



4th Experts Meeting, Annex 46

"Holistic Assessment Tool-kit on Energy Efficient Retrofit Measures for Government Buildings, EnERGo"

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Screening Methodology for Energy Retrofit of Canadian Government Office Buildings

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Outline

1. Describe basis of screening methodology for energy retrofit
2. Representative government office buildings
3. Results of analysis
4. Application of screening tool



Screening Methodology - Energy Retrofit

- Define representative government office buildings: construction date, size, current energy standard/best practice, weather
- Reliable energy consumption data of government office buildings
- Evaluate energy consumption and effectiveness of energy conservation measures, ECMs (Regressive analyses)
- Rank buildings using a cost benefit analysis: effectiveness of ECMs vs. implementation cost



Representative Gov.Office Buildings

Construction date / Energy standard/best practice

- Pre 1950 / ASHVE (1939)
- 1950 – 1975 / ASHVE (1939) & ASHRAE (1961)
- Post 1975 / ASHRAE (1977) & MNECB (1997)

Size of building

- 24150 m² (260,000 ft²), Floor height = 3.5 m
- 4,200 m² (45,000 ft²), Floor height = 3.5 m

Weather

- Ottawa
- Edmonton
- Vancouver



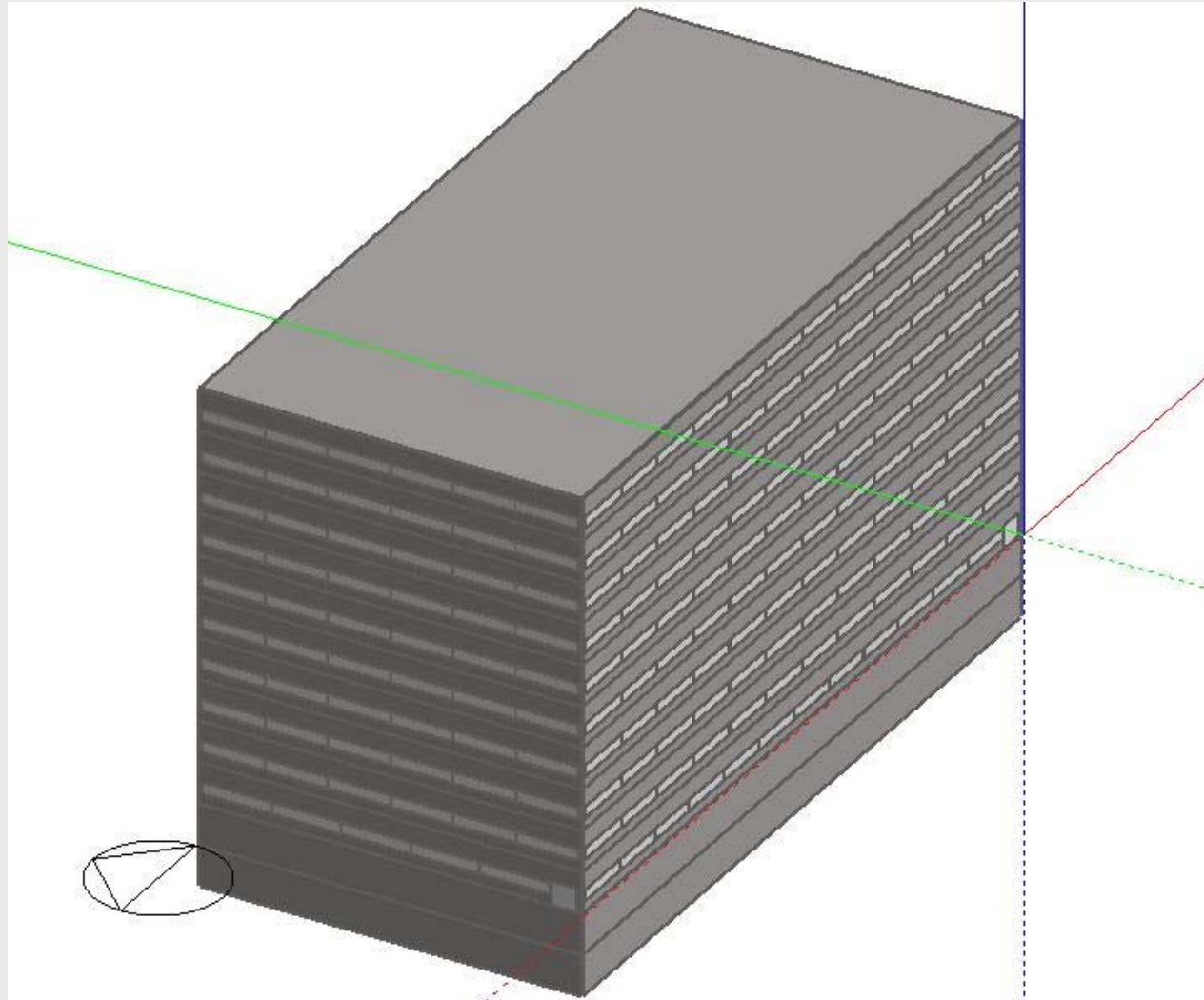
#1 - Large size building, Concrete BE

	Archetype #1	Archetype #2	Archetype #3
General Description			
Vintage	Pre 1950	1950 - 1975	Post 1975
No. Floors	10 + 2 Below ground	10 + 2 Below ground	10 + 2 Below ground
Area, Volume	24,150 (m ²), 72,450 (m ³)	24,150 (m ²), 72,450 (m ³)	24,150 (m ²), 72,450 (m ³)
Envelope			
Wall Type	Brick on Concrete	Brick on Concrete	Brick on Concrete
U-Value	1.21	1.21	1.16
Roof Type	Built-up roofing on Metal Deck	Built-up roofing on Metal Deck	Built-up roofing on Metal Deck
U-Value	1.41	0.74	0.64
Window Type	Single Glazed	Double glazed	Double glazed
U-Value	6.42	4.50	3.40
% to Wall	30	40	50
Distribution System Type			
Description	CAV Combination AHU and Pumps	CAV Combination AHU and Pumps	VAV Combination AHU and Pumps

#1 - Large size building, Concrete BE

	Archetype #1	Archetype #2	Archetype #3
Electrical Systems			
Lighting (W/m ²)	26	17.8	17.8
Equipment Loads (W/m ²)	10	20	30
Chiller Type COP	Chilled Water 1.8	Chilled Water 2.5	Chilled Water 5.2
Secondary Fuel Systems			
Boiler Fuel Capacity Efficiency	Natural Gas Hot Water 75%	Natural Gas Hot Water 75%	Natural gas Hot Water 75%
Miscellaneous			
SHW Fuel	Electricity	Electricity	Electricity

