	7	(2 to 15)	9	(1 to 16)	8	(3 to 15)	6	(-1 to 13)
Summer	206	-15	(-39 to 2)	-15	(-35 to 10)	-8	(-25 to 14)	-1	(-25 to 13)

(Metro Vancouver, 2016)

(Global News, 2019)

(CTV News, 2018)

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Infrastructure Age & Lifespan

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Hazard Type — Cascading Impact 1
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Hazard 2 ⟷ **Cascading Impacts**

Figure 4. Vancouver Olympic Village Green Roof *(Source: Vitaroofs International Inc.)*

Sub-System Lifespan, Related IPCC Scenario & Year

Sub-System	Lifespan	IPCC Scenario & Year	References
Roof Structure	80 years	RCP 8.5 (2100)	BOMA Preventative Maintenance Guidebook
Insulation and waterproof membrane	20 years	RCP 8.5 (2040)	Hydrotech Membrane Corp.
Roof Pavers	50 years	RCP 8.5 (2080)	Hanover Architectural Products
Growing Medium & Plants	10 years	RCP 8.5 (2030)	Hydrotech Membrane Corp.
Irrigation System	20 years	RCP 8.5 (2040)	Netafim Irrigation Inc.

Steps 4 to 7 – Evaluating Neighbourhood Resilience to inform Assets & Risks

3. Climate Hazards

4. Neighbourhood Resilience to Hazards

Infrastructure

Power
Water
Stormwater
Roads
Public Transportation
Other Transportation
Sanitation
Communications

Buildings

Building Density
% Vulnerable Buildings
% Vulnerable Adj. Buildings
Hotel Rooms/ Capita
Resilience of Hotels
Proximity to Resilience Hub
Resilience of Hub/Shelters

Demographics

% under 14 & over 65
% Official Language Speakers
% Indigenous or Immigrant
% Single Parent Households
% Single Households
% Differently Abled
% University Degree

Community Services & Governance

Density of Police & Fire Stations
Proximity to Hospitals/Clinics
Emergency Communications
Density of Gas Stations
Affordable Food Access
Commercial & Retail Services
Diversity of Businesses & Services
Proximity to Banking Services
Proximity to Shopping Centres
Proximity to Schools
Proximity to Libraries
Ratio of Municipal Staff/Residents
Level of Emergency Preparedness

Environment

Air Quality
Water Quality
% Open Space
% Vegetated Space
% Land Area at Risk

Transportation

Bus Frequency
Train Frequency
Bicycle Network
Walkability
Neighborhood Access

Economic Indicators

Median Household Income
Unemployment Rate
% Not in Labor Force
% Home Ownership
Avg. Property Value
% Commute by Vehicle

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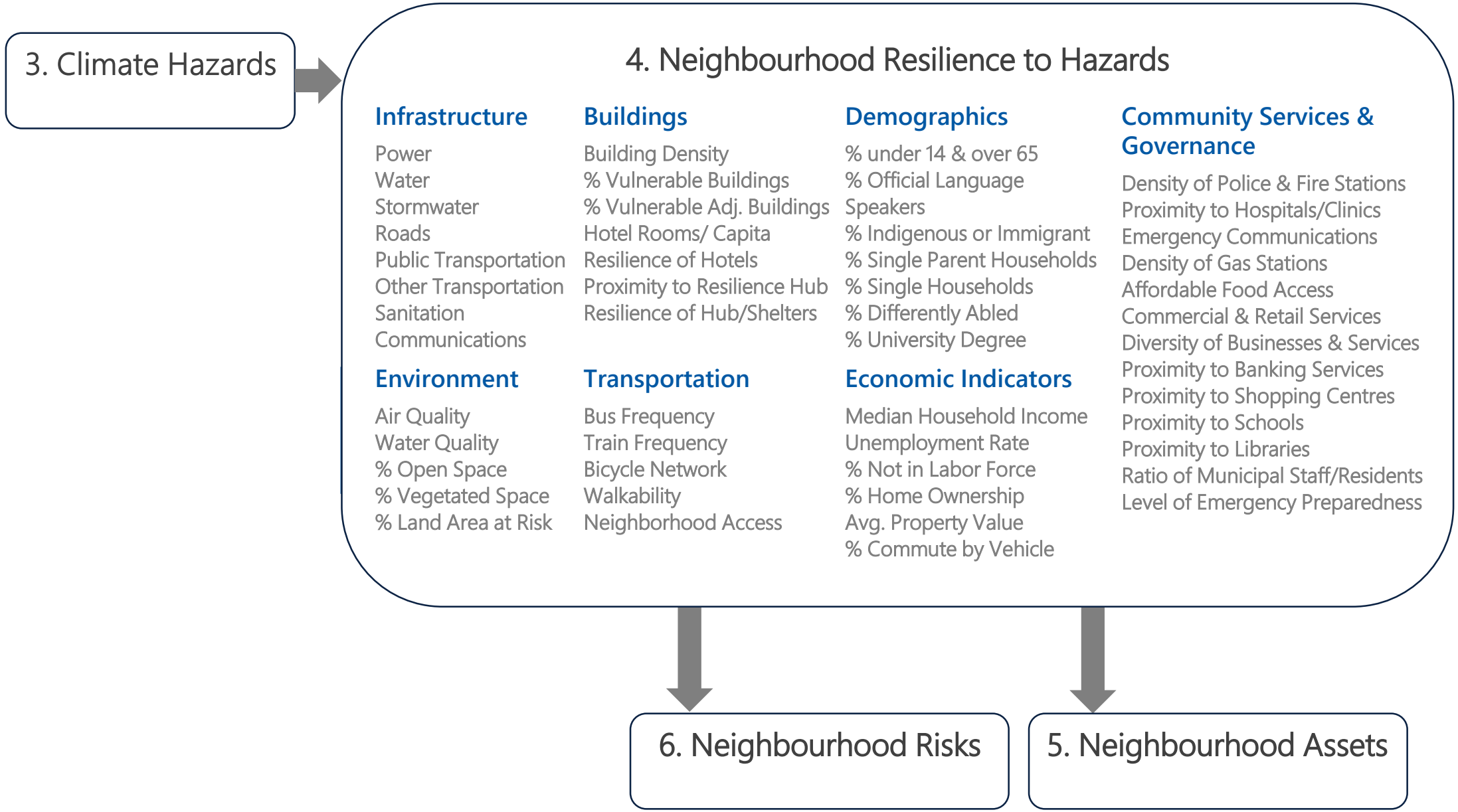
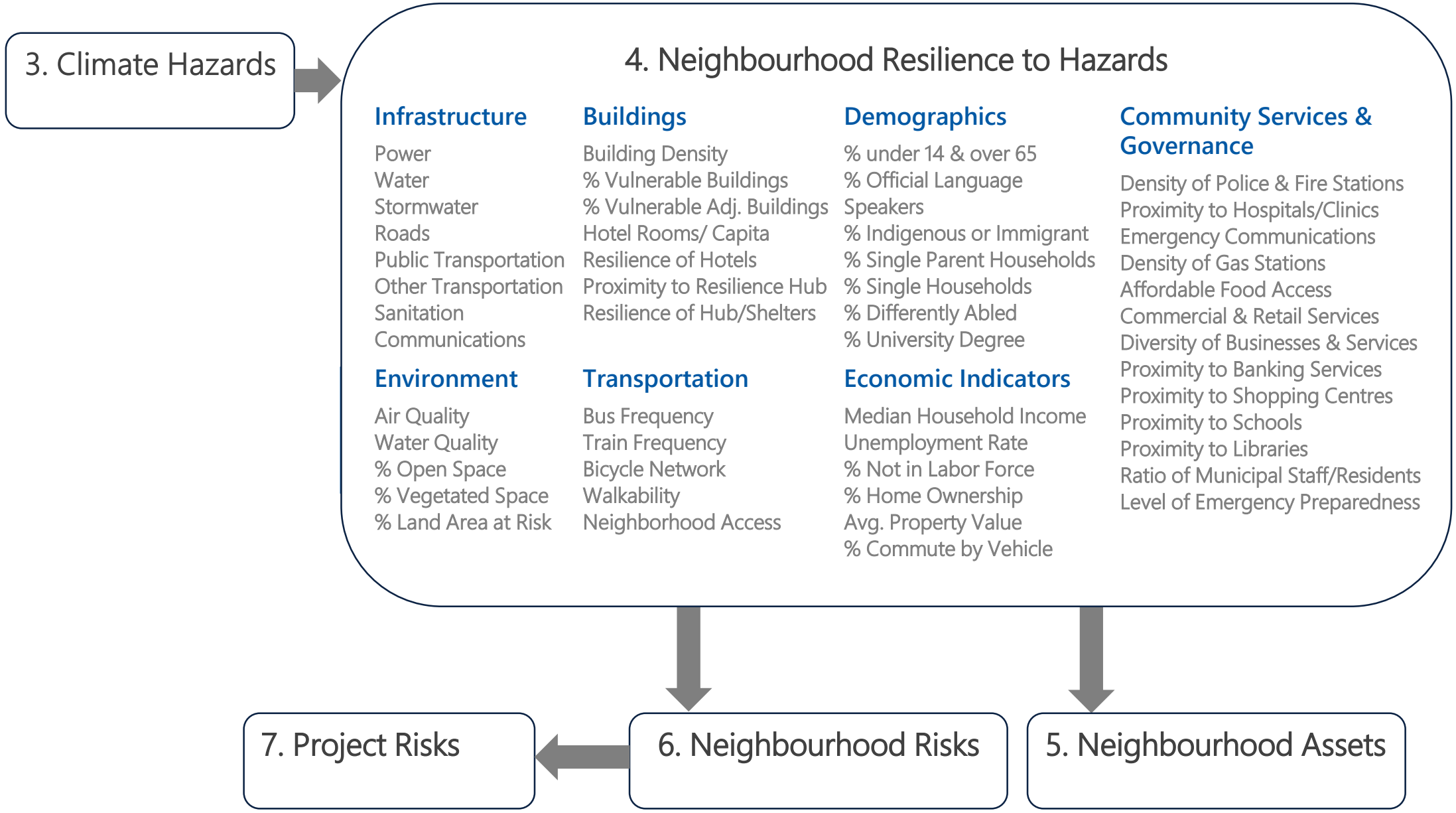
% Home Ownership
Avg. Property Value
% Commute by Vehicle

5. Neighbourhood Assets

Steps 4 to 7 – Evaluating Neighbourhood Resilience to inform Assets & Risks



Steps 4 to 7 – Evaluating Neighbourhood Resilience to inform Assets & Risks



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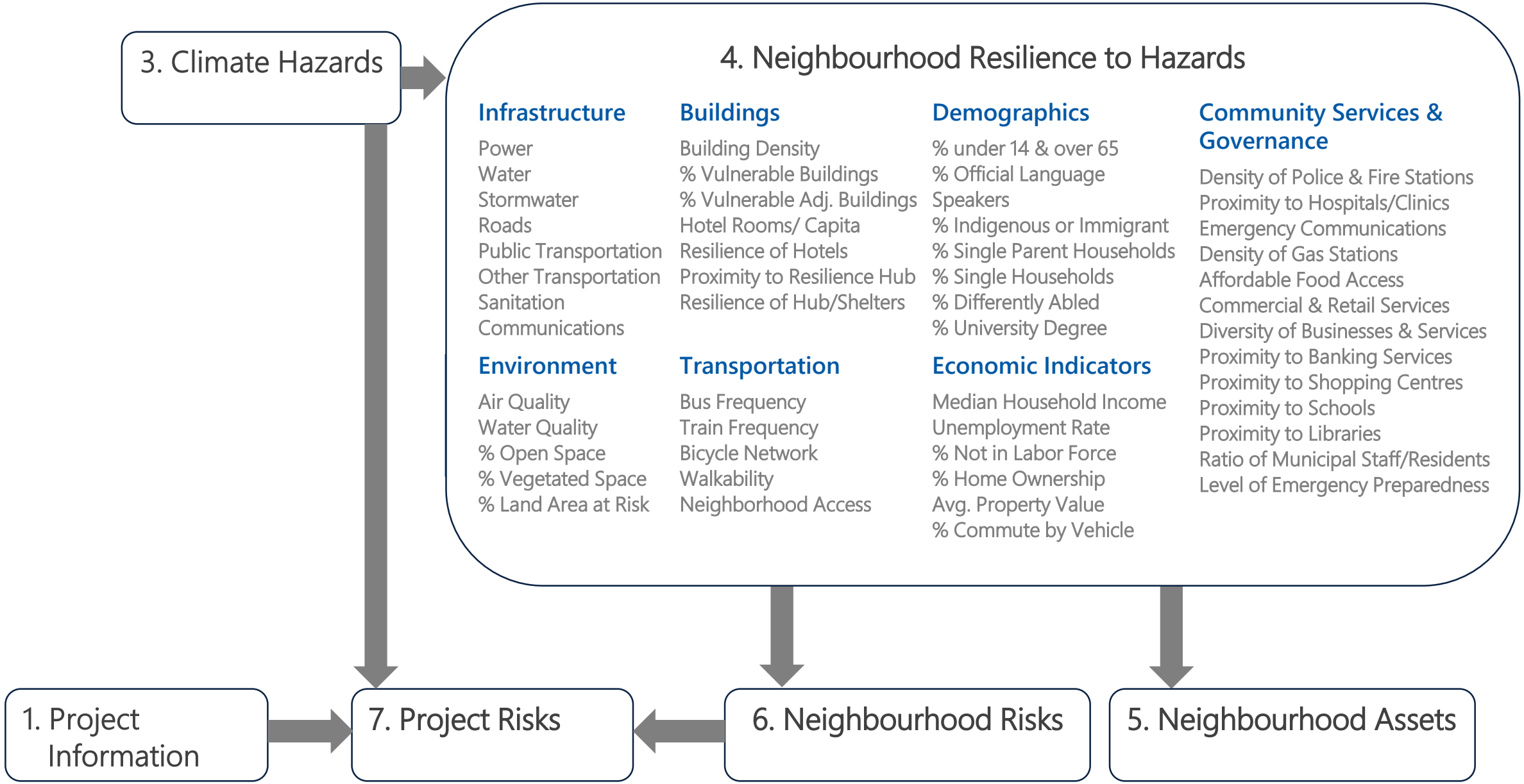


Steps 4 to 7 – Evaluating Neighbourhood Resilience to inform Assets & Risks

3. Climate Hazards

Hypothetical example not for use

4b. Heavy Precipitation/Flash Flooding - Built Environment

Parameter	Resilience Score	References/ Citations	Notes	Completed by
Building density	4	https://westvancouver.ca/home-building-property/planning	Low-mid density and compactness facilitates relocation and evacuation.	
% Project-adjacent buildings resilient to hazard	2	City of West Vancouver	Many homes vulnerable to basement floods, some to ground floor flooding.	
% Neighbourhood buildings resilient to hazard	2		Many homes vulnerable to basement floods, some to ground floor flooding. Some public facilities better prepared.	
Hotel rooms/capita	1		Closest hotels in North Vancouver. A few B&Bs in West Vancouver.	
Resilience & Reliability of hotel rooms to hazard	1		Motel-style lodging in North Vancouver doesn't appear to be flood resilient.	
Resilience & reliability of resilience hubs/shelters to hazard	n/a		No neighbourhood resilience hub identified.	
Resilience of community facility buildings to hazard	2	City of West Vancouver	Most buildings not designed to address flooding though some are moving critical equipment from basements.	

