BUILDING SCIENCE LIVE

APRIL 13, 2022

Historic Westinghouse HQ: The Path to Net-Zero Carbon

Kristen Yee Loong, B.A.Sc, P.Eng., LEED® AP BD+C
David Riley, P.Eng., PMP, LEED® AP BD+C
Drew Hauser, HONS. VIS. ARTS, B.Arch., OAA, FRAIC, AIA, CAHP

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Welcome!

- We are recording.
- Some FAQs:
  - You will get a follow-up email regarding how to access the recording and a pdf of slides.
  - **If you need a completion certificate for self-reporting or EPP and/or AIA or AIBC credits**, please follow the link in the chat box to let us know.
- Please use chat for housekeeping questions.
- Please use Q&A box for questions for the speaker.
  - We will break at the end for questions.
  - Use upvote feature to let us know what you're most curious about!

More questions? Please contact us at events@learnbuildingscience.com.

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TWENTY-FIVE YEARS | ESTABLISHED 1996

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David Riley

ASSOCIATE

David excels on projects that present a unique challenge, and where data can be employed to shape meaningful design solutions. It comes from his commitment to being a team player, both as a part of and leading teams through the complexities of the design process. His ability deliver thoughtful solutions is bolstered by his project management training and background. David is currently involved in the engineering and design of major mechanical building systems which include HVAC, plumbing and fire protection systems. Whether post secondary, corporate or residential work, all of David's projects reflect the priority he places on integrated solutions.

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Drew Hauser

DIRECTOR OF DESIGN & BUSINESS DEVELOPMENT

Drew is passionate about shaping environments that put clients' objectives at the forefront. He has been instrumental in creating one-of-a-kind designs, with a specific focus on integrating design concepts within the context of historically sensitive facilities. With more than 20 years of experience, and a Canadian Association of Heritage Professional Designation, he consistently demonstrates his ability to develop complex programmes. He has a thorough understanding of both modern and historic techniques and his clients trust his ability to present thoughtful solutions, which will help maintain assets for many years to come.

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Kristen Yee Loong

ASSOCIATE, ENERGY AND SUSTAINABILITY SPECIALIST

Kristen brings an invaluable depth of knowledge to the team with her experience on large multi-disciplinary projects. Her expertise includes consulting on energy-efficient system design strategies for net zero energy, net zero carbon, and other high-performance buildings. She supports the development of sustainability goals, simulating the whole-building energy use throughout the design process as well as developing building monitoring strategies to support post-construction performance verification. Her work with whole-building energy analysis includes assessments of existing buildings to identify areas where energy consumption and carbon emissions can be reduced to achieve deep energy retrofits, which includes capital and life cycle cost analyses to develop zero over time solutions.

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Partnered Projects

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We make buildings better through the integration of science, design and construction expertise.

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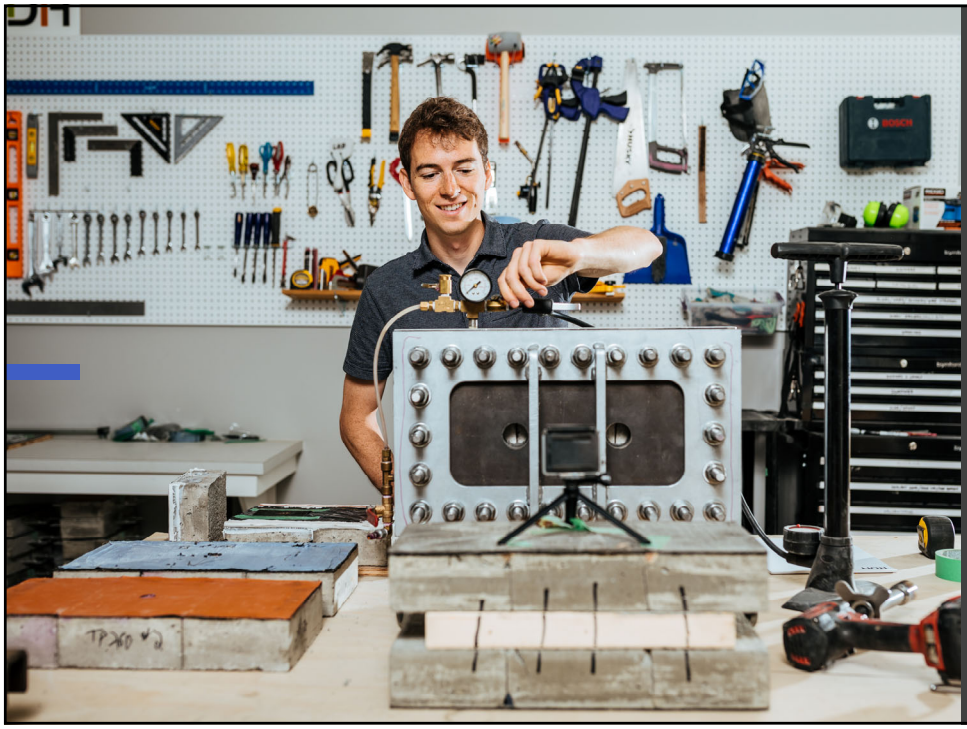

240+ staff

9 offices

Projects across North America

Focus on building science & building enclosures

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Education for Professionals

Disclaimer

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Applicable and current laws, codes, regulations, standards and policies, as well as project and site-specific conditions, procedures and circumstances when applying the information, details, techniques, practices and procedures described in this material.

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Agenda

- History and Architecture
- Mechanical Design Journey
- Energy and Financial Modelling
- Designing for Future Zero Carbon
- Sustainability Is The Smart Financial Choice

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Poll Question: Where do you primarily practice or operate?

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ALBERTA
Canada
MANITOBA
SASKATCHEWAN
Ontario
ONTARIO
QUEBEC
MONTANA
NORTH DAKOTA
MINNESOTA
WYOMING
SOUTH DAKOTA
WISCONSIN
Toronto
Hamilton
Buffalo
Westinghouse
NEW YORK
VERMONT
NEW HAMPSHIRE
MAINE
MASSACHUSETTS
CT
RI

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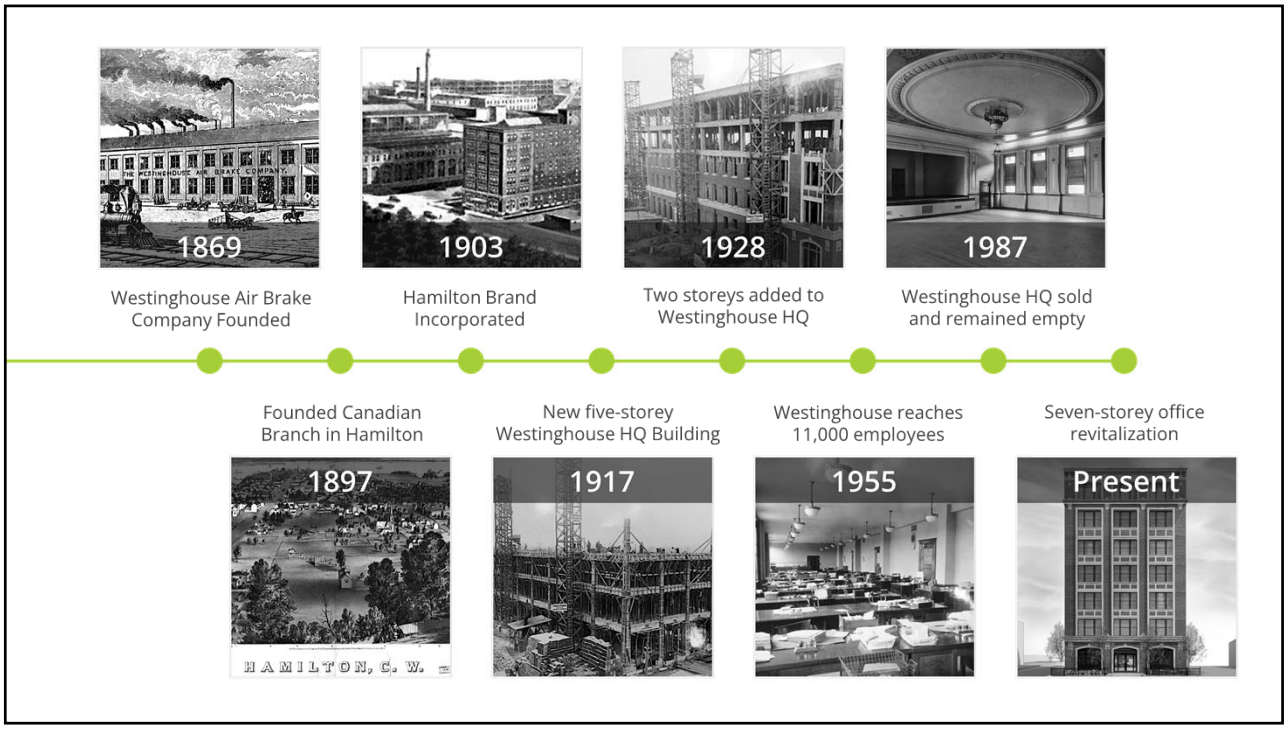
1869
Westinghouse Air Brake Company Founded
1903
Hamilton Brand Incorporated
1928
Two storeys added to Westinghouse HQ
1987
Westinghouse HQ sold and remained empty
Founded Canadian Branch in Hamilton
1897
HAMILTON, C. W.
New five-storey Westinghouse HQ Building
1917
Westinghouse reaches 11,000 employees
1955
Seven-storey office revitalization
Present

