Building the Future: Net Zero & Net Zero Ready

2016 PUBLIC SECTOR CLIMATE ACTION LEADERSHIP SYMPOSIUM

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BRITTANY COUGHLIN | P.ENG, BEMP, CPHC

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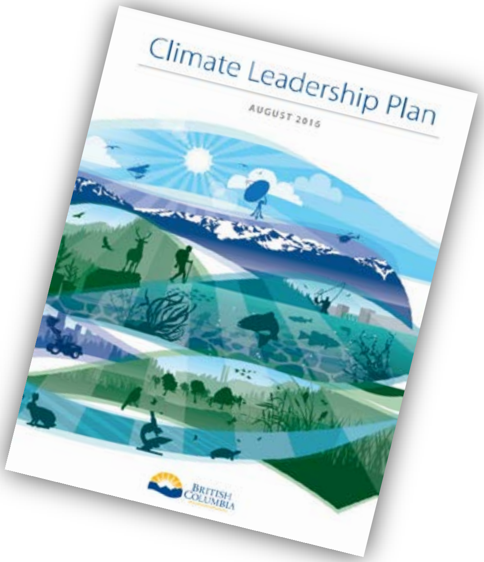
- → What is net zero and net zero ready?
- → Case study: Net Zero
- → Case study: Passive House
- → Case study: Net Zero Ready Strategy Development

Net Zero and the Climate Leadership Plan

→ “Promote more energy efficient buildings”, “developing requirements to encourage **net zero ready buildings**”

→ Accelerating increased energy requirements in the BC Building Code by taking incremental steps to make buildings **ready to be net zero by 2032**;

→ Developing energy efficiency requirements for new buildings that go beyond those in the BC Building Code, called **Stretch Codes**, that interested local governments could implement in their communities



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What is Net Zero? Net Zero Ready?

→ Net Zero: Facility generates *on-site* all the energy required to power its functioning through the course of the year

→ Any project can be Net Zero

  → Provided you have enough $$$

  → Or modest expectations for comfort, environmental quality, amenities, etc.

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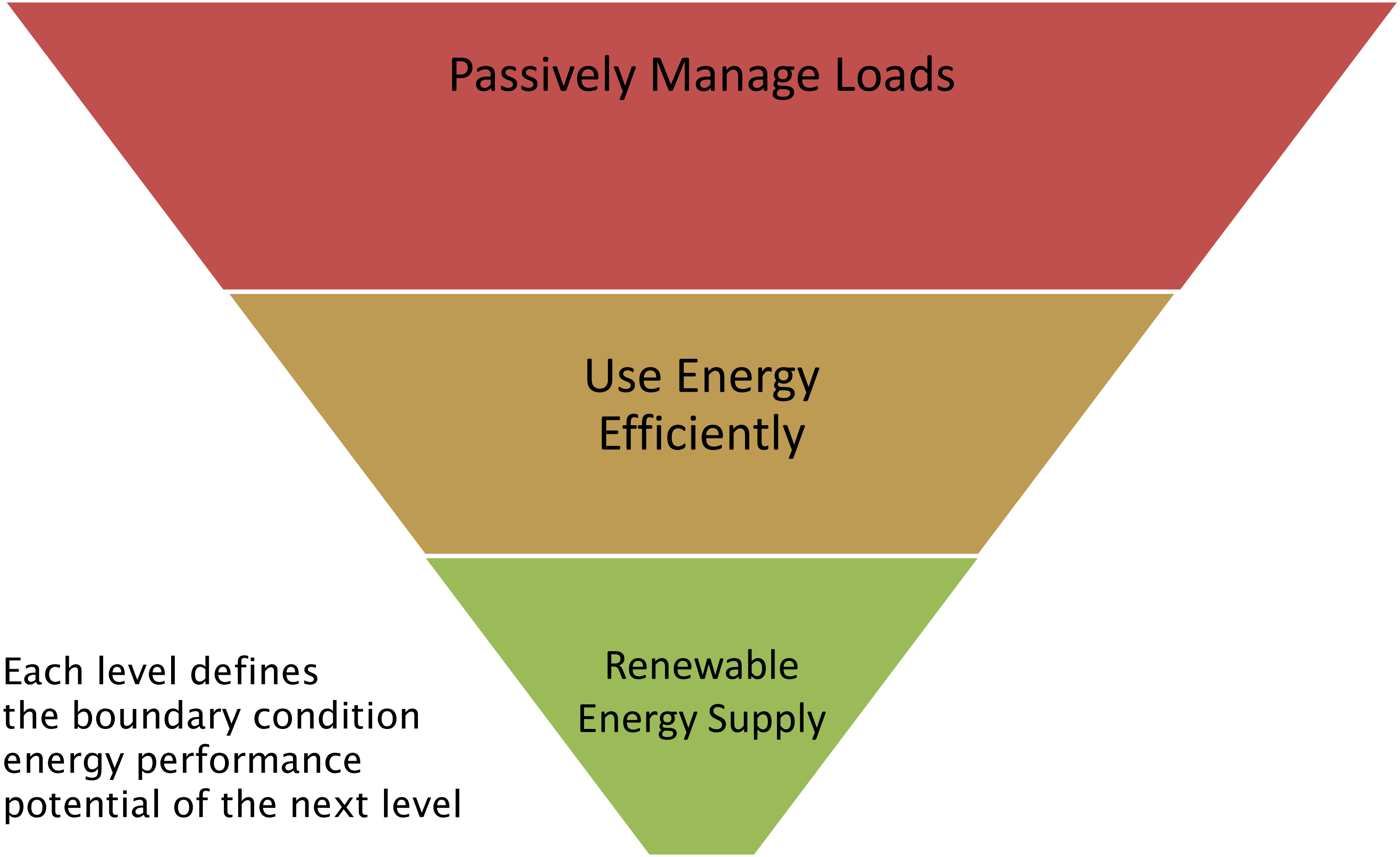
Toward Net Zero the "Right Way"



Each level defines the boundary condition energy performance potential of the next level

