

**AVANT**



**Katharine & Rebecca**



**RJ & Eric**



**Tyler & Nick**

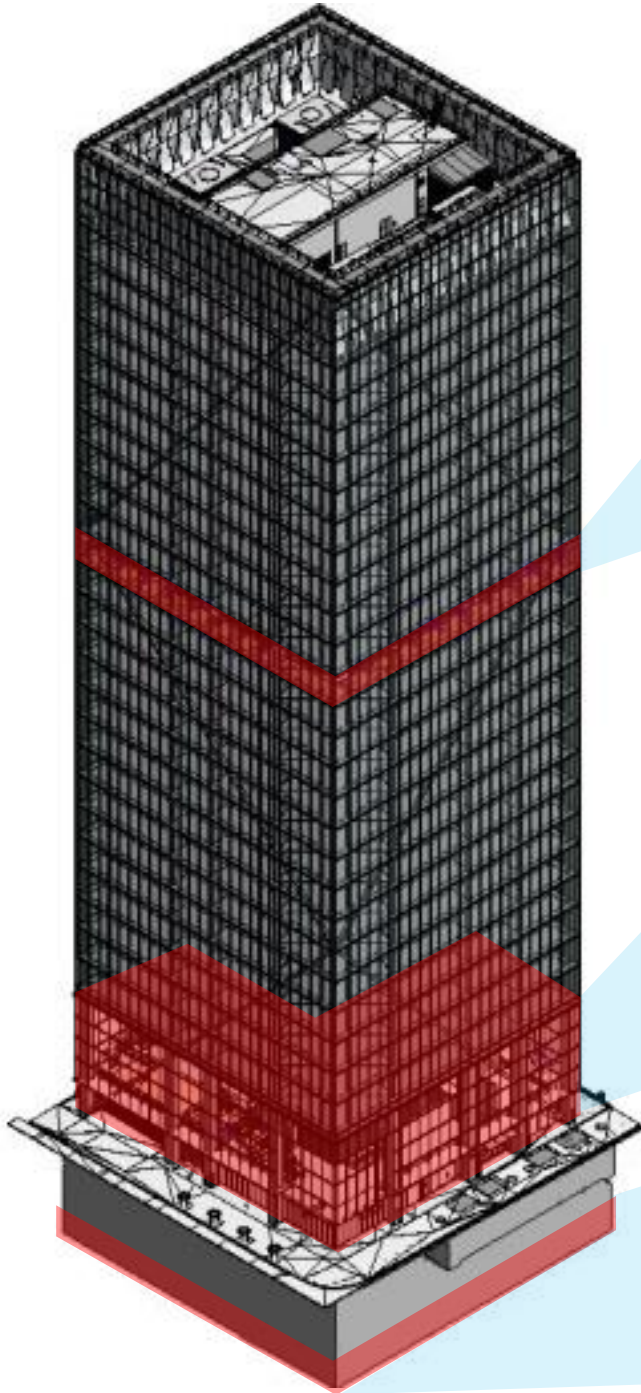


**Jordan & Chris**

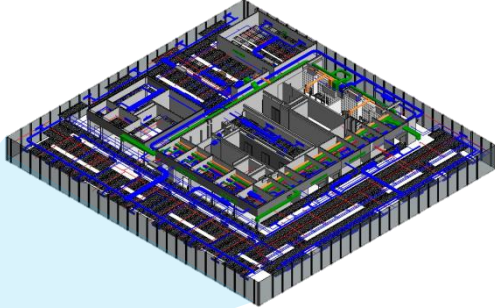




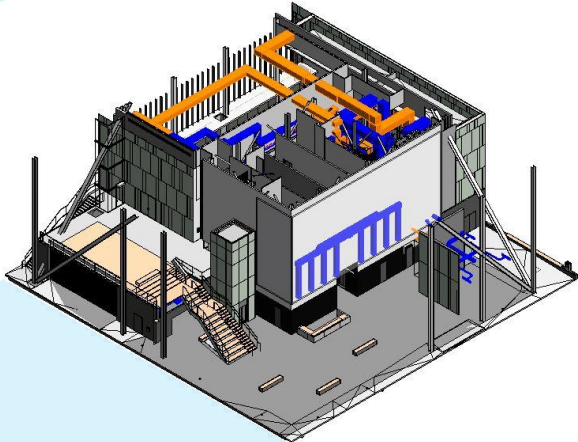
Photo Courtesy of SOM



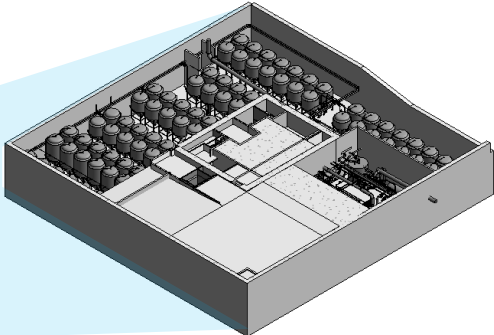
**Typical Office Floor**

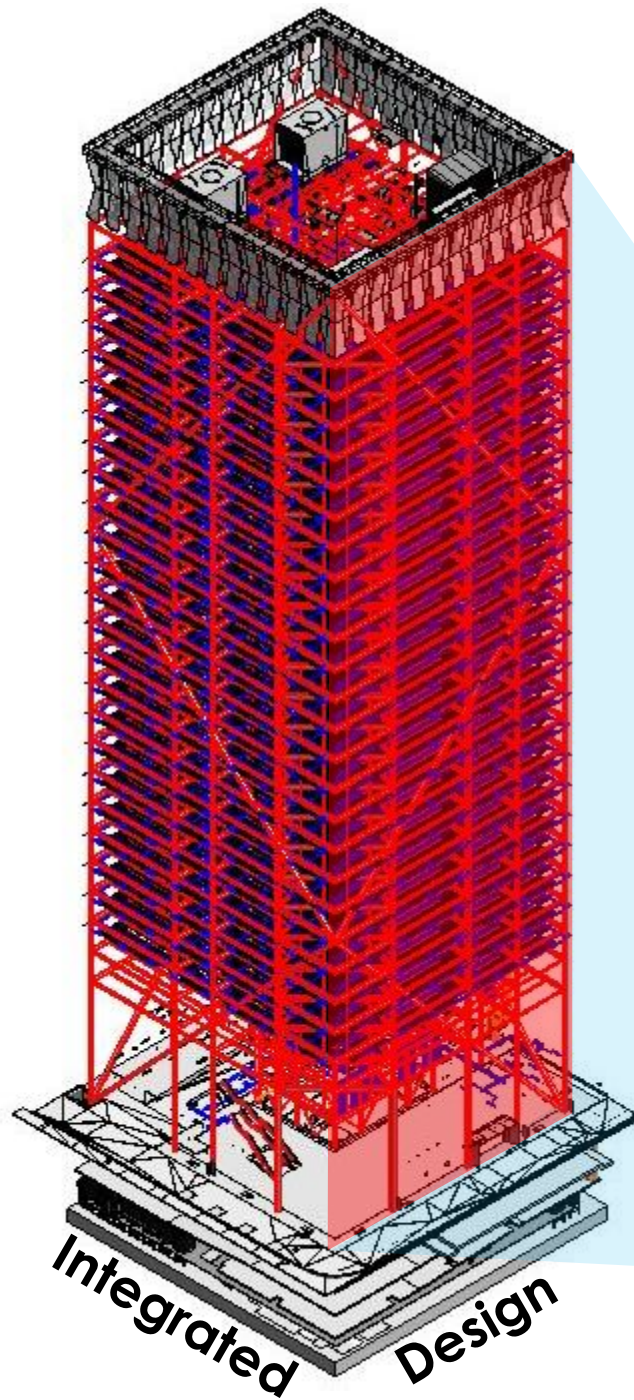


**Lobby**

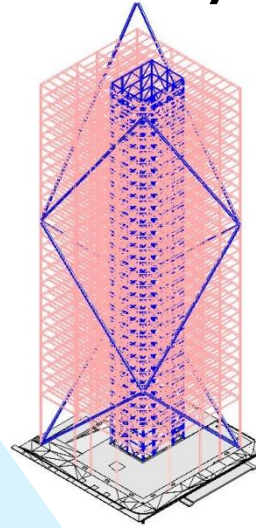


**Sustainability Plant**





**Structural System**



**Enclosure**



**Integrated Design**

# Mission Statement

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Avant is dedicated to connecting communities and enriching society through integrated, high-performance solutions and enduring principles.

# Pankow Foundation Goals

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1. To improve the **quality, efficiency** and **value** of large buildings by advancing **innovations** in structural components and systems that can be **codified**.
2. To improve the **performance** of building design and construction teams by advancing **integration, collaboration, communication**, and **efficiency** through **innovative new tools and technologies**, and by advancing new means and methods for project team practices

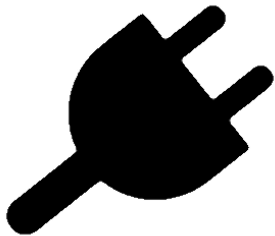
# Avant created three guiding principles for the design.



Performance



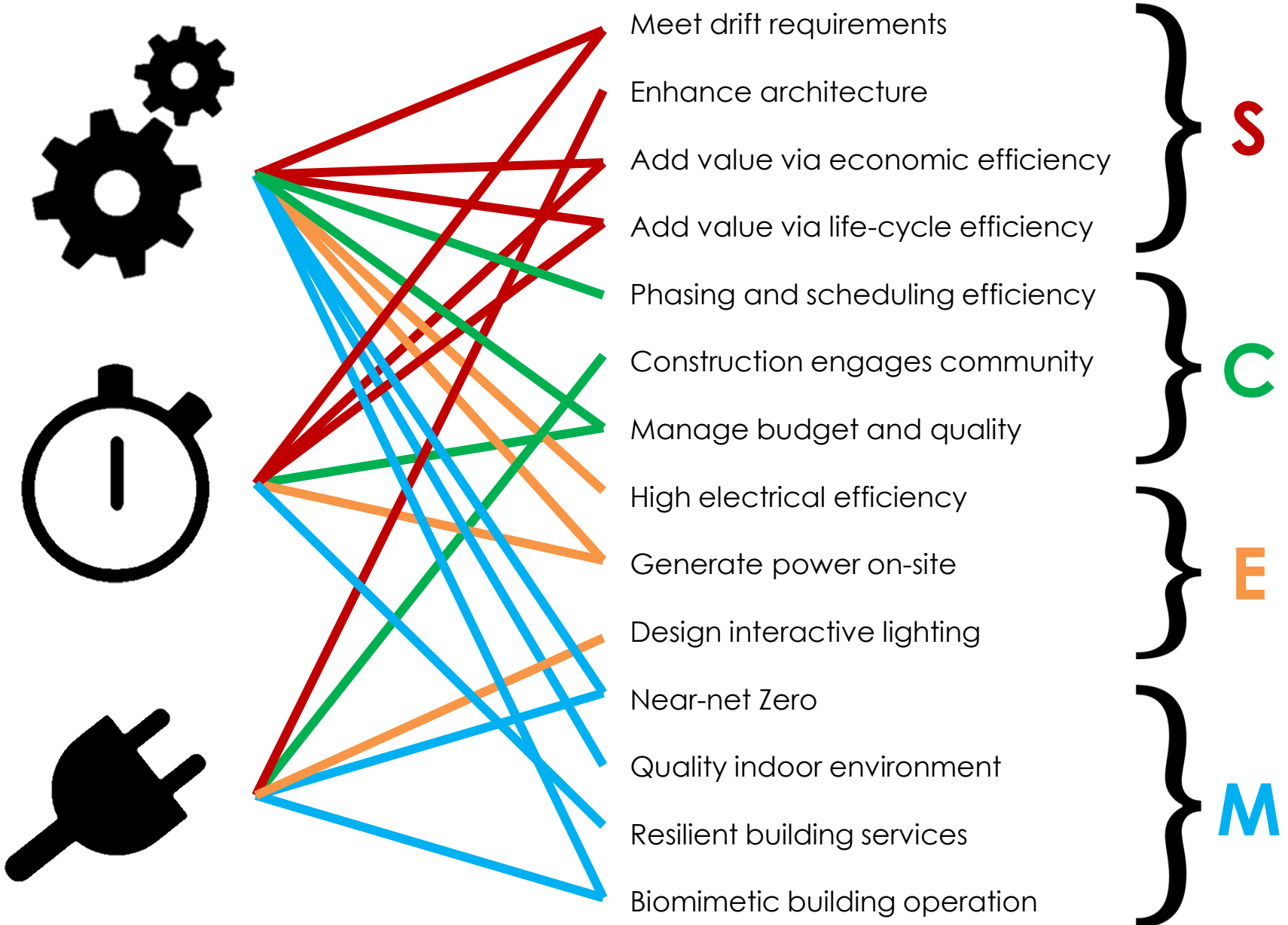
Endurance



Connectivity

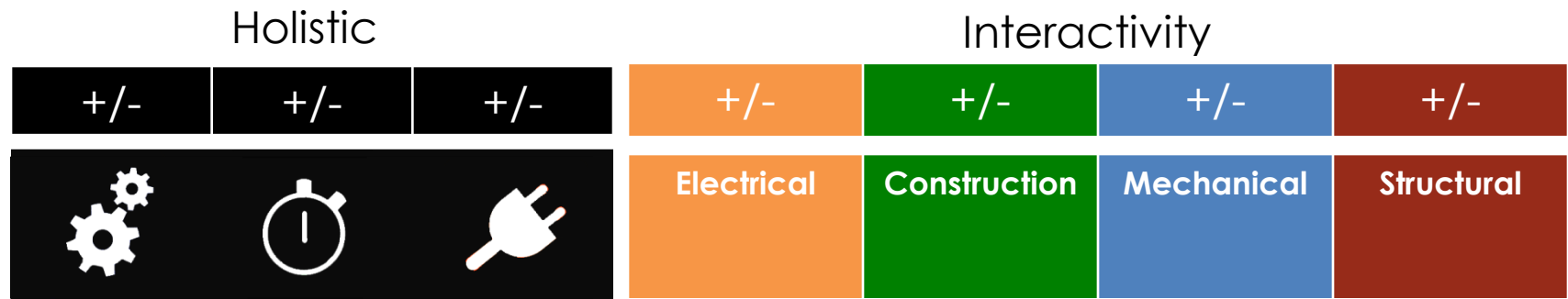


# All disciplines defined goals and tied them to the project principles, integrating our process into our solutions.



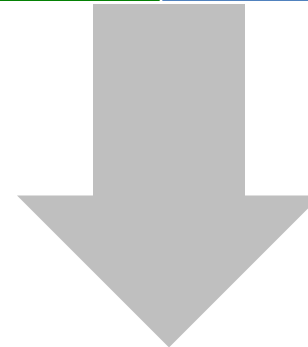
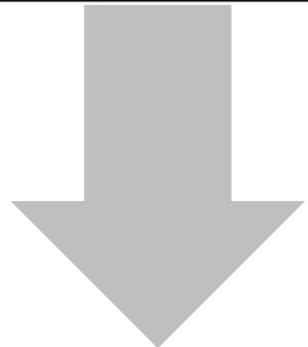
Avant developed holistic and interactive metrics that combined to produce the **integrated decision Metric**.

