Zero Carbon at University of Calgary

MacKimmie Tower Retrofit Case Study

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Office of Sustainability

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Agenda

- Climate Action Plan
- Project Context
- Tower Design Overview
- Tower Façade Construction
- Zero Carbon Performance
- Questions

DIALOG™

TRANS SOLAR
KlimaEngineering

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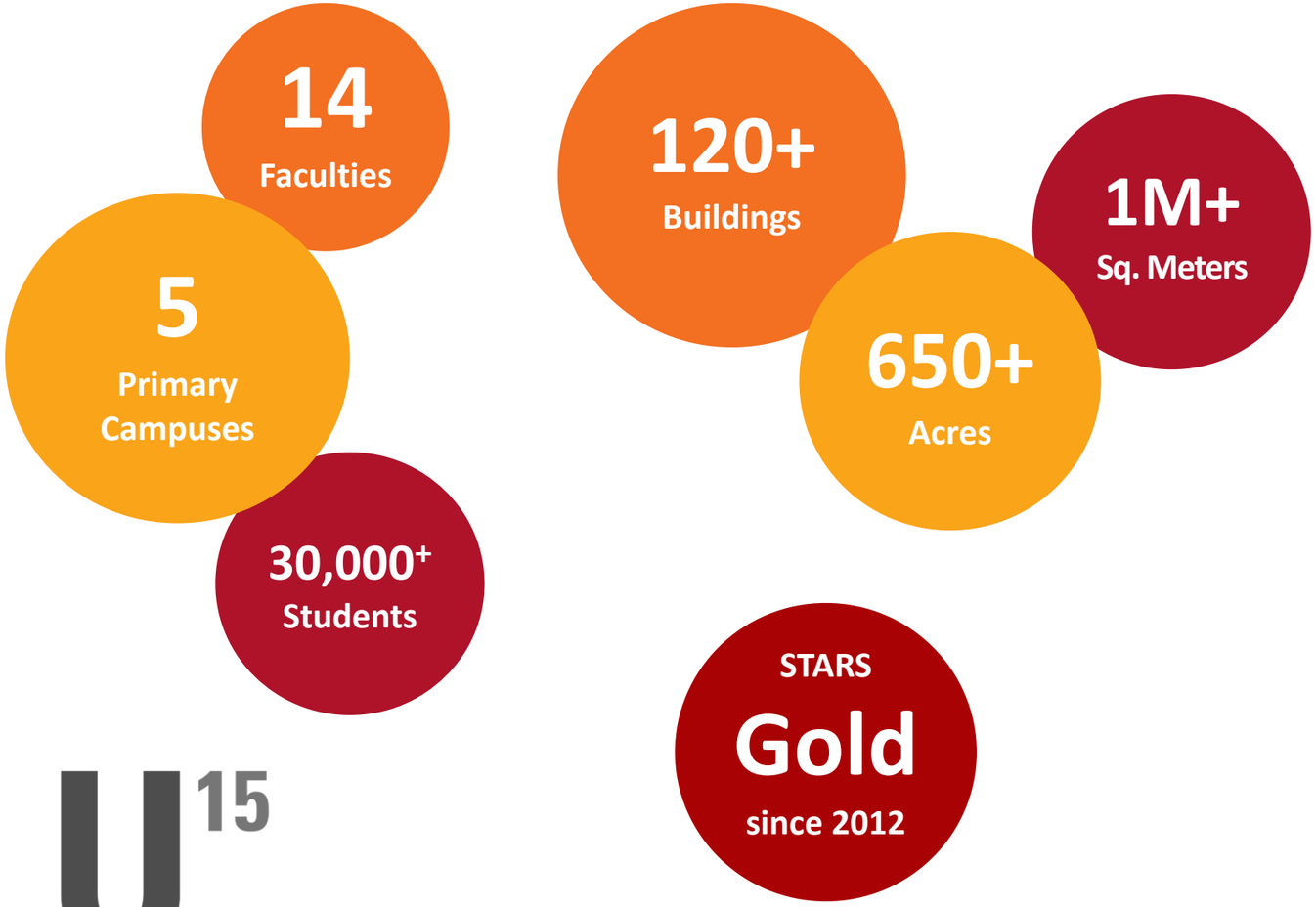
University of Calgary

1,800+ academic staff
actively engaged in research, scholarship and teaching

3,200+ non-academic staff
focused on operating the institution and delivering against our core mandate

$1.2 billion operating budget
UCalgary contributes nearly $8 billion annually to Alberta's economy



U15
Group of Canadian Research Universities
Regroupement des universités de recherche du Canada

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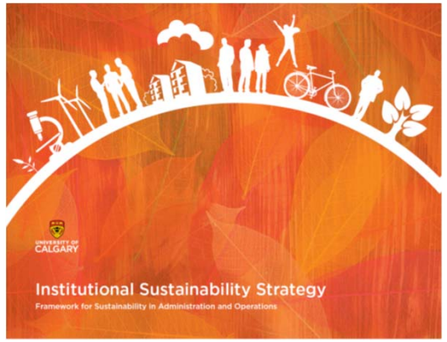
Institutional Plans and Strategies

The 2016 Institutional Sustainability Strategy provides a roadmap for continuous improvement in our pursuit of excellence and leadership in sustainability.

Engagement

Education and Research



Operations and Administration

Institutional Sustainability Strategy

We strive to continually improve our sustainability performance and infusing sustainability into the campus experience

Operational objectives include:

- To attain net carbon neutrality
- To become one of the most energy efficient campuses in Canada
- To be a Canadian leader in healthy high performance green buildings.

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2019 CLIMATE ACTION PLAN

The 2019 Climate Action Plan is the University of Calgary's operational roadmap to a carbon neutral campus by 2050, sparking innovation and accelerating the transition to a clean growth economy.

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Our emissions reductions to date

Despite substantial growth, In 2018 UCalgary achieved a 30% reduction in GHG emissions (2008 baseline)

3 Key Initiatives

30%
Absolute Reduction
69,000
tonnes CO2e annually
(2018)

$4.8M+
Annual utility cost avoidance realized from the 2010 CAP emission reduction measures.
(2018)

Buildings operations comprise 99% of our Scope 1 and 2 GHG emissions.

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Our renewed approach

2018 Realized:

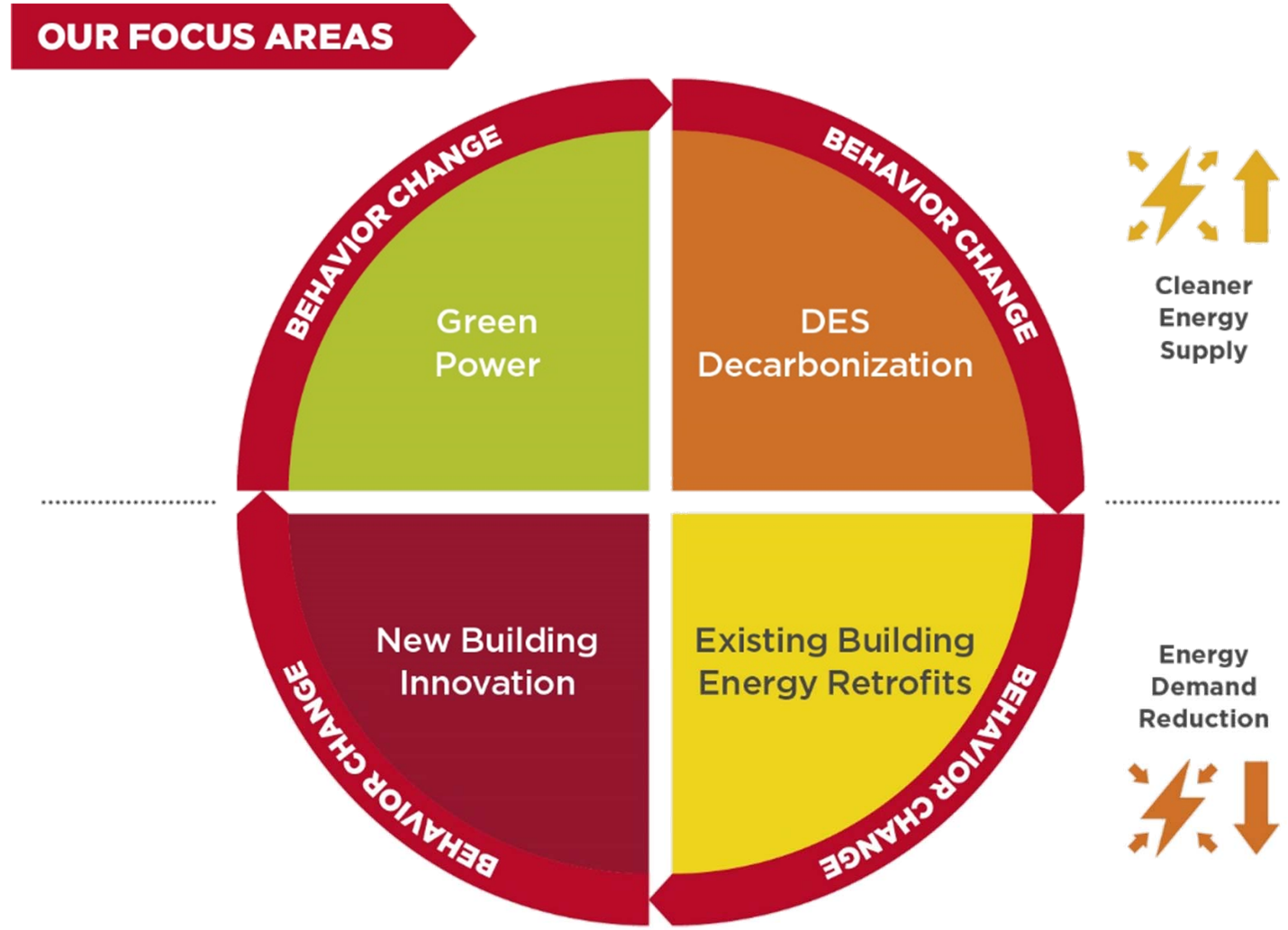
- 30% below 2008
- 69,000 tonnes CO2e reduction

2030 Target:

- 50% below 2008

2050 Target:

- Carbon Neutral
- >230,000 tonnes CO2e reduction



Project Context

Existing Buildings

- MacKimmie Library Complex constructed from 1962 to 1972
- Tower initially 6 floors, expanded vertically with an additional 6
- Concrete superstructure with precast cladding and an aluminum curtain wall envelope
- Low window to wall ratio
- Envelope and M+E systems beyond serviceable life