#1 - Large size building, Concrete BE



#2 - Large size building, Curtain wall

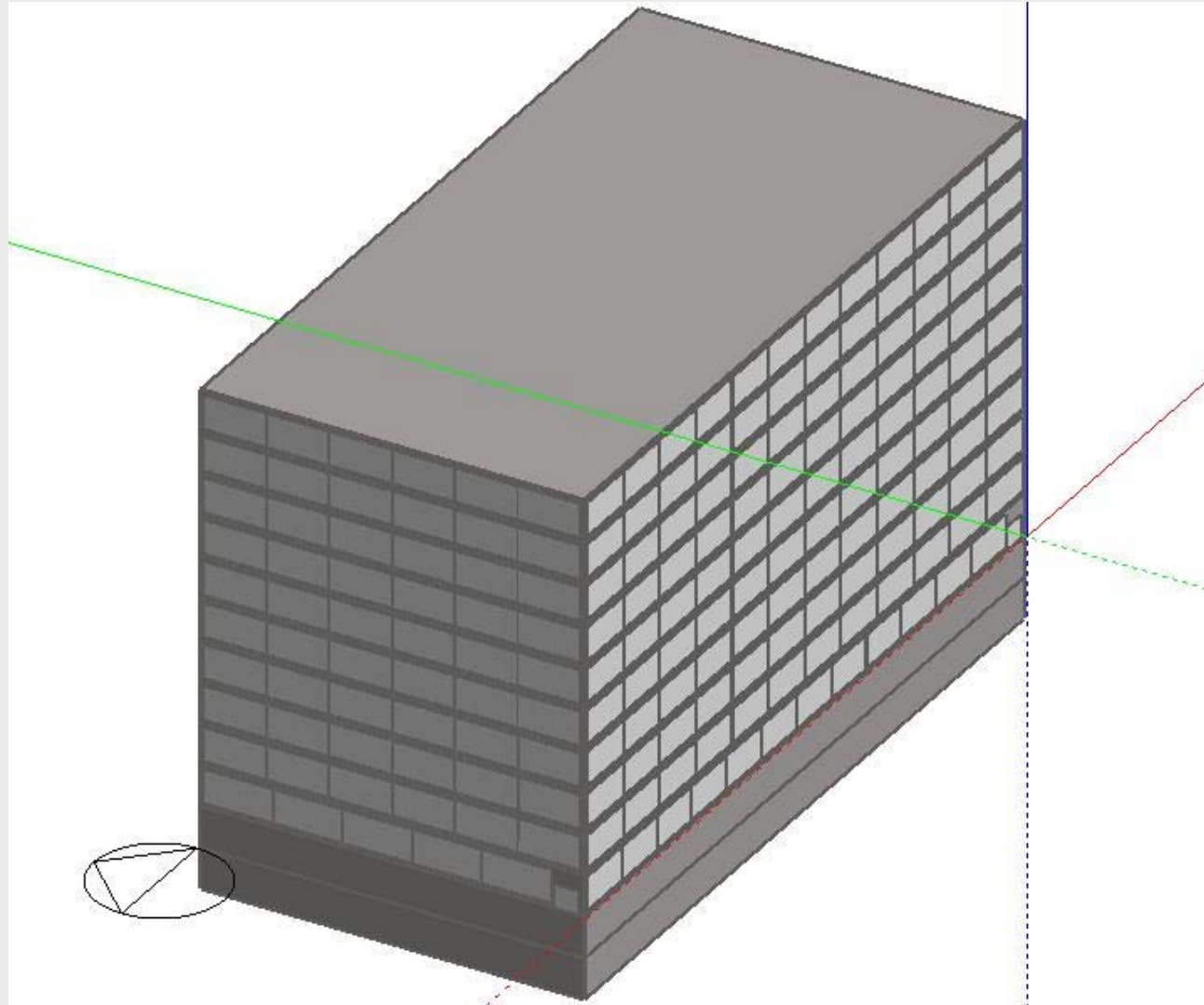
	Archetype #2	Archetype #3
General Description		
Vintage	1950 - 1975	Post 1975
No. Floors	10 + 2 Below ground	10 + 2 Below ground
Area, Volume	24,150 (m ²), 72,450 (m ³)	24,150 (m ²), 72,450 (m ³)
Envelope		
Wall Type	Curtain Wall w/Steel Siding	Curtain Wall w/Steel Siding
U-Value	0.37	0.37
Roof Type	Built-up roofing on Metal Deck	Built-up roofing on Metal Deck
U-Value	0.74	0.64
Window Type	Double glazed	Double glazed
U-Value	4.50	3.40
% to Wall	85	100
Distribution System Type		
Description	CAV Combination AHU and Pumps	VAV Combination AHU and Pumps



#2 - Large size building, Curtain wall

	Archetype #2	Archetype #3
Electrical Systems		
Lighting (W/m ²)	17.8	17.8
Equipment Loads (W/m ²)	20	30
Chiller Type COP	Chilled Water 2.5	Chilled Water 5.2
Secondary Fuel Systems		
Boiler Fuel Capacity Efficiency	Natural Gas Hot Water 75%	Natural gas Hot Water 75%
Miscellaneous		
SHW Fuel	Electricity	Electricity