## Integrated Decision Metric



Electrical  
Construction  
Mechanical  
Structural

**Team principles and disciplines will be represented on each slide, to guide you through the presentation.**



# **Performance** pertains to building life cycle processes in action



- BIM
- Reduce
- Produce
- Apply
- Sequencing
- Performance Summary



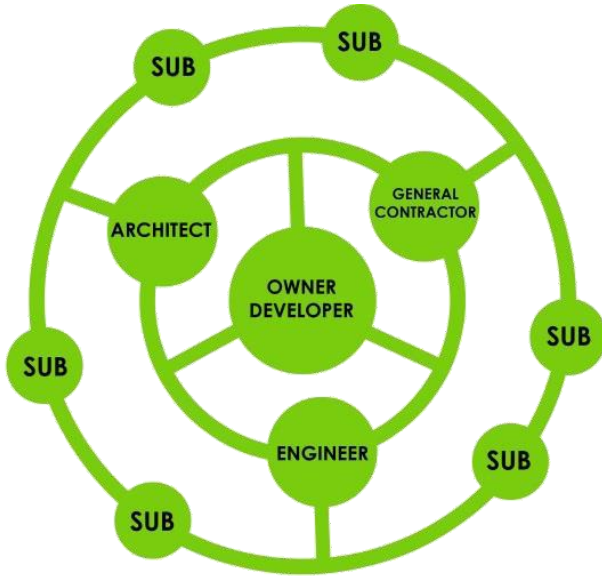
# Performance pertains to building life cycle processes in action



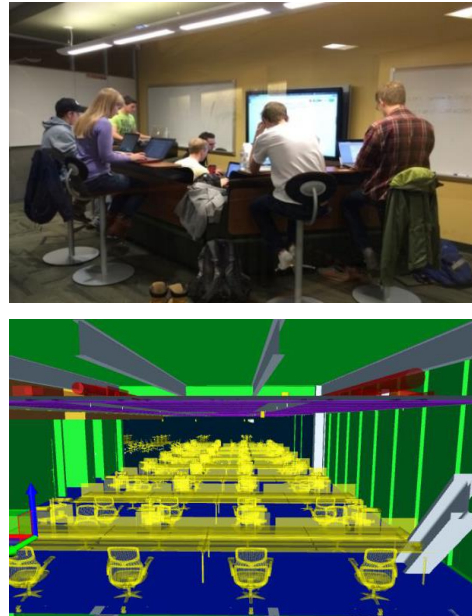
- **BIM**
  - Process
  - Software
  - Performance Workflow
- Reduce
- Produce
- Apply
- Sequencing
- Performance Summary



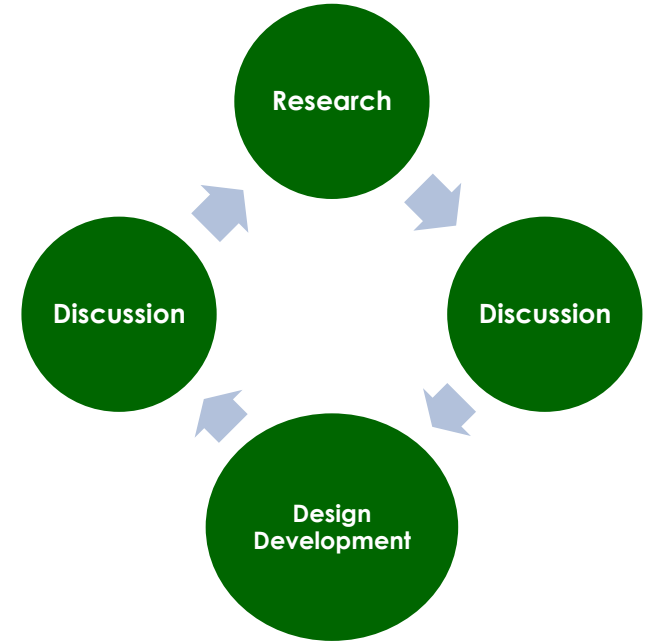
# Avant members collaborated to create an iterative, integrated design.



Team Organization



Collaborative Technology



Design Process

BIM

Reduce

Produce

Apply

Sequencing

Performance Summary



Electrical  
Construction  
Mechanical  
Structural

Avant created an **integrated workflow** in order to reduce environmental impacts.

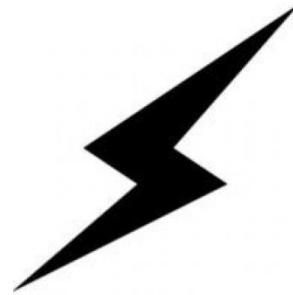
**Reduction**



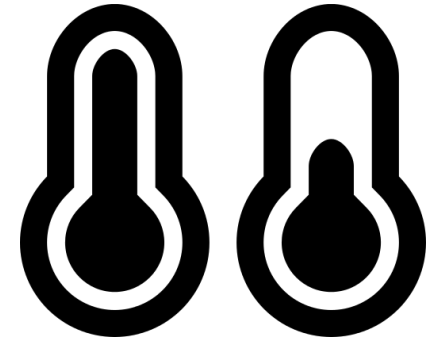
*Production*



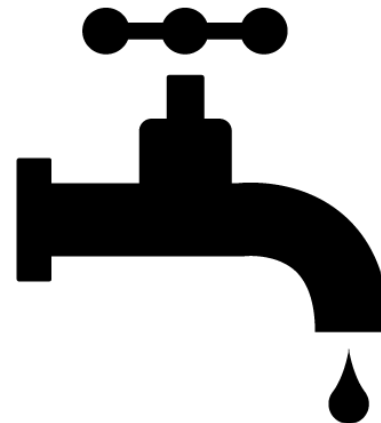
*Application*



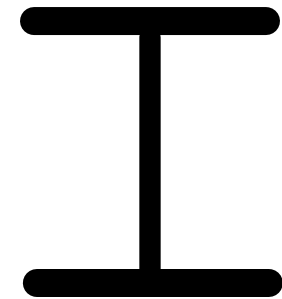
Electricity



Thermal Stress



Water Use



Structural Material

BIM

Reduce

Produce

Apply

Sequencing

Performance Summary



Electrical  
Construction  
Mechanical  
Structural

Avant created an **integrated workflow** in order to reduce environmental impacts.

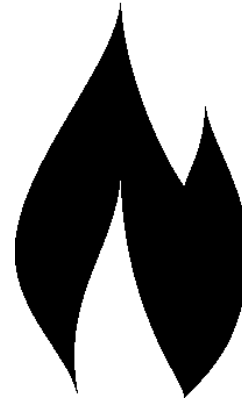
*Reduction*



**Production**



*Application*



**Thermal Energy**



**Electrical Energy**



**Reclaimed Water**

BIM

Reduce

Produce

Apply

Sequencing

Performance Summary



Electrical  
Construction  
Mechanical  
Structural



Avant created an **integrated workflow** in order to reduce environmental impacts.

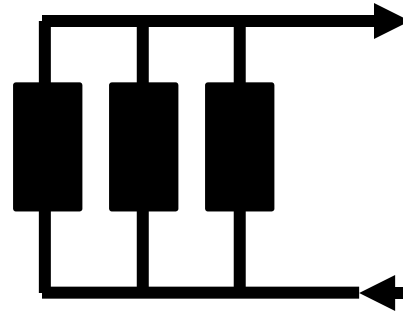
*Reduction*



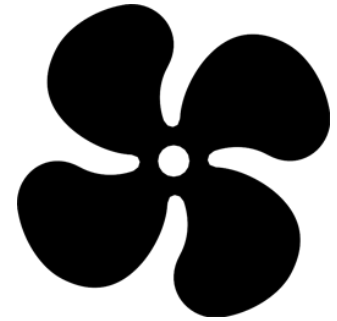
*Production*



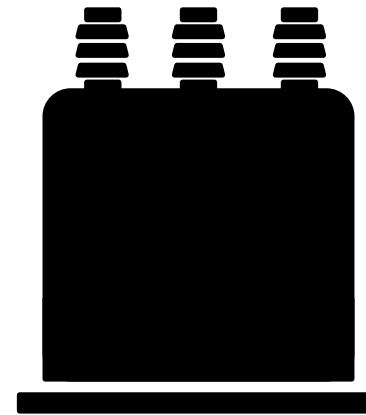
***Application***



Heating and Cooling  
Plants



HVAC End-uses



Power Distribution

BIM

Reduce

Produce

Apply

Sequencing

Performance Summary



Electrical  
Construction  
Mechanical  
Structural

Avant created an **integrated workflow** in order to reduce environmental impacts.

*Reduction*

+

*Production*

+

*Application*

BIM

Reduce

Produce

Apply

Sequencing

Performance Summary



Electrical  
Construction  
Mechanical  
Structural

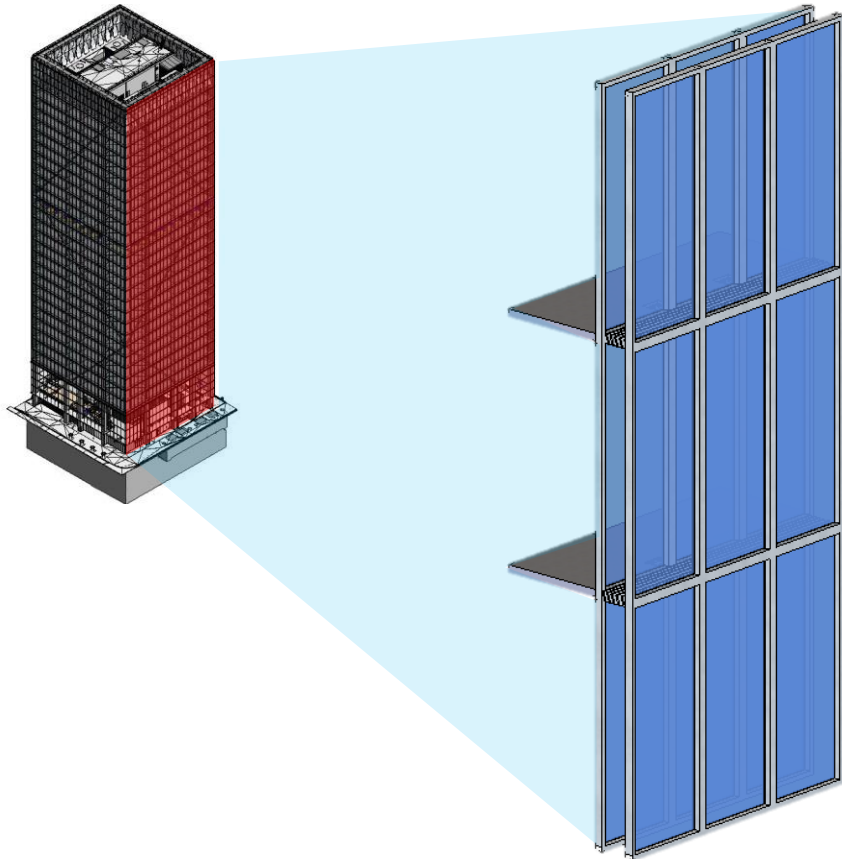
# Performance guided the sustainability and energy efficiency of 350 Mission



- BIM
- **Reduce**
  - Façade Study
  - Electrical Demand
  - Water use
  - Structural Weight
- Produce
- Apply
- Sequencing
- Performance Summary



# An iterative façade study was performed to optimize the effects of daylight and solar gain.



**Double-skin  
Façade**

+1	-2	+1
		

+1	-2	+1	-2
Electrical	Construction	Mechanical	Structural

*Good environmental barrier*

*Good for integrating MEP strategies*

*Poor rapid constructability*

*Poor seismic resilience*

BIM

Reduce

Produce

Apply

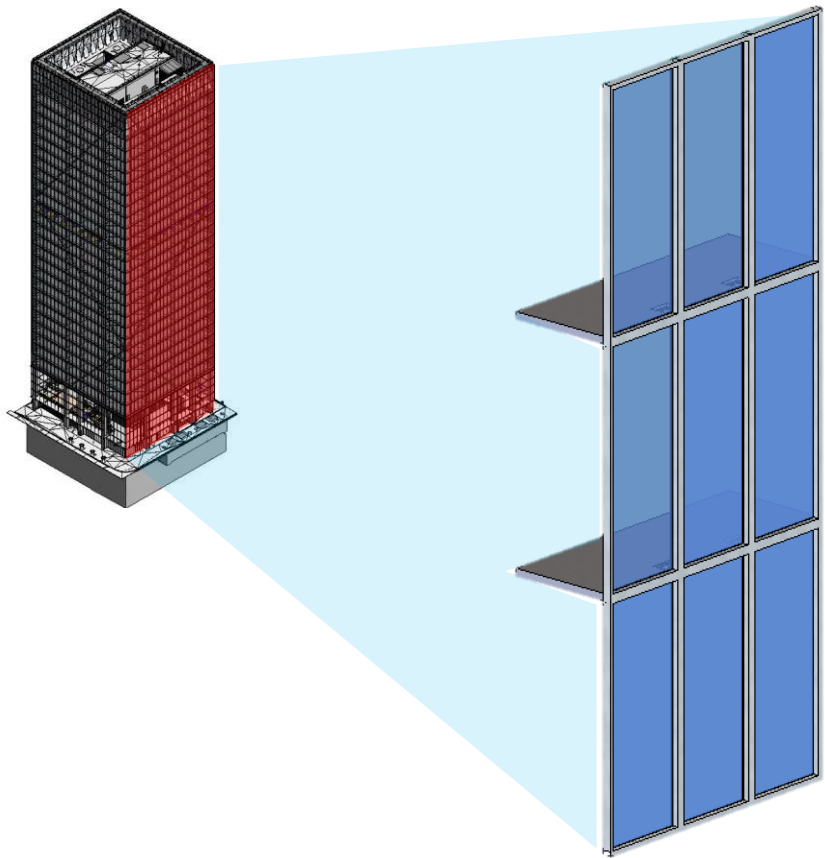
Sequencing

Performance Summary



Electrical  
Construction  
Mechanical  
Structural

# An iterative façade study was performed to optimize the effects of daylight and solar gain.



Unitized Curtain Wall

+2	+2	+1

+1	+1	+1	+1
Electrical	Construction	Mechanical	Structural

*Good environmental barrier*

*Good cost effectiveness*

*Good for rapid constructability*

*Good for seismic resilience*

BIM

Reduce

Produce

Apply

Sequencing

Performance Summary



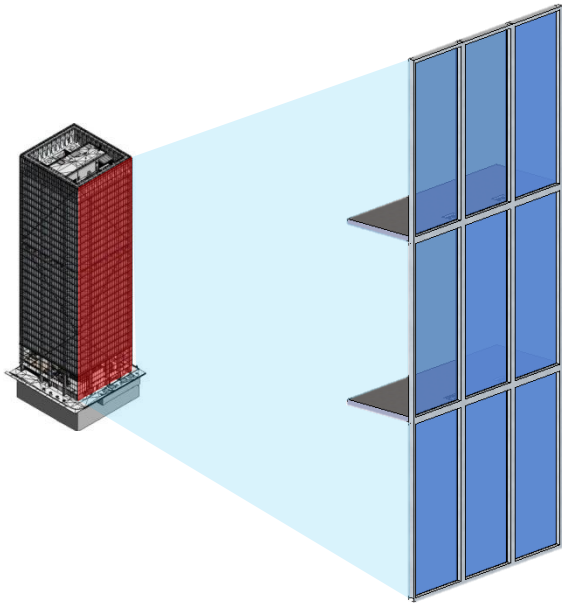
Electrical  
Construction  
Mechanical  
Structural