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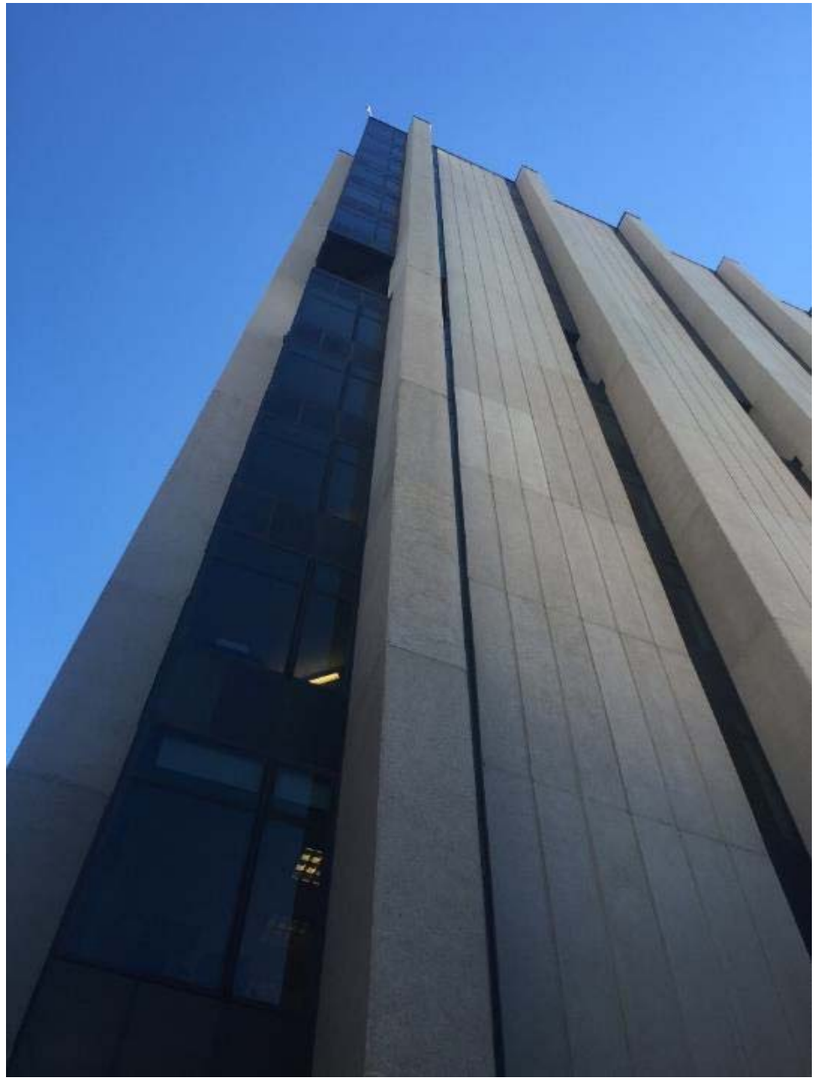
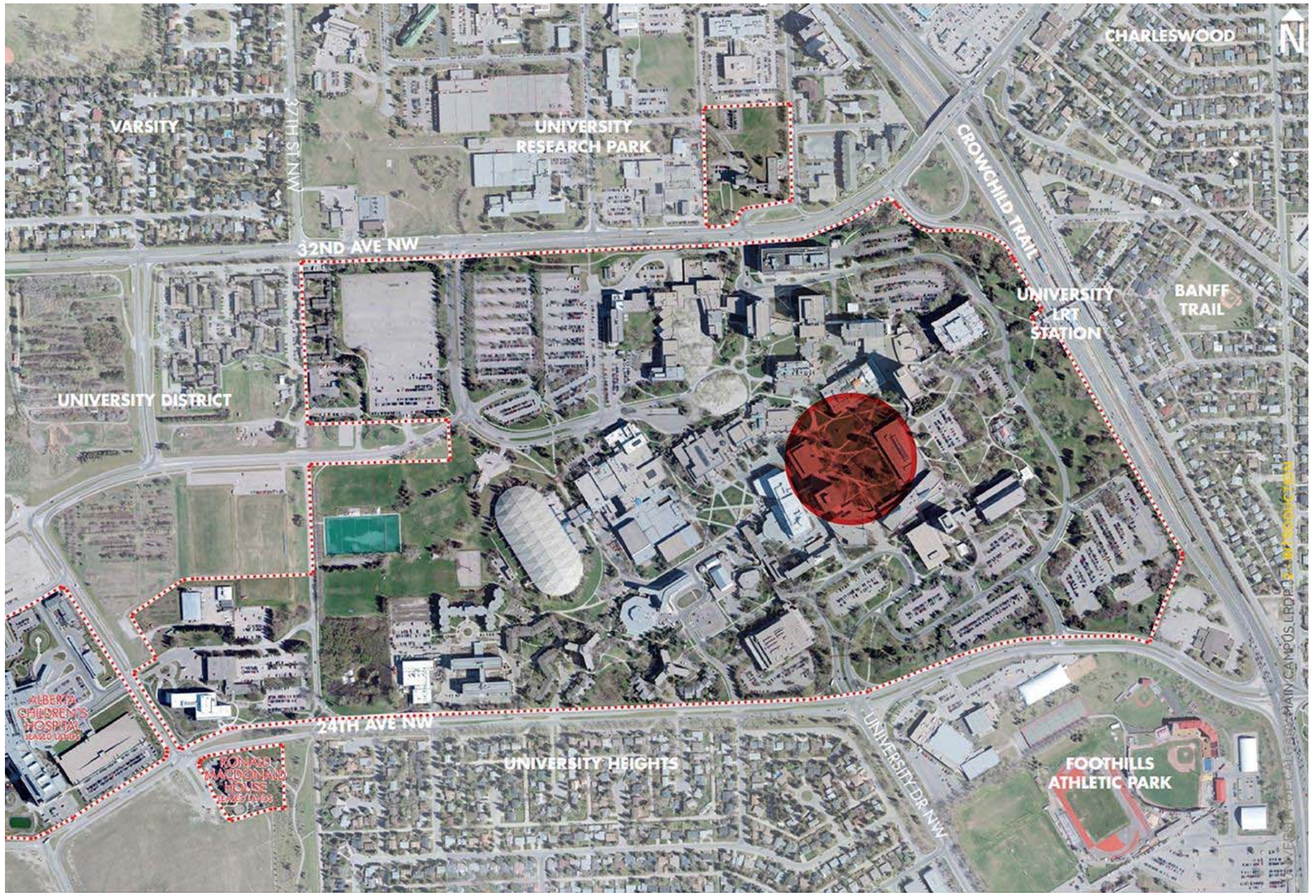
Project Context





Existing Buildings

Project Drivers

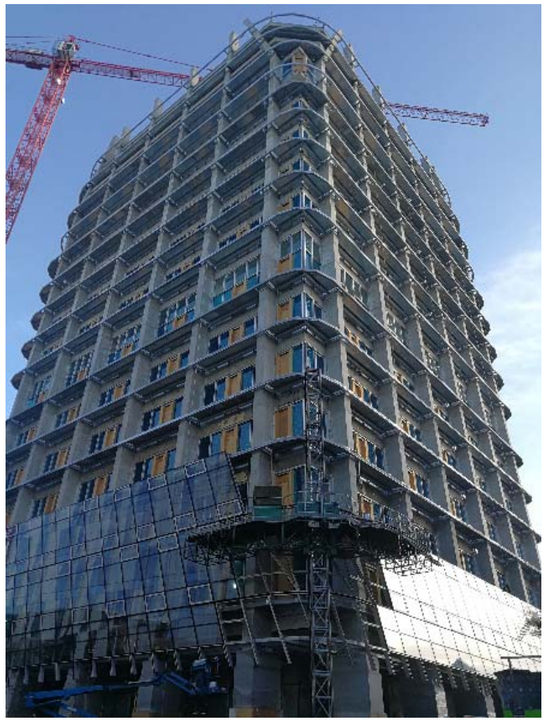
- Detailed condition assessment set the project direction to renovate and expand the Tower and replace Block and Link

Project Goals:

- Transparent and welcoming central focal point for the main campus
- Reflective of our commitment to sustainable design
- Responsive to the need for additional classroom and integrated study space
- Designed to unify and revitalize the landscaping adjacent to the building

Tower Design Concept

Design Concept Development



The well-tempered façade – a warm jacket
around an existing building structure

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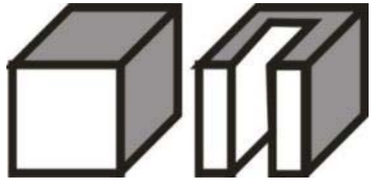
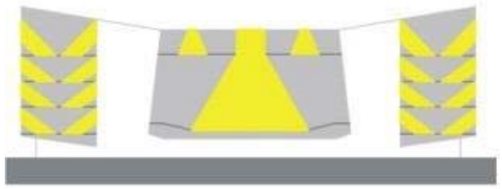
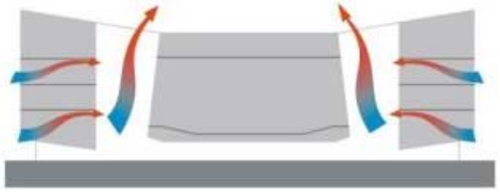
Design Concept Development



Building Massing



Daylight

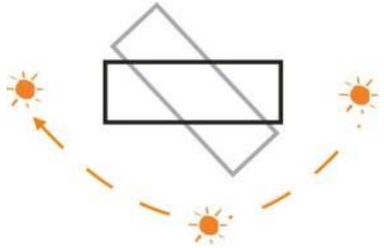


Natural Ventilation

Building orientation (wind)

Open space access

Program distribution



Building orientation (solar)

Passive strategies influence the performance of the building itself.

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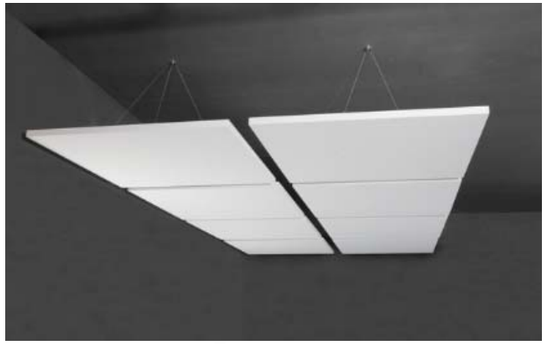
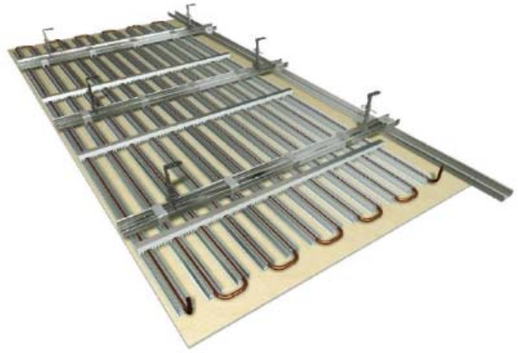
Design Concept Development





Active strategies influence the performance of engineered building systems.

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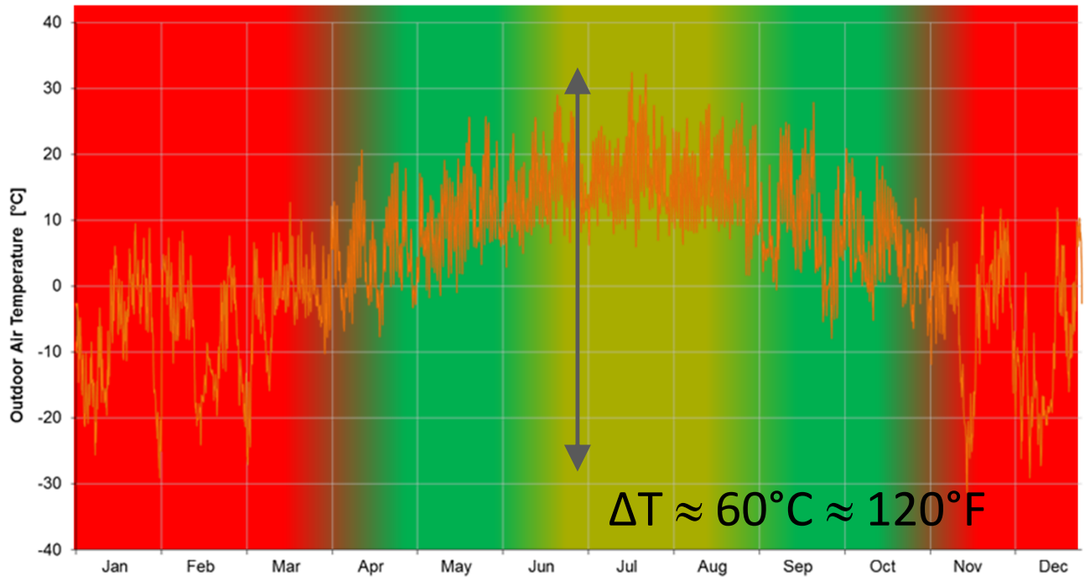
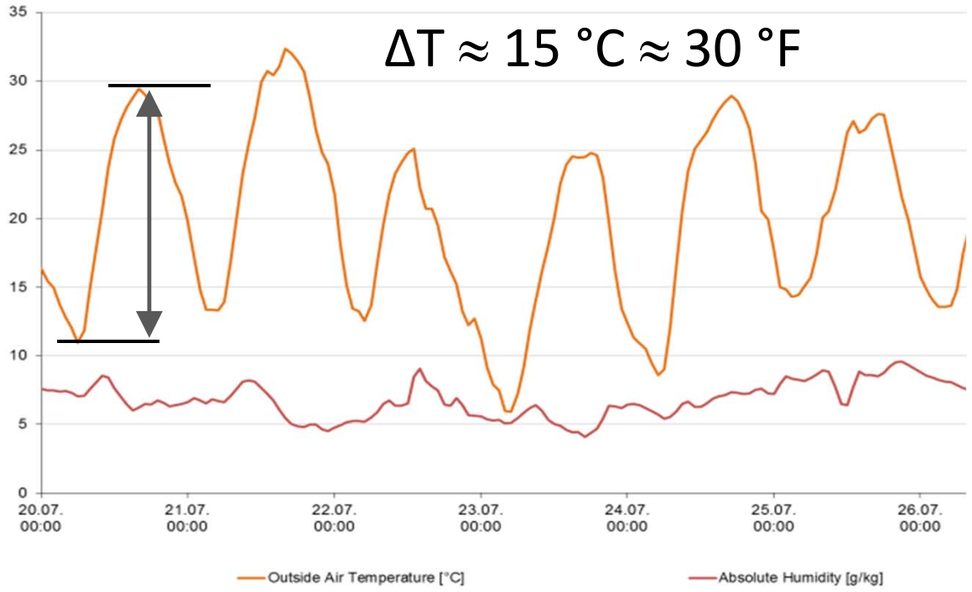
Climate Analysis & Potential