16


Ruljqdd#exlogqj#q#Dxjxvw#1<4:

17

Approach to Mechanical Concept Design

Surmfw#Renmfwlyhv

Exloglqj#Frqvwudlqw

V|vwhp v

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Process of Elimination

- Identify project constraints
- Understand the "End Goal" & Vision of the finished product
- Develop a list of options that possess qualitative attributes that "work" with the building

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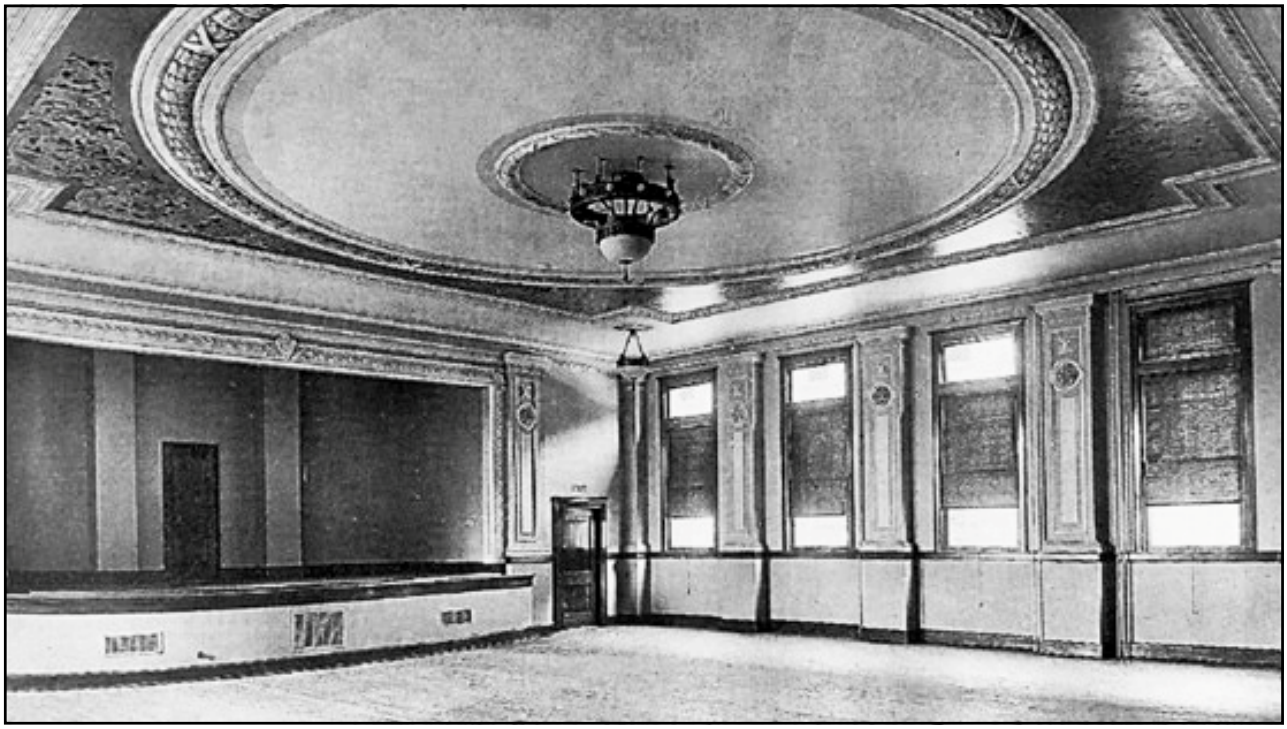

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Chat Question:
What size of pipe would you need to match the thermal energy provided by an 18"x18" air duct?

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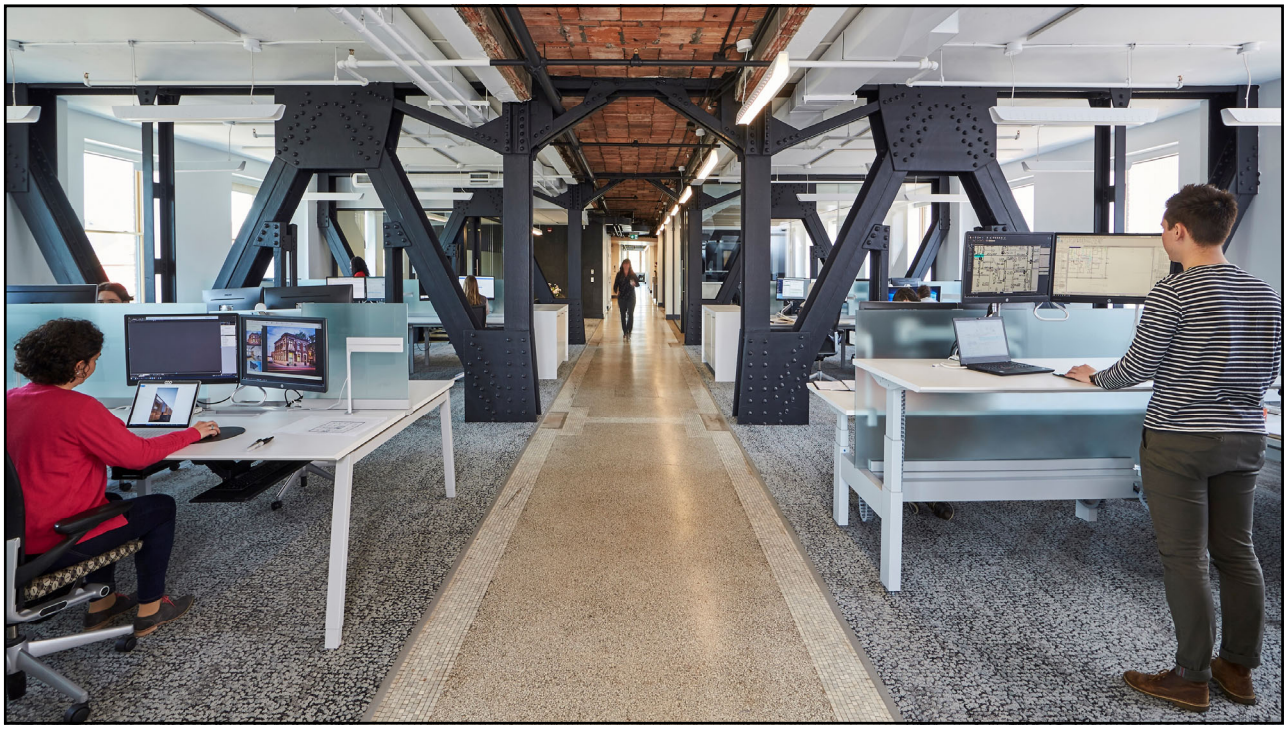

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Energy Consumption, Cost and GHG emissions

	Annual Energy Consumption				GHG Emissions*	Annual Energy Cost		
	Electricity (kWh)	Natural Gas (ekWh)	Total Energy (ekWh)	ekWh/m2	kg/m²	Total ($)	$/ft2	
SB-10 Baseline - Hydronic VAV	471,300	515,400	986,900	150	17.76	$91,600	$1.30	
Option 1 Distributed WLHP	419,200	257,200	676,400	103	10.27	$77,400	$1.09	Vhdhfwhg
Option 2 Distributed GSHP	491,400	-	491,400	75	3.74	$80,500	$1.14	Uhfrp p hqghg
Option 3 - Hybrid Water-Cooled VRF	458,400	-	458,400	70	3.49	$75,900	$1.07	
Option 4 Air source VRF	490,900	-	490,900	75	3.73	$83,300	$1.18	
Option 5 - Hybrid Distributed GSHP	491,000	-	491,000	75	3.73	$80,100	$1.13	

*Emissions (kg) have been calculated using the OBC SB-10 2017 published CO2 equivalent emission factors (SB-10 - 2017 Table 1.1 2.2)

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Capital Cost Estimates

	Capital Cost			
	Capital Cost	$/ft2	delta-Cost	
SB-10 Baseline VAV	$1,781,000	$25		
Option 1 - Distributed WLHP	$1,254,000	$18	-$527,000	Vhdhfwhg
Option 2 - Distributed GSHP	$1,242,000	$18	-$540,000	Uhfrp p hqghg
Option 3 - Hybrid Water-Cooled VRF	$1,737,000	$25	-$44,000	
Option 4 - VRF ASHP	$1,200,000	$17	-$581,000	
Option 5 - Hybrid Distributed GSHP	$1,371,000	$19	-$410,000	

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Chat Question:
Tell us about a zero-carbon building you have worked on.