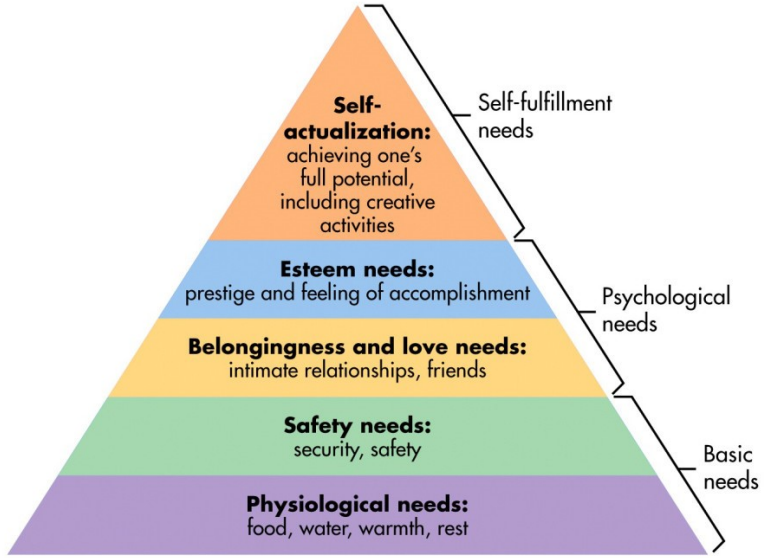
6. Neighbourhood Risks

7. Project Risks

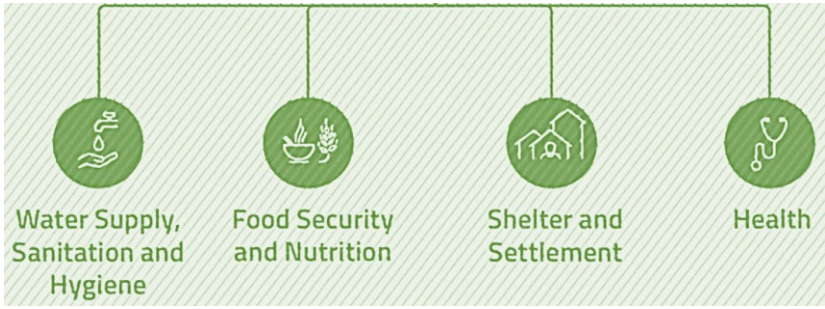
Steps 8 to 11 – Setting Goals to Inform Strategies

7. Project Risks

1. Project Information



(Maslow, 1943) (McLeod, 2018)



(Sphere Association 2018)

Steps 8 to 11 – Setting Goals to Inform Strategies

7. Project Risks

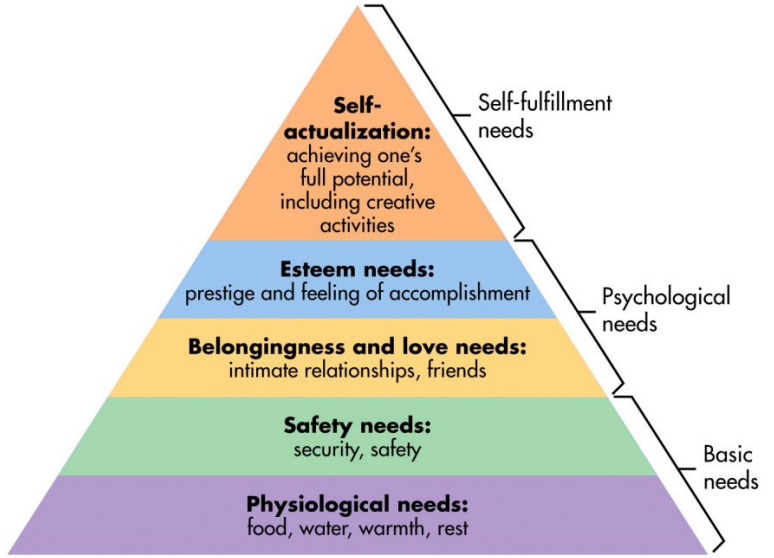
1. Project Information

8. Adaptation Goals

Occupant-based Goals

Asset-based Goals

Other Goals (e.g. Economic, Community, Infrastructure)



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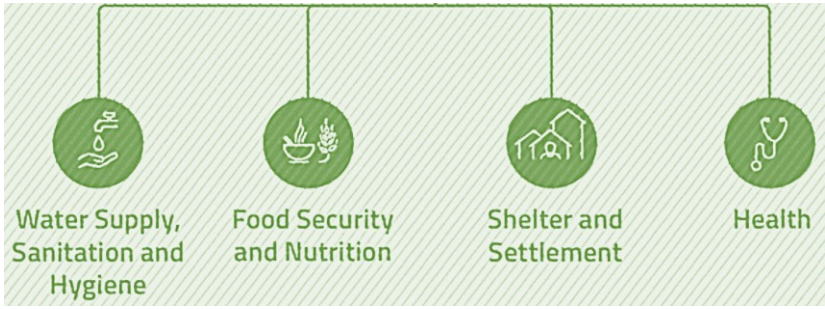

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Steps 8 to 11 – Setting Goals to Inform Strategies

7. Project Risks

1. Project Information

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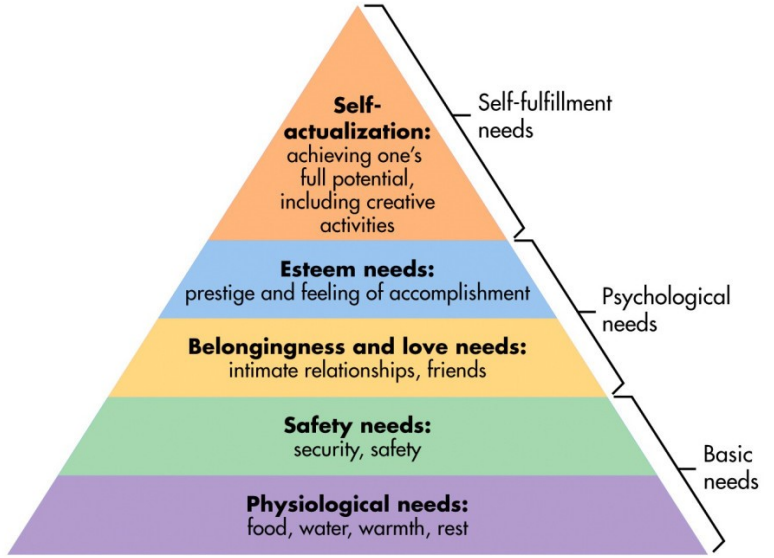
- Occupant-based Goals
- Asset-based Goals
- Other Goals (e.g. Economic, Community, Infrastructure)

9. Mitigation & Sustainability Goals

- GHG Reduction Goals
- Embodied Carbon Goals
- Renewable Energy Goals
- Water Efficiency Goals
- Biodiversity Goals, etc.



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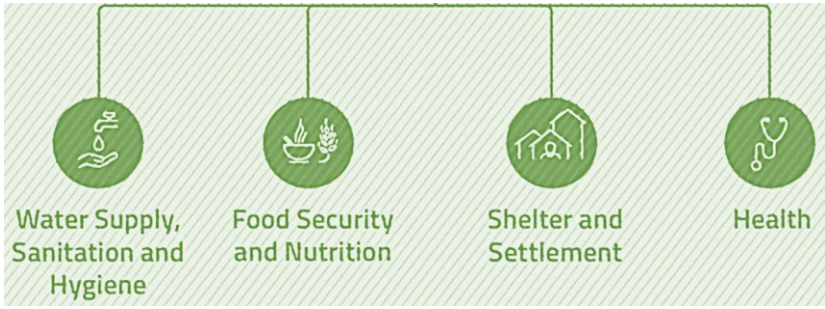

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Steps 8 to 11 – Setting Goals to Inform Strategies

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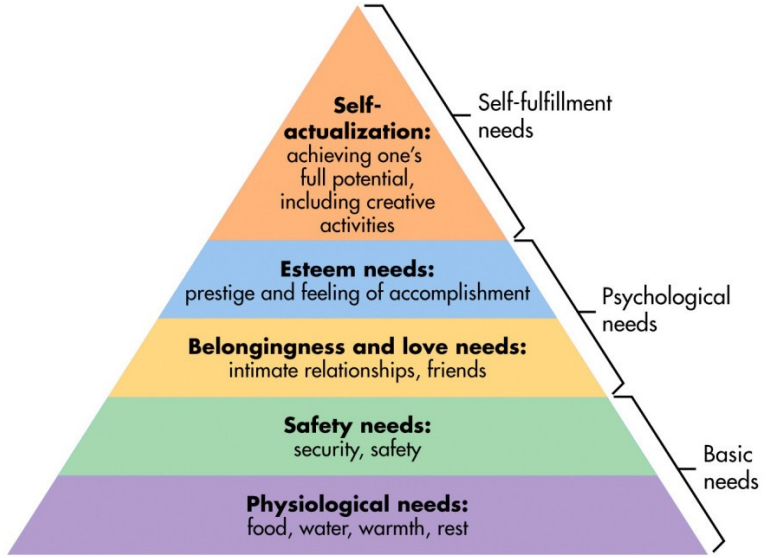
10. Adaptation Strategies

11. Mitigation & Sustainability Strategies



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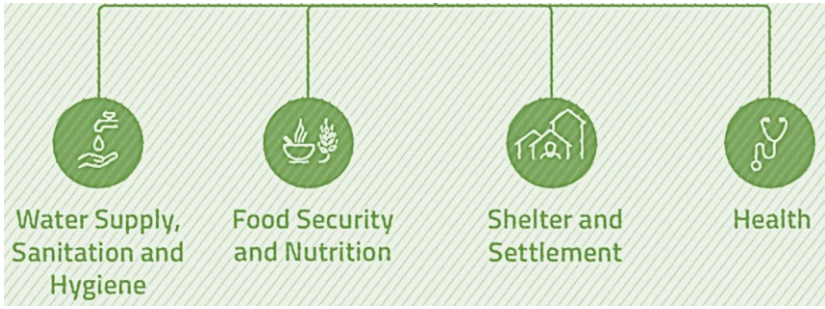
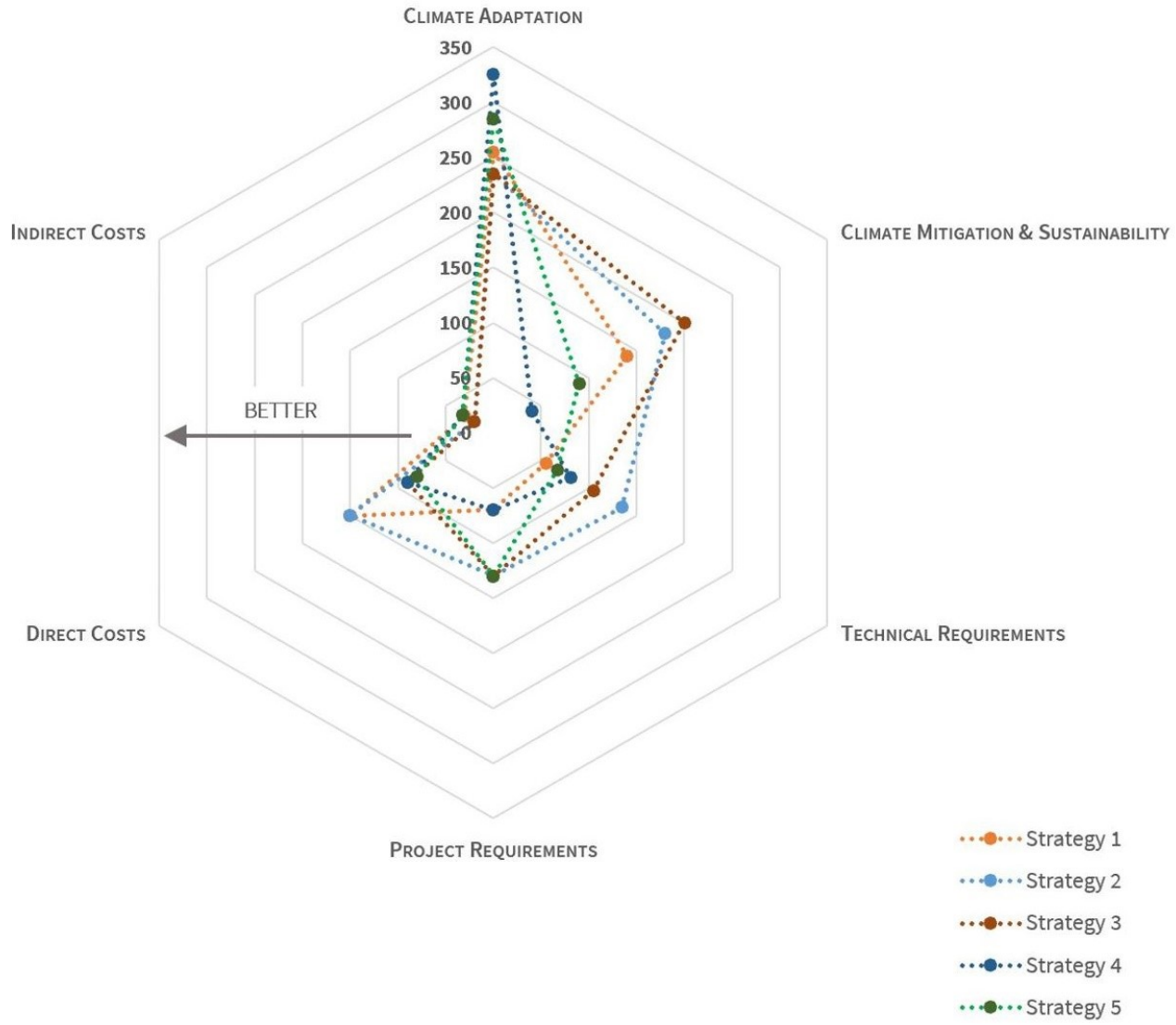