Annual Temperature Variation

Diurnal Temperature Swings



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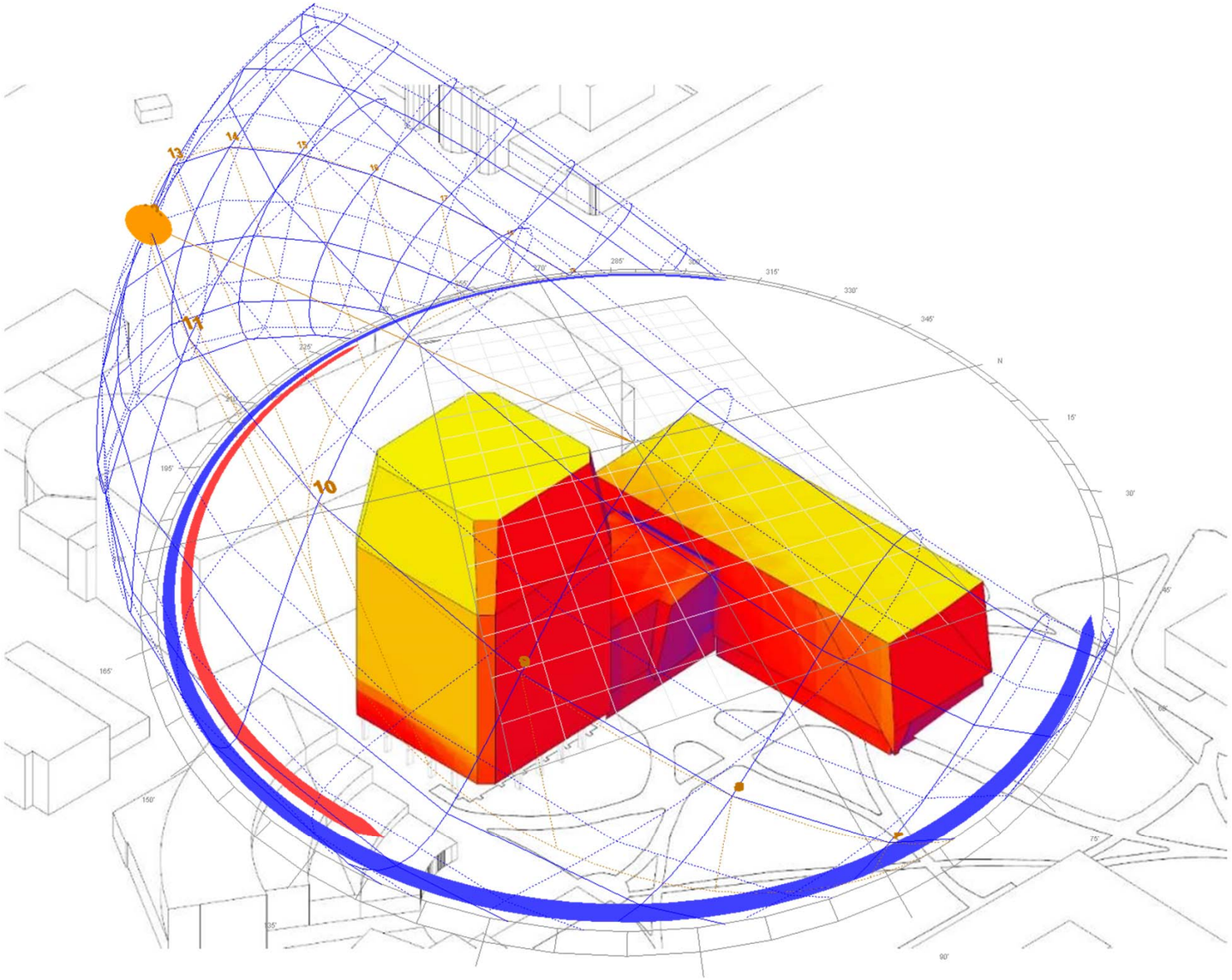
Solar Analysis



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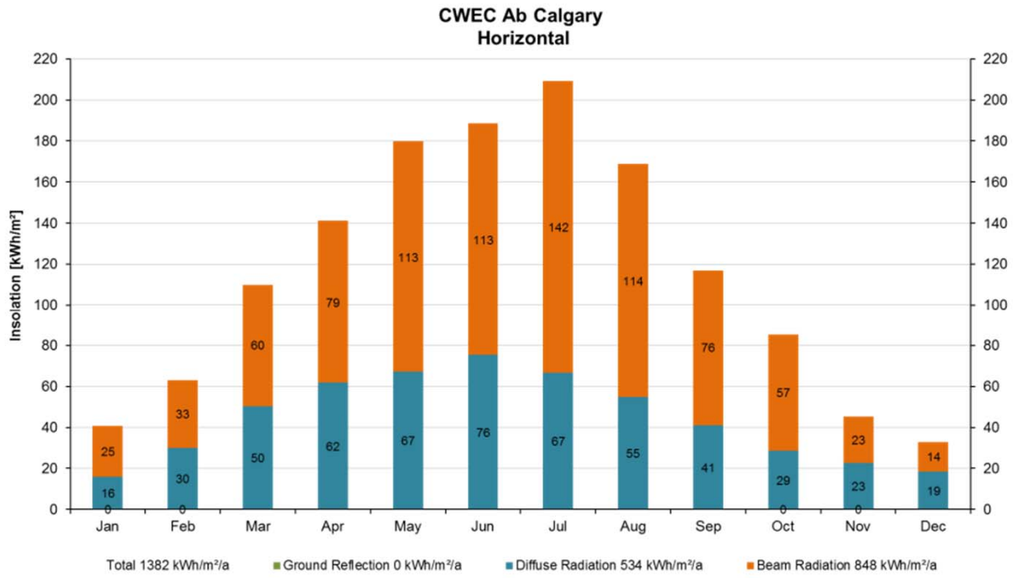
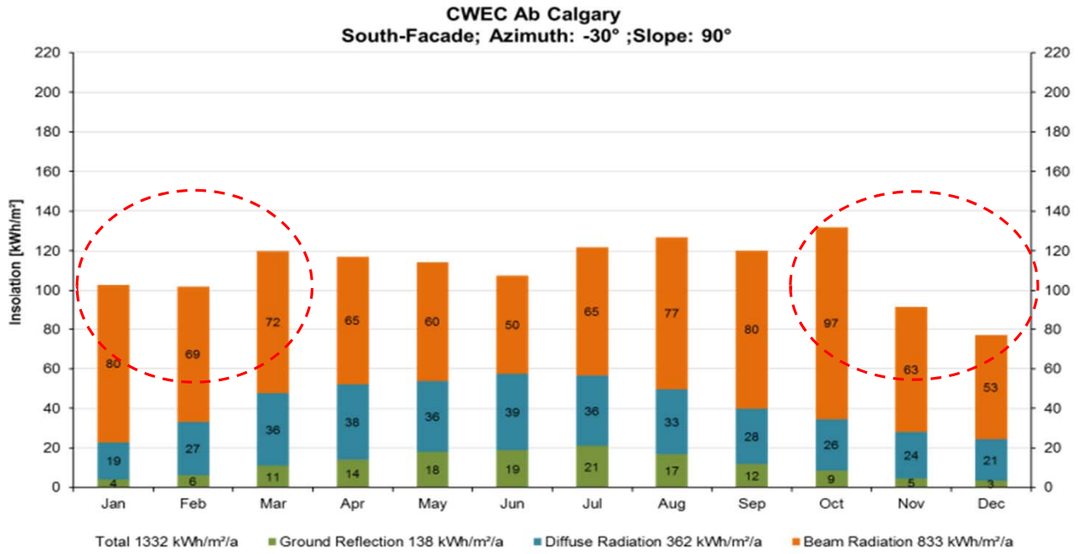
Climate Analysis & Potential



Annual Horizontal Surface Radiation: 1382 kWh/m²a



Annual Vertical Surface Radiation: 1332 kWh/m²a

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Concept Refinement

Headquarter Sparkasse
Rosenheim, Germany
2010

KfW Westarkade
Frankfurt, Germany, 2010

Manitoba Hydro Place
Winnipeg, MB, Canada
2009

MacKimmie Tower
2019

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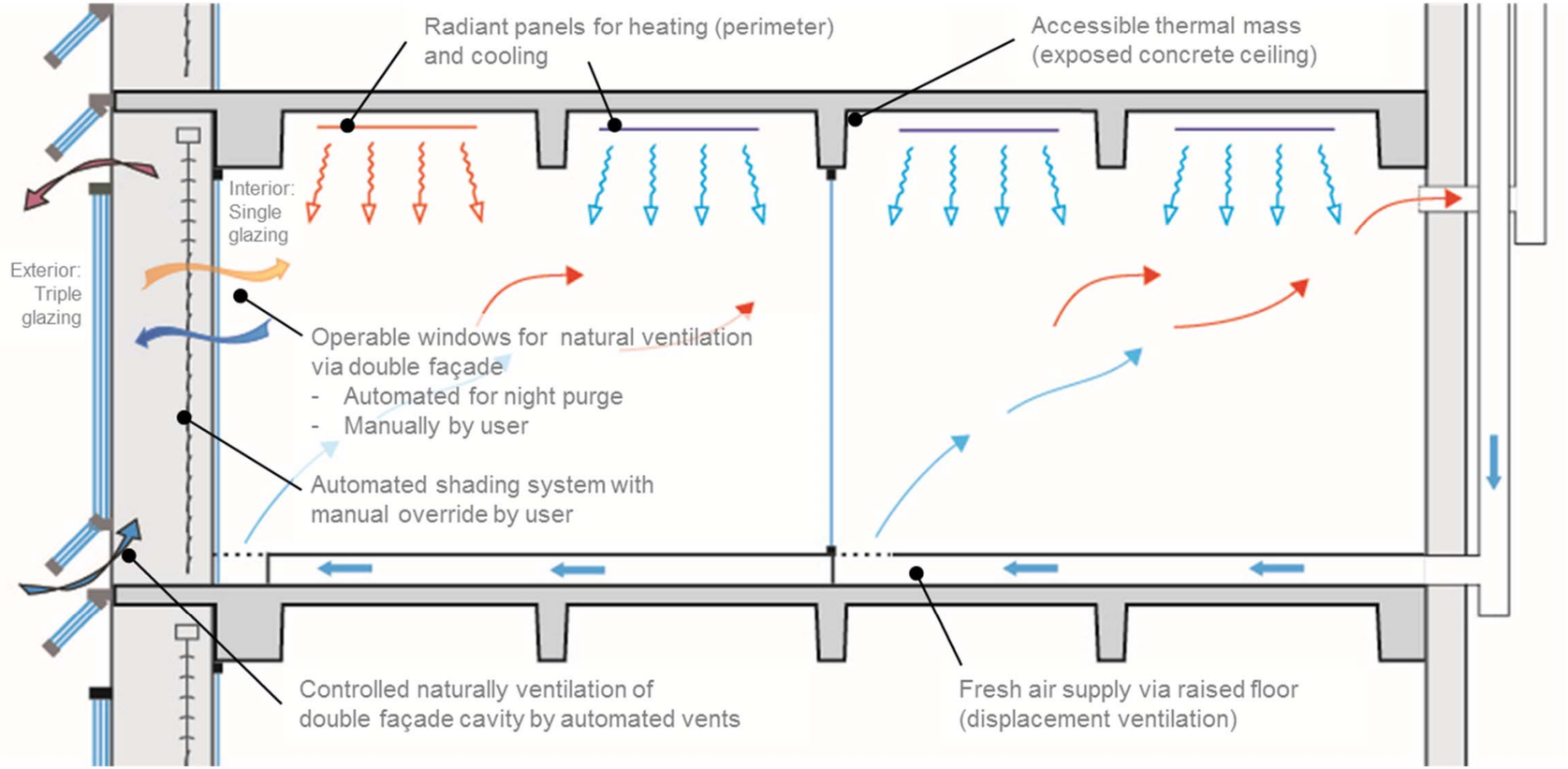
Indoor Climate Concept



Glazing System

- Exterior Triple Glazing
- Shading Blinds
- Interior laminated Single
- Interior low-e coating

Glazing Performance

- VLT: 0.70
- Ucog-value (W/m2K): 0.55
- SHGC: 0.49
- SHGC: 0.06 (glass + activated blinds)