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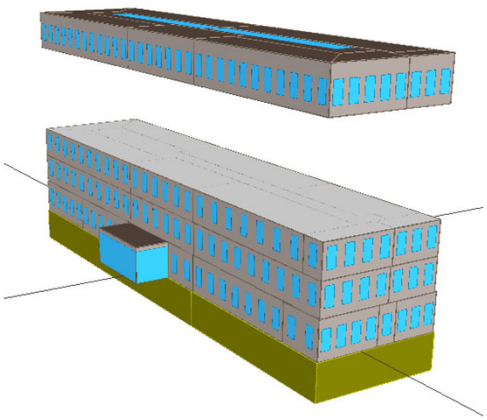
Energy and Financial Analysis



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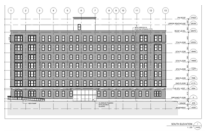
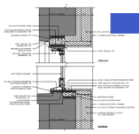
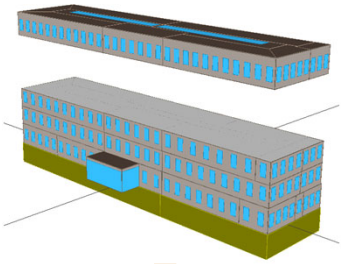
Energy Analysis – Hourly Modelling Primer

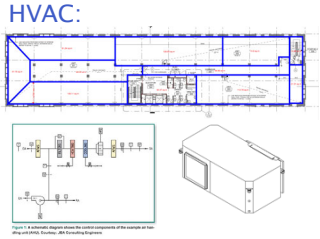
Architecture:



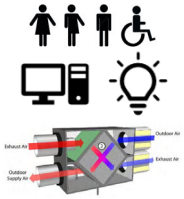




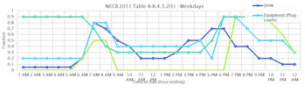
HVAC:



Loads:



Schedules:



Calculation/Output:
- 8760 hours
- Load on each zone
- Energy end use breakdown
- Energy cost

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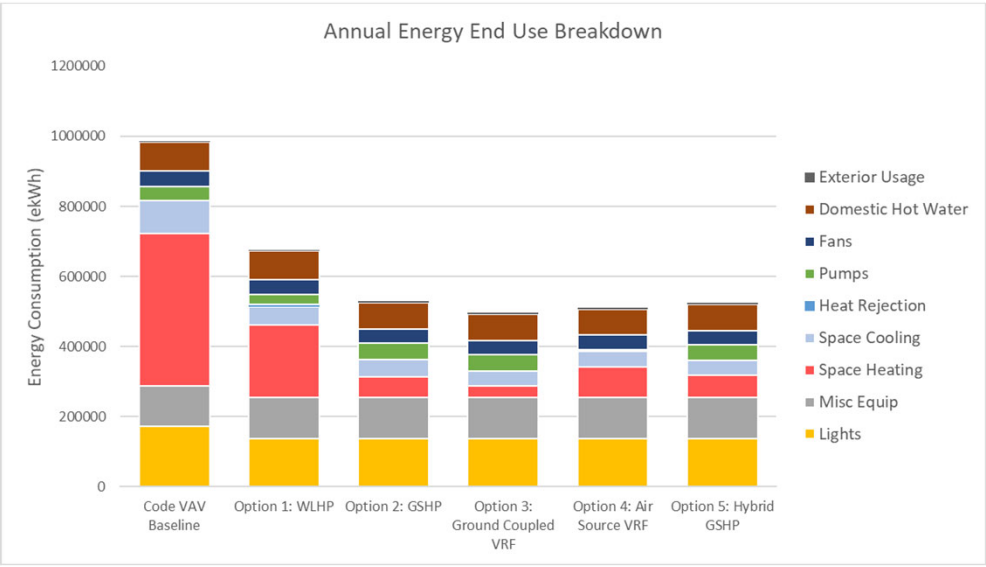
Energy Analysis – Consumption



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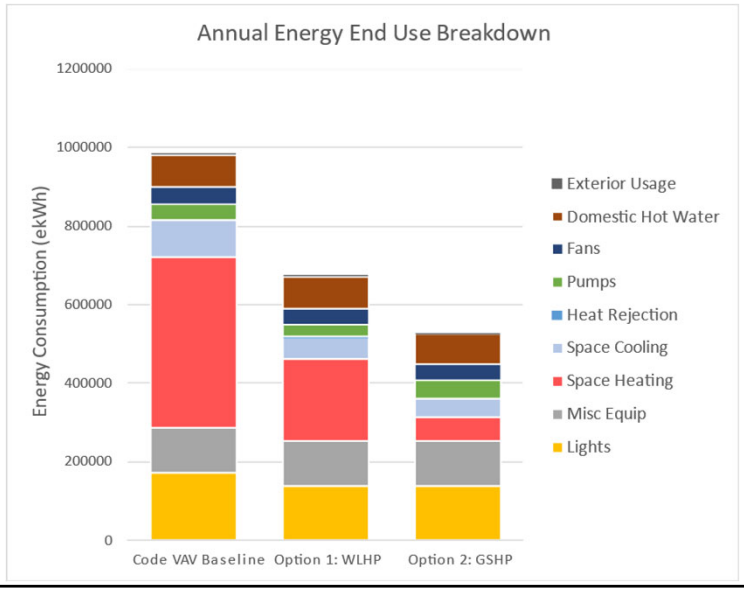
Energy Analysis – Consumption



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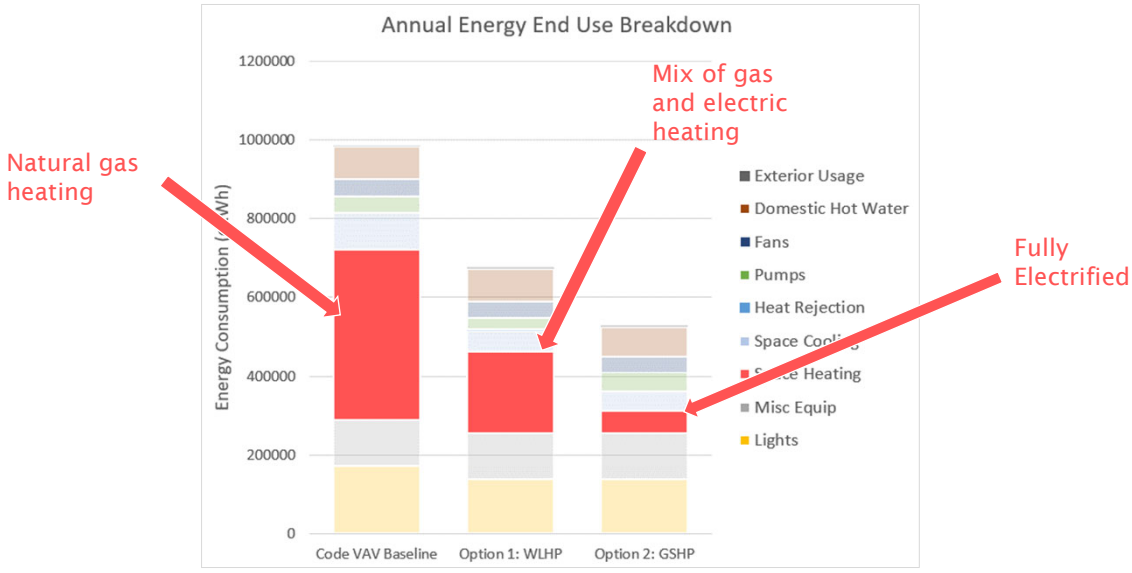
Energy Analysis – Consumption