(Sphere Association 2018)

Step 12 – Evaluating Adaptation, Mitigation & Sustainability Strategies

10. Adaptation Strategies

11. Mitigation & Sustainability Strategies



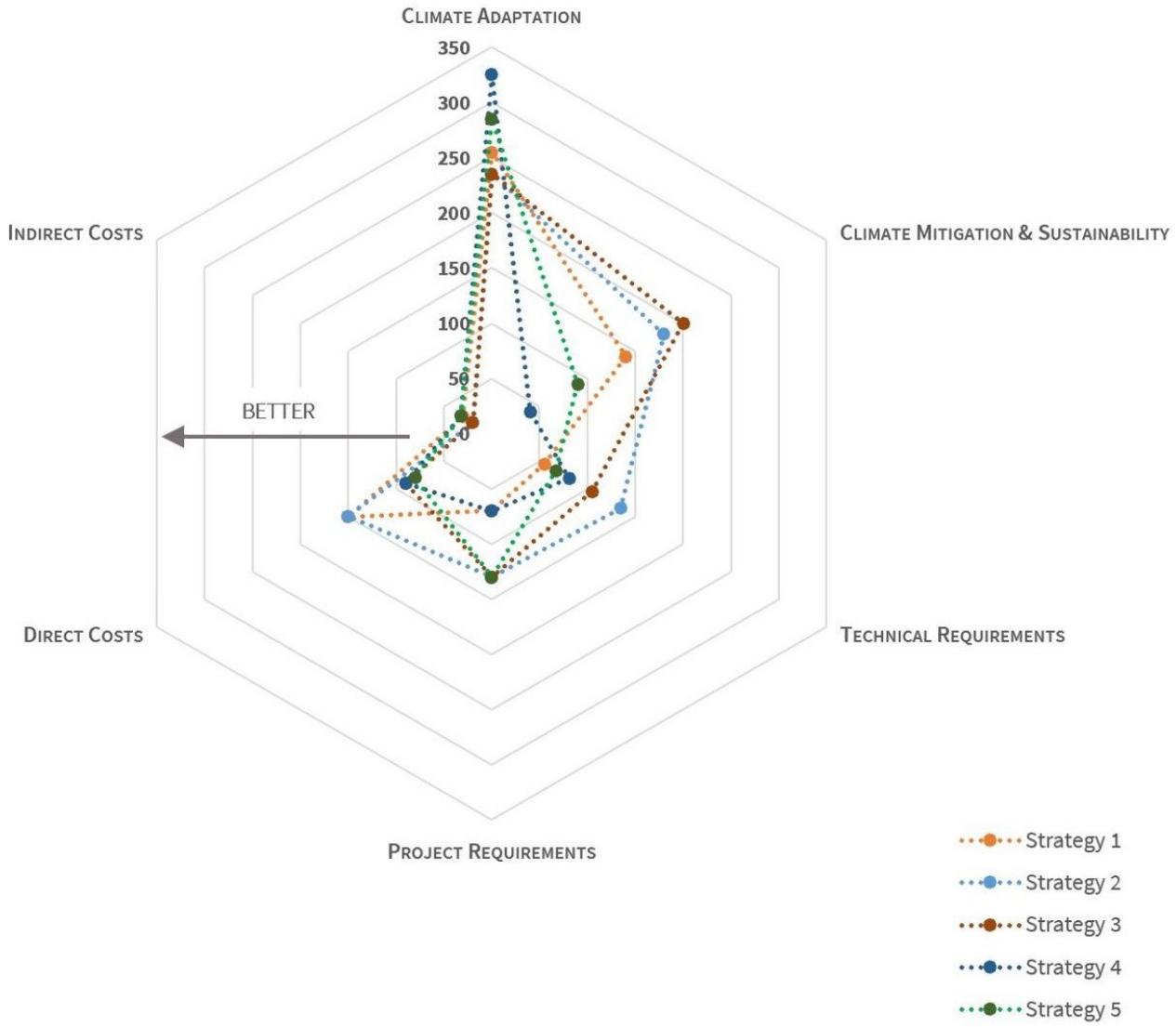
Step 12 – Evaluating Adaptation, Mitigation & Sustainability Strategies

10. Adaptation Strategies

11. Mitigation & Sustainability Strategies

12. Integrated Evaluation of Adaptation, Mitigation & Sustainability Strategies

- Climate Adaptation Criteria
- Mitigation & Sustainability Criteria
- Technical Requirements Criteria
- Project Requirements Criteria
- Direct Costs Criteria
- Indirect Costs Criteria



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10. Adaptation Strategies

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12. Integrated Evaluation of Adaptation, Mitigation & Sustainability Strategies

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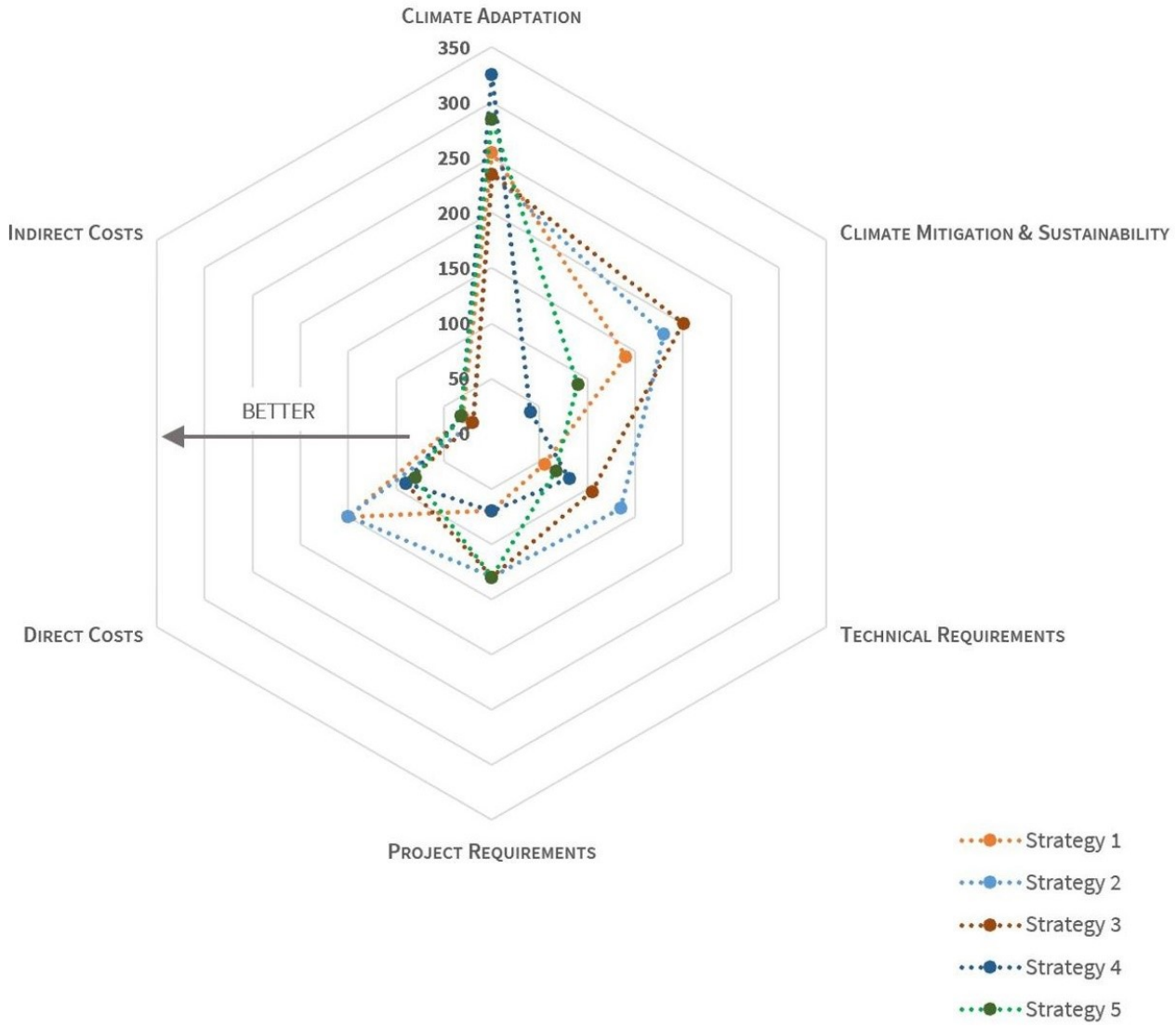
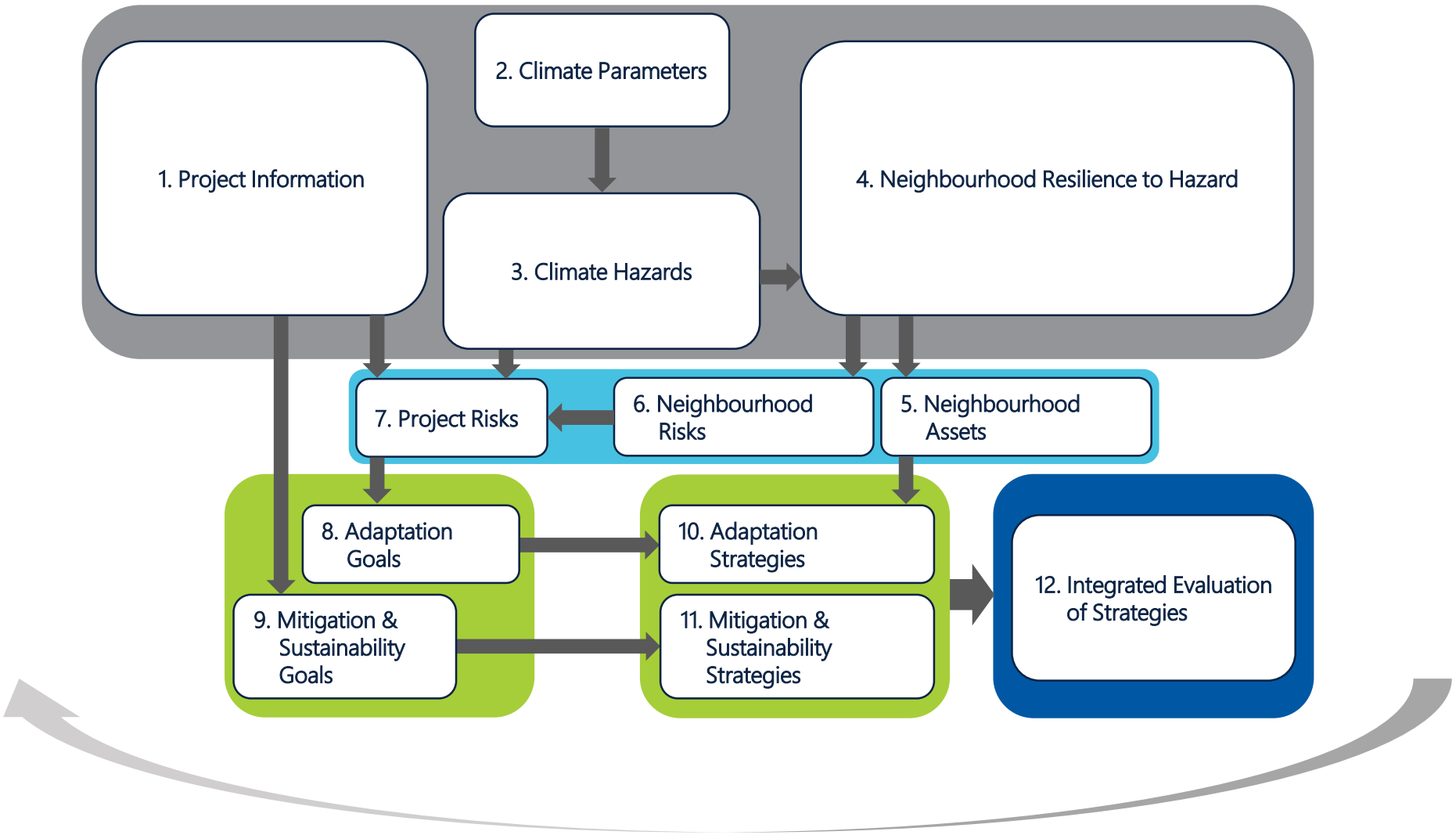
Optimized Strategies



Integrated Building Adaptation & Mitigation Assessment (IBAMA) Framework



Questions

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Kwayatsut, NSDA Architects
(Derek Lepper Photography, 2015)

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CLIMATE RECOVERY AND RESILIENCE

THERMAL RESILIENCE

PASSIVE

- Low TEDI + mass = slow change
- Seasonal solar control
- Natural ventilation
- Ground moderation