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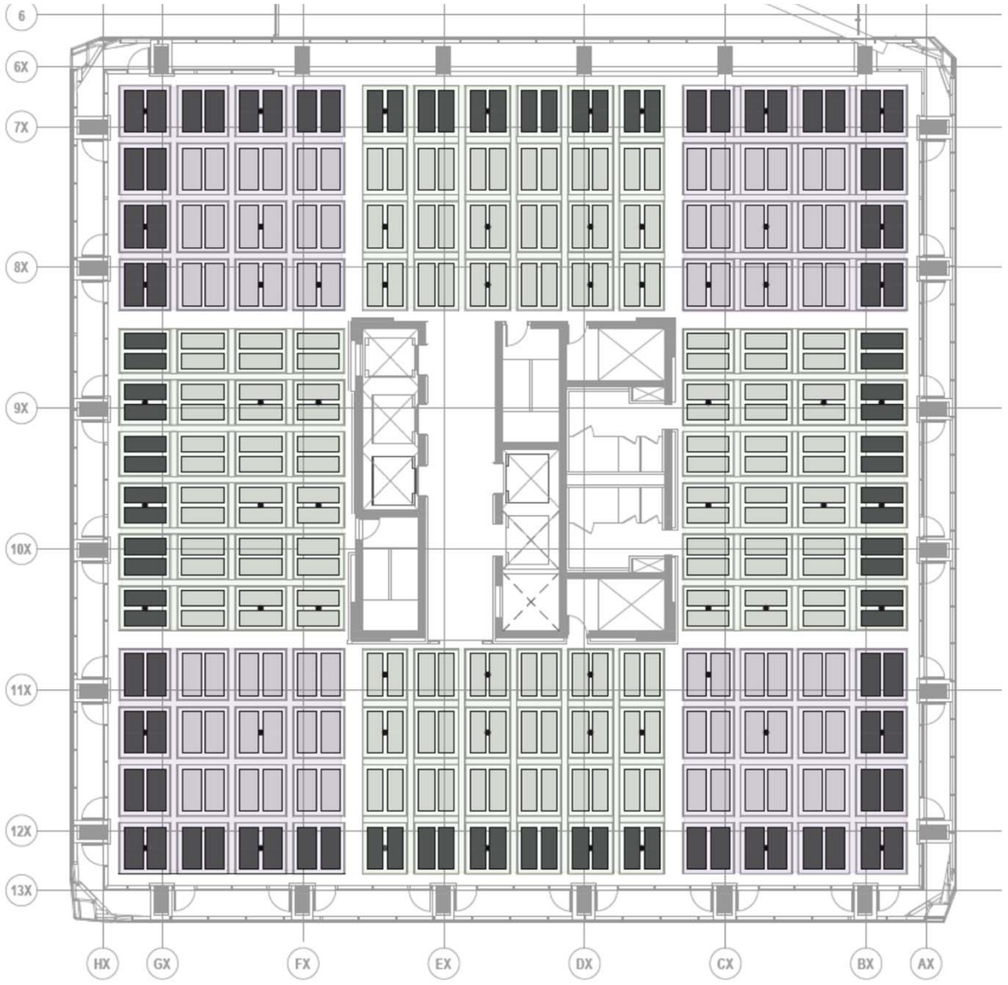
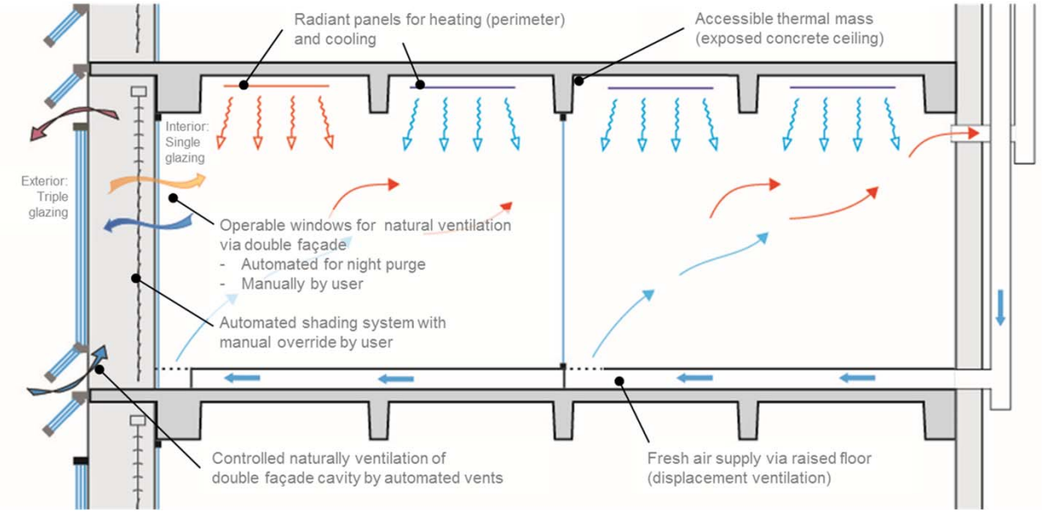
Radiant Panel Layout



TYPICAL TOWER FLOOR
RADIANT PANEL LAYOUT



HYDRONIC PANEL SERVICE LEGEND

- HEATING & COOLING PANEL (PERIMETER ZONE)
- TWO PANELS PER COFFER WITH BOTH PANELS ACTIVE.

- COOLING PANEL (INTERIOR ZONE)
- TWO PANELS PER COFFER WITH ONE PANEL ACTIVE, ONE AS MATCHING ACOUSTIC PANEL.

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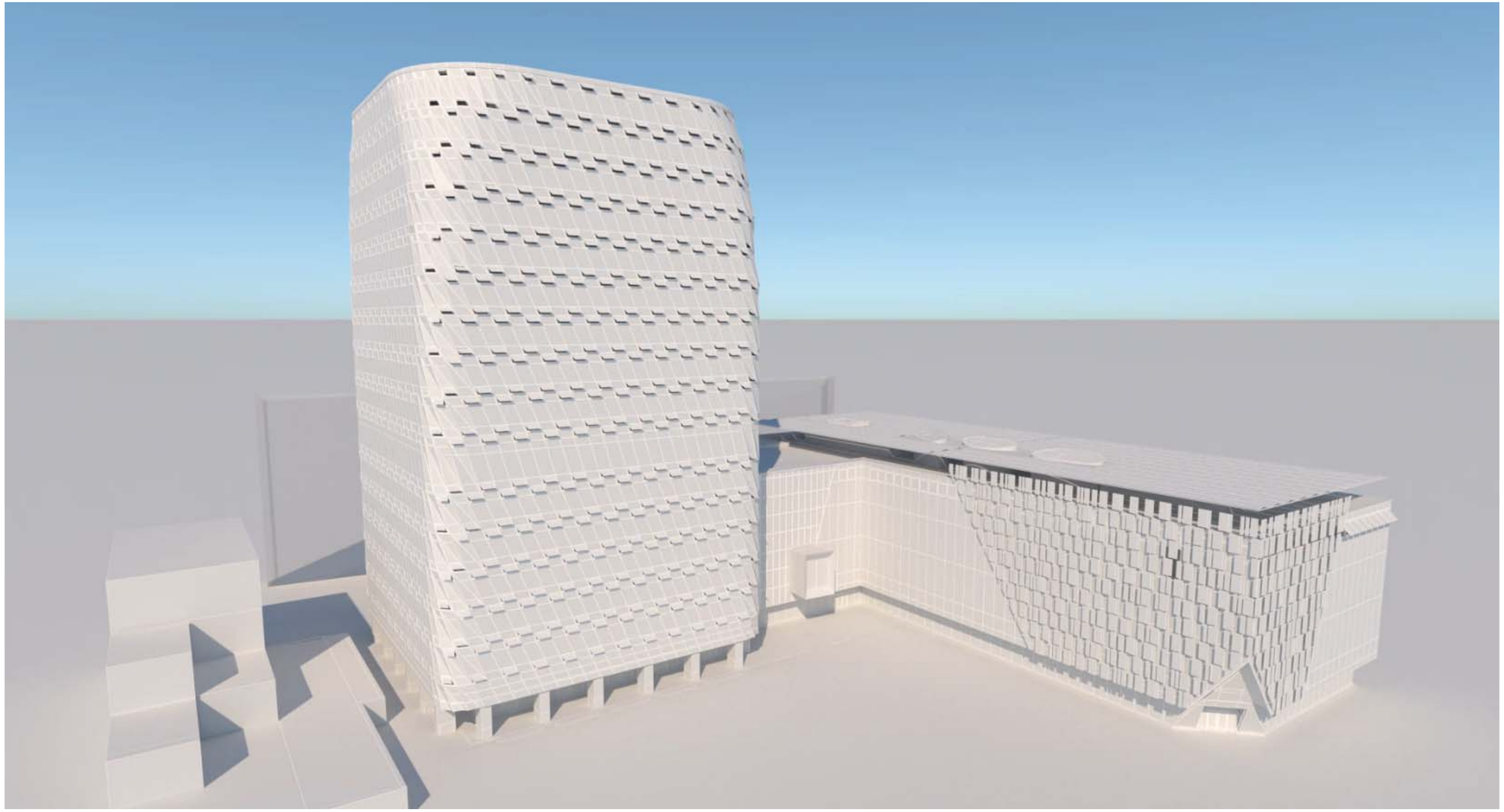
Rendering – Typical Façade Operation



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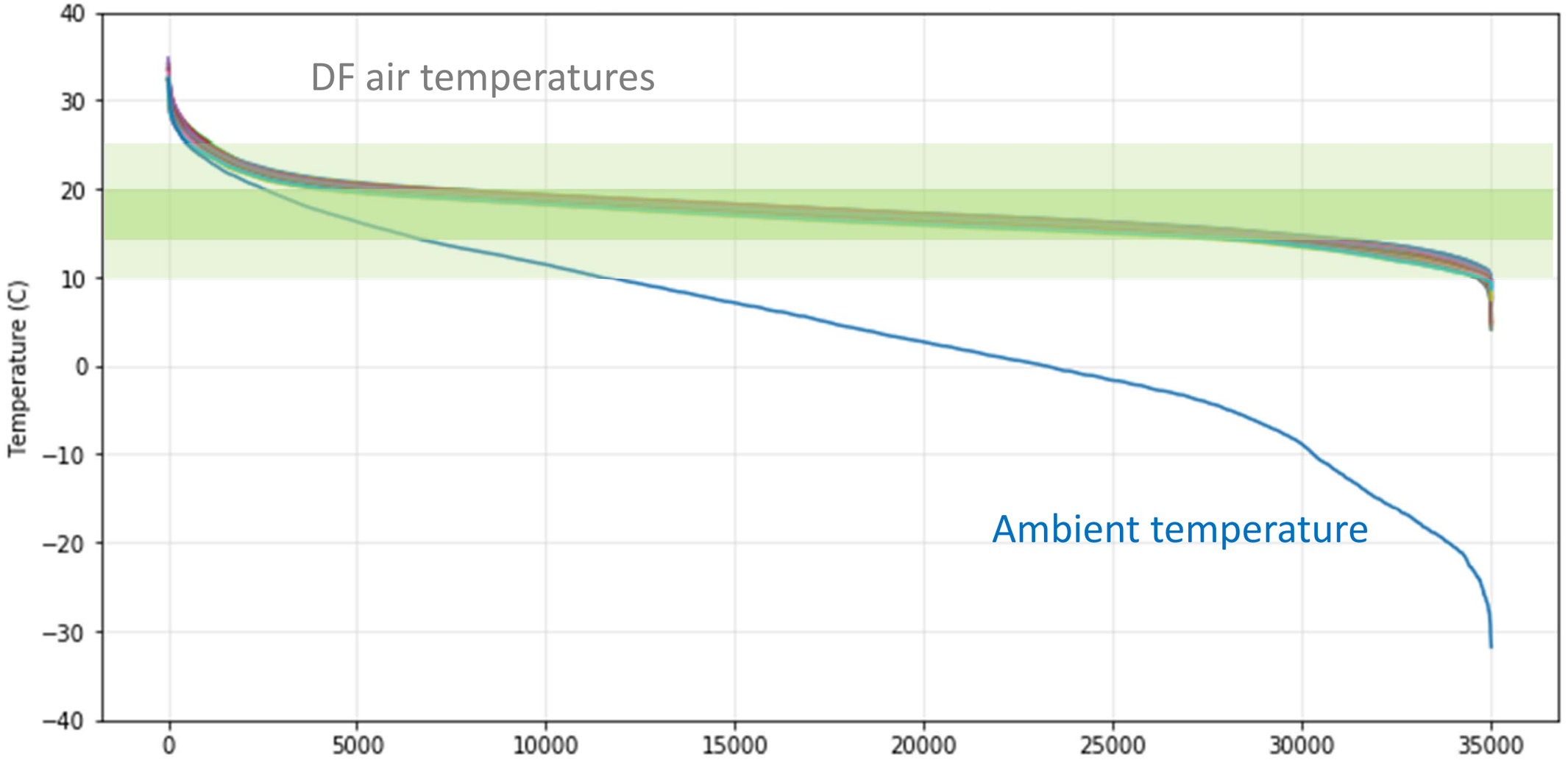
Façade Air Temperature



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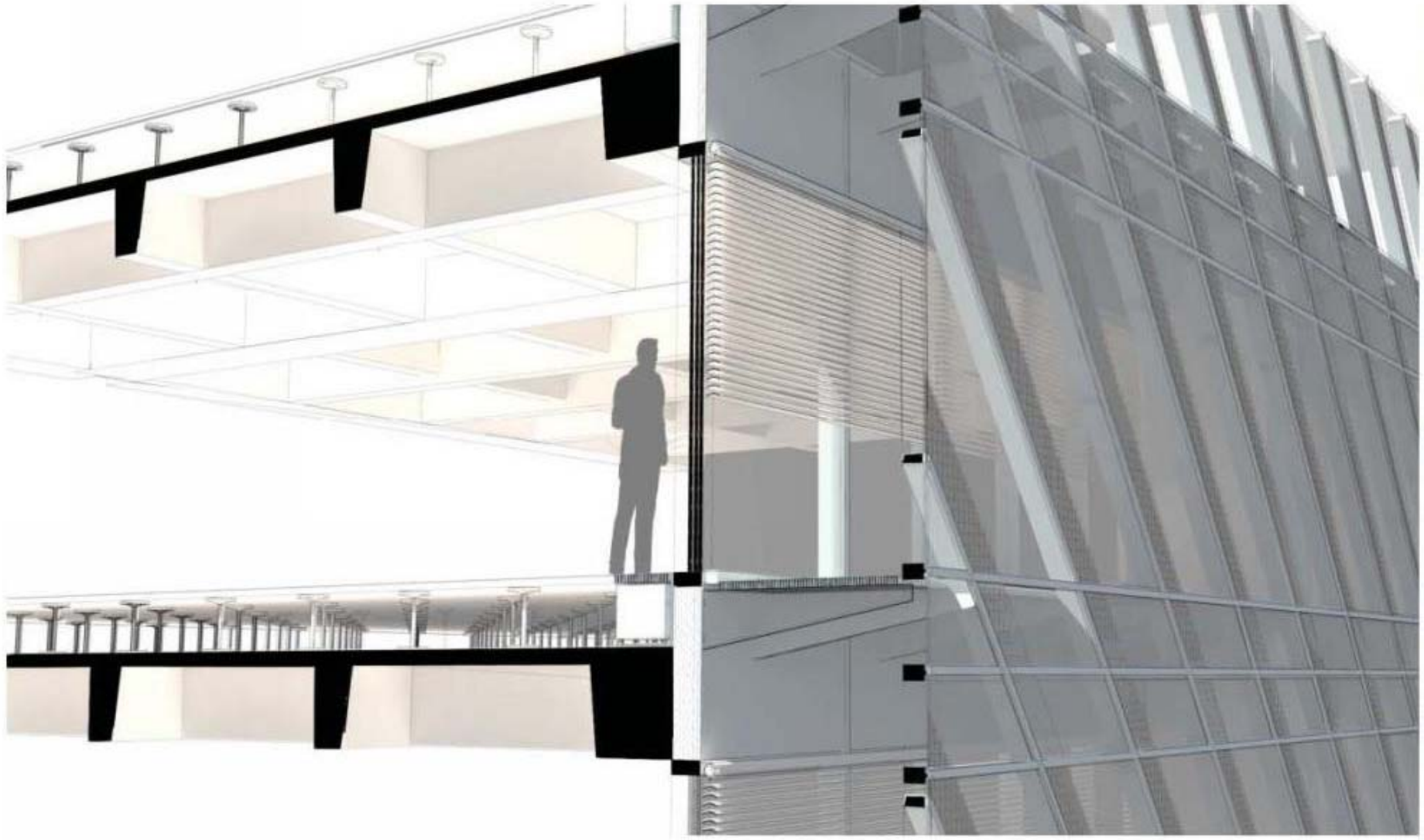
Tower Façade Construction