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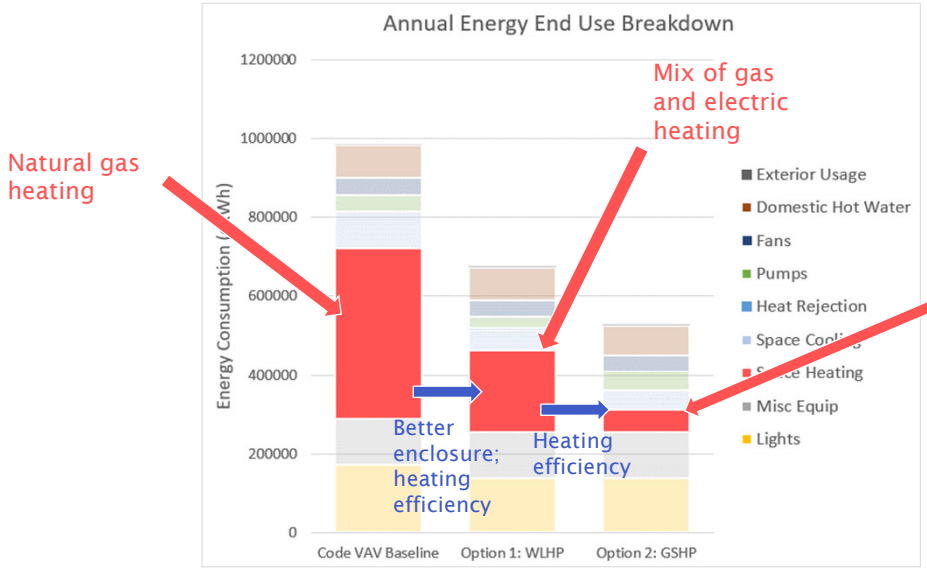
Energy Analysis – Consumption



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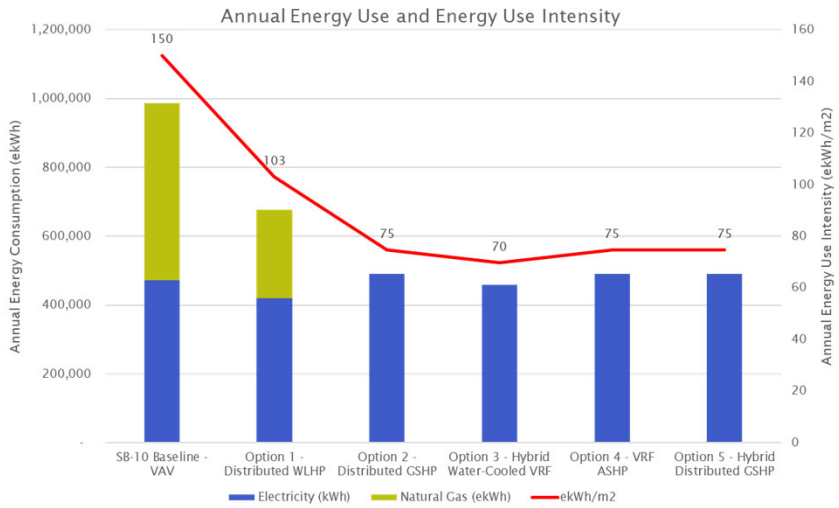
Energy Analysis (Metric)



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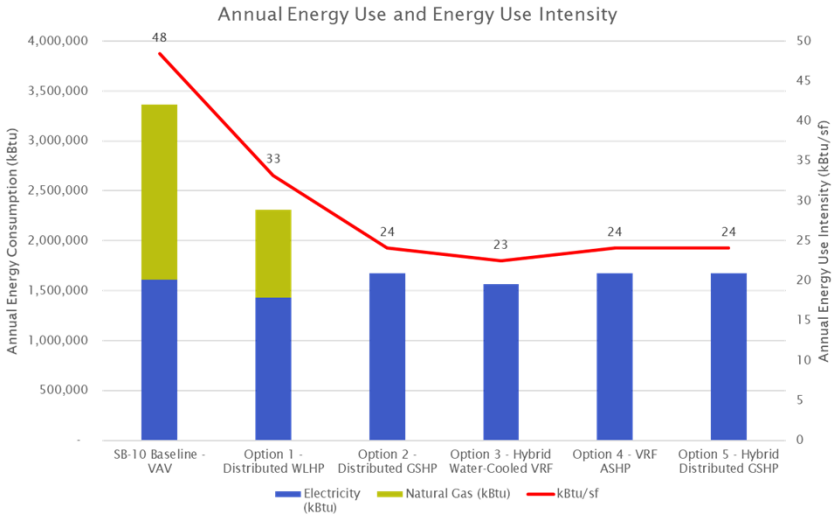
Energy Analysis (Imperial)



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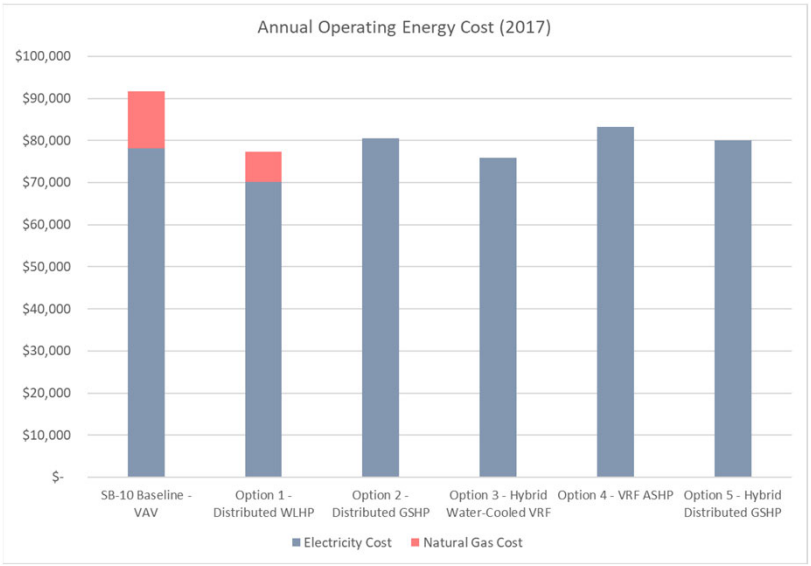
Energy Analysis – Energy Cost



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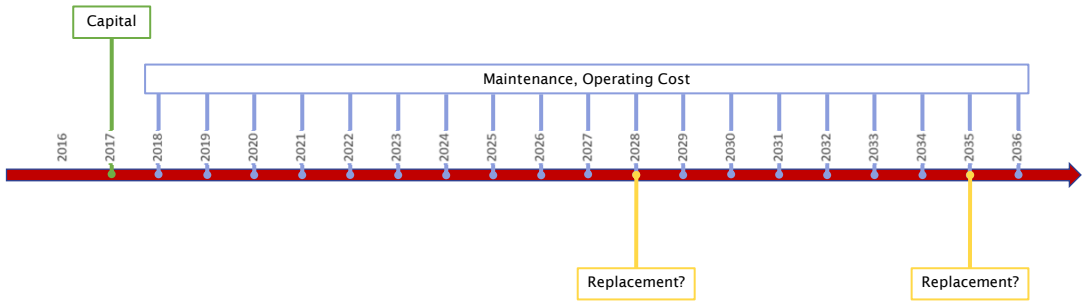
Life Cycle Cost Analysis (LCCA)



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Life Cycle Cost Analysis (LCCA)

Terms of Engagement:

Study Period	**20 Years**
Capital Cost	Class D
Down Payment	33%
Discount Rate	10%
Interest Rate	3.5%, (10 Year Term)
Inflation Rate and Fuel Inflation Rate	**2.5%**
Carbon Pricing	*

