Decarb Lunch Series

zebx

CLF Carbon Leadership Forum British Columbia

Powered by zeic

PASSIVEHOUSE CANADA Build better. Feel better.

Marpole Community Centre

Achieving 40% Embodied Carbon Reduction on Passive House Design

Thu Oct 10, 2024
from 12 - 1pm PDT
Free Webinar
zebx.org

North Family FOUNDATION

CITY OF VANCOUVER

BC Hydro Power smart

Powered by zeic MORE SOLUTIONS, LESS CARBON.

B2E
Building to Electrification

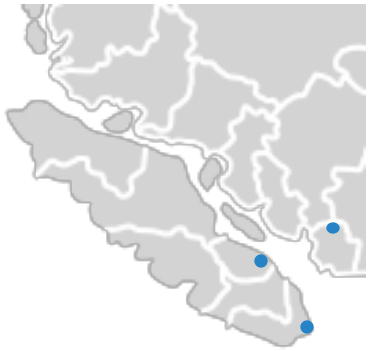
CLF Carbon Leadership Forum British Columbia

zebx
ZERO EMISSIONS BUILDING EXCHANGE

BC Retrofit ACCELERATOR

NearZero

FOCAL ENGINEERING

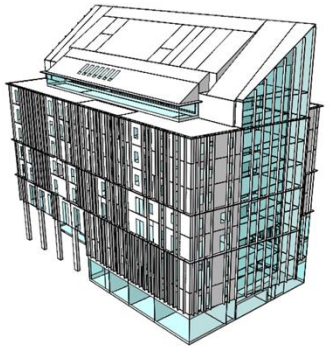


About

- 12 people & 10 years
- Victoria / Vancouver / Nanaimo

Building Performance

- Energy & emissions
- New & existing buildings



ECOSTAR AWARDS 2019 WINNER

ECOSTAR AWARDS 2023 WINNER

Values

- Carbon Neutral
- Equity, Diversity, Inclusion

Strategy to 2024

PASSIVEHOUSE CANADA
Build better.
Feel better.

Marpole Community Centre

Caroline Inglis
cinglis@dsai.ca

Forest Borch
forest@reloadsustainable.com

diamond schmitt

reLoad Sustainable Design Inc.

agenda

- Project Introduction
- Values, Vision, Principles, and Goals
- Balancing Operational vs Embodied Carbon Goals
- Achieving Embodied Carbon Reductions
- Q&A

Project Introduction

diamond schmitt

Stats

Client: City of Vancouver

GC: Heatherbrae Builders Co

Size: 6,140 sqm/66,090 sqft (+underground parkade)

Cost: $96 million

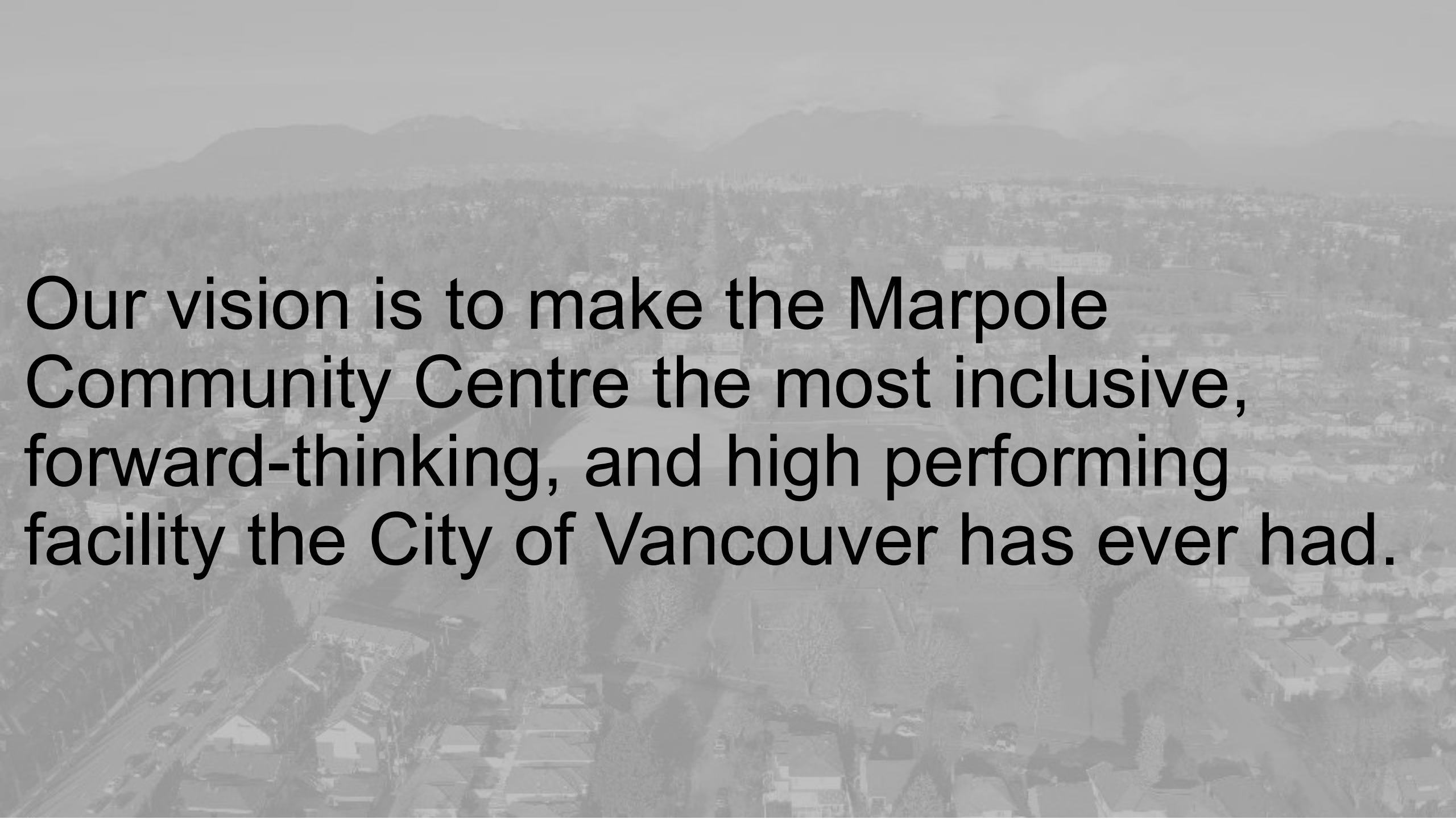
Phase 1 Completion: 2026

Passive House

LEED Gold

40% Embodied Carbon Reduction

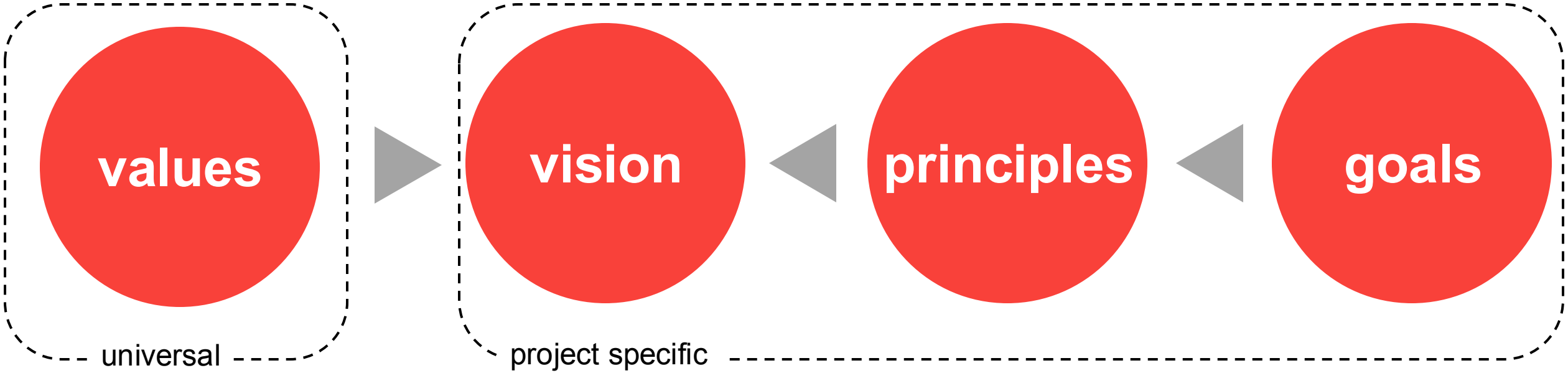
RHFAC Gold

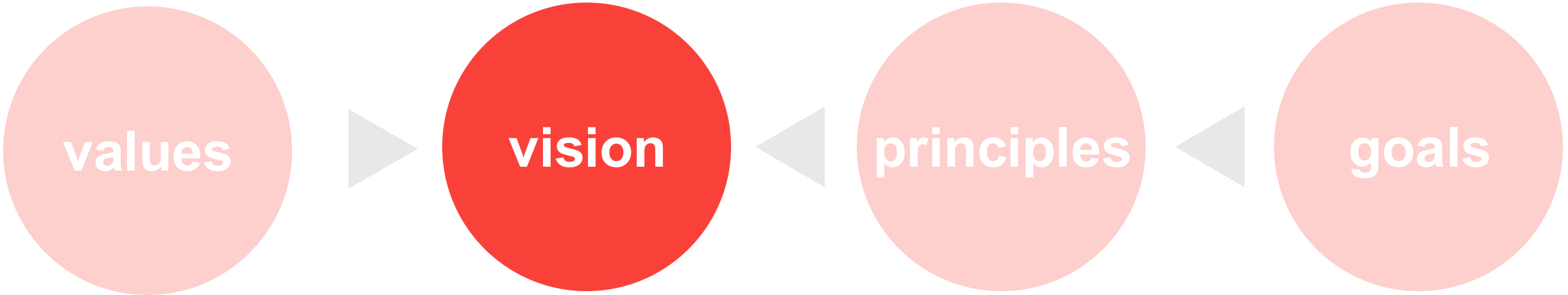


Our vision is to make the Marpole Community Centre the most inclusive, forward-thinking, and high performing facility the City of Vancouver has ever had.