Façade Construction Concept



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Façade Construction Concept – Interior View

Typical Tower Floorplan

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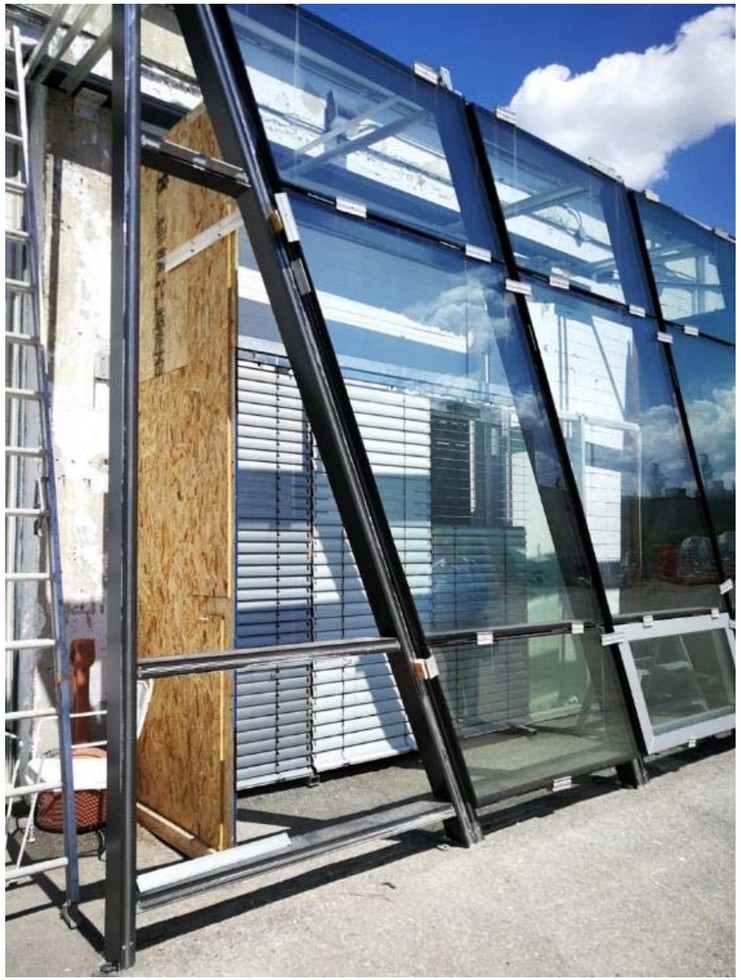
Visual and Function Mockups



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Performance Mockups

- Workmanship
- Infiltration
- Exfiltration
- Constructability

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In-situ Mockups

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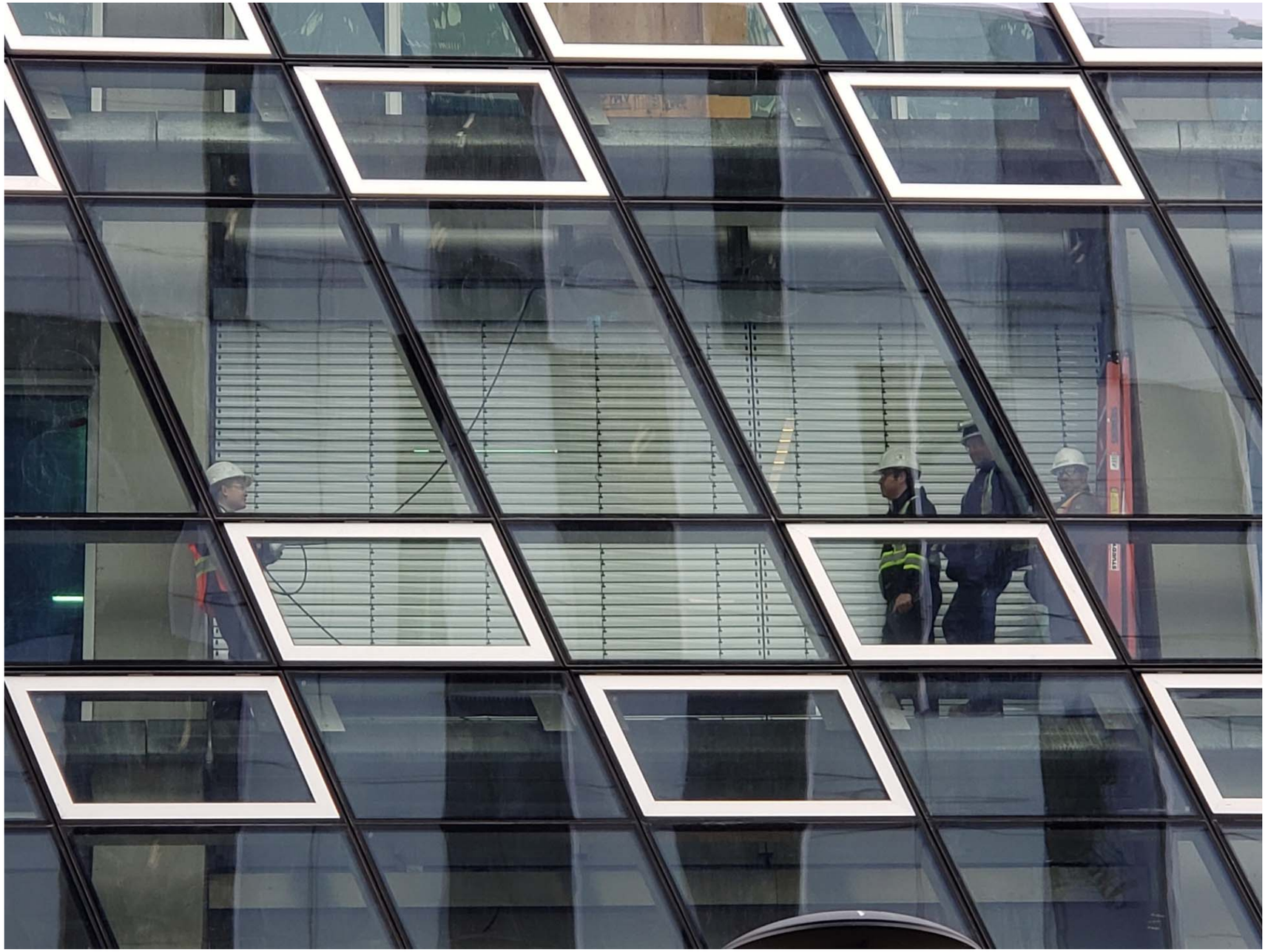
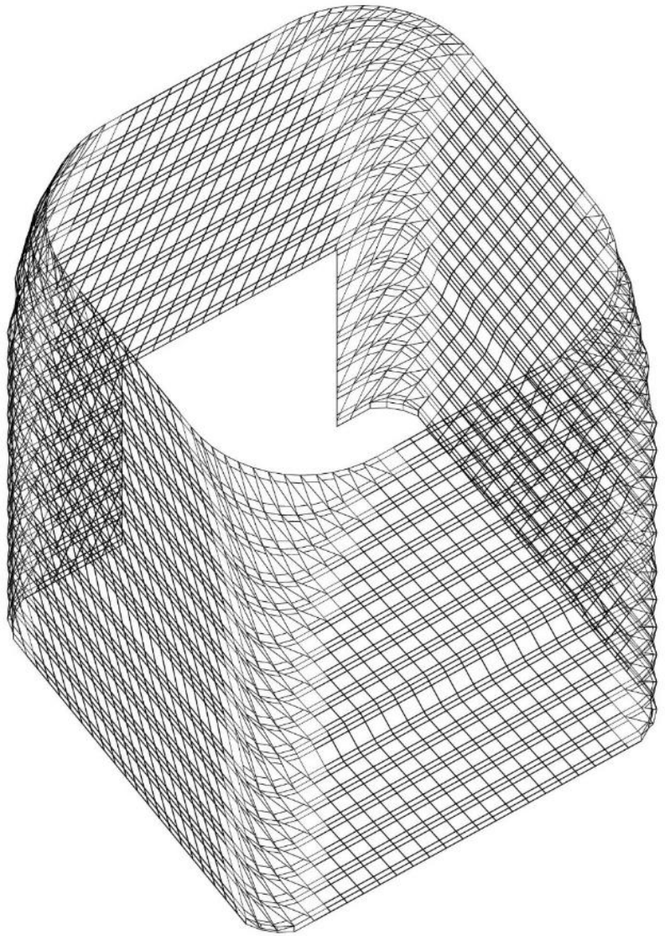
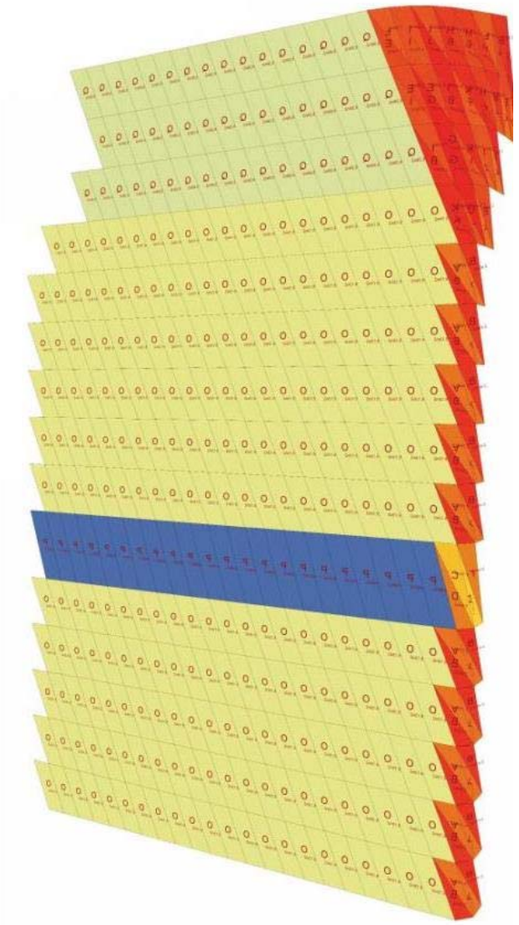


Computational Design



Final design incorporated only 17 unique panels

Less material, reduced schedule, reduced cost through prefabrication



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Zero Carbon Performance

Zero Carbon Performance

A zero carbon building is defined as one that is **highly energy-efficient** and **produces onsite, or procures, carbon-free renewable energy** in an amount **sufficient to offset the annual carbon emissions** associated with operations.