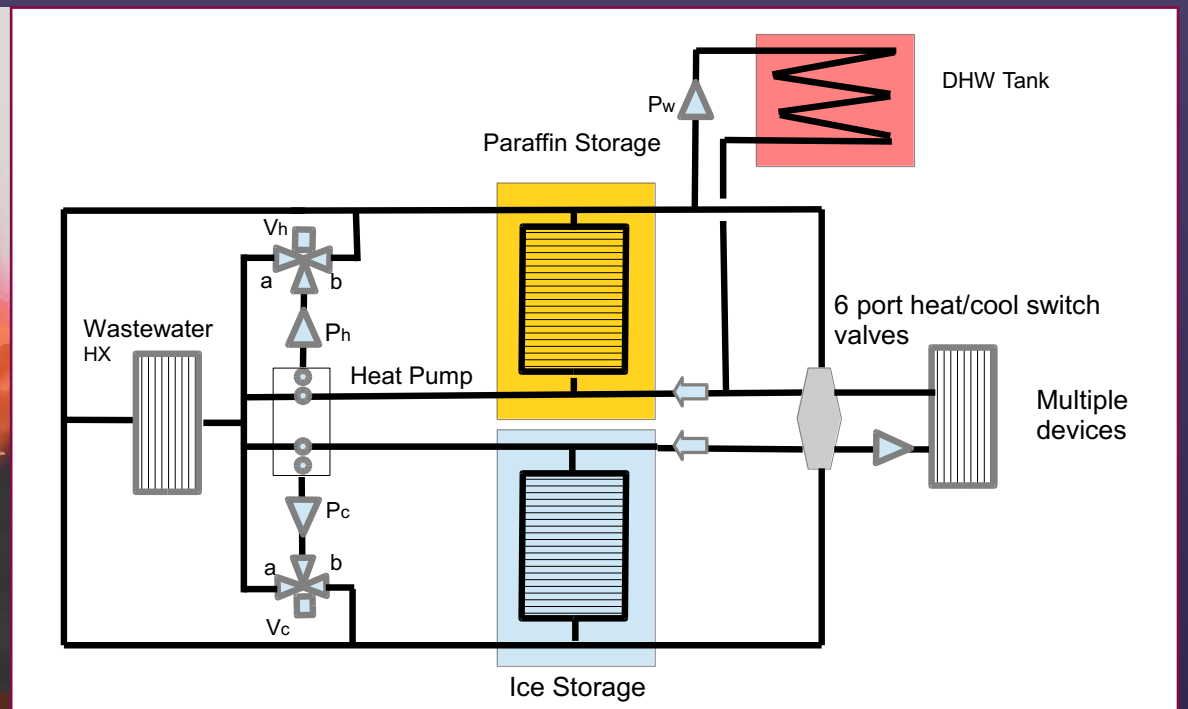
ACTIVE

- Enthalpy recovery ventilation
- Thermal storage
- Low fan and pump power
- Cogeneration back-up

TECHNICAL SOLUTIONS

R 14 + THERMOCHROMIC

HOT/COLD STORAGE



ELECTRICITY RESILIENCE

PASSIVE

- Efficient lighting & appliances
- Scheduled usage
- Priority load circuits
- Buried wiring

ACTIVE

- Wind/solar self generation
- Battery storage grid interface
- Micro-grid islanding
- Back-up power supply

TECHNICAL SOLUTIONS

VACUUM INDUCTION POT

SELF DRIVING BATTERY

WIND & SOLAR ROOF

WATER RESILIENCE

PASSIVE

- Micro-flush toilets
- Harvest and store rainwater
- Flood protection sealing

ACTIVE

- Cistern pump, filtration, UV
- Plumbing for flushing, washing
- Sump powered during outages

TECHNICAL SOLUTIONS

URINE SEPARATING TOILET

POTABLE RAINWATER SYSTEM

FLOODPROOF AND INSULATE

FOOD RESILIENCE

PASSIVE

- Rooftop greenhouse
- Root cellar
- Nutrient recycling

ACTIVE

- Irrigation system
- Food preserving
- Biochar

TECHNICAL SOLUTIONS

SOLAR GREENHOUSE

BIO-COGENERATOR

WIN-WIN-WIN

- Biochar
- Hot Water
- Electricity

Power Pot X
Thermo-electric Generator

Champion Stove
Biochar Maker

USB Compatible Fan

OUR FUTURE IS GREEN

Maintaining Thermal Comfort in MURBs under a Changing Climate

Pembina Reframed Tech Series

Climate Resilience & Deep Retrofits

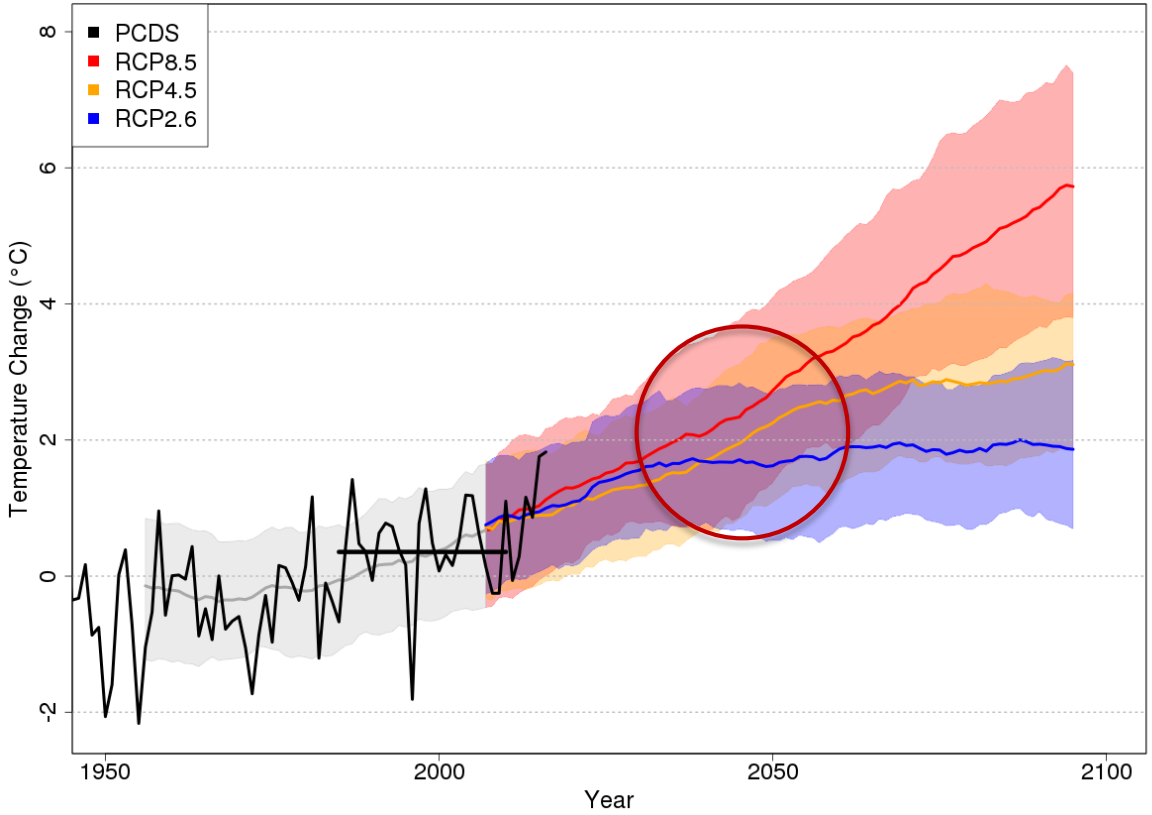
June 10, 2020

Ralph Wells
Community Energy Manager
University of British Columbia

OUTLINE (3 QUESTIONS)

- What are climate warming trends – and implications for buildings in Metro Vancouver?
- Are existing multifamily buildings in Metro Vancouver prepared for future climate?
- What are effective and energy efficient retrofit strategies to provide thermal comfort in multifamily buildings?
- Conclusions and Resources

Climate Context: Future Warming in British Columbia



Climate Context: Cooling Degree Days in Metro Vancouver

Cooling Degree Days: Recent Past

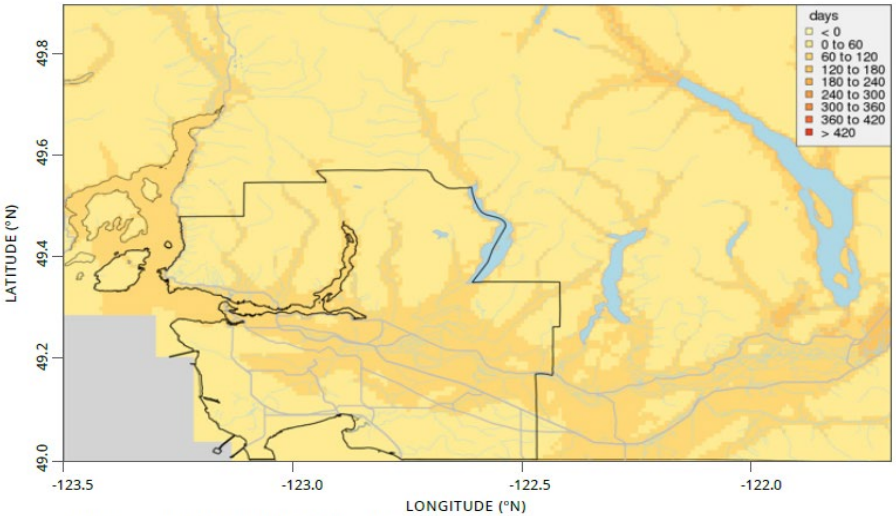


FIGURE 15: COOLING DEGREE DAYS – PAST

Cooling Degree Days: 2050s

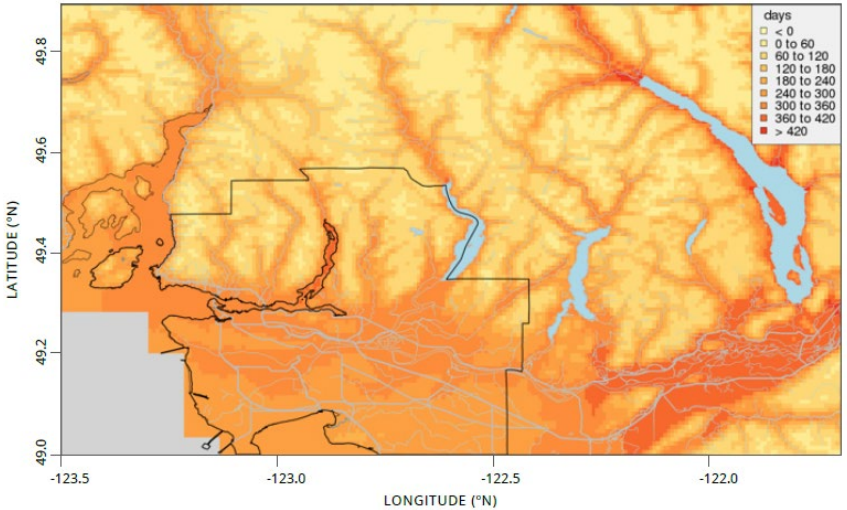
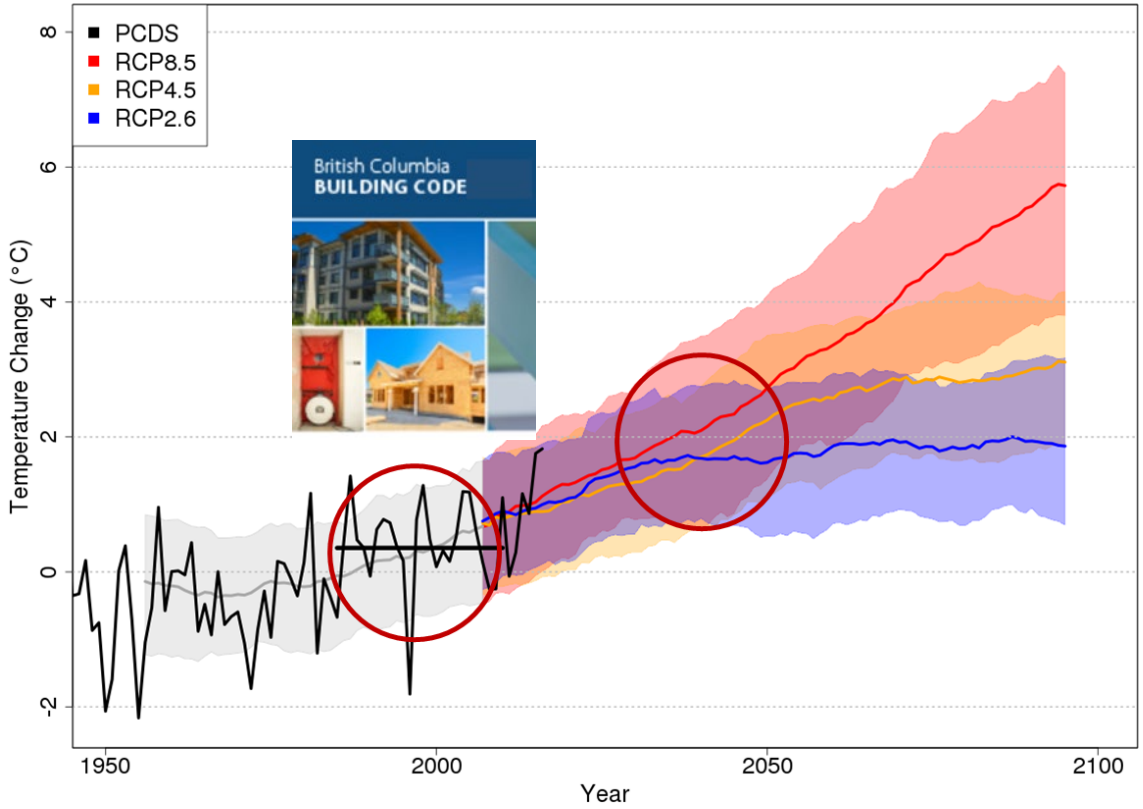


FIGURE 16: COOLING DEGREE DAYS – FUTURE (2050s)