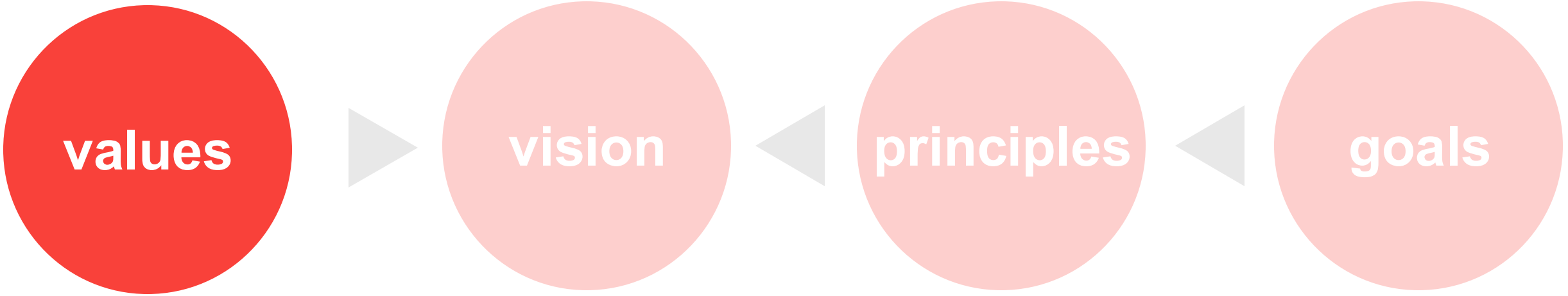
Values, Vision, Principles, and Goals

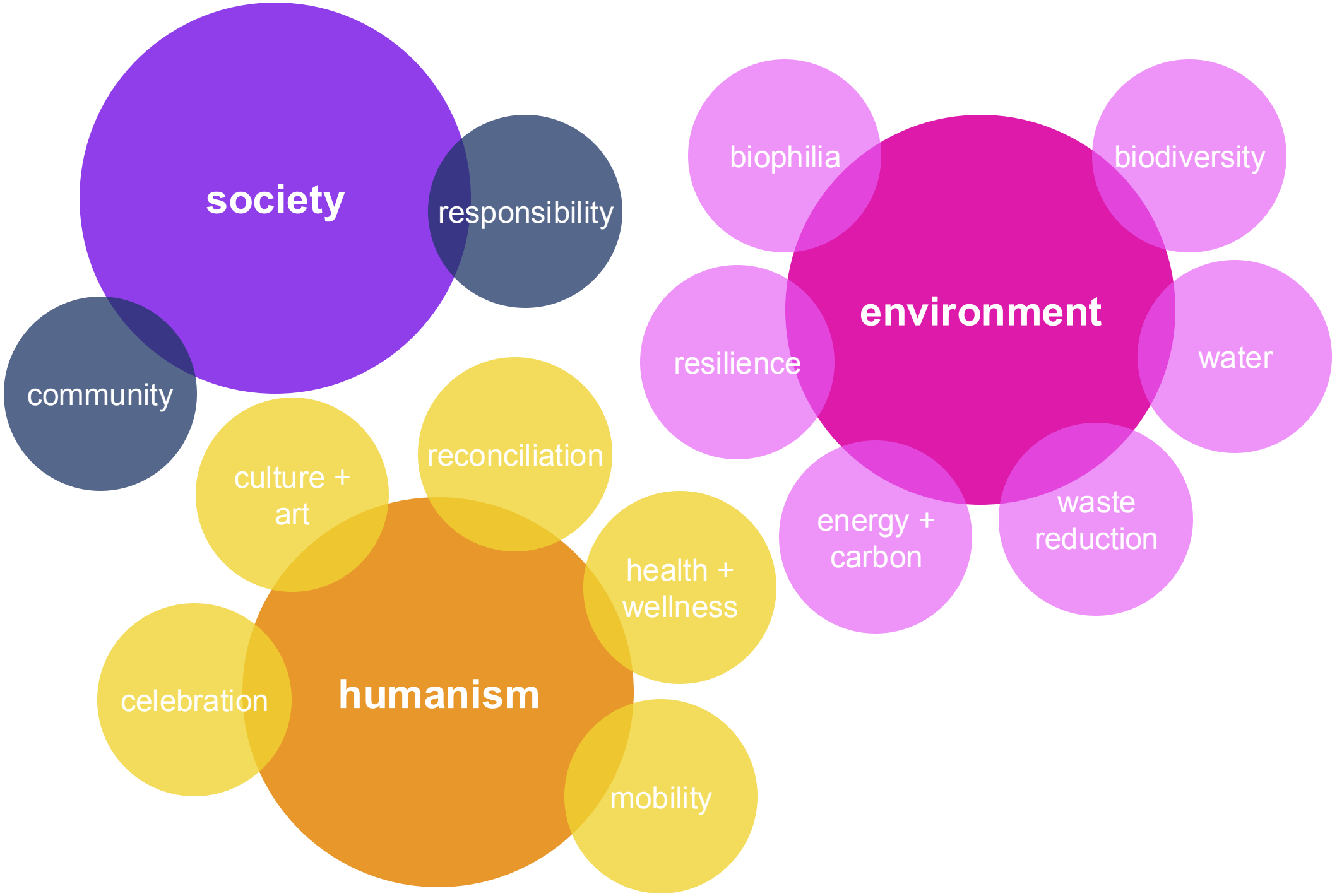
diamond schmitt

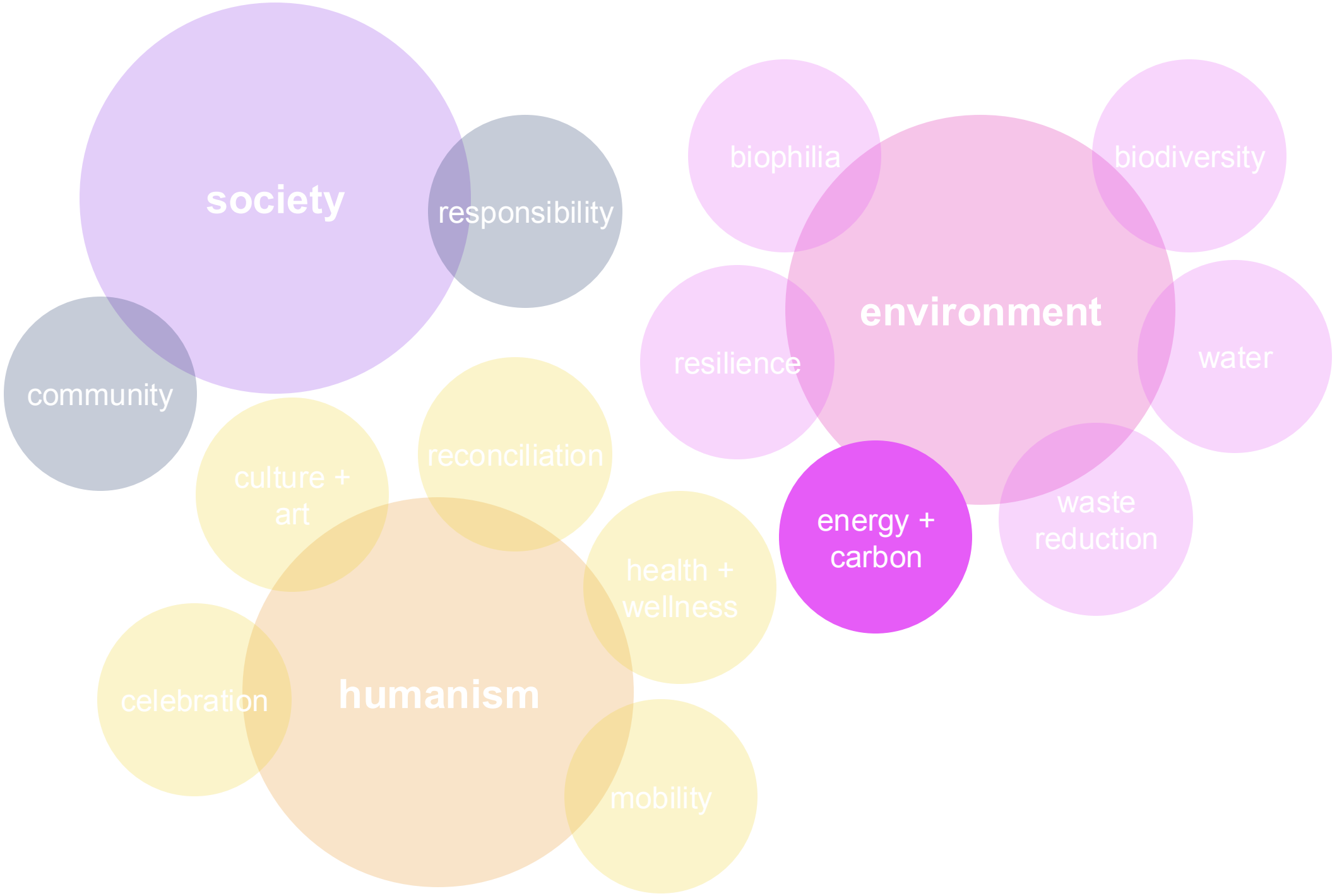

values
vision
principles
goals
universal
project specific

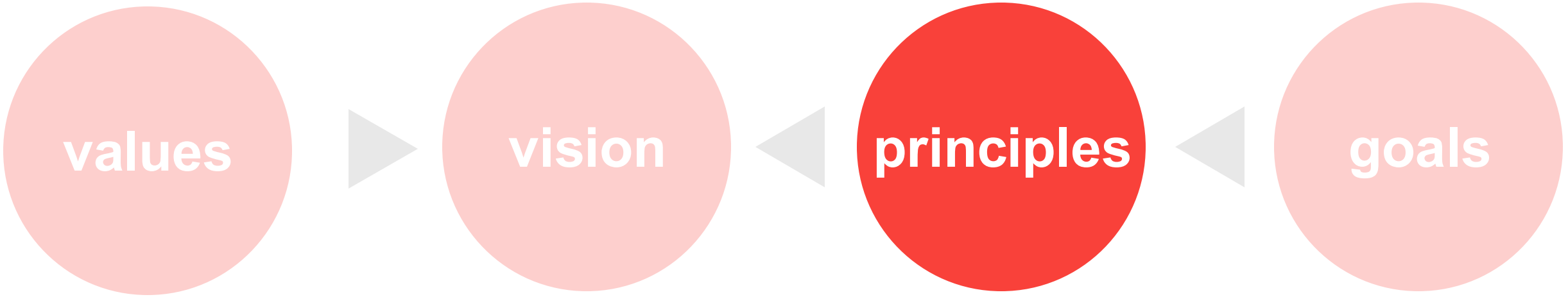


To make the Marpole Community Centre the most inclusive, forward-thinking, and high performing facility the City of Vancouver has ever had.

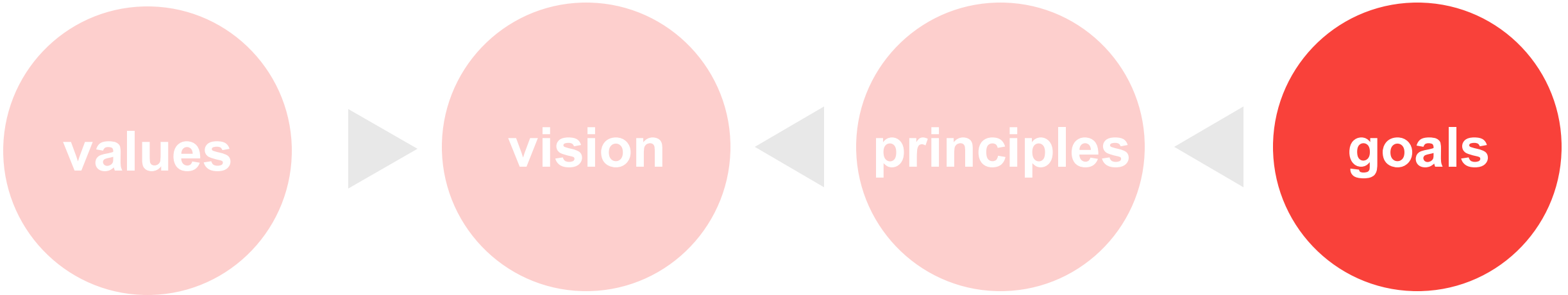

values
vision
principles
goals


society
responsibility
community
biophilia
biodiversity
environment
resilience
water
energy +
carbon
waste
reduction
culture +
art
reconciliation
health +
wellness
celebration
humanism
mobility

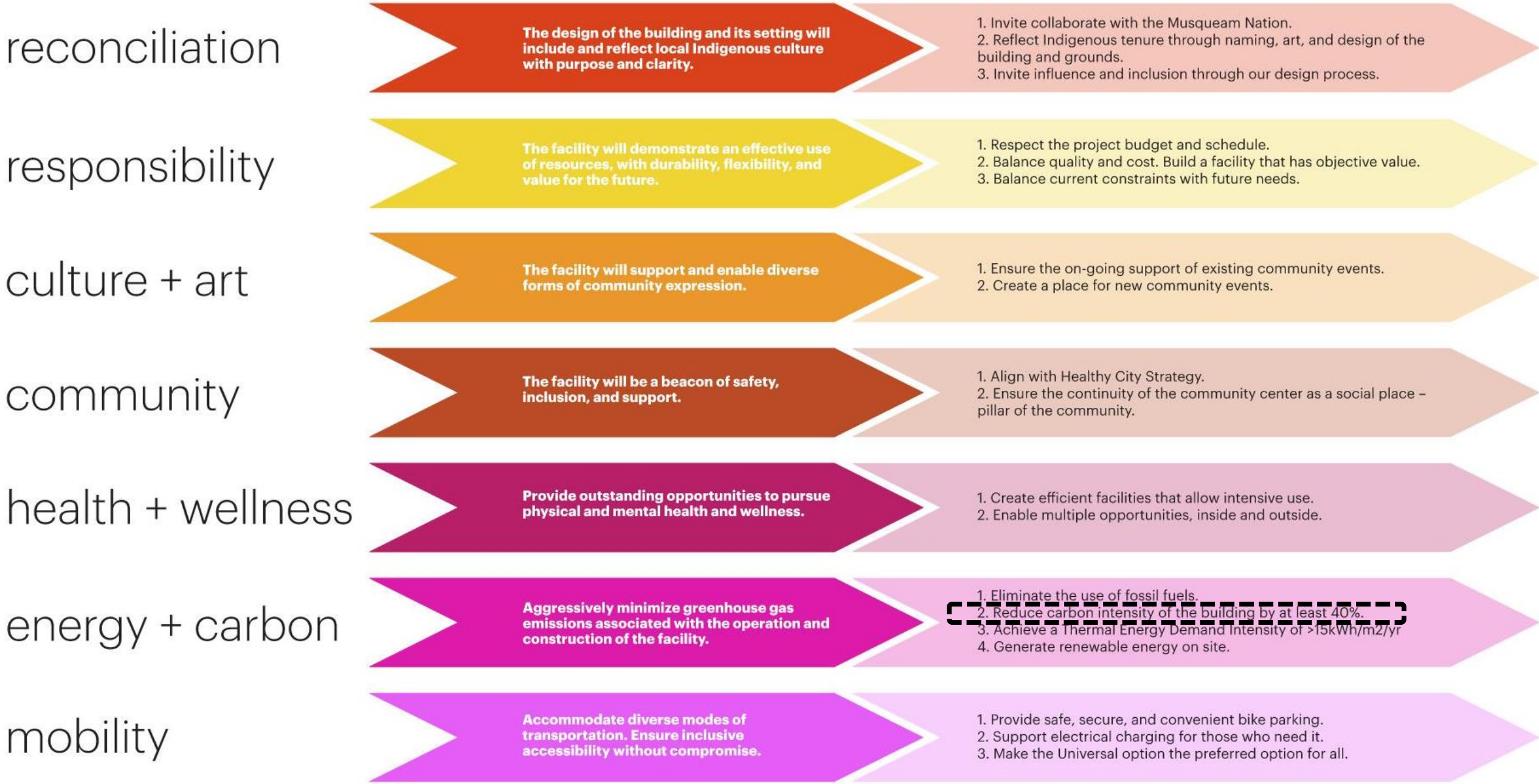

society
responsibility
community
biophilia
biodiversity
environment
resilience
water
energy +
carbon
waste
reduction
culture +
art
reconciliation
health +
wellness
humanism
celebration
mobility



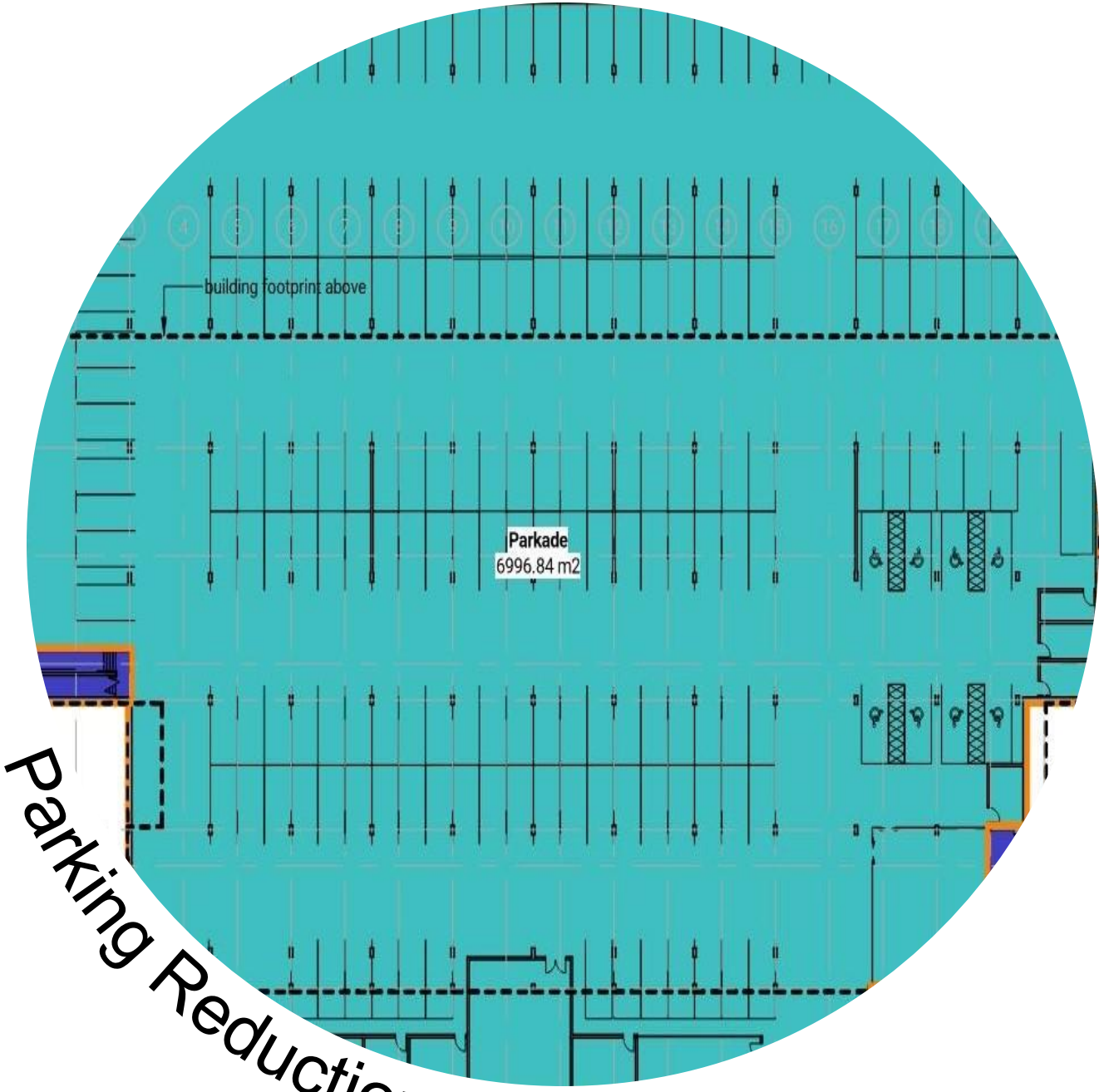
Aggressively minimize greenhouse gas emissions associated with the operation and construction of the facility



1. Eliminate the use of fossil fuels
2. Generate renewable energy on site
3. Achieve a TEDI of <15kWh/m^2/yr
4. Reduce the carbon intensity of the building by 40%


reconciliation
The design of the building and its setting will include and reflect local Indigenous culture with purpose and clarity.
1. Invite collaborate with the Musqueam Nation.
2. Reflect Indigenous tenure through naming, art, and design of the building and grounds.
3. Invite influence and inclusion through our design process.
responsibility
The facility will demonstrate an effective use of resources, with durability, flexibility, and value for the future.
1. Respect the project budget and schedule.
2. Balance quality and cost. Build a facility that has objective value.
3. Balance current constraints with future needs.
culture + art
The facility will support and enable diverse forms of community expression.
1. Ensure the on-going support of existing community events.
2. Create a place for new community events.
community
The facility will be a beacon of safety, inclusion, and support.
1. Align with Healthy City Strategy.
2. Ensure the continuity of the community center as a social place – pillar of the community.
health + wellness
Provide outstanding opportunities to pursue physical and mental health and wellness.
1. Create efficient facilities that allow intensive use.
2. Enable multiple opportunities, inside and outside.
energy + carbon
Aggressively minimize greenhouse gas emissions associated with the operation and construction of the facility.
1. Eliminate the use of fossil fuels.
2. Reduce carbon intensity of the building by at least 40%.
3. Achieve a Thermal Energy Demand Intensity of >15kWh/m2/yr
4. Generate renewable energy on site.
mobility
Accommodate diverse modes of transportation. Ensure inclusive accessibility without compromise.
1. Provide safe, secure, and convenient bike parking.
2. Support electrical charging for those who need it.
3. Make the Universal option the preferred option for all.

water	**Minimize the consumption of municipal potable water, and use rainwater to minimize impact on stormwater infrastructure.**	1. Accommodate 90% of the annual rainfall on site, or first 48mm of a 24hr period. 2. Create meaningful and deliberate landscapes to manage water on site. 3. Celebrate water in an expressive and culturally impactful way.
biodiversity	**The project will increase biodiversity in Oak Park.**	1. Ensure a net increase in tree cover and a diversity in age and species 2. Create new habitat for plants and animals not present in Oak Park. 3. Design with ecological benefits in mind. 4. Make space for culturally significant plants and planting patterns
biophilia	**The project will seek connections to nature, both through landscape design and building configuration and materiality.**	1. Prioritize natural materials. 2. Create meaningful connections between interior and exterior spaces. 3. Embrace the park setting. Prioritize superior daylight and air. 4. Employ natural patterns and motifs in the design.
resilience	**Anticipate future climate conditions and events, and be capable of operating with minimal adaptation.**	1. Anticipate future climate and accommodate changes. 2. Address consequences of known hazards and mitigate them. 3. Build with the intent of longevity. 4. Anticipate future needs.
waste reduction	**The project will demonstrate and support the to minimize waste.**	1. Conserve heat energy. 2. Configure space to make recycling and composting 'automatic'. 3. Minimize use of materials. 4. Reduce waste generated during construction.
celebration	**Create a place for optimism and delight.**	1. Create a vibrant place for the community to gather and celebrate. 2. Celebrate the history of the place



