# Synergies and Contradictions Between Optimizing Care and Environmental Sustainability

Canadian Centre for Healthcare Facilities

ZGF

PARKIN

# Agenda

1. Introduction
2. Case Studies:
    1. Hospital Building Area
    2. Impact of Electrification
    3. Embodied Carbon
    4. Inpatient Room Module
    5. Procurement Model
3. Path Forward
4. Q&A

Introduction

# Quality Care Environment


Bayers Lake Community Outpatient Centre, NS (Parkin/FBM)

Introduction

# Quality Care Environment

## Planning and Design Trends

- EBD/POE
- Patient & Familycentred care
- Healing environments, biophilic design
- Amenities for health and wellness

## Patient and Staff Safety

- IPAC and minimizing HIA’s
- Safety and Security (CPTED)
- Human factors

South Niagara Hospital, ON (Parkin/Adamson)

Introduction

# Quality Care Environment

## Patient and Staff Safety

- IPAC and minimizing HIA's
- Safety and Security (CPTED)
- Human factors

## Accessible Design

- Bariatric Design
- Elder Care
- Diversity, Equity, Inclusion
- Indigeneity

Providence Care Hospital – Mental Health/Rehabilitation (Parkin/Adamson)


South Niagara Hospital, ON (Parkin/Adamson)

Introduction

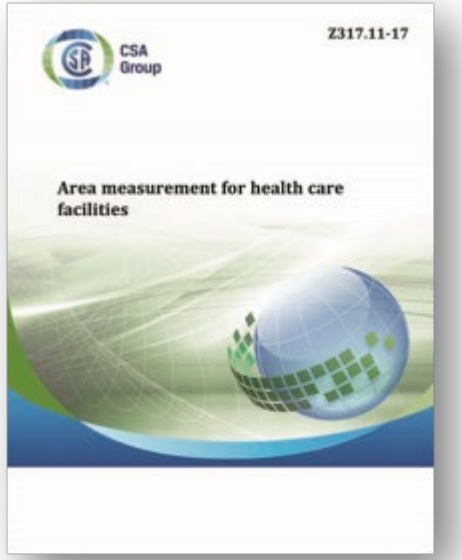
# Quality Care Environment

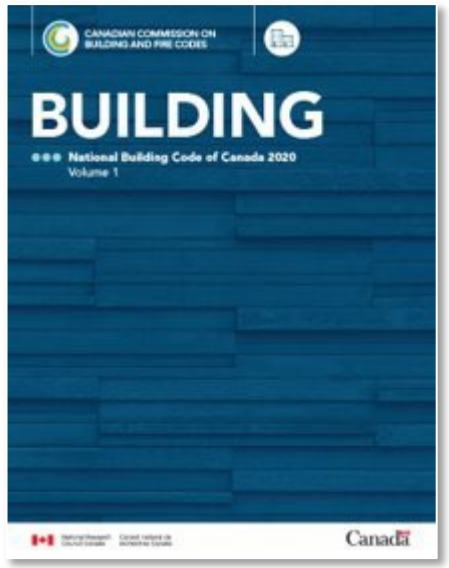
## Focus on Operational Efficiency

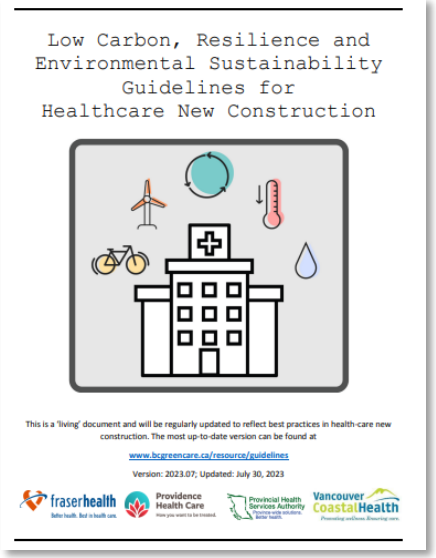
- Sneaker time
- Segregation of flow
- LEAN process improvement

## Well documented industry standards

- Codes, standards, best practice guidelines
- Savvy procurement process
- PSOS/SoR requirements

The Why

# Climate Crisis

“Earth has just seen its hottest three - month spell on record”

“World on Fire: 2023 is Canada’s worse wildfire season on record”

“Rapid ice melt in west Antarctica now inevitable, research shows”

"Global sea surface temperature reaches a record high"

The Why

# Healthcare

accounts for nearly

# 5.25%

of the national total emissions

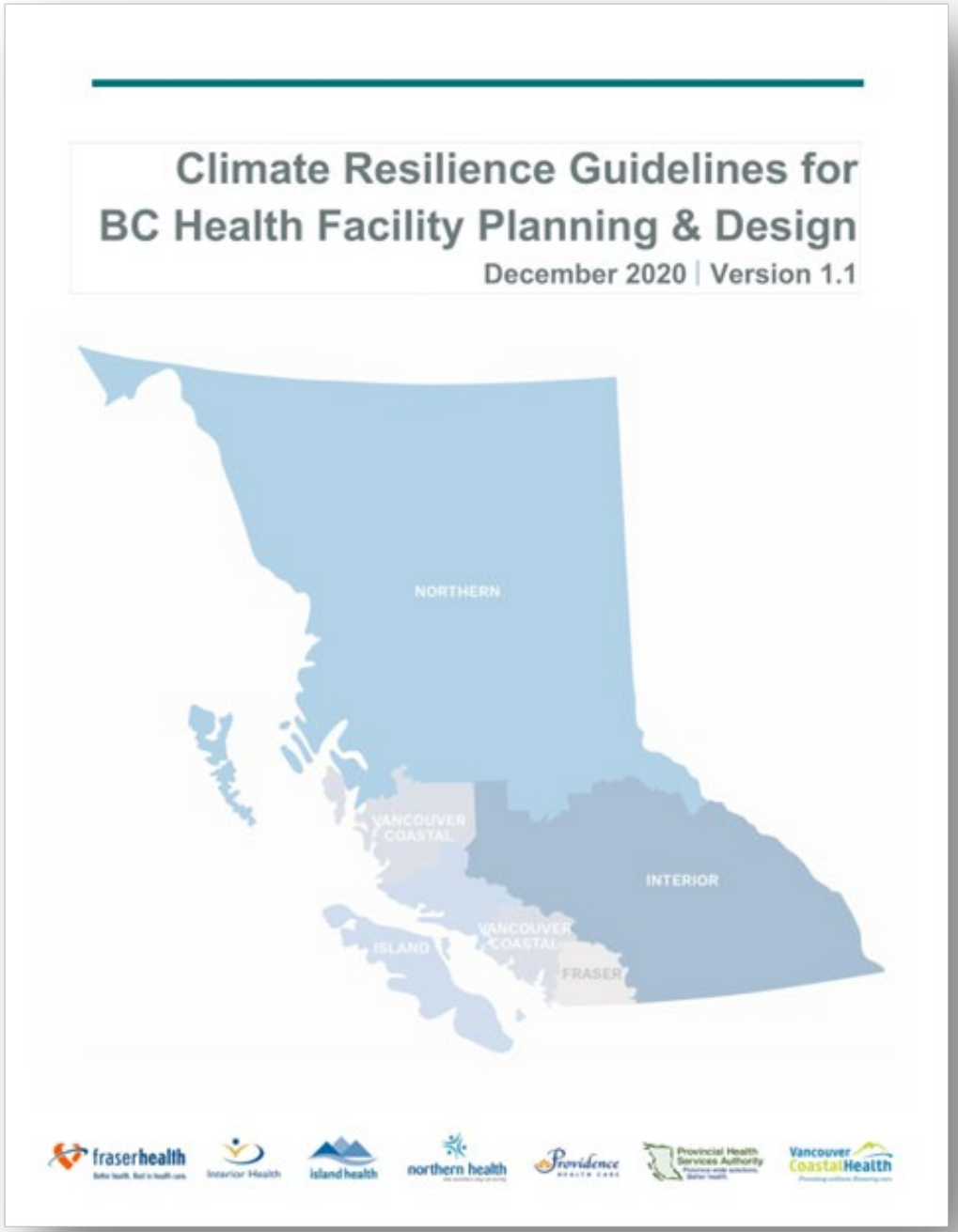
Global Road Map for Health Care Decarbonization, Key facts (2014)