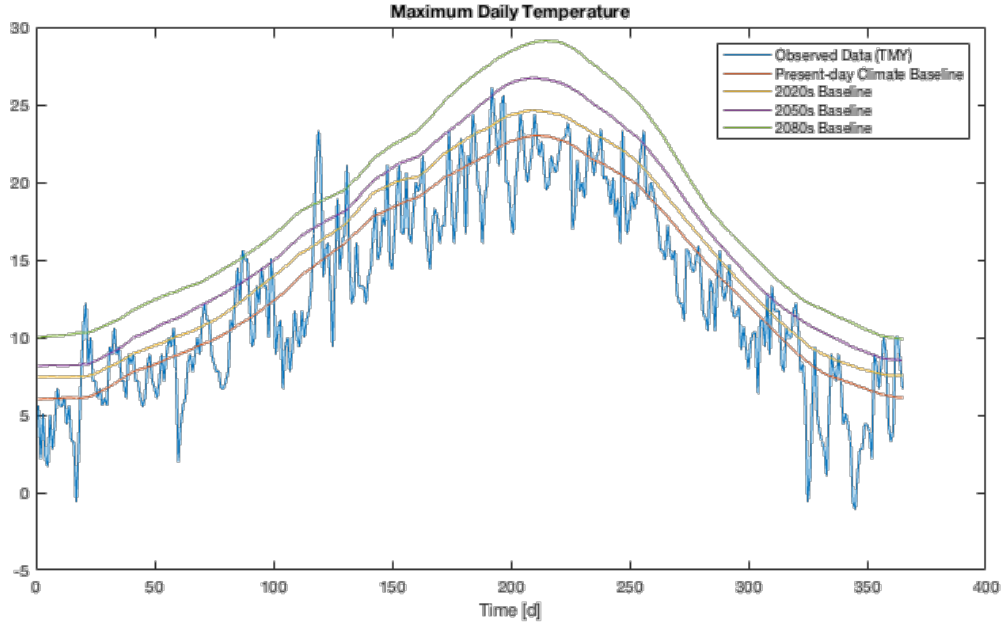
Source: Metro Vancouver (2016)

Climate Context: Future Warming in British Columbia



Source: Pacific Climate Impacts Consortium

Generating “Future Climate Weather Files” For Building Energy Modelling



Malin Ek Trevor Murdock (PCIC)

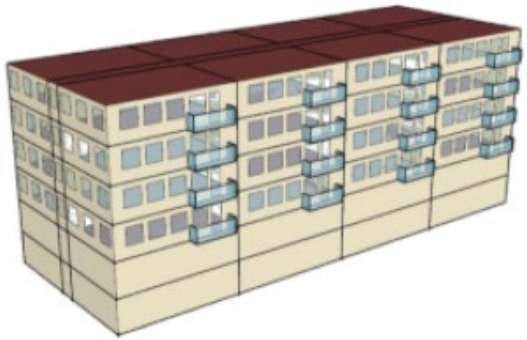
- TMY – Typical Meteorological Year for building modelling
- “Morphing” future daily temperature to hourly TMY

UBC SEEDS Project: Future weather files to support climate resilient building design in Vancouver. Ek *et al*. 2018

Designing Climate Resilient MURBs – Partnership Project

Innovative Clean Energy (ICE) Fund

Overheated Hours – Existing Low Rise Archetype



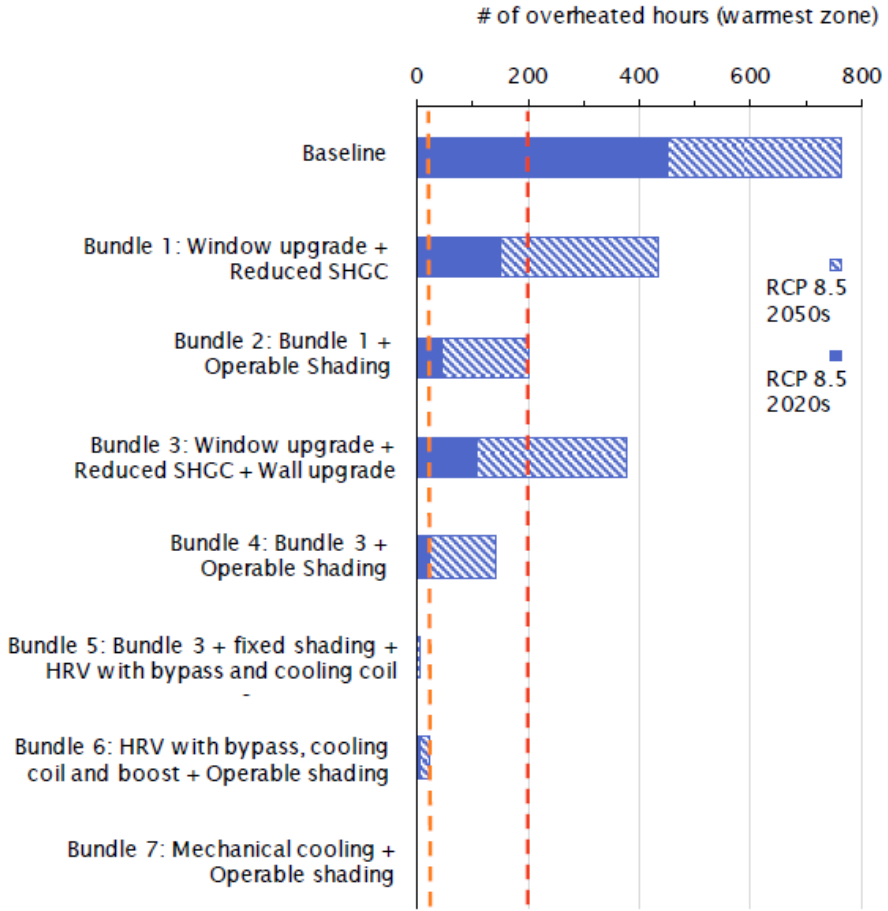
Building Archetype
Low Rise Existing
(No Mechanical Cooling)

NW	N1	N2	NE
CORRIDOR			
SW	S1	S2	SE

≤ 100 hrs	101-200 hrs	201-500 hrs	501-800 hrs	> 800 hrs	# of hrs pear year above the upper temperature limit
< 1%	1-2%	2-6%	2-9%	>9%	% of hrs per year above the upper temperature limit

	CWEC 2016 *Hottest Suite: SW - Top Floor*				RCP-8.5 2020s *Hottest Suite: SW - Top Floor*				RCP-8.5 2050s *Hottest Suite: SW - Top Floor*				RCP-8.5 2080s *Hottest Suite: SW - Top Floor*			
Top Floor	107	19	18	36	178	53	49	73	440	225	221	305	512	301	294	378
			117				201				661				788	
	321	216	219	188	452	317	314	294	761	687	685	668	877	808	803	760
Mid Floor	41	2	2	9	69	7	7	28	282	108	105	170	340	146	137	215
			36				89				476				609	
	194	145	146	131	299	210	213	193	613	559	557	525	707	660	653	615
First Floor	21	0	0	4	41	2	2	9	181	48	45	101	227	72	66	128
			19				36				266				352	
	154	113	116	96	232	166	170	144	494	447	443	405	576	529	526	470

Unmet Cooling Hours: Existing Low Rise Archetype Retrofit Options



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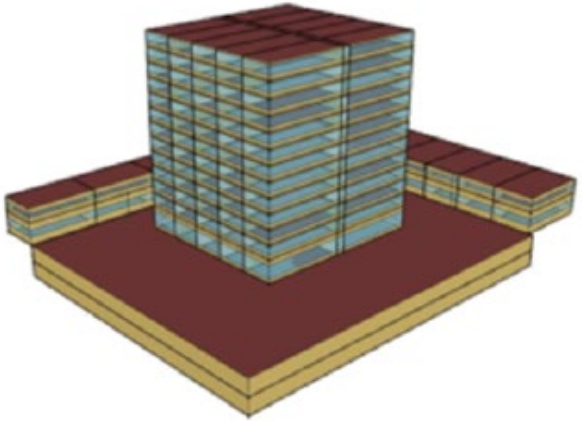
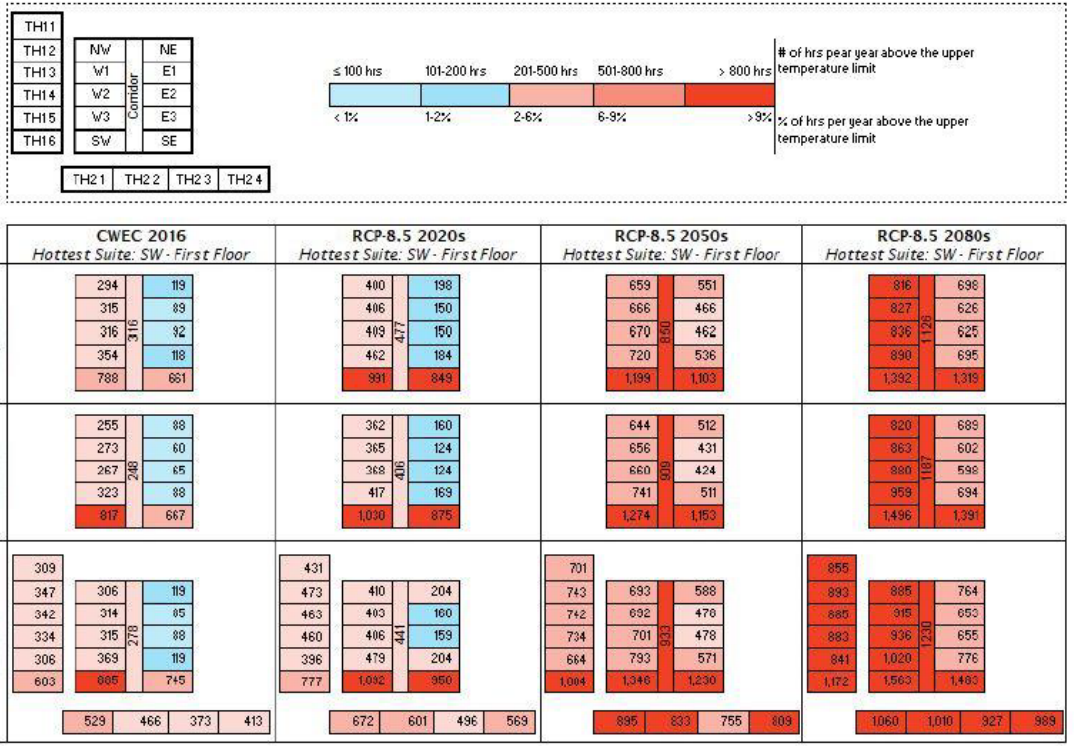
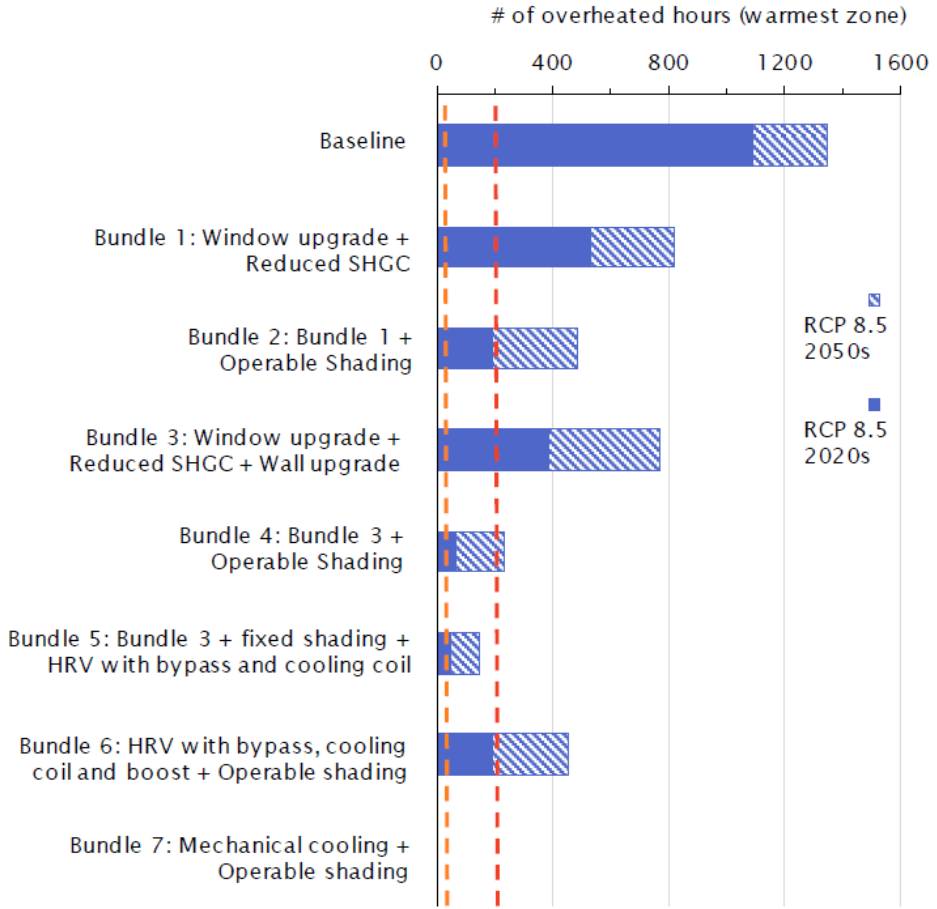
Overheated Hours – Existing High Rise Archetype



Building Archetype
High Rise Existing
(Mechanical Cooling)