Parking Reductions

responsibility

2.1 Respect the project budget and schedule

mobility

7.1 Provide safe, secure, and convenient bicycle parking
7.2 Support electrical charging for those who need it

energy + carbon

6.2 Reduce the embodied carbon intensity of the building by 40%

waste reduction

12.3 Minimize the use of materials

Mass Timber Construction

responsibility

2.1 Respect the project budget and schedule

biophilia

10.1 Prioritize the use of natural materials.

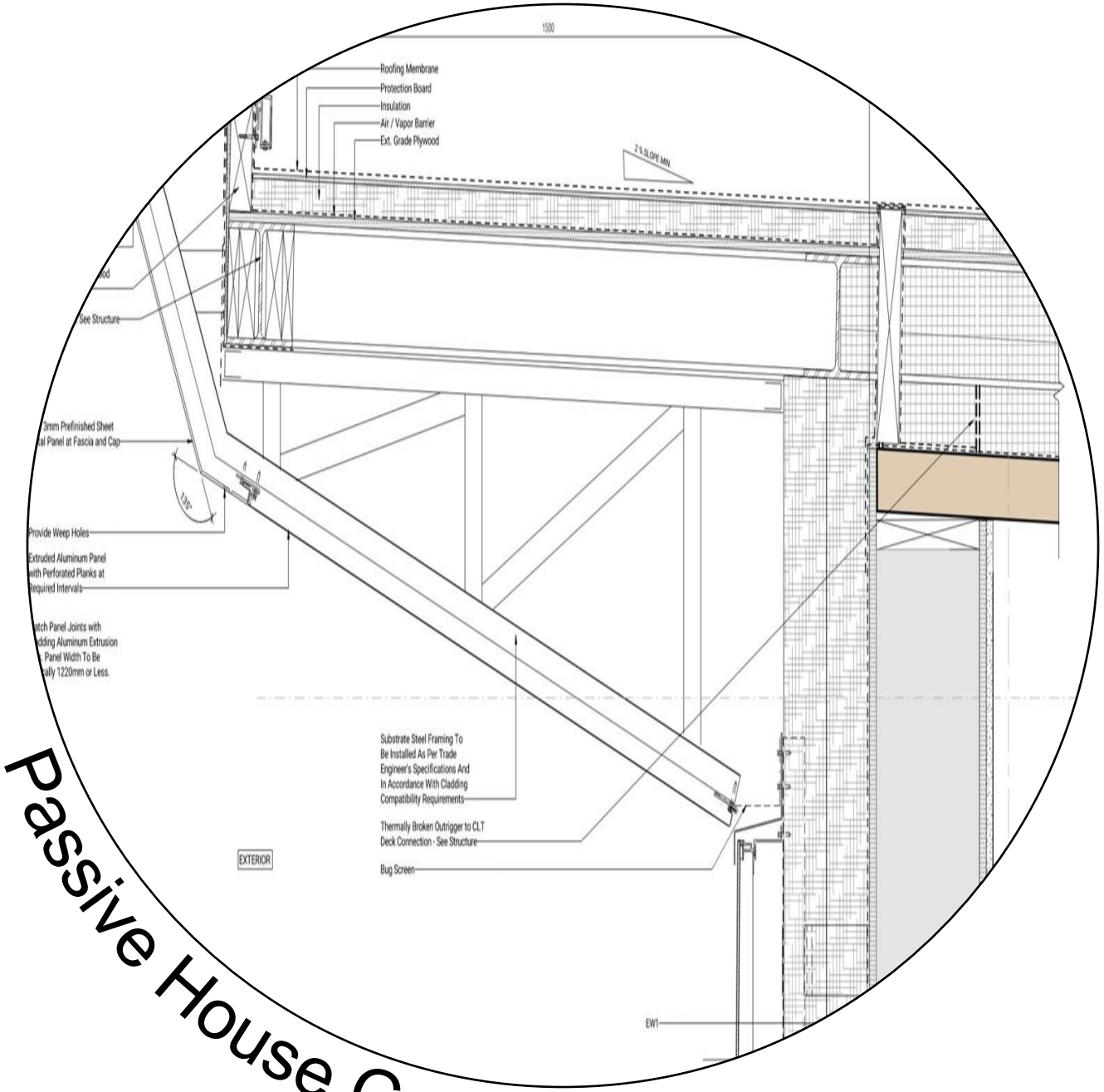
energy + carbon

6.2 Reduce the embodied carbon intensity of the building by 40%

Balancing Operational vs Embodied Carbon Goals

diamond schmitt

Passive House Certification



energy + carbon

6.3 Achieve a Thermal Energy Demand Intensity of less than 15 kWh/m2/yr

energy + carbon

6.2 Reduce the embodied carbon intensity of the building by 40%

Passive House Requirements

15 kWh/m^2/yr

Space Heating Energy Demand

(Thermal Demand Energy Intensity)

low energy

+

0.6 Air changes per hour at 50 Pascals pressure

airtight

Passive House Principles

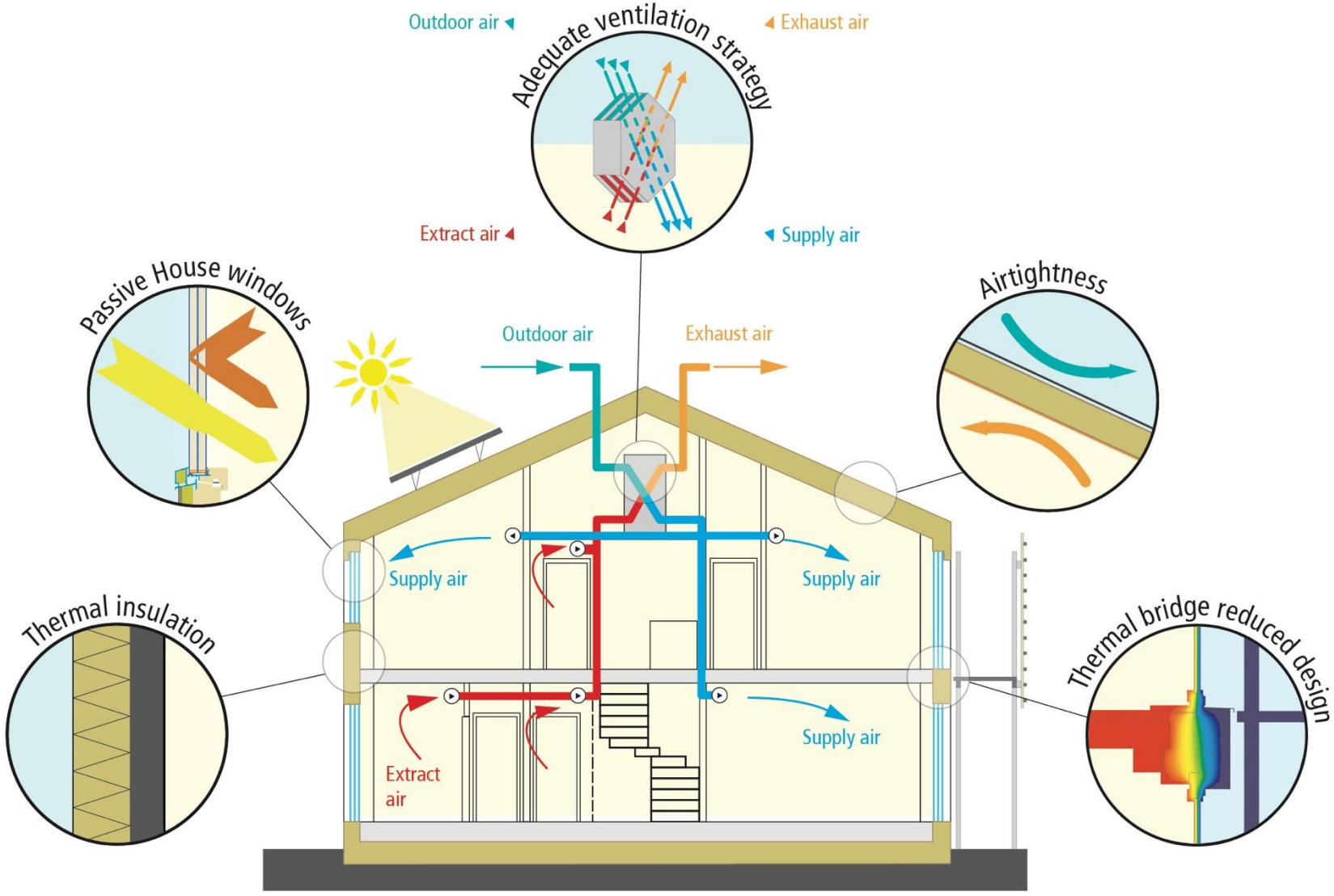
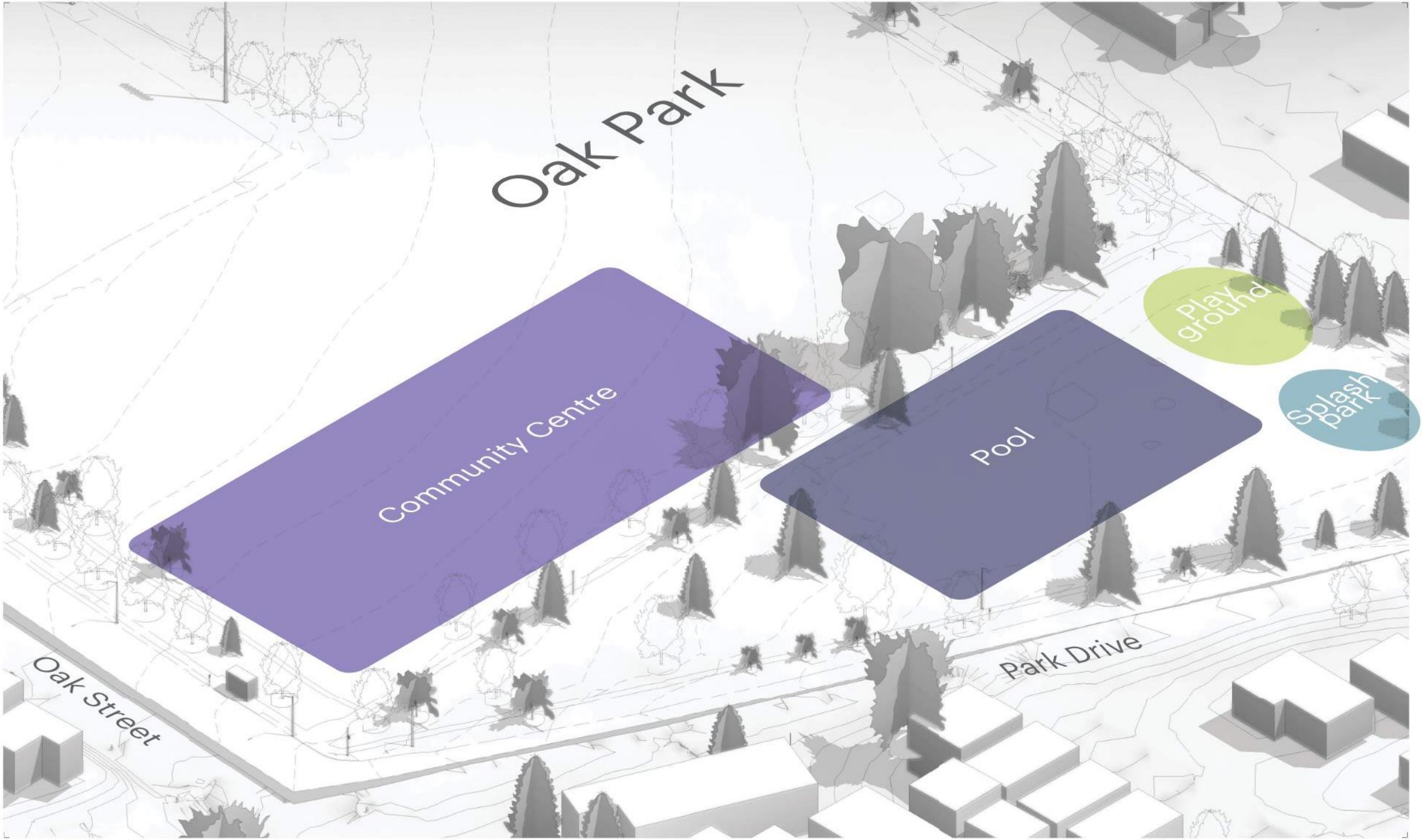
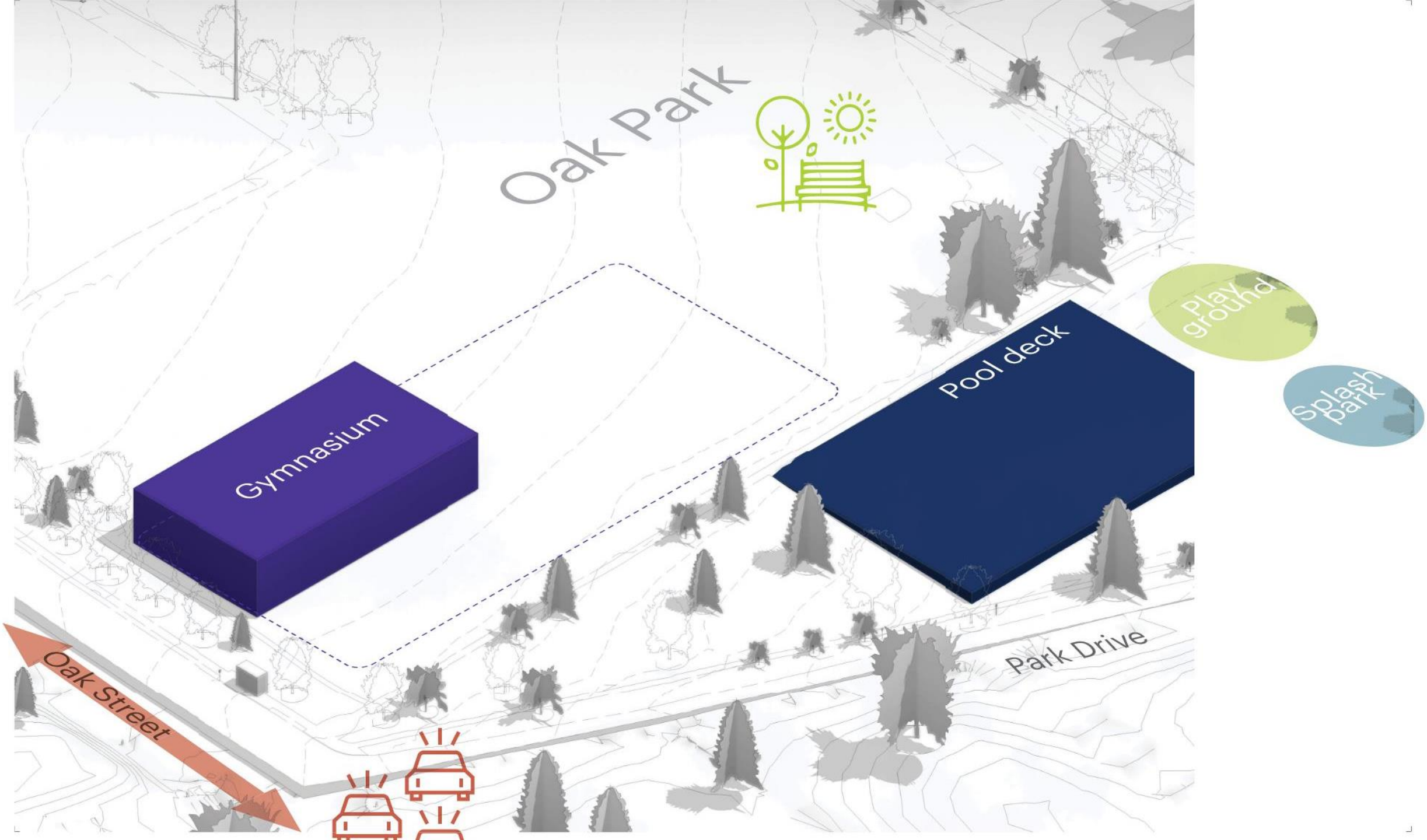
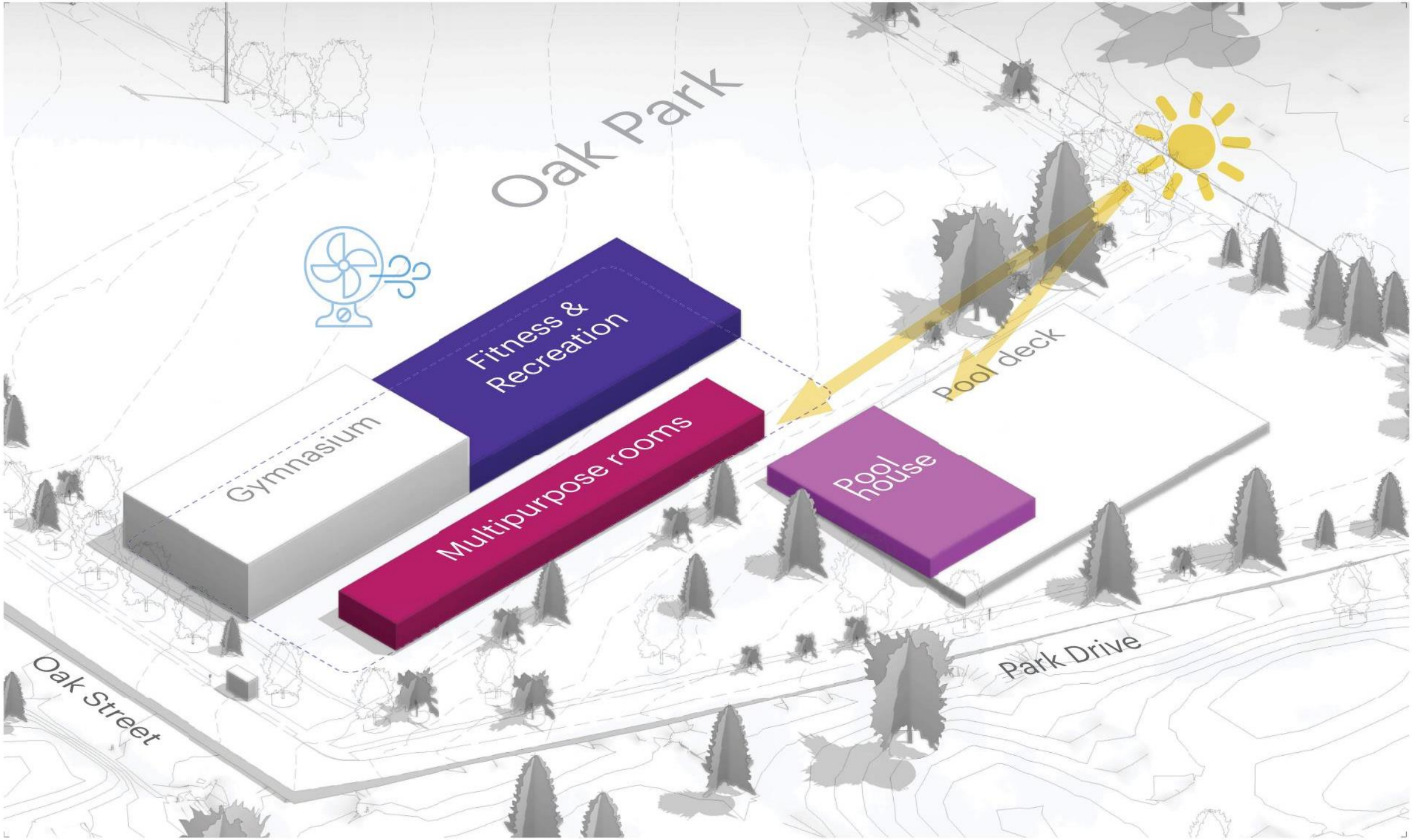