The Why

## Commitment Area 1

# Climate Resilient Health Systems

COP 26 – Health Program, WHO, HCWH, 2021

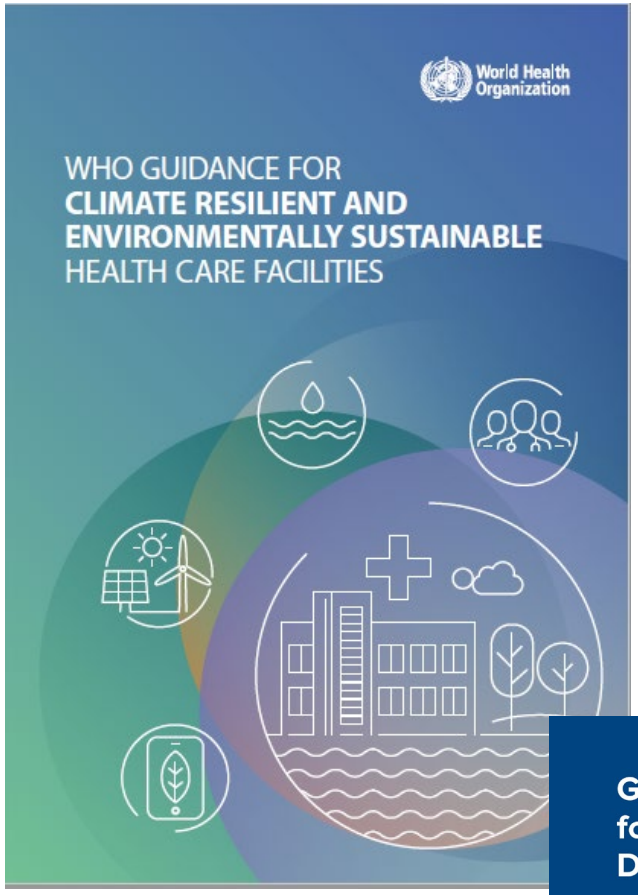


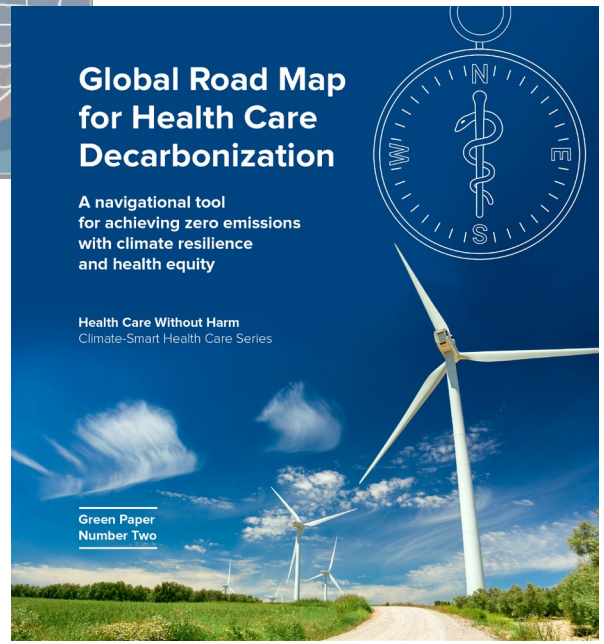
The Why

## Commitment Area 2

# Sustainable low carbon health systems

COP 26 – Health Program, WHO, HCWH, 2021



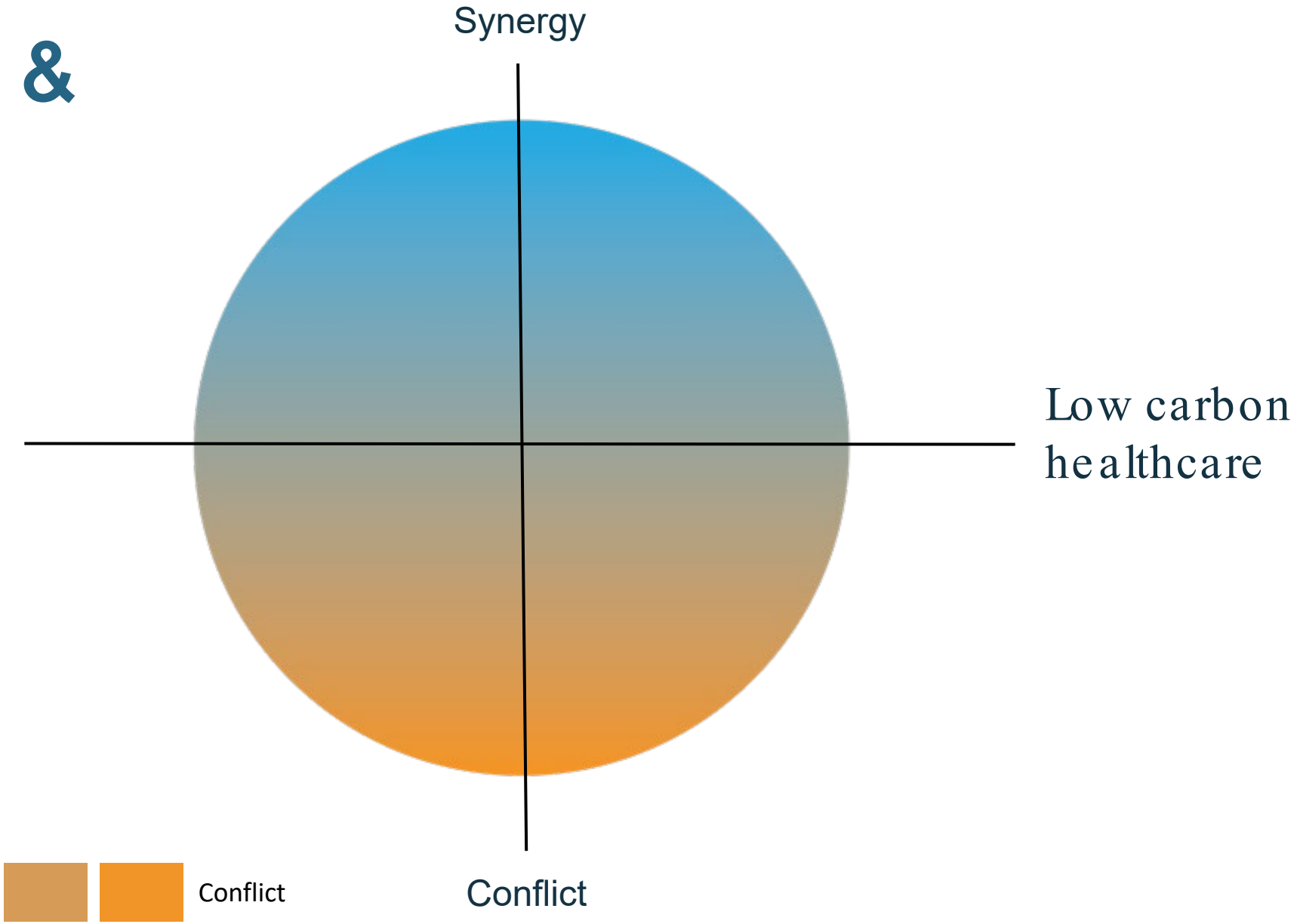



# Low Carbon Healthcare

## Decarbonizing Healthcare

- Energy / Operational Carbon
- Embodied Carbon

# Synergies & Conflicts




Synergy Conflict

# Hospital Building Area

# Ongoing Growth in Hospital Building Area

Program net, component and building gross areas are growing

- Current Best Practices in healthcare planning standards **increases building area**
- Also **increases energy consumption, emissions, embodied carbon**

# Ongoing Growth in Hospital Building Area

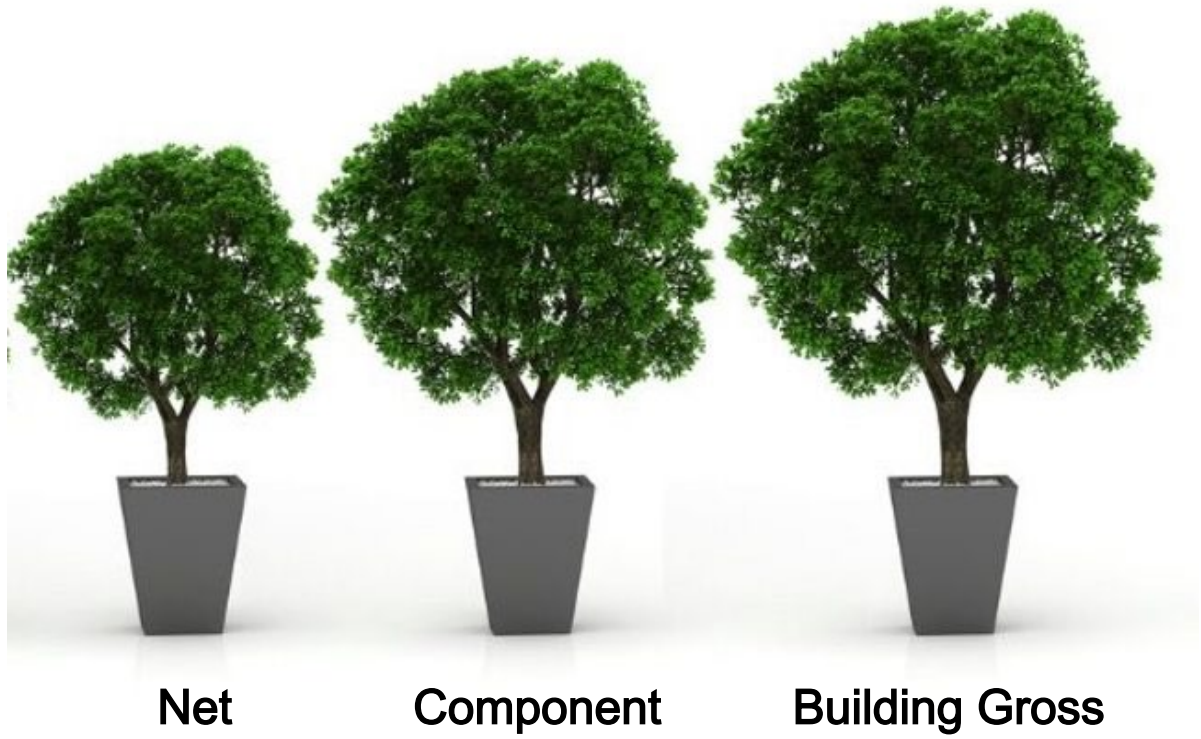
Program net, component and building gross areas are growing

**Quality Care Environment:**

- Codes, standards well established
- PSOS/SoR rules - meet and exceed

**Low Carbon Healthcare**

- Scope not clearly defined
- Limited codes/standards/guidelines
- Not fully embedded in PSOS/SoR

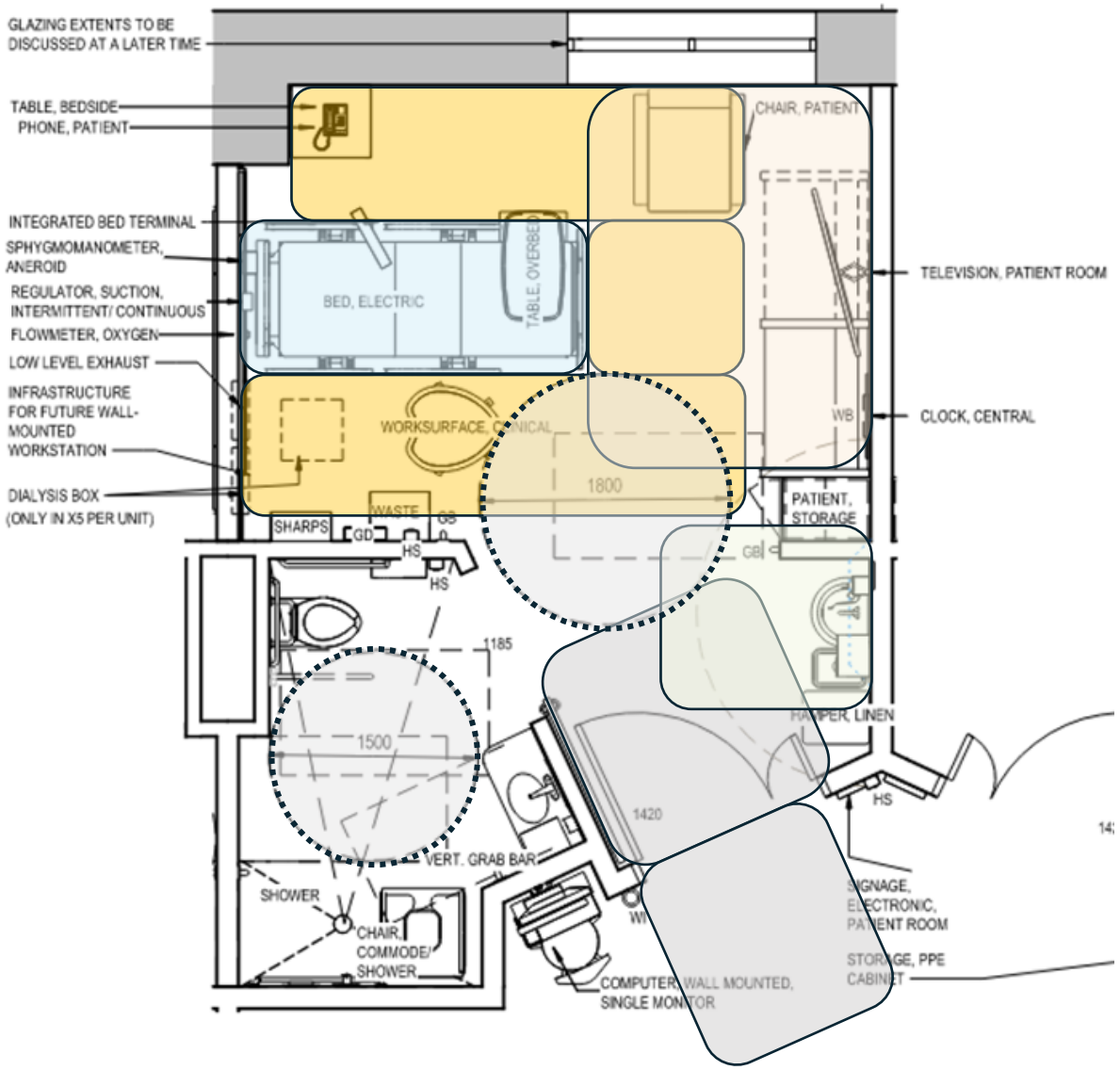


# Ongoing Growth in Hospital Building Area

**Net Area (room) growth:**

Drivers:

- Codes/Standards
- IPAC
- Accessibility
- FFE
- Patient/Staff safety



# Ongoing Growth in Hospital Building Area

**Component Area (departmental) growth :**

Drivers:

- Segregation of flow
  - On stage/off stage
  - Separation of clean/soiled
- Standardization
- Single patient rooms
- Privacy/dignity (e.g. registration)

| Row Labels | Program Grossing Ratio | Design Grossing Ratio |
|---|---|---|
| AMB SERV. - MED SURG | 1.47 | 1.60 |
| AMB SERV. - WOMEN AND CHILD | 1.48 | 1.50 |
| MENTAL HEALTH AMB | 1.46 | 1.52 |
| CRITICAL CARE | 1.53 | 1.61 |
| MATERNAL NEWBORN | 1.57 | 1.61 |
| MED SURG | 1.55 | 1.67 |
| MENTAL HEALTH | 1.55 | 1.70 |
| NICU | 1.49 | 1.60 |
| PAEDIATRIC | 1.55 | 1.60 |
| CARDIAC CATHERIZATION | 1.52 | 1.56 |
| CARDIAC CLINICS AND DIAG | 1.48 | 1.61 |
| DIAGNOSTIC IMAGING | 1.49 | 1.69 |
| EMERGENCY DEPARTMENT | 1.70 | 1.84 |
| ENDOSCOPY | 1.55 | 1.56 |
| RENAL IMPATIENT DIALYSIS | 1.48 | 1.54 |
| LAB MED & GENETICS | 1.39 | 1.44 |
| PHARMACY | 1.34 | 1.37 |
| SURGICAL INTERVENTIONAL | 1.54 | 1.55 |
| CORPORATE ADMIN | 1.28 | 1.30 |
| HUMAN RESOURCES | 1.30 | 1.38 |
| INFORMATION SERVICES | 1.25 | 1.31 |
| INTERPROF EDU & LEARN | 1.29 | 1.35 |
| PROFESSIONAL PRACTICE | 1.30 | 1.04 |
| PATIENT REGISTRATION | 1.38 | 1.40 |
| PUBLIC AREAS RETAIL AND AMENITY | 1.18 | 1.15 |
| RESEARCH AND INNOVATION | 1.31 | 1.38 |
| SPIRITUAL CARE | 1.28 | 1.27 |
| STAFF + MED STAFF | 1.29 | 1.39 |
| VOLUNTEER RESOURCES | 1.25 | 1.39 |
| BIOMEDICAL | 1.31 | 1.18 |
| COMMAND CENTRE | 1.32 | 1.35 |
| CORPORATE SERVICES | 1.17 | 1.13 |
| FACILITIES | 1.50 | 1.55 |
| MATERIALS MANAGEMENT | 1.17 | 1.19 |
| MDRD | 1.38 | 1.45 |
| FOOD SERVICES | 1.25 | 1.28 |
| SECURITY SERVICES FIRE AND LIFE SAFETY | 1.30 | 1.54 |
| Grand Total | 1.47 | 1.54 |

# Ongoing Growth in Hospital Building Area

**Building Gross Area growth:**

Drivers:

- Building systems
  - Mechanical systems
  - ATS systems (AGV, AMR, chutes, etc)
- Redundancy codes/standards
- Flexibility, Adaptability, Expandability
- 'Special Features' (COVID, amenities)
- Electrification

| Era | BGA Gross-up* |
|---|---|
| 2010-2015 | ~ 1.45 - 1.50 |
| 2016-2020 | ~ 1.47 - 1.55 |
| 2020 to present | ~ 1.49 - <1.6 |
| *BGA/CGA (departmental) Acute care hospital s | Based on Parkin projects |

Example - new 500-600 bed acute care facility:

- 1,000,000 CGA x 1.45 = 1,450,000 BGA
- 1,000,000 CGA x 1.55 = 1,550,000 BGA

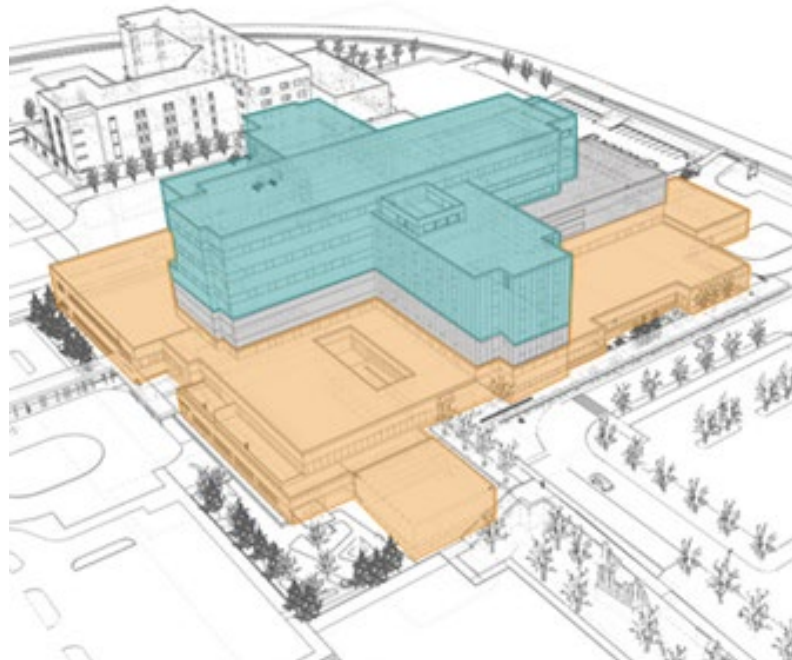
- **100,000 BGA increase**

Hospital Building Area

# Corner Brook Acute Care Hospital

## Efficient Planning Drivers

- Relaxed PSOS rules
  - Adjacencies, travel distances, etc.
  - Stacked podium & tower
  - Centralized circulation core
  - Leveraged sloping site
- Cruciform IPU plan
- Efficient clinical planning
- Geothermal heating/cooling



# Corner Brook Acute Care Hospital

## Efficient Clinical Planning

- Significantly reduced building gross and departmental (component) area compared to similar facilities
- 15% less floor area

**The Most Efficient Acute Care Hospital We Have Designed to Date.** Without compromising the required net room areas and functionality, the design achieved 15% less building grossing factor and 10% less departmental grossing factors on average than comparable facilities – resulting in operational savings including:

- Reduced energy use of 1,500,000 kWh annually, saving over **$125,000/yr** in electricity costs
- Maintenance savings of approximately **$240,000/yr**
- Estimated hospital operational savings of approximately **$100,000/yr** through a reduction in "sneaker time" and other efficiencies

**Building Gross/Departmental Gross/Net Area Comparison**

| Floor Area Ratios | CBACH | average | % | Hospital 1 | Hospital 2 | Hospital 3 | Hospital 4 | Hospital 5 | Hospital 6 |
|---|---|---|---|---|---|---|---|---|---|
| BGA to Program Net | 1.96 | 2.31 | 84.85 | 2.4 | 2.21 | 2.35 | 2.19 | 2.37 | 2.34 |
| DGA to Program Net | 1.41 | 1.56 | 90.48 | 1.55 | 1.52 | 1.5 | 1.51 | 1.59 | 1.68 |
| BGA to DGA | 1.39 | 1.50 | 92.56 | 1.55 | 1.46 | 1.57 | 1.45 | 1.59 | 1.39 |

Note: Building areas shared by PCL from 6 recently completed acute care hospital projects. Projects names are confidential.

# Ongoing Growth in Hospital Building Area

**Increased scrutiny on:**

- Codes, standards, guidelines
- PSOS/SoR rules
- NSA/CGA/BGA analysis
- Planning innovations

**Too Big?**

**Just Right?**

**Still Growing?**

# Impact of Electrification

# Electrification: Innovation Across Canada

## Projects Across Canada

- Cornerbrook, Newfoundland
- Cowichan, BC

Electrification

# Cowichan Hospital Performance Targets

## Project Targets

Minimize Greenhouse Gas Emission *4.182 kgCO2e/m²/year*

Maximize Energy Efficiency *392 kWh/m²/year*

Embodied Carbon 15% reduction on baseline

## Additional Project Targets

CaGBC Zero Carbon Building Design

☑ LEED Gold: Optimize Energy Performance

# Cowichan– Mechanical System Overview

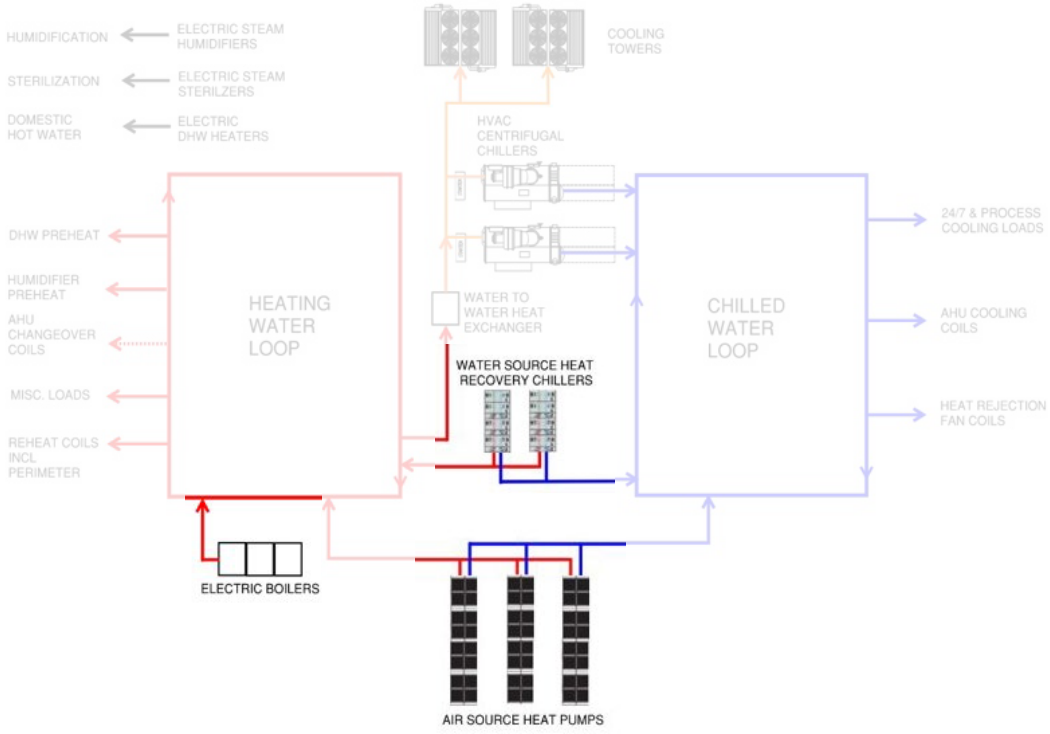
## Drivers Energy Consumption

**Large ventilation and air flow demands:**

- Large fans to move air
- Significant energy used for heating and cooling
- Large humidification loads

**Heating and cooling plant design:**

- Heating and cooling sequence which optimizes high efficiency systems: Heat recovery chillers > Air sourced heat pumps > Electric boilers
- Heat recovery chillers to optimize the use of “waste heat” for heating the building



# Cowichan – Full Electrification Overview

### Mechanical Systems
Fully electrified mechanical systems, electrification of kitchen equipment and photovoltaic array support in achieving:
- 336kWhr/m2/yr
- 3.5kgCO2e/m2

### Energy Capture and Reuse
Heat produced by the mechanical systems, like heating and cooling systems, is captured and used to preheat water and air, reducing overall energy consumption.

### Process Load
Steam / humidification and DHW fully electrification.

### Renewable Energy
Onsite solar panels provide carbon-free power, supplying more than 2% of the hospital's energy needs. The carbon savings are the equivalent of taking 38 passenger cars off the road each year.

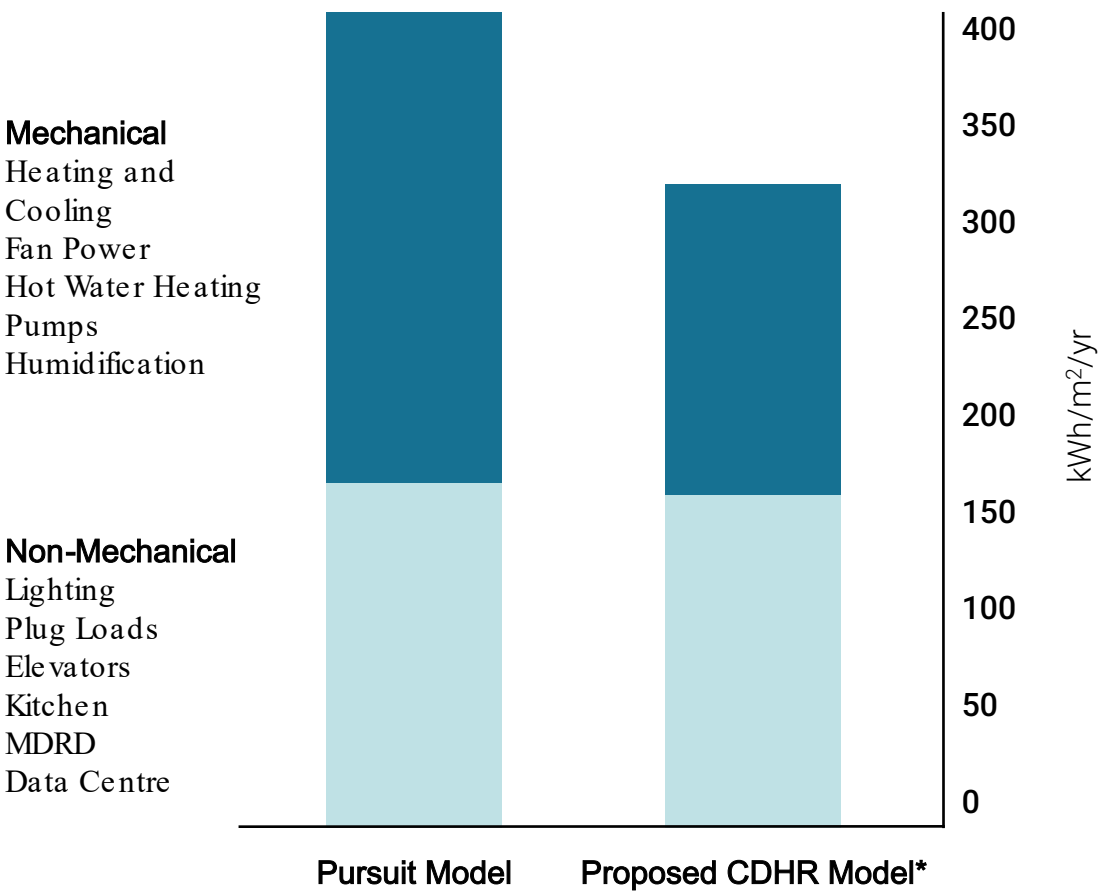
### Reduced Energy Demand
LED lighting will be used throughout the hospital, using 75% less energy than incandescent bulbs.

### Minimized Heat Loss / Gain
A high performing building envelope minimizes heat loss. This includes insulated walls and roof and triple-glazed windows to the south and west of patient tower to minimize solar heat gain.

Electrification

# Cowichan – Operational Energy Use Intensity

## Results




ON TRACK FOR
20 POINTS

**LEED**
(17 points targeted of 20)
Alternative Energy Performance Metric

Energy Use Intensity Target
392 kWh/m²/yr

**CAGBC Zero Carbon Buildings**

* Interim results based on available information as of Nov 2023.