Unmet Cooling Hours: Existing High Rise Archetype Retrofit Options



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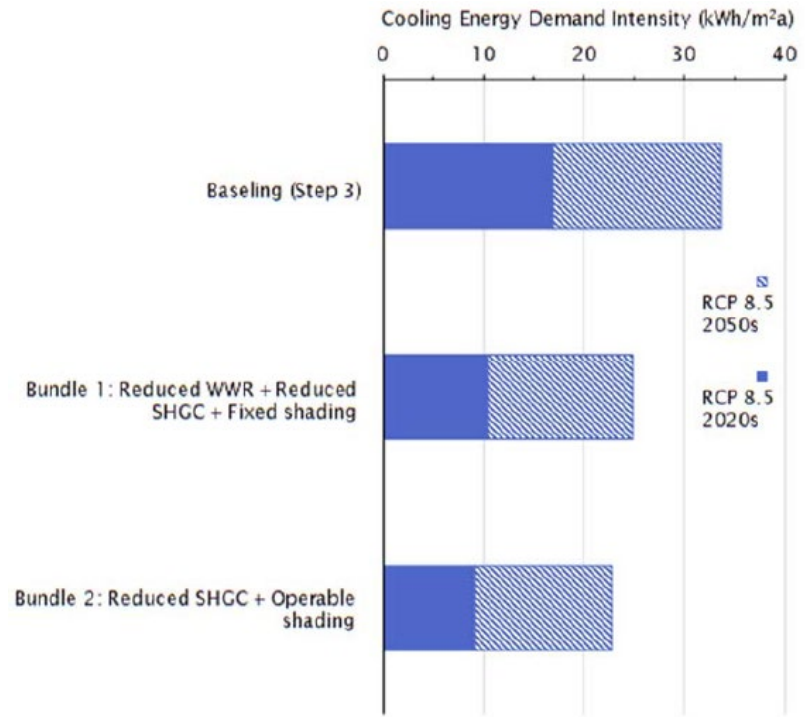
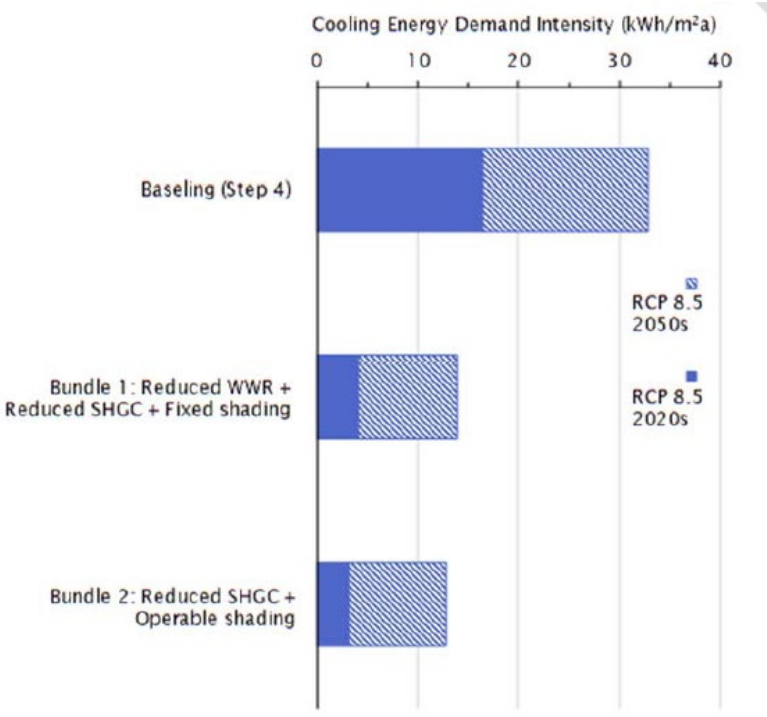
Cooling Energy Demand Intensity (CEDI): New High Rise Archetype



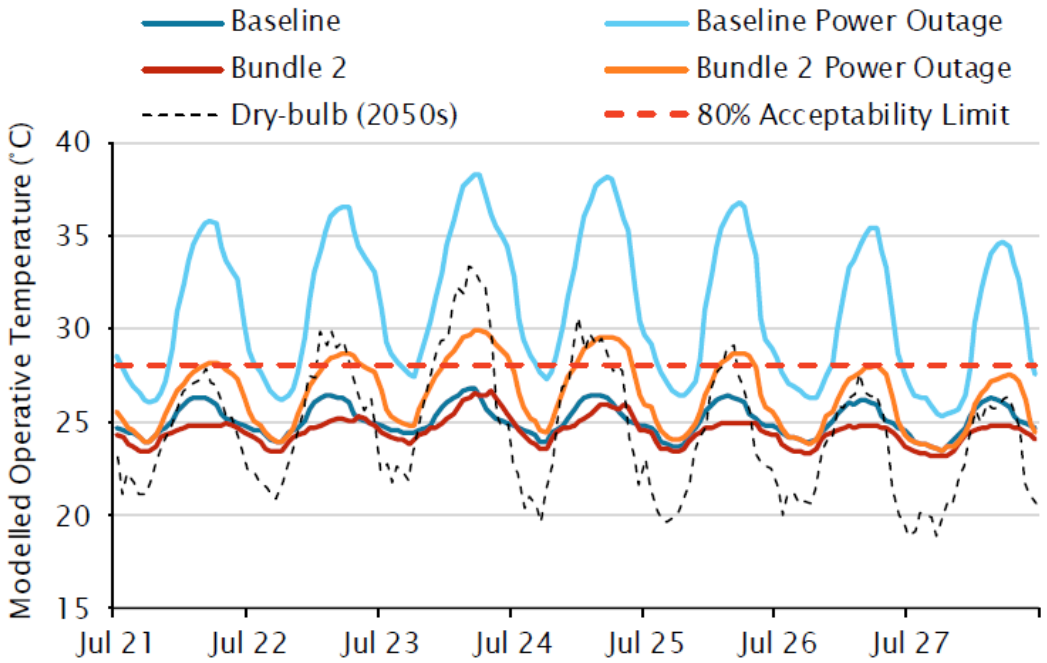
Energy Step Code: Step 3



Energy Step Code: Step 4

Draft Results

Resilience to Power Outage: New High Rise Archetype



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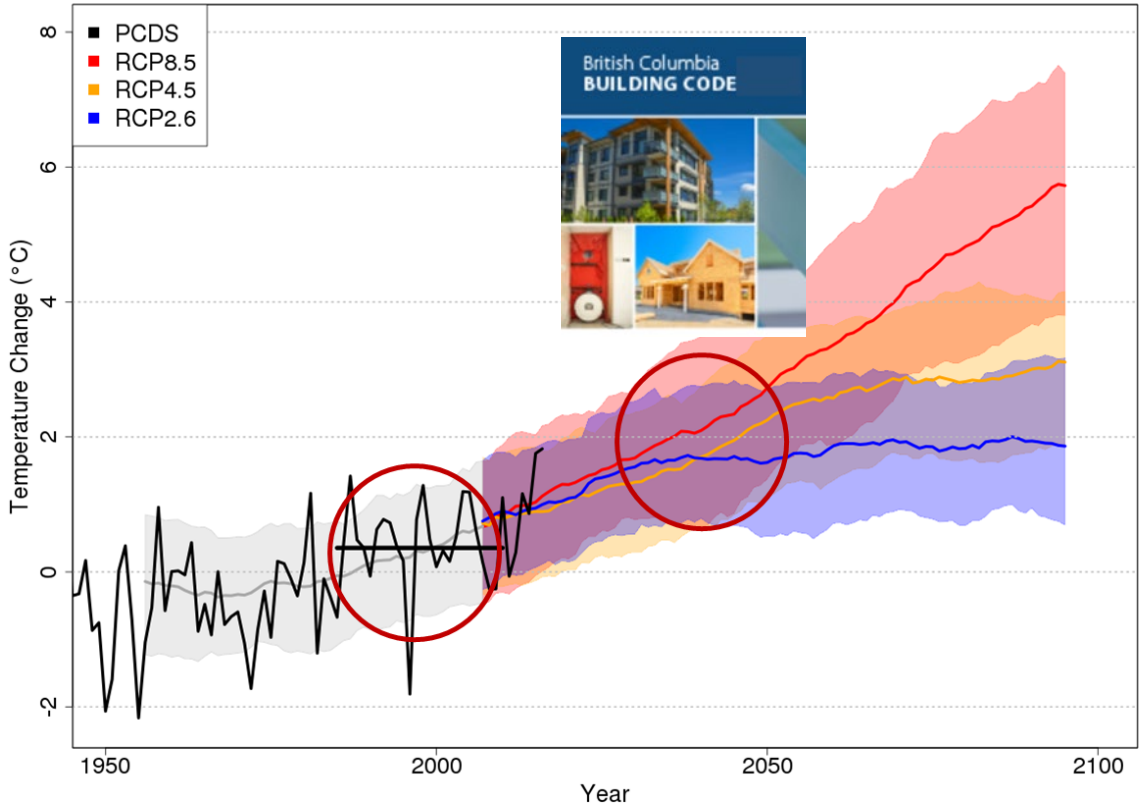
Draft Results

Looking Ahead



Source: Pacific Climate Impacts Consortium

CONCLUSIONS AND FUTURE WORK

1. Urgent need to undertake retrofits in multifamily buildings to avoid future overheating
2. Passive envelope measures are a 2050-ready strategy for low rise but high rise buildings also require mechanical solutions
3. Passive measures improve energy efficiency and resiliency
4. Envelope upgrades + heat pumps provide energy efficient adaptation *and* mitigation
5. Need to move away from using the past to design for the future

RESOURCES

UBC Designing Climate Resilient Multifamily Buildings
https://planning.ubc.ca/sites/default/files/2020-05/REPORT_UBC_Climate%20Resilient%20Multifamily%20Buildings.pdf

BC Housing: BC Energy Step Code Design Guide & Supplemental
https://www.bchousing.org/research-centre/library/residential-design-construction/bc-energy-step-code-design-guide&sortType=sortByDate

PCIC Future shifted water files
https://www.pacificclimate.org/data/weather-files

Future weather files to support climate resilient building design in Vancouver. Ek *et al*. 2018
https://www.pacificclimate.org/sites/default/files/Eketal_2018_Proceedings_22_Feb_2019.pdf

Questions?

Pembina Reframed Series

Climate Resilience & Deep Retrofits

Alex Hutton, Energy Manager, PHSA

alex.hutton@phsa.ca | 604 290 7504

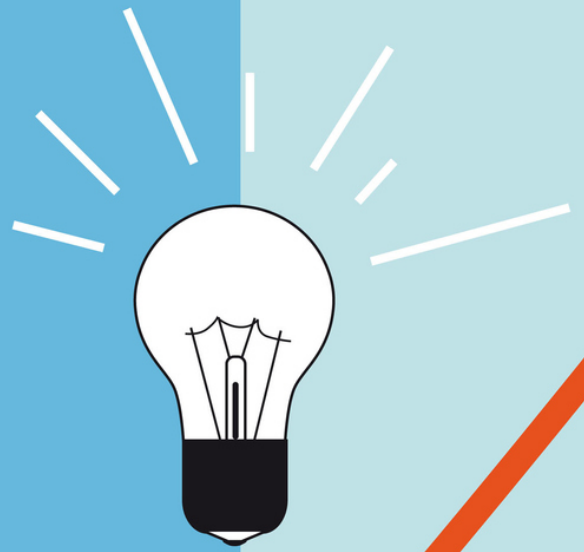
June 10th 2020

Types of Change

DEVELOPMENTAL	TRANSITIONAL	TRANSFORMATIONAL
Improvement	Replacement	Metamorphosis
Destination is known		Future state unknown
Pre-determined linear plans		Change process must "emerge" as you go
About taking the "right steps"		About cultivating the "right conditions"
Impacts people's skills & actions		Must impacts people's mindset & culture

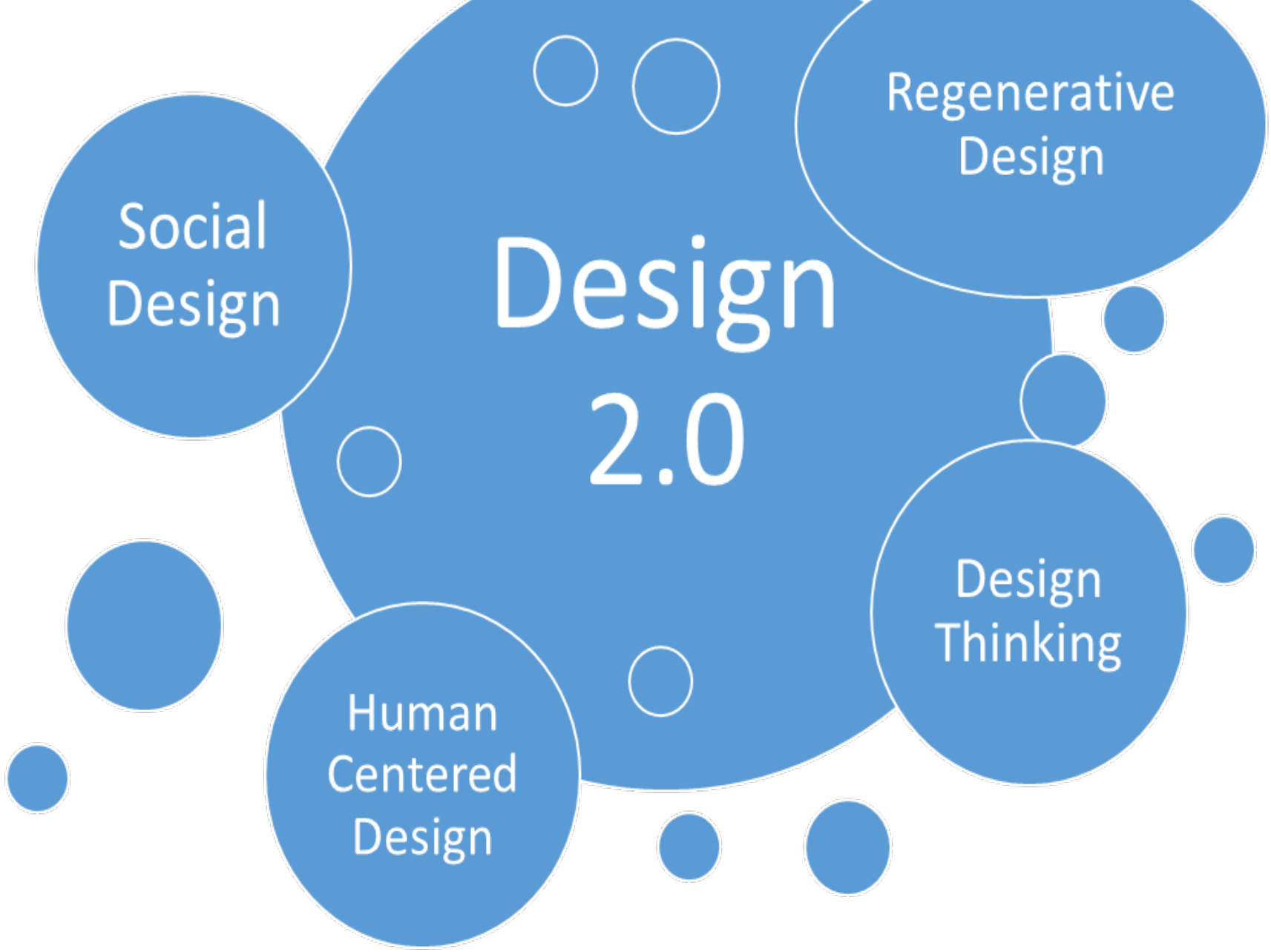
Source: Adapted from " What is Transformation, and Why Is It So Hard to Manage?", Anderson, 2010

Slow Down!