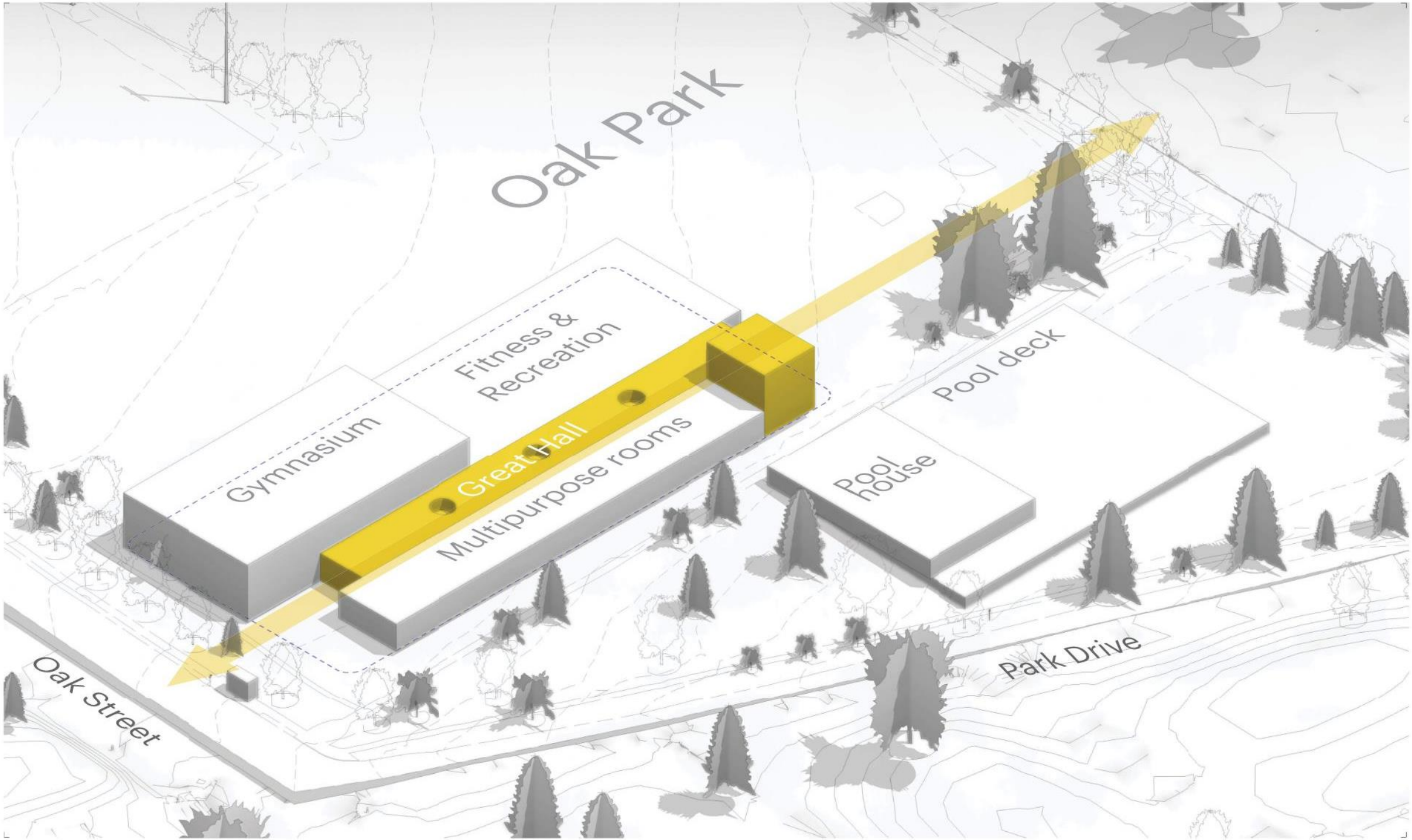
Image from Passive House Institute

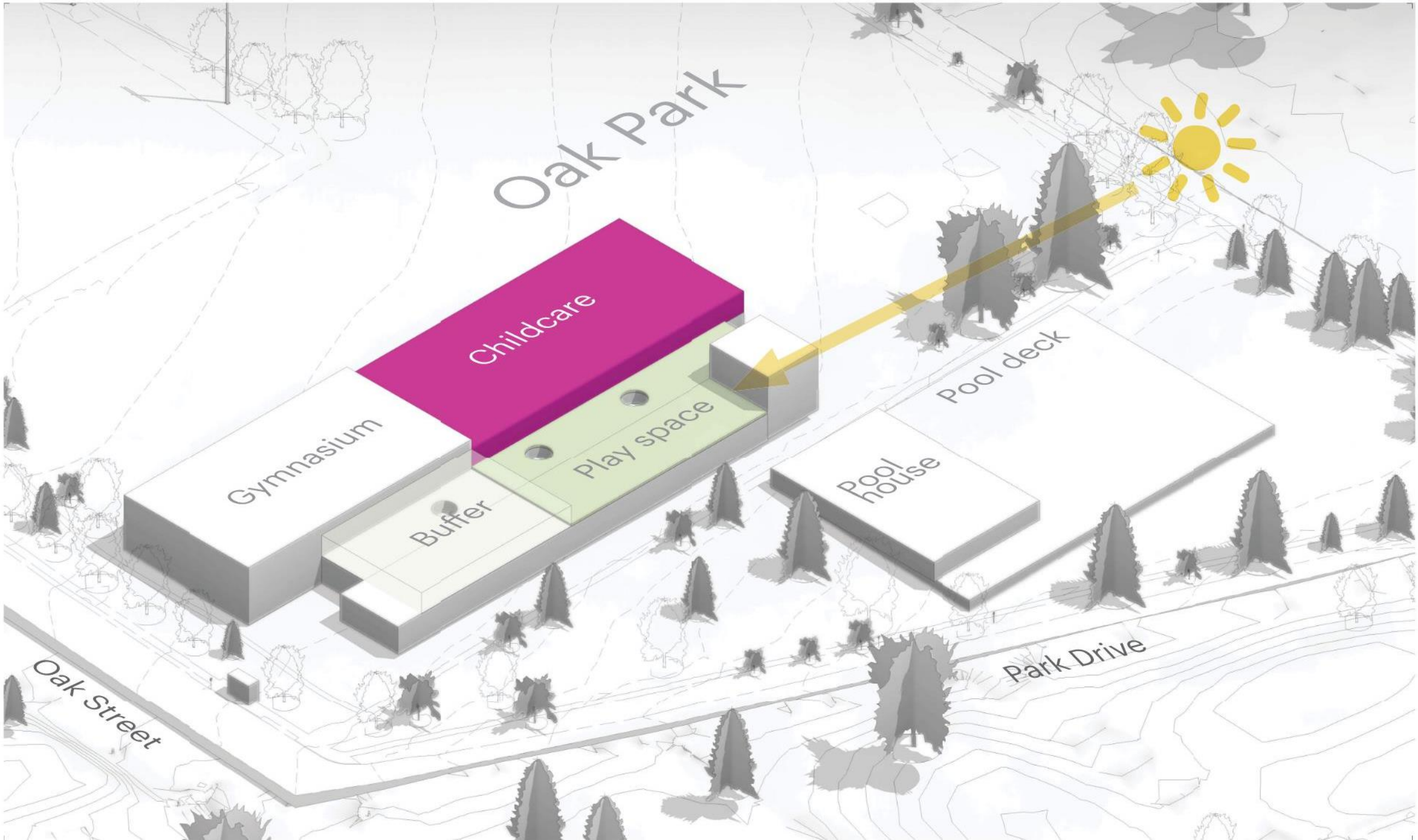
https://passiv.de/en/02_informations/02_passive-house-requirements/02_passive-house-requirements.htm

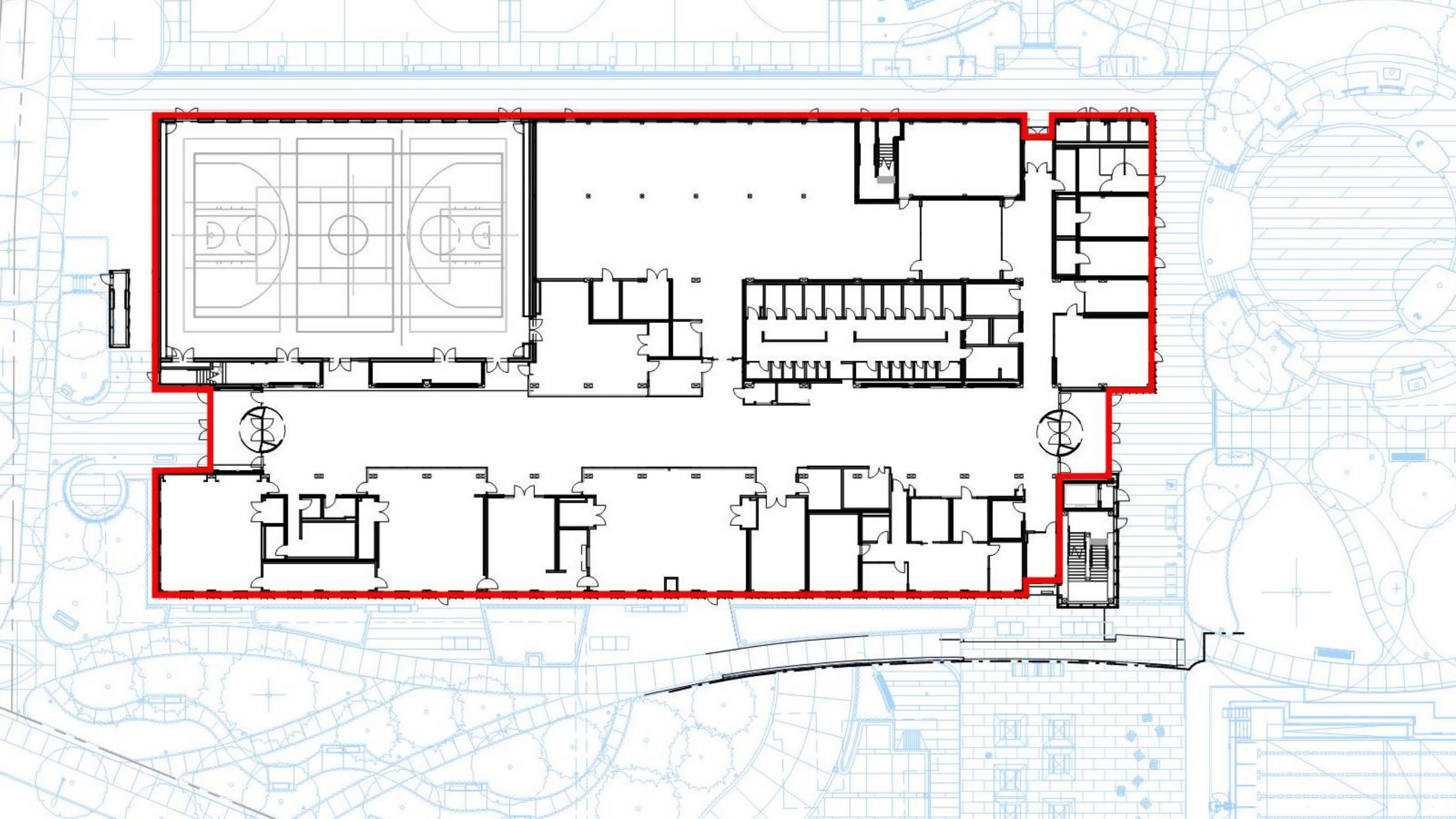

Oak Park
Community Centre
Pool
Play ground
Splash park
Oak Street
Park Drive

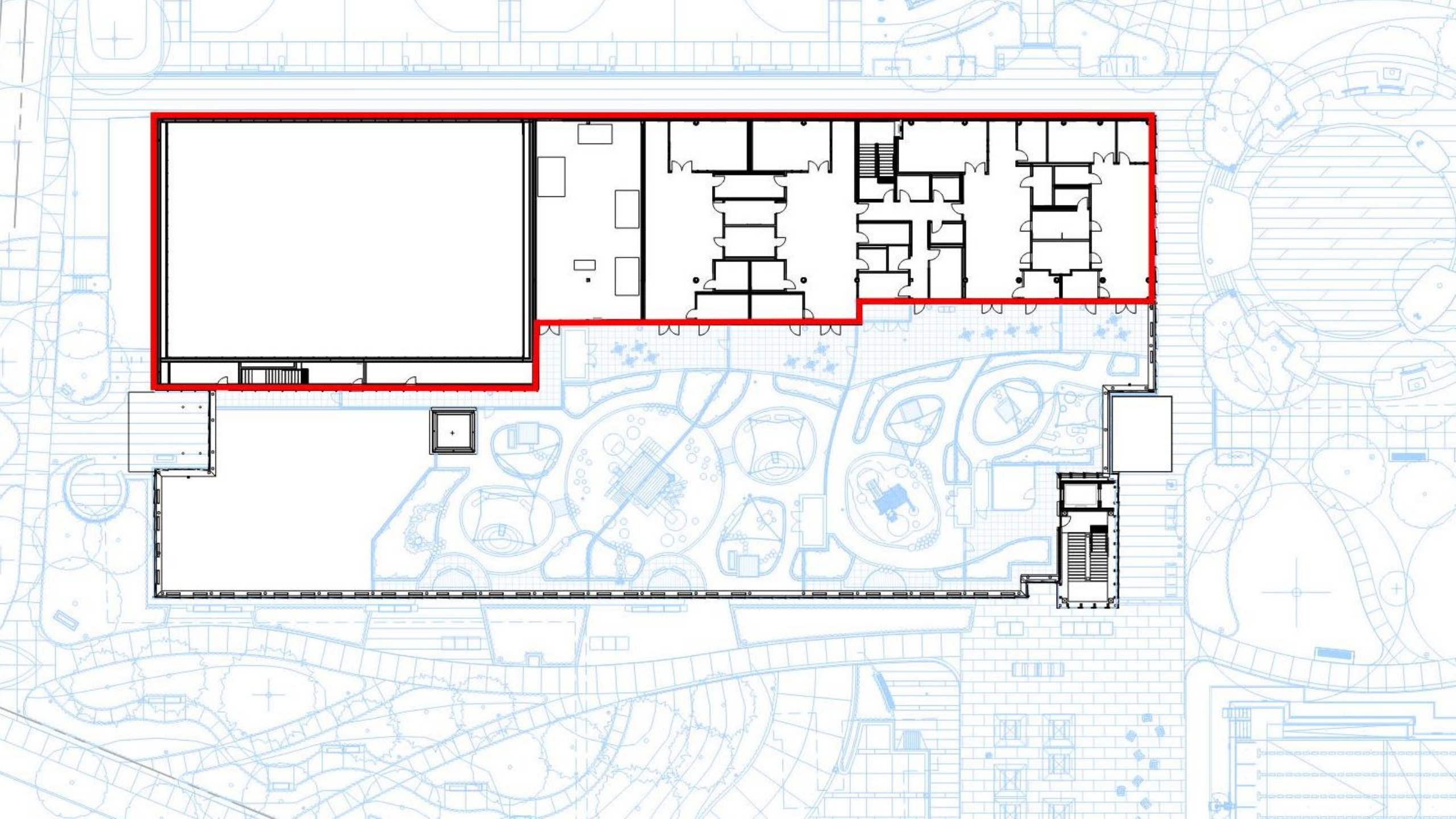

Oak Park
Gymnasium
Pool deck
Playground
Splash park
Park Drive
Oak Street


Oak Park
Fitness &
Recreation
Gymnasium
Multipurpose rooms
Pool
house
Pool deck
Oak Street
Park Drive