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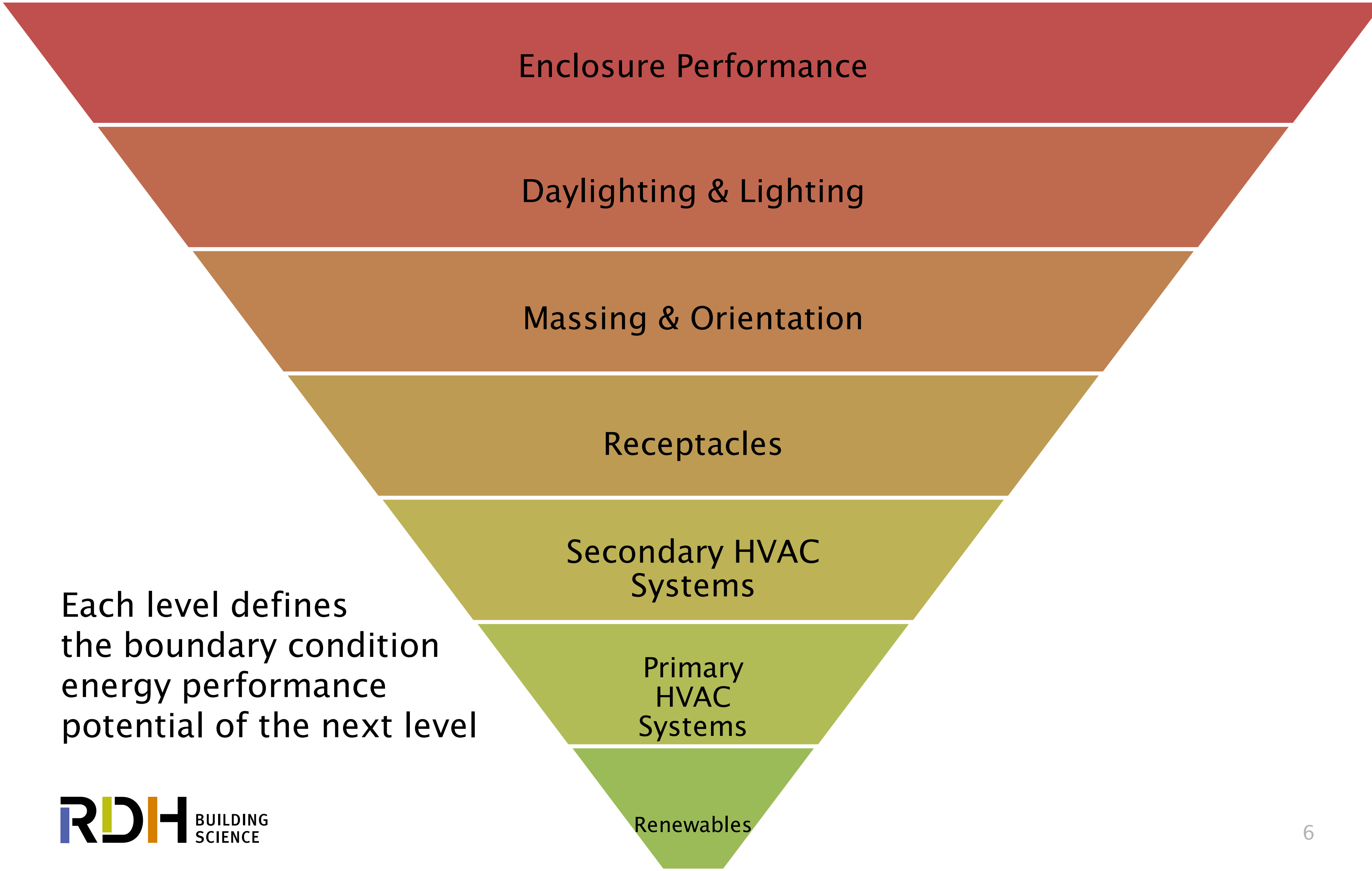
Toward Net Zero the "Right Way"



Each level defines the boundary condition energy performance potential of the next level

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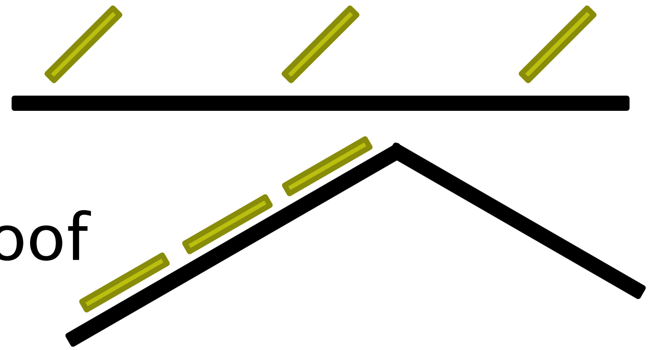
Net Zero Rules of Thumb

→Achieve Base building less than 100 ekWh/m²-year

Flat Roof

Sloped Roof



<u>Typical PV output</u>

72 kWh/year for every square meter roof area

	Single Floor	2 Floors	4 Floors
	Number of Flat or Sloped Roofs Required for PV		
100 ekWh/m²	1.4 flat / 1.2 shed	2.8 / 2.4	5.6 / 4.8
70 ekWh/m²	1.0 / 0.8	1.9 / 1.7	3.9 / 3.4
50 ekWh/m²	0.7 / 0.6	1.4 / 1.2	2.8 / 2.4

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Net Zero Rules of Thumb

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Mohawk College Net Zero:
Joyce Centre for Partnership and Innovation

→ Client: Mohawk College

→ Architects: B+H Architects, McCallum Sather (joint venture)

→ Energy and Enclosure Consultant: RDH

→ Mechanical: The Mitchell Partnership

→ Electrical: Mulvey and Banani International Inc.

→ CaGBC Pilot Project for “Zero Carbon Buildings Initiative”