# Electrification - Considerations

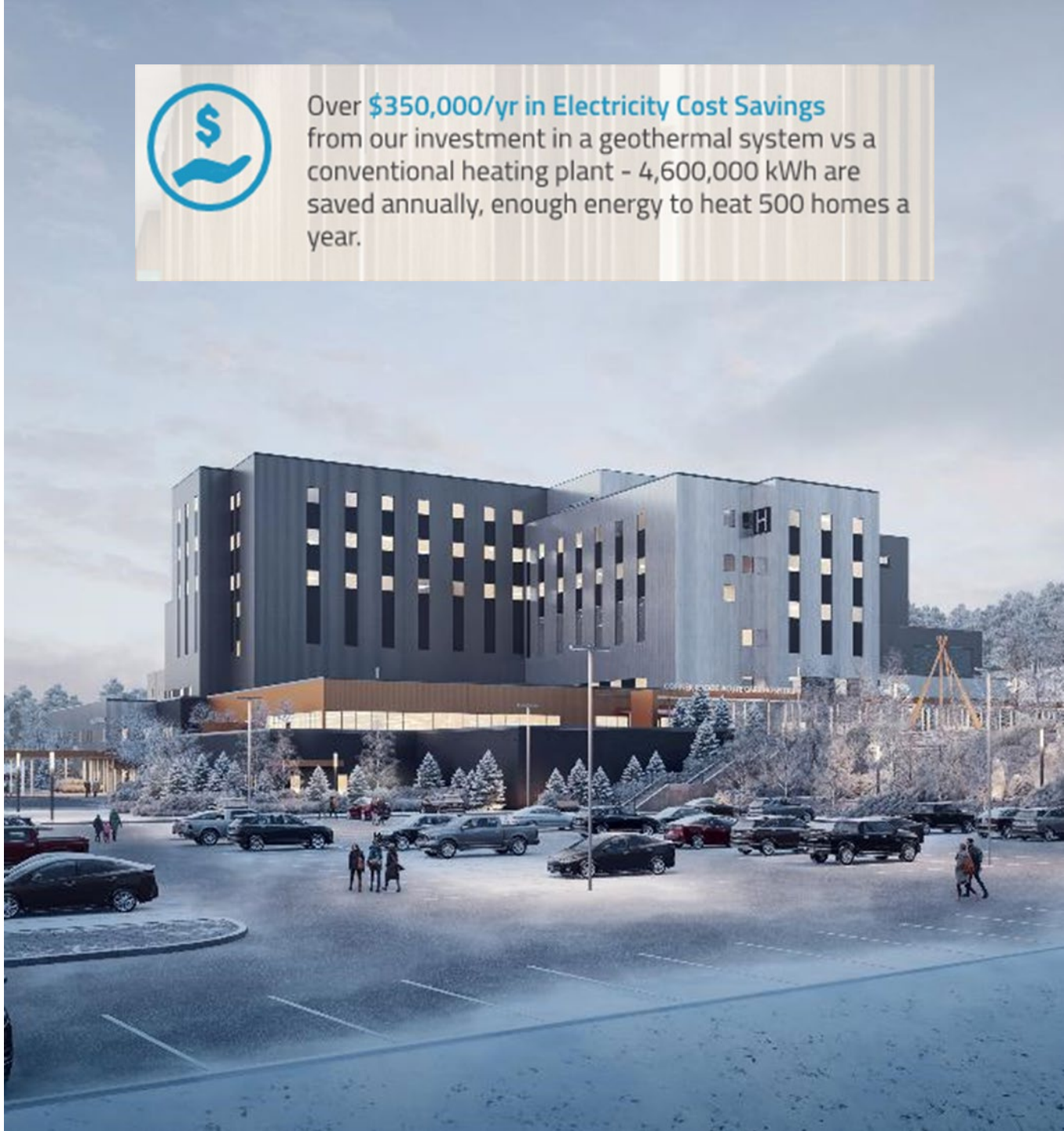
| | Full Electric | Hybrid | Gas Primary | Notes |
|---|---|---|---|---|
| Clinical | | | | Consideration to increased floor area for electrification |
| Operational Carbon | | | | Electrification provides opportunity to meet carbon reduction targets |
| Embodied Carbon | | | | |
| Building area | | | | Considering gas as the base<br><br>Many issues at interplay |
| First Capital Cost | | | | |
| Generator size | | | | |

Synergy  Conflict

Electrification

# Corner Brook Performance

- Lack of natural gas in Newfoundland and Labrador for traditional heating and cooling systems
- Seeking Cost Effectivesolutions that positively-affect the surrounding environment
- **Geothermal System** ideal low-energy and low-emission solution for heating and cooling proposed by Corner Brook Health Partnership (Project Co.)

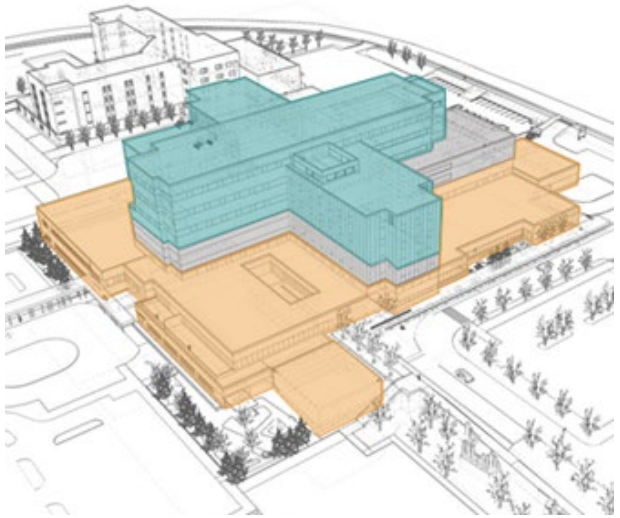


Electrification

# Corner Brook Performance

## Overview

- **DBFM** (P3) Project
- **$700M** (NPV)
- **~600,000 sf**
- 164 beds (replacement)
- Substantial Completion– Nov 2023



Electrification

# Corner Brook Performance

## Largest Geothermal System in Canadian Healthcare

- Geothermal field stretching 96,000’ (29,300m)
- ~375 boreholes
- 600’ deep
- ~500,000’ of piping

## Zero-emissions* for heating & cooling

*including hydro electric power

Electrification

# Corner Brook Performance

## The Payback

- 17-year simple payback period (based on current electricity costs)
- True payback period anticipated to improve over lifecycle (as carbon pricing goes up)
- Energy modelling team (Footprint) project 35% energy cost savings

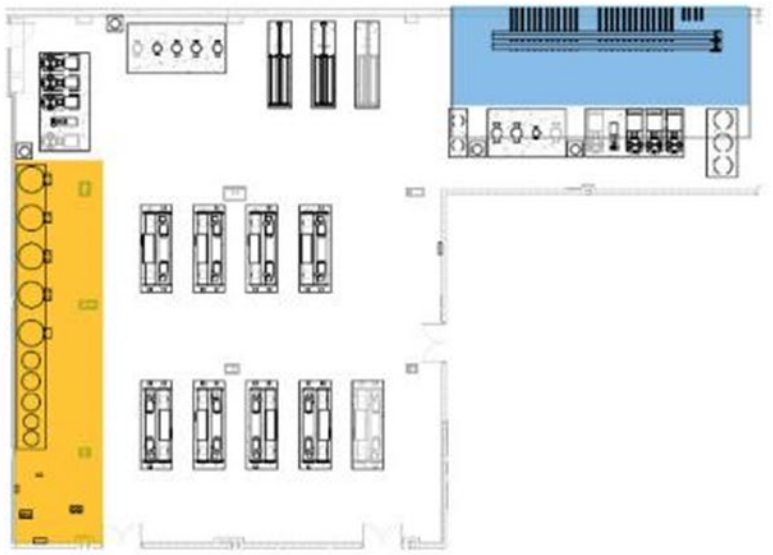
Steam Boilers and Equipment

Electrical/ICAT

Medical Gas Equipment

Additional Healting Boilers*

*Required if no geothermal



Domestic Hot Water Heaters

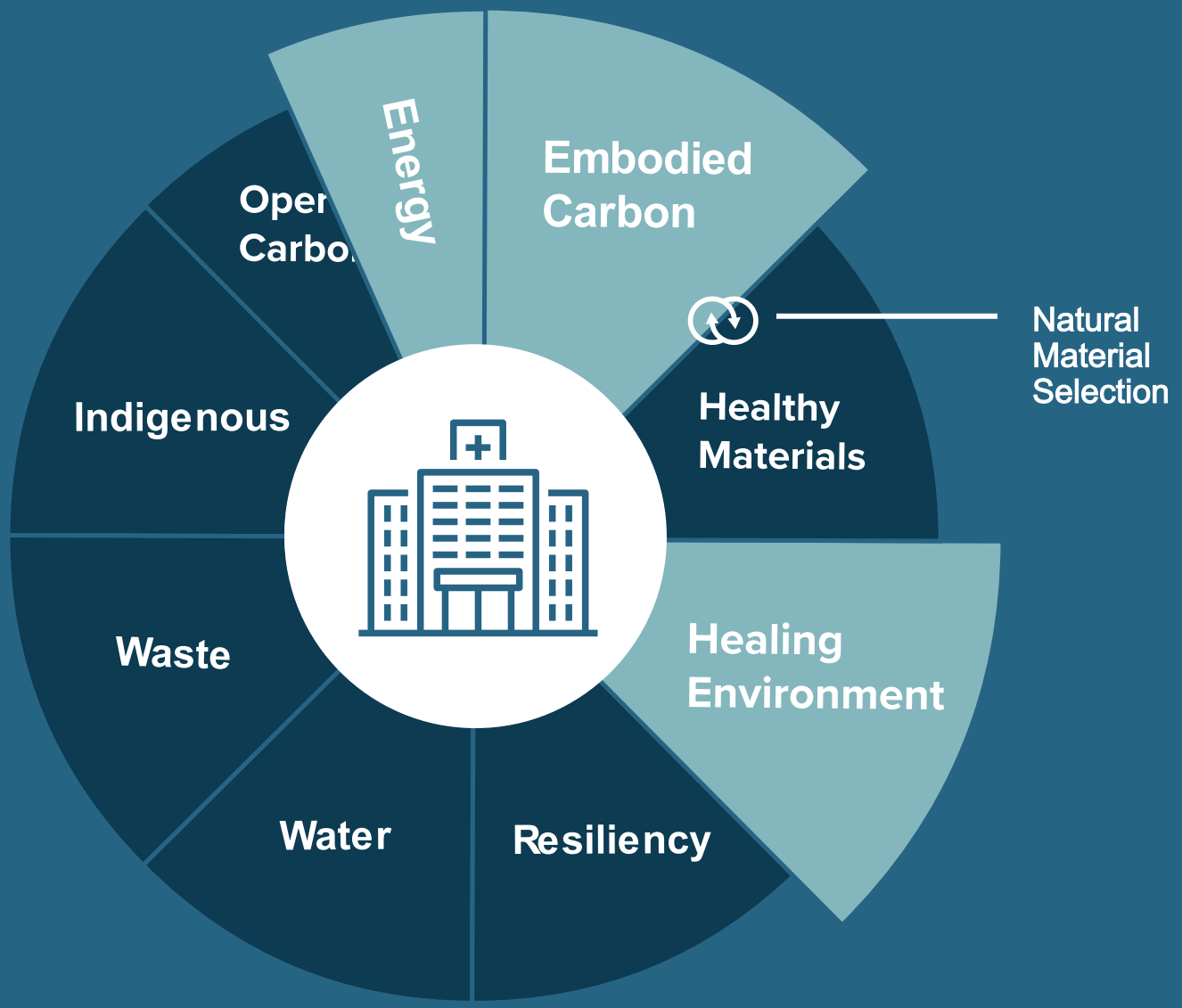
Geothermal Headers

Rest of Room:
Ground Source Heat Pumps System for Geothermal Heating & Cooling

Synergy

Conflict

# Embodied Carbon



# Building Performance & Sustainability

## What is Embodied Carbon?

- Carbon dioxide (CO2)or greenhouse gas (GHG) emissions associated with the manufacture and use of a product or service.

- Measured via global warming potential (GWP), andquantified in kilograms of $CO_2$ equivalent (kg $CO_2$ e).

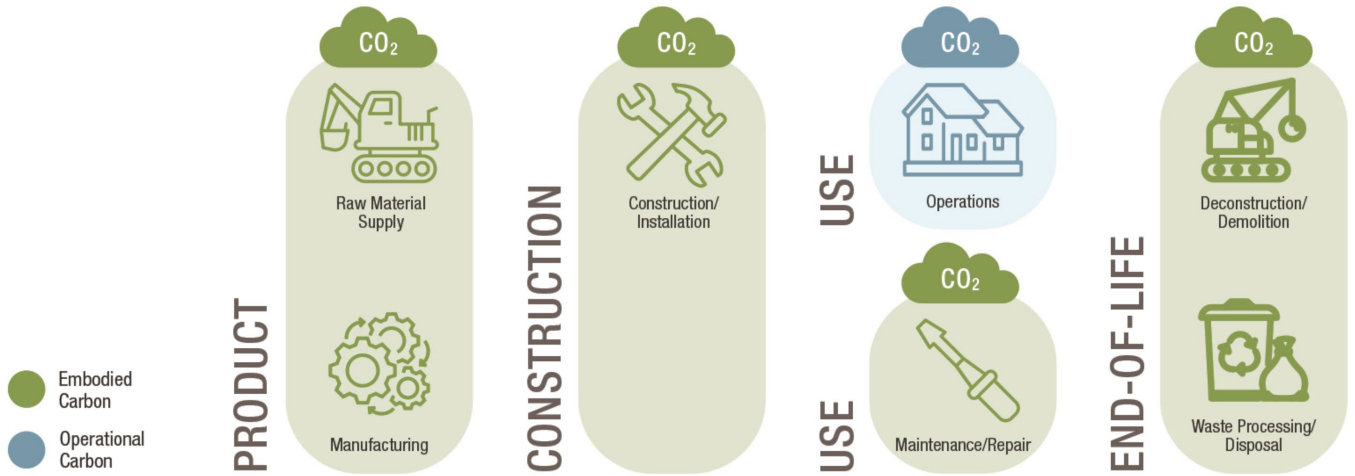



Image credit
: https://www.armstrongceilings.com/commercial/en/performance/sustainable-building-design/embodied-carbon-in-buildings.html

# Building Performance & Sustainability

## How is Embodied Carbon Measured?

**Life Cycle Assessment (LCA )–** Evaluation of the impacts of products/ or service on the environment throughout its life span.