Oak Park
Fitness &
Recreation
Gymnasium
Great Hall
Multipurpose rooms
Pool deck
Pool
house
Park Drive
Oak Street


Oak Park
Childcare
Gymnasium
Play space
Buffer
Pool deck
Pool house
Oak Street
Park Drive





Achieving Embodied Carbon Reductions

WHAT WE DO

Building Design Advisory

Design Strategy Development
AHJ Code Compliance - VBBL, BCBC
Energy Specialists - Step Code, ASHRAE, NECB, Passive House
Low-Carbon Design Experts - LEED, Net Zero, LBC, Policy

Building Performance Analysis

Energy Modelling
Whole Building LCAs & Embodied Carbon
CFD, Natural Ventilation & Daylighting
LCCAs & Cost-Benefit Studies

Performance Management

CAGBC – Zero Carbon Building Certification
Clean BC Incentive Studies
FCM & CMHC Funding Studies
Technical Review Teams

Climate Adaptation & Resilience

Warming Climate Planning
Thermal Comfort Studies
Scenario Testing 2050s & 2080s

WHO WE ARE

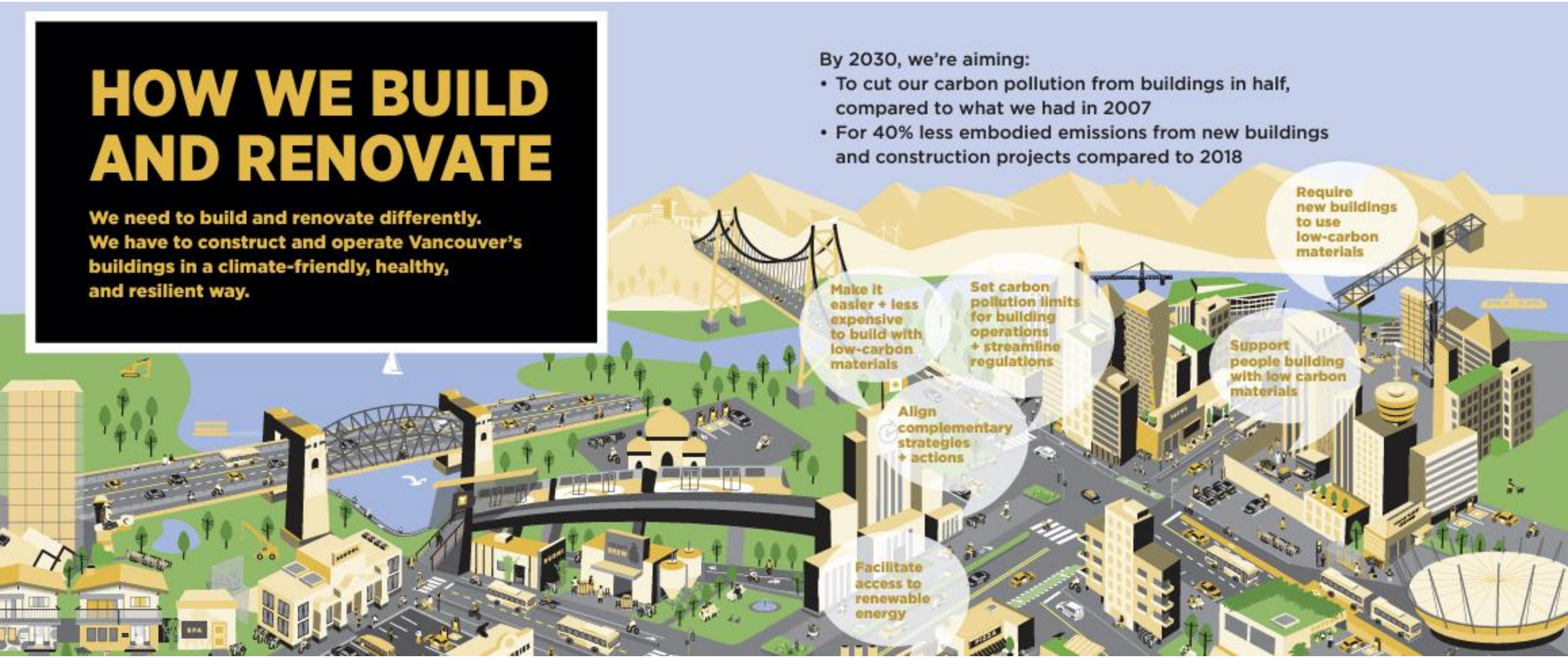




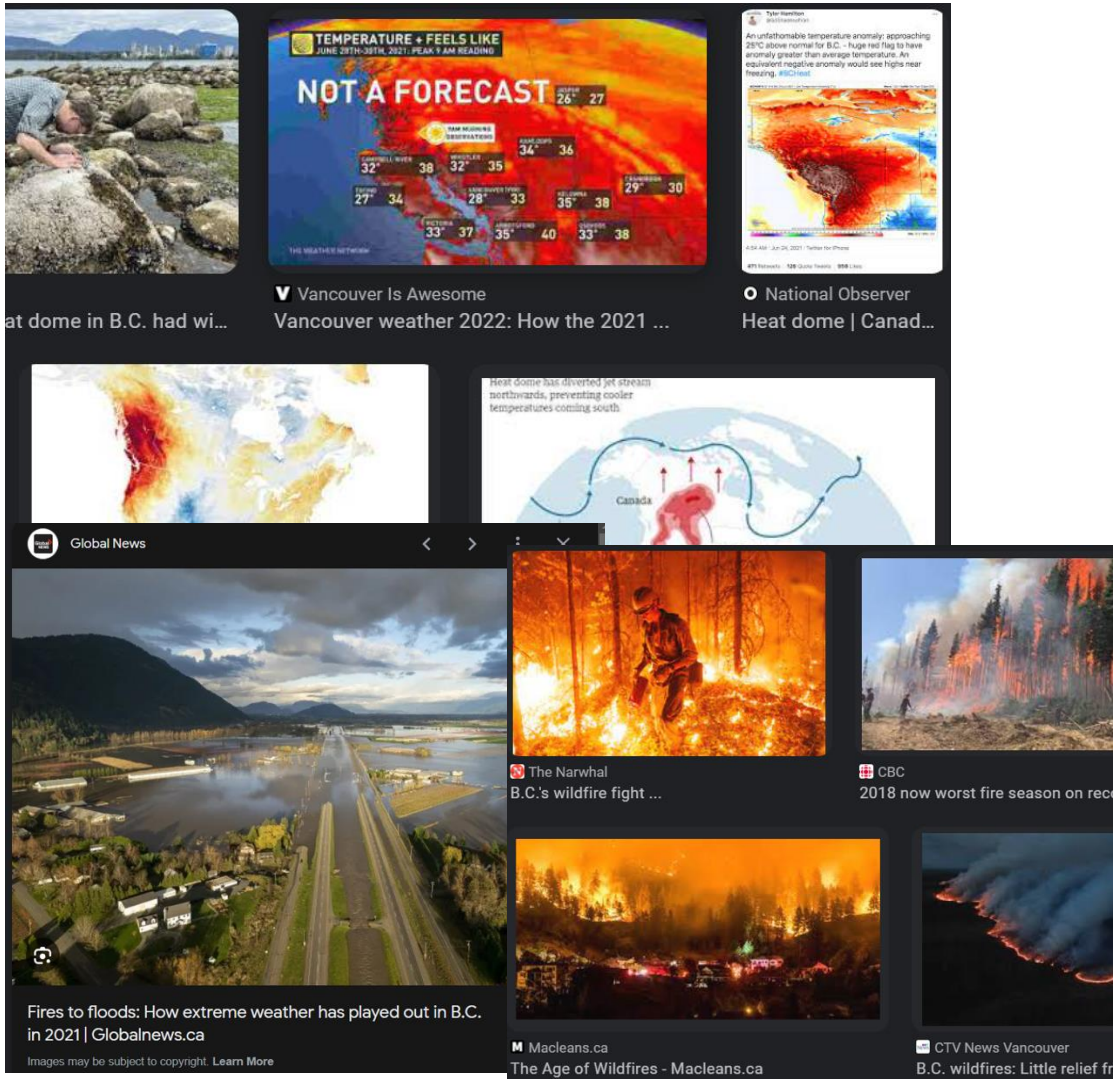

OUTLINE

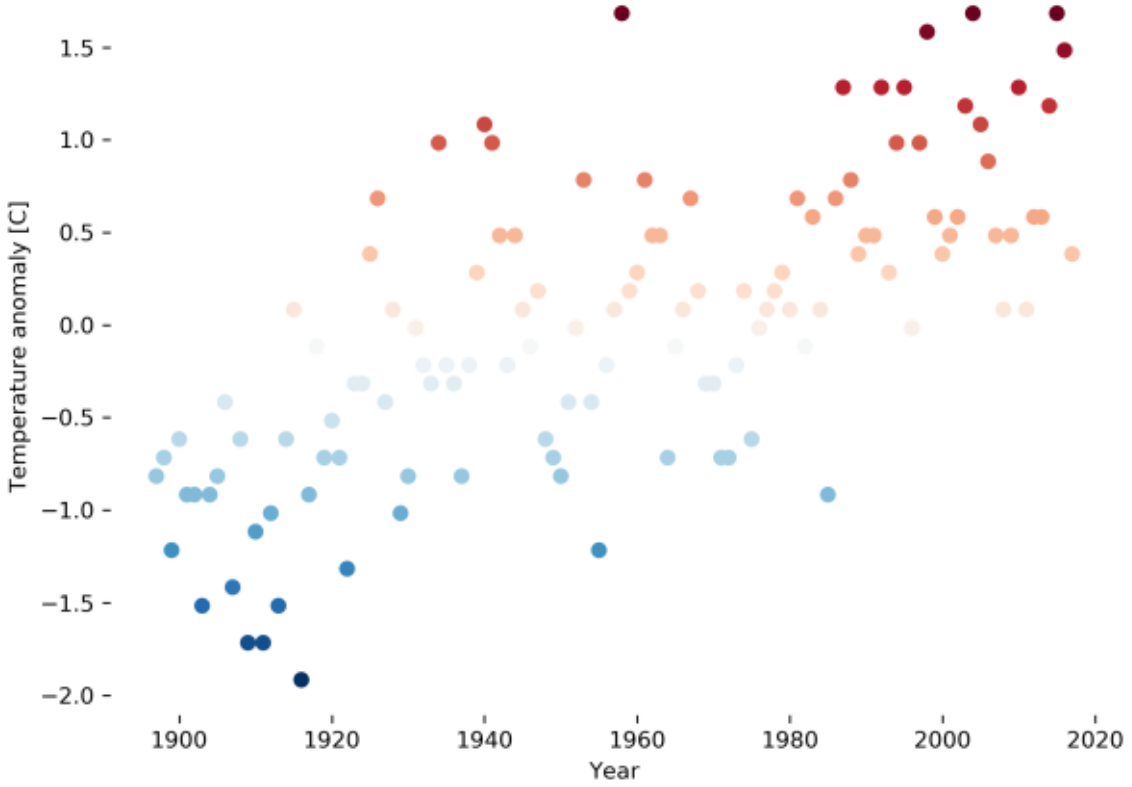
- Project Context and Goal Overview
- Baseline and City of Vancouver Embodied Carbon Guidelines Pilot
- Low-Carbon Design Strategies
  - Early-Stage Coordination for Carbon-Conscious Design
  - Enabling Mass Timber Structure
  - Construction Management & Procurement Collaboration
  - Reduce Below-Grade Parking for less Cost and Carbon
  - Insulating for Passive House: Carbon Considerations
- Current Project Carbon Status

CITY OF VANCOUVER CLIMATE ACTION PLAN 2020-2025



WHY DO GHG EMISSIONS MATTER?

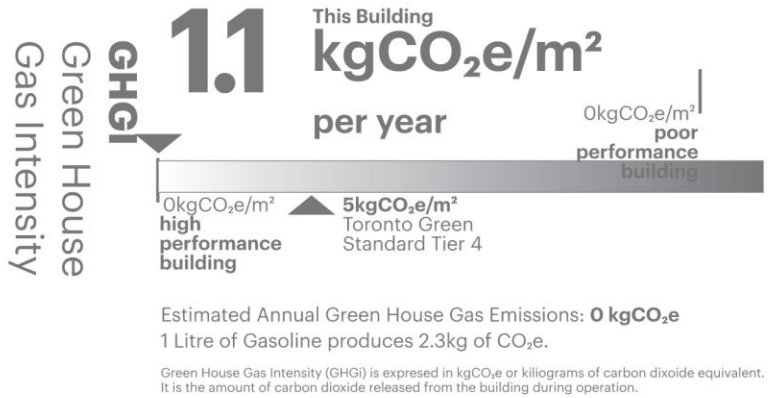


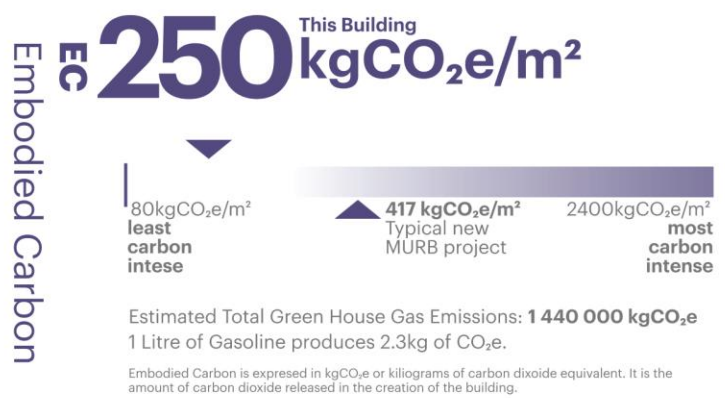


Vancouver Average Weather – Environment Canada

PROJECT GOAL SETTING IN PRE-DESIGN

themes	principles	goals
responsibility	The facility will demonstrate an effective use of resources, with durability, flexibility, and value for the future.	1. Respect the project budget and schedule. 2. Balance quality and cost. Build a facility that has objective value. 3. Balance current constraints with future needs.
energy + carbon	Aggressively minimize greenhouse gas emissions associated with the operation and construction of the facility.	1. Eliminate the use of fossil fuels. 2. Reduce carbon intensity of the building by at least 40%. 3. Achieve a Thermal Energy Demand Intensity of >15kWh/m2/yr 4. Generate renewable energy on site.





Baseline & Embodied Carbon Guidelines Pilot

PILOT PROJECT FOR EMBODIED CARBON GUIDELINES

Pre-Design	2020	OPR, 40% Reduction Based on “2018 Baseline”
	2021	reLoad, DSA, CoV work collaboratively to establish performance based targets based on the “2018 baseline”.
SD	2021	First draft of “LCA Modelling Guidelines” are released.
DD	2022	First wbLCA complete at DD stage & feedback provided to City.
	2022	Concrete BC releases BC Member Industry Wide EPD for Ready Mix Concrete.
CD	2023	wbLCA complete at BP using CoV Embodied Carbon Guidelines v0.3.
	2023	CoV Embodied Carbon Guidelines v1.0 released & BP wbLCA checked.