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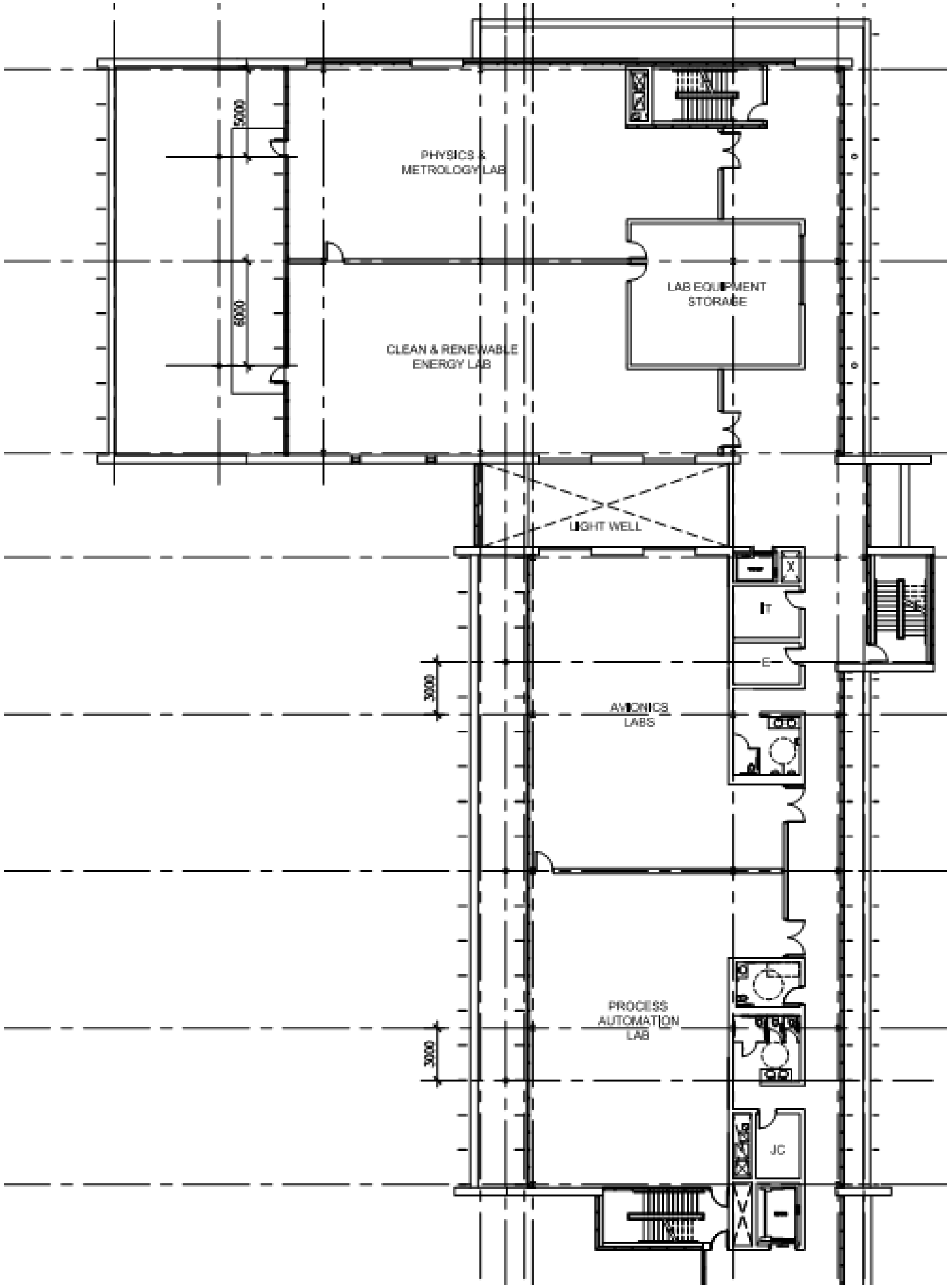
The Building

- → 90,000 sqft
- → 4 storeys
- → 2 large lecture theatres
- → 8 electronics labs
- → Commons/ collaboration space
- → Café space



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Mission: Net Zero

- → Definition: Net zero energy on annual basis
  - → Roof top generation will equal consumption
    - › Solar PV (~550 kW)
    - › Solar thermal for domestic hot water
  - → (No Renewable Energy Credits or offsets purchased)

The Process

- → Preliminary exercise to define an "Energy Budget" (75 kWh/m^2)
- → Preliminary energy models, conceptual design
- → Pushed the envelope
- → Energy efficient HVAC

	Preliminary Energy Budget Estimates			Current Modelled Performance
End Use	3 Water Source VRF + GHSP	4 Water Source VRF + GHSP + Solar Thermal	7 Air Source VRF Heating / Cooling	4 Water Source VRF + GHSP + Solar Thermal
Interior Lighting	10.7	10.7	10.7	12.4
Receptacle and Process	19.3	19.3	19.3	18.9
Space Heating - Heat pumps	13.7	9.6	21.4	13.0
Space Cooling - Heat pumps	6.4	6.4	8.7	1.5
Pumps and Aux	6.7	8.2	**0.0**	8.8
Fans	11.3	11.3	11.3	12.5
DHW	4.5	2.3	4.5	1.2
Boiler	0.0	0.0	0.0	0.0
Elevator Estimate				0.8
Microgrid Losses				0.3
Exterior Lighting				1.0
Total (ekWh/m²)	**72.5**	**67.6**	**75.9**	**70.5**
Rank (lowest to highest)	3	2	4	
Net Solar Thermal Effect (ekWh/m²)		-4.9		-0.9
Total ekWh	624,000	582,000	653,000	607,000
Annual Energy Cost	**$ 74,880**	**$ 69,840**	**$ 78,360**	**$ 72,840**
Size of PV Array (kWp)	567	529.09	594	545
Size of PV Array (m²)	4,727	4,409	4,947	4,542
Flat Roof Area (m²)	9,455	8,818	9,894	9,084
Cost of PV	**$ 1,420,000**	**$ 1,330,000**	**$ 1,490,000**	**$ 1,370,000**
NREL Recommended O&M / year	**$ 10,650**	**$ 9,975**	**$ 11,175**	**$ 10,275**
Linear m of Borehole	5,000	5,000		5,000
# of 600' boreholes	27	27		27
m² Area of Field using 6 m spacing	984	984		984
Weeks to install	2.3	2.3		2.3
Cost of Borehole	**$ 250,000**	**$ 250,000**		**$ 250,000**

EUI Estimates

PV Costs

Other Major System Costs

The Design

Enclosure:

→ R-40 roof: 2-ply modbit, polyiso

→ R-10 overall for window + wall

- → R-30 target for opaque wall elements
  - › Spandrel glass system with thermal clips, roxul, interior sprayfoam
  - › Precast sandwich panel with XPS; sprayfoam inboard
- → Triple glazed windows with 3 low-e coatings
- → ~40% window-wall ratio

→ Sensitivity analysis on nearly all aspects

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The Design

Mechanical:

→ Separate ventilation (DOAS) with ERV

→ Distributed heating/cooling VRF, zone-to-zone heat recovery

  → Connected to geoexchange field

→ Demand controlled systems (ventilation, heating/cooling) to handle variable occupancy

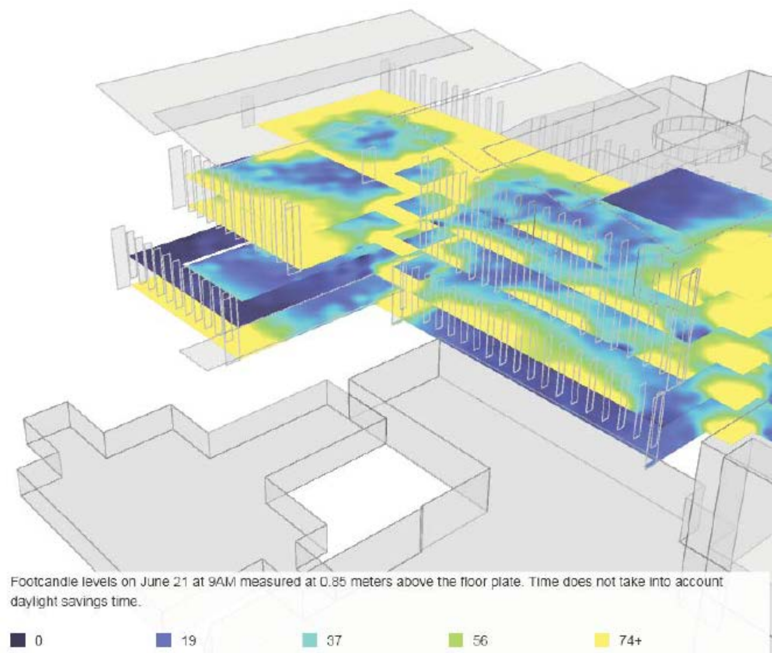
Electrical

→ LED lighting

→ Occupancy and daylight sensors

  → Daylight glazing panels

→ Process loads?