# An iterative façade study was performed to optimize the effects of daylight and solar gain.

Double-pane, Low-e chosen

Largest lighting savings

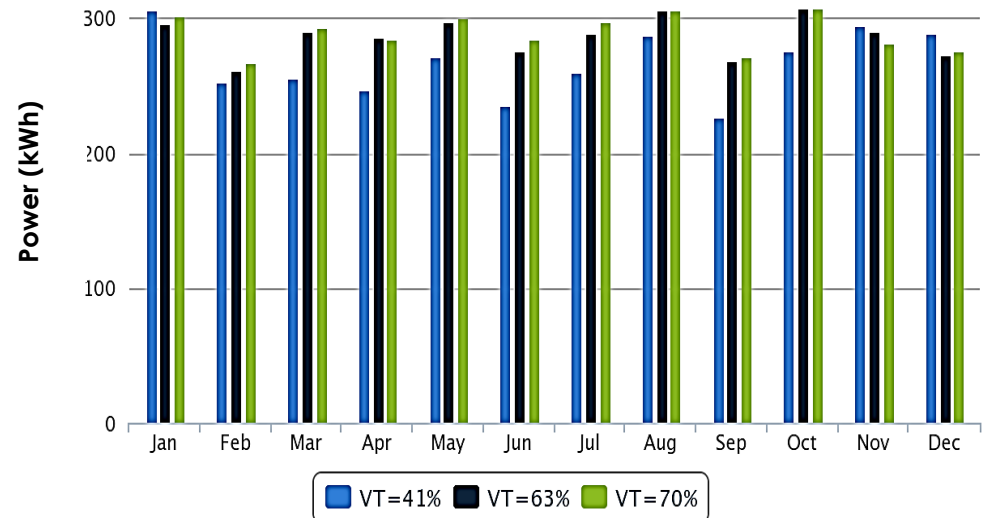
Largest thermal savings



Unitized Curtain Wall

Assembly Type	Assembly U-Value [BTU/hr-SF-F]	SGHC	VT
Viracon Triple Pane	0.17	0.25	41%
Solarban 60	0.4	0.39	70%
Guardian 62/72	0.35	0.27	63%

Energy Savings from Tambient Dimming  
20<sup>th</sup> Office Floor



BIM

Reduce

Produce

Apply

Sequencing

Performance Summary



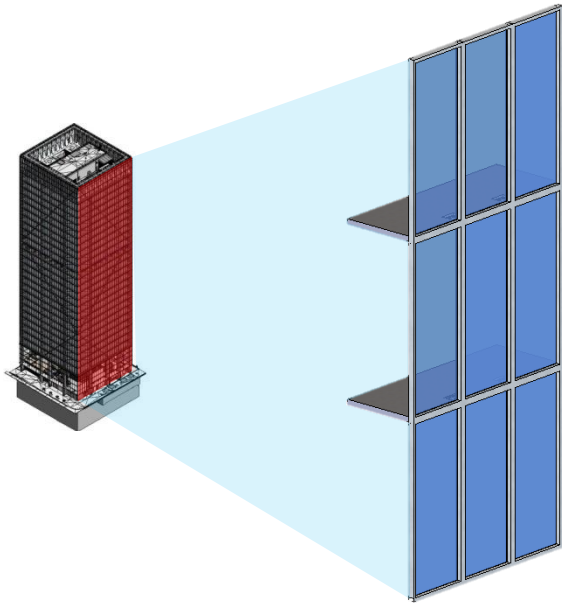
Electrical  
Construction  
Mechanical  
Structural

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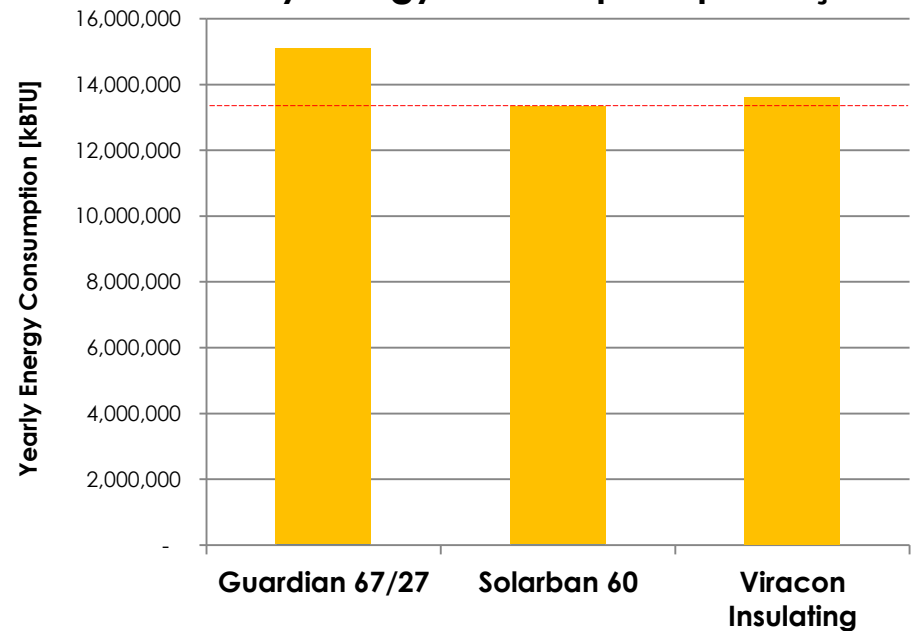
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Yearly Energy Consumption per Façade



BIM

Reduce

Produce

Apply

Sequencing

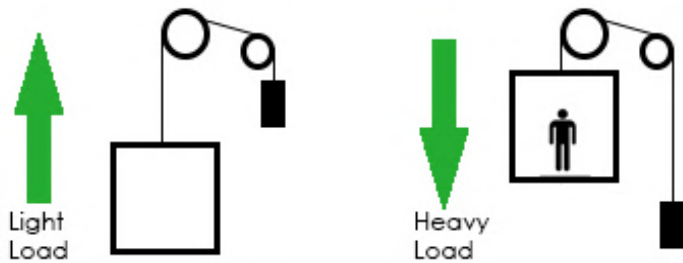
Performance Summary



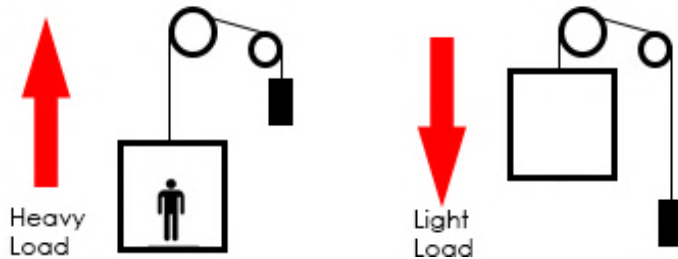
Electrical  
Construction  
Mechanical  
Structural

# Building Elevators use **Regenerative braking** to minimize energy usage.

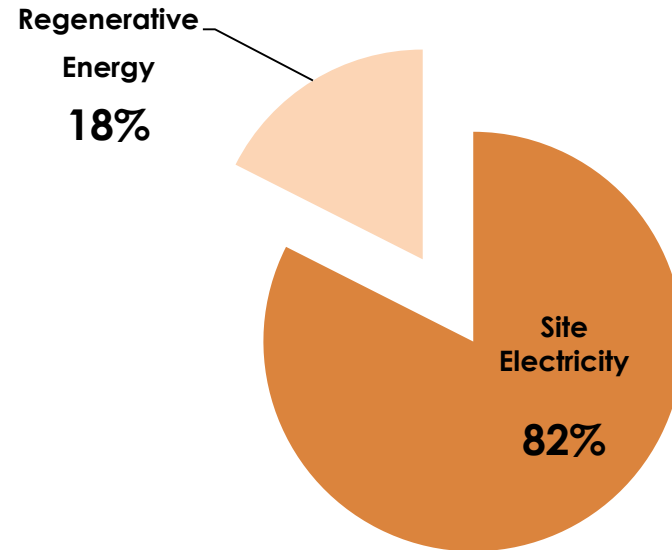
## Electrical Generation Consumption



## Electrical Power Consumption



## Total Elevator Electricity Usage



## Energy Calculations

Total Electricity Used	59,669 (kWh/yr)
Regenerative Energy Produced	10,469 (kWh/yr)

BIM

Reduce

Produce

Apply

Sequencing

Performance Summary

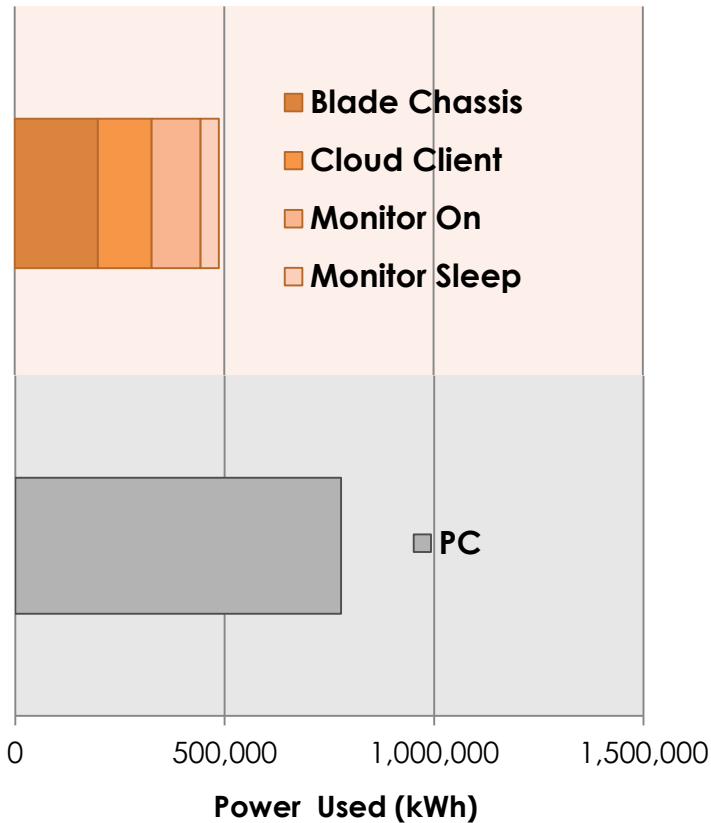


Electrical  
Construction  
Mechanical  
Structural



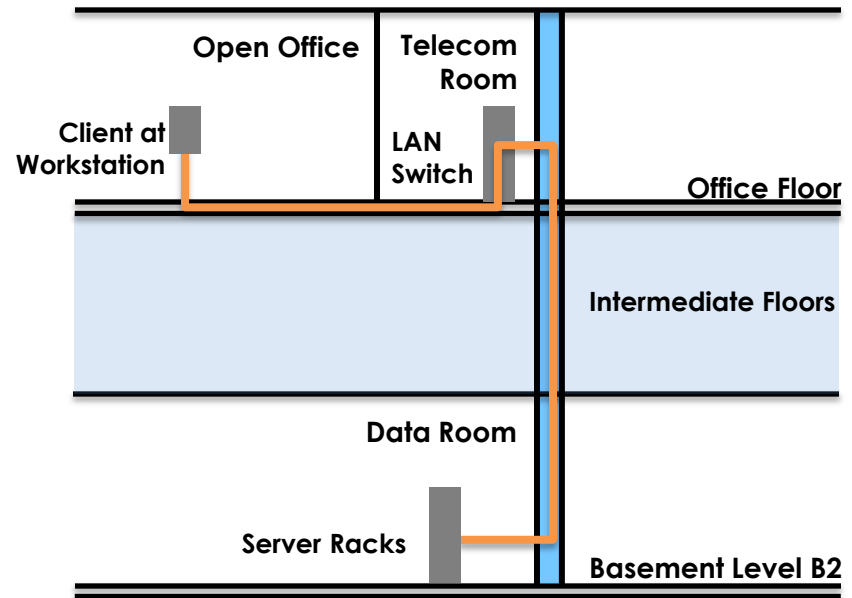
# Virtual Desktop computing enhances **Telecom Data** infrastructure while minimizing energy usage.