BASELINE DEVELOPMENT

Table 2: 2018 Baseline Building Materials Assumptions

Assembly	Materials Assumption
Below-grade structure Footings & Foundation Columns & Beams Floors Stairs	• CRMCA GUL 15% SCM • No air entrainment • At equivalent strength • 266 $kgCO_2e$ at 0-25 MPa to 477 $kgCO_2e$ at 56-60 MPa
Interior Walls	• Not considered
Exterior Walls	• GWB, steel-stud, mineral wool batt insulation (equivalent R-value), aluminum cladding. • Curtain wall (e.g., Kawneer EPD) for community centre typology for some areas.
Glazing	• Aluminum frame window wall • Same # panes as proposed
Roof	• Steel beams with inverted roof, *reduced GWP XPS* insulation

Questions in early design:

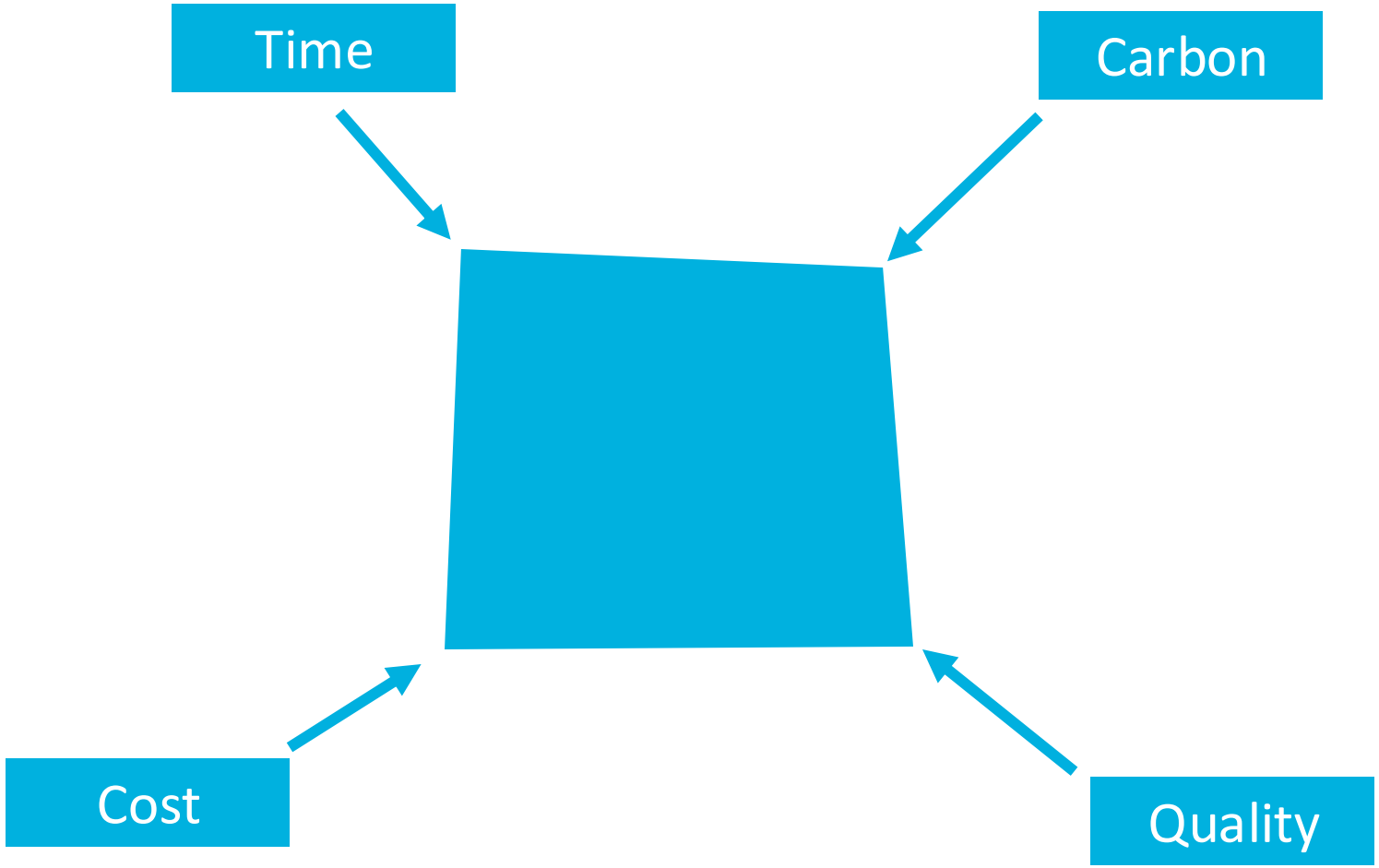
- How much parking does the baseline have?
- Should the baseline insulation be VBBL or Passive House?
- Is wood carbon negative?

Embodied Carbon Guidelines & Functional Equivalence:

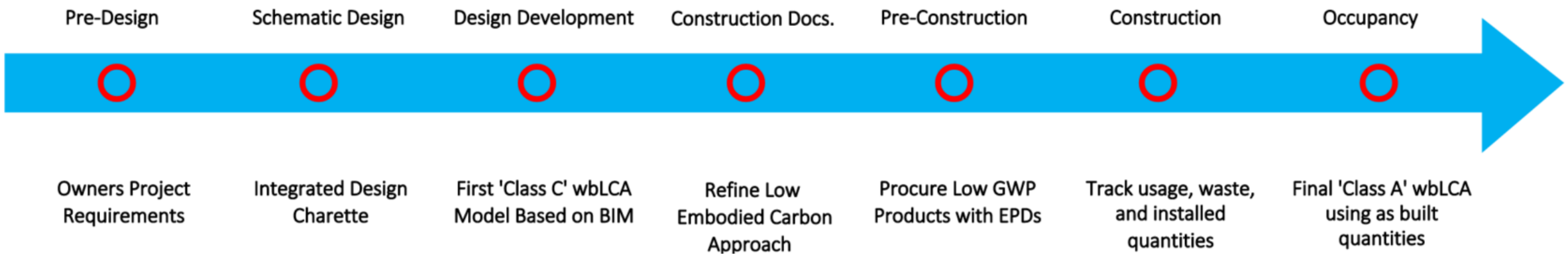
- Min. parking in CoV Parking Bylaw.
- Thermal equivalence should be maintained.
- Biogenic carbon is counted separately.

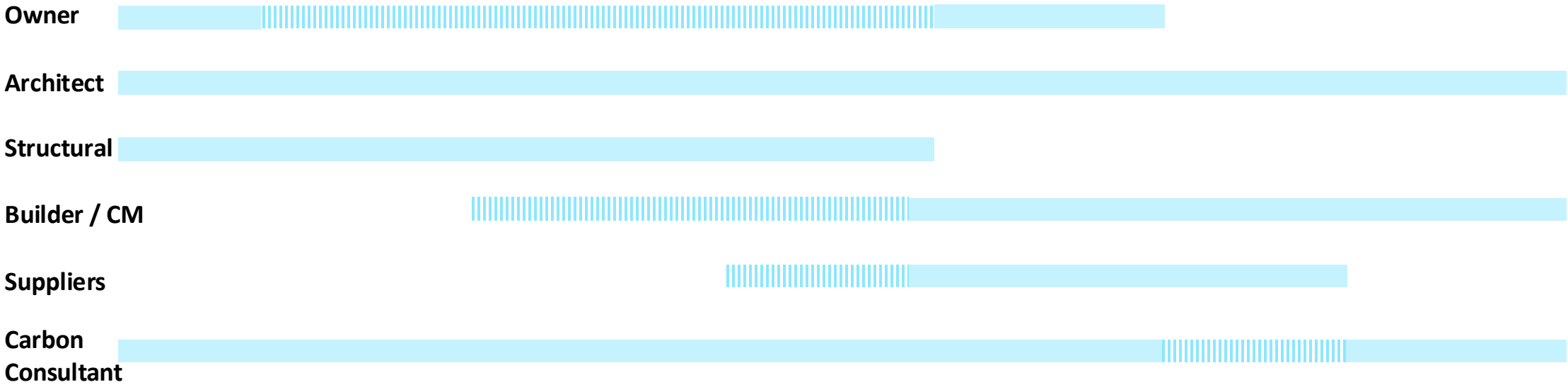
Marpole Low-Carbon Design Strategies

GOLDEN TRIANGLE TO A CARBON SQUARE



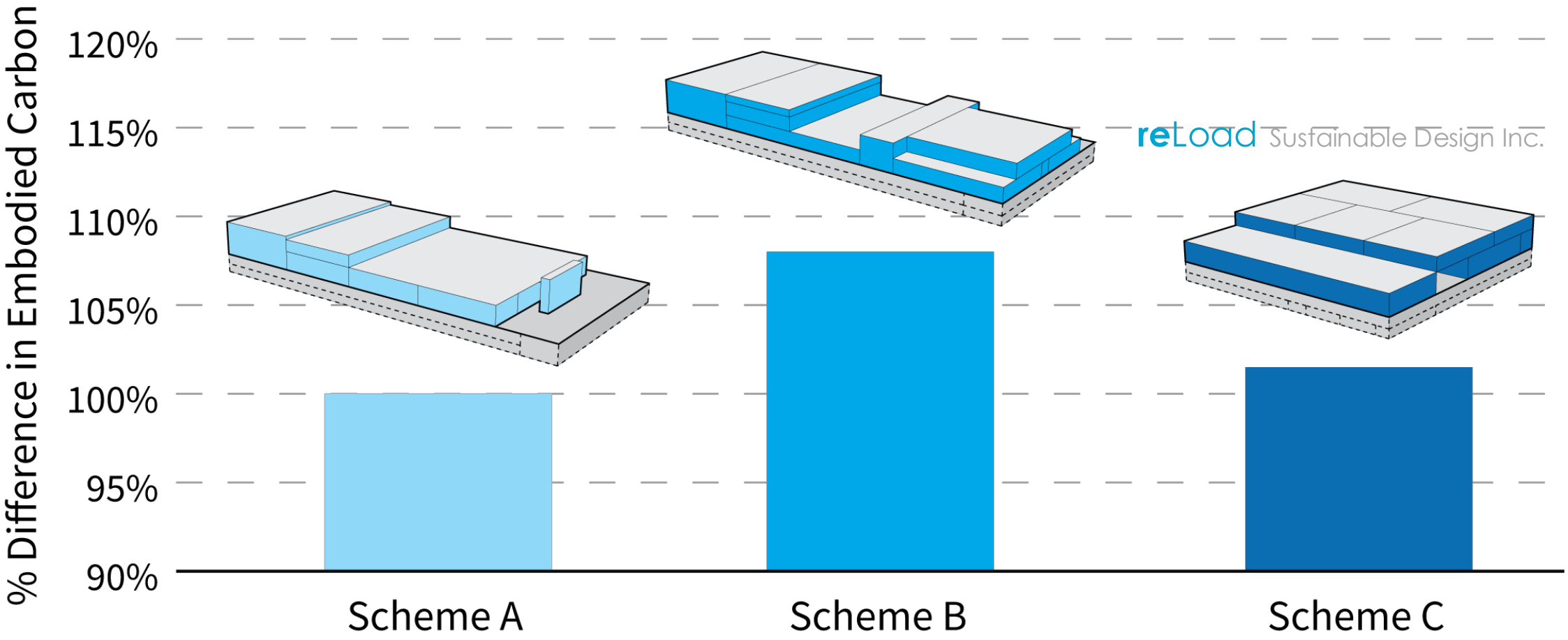
EMBODIED CARBON – DESIGN INTEGRATION – KEY PLAYERS



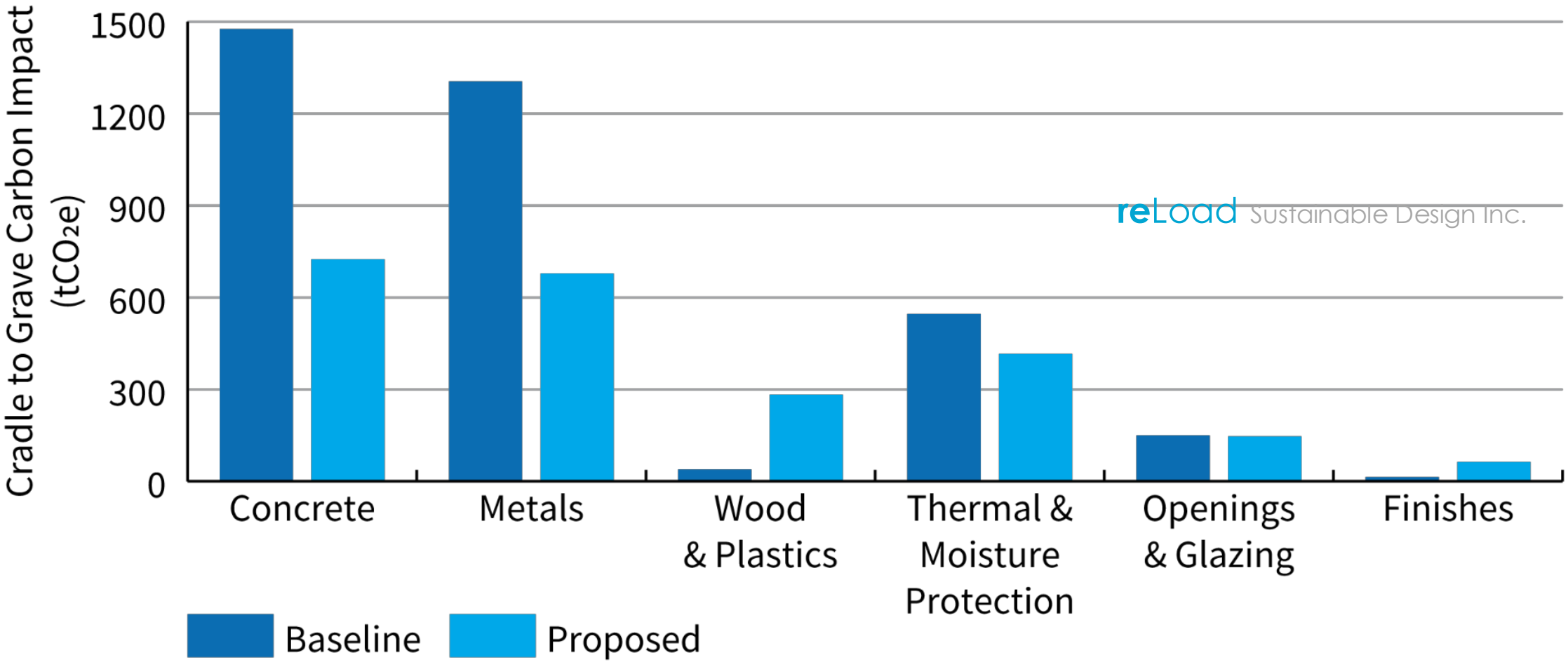


Source: reLoad Image

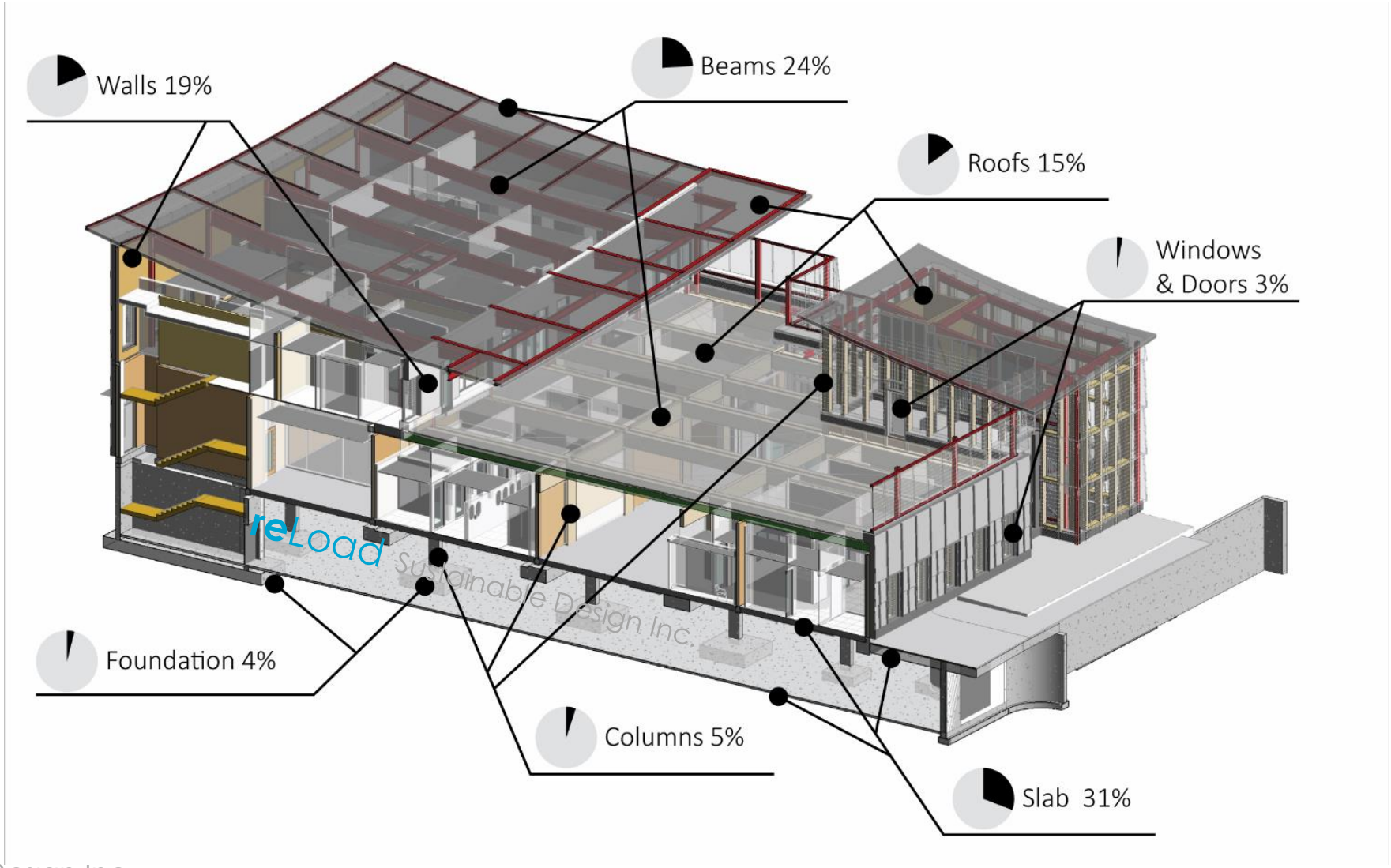
EARLY-STAGE MASSING ANALYSIS



BP CONTRIBUTION ANALYSIS: BUILDING MATERIALS



BP CONTRIBUTION ANALYSIS: BUILDING ELEMENTS



PROJECT SPECIFICATIONS - 1

Submittals

.1 A Base Bid representing 'business as usual' and an Alternate Bid - lower Global Warming Potential (GWP).