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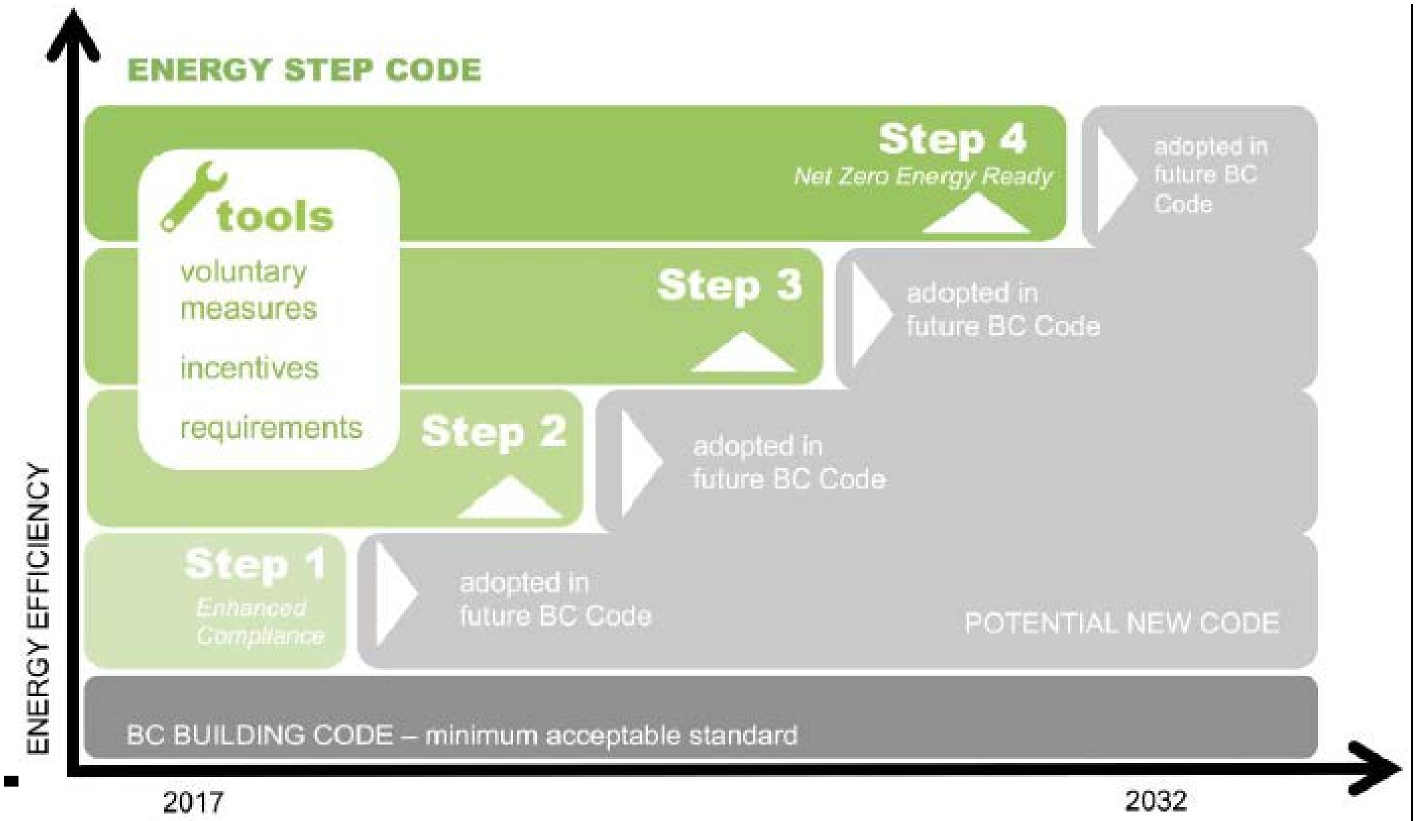
THE JOYCE CENTRE