Accelerate our evolution

Credit: Image and idea from Cheryl Heller's webinar: Applying Social Design to Sustainability



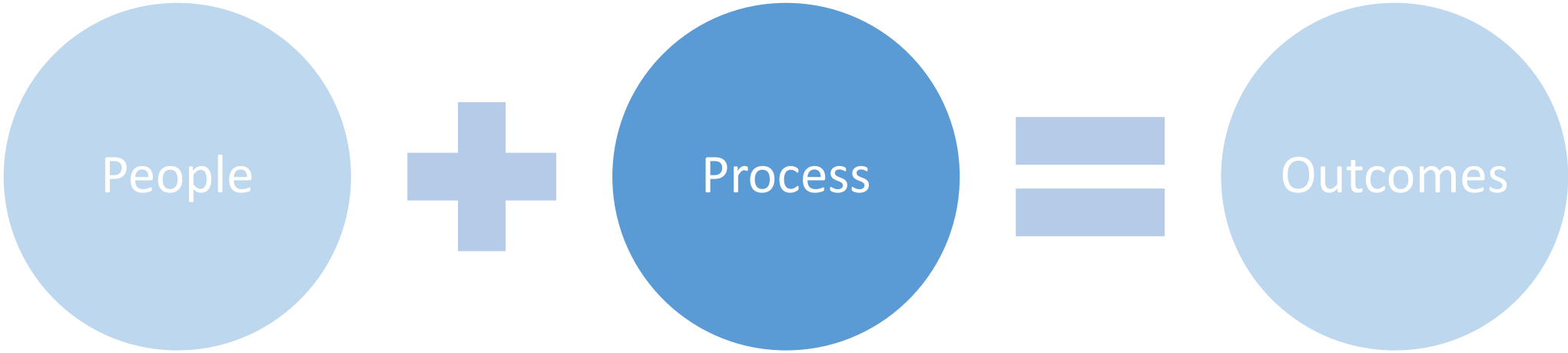
Credit: Slide informed by Cheryl Heller's webinar: Applying Social Design to Sustainability

Design…simplified

Design…transformed

- More skills/knowledge at the table
  - Resilience, contractor, trades, FMO, users, etc.
- Under represented voices & perspectives
- Higher quality skills/knowledge at the table
- People who embrace collaboration

Design…transformed



- Front-loaded effort
- More integrated process
- More iterative process
- More collaborative process
- Co-creative process

✓WHY

✓WHAT

✓WHO

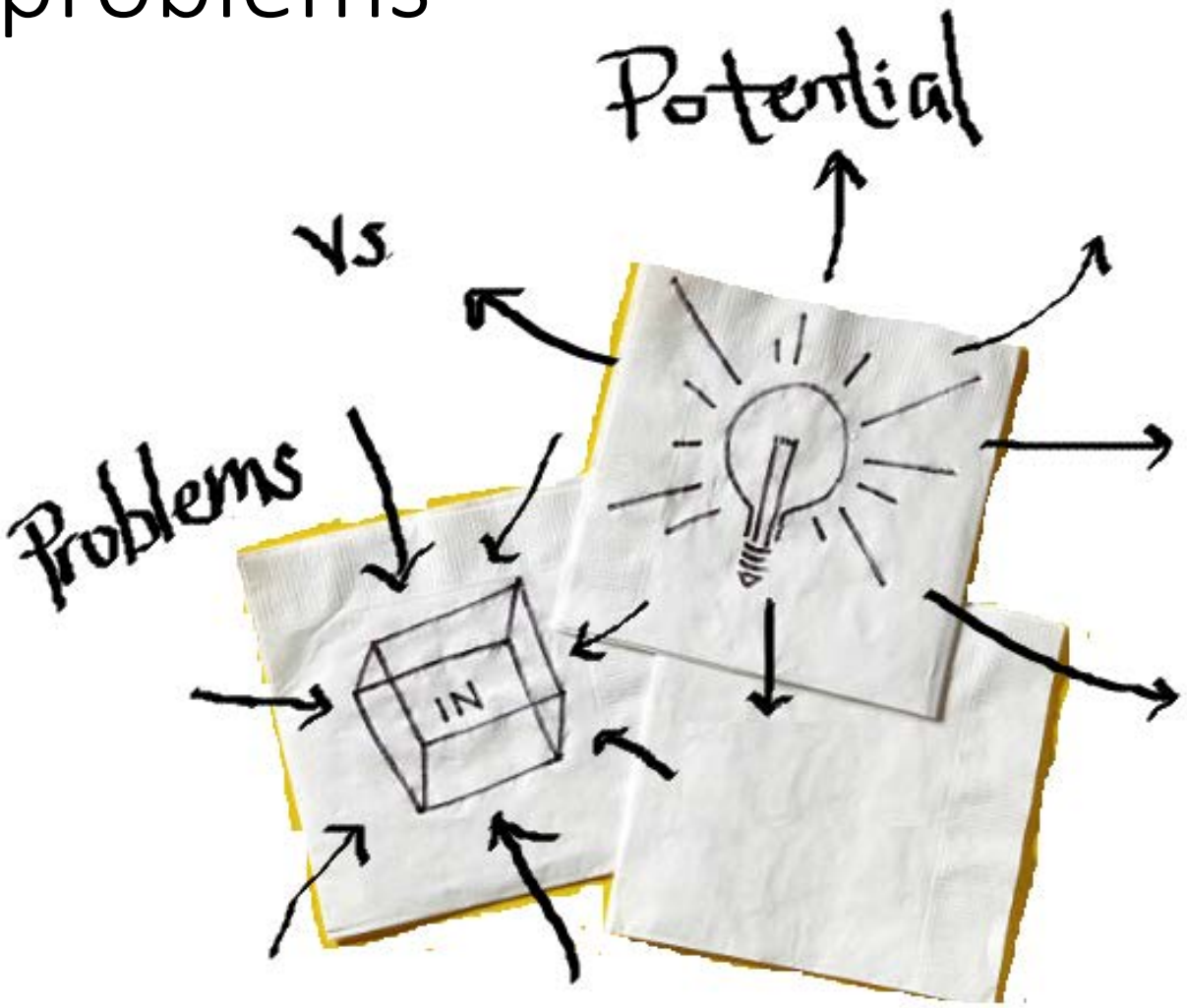
? HOW

A different approach to design

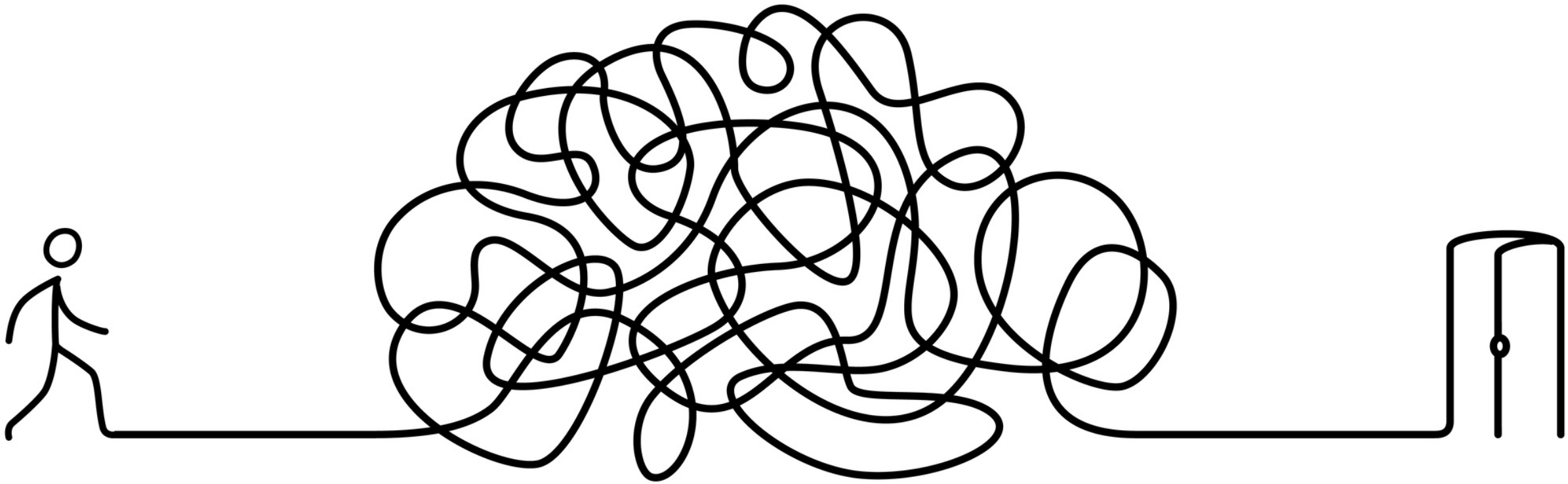
	Conventional Approach to Design	Approach informed by Regenerative Development
Focus	**Problem** Solving	Realizing **potential**
Type of change	**Incremental**	**Transformational** (process & outcomes)
Physical scale	Often confined to the **project boundary**	Consider at least three **nested wholes**
Specificity	Solutions are often **generic**	Solutions born out of the **uniqueness** of the place
Time scale	Conceives of a **static** end state	Conceives of a **dynamic evolution**