#2 - Large size building, Curtain wall



#3 - Small size building

	Archetype #1	Archetype #2	Archetype #3
General Description			
Vintage	Pre 1950	1950 - 1975	Post 1975
No. Floors	2	2	2
Area, Volume	4,200 (m ²), 14,700 (m ³)	4,200 (m ²), 14,700 (m ³)	4,200 (m ²), 14,700 (m ³)
Envelope			
Wall Type	Brick on Concrete	Brick on Concrete	Brick on Concrete
U-Value	1.21	1.21	1.16
Roof Type	Built-up roofing on Concrete	Built-up roofing on Concrete	Built-up roofing on Concrete
U-Value	1.36	0.74	0.64
Window Type	Single Glazed	Double glazed	Double glazed
U-Value	6.42	4.50	3.40
% to Wall	30	40	50
Distribution System Type			
Description	CAV Combination AHU and Pumps	CAV Combination AHU and Pumps	VAV Combination AHU and Pumps

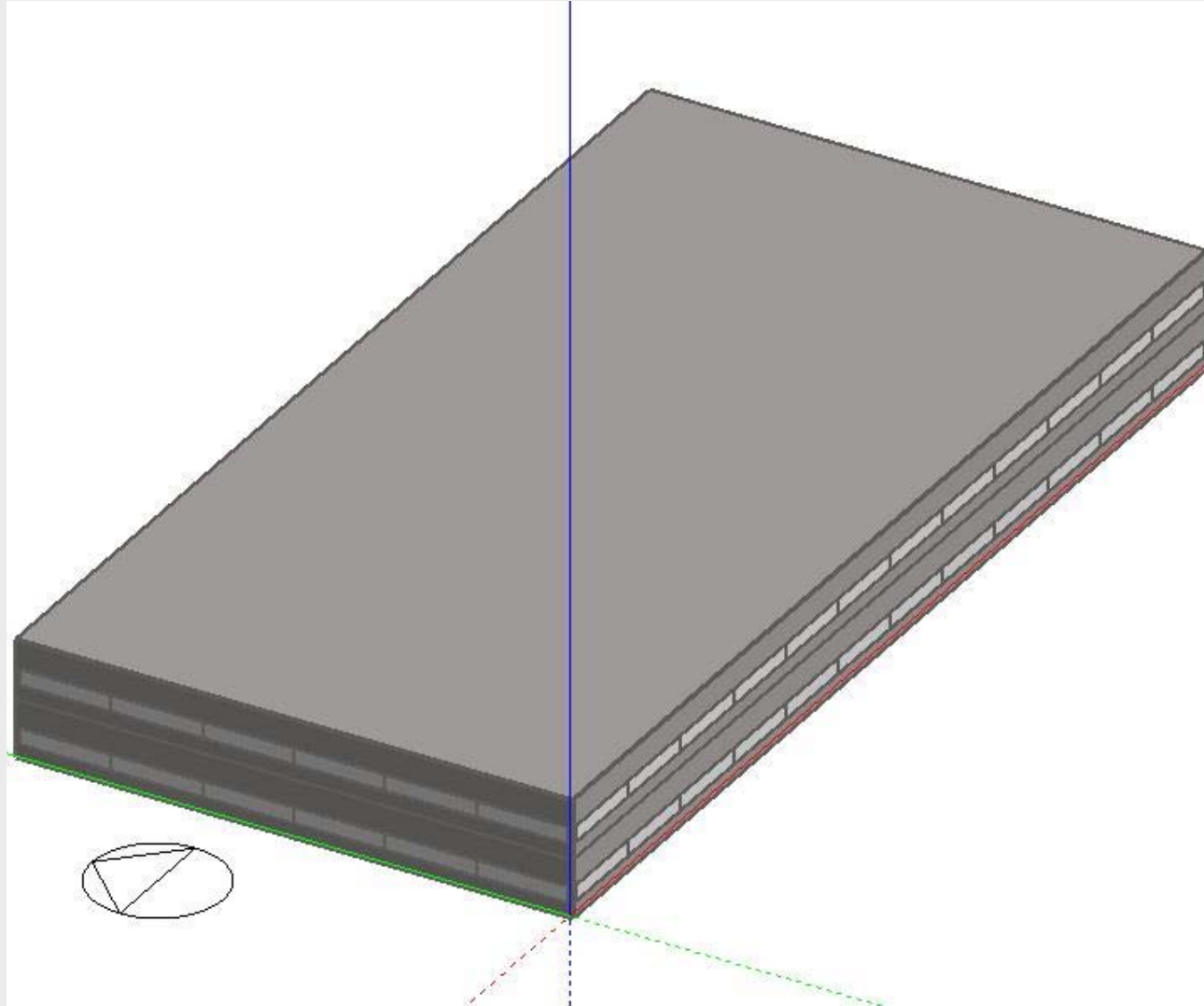


#3 - Small size building

	Archetype #1	Archetype #2	Archetype #3
Electrical Systems			
Lighting (W/m ²)	26	17.8	17.8