## PC vs. Thin Client Comparison



Yearly building energy savings of **290,725 kWh (37%)**

## Building Section View



BIM

Reduce

Produce

Apply

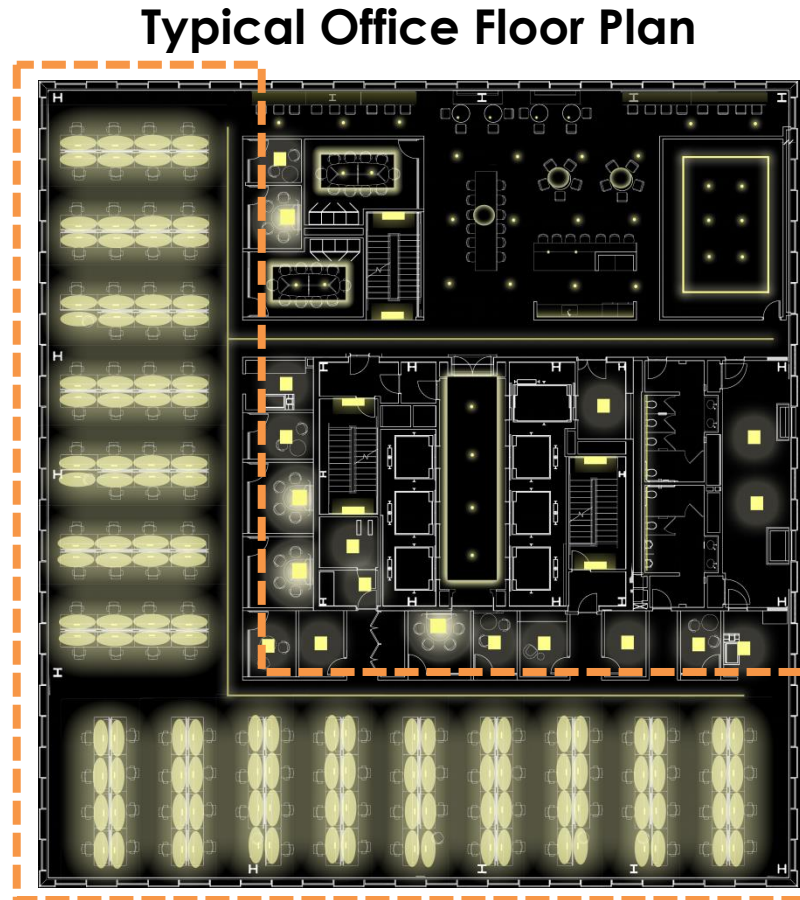
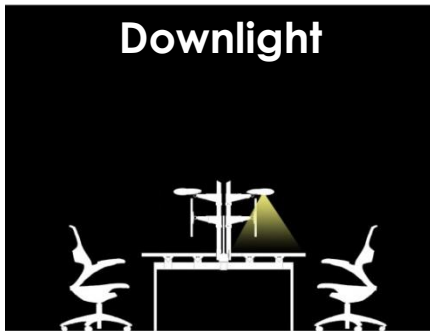
Sequencing

Performance Summary



Electrical  
Construction  
Mechanical  
Structural

# Office Lighting Design used Tambient Fixtures to improve energy efficiency.



Tambient System  
Watts  
**27.5 W**

Actual Lighting  
Power Density  
**0.65 W/sf**

Max Allowable  
Lighting power  
Density  
**0.75 W/sf**

BIM

Reduce

Produce

Apply

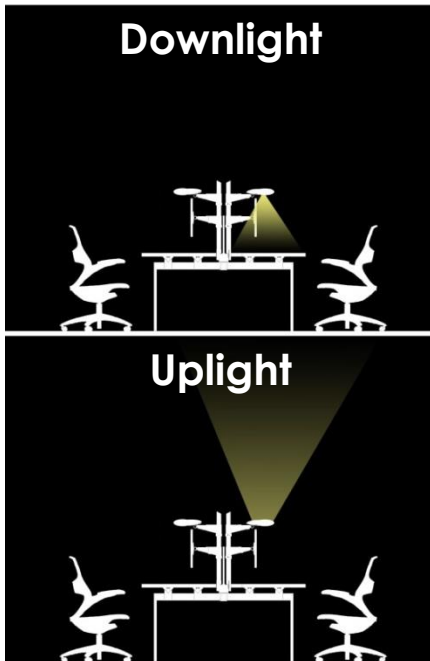
Sequencing

Performance Summary

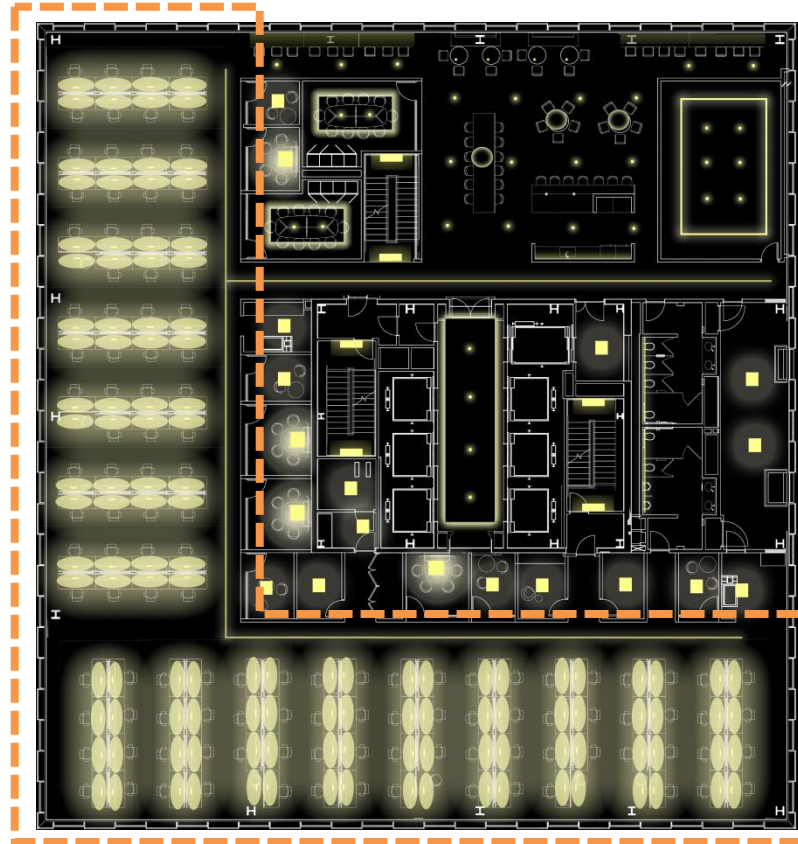


Electrical  
Construction  
Mechanical  
Structural

# Office Lighting Design used Tambient Fixtures to improve energy efficiency.



## Typical Office Floor Plan



**Tambient System  
Watts**  
**27.5 W**

**Actual Lighting  
Power Density**  
**0.65 W/sf**

**Max Allowable  
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Density**  
**0.75 W/sf**

BIM

Reduce

Produce

Apply

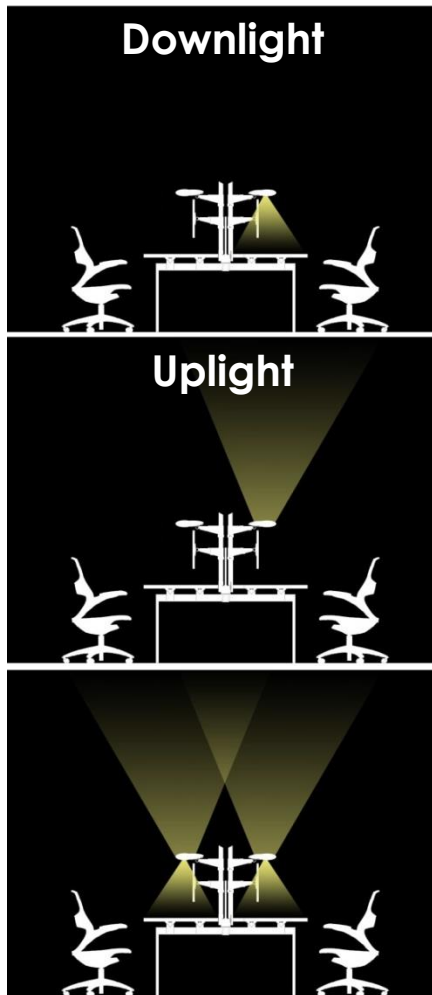
Sequencing

Performance Summary

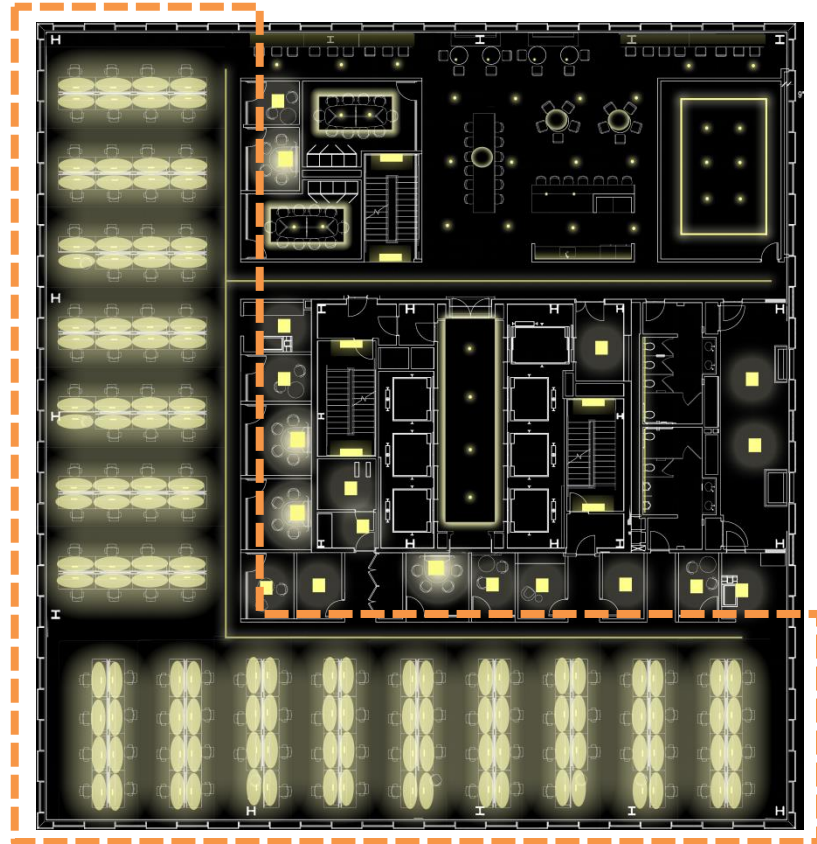


**Electrical  
Construction  
Mechanical  
Structural**

# Office Lighting Design used Tambient Fixtures to improve energy efficiency.



### Typical Office Floor Plan



**Tambient System  
Watts**

**27.5 W**

**Actual Lighting  
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**0.65 W/sf**

**Max Allowable  
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Density**

**0.75 W/sf**

BIM

Reduce

Produce

Apply

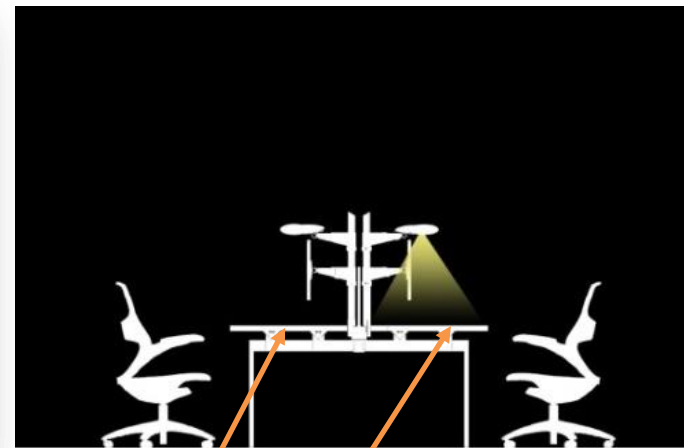
Sequencing

Performance Summary

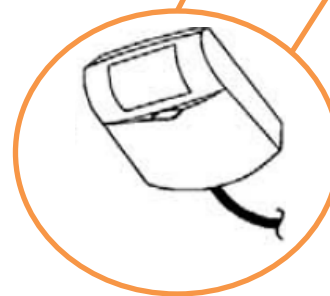


**Electrical  
Construction  
Mechanical  
Structural**

# Electrical Team creates “efficient workstation” for office workers.



**Workstation Monitors** and  
**Tambient Downlights** will be  
controlled



**Workstation  
Motion Sensor**

BIM

Reduce

Produce

Apply

Sequencing

Performance Summary



**Electrical**  
**Construction**  
**Mechanical**  
**Structural**

# Automated Shading works with Office Lighting, maximizing useable **Daylight** and reducing electrical demand.

## Typical Office Floor Plan



● Photosensor

BIM

Reduce

Produce

Apply

Sequencing

Performance Summary



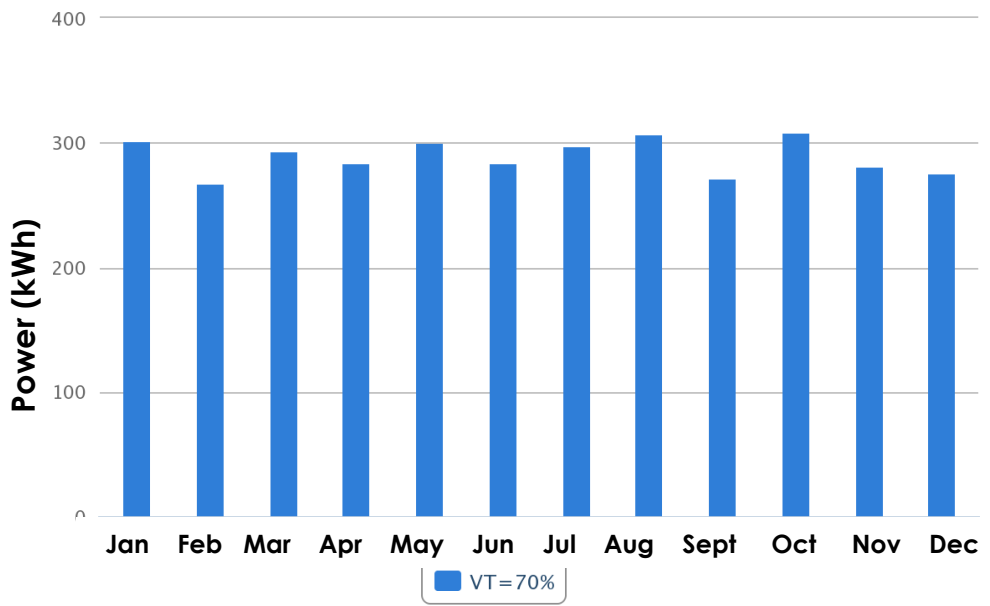
Electrical  
Construction  
Mechanical  
Structural

# Automated Shading works with Office Lighting, maximizing useable **Daylight** and reducing electrical demand.

### Typical Office Floor Plan



### Energy Savings From Tambient Dimming on 20<sup>th</sup> Office Floor



● Photosensor

BIM

Reduce

Produce

Apply

Sequencing

Performance Summary



Electrical  
Construction  
Mechanical  
Structural

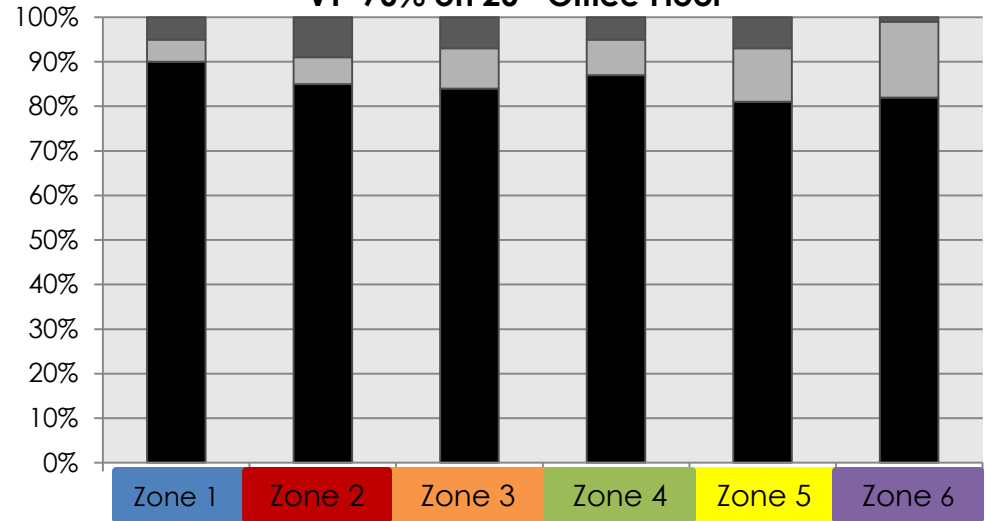
# Automated Shading works with Office Lighting, maximizing useable **Daylight** and reducing electrical demand.

