Better Buildings Series:

Advantages of Retrofit vs. New Build

19/11/2020

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Agenda

- Terminology
- Why Retrofit
- What/How to Retrofit (in an earth-friendly way)
- When to Retrofit
- Retrofits and Code Compliance

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Terminology

- Embodied Carbon
  - Cumulative life cycle CO2-equivalent greenhouse gases (eCO2) associated with a building's materials and construction (does not include emissions associated with building operation)
  - Also referred to as "Upfront Carbon" (= material EC + construction emissions)
- Energy Use Intensity (EUI)
  - Annual energy consumption per unit area (typically kWh/m2 or kWh/sqft)
- Retrofit/Renovation/Alteration
  - Often used interchangeably to describe modifications/upgrades to buildings

Why Retrofit?

1. Value of Existing Buildings

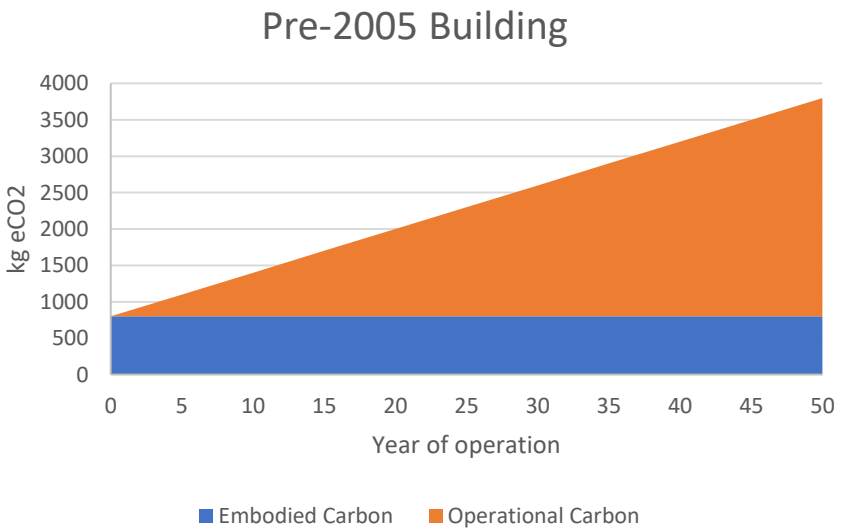
Source: https://www.tpsgc-pwgsc.gc.ca/citeparlementaire-parliamentaryprecinct/rehabilitation/ouestgalerie-westgallery-eng.html

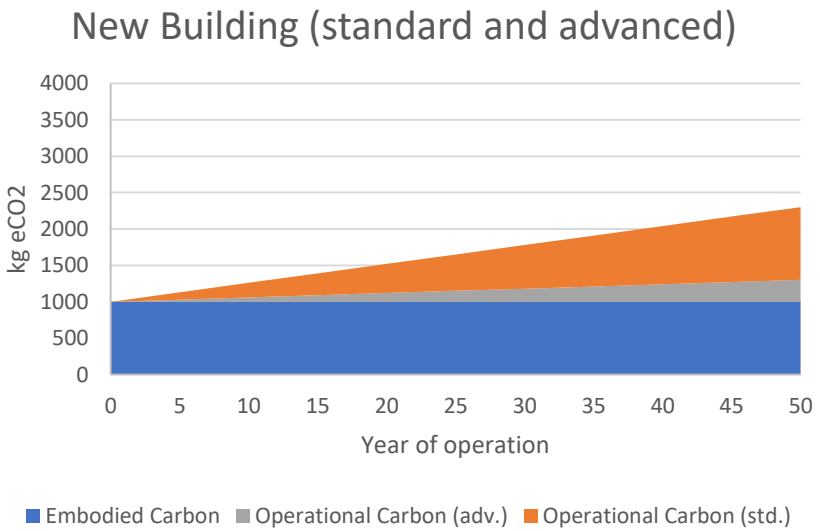
1. Value of Existing Buildings

- Cultural
  - Buildings can be an important piece of local/national culture
- Economic
  - Retrofits in urban areas preserve urban centers
  - Less disruption to neighbouring buildings (e.g. Spring Garden Road)
- Environmental: Preservation of resources
  - Structural components can last 100s of years
  - Some is recyclable, but…

2. Lower Embodied Carbon

- New buildings have a high ratio of EC:OC
- In high-performance buildings, embodied carbon can account for 90% of a building's lifetime carbon
  - To reduce carbon footprint, materials are as important as energy use





Hypothetical buildings, based on findings in Rock et al. (2020)

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Mitigating Embodied Carbon through Retrofit

- Steel and Cement account for a high proportion of embodied carbon in buildings
  - Manufacturing of iron, steel, & cement accounts for ~5% of global GHG emissions (IEA, 2019)
  - Demand for these materials has increased 3x for steel, 7x for cement since 1970s
- Retrofitting significantly reduces steel and cement input compared to a new building

3. Emissions Reduction Opportunity

- Upgrades to existing buildings (retrofits, recommissioning, fuel switching) could decrease building sector emissions by 50% (CaGBC, 2017)
  - This would meet the entire national 2030 emissions target

Compare and Contrast

	Major Retrofit	Standard New Building
Immediately eliminates an energy-consuming old building	✓	X
Minimizes material inputs	✓	X
Preserves cultural significance	✓	X
Reduces construction disruption	✓	X
Is energy efficient & comfortable for occupants	✓	✓
Provides a necessary service (office, housing, school, etc)	✓	✓