- Zero Carbon Balance
- Zero Carbon Transition Plan
- Onsite Renewable Energy
- Thermal Energy Demand Intensity (TEDI)
- Report EUI, Peak Demand, Embodied Carbon

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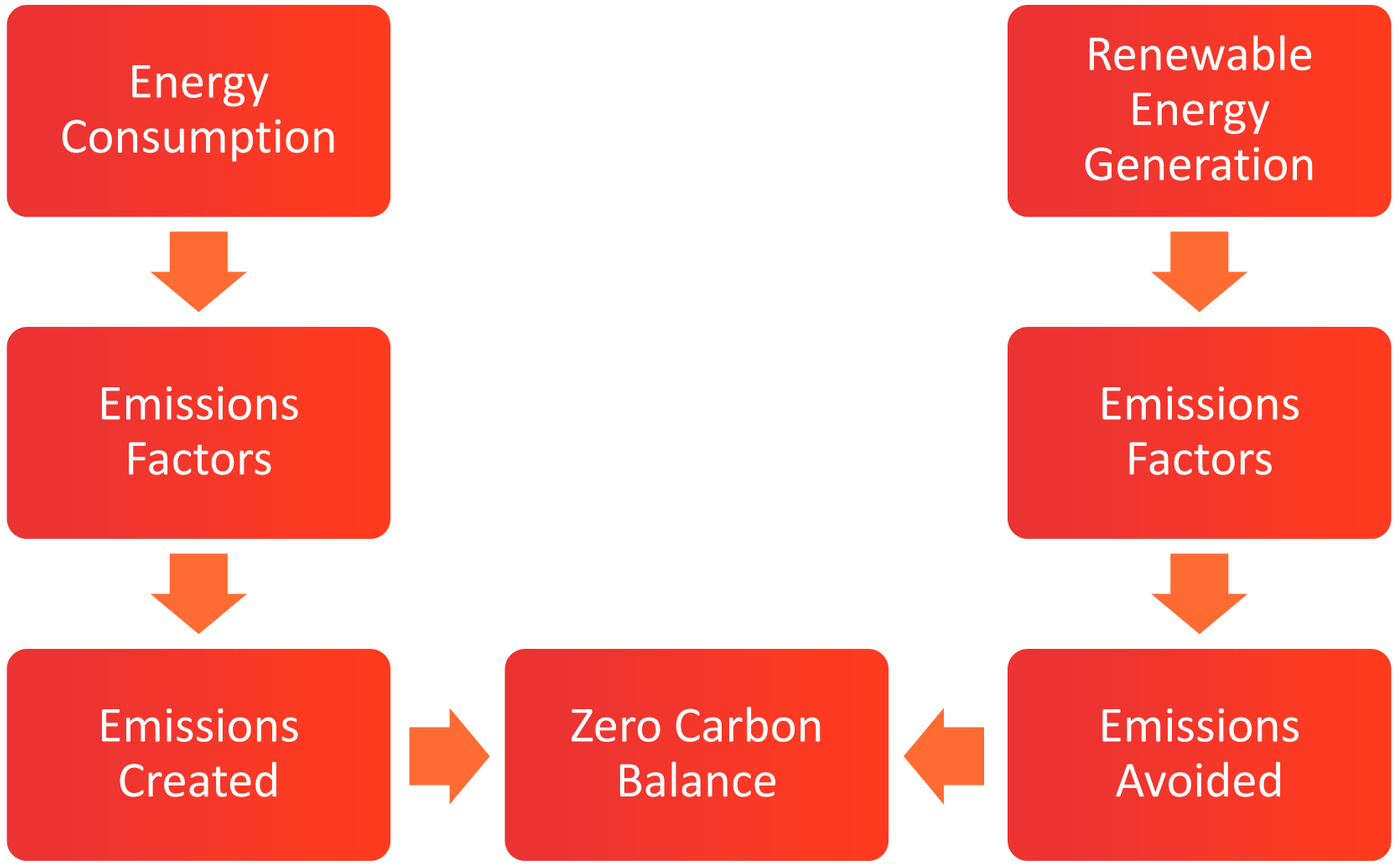
What is the Zero Carbon Balance?



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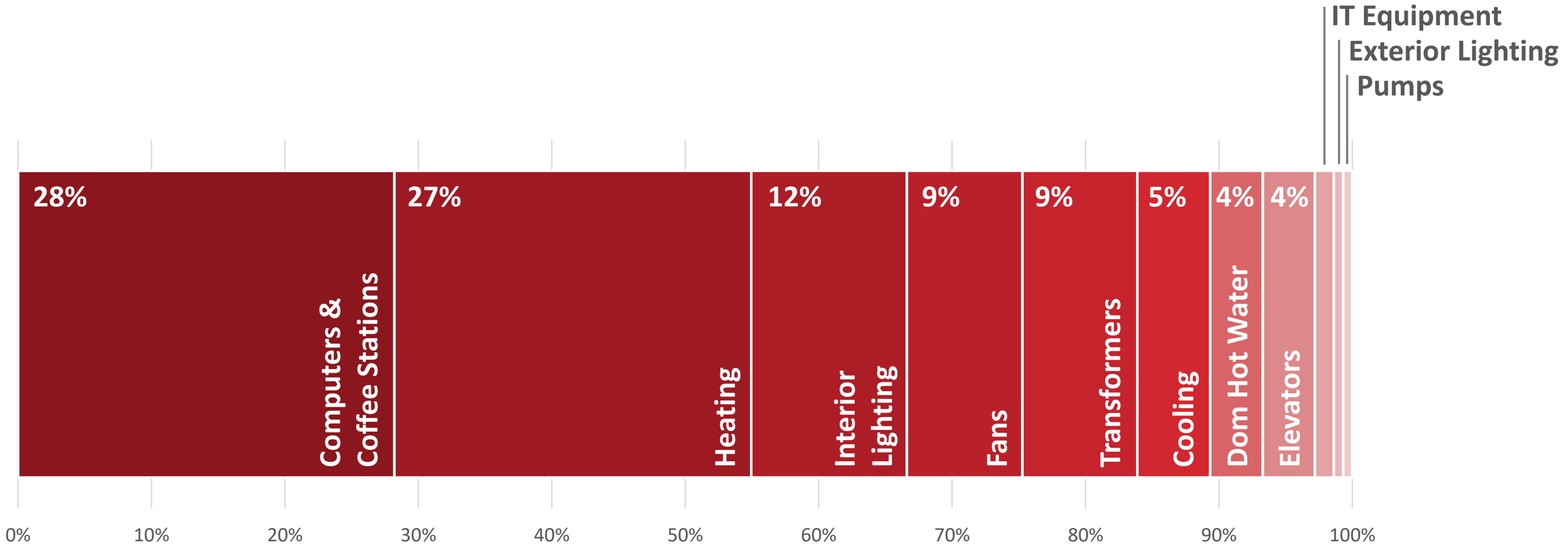
How Does the Building Consume Energy?



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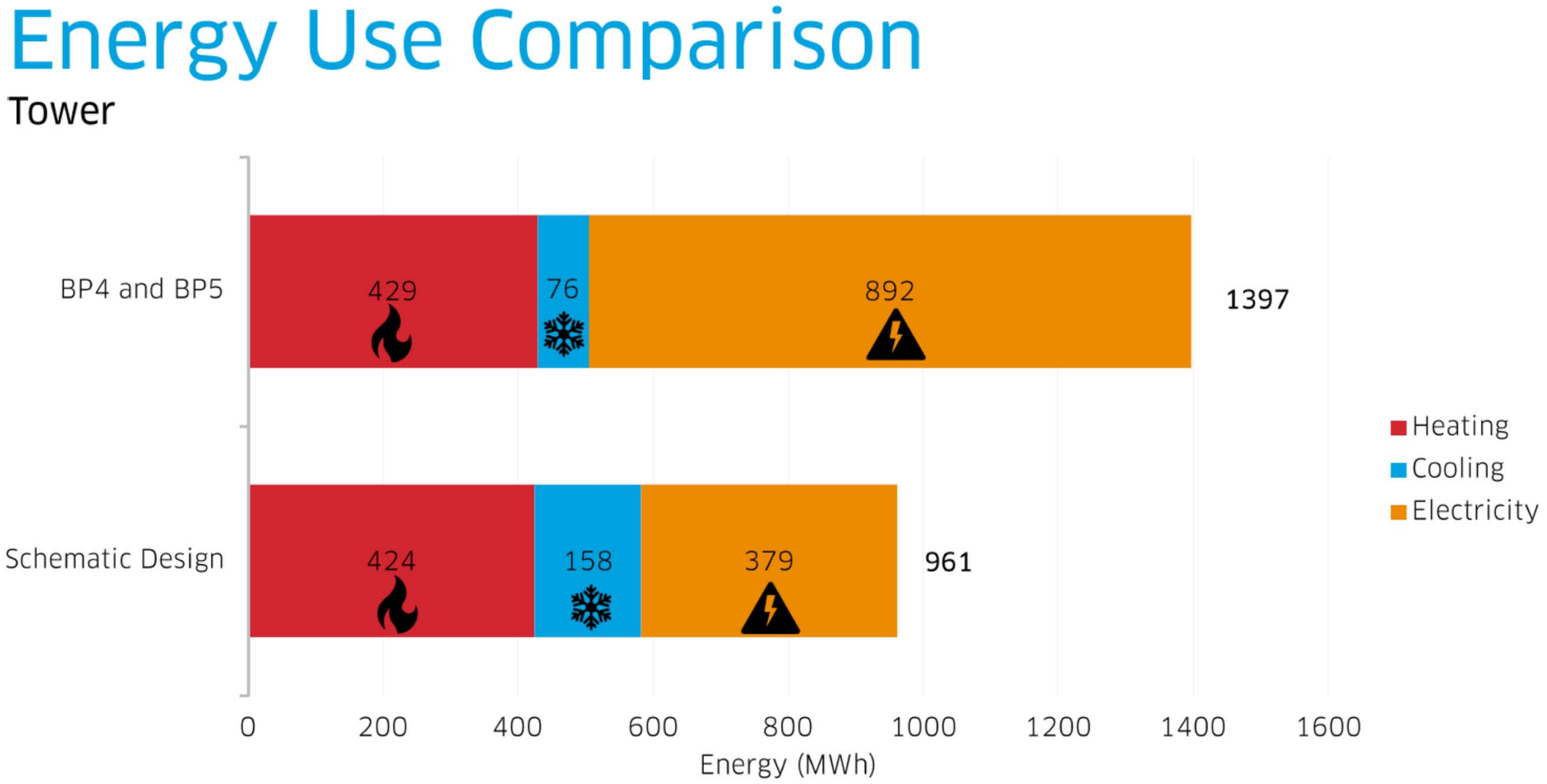
How has Modelled Performance Evolved?



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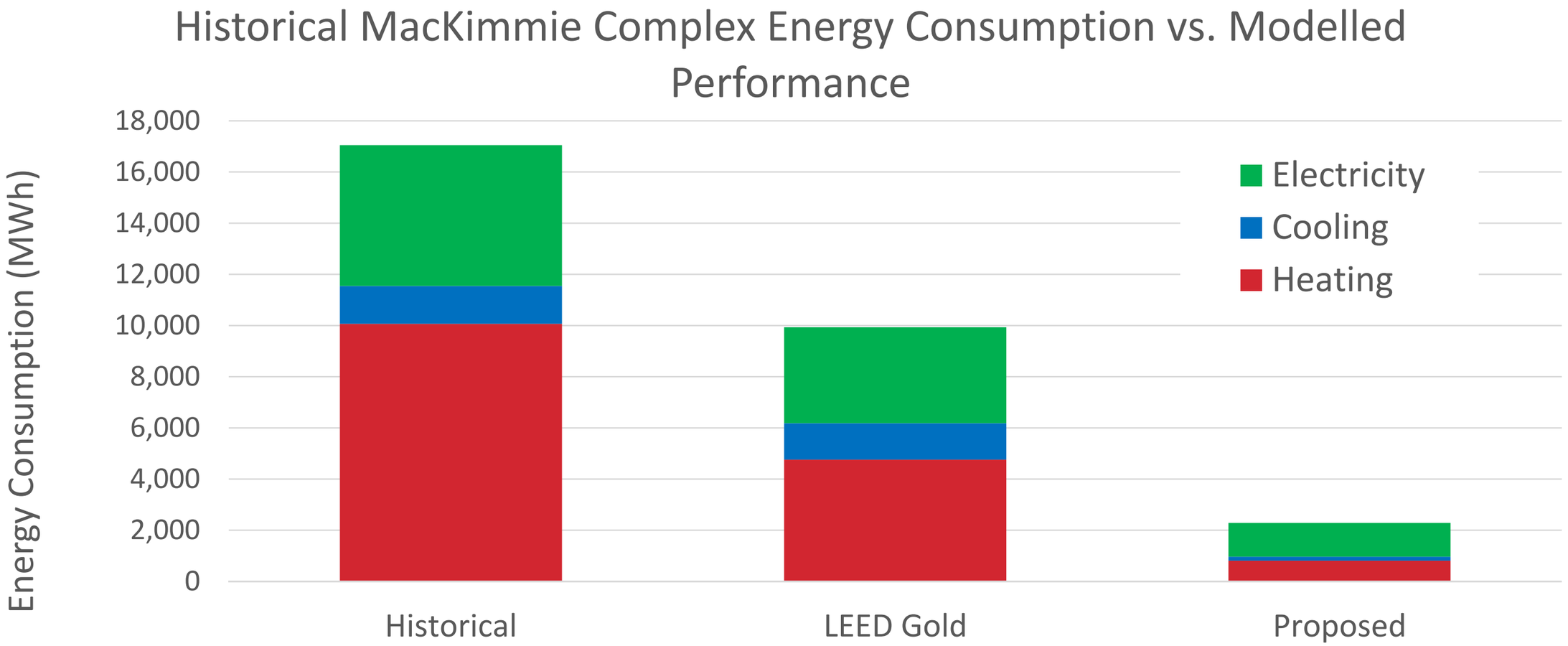
What Impact will the Redevelopment Have?