**Environmental Product Declaration (EPD):**

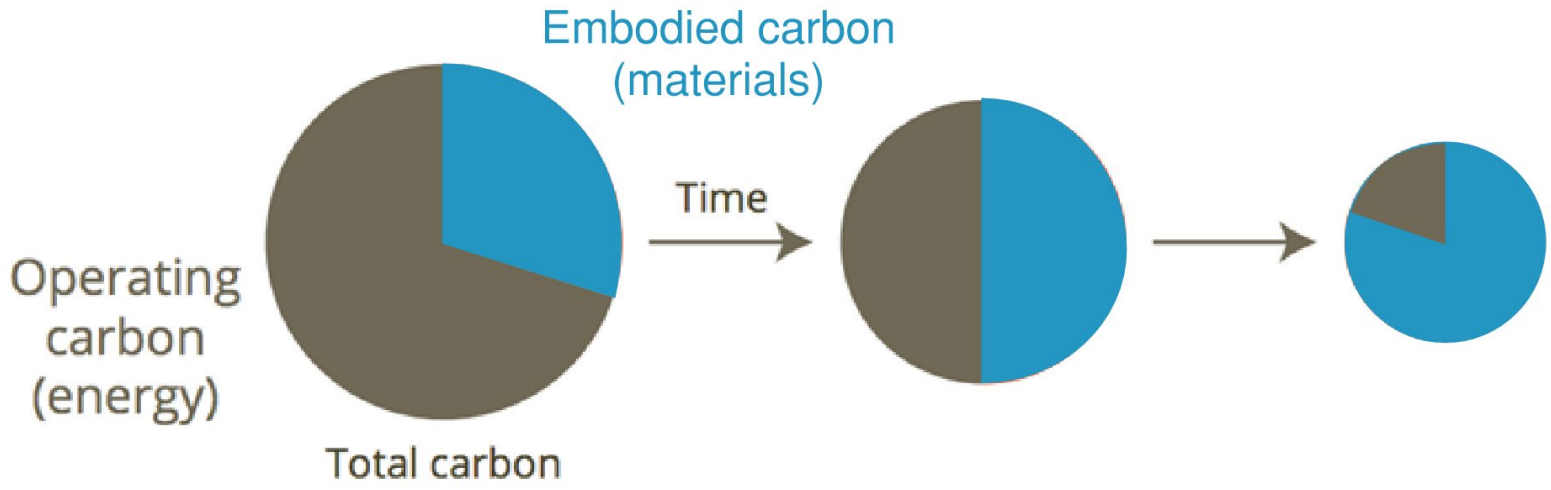
standardized declaration for a product or product family that offer a comparable, objective and third party verified environmental performance.


Image credit
https://pre-sustainability.com/articles/life-cycle-assessment-lca-basics/

# Building Performance & Sustainability

## Why is Embodied Carbon an important Metric?

- Accounts for approximately 30% of the overall emissions over the lifecycle of a building
- As buildings become more efficient, embodied carbon is a significant contributor to emissions for the project.

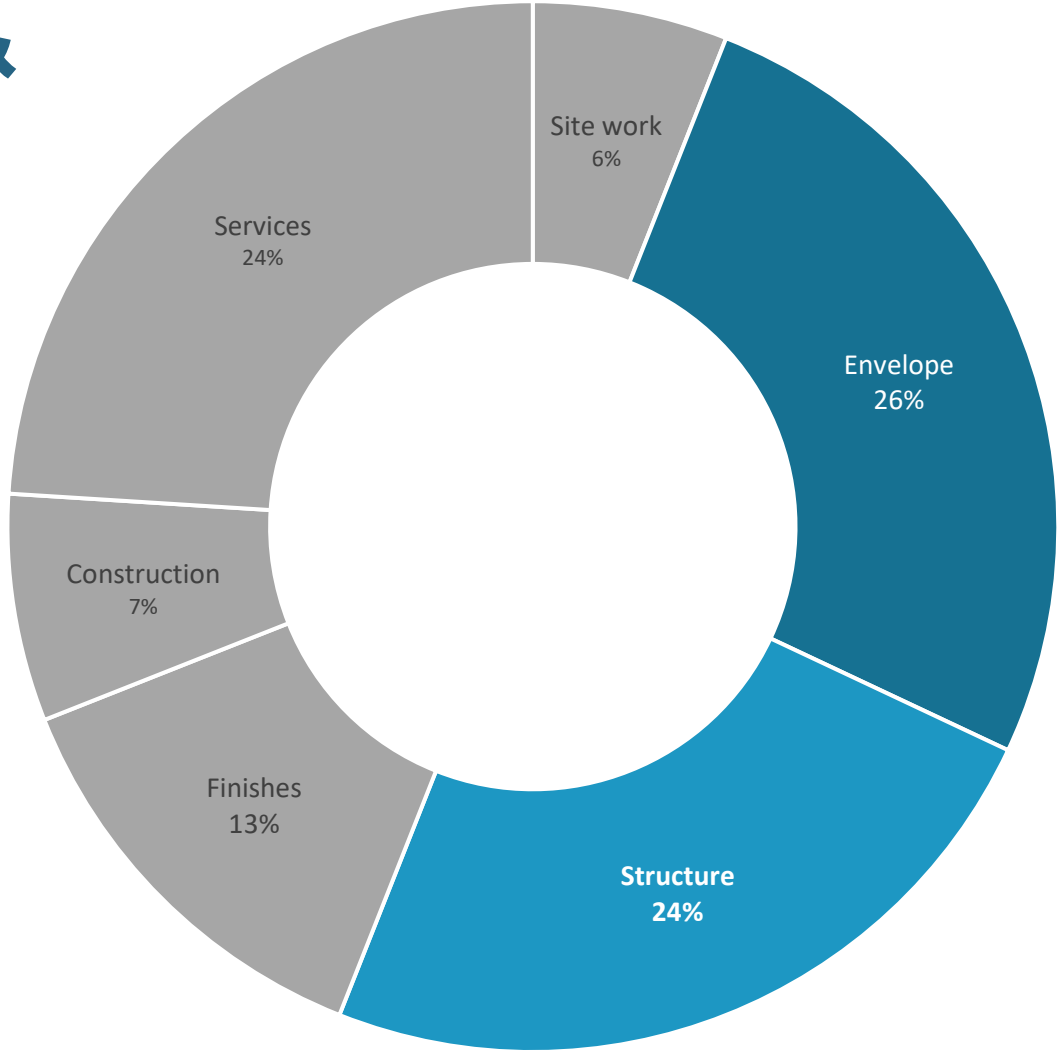


Embodied Carbon

# Building Performance & Sustainability

**Where in a building  is the significant stores of Embodied Carbon?**

Envelope & Structure accountfor over half of embodied carbon emissions for the building



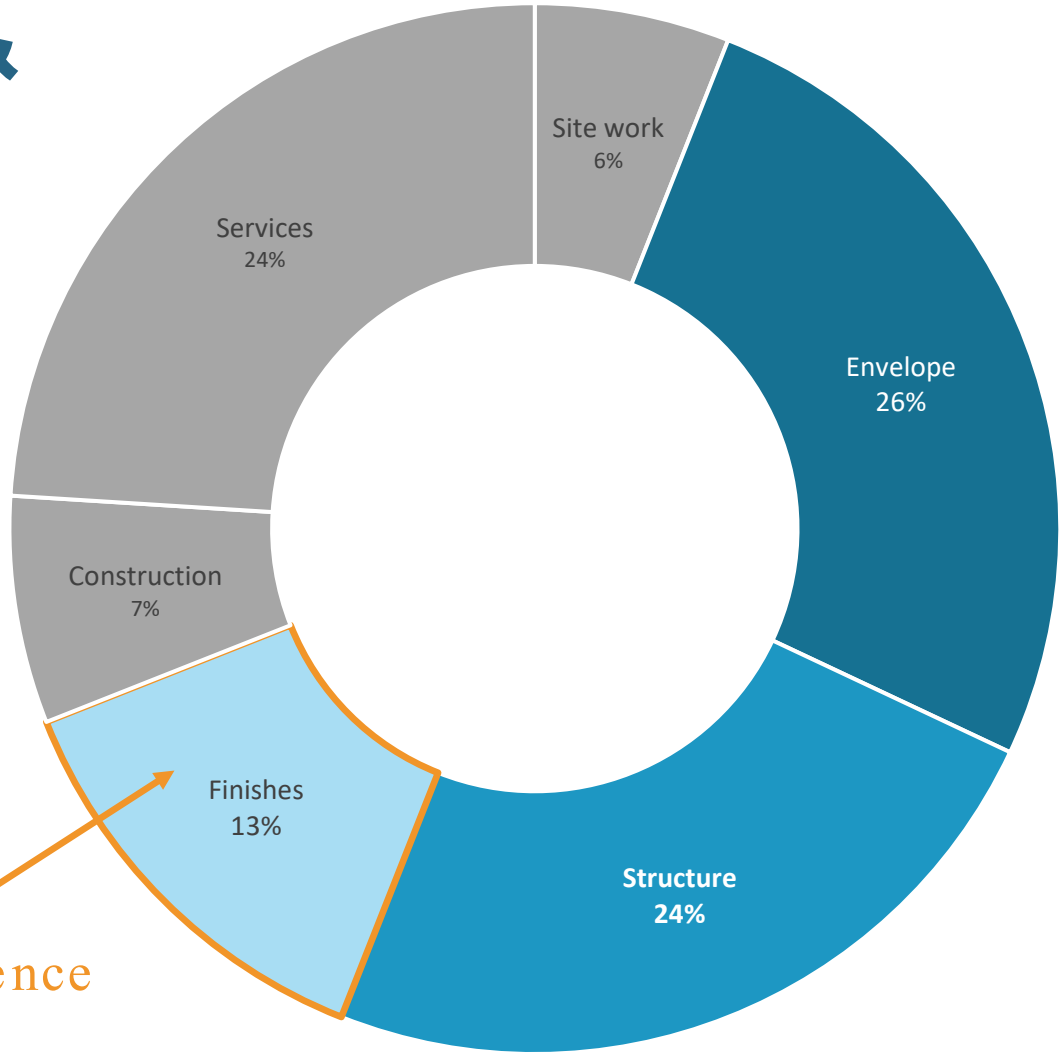

*Source: Cole and Kernan, 1996*

Embodied Carbon

# Building Performance & Sustainability

## Interior Finishes

Interior Finishes account for over 13% of overall carbon footprint of building.