How-to: Climate-Friendly Retrofits

Maximize the positive environmental impact

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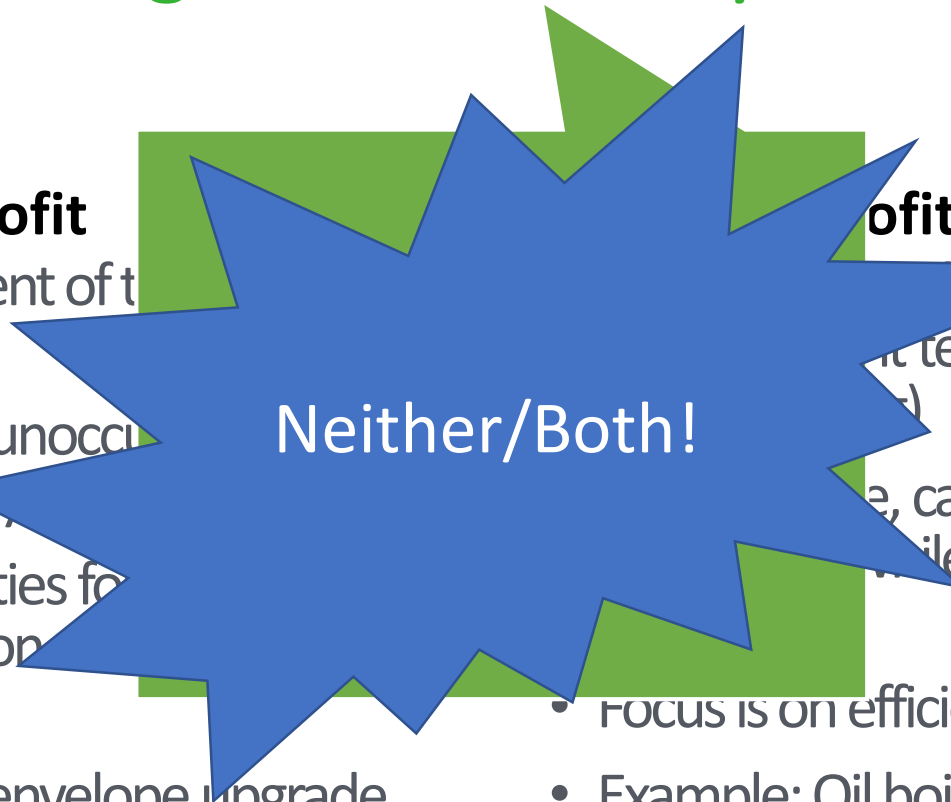
8 tips for a climate-friendly retrofit

1. Start planning early
   - Determine the existing benchmark
   - Conduct an audit (level II or III)
   - Set performance goals
2. Consider various design options
   - Integrated design is still valuable for retrofits
   - Use an energy model to evaluate alternatives
3. Consider impacts on existing/remaining systems
   - Avoid unintended post-retrofit renovations
4. Select materials with low embodied carbon and high renewable content
   - e.g. cellulose insulation
   - Locally-sourced will further decrease building's EC

5. Select systems/equipment with long expected useful life
   - Water-to-air heat pumps 25 years, air-to-air 17 years
   - Passive solar heating never expires
6. Manage demolition waste
   - Salvage materials and donate
   - Sort demo waste for proper disposal
   - Always use qualified demo contractors to avoid contaminant leakage (e.g. oil spills, refrigerant leaks)
7. Be open to change (in concept and cost)
   - Retrofits can be messy (as can new construction)
   - Old buildings are full of surprises (some interesting, some expensive)
8. Monitor the results
   - Track savings and analyze payback
   - Document lessons-learned

Energy-Saving Retrofit Pathways



Major Retrofit

- Replacement of t… systems
- Building is unoccu… months to …
- Opportunities fo… conservation… efficiency
- Example: envelope upgrade decreases heating load (conservation); new HVAC uses consumes less energy (efficiency)

…ofit

- …system with …t technology (e.g. …)
- …e, can often be …ile building is …
- Focus is on efficiency
- Example: Oil boiler system replaced with natural gas boiler system

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Energy-Saving Retrofit Pathways

Major Retrofit

- ✓ Saves energy
- ✓ Reduces GHGs

System Retrofit

- ✓ Saves energy
- ✓ Reduces GHGs

When to Retrofit?

> **The best time to [design for efficiency] was 20 years ago; the next best time is now.**

Chinese Proverb - modified

Opportunities for Energy-Efficient Retrofits

Replacement of end-of-life systems

Repair of damaged infrastructure

Planned aesthetic upgrades

Conversion to a different usage type

Example: Replacement of end-of-life systems

- An office tower built in the 1990s is heated with fuel-fired hydronic baseboards
- The boilers are now 30 years old and need to be upgraded
- The boilers will be replaced with newer, more efficient technology

And…?
What else could be done during this retrofit to increase the building's energy efficiency?

Examples: Repair of damaged infrastructure

- A commercial building sustains roof damage in a hurricane
  - Opportunity to increase roof insulation during the repair
- A plumbing failure results in significant interior water damage
  - Can intrusive energy-efficiency upgrades be implemented while the building is unoccupied?
- An apartment building's envelope requires remediation of moisture ingress damages
  - Opportunity to improve envelope performance

Code Compliance

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Old Meets New: Proceed With Caution

- Gaps/contradictions in building codes can lead to unintended consequences
- Risks for health and safety of occupants
- Examples:
  - Fire safety
  - Mold/water damage
  - Snow loading

Questions?

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