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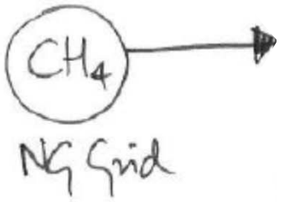
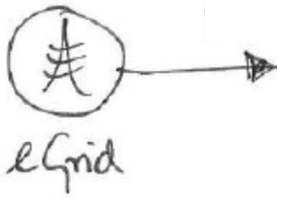
Connecting to District Energy Systems





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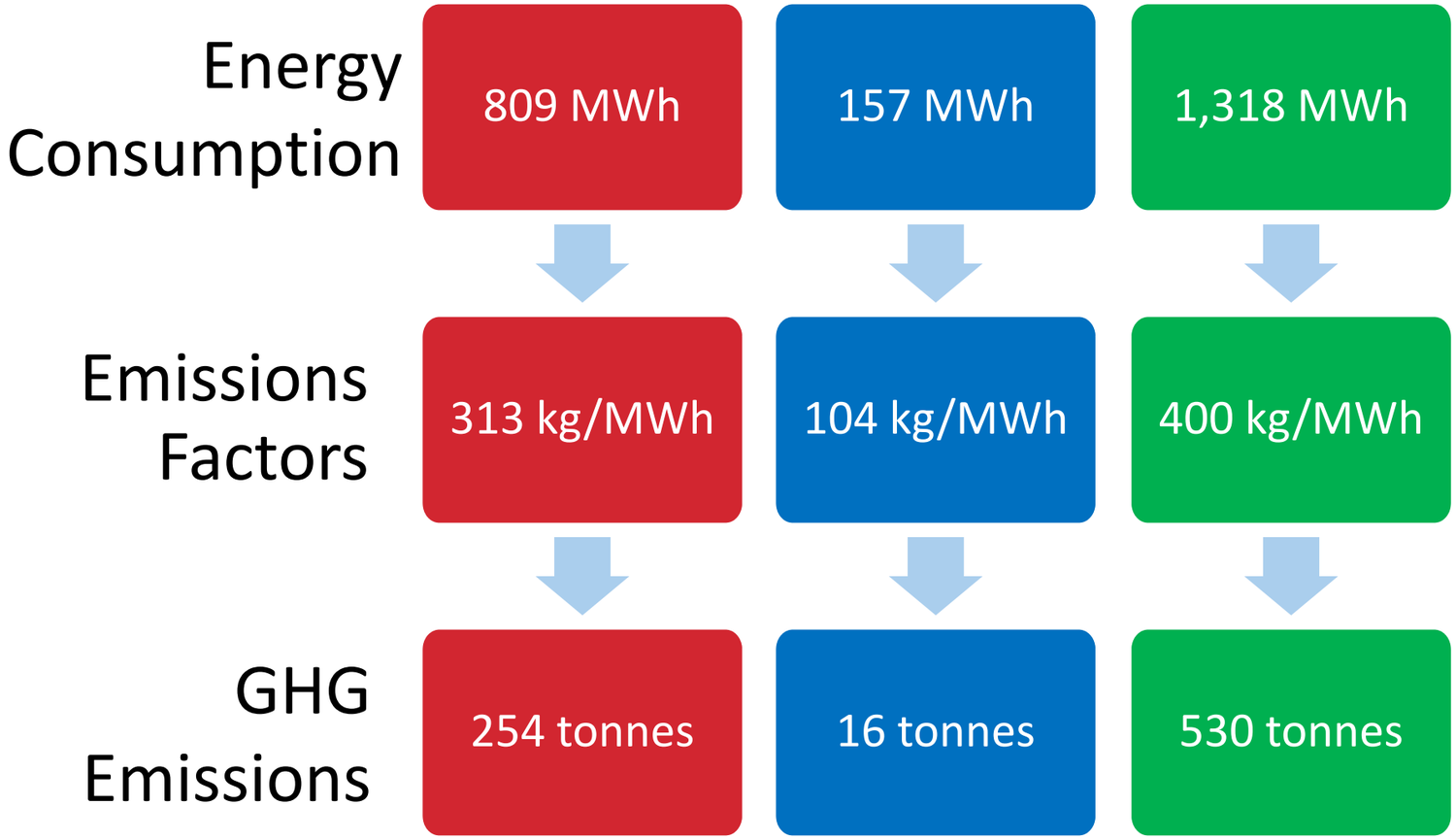
What GHG Emissions are Expected?



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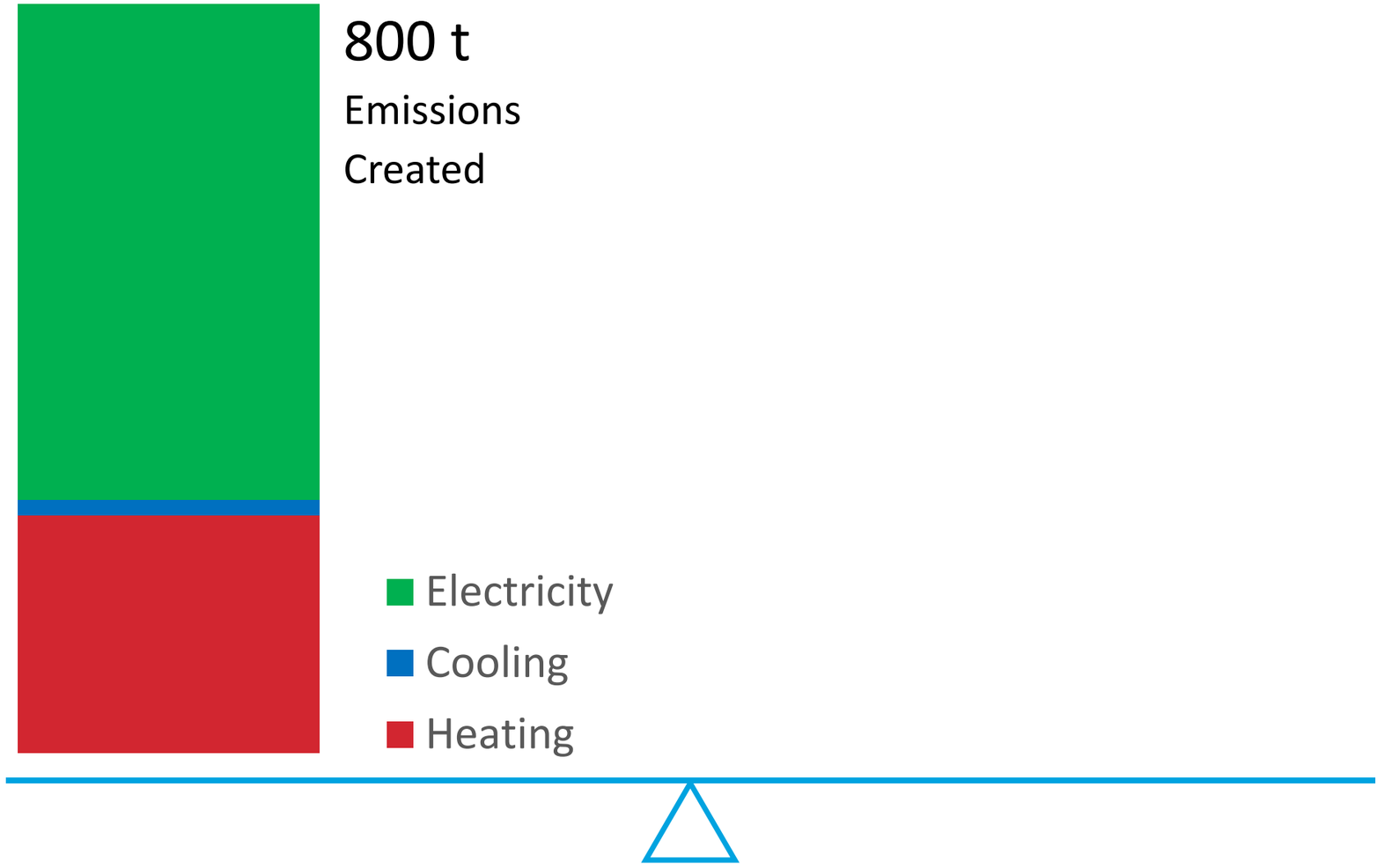
Zero Carbon Balance



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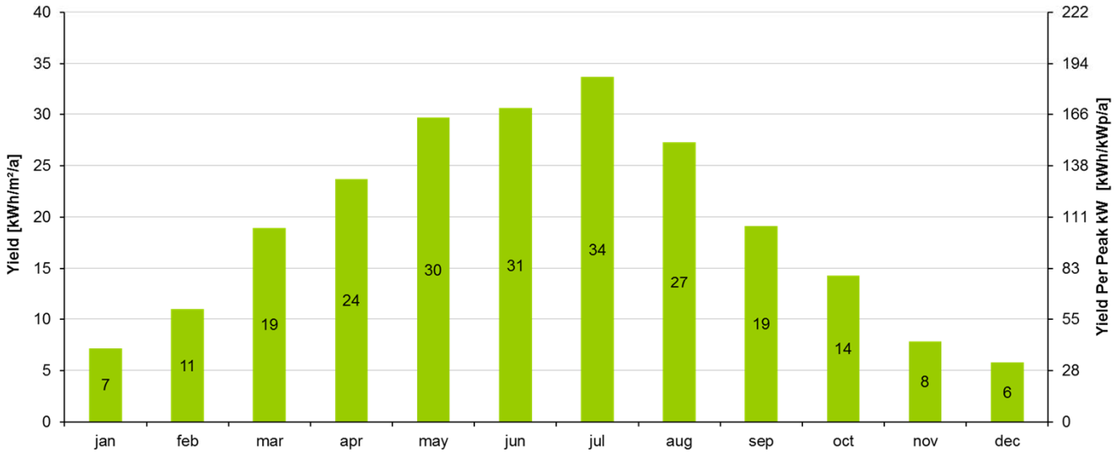
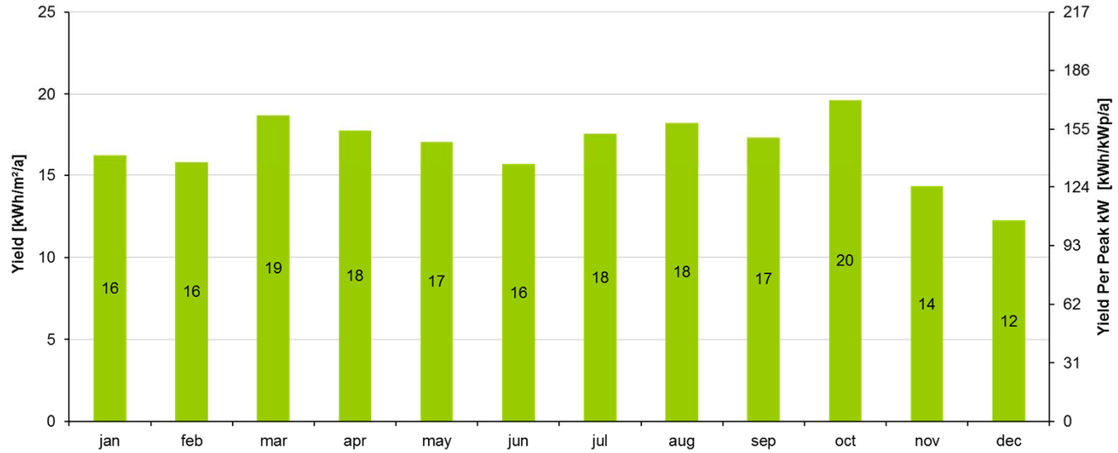
Annual Renewable Energy Generation



Roof Horizontal

1265 kWh/kW_{peak}



South Façade

1245 kWh/kW_{peak}

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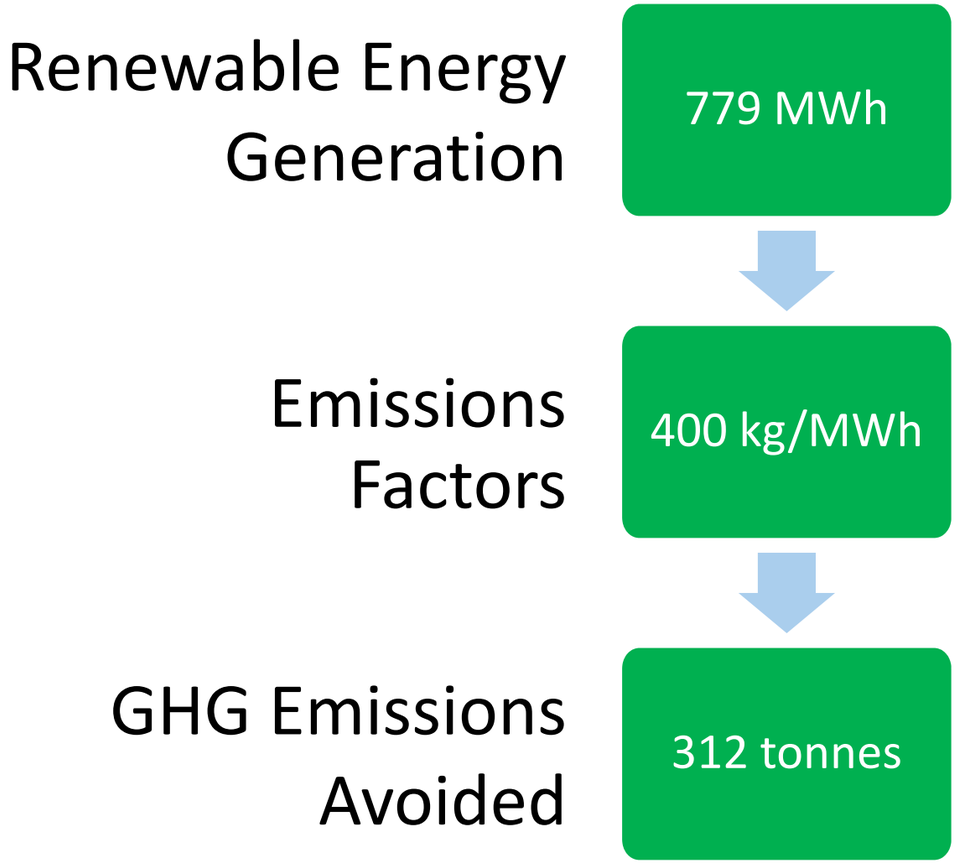
Tower Roof
227 MWh
Block Roof
432 MWh
Façade
120 MWh