The Energy Step Code and Net Zero Ready

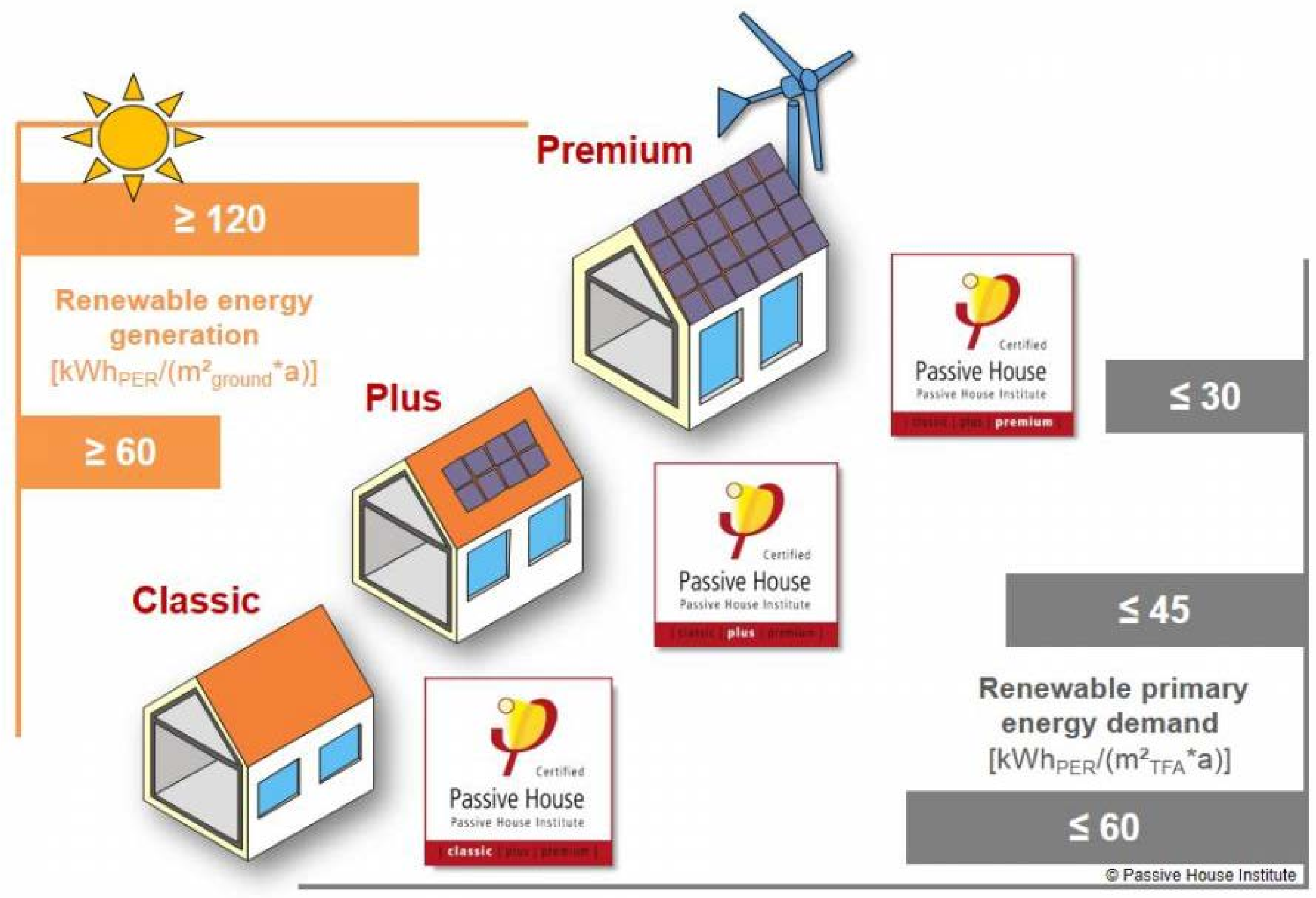
- → Proposed step code introduces targets for
  - → Thermal Energy Demand Intensity (TEDI)
  - → Total Energy Use Intensity (EUI)
  - → Airtightness



Source: SCIWG Final Report

Passive House: Net Zero Ready?

→ Step code's TEDI, EUI, airtightness requirements follow Passive House principles



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Passive House: Net Zero Ready?

→ Passive House as a path to Net Zero

→ ~90% reduction in heating energy compared to typical building, low annual energy consumption

→ Higher levels of certification include renewables

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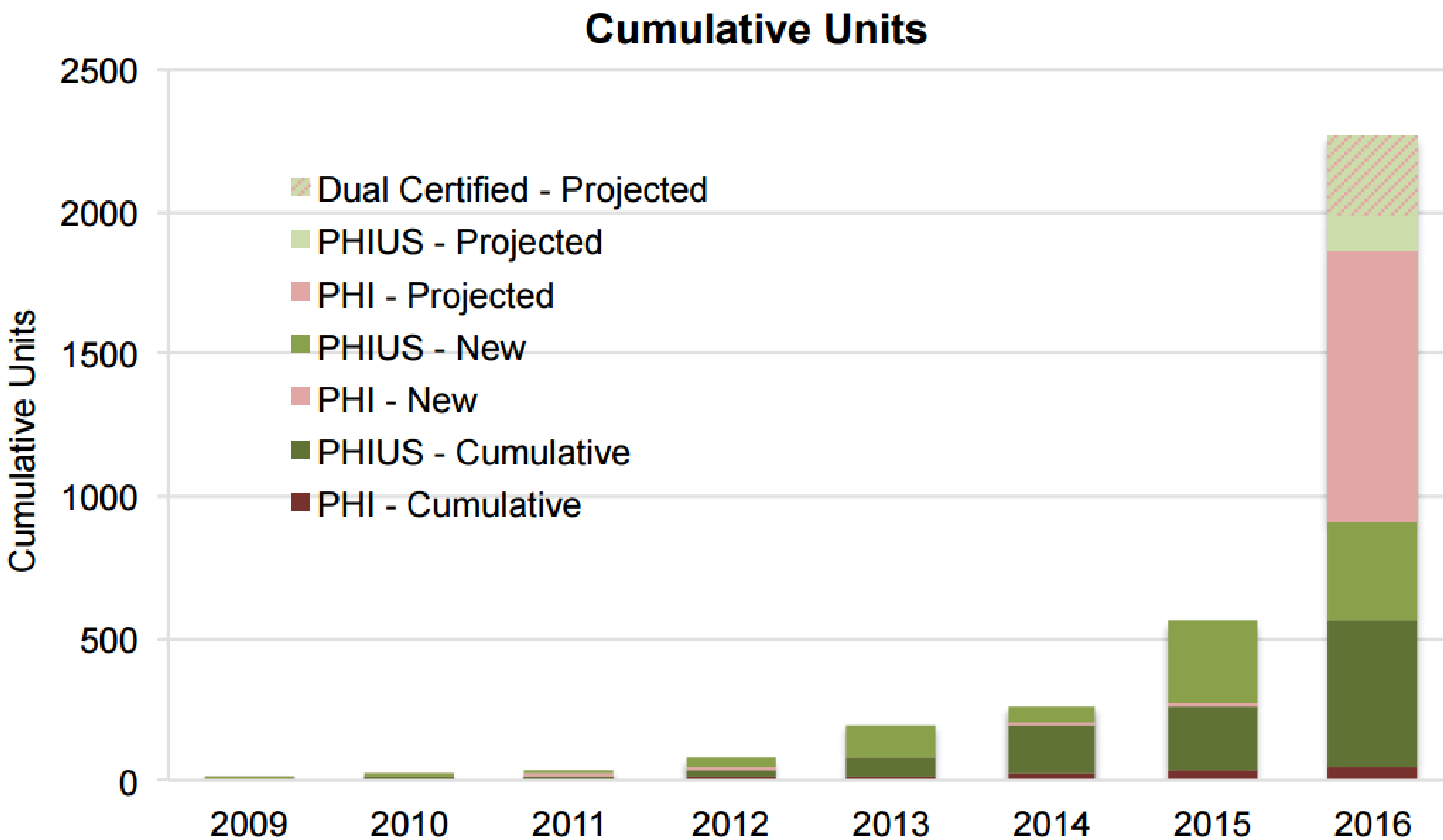
Passive House in North America