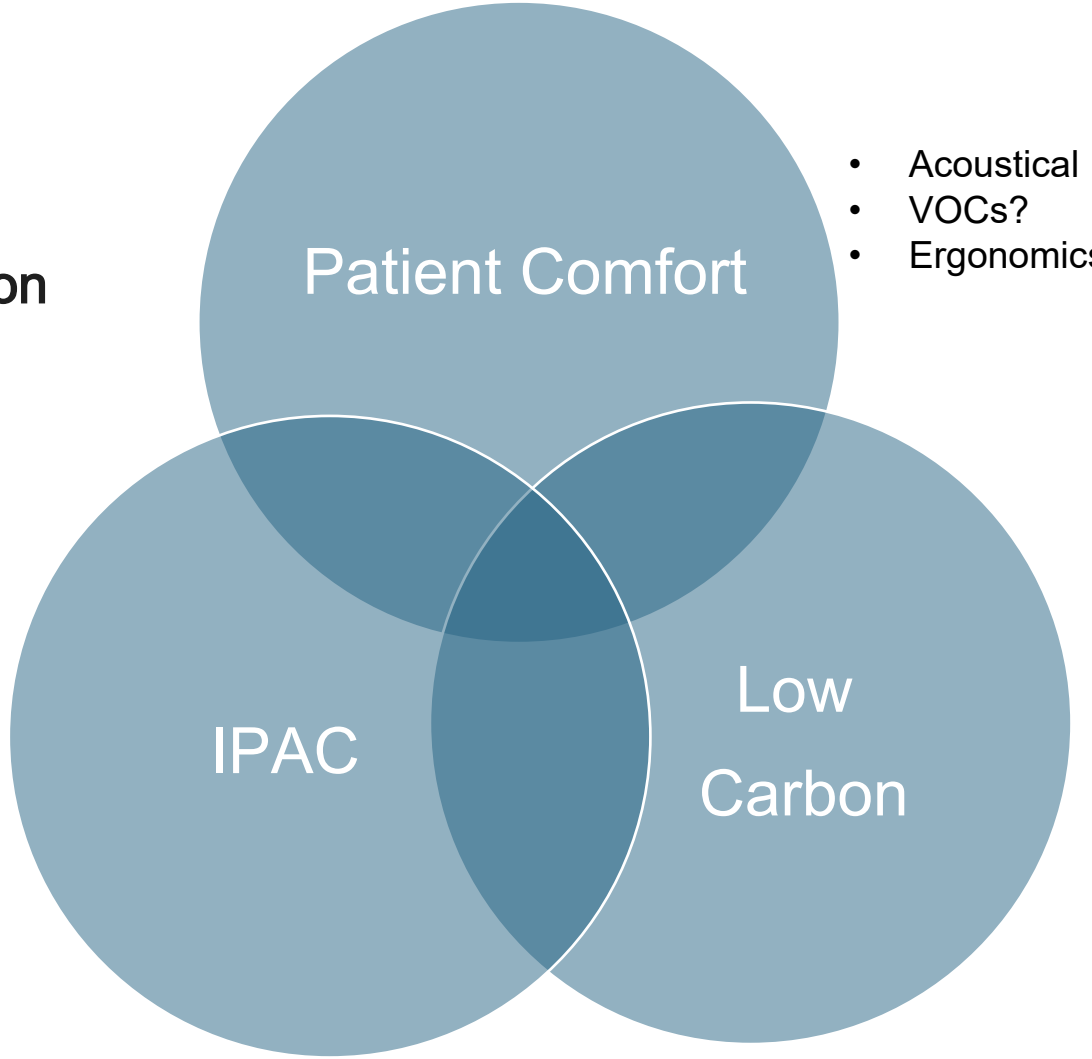

*Source: Cole and Kernan, 1996*

Embodied Carbon

# Building Performance & Sustainability

## Interior Finishes

### Complex Contextual Conversation




- Acoustical Properties?
- VOCs?
- Ergonomics/ Flexibility?

- Cleanability?
- Durability?
- Appropriate environment?

- Where is the product Sourced?
- End of life state?
- (ie can it be recycled?

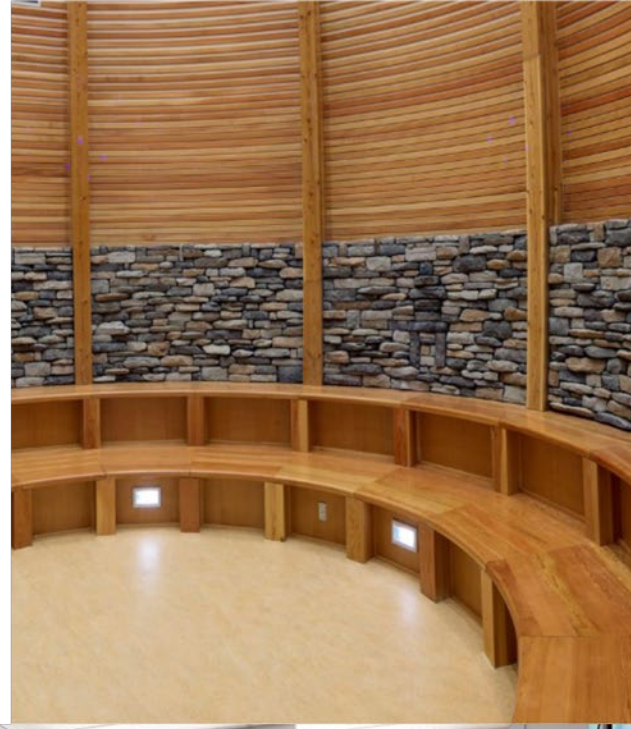
Embodied Carbon

# Building Performance & Sustainability

## Interior Finishes

Wood Finishes are widely advocated as both restorative biophilic design elements and low carbon interior finishes.

IPAC consideration.



# Interior Finishes - Considerations

| | Natural Wood | Wood Look Laminate | Notes |
|---|---|---|---|
| Patient Experience/ Clinical Excellence | | | Considerations for impact to acoustics, Air Quality.. |
| IPAC (cleaning protocols) | | | * |
| Embodied Carbon | | | * Impacted by regional sourcing, material composites, and end of life process (ie. Capacity to recycle? Cradle to cradle considerations?). |
| Esthetics | | | |
| Durability | | | *Impacted by capacity to repair over life of product. |
| Initial First Cost | | | |

Synergy  Conflict

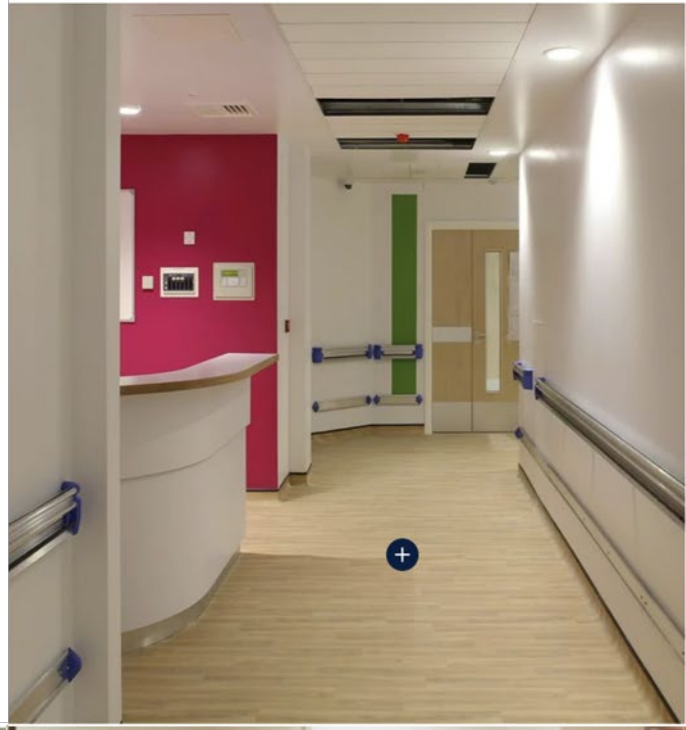
Embodied Carbon

# Building Performance & Sustainability

## Interior Finishes

Flooring: Rubber vs Vinyl vs Linoleum

Considerations: Patient/Staff Comfort, IPAC, VOCs, Regional Sourcing.



# Interior Finishes - Considerations

| | Rubber Flooring | Linoleum | Vinyl Sheet | Notes |
|---|---|---|---|---|
| Patient Experience/ Clinical Excellence (Acoustics/ Soft Underfoot/VOCs) | | | | Considerations for impact to acoustics, Air Quality, impact on staff fatigue… |
| IPAC (cleaning protocols) | | | | |
| Embodied Carbon | | | | ** Impacted by regional sourcing. |
| Esthetics | | | | |
| Durability | | | | **Impacted by installation protocols, foot traffic, |
| Initial First Cost | | | | |