## Typical Office Floor Plan



● Photosensor

## Percentage of Time for Each Shade Setting: VT=70% on 20<sup>th</sup> Office Floor



Shade Settings Modeled in DAYSIM

BIM

Reduce

Produce

Apply

Sequencing

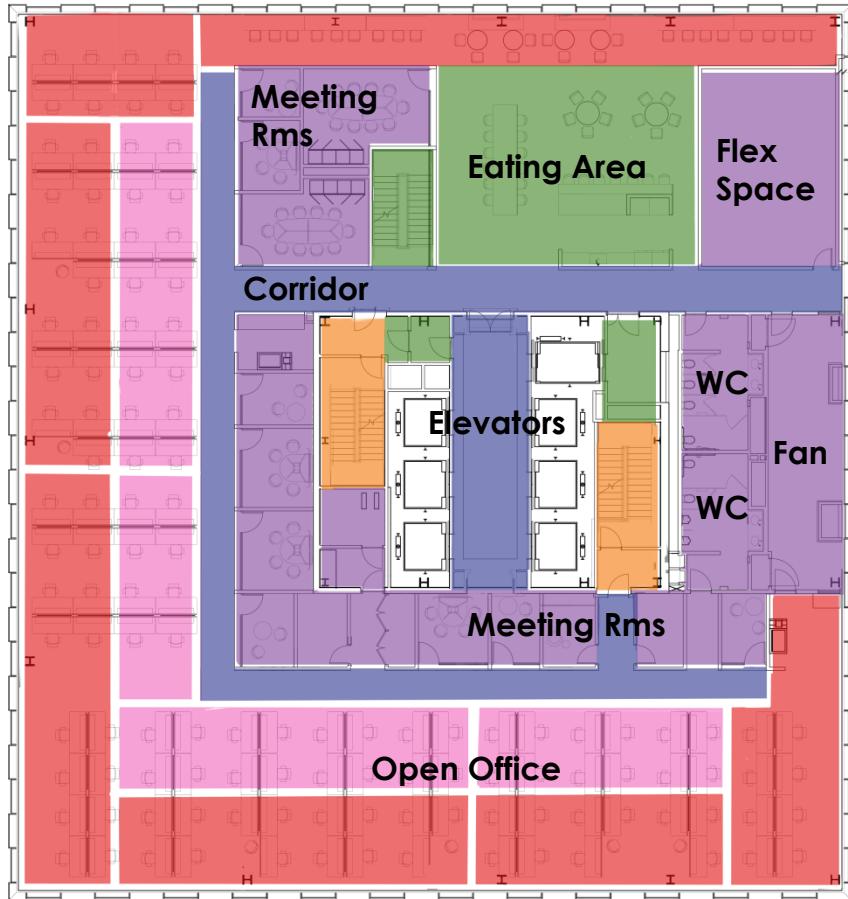
Performance Summary









Electrical  
Construction  
Mechanical  
Structural



# Advanced Lighting Controls will reduce building Electrical Demand.



-  Automatic On/Automatic Off
-  Daylight Zone 1
-  Daylight Zone 2
-  Automatic On/Automatic Off
-  Switch On/Automatic Off
-  Always on

BIM

Reduce

Produce

Apply

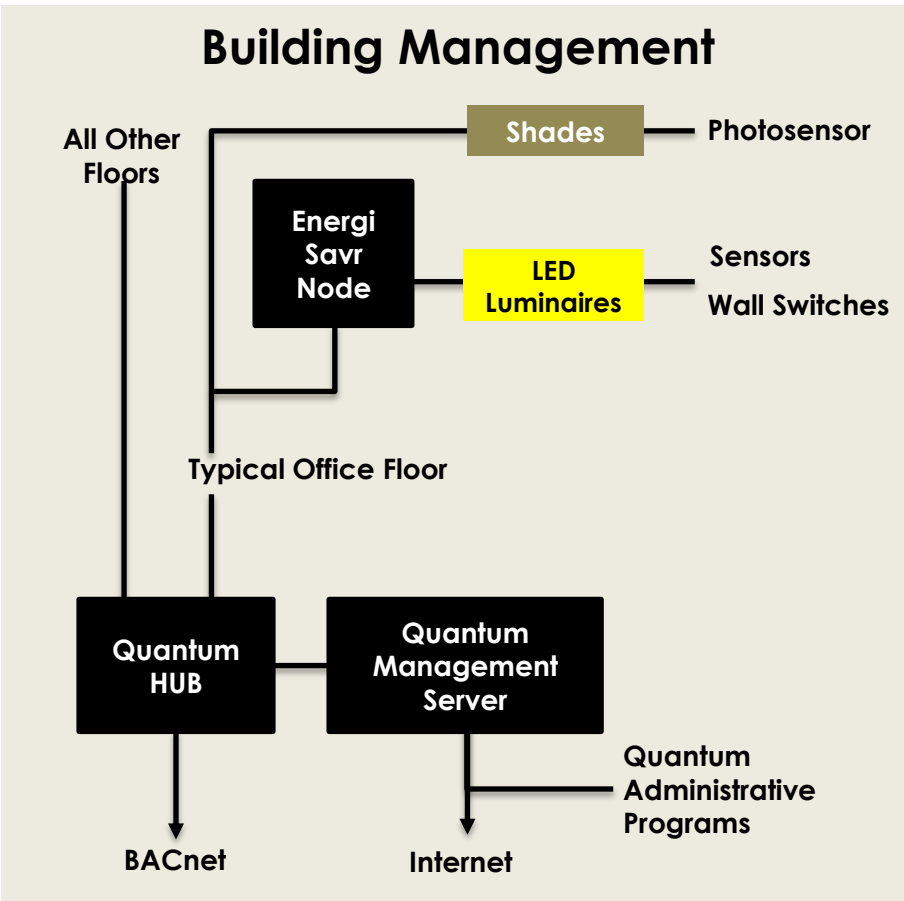
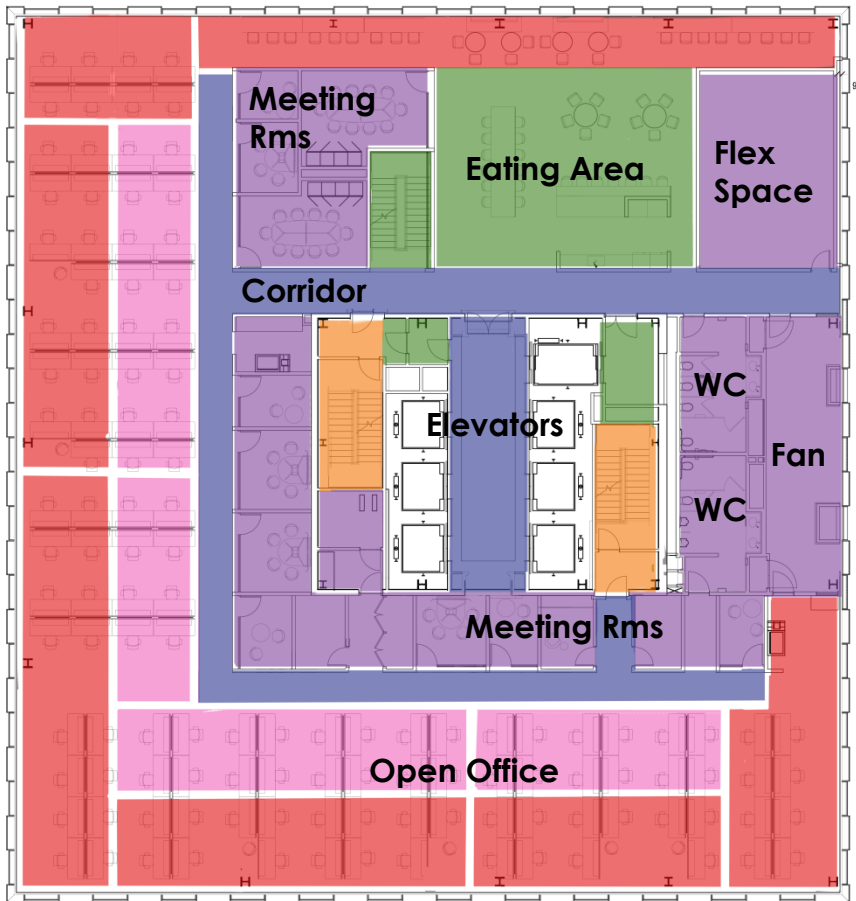
Sequencing

Performance Summary



Electrical  
Construction  
Mechanical  
Structural

# Advanced Lighting Controls will reduce building Electrical Demand.

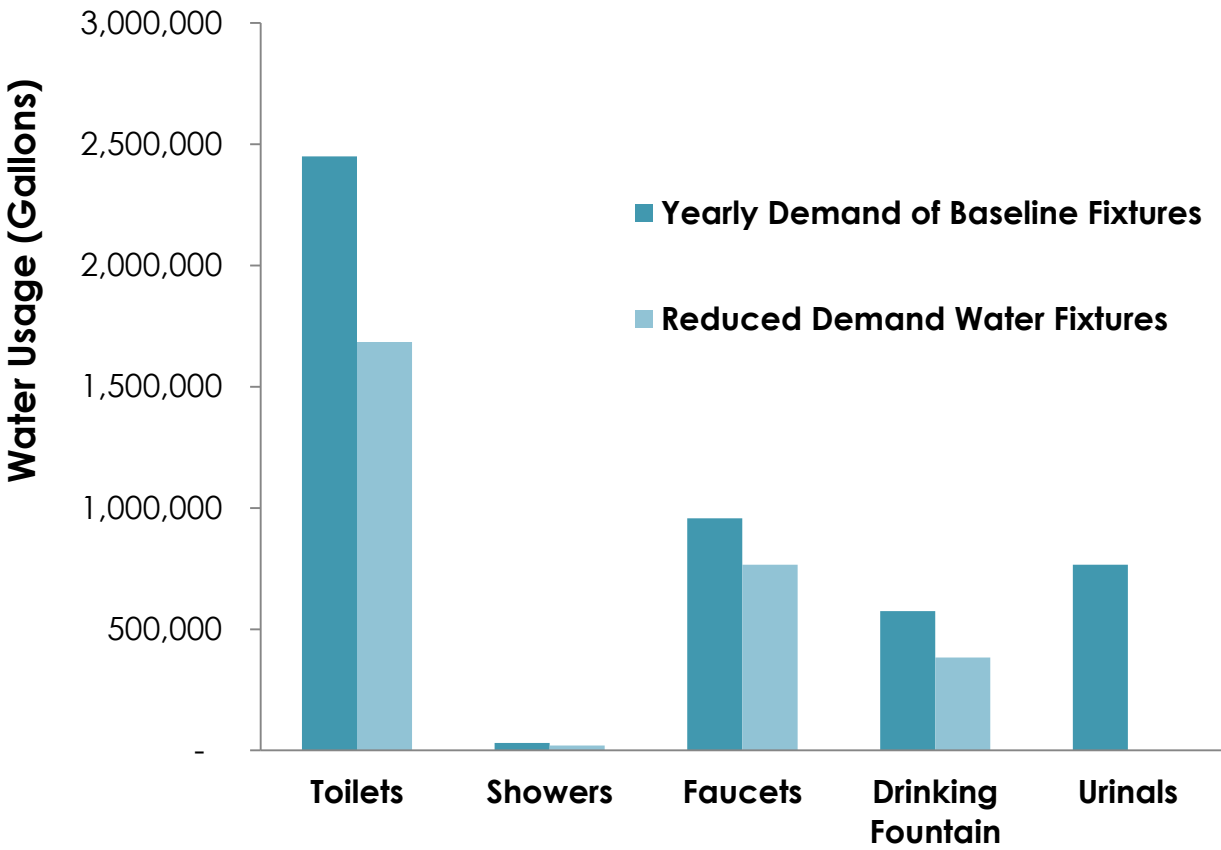


BIM	<b>Reduce</b>	Produce	Apply	Sequencing	Performance Summary
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**Electrical**  
Construction  
Mechanical  
Structural