.2 A complete Embodied Carbon Tracking Form, to be supplied by the *Construction Manager*.

.3 Environmental Product Declarations (EPDs) to substantiate GWP claims that are facility, mix, or product specific for both the Base Bid and the Alternate Bid. The Global Warming Potential (GWP), measured in $kgCO_2e$ per [Unit], as provided in EPD(s) submitted will be included in the assessment of submittals.

.4 If facility, mix, or product specific EPDs are not currently available:

.1 GWP numbers utilizing industry averages will be assumed, e.g., those from the Carbon Leadership Forum (https://carbonleadershipforum.org/clf-materialbaselines-2023/).

.2 The following questions shall be answered:

.1 Will you commit to providing facility, mix, or product specific EPDs for this *Project* by the construction start date?

.2 If not, why not?

.3 If so, will you charge the *Project* for the generation of facility, mix, or product specific EPDs?

EMBODIED CARBON TRACKING FORM

Product Name	Information Type	Description (location on project)	GWP, per EPD [$kgCO_2e$/unit]	Unit	EPDs Are Required. Are they Attached?*	EPD Expiry Date	Unit Cost [$/unit]	Unit	Total Cost [$]
***Example* Ocean mix LH30E0YB6D08, 30 MPa Concrete, 56 day**	Base Bid / Design	L1 Structural slab	275.0	m3	Yes	12-16-2026	$ 1.00	m3	$ 300.00
	Base Bid / Design						$ -		$ -
	Alternate						$ -		$ -
	Substitution						$ -		$ -
	Other						$ -		$ -
							$ -		$ -
							$ -		$ -
							$ -		$ -

Elements Required to Track Embodied Carbon:
1. Cast-in-Place Concrete
2. Structural Steel & Metal Deck
3. Rebar
4. Fireproofing
5. Curtain Wall, Window Wall, and Storefront systems
6. Glass and Other Glazing Products
7. Aluminium or Steel Extrusions for Glazing Systems
8. Glue-Laminated Timber
9. Cross-Laminated Timber
10. Dowel-Laminated Timber
11. Gypsum wall board
12. Insulation all types
13. All Structural Elements, refer to Boundary below.
14. All Envelope Elements, incl. major layers or components of an assembly. Finishes (eg paint) and smaller supplementary components (eg, nails, screws and glue etc) are optional. For example, an exterior wall should include major elements like cladding, strapping, moisture/vapour/air barriers, insulation, wood framing, and gypsum wall board.

PROJECT SPECIFICATIONS - CONCRETE

.8 The maximum A1-A3 Global Warming Potential, GWP, measured in kgCO2e/m3, of the Base Bid is to meet the maximum GWP specified on the structural drawing specifications, to be substantiated by a product specific, Type III, EPD in accordance with ISO 14025 and complying with ISO 21930 (2017).

ELEMENTS	MIN. 56 DAY STRENGTH MPa (psi)	EXPOSURE CLASSIFICATION	GOBAL WARMING POTENTIAL (kg CO_2 eq per m^3)
Foundations and Footings Walls	25 (3600) 35 (5000)	- F2	182 215

CONCRETE

Project specified maximum GWP limits for concrete.

Project claimed **155 tCO_2e** reduced from concrete at BP.

Procuring lower GWP concrete from Lafarge, with **238 tCO_2e** reduction – 6% from baseline.

Increased cost of **$9,000 (0.1%)** (Jan. 2024). ~$35/$tCO_2e$.

ENVIRONMENTAL IMPACTS

Declared Product:

Mix RMXUG25A3A8M • Kent Avenue Ready-Mix Plant
Description: ECOPACTMAX25 20MM 1-4%
Compressive strength: 25 MPa at 56 days

Declared Unit: 1 m^3 of concrete

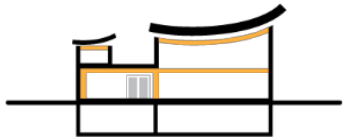
LAFARGE

Global Warming Potential (kg CO_2-eq)	**130**
Ozone Depletion Potential (kg CFC-11-eq)	**7.49E-6**
Acidification Potential (kg SO_2-eq)	**0.90**
Eutrophication Potential (kg N-eq)	**0.14**
Photochemical Ozone Creation Potential (kg O_3-eq)	**15.3**
Abiotic Depletion, non-fossil (kg Sb-eq)	**3.75E-6**
Abiotic Depletion, fossil (MJ)	**524**
Total Waste Disposed (kg)	**0.54**
Consumption of Freshwater (m^3)	**3.68**

Product Components: crushed aggregate (ASTM C33), admixture (ASTM C494), natural aggregate (ASTM C33), slag cement (ASTM C989), batch water (ASTM C1602), portland limestone cement (ASTM 595)

Additional detail and impacts are reported on page three of this EPD

MASS TIMBER APPROACH



- Project set on rigid grid to minimize transfer slabs.
- Biogenic carbon accounting for bio-based building materials is evolving and counted separately.
- Both volume of material and embodied carbon intensity of material contribute to embodied carbon savings for mass timber.
- Fire approach must be considered.
- Long lead times for Mass Timber.

KALESNIKOFF

Table 3: Results Summary for 1 m^3 CLT Cradle-to-Gate Scope

Core Mandatory Impact Indicator	Unit	A1-A3	A1	A2	A3
Global warming potential – Total	kg CO2e	124.50	-953.23	0.33	1077.41
Global warming potential - Fossil	kg CO2e	124.50	92.40	0.33	31.78
Global warming potential - Biogenic	kg CO2e	0.00	-1045.63	0.00	1045.63

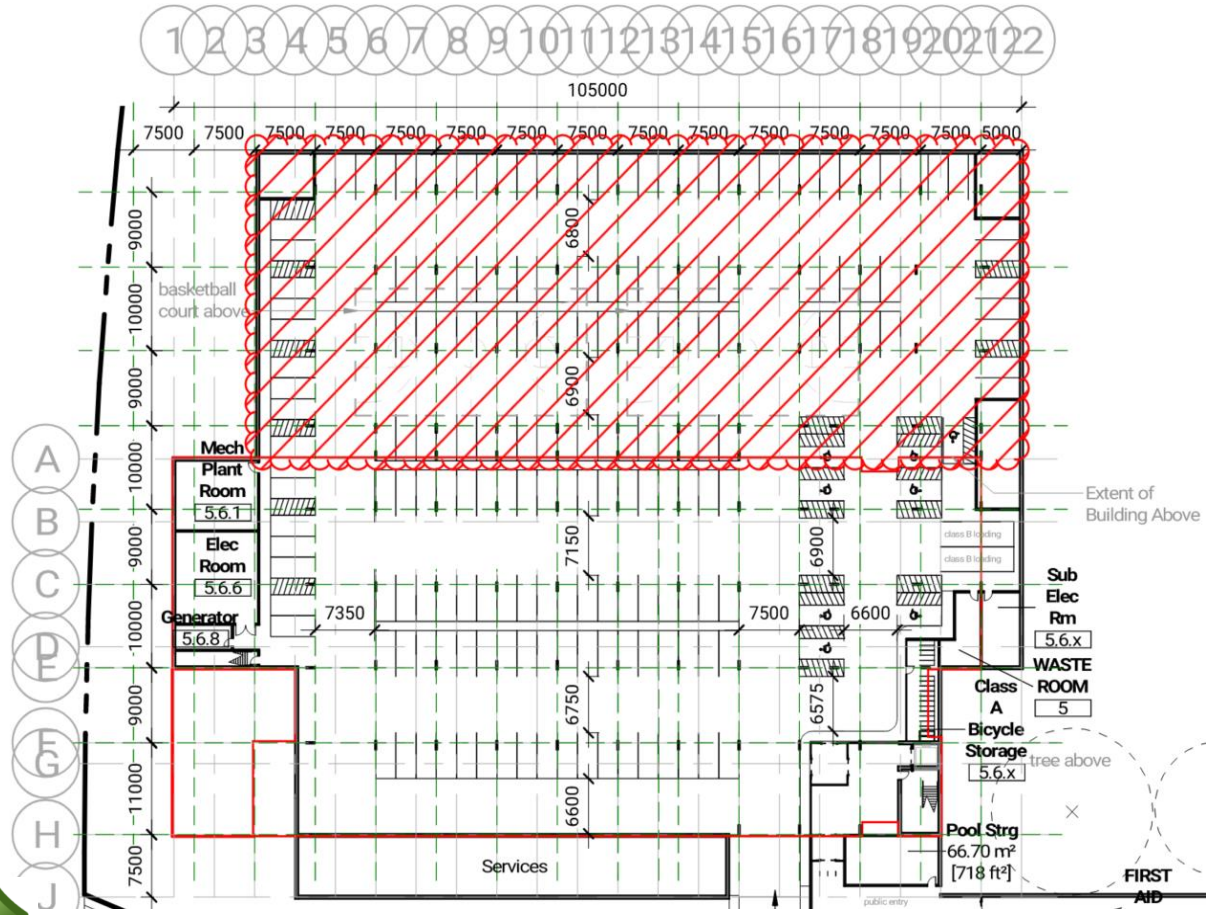
Cradle to Gate EPD for Cross Laminated Timber produced by Kalesnikoff in South Slocan, BC

PARKADE DELETE

Parking reduced by over 40% by enhancing provisions for active, public, and alternate forms of transport.

Saved ~**$3.5M** in construction costs.

Decreased embodied carbon of project by **702 tCO_2e** – 19% compared to baseline.



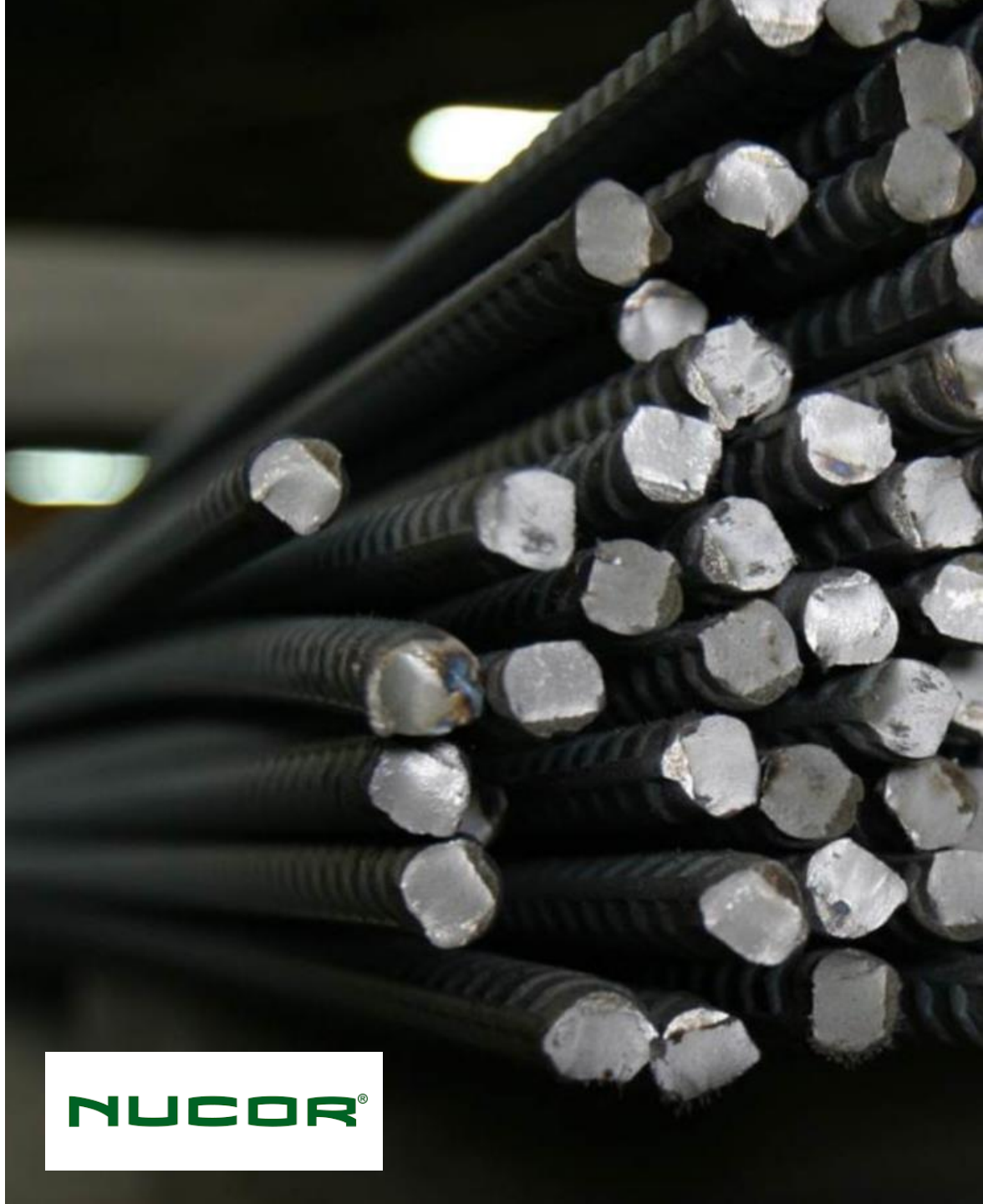
REBAR

Specifications called for Base Bid and Alternate Bid for lower-carbon rebar.

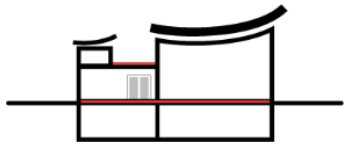
Declared **0 tCO_2e** reduced at BP.

Alternate bid for lower GWP rebar from Nucor came in at 15% cost increase ($155k) for **113 tCO_2e** reduction. ~$1,300/$tCO_2e$.

Project assumed North America industry average rebar EPD (CRSI 2022) but is sourcing internationally.



INSULATION



Roofs & floors: XPS insulation required due to high compressive strength and resiliency requirements.

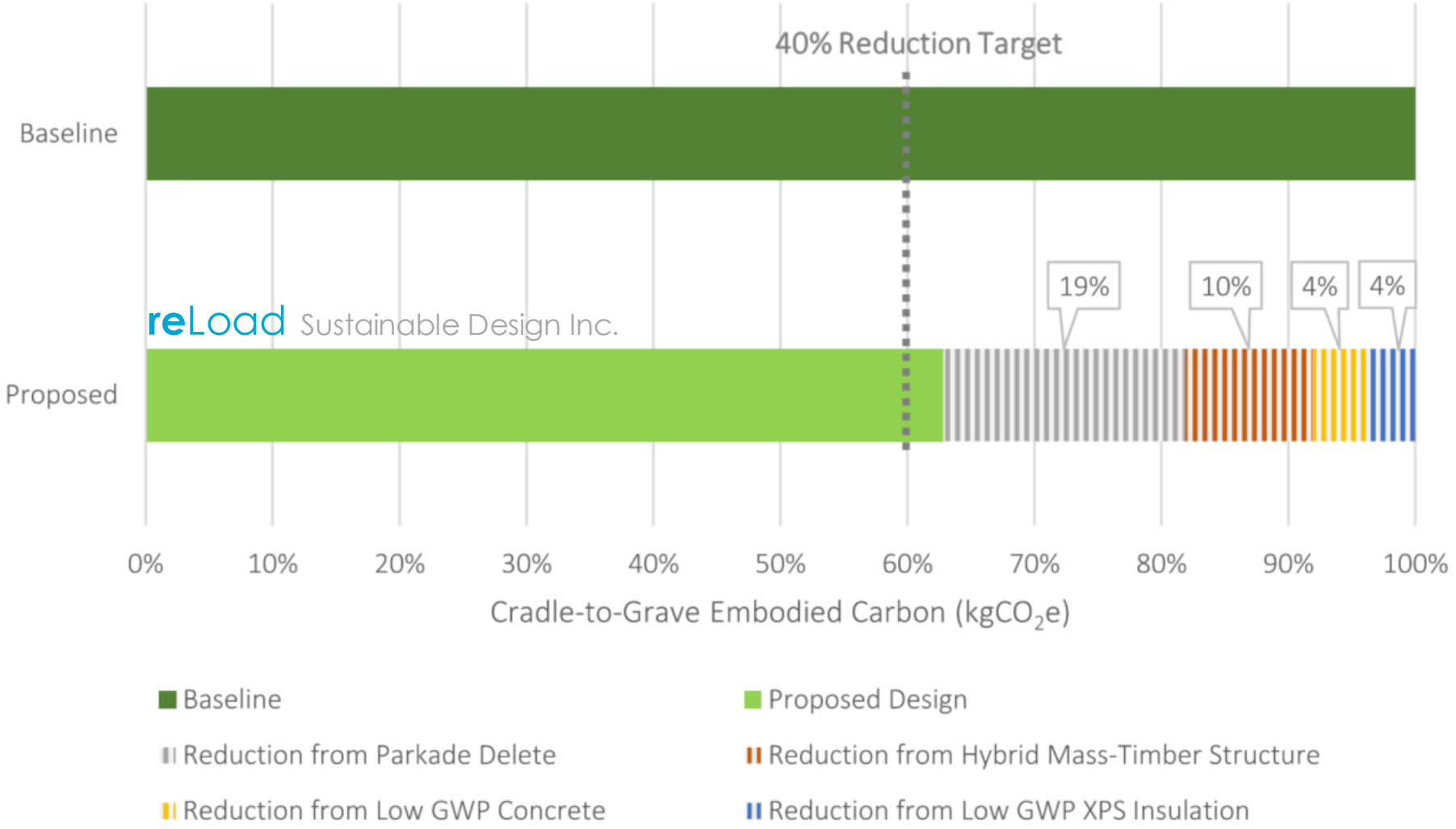
Walls: Few alternatives to mineral wool due to resiliency requirements.