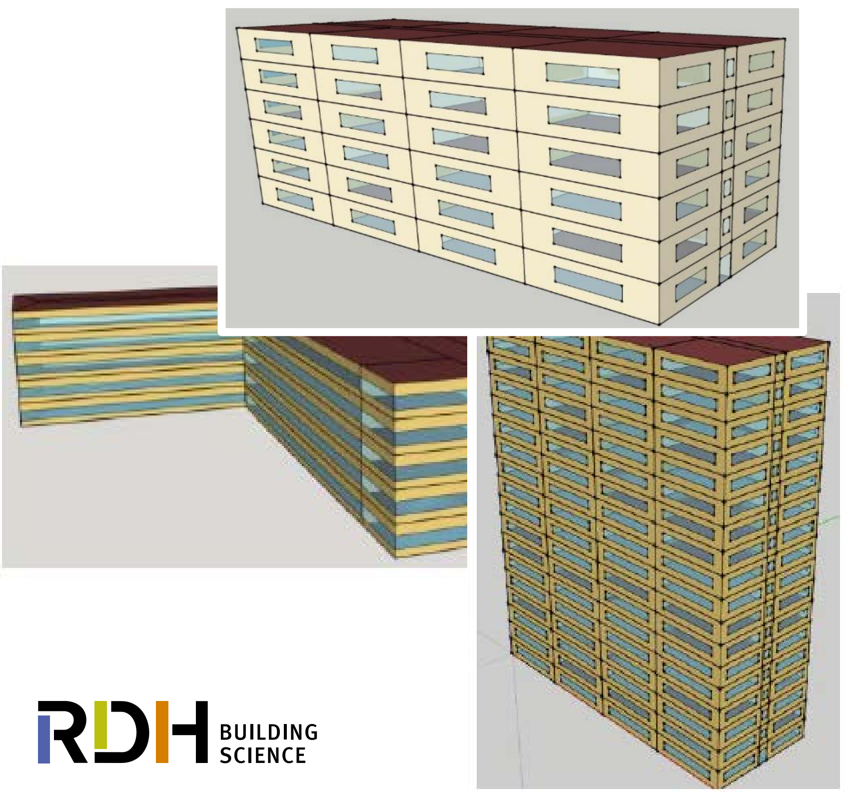
Source: Pembina Institute

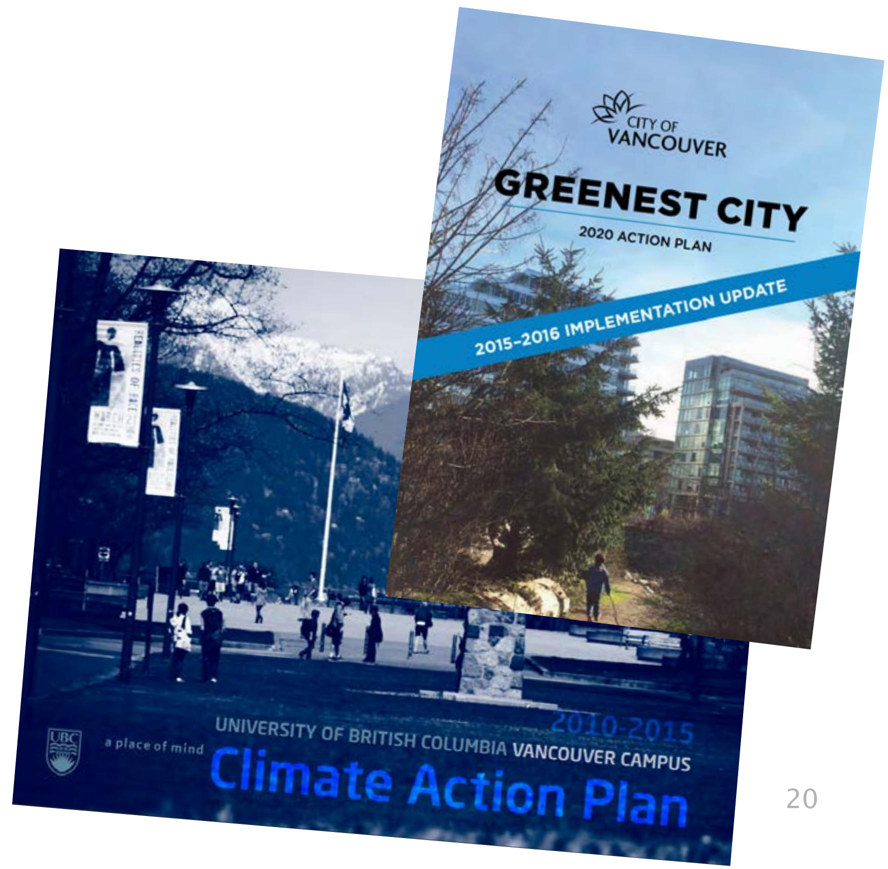
Developing a Path to Net Zero

→ Archetype energy modelling studies

→ Organizations setting strategic goals to achieve net zero energy & carbon in the next 5 to 15 years

→ Important to develop a road map to get there





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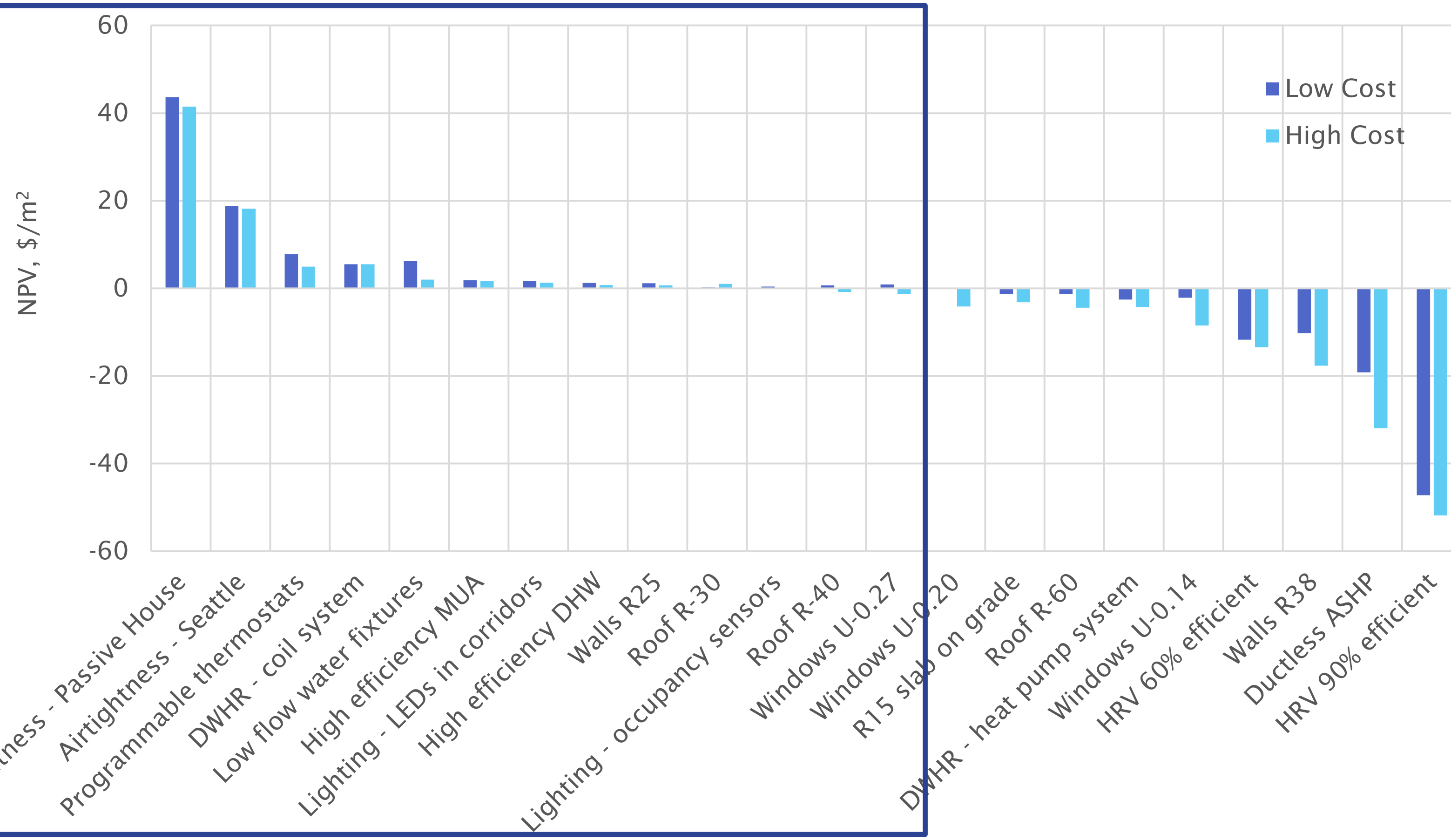
ECMs Using Readily Available Technology