# Low-flow plumbing fixtures reduce demand for municipal potable water.

### Annual Baseline vs. Reduced Water Use



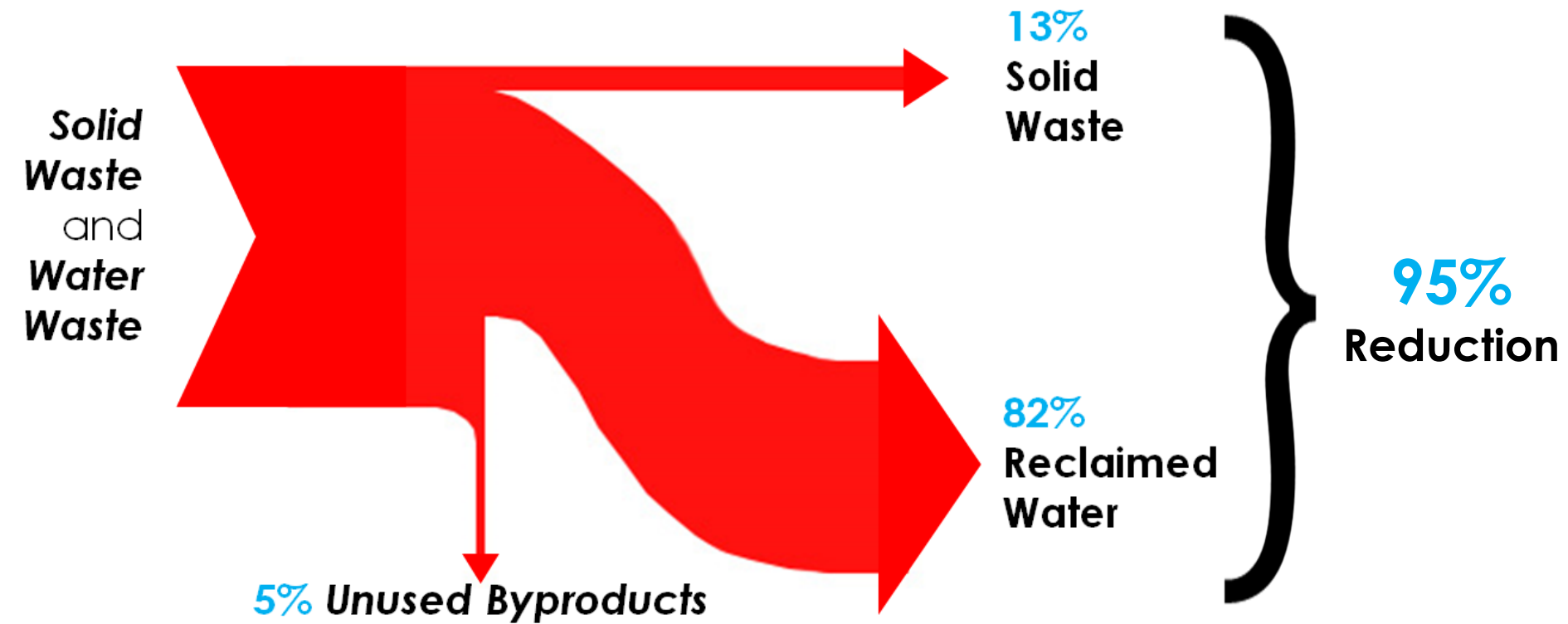
### Fixture Reductions

- Toilets **31%**
- Shower **34%**
- Faucets **20%**
- Fountains **33%**
- Urinals **100%**

**Overall Reduction**  
**30%**

**Savings**  
**\$7,700/year**

# Several strategies are used to minimize 350 Mission's outgoing waste stream.



BIM

Reduce

Produce

Apply

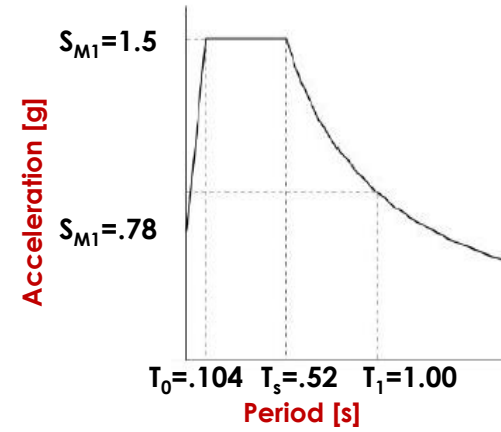
Sequencing

Performance Summary



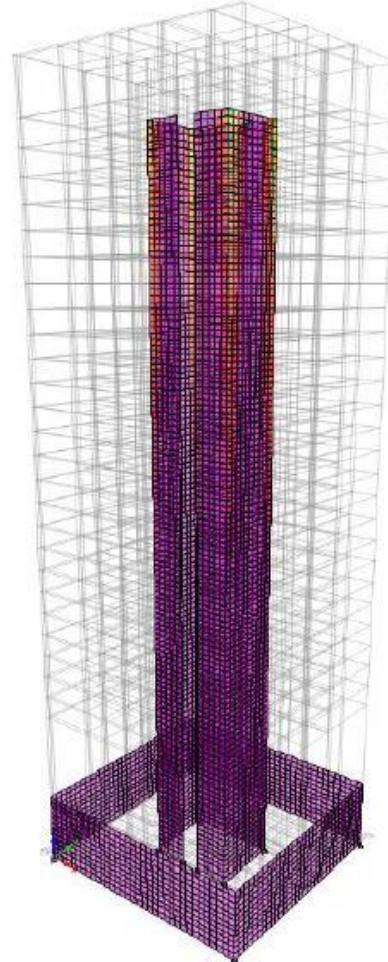
Electrical  
Construction  
Mechanical  
Structural

# Seismic load reduction desired, original system estimated for baseline.



Seismic Parameter	Value
R	1
Ss	1.5g
S1	.6g
Sms	1.5g
Sm1	.78g
Sds	1g
Sd1	.52g
TL	12s
Ts	.52s
le	1.25
SDC	D

Equivalent Lateral Force Procedure (ELF)



Modal Response Spectrum Analysis

BIM

Reduce

Produce

Apply

Sequencing

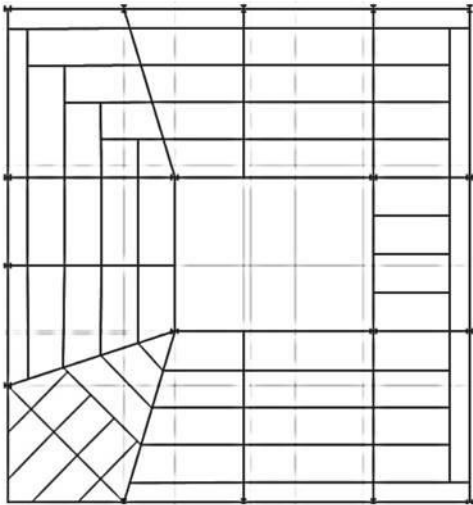
Performance Summary



Electrical  
Construction  
Mechanical  
Structural

**Multiple layouts were evaluated** for their potential to meet project criteria and **reduce seismic loads.**

Angular Layout



BIM

Reduce

Produce

Apply

Sequencing

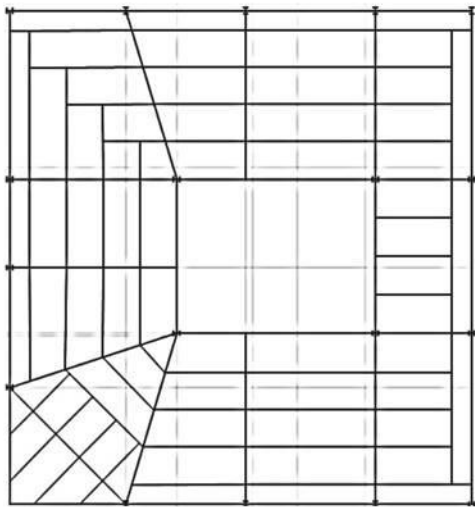
Performance Summary



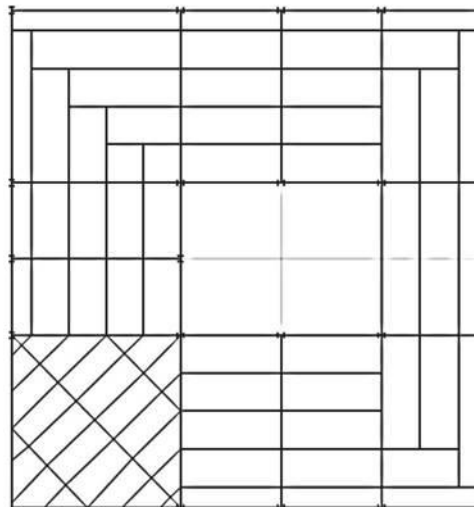
Electrical  
Construction  
Mechanical  
Structural

# Multiple layouts were evaluated for their potential to meet project criteria and reduce seismic loads.

Angular Layout



Revised Column Layout



BIM

Reduce

Produce

Apply

Sequencing

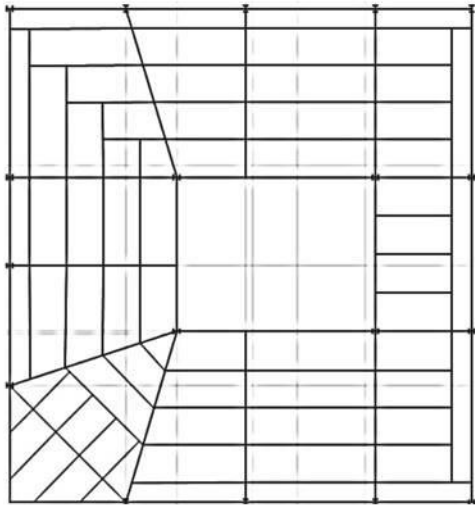
Performance Summary



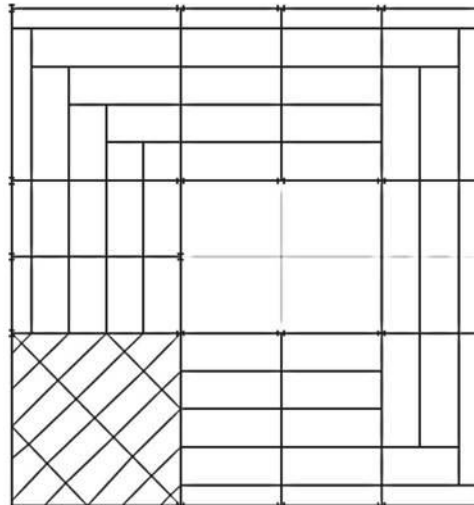
Electrical  
Construction  
Mechanical  
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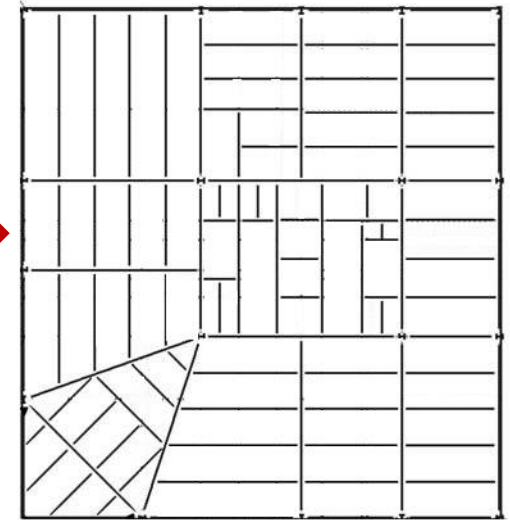
Angular Layout



Revised Column Layout



Final Layout



BIM

Reduce

Produce

Apply

Sequencing

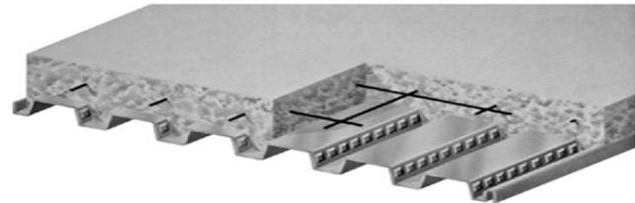
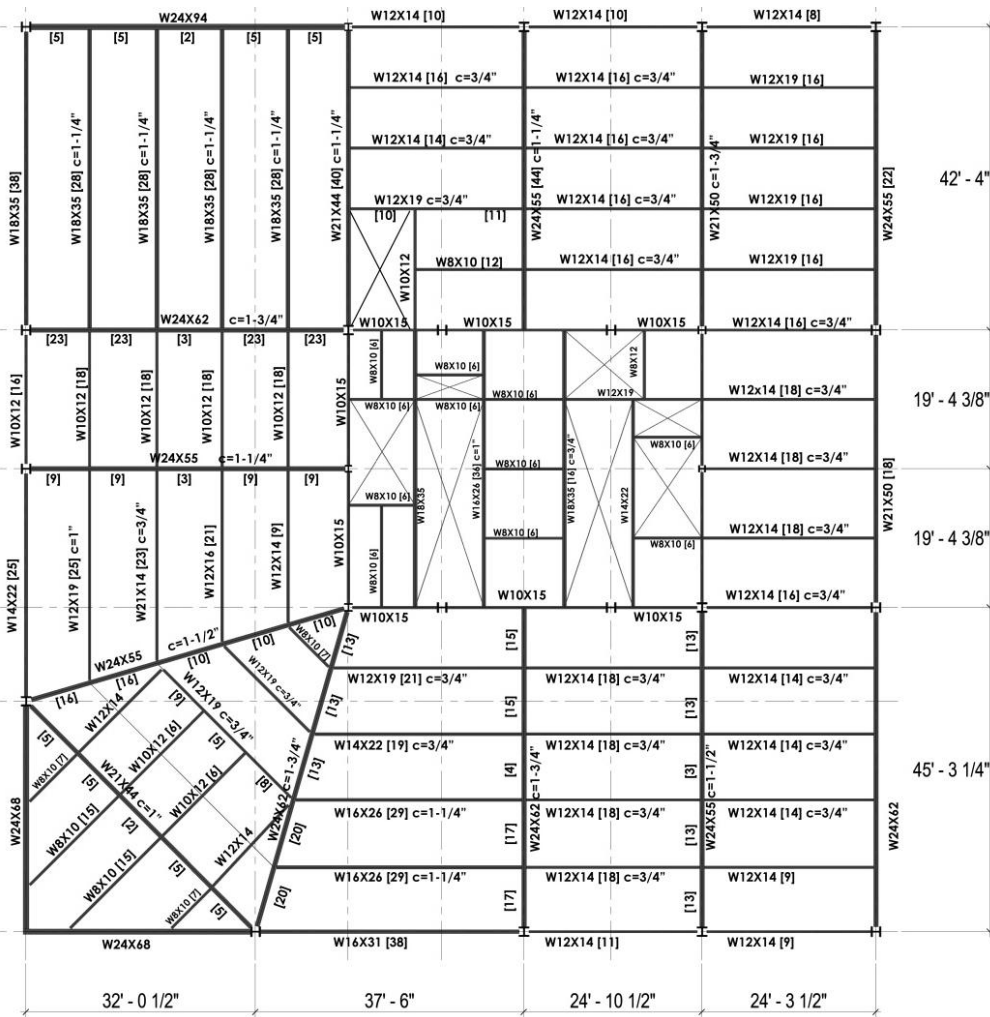
Performance Summary



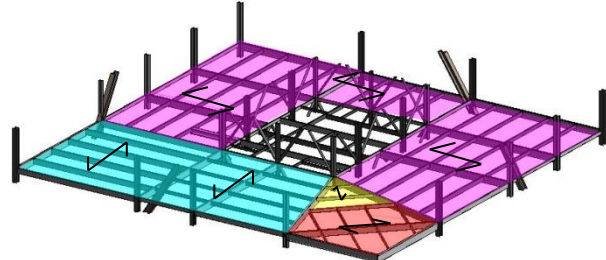
Electrical  
Construction  
Mechanical  
Structural



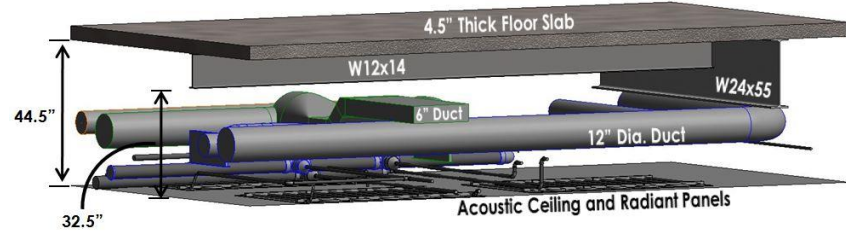
# Framing was optimized for **constructability and coordination** with MEP.