A story to illustrate

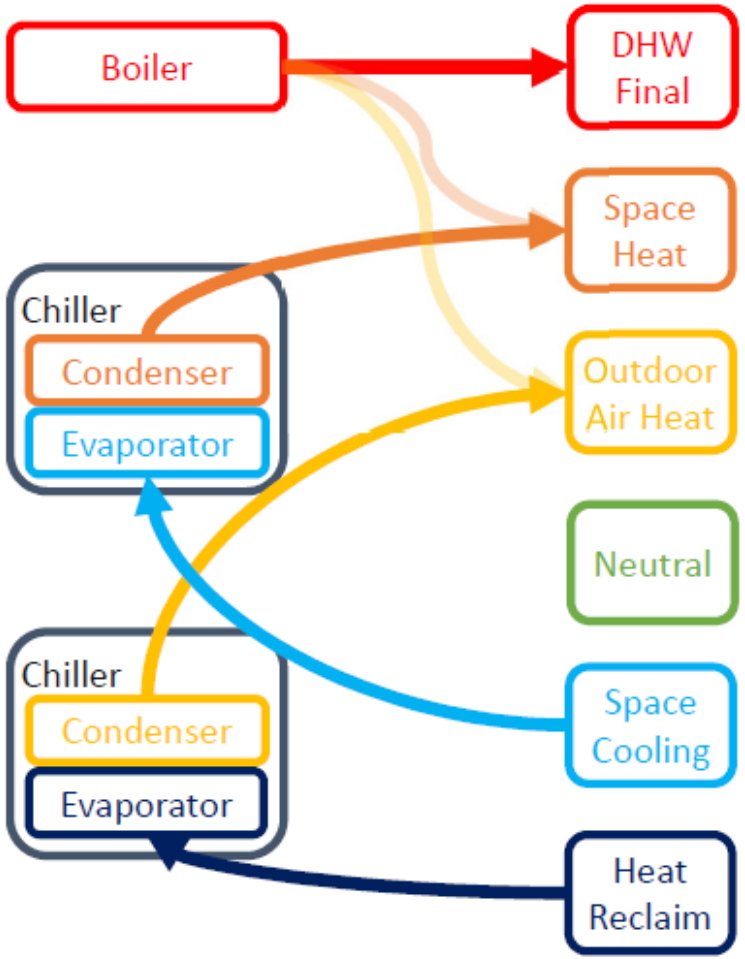
Potential vs problems



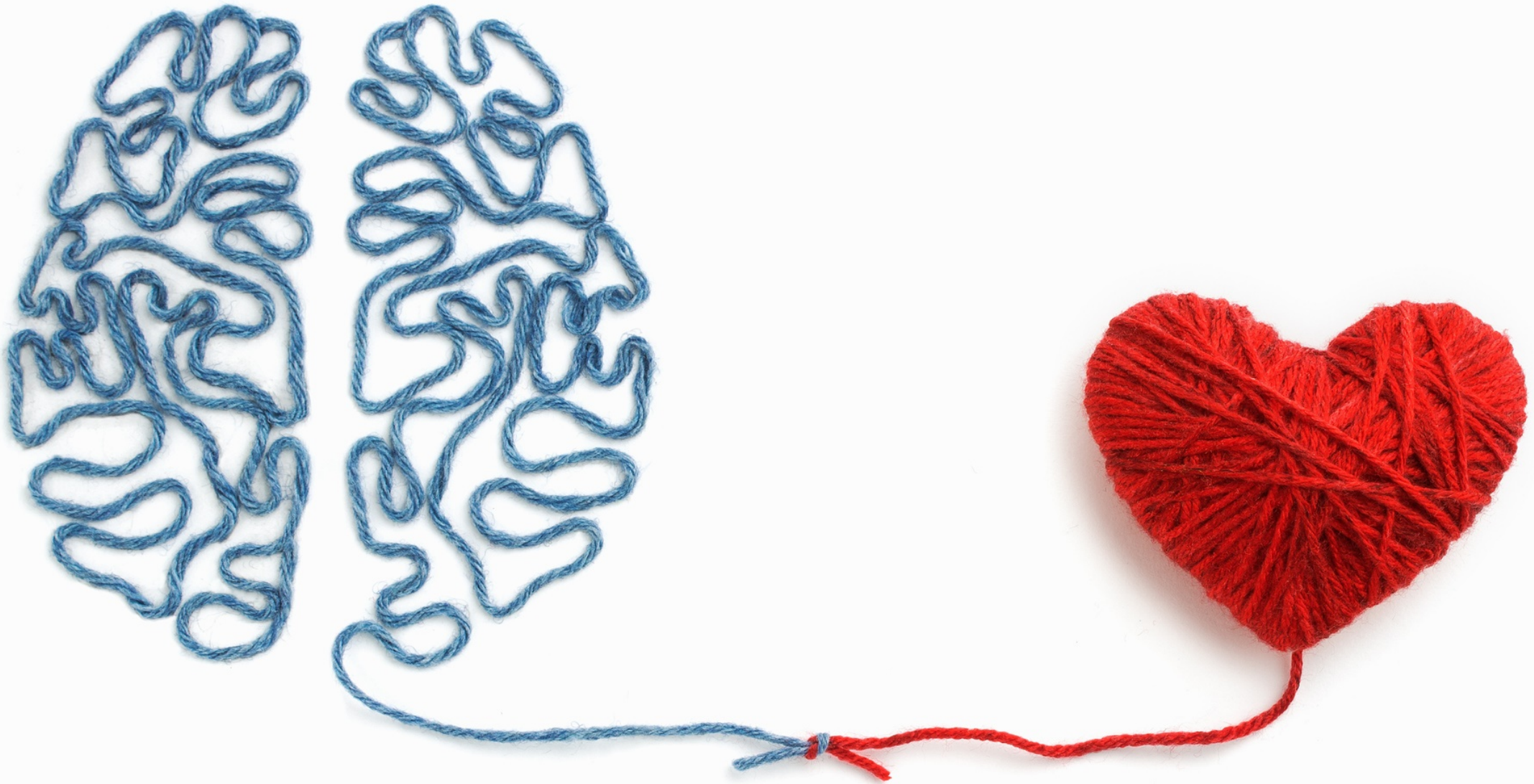

A+B=C



vs



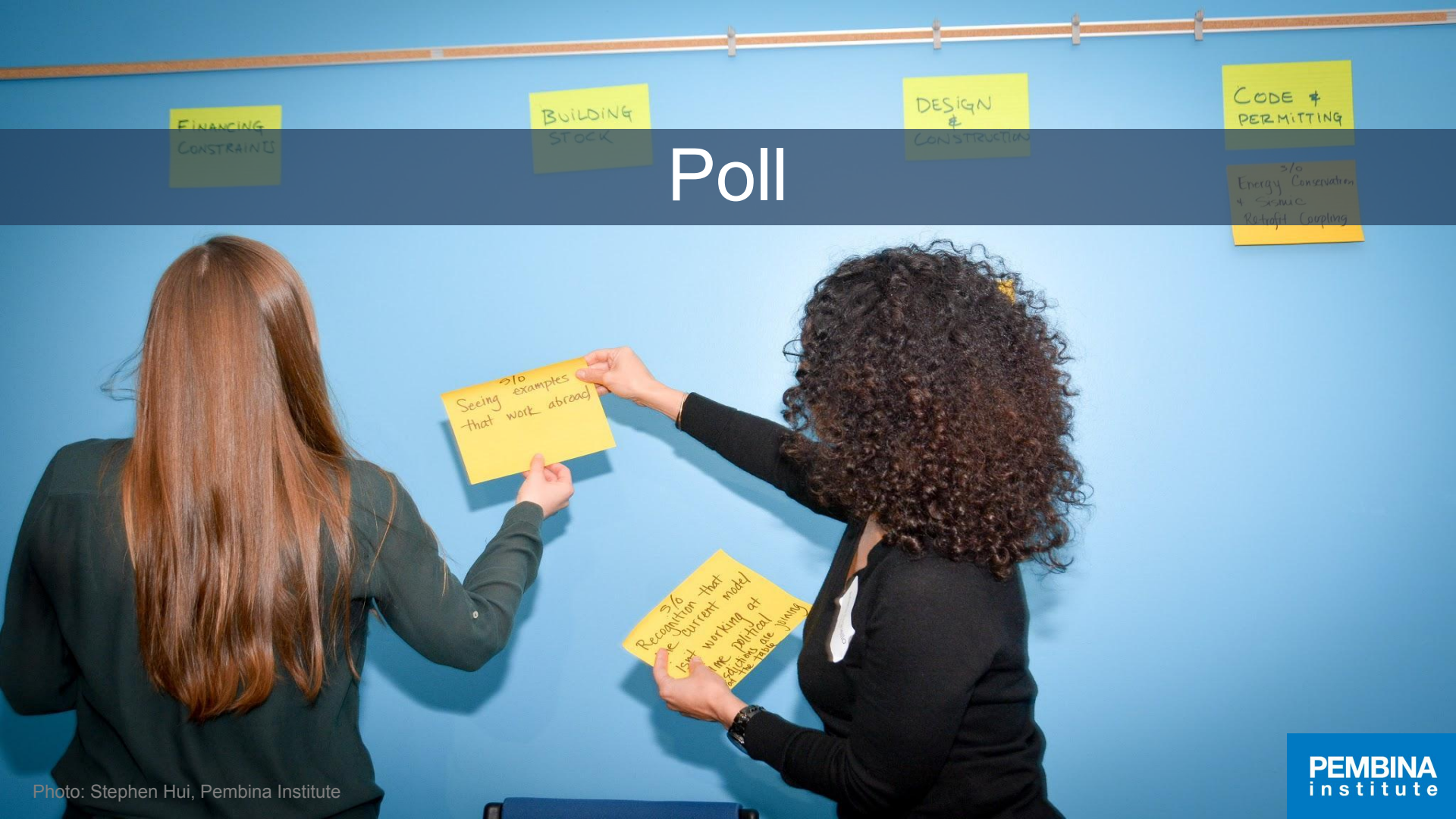
Thermal Gradient Header



Discussion

Thank you!

Poll



PEMBINA institute

Questions

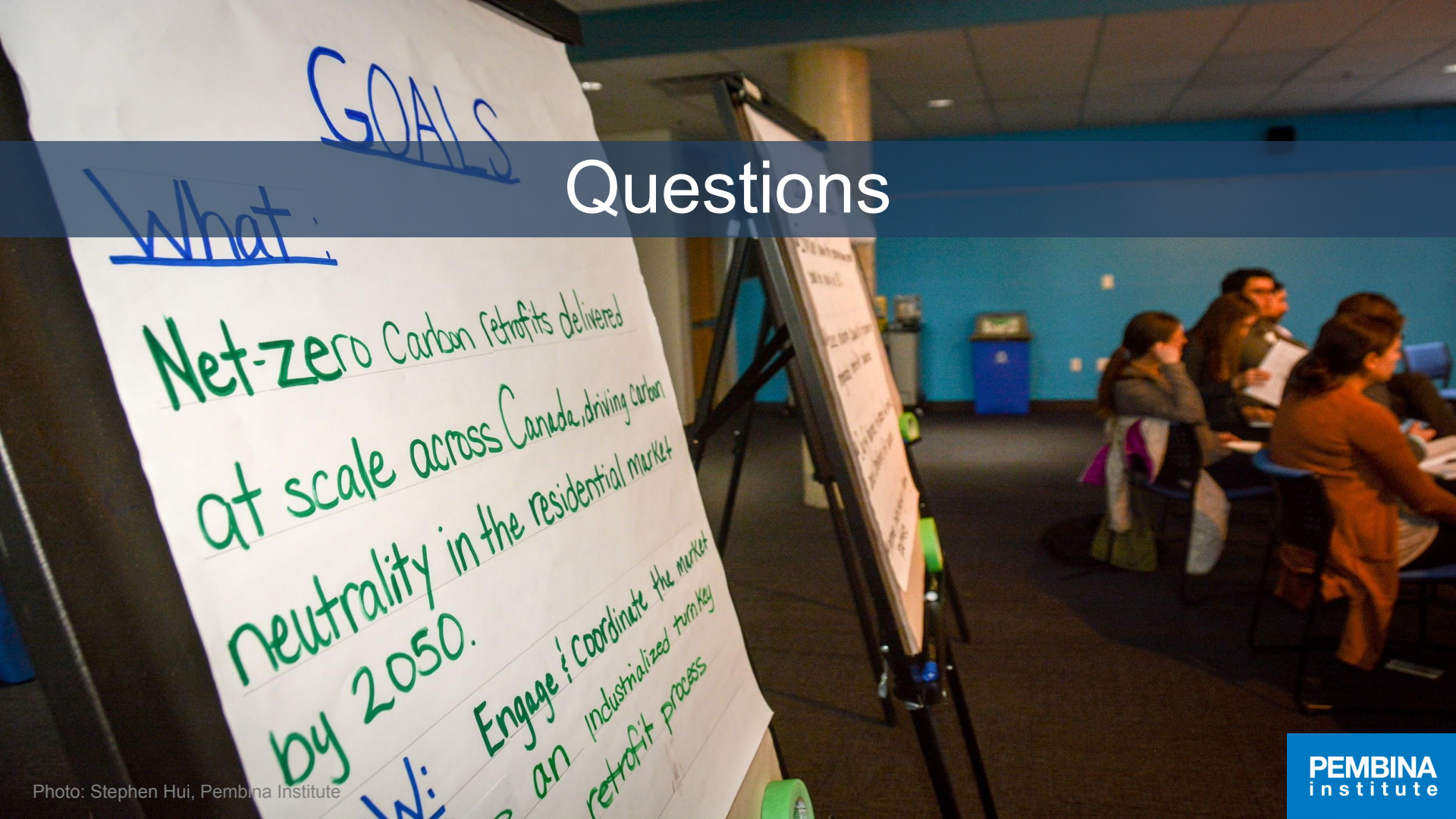


Photo: Stephen Hui, Pembina Institute

PEMBINA institute

Upcoming Reframed Lab

- Request for proposals expected in summer 2020
- Multi-disciplinary teams will design solutions for low-rise residential buildings in B.C.’s Lower Mainland or Victoria area
- Six-month exploration lab with support from climate, energy, and health experts

REGISTER YOUR INTEREST: pembina.org/reframed

PEMBINA institute

Integrated design teams

- Architects
- Building science, electrical, mechanical, and structural engineers
- Contractors, builders, and retrofitters
- Manufacturers, fabricators, and suppliers
- Modeling and data capture specialists
- Monitoring and control equipment specialists

REGISTER YOUR INTEREST: pembina.org/reframed

PEMBINA institute

Solutions of particular interest

- Prefabricated exterior wall and roof panels
- High-efficiency and low-carbon mechanical systems
- Roofing solutions that integrate on-site renewable electricity
- Storage and/or thermal generation
- Seismic upgrades
- Climate adaptation measures
- System controls and performance monitoring

REGISTER YOUR INTEREST: pembina.org/reframed

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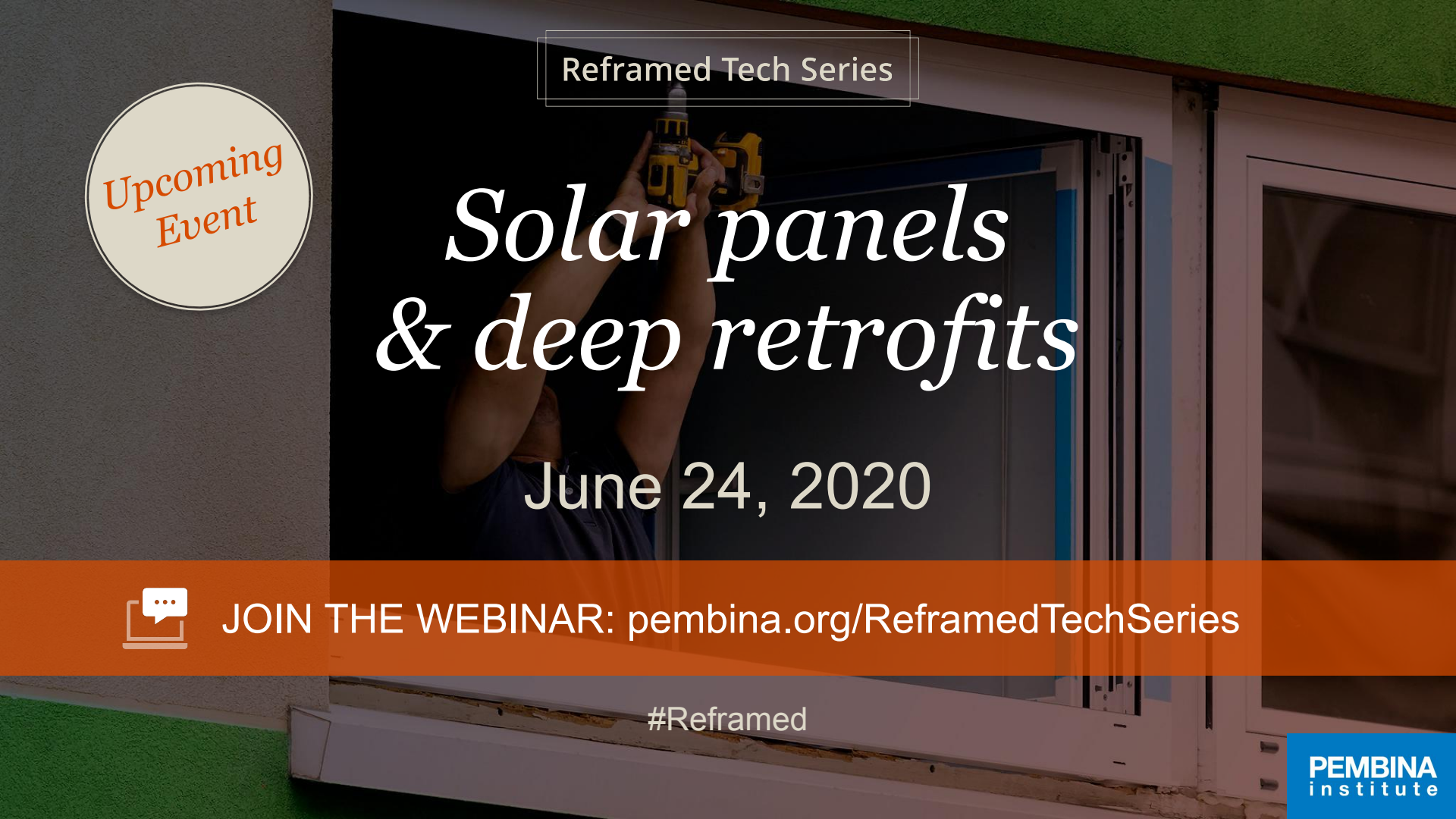
Reframed Tech Series
Upcoming Event
Solar panels & deep retrofits
June 24, 2020
JOIN THE WEBINAR: pembina.org/ReframedTechSeries
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