→ Net Present Value (NPV) ranked from highest to lowest using **utility** energy prices



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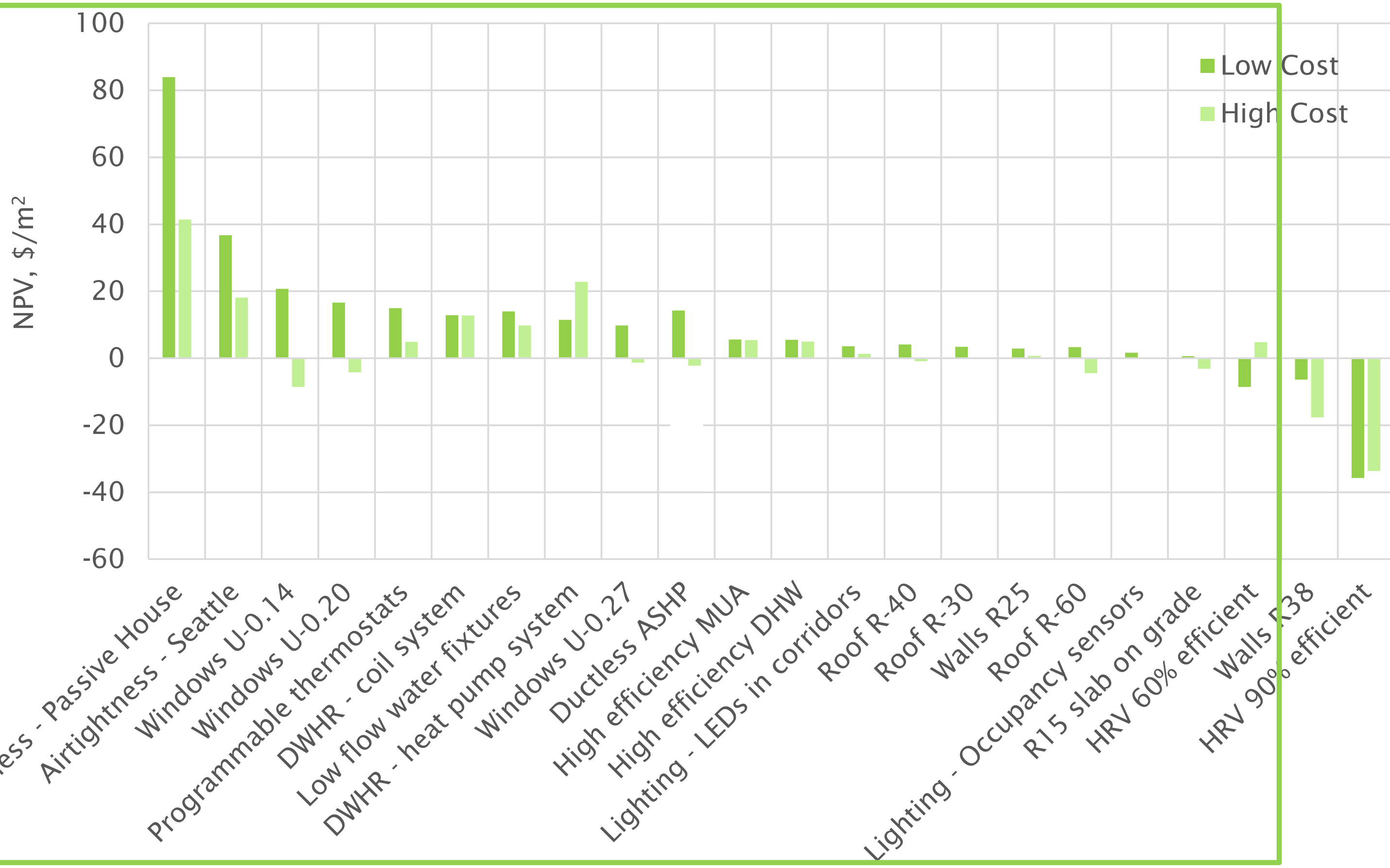
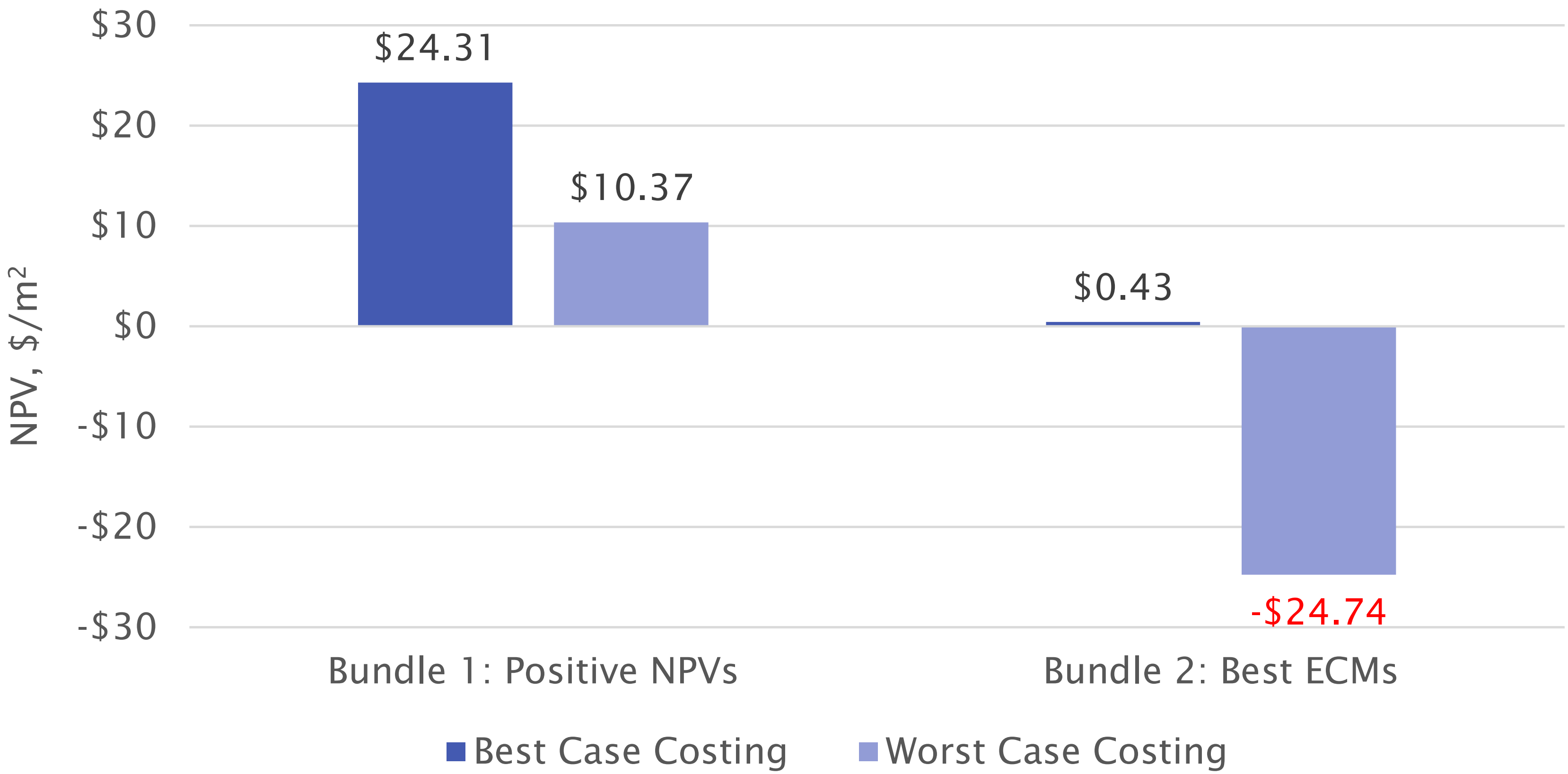