Equipment Loads (W/m ²)	10	20	30
Chiller Type COP	Chilled Water 1.8	Chilled Water 2.6	Chilled Water 2.6
Secondary Fuel Systems			
Boiler Fuel Capacity Efficiency	Natural Gas Hot Water 75%	Natural Gas Hot Water 75%	Natural gas Hot Water 75%
Miscellaneous			
SHW Fuel	Electricity	Electricity	Electricity



#3 - Small size building



Energy Conservation Measures

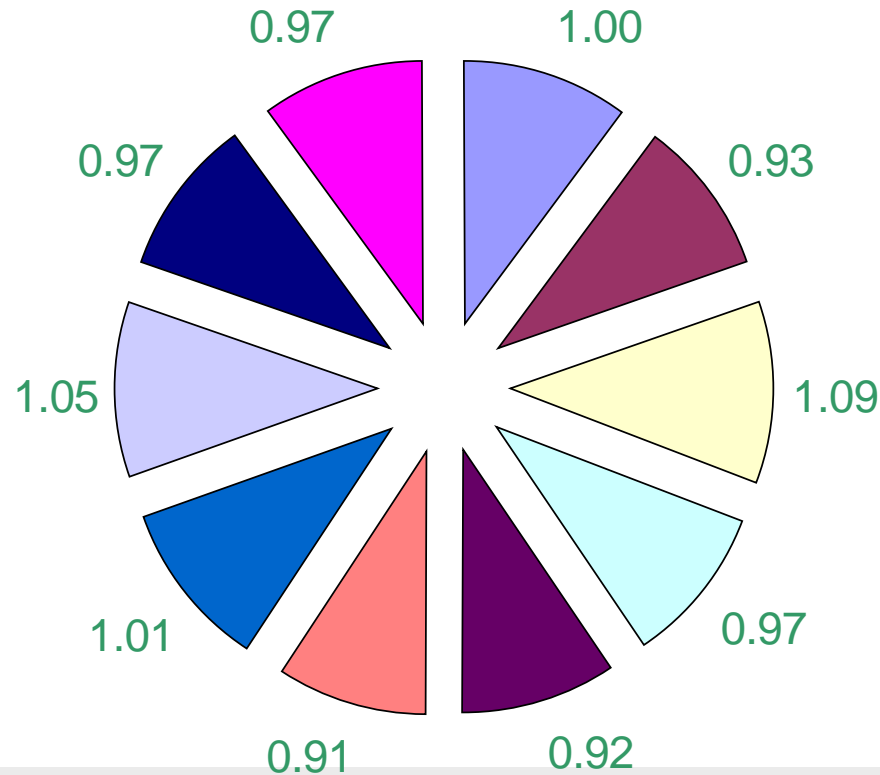
Retrofits considered for ECMs

- Decrease lighting power density
- Add perimeter day lighting with light dimming
- Replace windows with improved thermal resistance
- Add condensing boiler (thermal efficiency=95%)
- Increase insulation of roof
- Install variable speed fan system
- Add 60% air to air heat recovery
- Add a solar air pre heating system



Results: Pre 1950 to 1950 – 1975, Van

Large Building (concrete walls) Pre - 1950 to 1950 - 1975 levels Vancouver, BC, Canada