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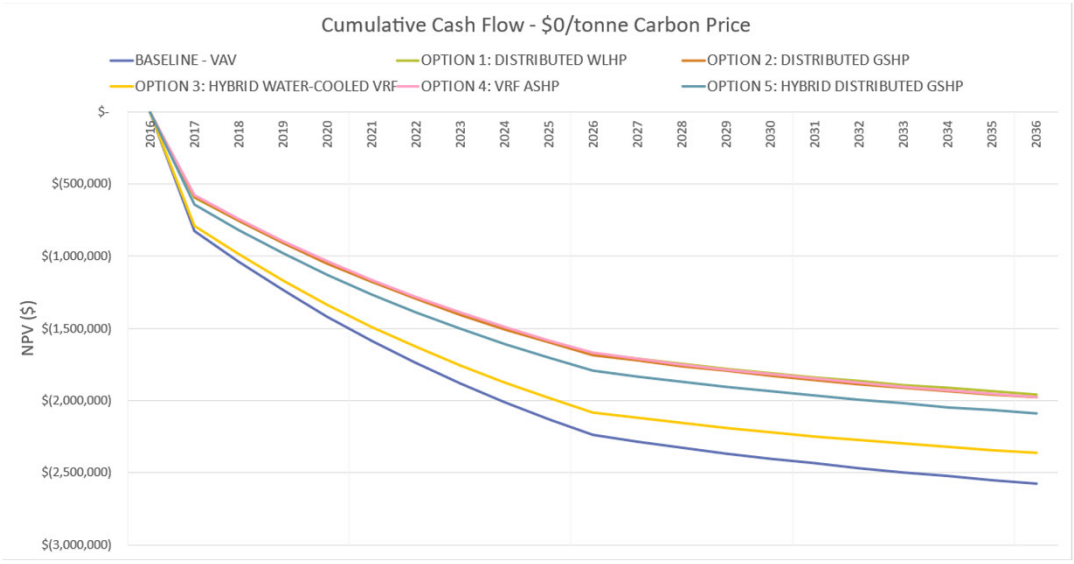
Net Present Value



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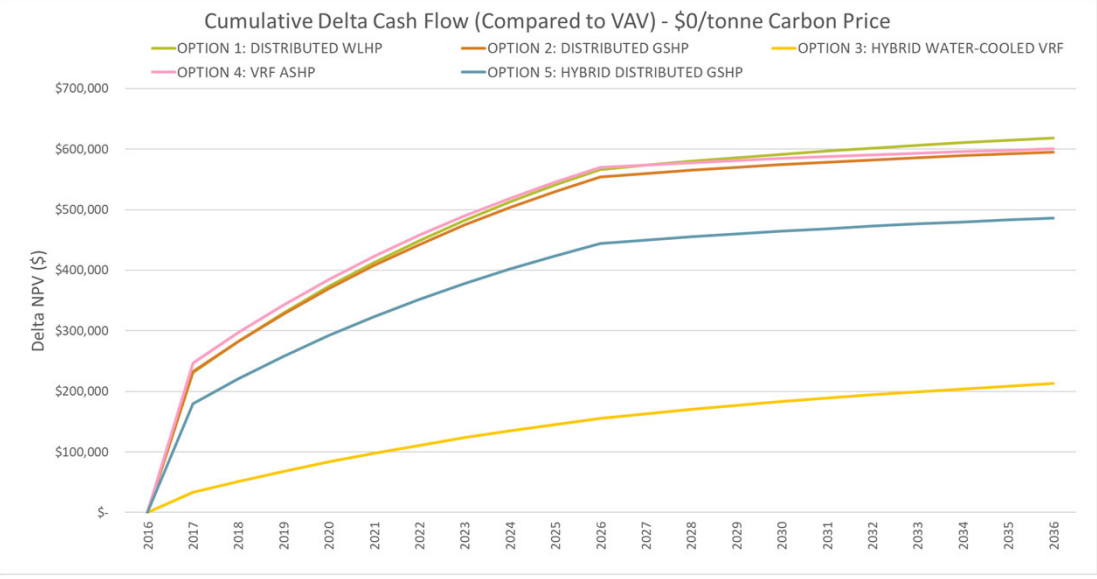
Net Present Value - Delta



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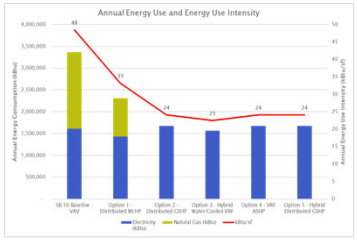
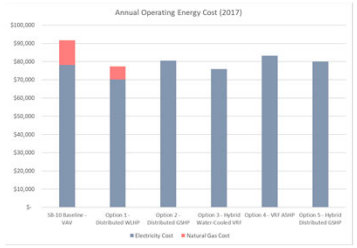
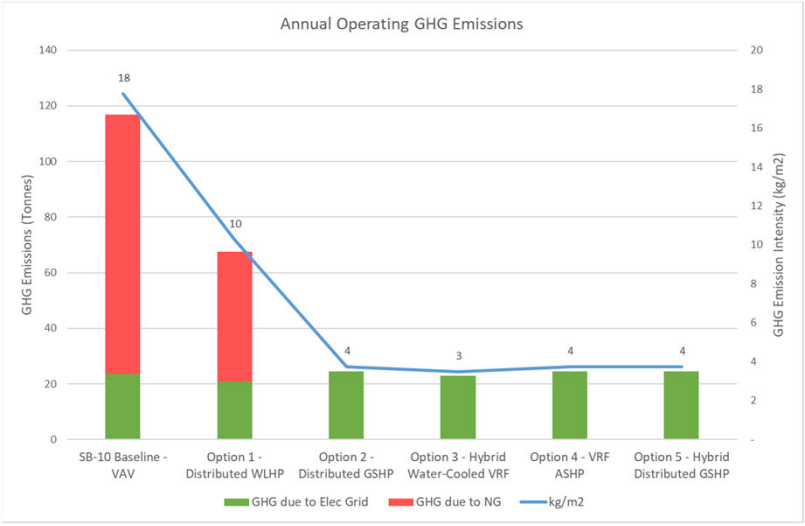
Consumption, Cost, Carbon







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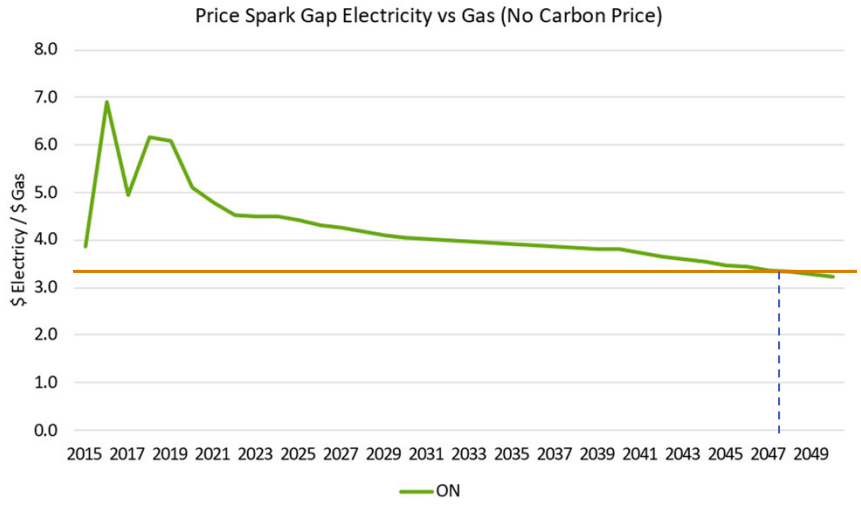
Balancing Act



Source: 2020 Canada's Energy Future - https://www.cer-rec.gc.ca/en/data-analysis/canada-energy-future/index.html

Assume:

- 90% efficient gas boiler

Swap out with a

- 300% efficient electric heat pump

Elec/Gas Ratio = 3.3

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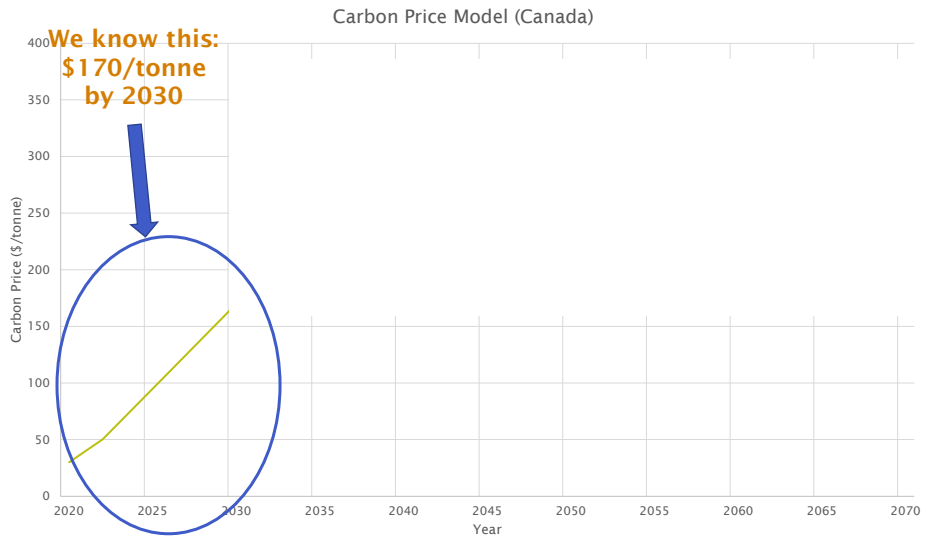
Price on Pollution: Carbon Price