Sopra Suprema XPS sole-sourced due to significantly lower GWP.

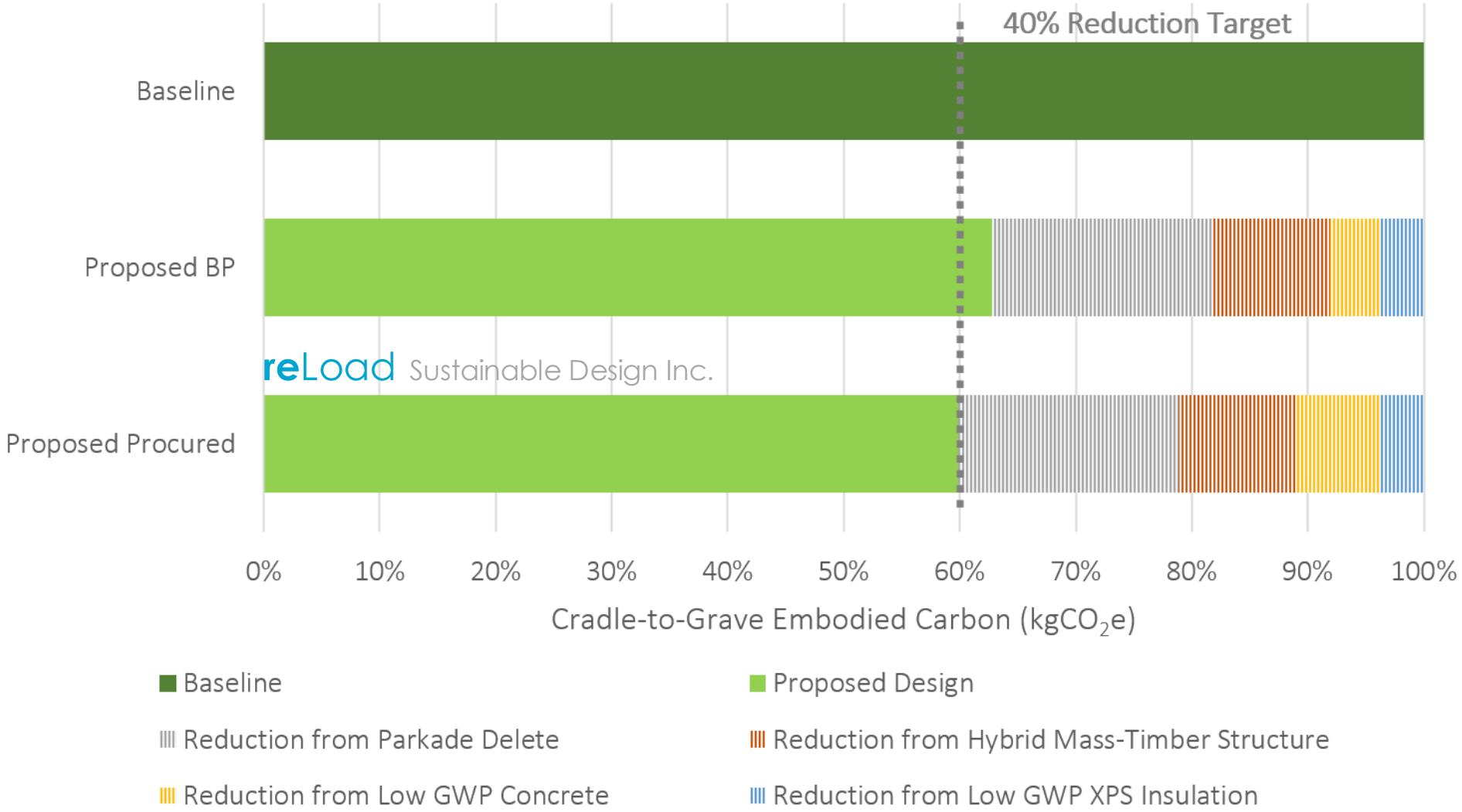
Reduced project emissions by **143 tCO_2e**.

No cost premium identified.

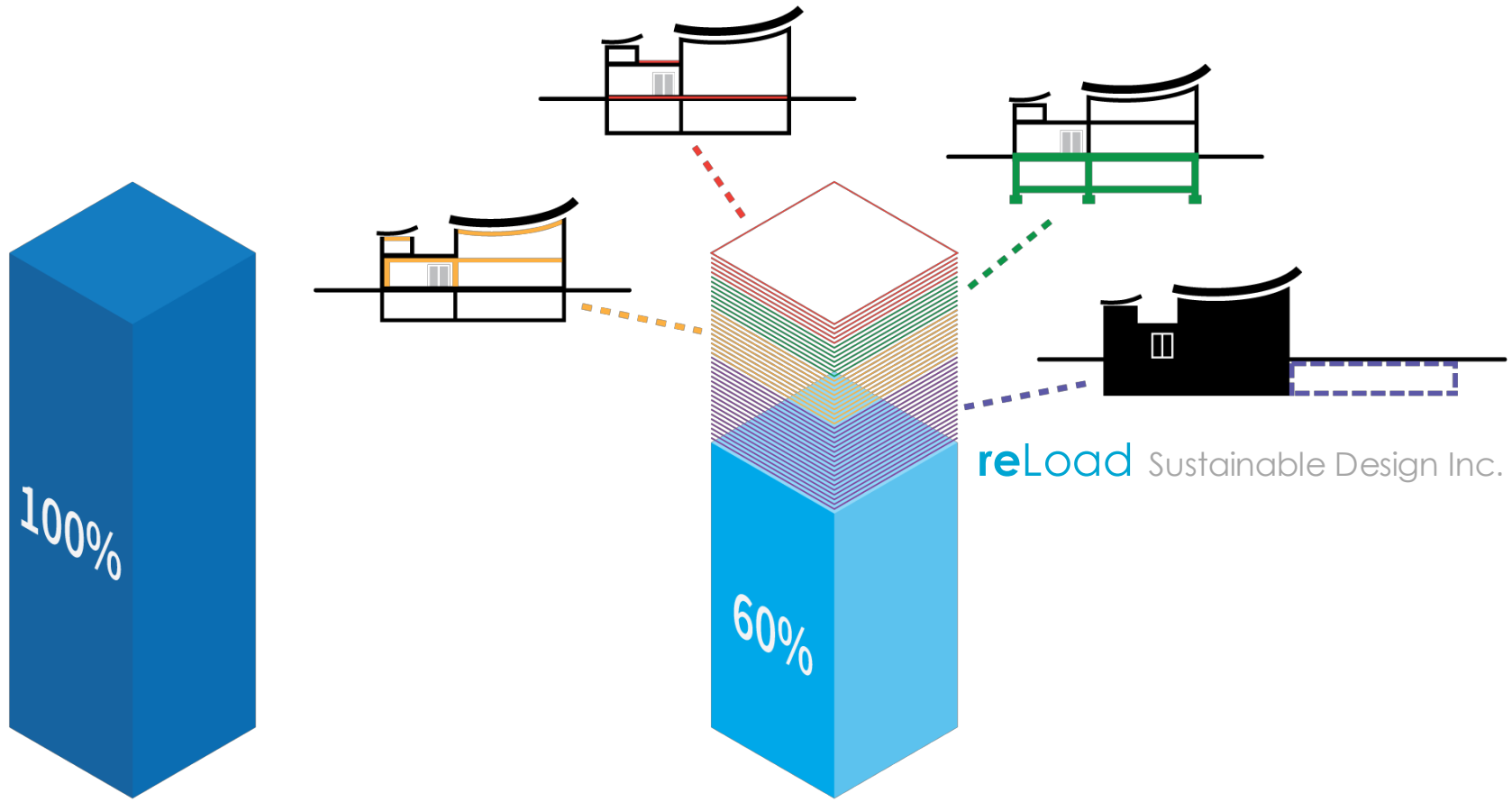
EMBODIED CARBON SAVINGS AT BP



MARPOLE: CURRENT STATUS



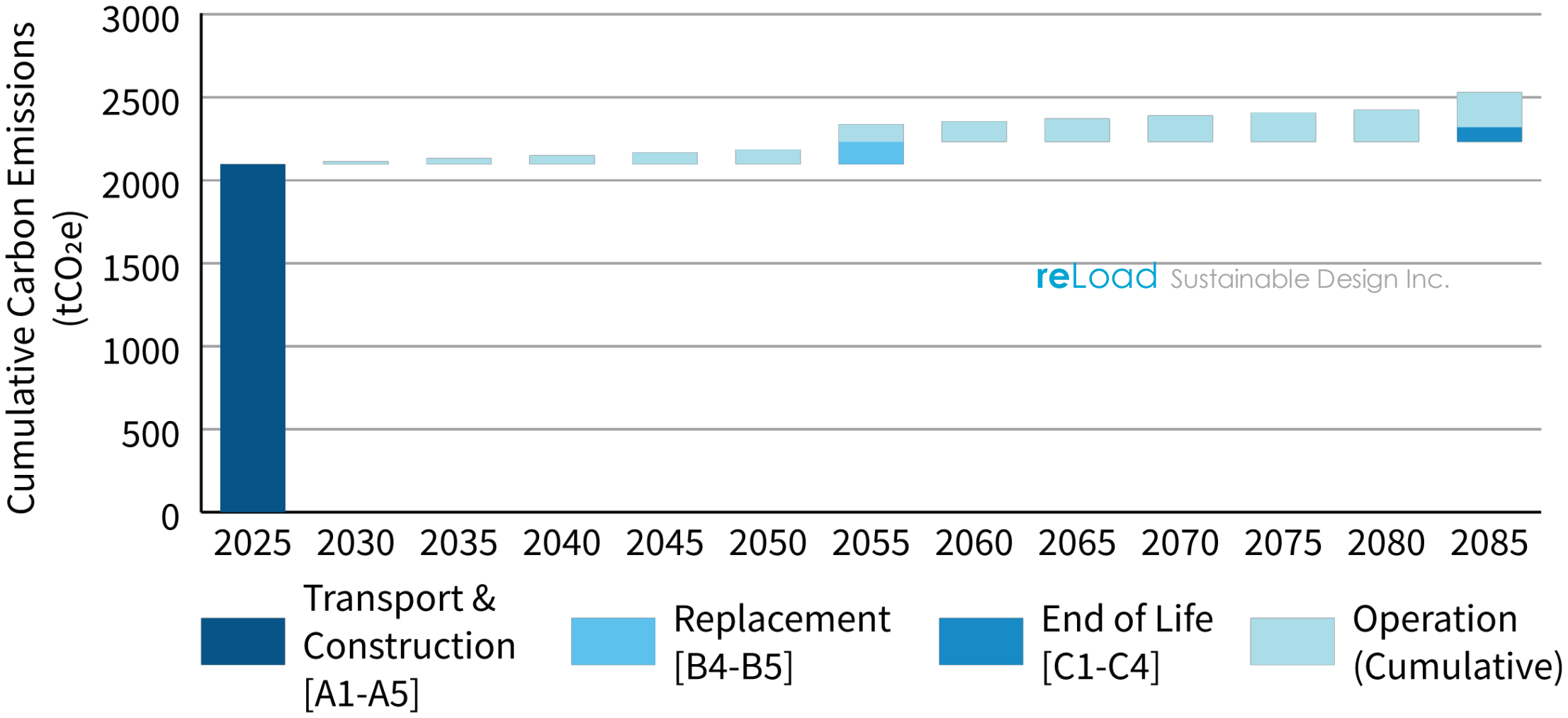
MARPOLE: CURRENT STATUS



Baseline
605 kgCO₂e/m²

Proposed
362 kgCO₂e/m²

CUMULATIVE CARBON EMISSIONS



MARPOLE: SUMMARY

1. Ambitious client targets fuel innovation.
2. Mass timber structure not as low-carbon as perceived in pre-design.
3. Sufficiency is a climate change solution, and it costs less.
4. Procurement phase is essential to realize embodied carbon reductions.
5. Next steps:
   i. Continue to track EPDs and material quantities during construction.
   ii. Conduct final wbLCA at substantial completion.

Image Source: Kalesnikoff LinkedIn

View of East Entrance of the Proposed Marpole Community Centre

Image by Diamond Schmitt Architects and Vismo

Design Team

Structural: Fast + Epp

Mechanical: Introba

Fire Suppression: Introba

Electrical: Introba

Landscape: PFS Studio

Civil: Aplin Martin

Code: Jensen Hughes

Building Enclosure: RDH Building Science

Passive House: RDH Building Science

LEED: Introba

Embodied Carbon: reLoad

Coast Salish Design Consultant: Sky Spirit Studio

Acoustics: RWDI

Questions?

Caroline Inglis
cinglis@dsai.ca

Forest Borch
forest@reloadsustainable.com

NearZero

Powered by zeic

Embodied Emissions

Stream 2

An applied research project for low-rise homes that minimize embodied emissions.

Utility Data

Stream 4

A ZEBx utility data collection initiative to determine the real emissions and energy profiles of BC homes.

nearzero.ca

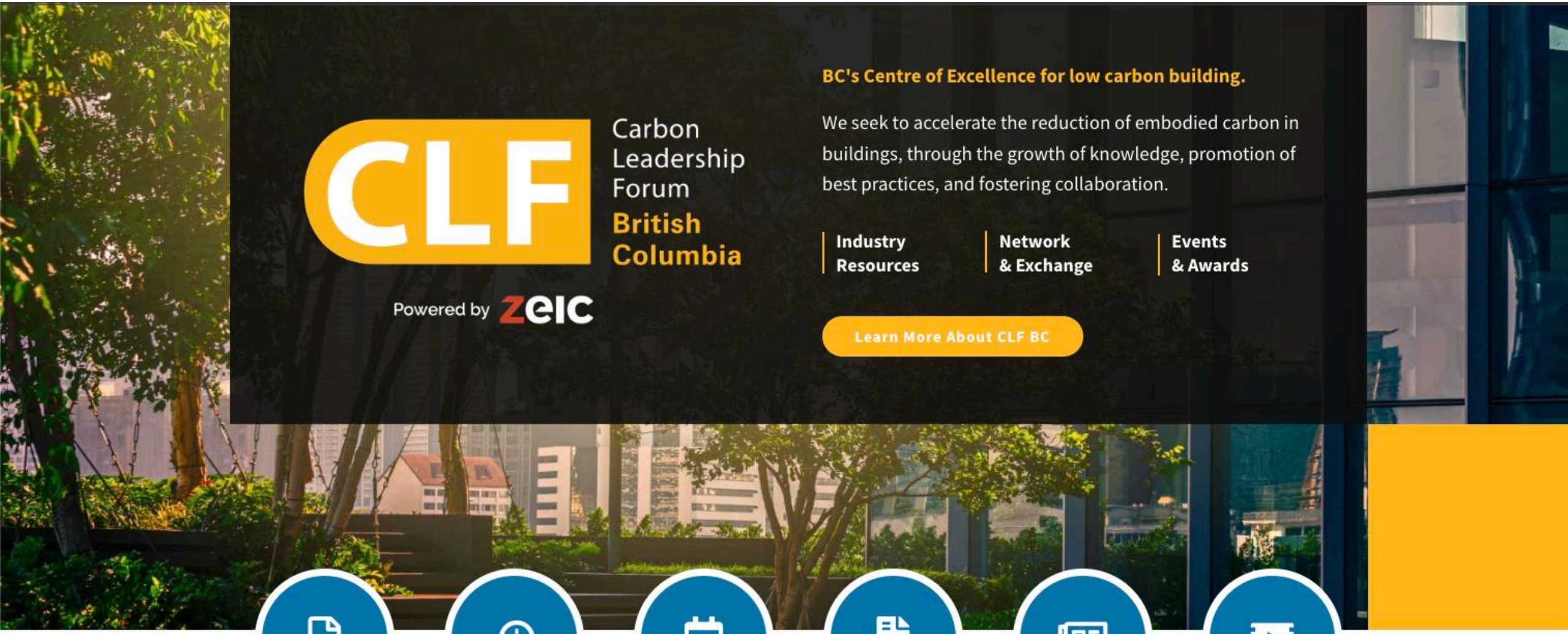
JOIN US AND CELEBRATE

FIVE YEARS

OF CLF BRITISH COLUMBIA

WED OCT 16, 2024
FROM 5PM

Ventura Room,
695 Cambie St, Vancouver
clfbritishcolumbia.com



Resources

Past Events

Embodied Carbon Exchange

Low-Carbon Material Sourcing Guide

Newsletters

Videos