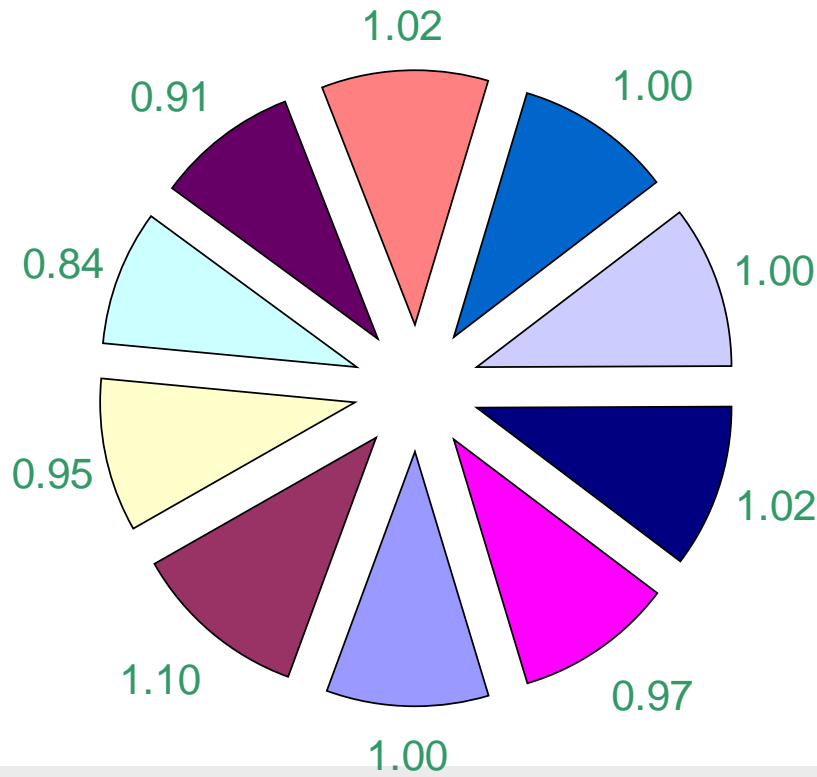


- Base Model (9,265,826 kWh)
- Added Medium Reflectivity Blinds
- Change Computer and Office Equipment Load from 10 to 20 W/m²
- Change Cooling COP from 1.8 to 2.5
- Change infiltration Rate From 1.0 to 0.75
- Upgrade Lighting Load from 26 to 17.8 W/m²
- Change Occupancy Load from 30 to 25 m²/person
- Change %Fenstration From 30 to 40%
- Increase Roof U-Value from 1.41 to 0.74
- Changed Windows from U-Value 6.42 to 4.50



Results: 1950 – 1975 to Post 1975, Van

Large Building (Concrete walls) 1950 - 1975 to Post 1975 levels Vancouver, BC, Canada