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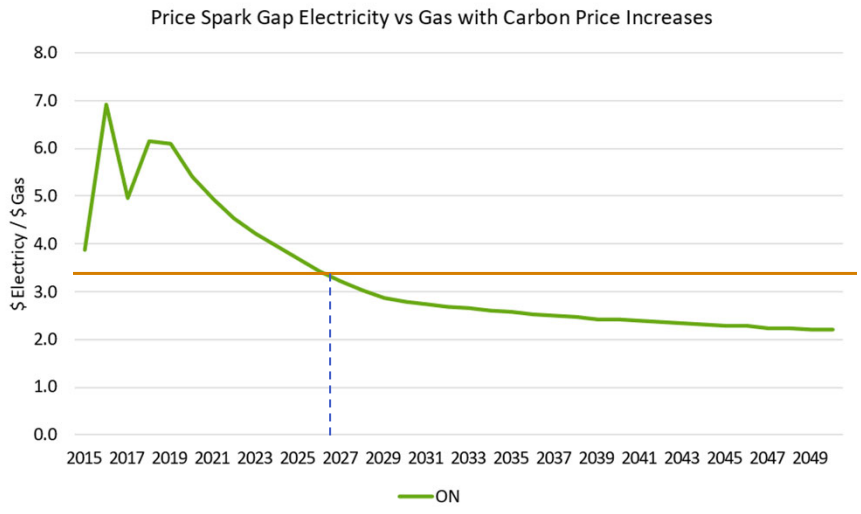
Balancing Act



Assume:

- 90% efficient gas boiler
- 300% efficient electric heat pump

Elec/Gas Ratio = 3.3

Source: 2020 Canada's Energy Future - https://www.cer-rec.gc.ca/en/data-analysis/canada-energy-future/index.html

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Price on Pollution – 2017?

Carbon Price Scenarios (2017 Mindset)

$0/tonne	(2017 Actual)
$15/tonne	(Something Modest)
$50/tonne	(Applying Pressure)
$100/tonne	(No Way Will It Ever….)

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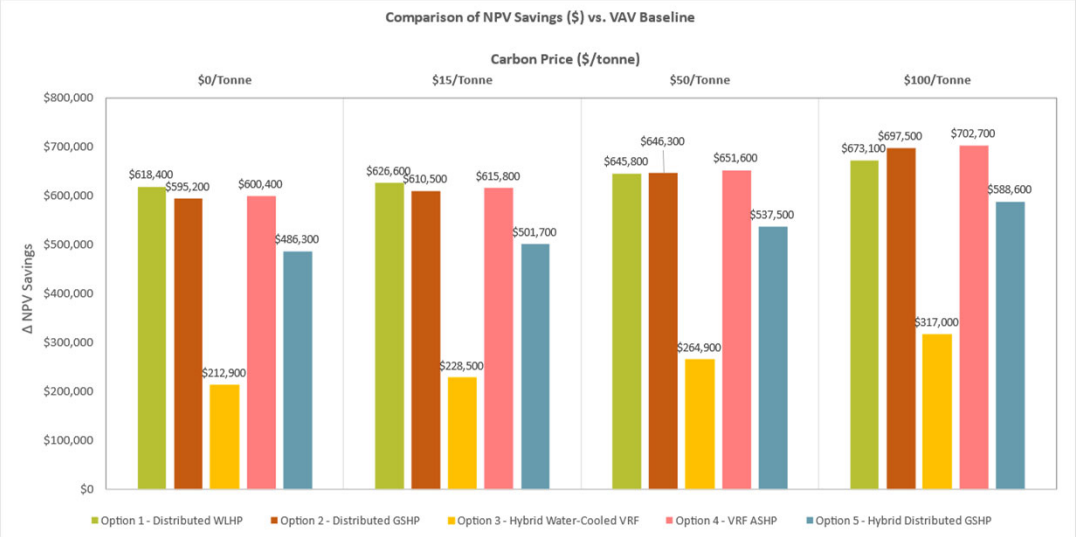
Carbon Price Scenarios (2017 Mindset)



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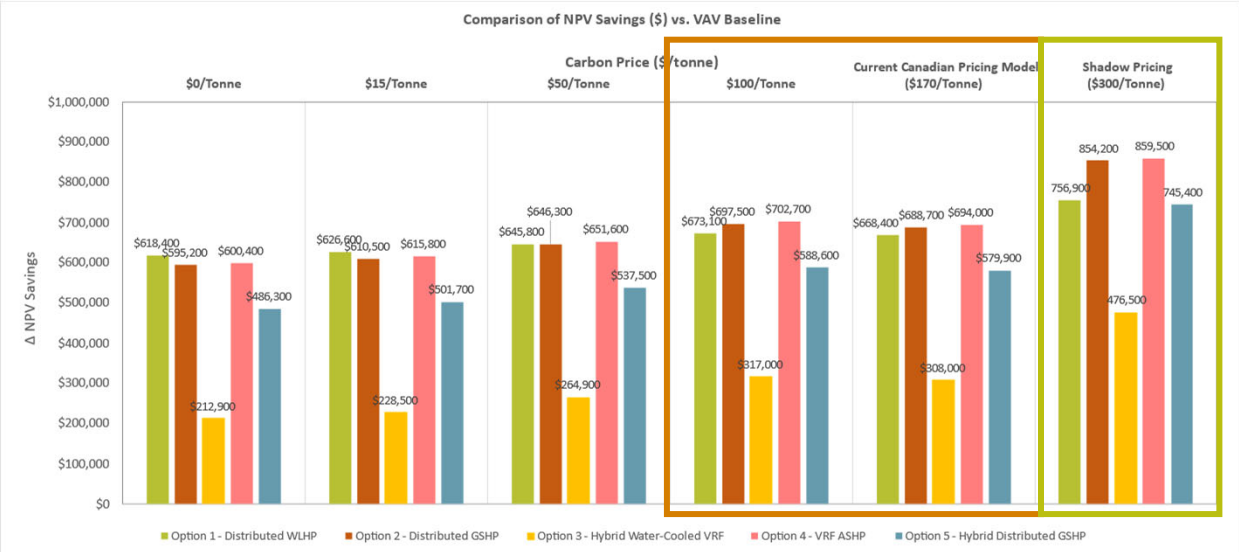
Carbon Price Scenarios



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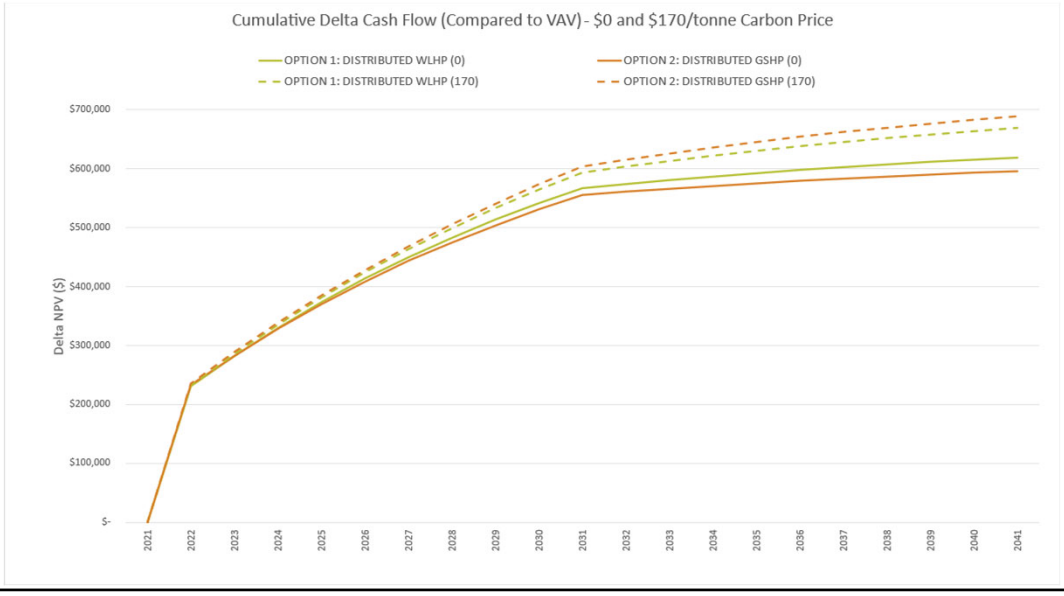
The Difference