1.5 VLI Vulcraft Decking with **Lightweight Concrete**



Deck Span Directions on a Typical Floor



Preliminary **MEP Coordination** of Typical Bay

BIM

Reduce

Produce

Apply

Sequencing

Performance Summary



Electrical  
Construction  
Mechanical  
Structural

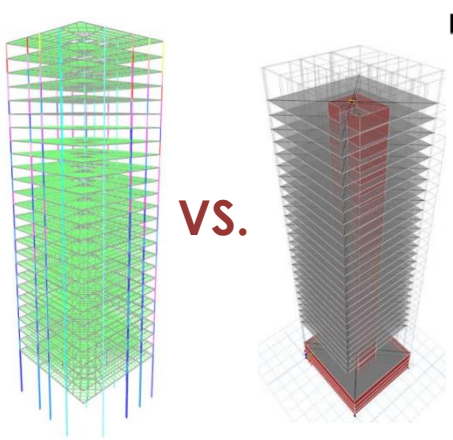
# Load reduction confirmed with Equivalent Lateral Force Procedure.

Steel Gravity System Dead Loads [Typical Floor]		
Type:	Notes:	Value:
Decking	LWC slab on composite metal deck (Vulcraft VLI 1.5)	37 lb/ft <sup>2</sup>
Misc. Concrete Overpour	Account for accidental overpour	1 lb/ft <sup>2</sup>
Flooring Finish	Superimposed	3 lb/ft <sup>2</sup>
Ceiling		2 lb/ft <sup>2</sup>
Lighting		5 lb/ft <sup>2</sup>
MEP		10 lb/ft <sup>2</sup>
Columns	Allowance	5 lb/ft <sup>2</sup>
Beams	Allowance	5 lb/ft <sup>2</sup>
<b>Total</b>		<b>68 lb/ft<sup>2</sup></b>

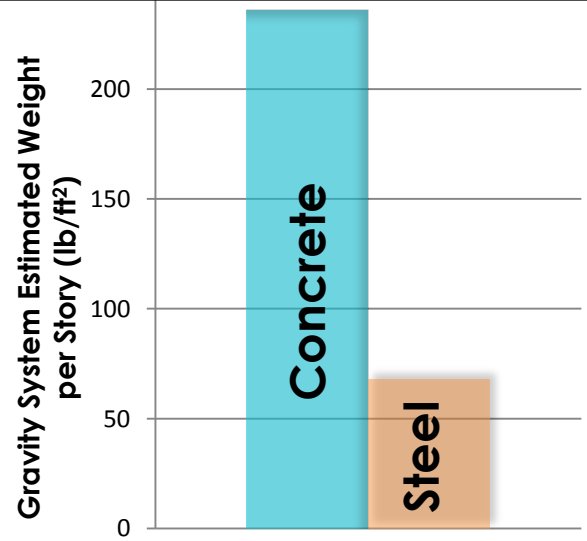


# Load reduction confirmed with Equivalent Lateral Force Procedure.

Steel Gravity System Dead Loads [Typical Floor]		
Type:	Notes:	Value:
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Ceiling		2 lb/ft <sup>2</sup>
Lighting		5 lb/ft <sup>2</sup>
MEP		10 lb/ft <sup>2</sup>
Columns	Allowance	5 lb/ft <sup>2</sup>
Beams	Allowance	5 lb/ft <sup>2</sup>
<b>Total</b>		<b>68 lb/ft<sup>2</sup></b>



VS.



**ELF Roughly Estimated a Potential for up to a 60% Reduction of Seismic Weight and Base Shear**

BIM	<b>Reduce</b>	Produce	Apply	Sequencing	Performance Summary
-----	---------------	---------	-------	------------	---------------------



Electrical  
Construction  
Mechanical  
Structural

# Performance guided the sustainability and energy efficiency of 350 Mission

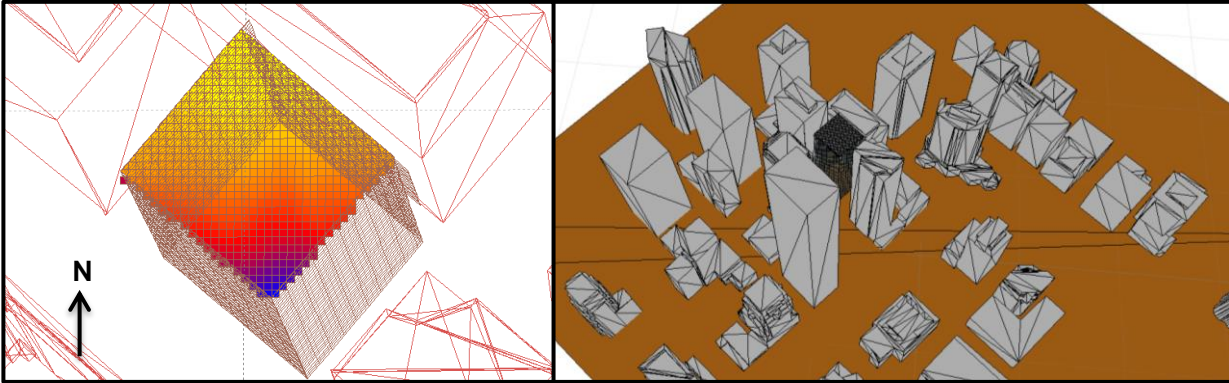


- BIM
- Reduce
- **Produce**
  - Invalid Technology
  - Mat Slab
  - BioMethane & Water Production
  - Energy Production
- Apply
- Sequencing
- Performance Summary



# In studying resource production onsite, several Power Generation methods were deemed **impractical solutions**.

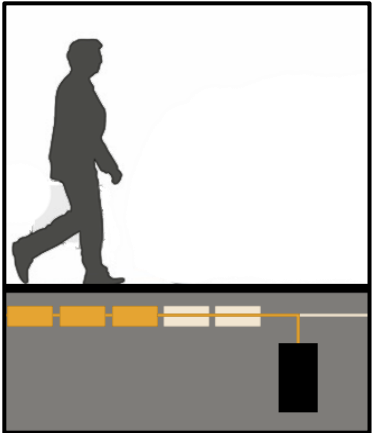
## Photovoltaics



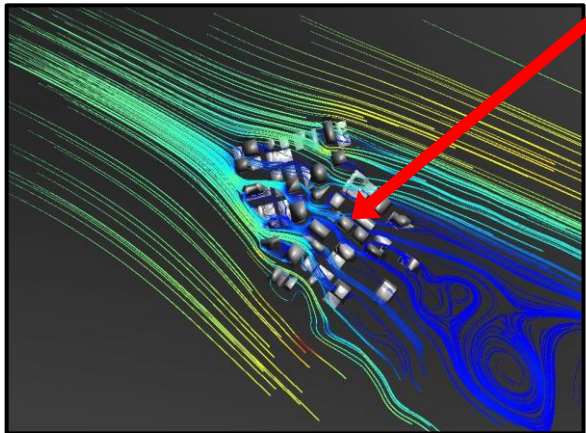
Possible Power Generation

Entire Roof:  
**81,738.04 kWh**

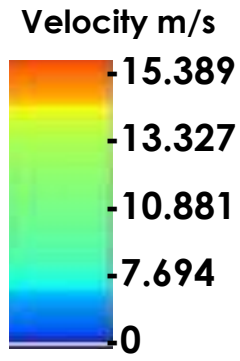
## Piezoelectricity



## Wind Turbines



**350 Mission**



BIM

Reduce

Produce

Apply

Sequencing

Performance Summary



Electrical  
Construction  
Mechanical  
Structural

# Avant visited a **farm with a biomethane digester** system to determine the viability of this design solution.



BIM

Reduce

Produce

Apply

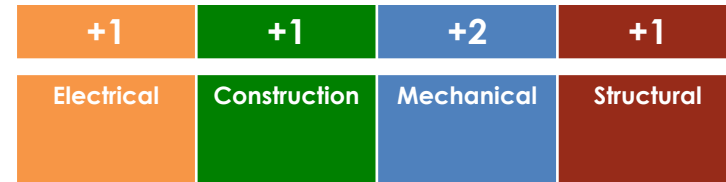
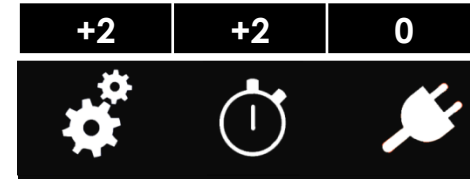
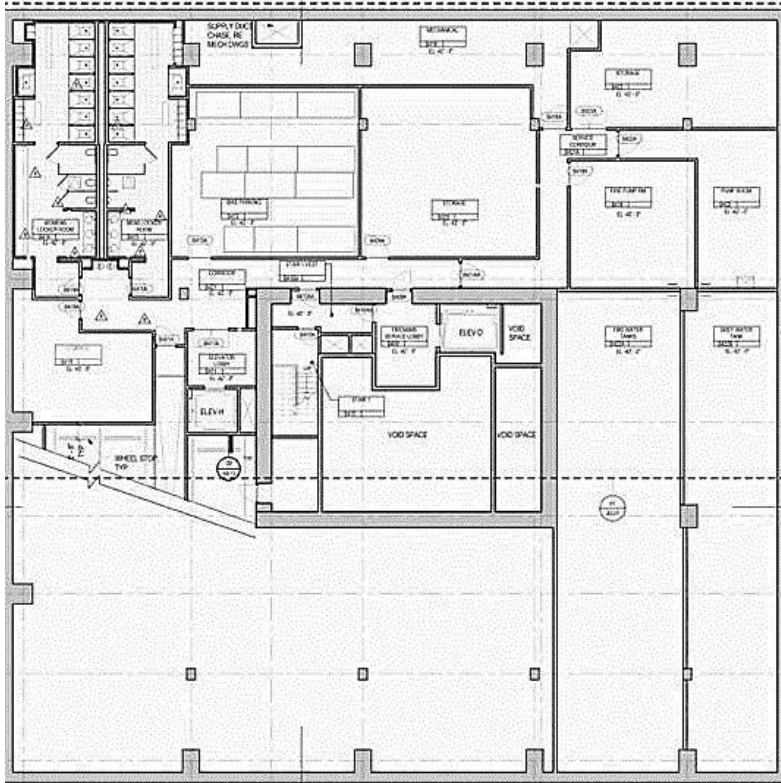
Sequencing

Performance Summary



Electrical  
Construction  
Mechanical  
Structural

**Additional space was needed** for anaerobic digestion, so a reduction in mat slab size was proposed.



**Good for sustainability**

**Good for material reduction**

**Good for construction performance**

**Good for equipment resilience**

BIM

Reduce

Produce

Apply

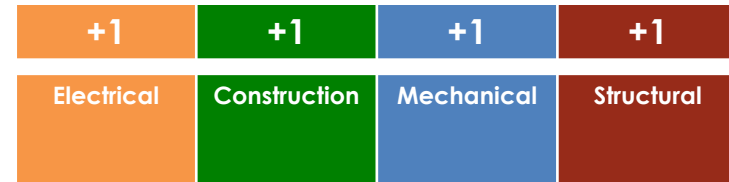
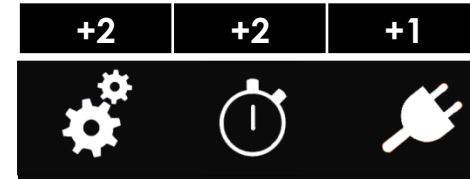
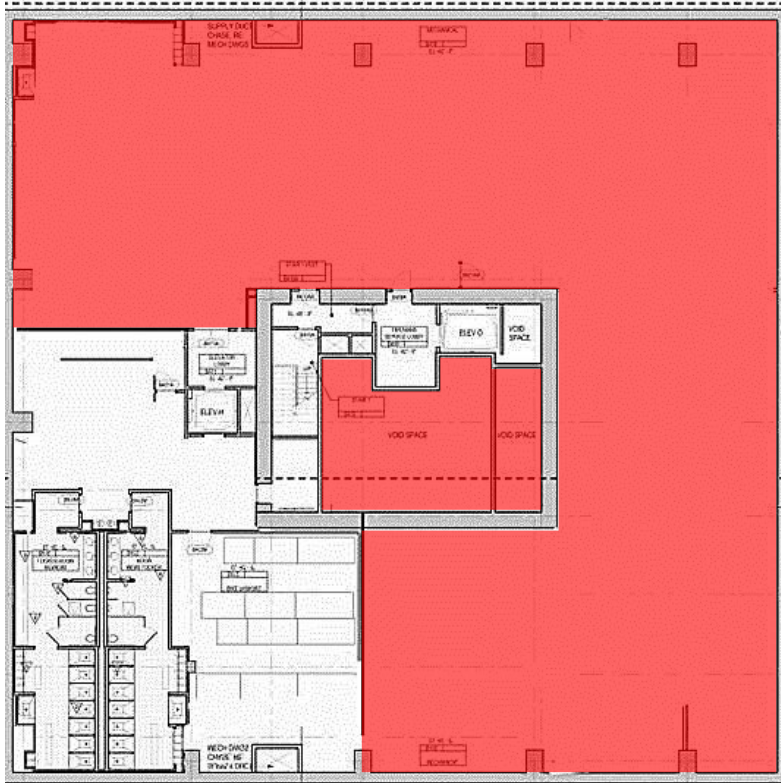
Sequencing