Zero Carbon Performance



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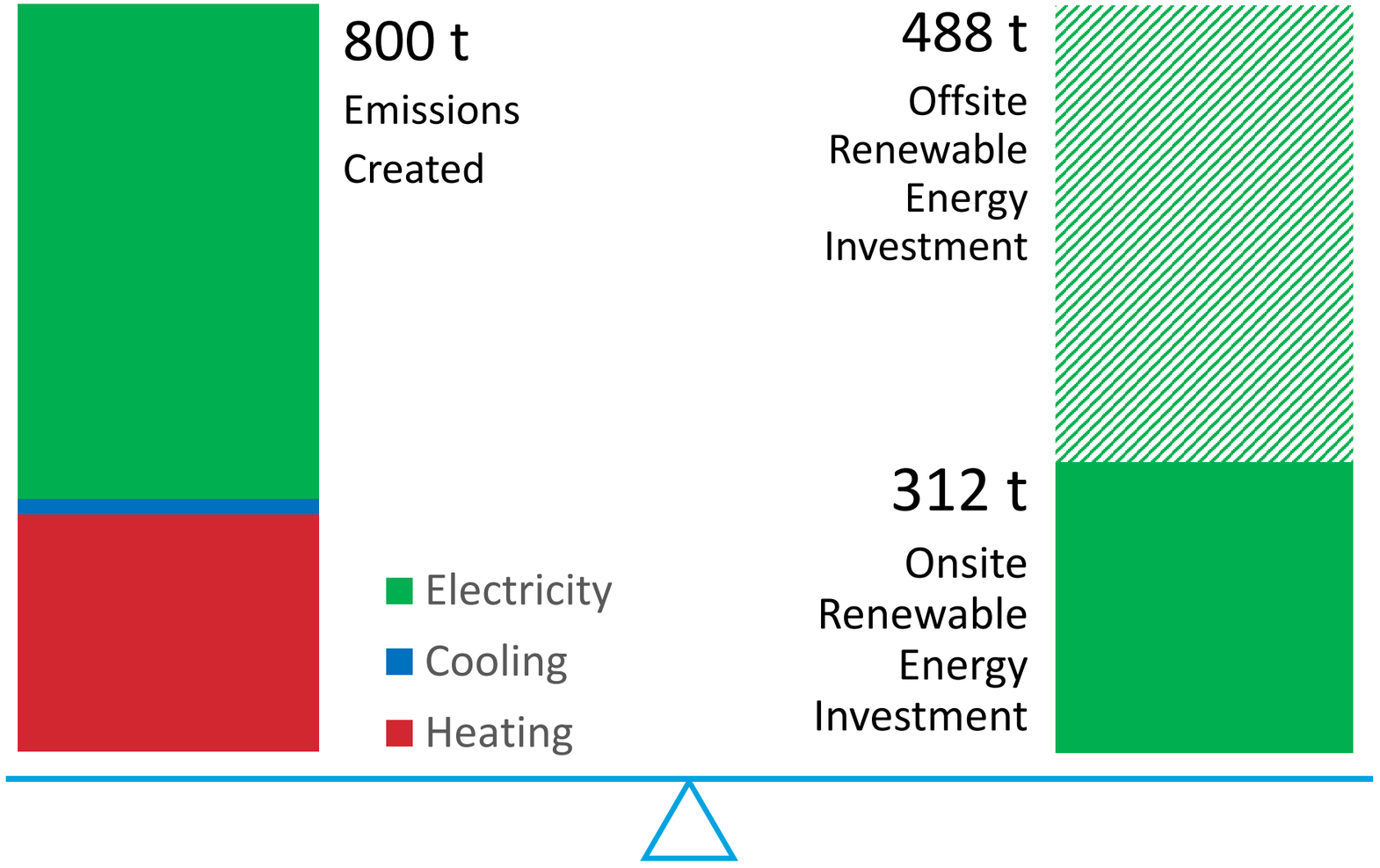
Zero Carbon Performance



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Zero Carbon Performance

- Thermal Energy Demand Intensity (TEDI)

Target:	Design:
<36 kWh/m²/year	33 kWh/m²/year

- Onsite Renewable Energy Generation

Target:	Design:
>5% of energy	>35% of energy

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Transitioning to Operations

Transitioning to Operations

Facility Management representation from initial concept selection

Transitioning to Operations

University of Calgary
Energy Management
System

Transitioning to Operations

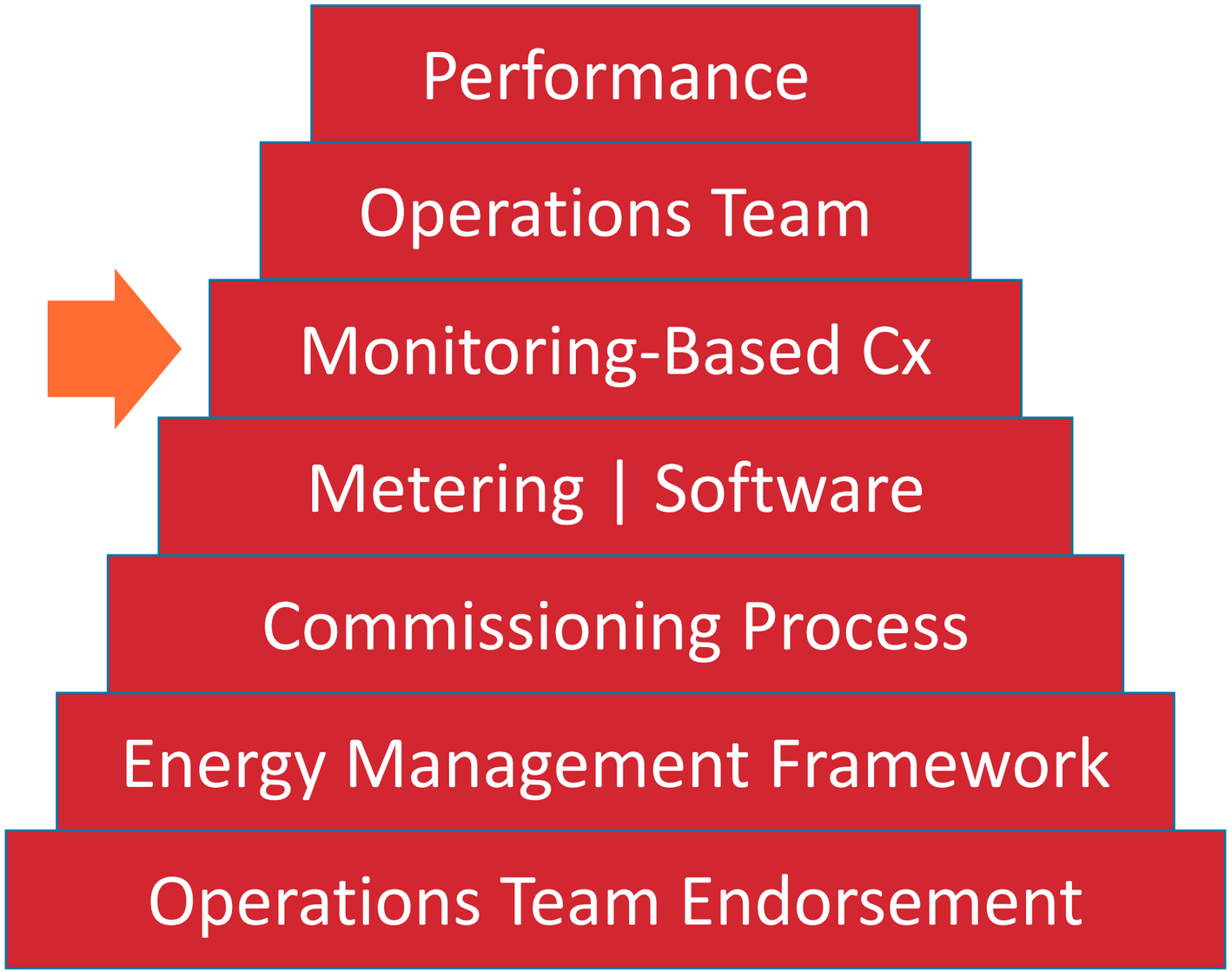
New scope of work: designing operational performance testing

Transitioning to Operations

Integrating metering equipment, BAS equipment and FDD software

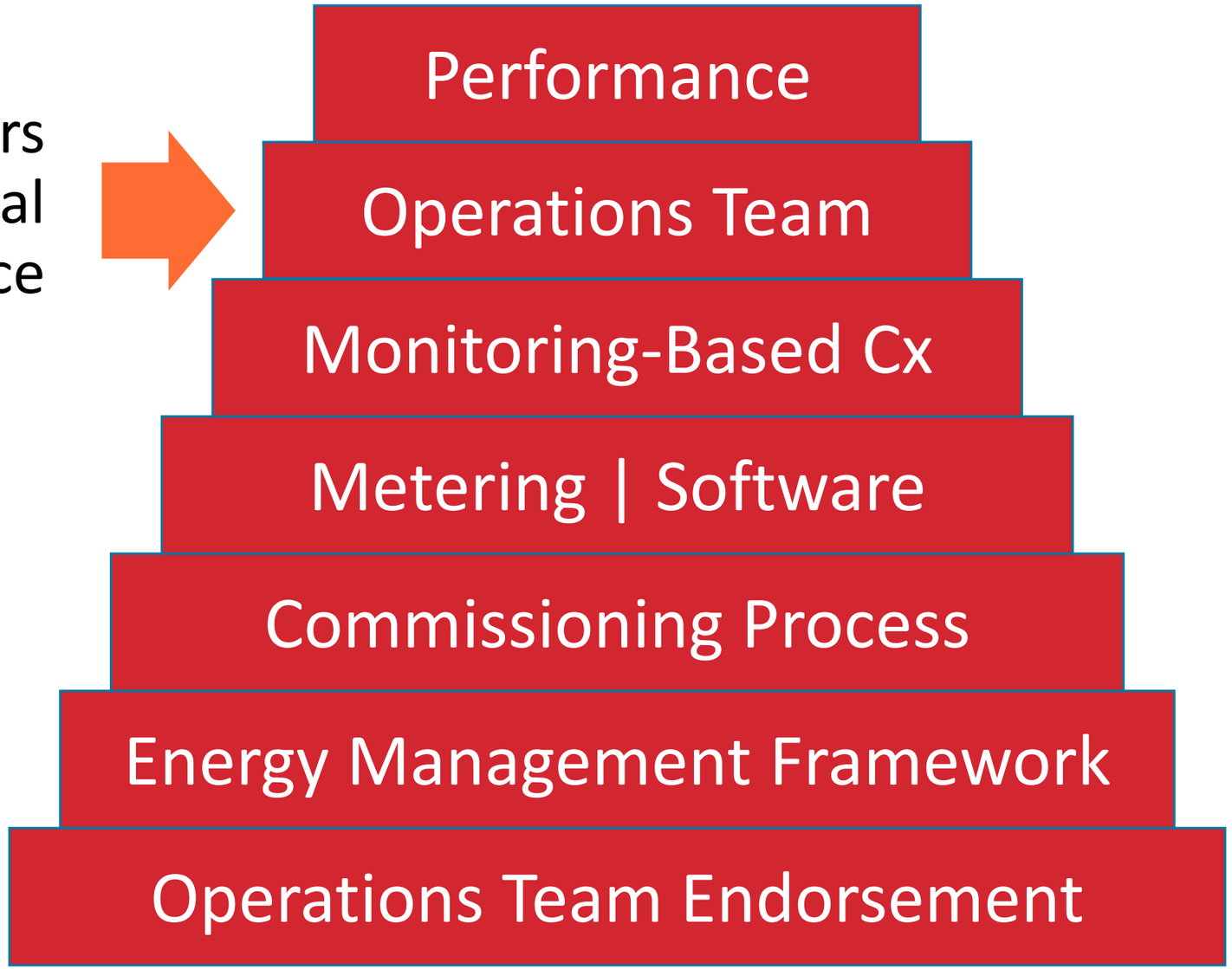
Transitioning to Operations

24 months of monitoring-based commissioning to support operations and optimize building



Transitioning to Operations

Engaged, empowered operators have the most substantial connection to performance



Questions?