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LCCA - Takeaways

- Straightforward analysis – all retrofits happened at the beginning (mostly)
- Apply this energy and financial modelling methodology to phased retrofit planning (Retrofit Roadmap, Zero Over Time)

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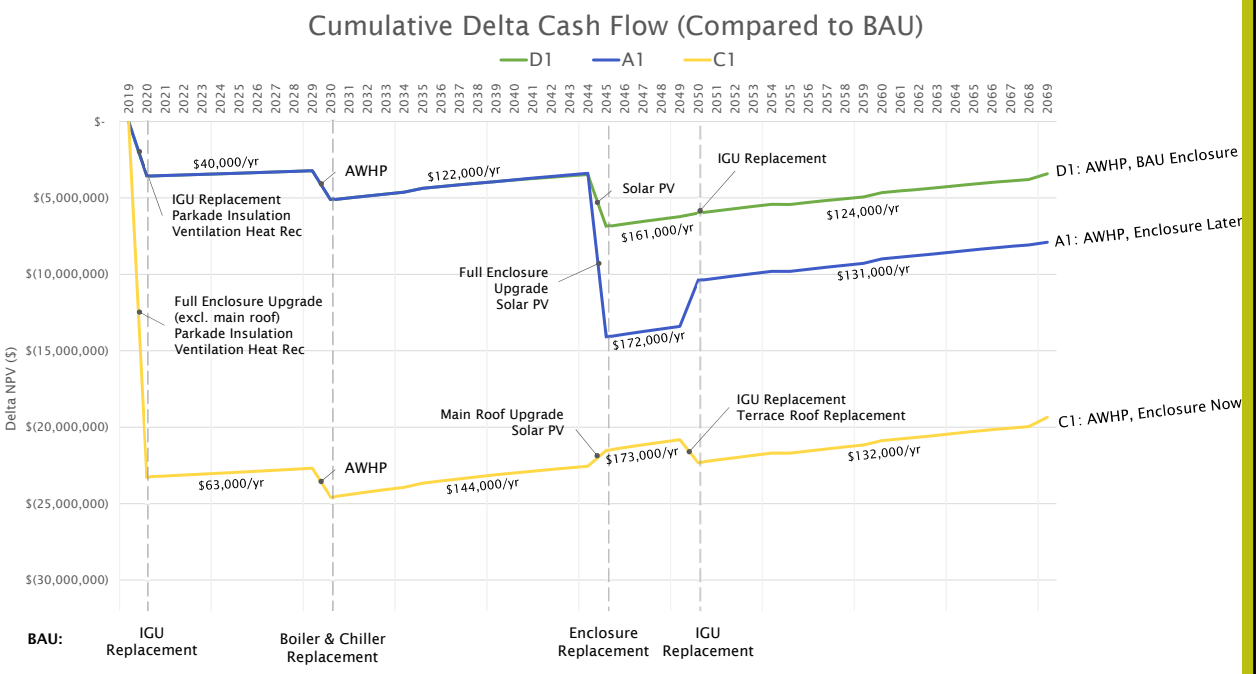

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LCCA - Takeaways

- We don't have a crystal ball – but we did our best
- Physical Future Planning hand in hand with Financial Planning

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Chat Question: Share how you have convinced a client to go net-zero.

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Designing for Future Net-Zero Carbon

- Deep energy reduction
- Compatible Equipment selection
- Thoughtful consideration to system layout to allow for an easy transition
- Be "NET-ZERO READY"

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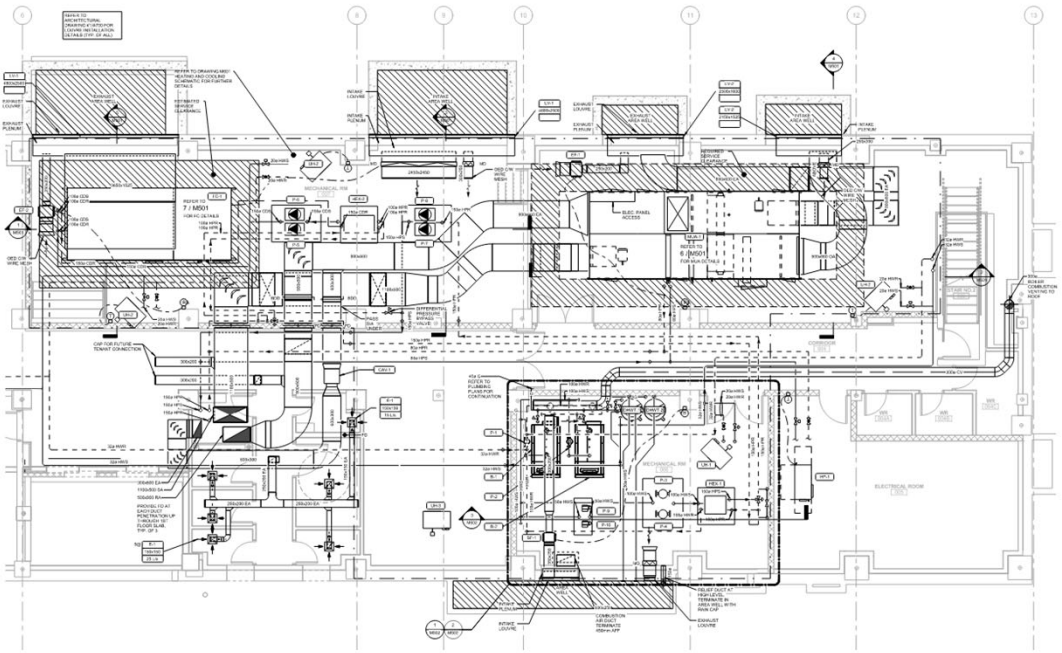

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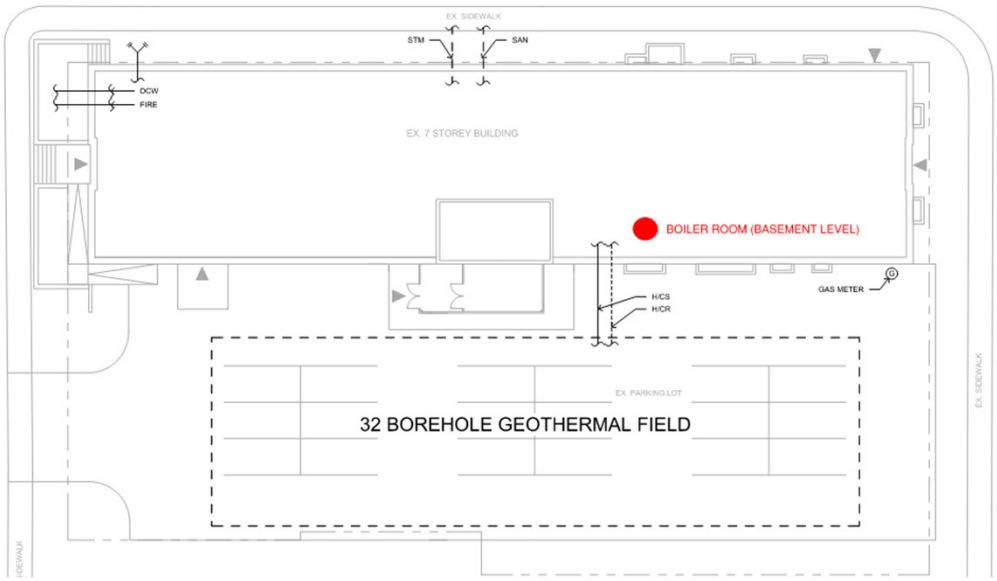

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the case for intelligently designed sustainable buildings

- **Canada's Commitment:**
  - 2030 – 30%* reduction in GHG emissions below 2005 levels
- If Canada is to have any chance of meeting our commitments, the retrofit of existing buildings toward carbon neutral is imperative.
- We have 8 years to get our emissions under control.