Combining Measures into Bundles

→ NPV using **utility** energy prices



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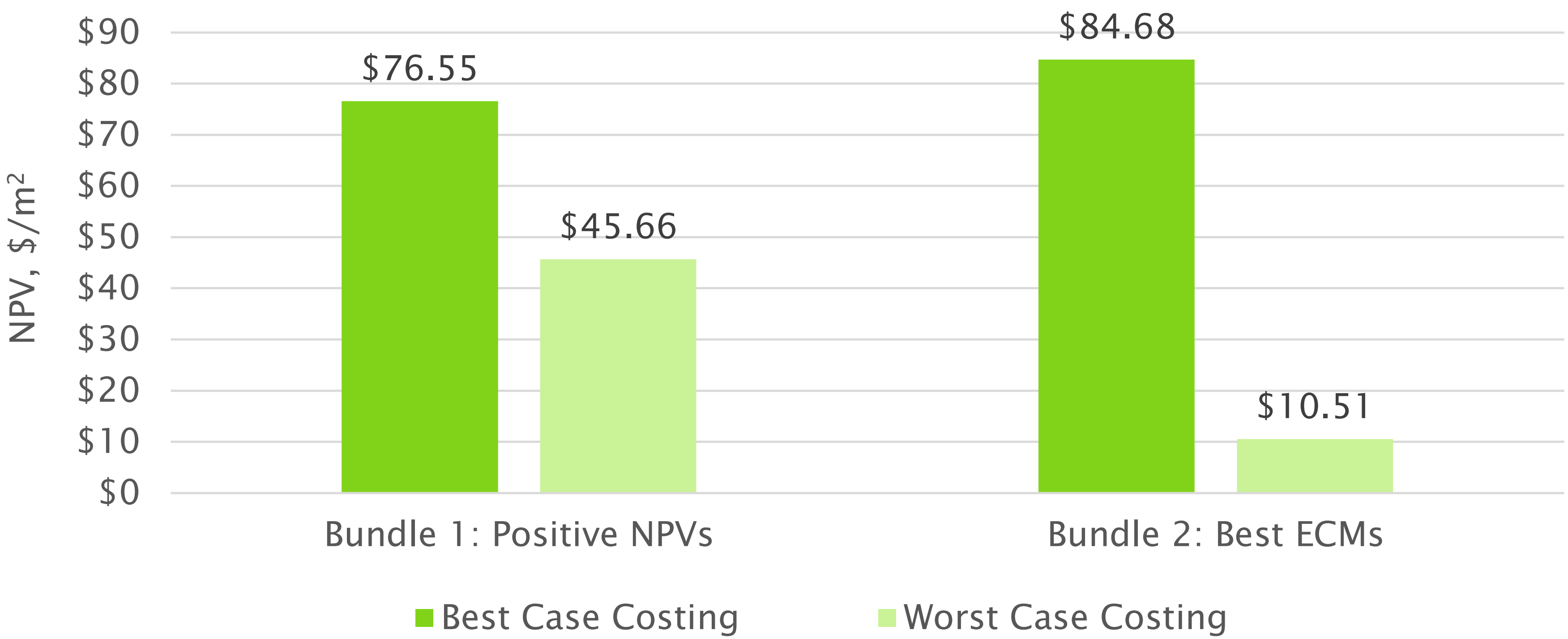

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Developing a Path to Net Zero

- → Energy **conservation** is typically more cost effective than renewable **supply**
- → Economics are good for long term building owners/operators
- → Road map to zero energy & carbon new buildings
  - → Establish goals for 2020, 2025, 2030 and beyond
  - → Identify capacity building and market transformation needs

Discussion + Questions

BCOUGHLIN@RDH.COM

WWW.RDH.COM

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