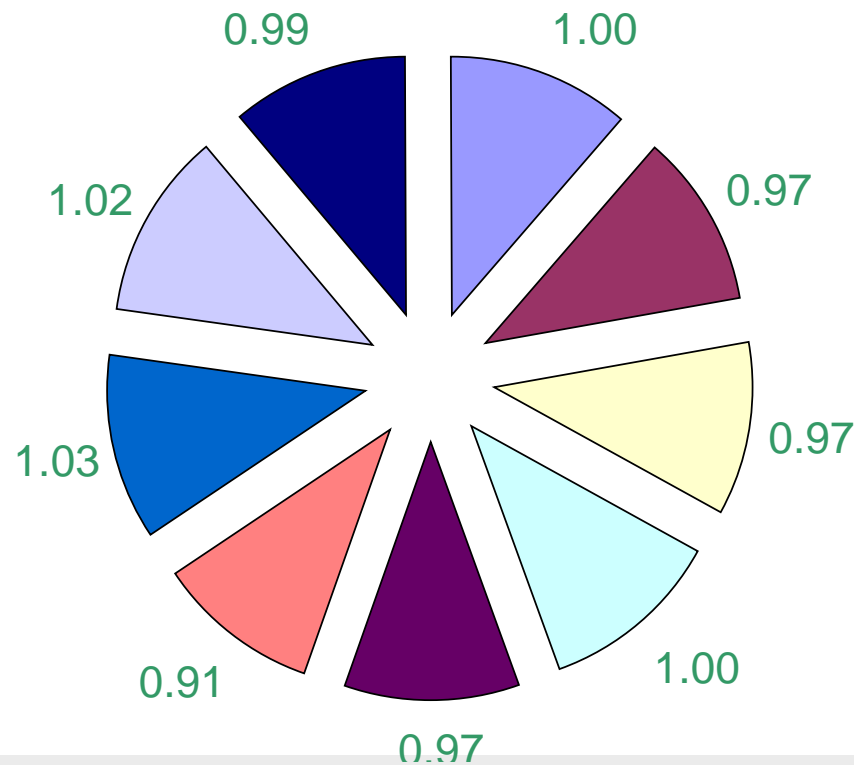


- Base Model (7,562,117 kWh)
- Change Computer and Office equipment Load from 20 to 30 W/m²
- Changed Chiller COP from 2.5 to 5.2
- Changed HVAC from CAV to VAV with Turndown Ratio of 0.3
- Change Infiltration From 0.75 to 0.5
- Change Occupancy from 25 to 20 m² per person
- Change Roof U-Value from 0.74 to 0.64
- Change Wall U-Value from 1.21 to 1.16
- change % Fenstration from 40 to 50
- Change Window U-value from 4.5 to 3.4



Results: Post 1975 to Retrofit, Van

Large Building (Concrete walls) Post 1975 to Retrofit levels Vancouver, BC, Canada



- Base Model (6,244,889 kWh)
- Change Windows U-Value from 3.4 to 1.8
- Added 60% Air to Air Heat Recovery
- Change Heating to 95% Efficiency with And Economizer/Pre Heat
- Change Wall U Values from 1.21 to 1.16
- Upgrade Lighting From 17.8 to 10.0
- Added Daylighting Control
- Occupancy from 20 to 18 m2/person
- Change Roof U Value 0.64 to 0.47



Results: Post 1975 to Retrofit, Van

Post 1975 to Retrofit levels	Total Electricity	Natural Gas : Boiler
Base Model	5,386,174 kWh	858,715 kWh
Change Windows U-Value from 3.4 to 1.8	0.99	0.85
Added 60% Air to Air Heat Recovery	1.00	0.76
Change Heating to 95% Efficiency with And Econ	0.94	1.35
Change Wall U Values from 1.21 to 1.16	1.00	0.84
Upgrade Lighting From 17.8 to 10.0	0.85	1.28
Added Daylighting Control	1.00	1.22
Occupancy from 20 to 18 m ² /person	1.01	1.08
Change Roof U Value 0.64 to 0.47	1.00	0.99





	Large building-concrete walls (kWh)		
	Ottawa	Edmonton	Vancouver
Pre - 1950	12,084,202	11,780,866	9,265,826
1950 - 1975	9,553,779	9,443,991	7,562,117
Post 1975	7,532,188	7,491,128	6,244,889
Pre - 1950	1.00	1.00	1.00
1950 - 1975	0.79	0.80	0.82
Post 1975	0.62	0.64	0.67



	Large building-concrete walls (kWh)		
	Ottawa	Edmonton	Vancouver
1950 - 1975	9,553,779	9,443,991	7,562,117
Post 1975	7,532,188	7,491,128	6,244,889
1950 - 1975	1.00	1.00	1.00
Post 1975	0.79	0.79	0.83

	Large building-curtain walls (kWh)		
	Ottawa	Edmonton	Vancouver
1950 - 1975	10,037,583	10,015,127	8,070,458
Post 1975	7,826,746	7,830,511	6,535,714
1950 - 1975	1.00	1.00	1.00
Post 1975	0.78	0.78	0.81



	Small building (kWh)		
	Ottawa	Edmonton	Vancouver
Pre - 1950	2,186,793	1,984,148	1,676,328
1950 - 1975	1,601,429	1,356,917	1,302,983
Post 1975	1,361,273	1,337,903	1,167,798
Pre - 1950	1.00	1.00	1.00
1950 - 1975	0.73	0.68	0.78
Post 1975	0.62	0.67	0.70



Concluding Remarks

1. Proposed screening methodology is expected to provide a ranking to Government Office Buildings on the basis of expected energy consumption and cost of energy.
2. Cost benefits analyses require input of cost of ECMs (direct and indirect), interest rate and inflation rate.
3. Further validation and calibration of the screening tool using metered energy data will be carried out this coming year.
4. Need to consider other ECMs.



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Questions?