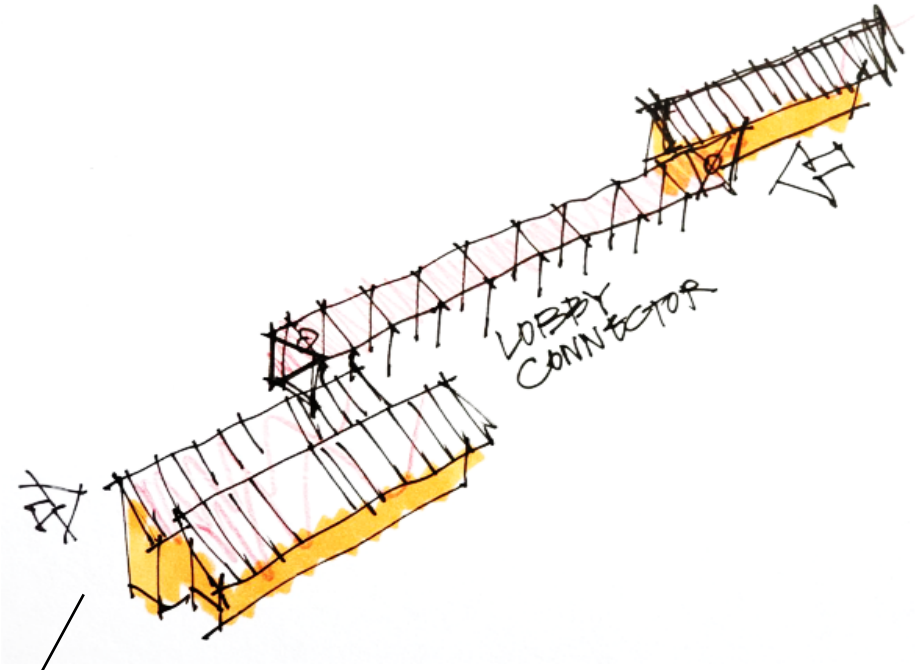
Synergy Conflict

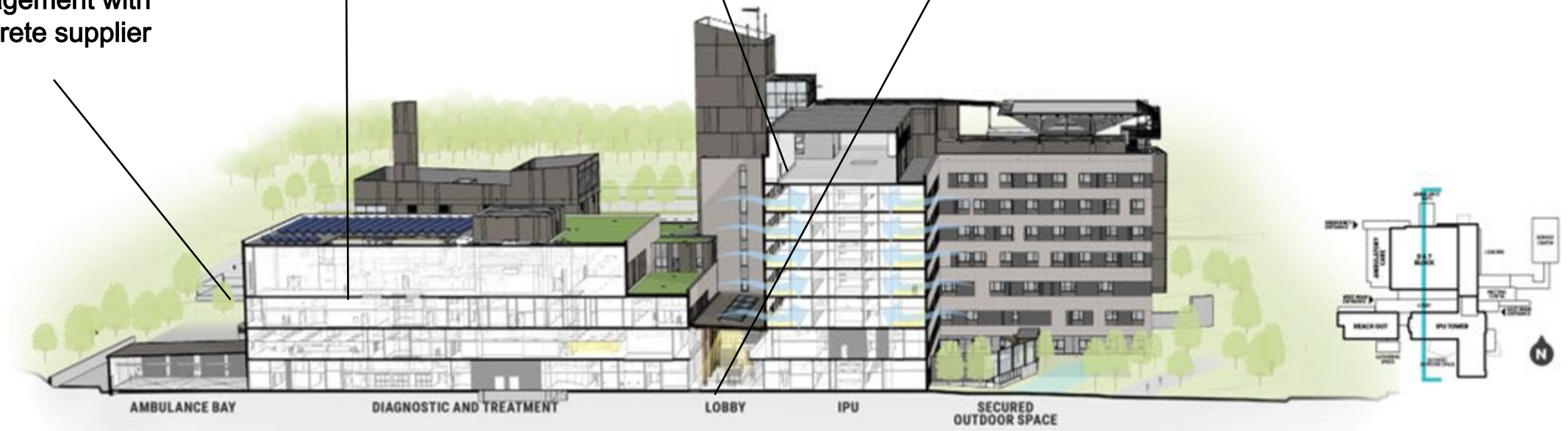
# Cowichan Embodied Carbon Approach

Low Embodied Concrete, early engagement with concrete supplier

Electric Arc furnace sourced rebar

Insulation with max GWP limits

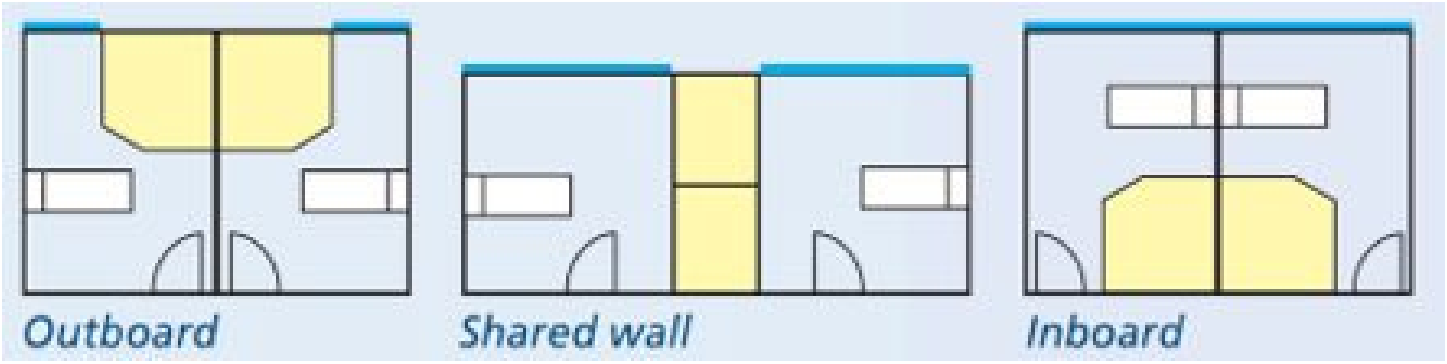


# The Inpatient Room Module

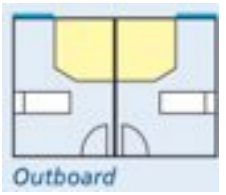
The Inpatient Room Module

# Clinical Delivery, Energy and the Patient Experience



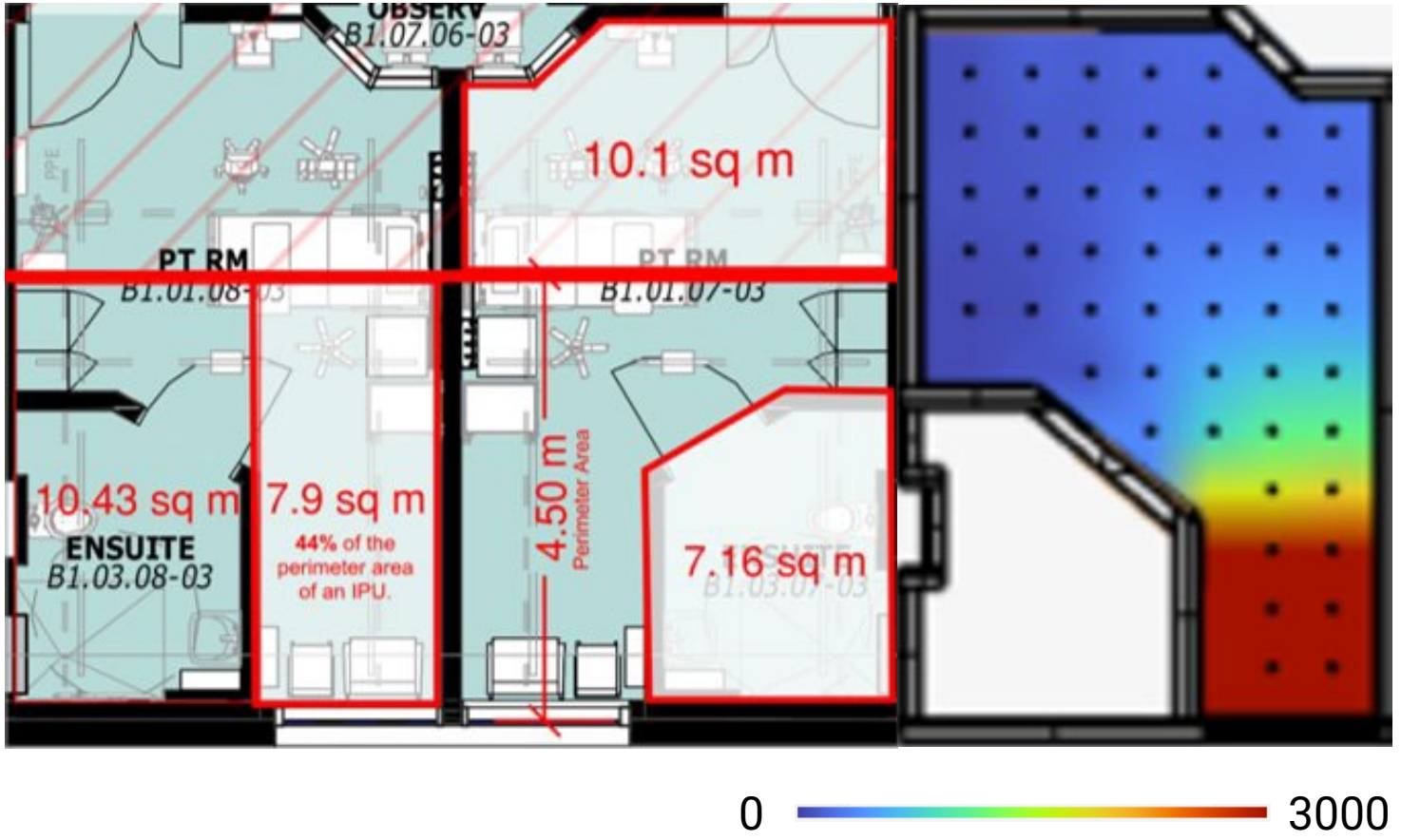
# Patient Washroom Location

## Outboard – maximum patient visibility from the corridor



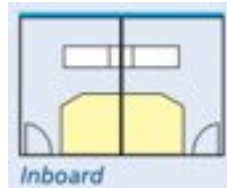

**BEST-CASE SCENARIO**
South-facing IPU showing
Av. Lux in daylit hours

- Staff visibility of patient
- Impact on patient privacy
- Impact on access to daylight and quality views

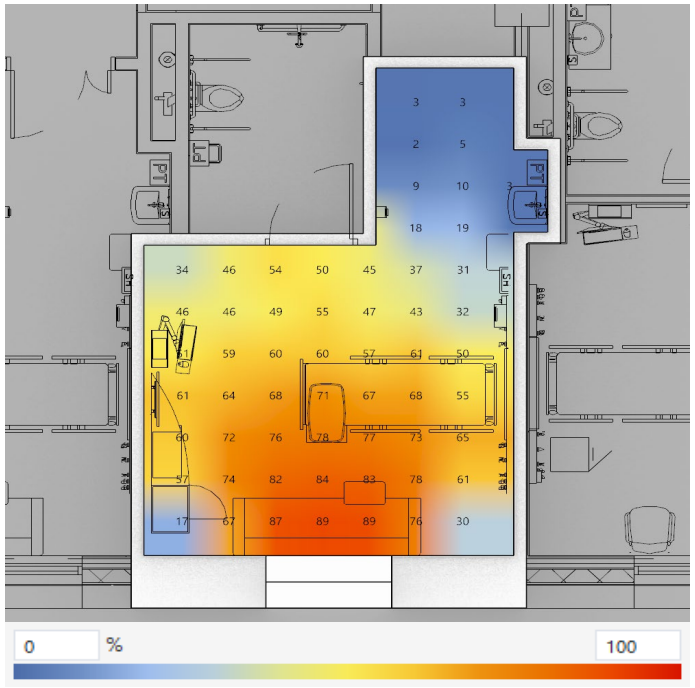


# Patient Washroom Location

## Inboard

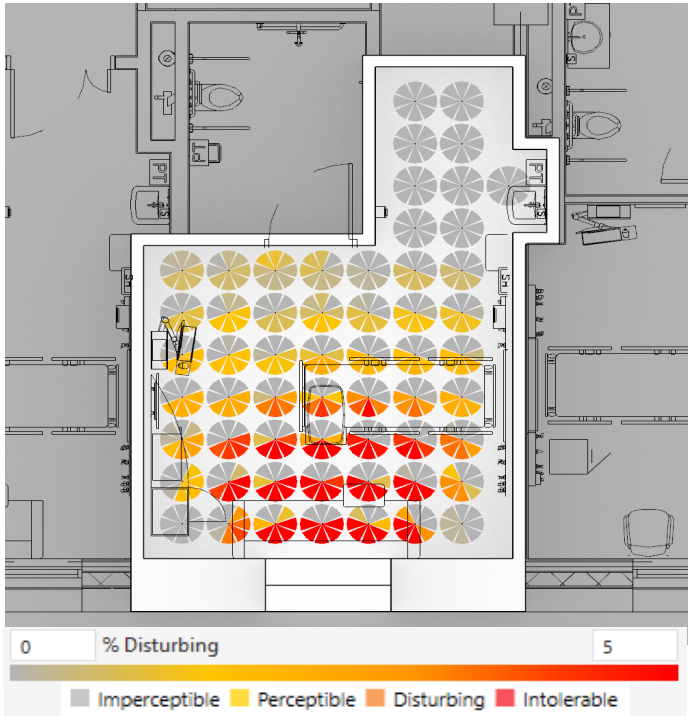



- Most space in family area
- Better Daylight and Quality views
- Reduces staff visibility of patient




**Target:**

Spatial Daylight Autonomy (sDA):
>55% = 2 LEED Points
>75% = 3 LEED points

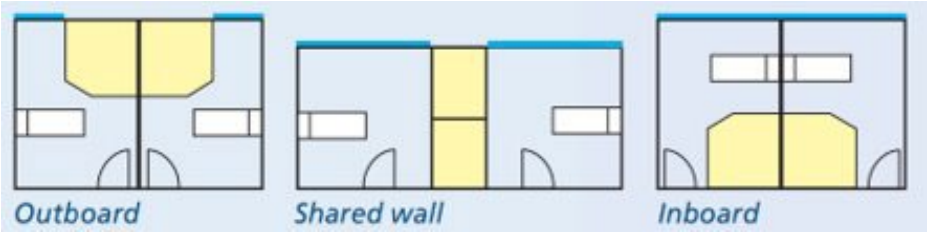



**Target:**

Annual Solar Exposure (ASE) (Directional Glare): <20%

*Based on sDA and ASE requirements by USGBC, CaGBC, and IWBI

# Patient Washroom Location - Considerations




| | Outboard | Shared / Nested | Inboard | Notes |
|---|---|---|---|---|
| Clinical (staff view of patient) | | | | Consider patient privacy concerns |
| Operational Carbon | | | | Increase in floor area leads to increase in conditioning needs |
| Embodied Carbon | | | | Increase in floor area leads to increase in materiality |
| Daylight and Quality View | | | | |
| Space in family zone | | | | |
| Acoustic separation | | | | |

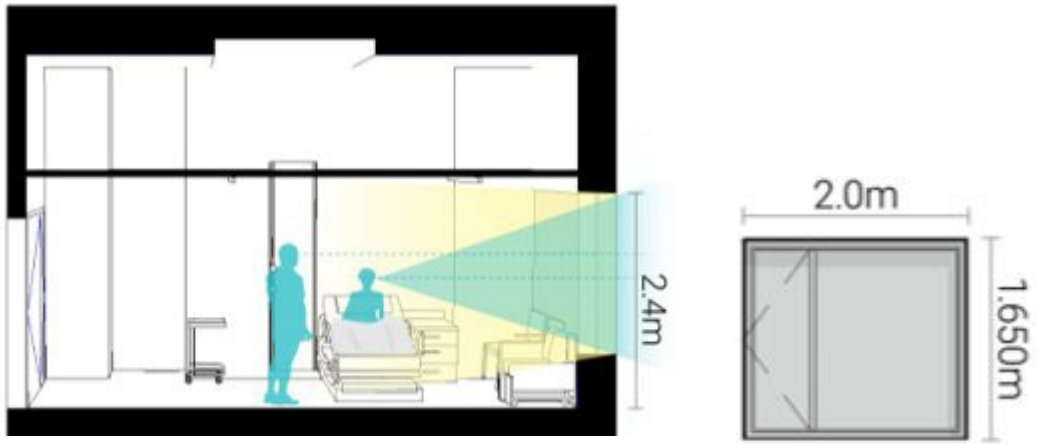
Synergy Conflict

The Inpatient Room Module

# Patient Window Sizing

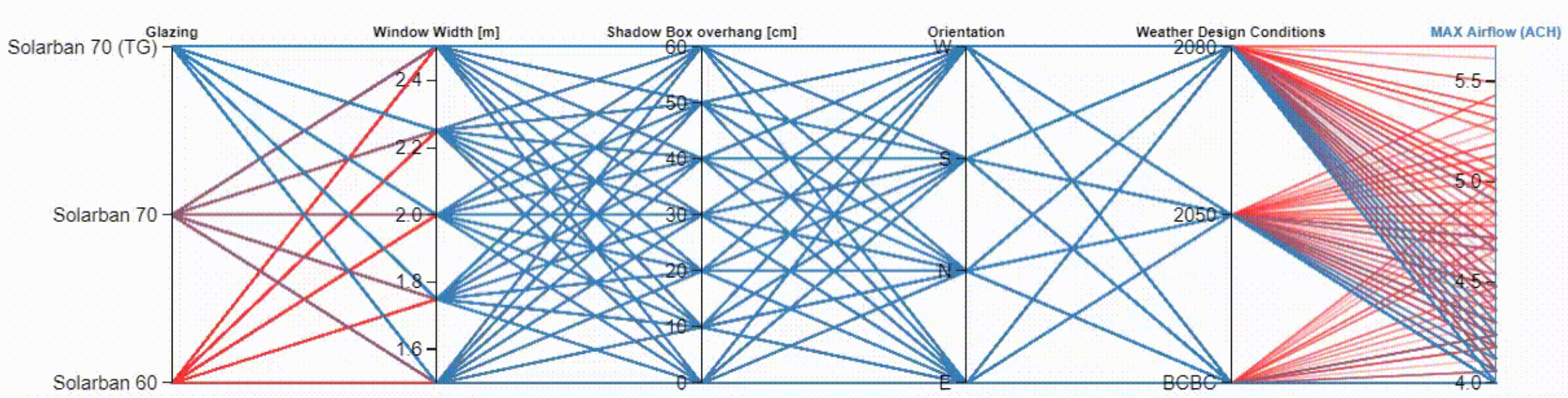
## Healing Environment

- Patient Room window size has been maximized to meet daylight and view out best practices
- Balanced with the peak cooling load – keeping system at 4ACH
- Window at 35.52sf