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Retrofit Motives

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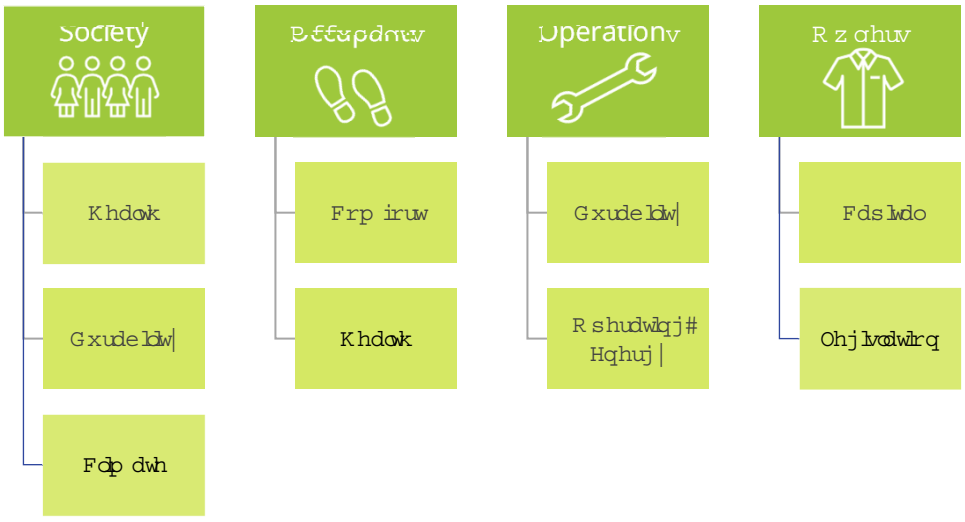

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Carbon Reduction Leaders

Jurisdiction	Goal	Timing
New York City Local Law 97	Cut carbon emissions by over 80 percent. Buildings that do not comply will face fines set at $268 per ton of emissions	By 2050
City of **Boston** Building Emissions Reduction and Disclosure Ordinance **(BERDO)**	Energy and emissions reporting for all buildings over 20,000sf	By 2022
	50% carbon emissions reduction	By 2030
	Net Zero carbon emissions	By 2050
Washington State Clean Buildings Act	Reduce GHG emissions from the building sector (large commercial)	2020, with phased implementation
City of **Vancouver** Climate Emergency Response Plan	All new and replacement heating and hot water systems will be zero emissions	By 2025
Toronto 2030 District and Transform TO	Net Zero GHG emissions	By 2050
Pan-Canadian Framework on Clean Growth and Climate Change	Develop an energy code for existing building – may require the start of retrofits, labelling, financing	Existing Building Energy Code by 2022

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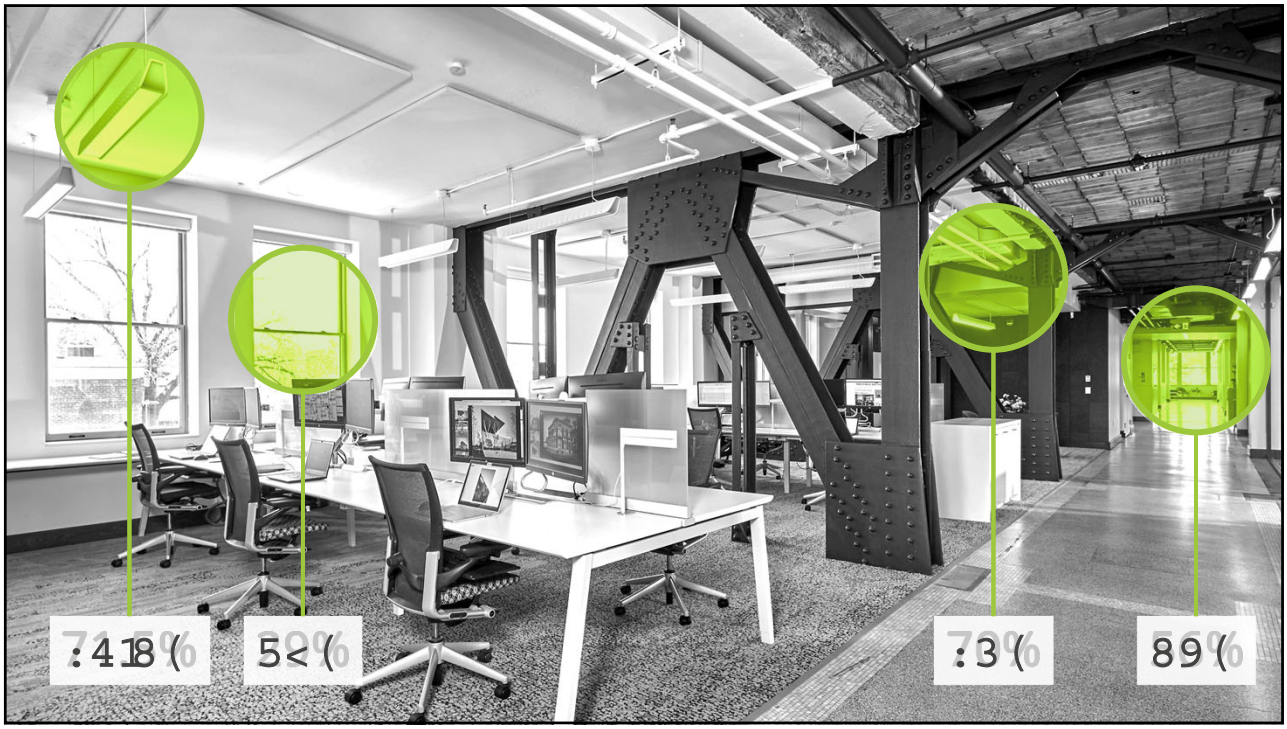

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Embodied Carbon Avoided

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Frqfuhwh#Lorruv2Vkdiw2Vwhhc#
Ehdp v2Vwuhhc#Wuxvvhv

Hp erglhg#Fduerq#Dyrlghg-#
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fduerq#htxlydqw

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Wuhh#vhhgdqjv#jurz q#ru#43#hduv

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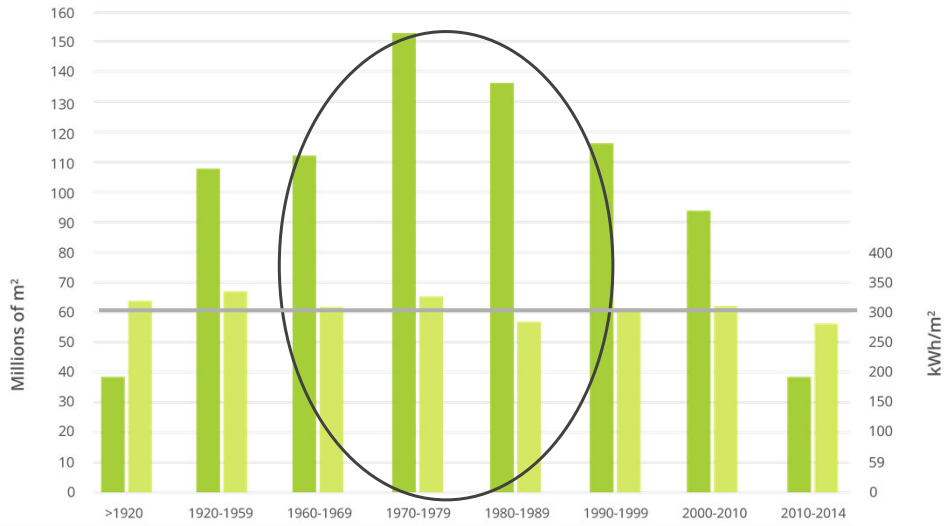
Canadian Context: Retrofit Opportunity By Age



	>1920	1920-1959	1960-1969	1970-1979	1980-1989	1990-1999	2000-2010	2010-2014	
Building Area m²	38.9	109.6	111.3	152.7	139.5	117.8	94.7	38.9	
EUI kWh/m²	325	345	318	331	278	320	325	276	EUI
Number of Buildings	27,108	86,760	51,004	95,861	69,096	68,978	64,112	19,483	

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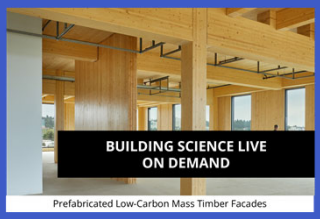
Iconic Passive House and Net-Zero Facades for High-Rise Buildings



Prefabricated Low-Carbon Mass Timber Facades

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