# Patient Window Sizing

## Healing Environment




- 1,260 design options for window design

The Inpatient Room Module

# Consideration: Reduce Window Size

## 100% Outside Air in the Patient Tower (Southern Ontario)

**Mechanical PSOS Complaint Approach**

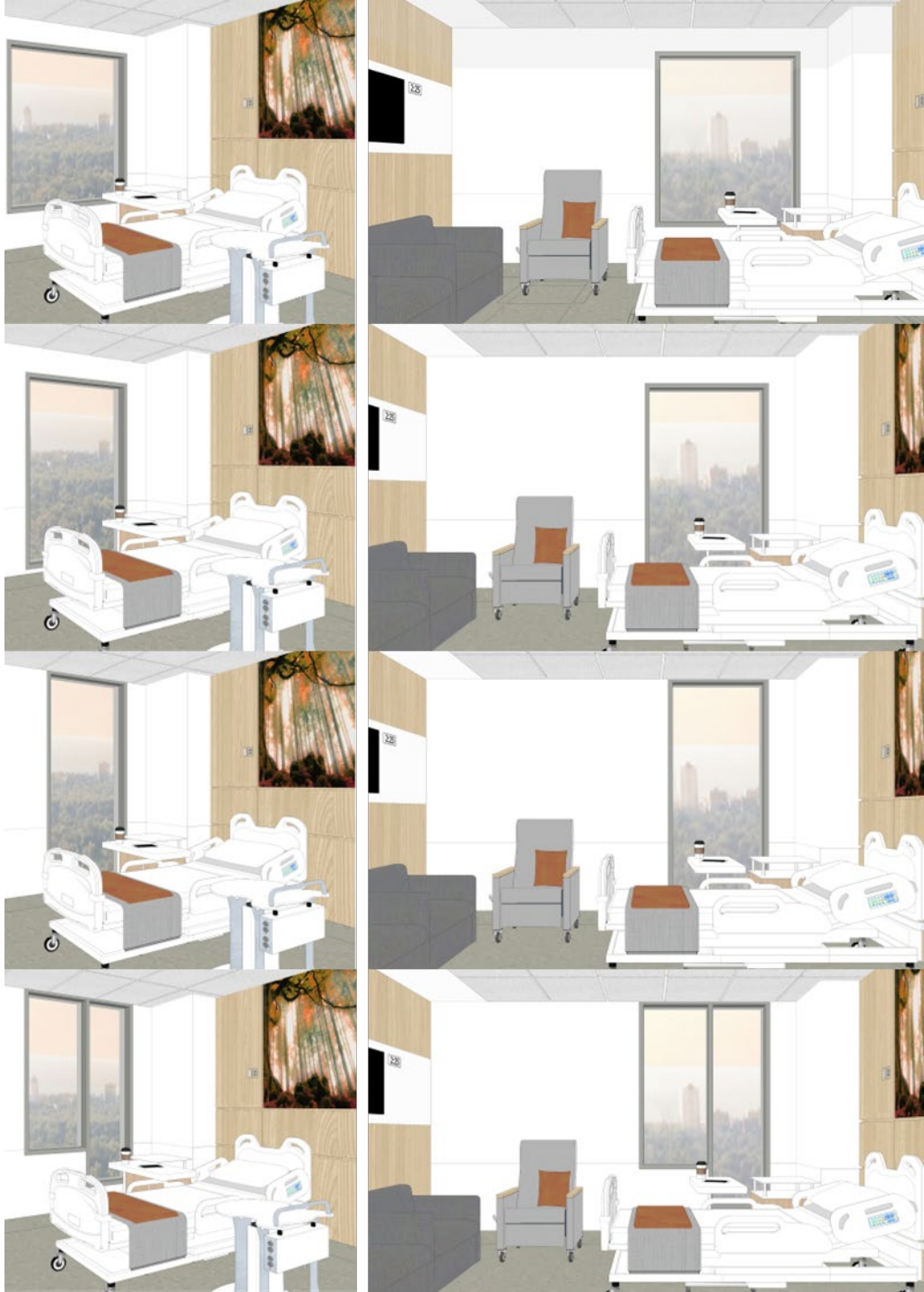
- Window at  42sf,
- 6ACH

**Proposed Approach: Reduce window size to 30sf**

- Provide 100% outside air in Patient Tower and target 4 ACH in patient rooms. [Dependent on envelope performance and window/ wall ratio.] Remaining areas of facility would operate in accordance with 1.4.5.12.4.1 / 1.4.5.12.4.2,

**Decision:**

- Reduce window nominally in inpatient rooms to coordinate with other descoping measures.



# Patient Window Sizing - Considerations

| | Small Window | Optimizing Window Size | 100% WWR | Notes |
|---|---|---|---|---|
| Clinical | | | | Improved healing environment (daylight and view out) |
| Operational Carbon | | | | Energy impact / mechanical size impact |
| Embodied Carbon | | | | |
| Other Considerations | | | | Coordinate with all disciplines to find balance<br>Local climate considerations |

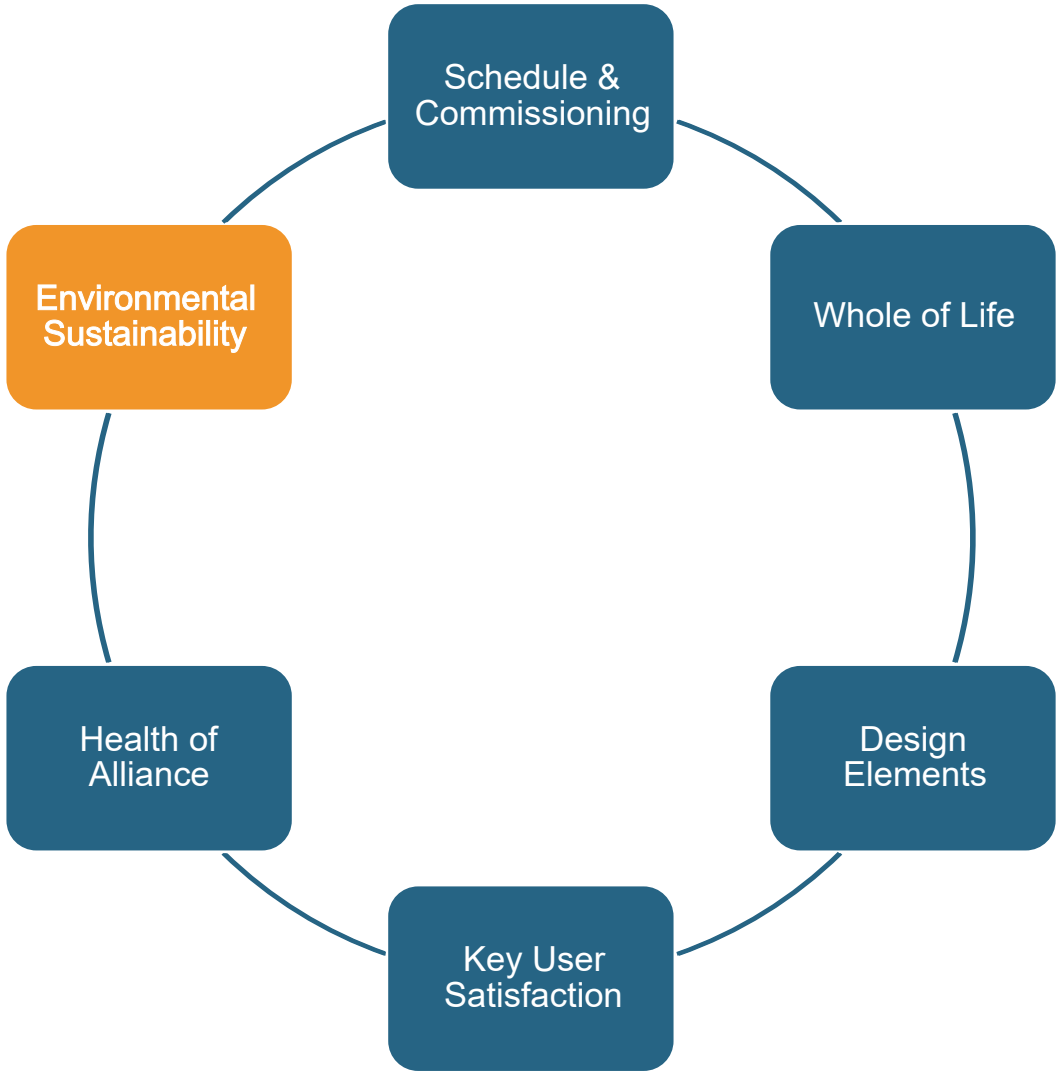
# Procurement Model

Path Forward

# Decarbonization in Healthcare

## Balancing objectives

- Key Performance Areas
- Key Performance Indicators

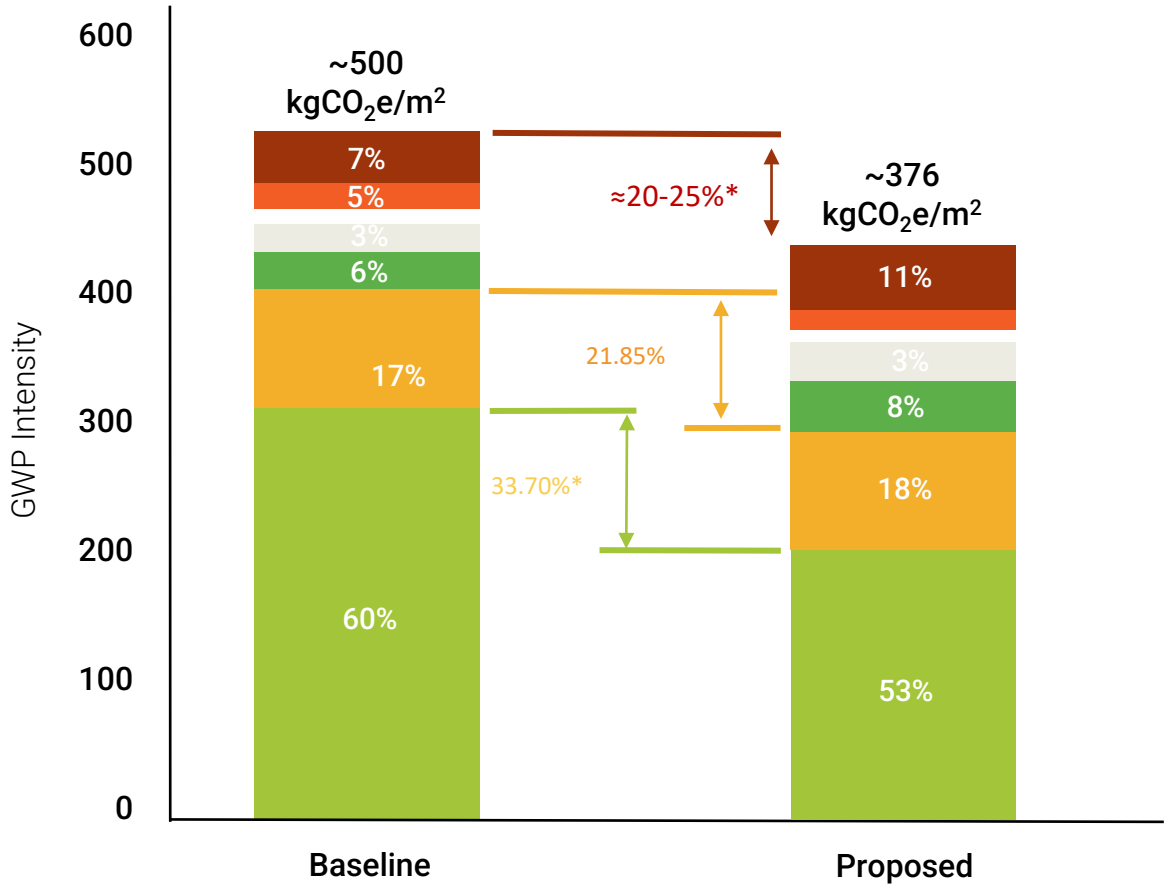


Path Forward

# Decarbonization in Healthcare

## Impact on contract models

- Allow flexibility for innovation
  - Pain share / gain share ~~—~~ Safe space to explore
- What is the project objective
  - Performance based targets



Path Forward

# Decarbonization in Healthcare

# Path Forward

Path Forward

# Optimizing Care and Environmental Sustainability

- **Low Carbon Healthcare - MANDATORY**
- Codes, standards, guidelines, policy
- Early inclusion (e.g. master planning, KPI's, etc)
- Leverage 'value driven' procurement models
- Focus on PSOS & SoR rules
- Designer/vendor innovations
- Business Case Analysis

# Q+A