Performance Summary



Electrical  
Construction  
Mechanical  
Structural

**Additional space was needed** for anaerobic digestion, so a reduction in mat slab size was proposed.



*Good for sustainability*

*Good for material reduction*

*Good for construction performance*

*Good for equipment resilience*

BIM

Reduce

Produce

Apply

Sequencing

Performance Summary

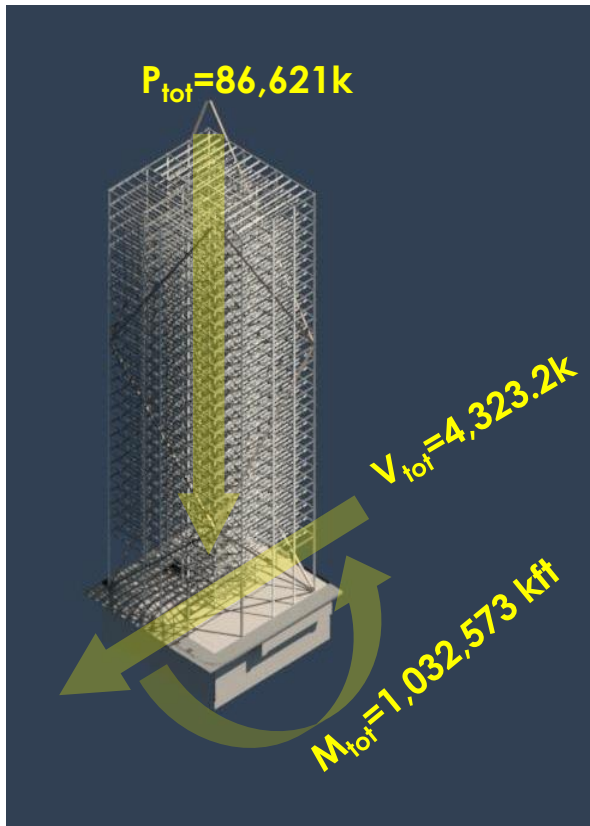


Electrical  
Construction  
Mechanical  
Structural



# Lightweight gravity system enables **resource production** via mat slab thickness reduction.

1. Check if loads are suitable for soil bearing



BIM

Reduce

Produce

Apply

Sequencing

Performance Summary



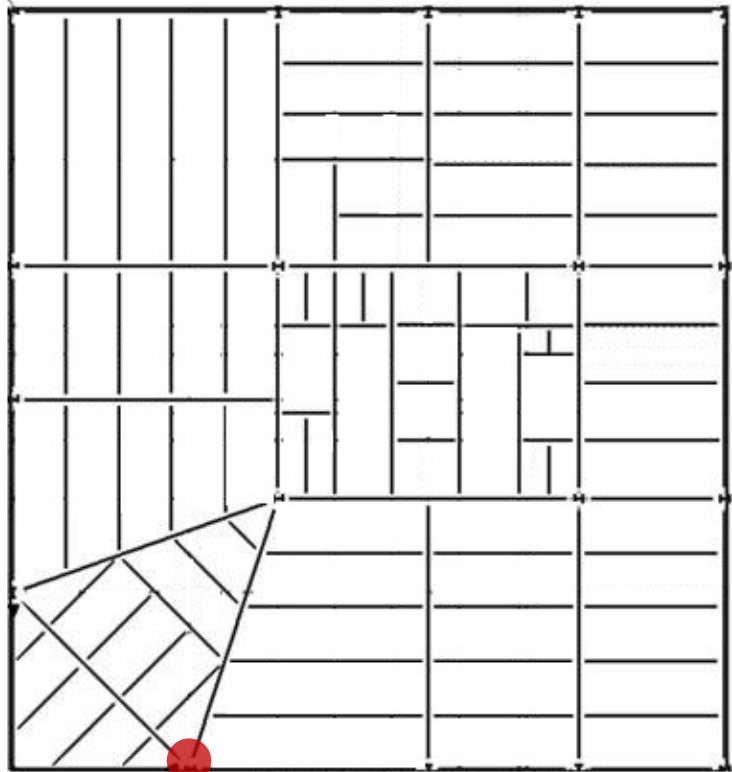
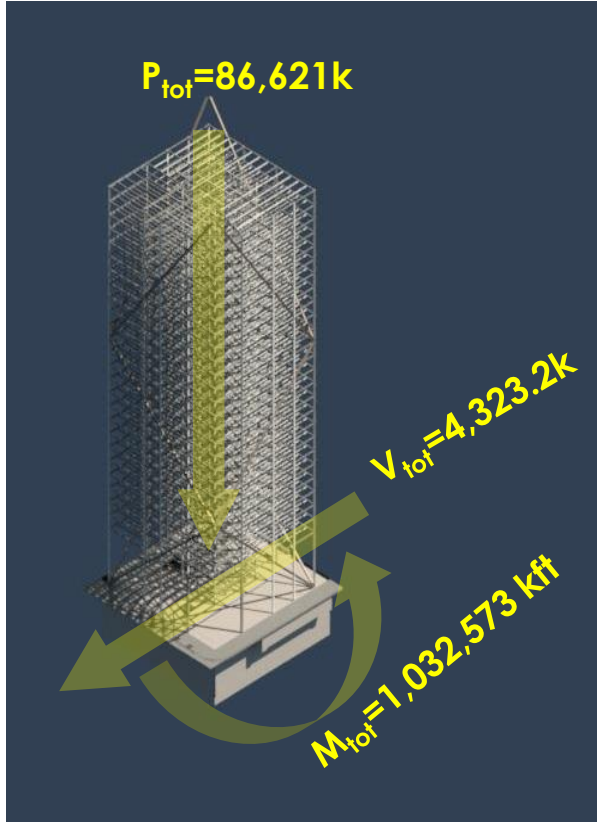
Electrical  
Construction  
Mechanical  
Structural

# Lightweight gravity system enables resource production via mat slab thickness reduction.

1. Check if loads are suitable for soil bearing



2. Size Mat Slab for punching shear



Critical Column  $P_u = 158k$

BIM	Reduce	<b>Produce</b>	Apply	Sequencing	Performance Summary
-----	--------	----------------	-------	------------	---------------------

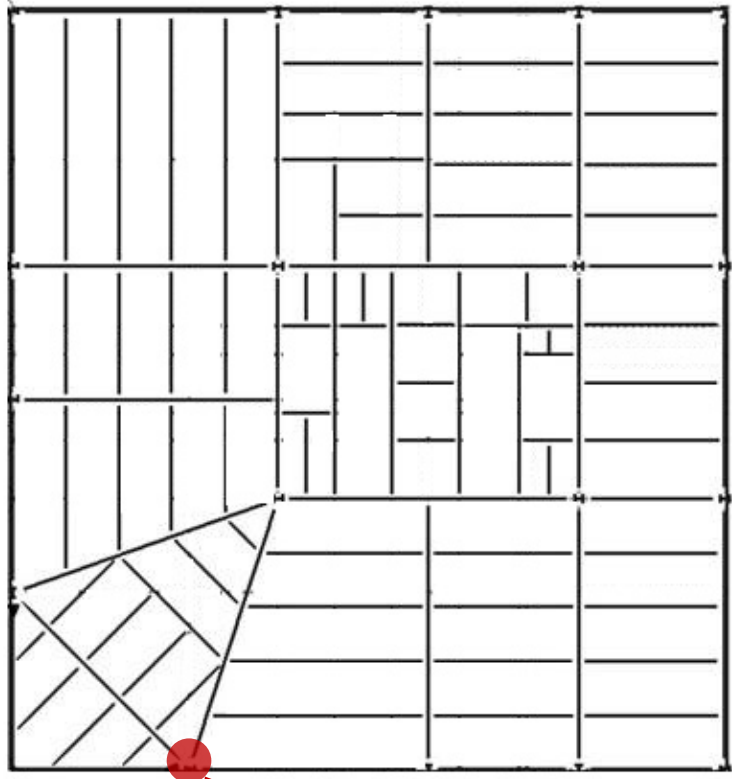
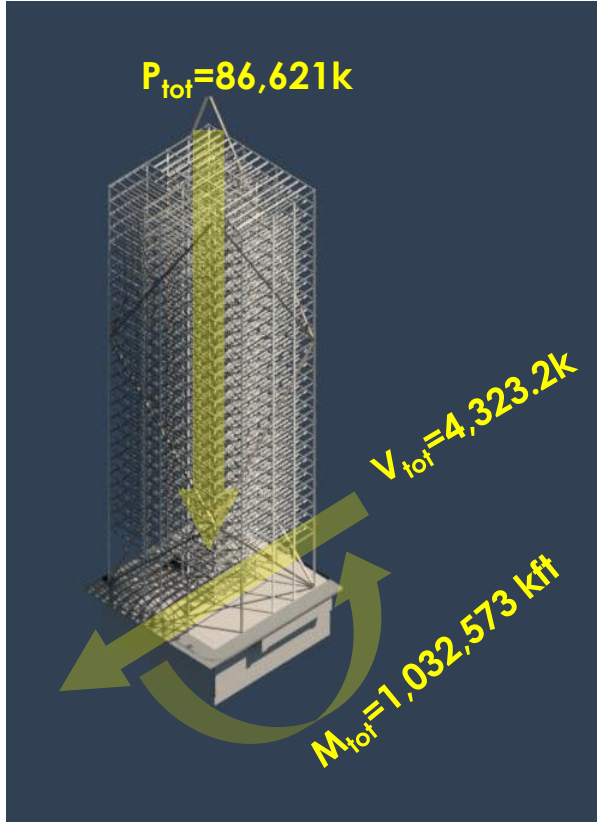
Electrical  
Construction  
Mechanical  
Structural

# Lightweight gravity system enables resource production via mat slab thickness reduction.

1. Check if loads are suitable for soil bearing

2. Size Mat Slab for punching shear

3. Reinforcement



$$A_{s\&t} = \frac{.0018}{bH}$$



Critical Column  $P_u = 158k$

BIM

Reduce

Produce

Apply

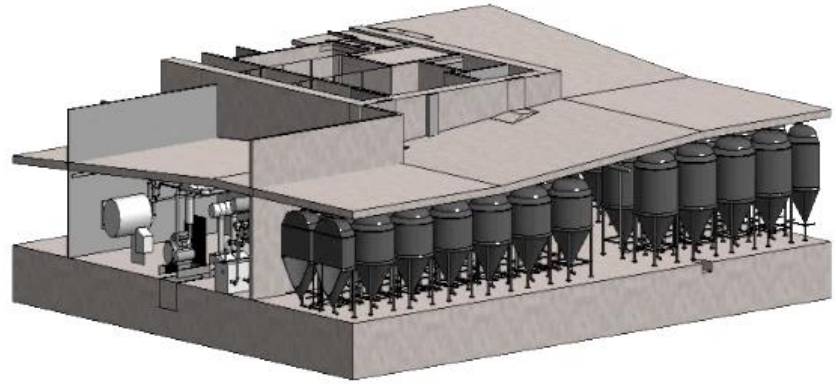
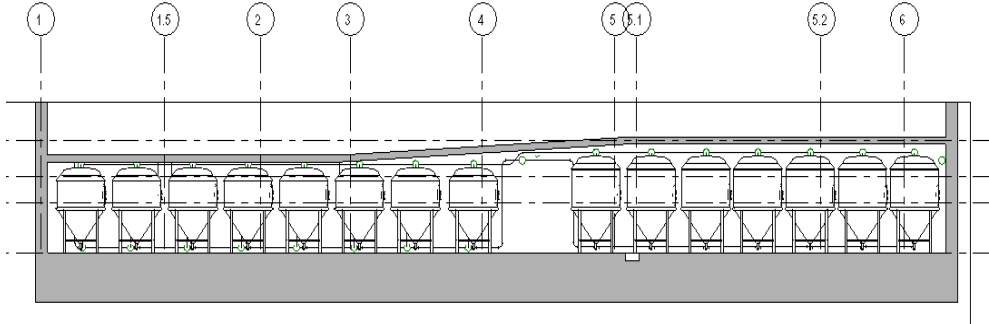
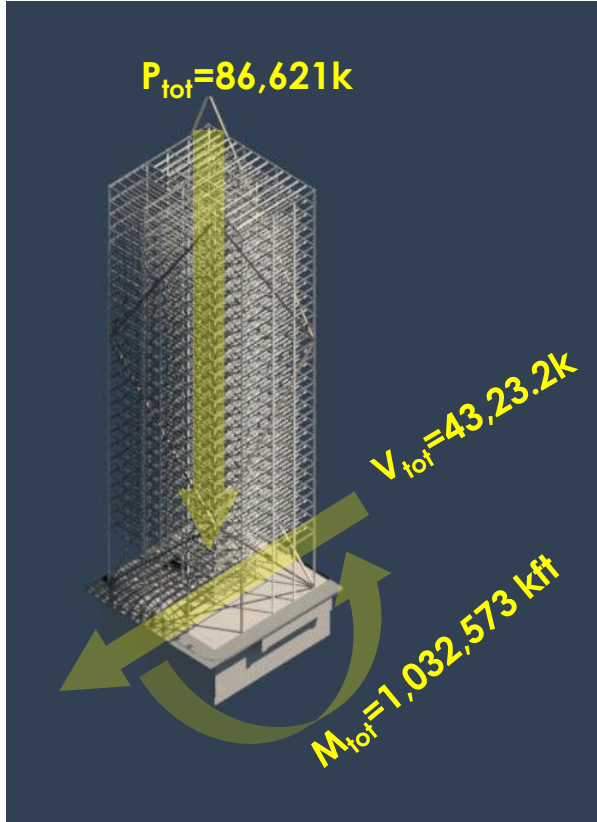
Sequencing

Performance Summary



Electrical  
Construction  
Mechanical  
Structural

# Lightweight gravity system enables **resource production** via mat slab thickness reduction.



2D and 3D Sections showing **newly-created space**

BIM	Reduce	<b>Produce</b>	Apply	Sequencing	Performance Summary
-----	--------	----------------	-------	------------	---------------------

Electrical  
Construction  
Mechanical  
Structural

An **integrated, multidisciplinary effort** to reduce the mat slab size resulted in the ability to achieve **Net Zero Energy**.

Original



Proposed



Almost **10,000 SF** of usable space added

Space created for **renewable, on-site energy**

Space created for **on-site water reclamation**

} **Near-net Zero Achievable**

BIM

Reduce

Produce

Apply

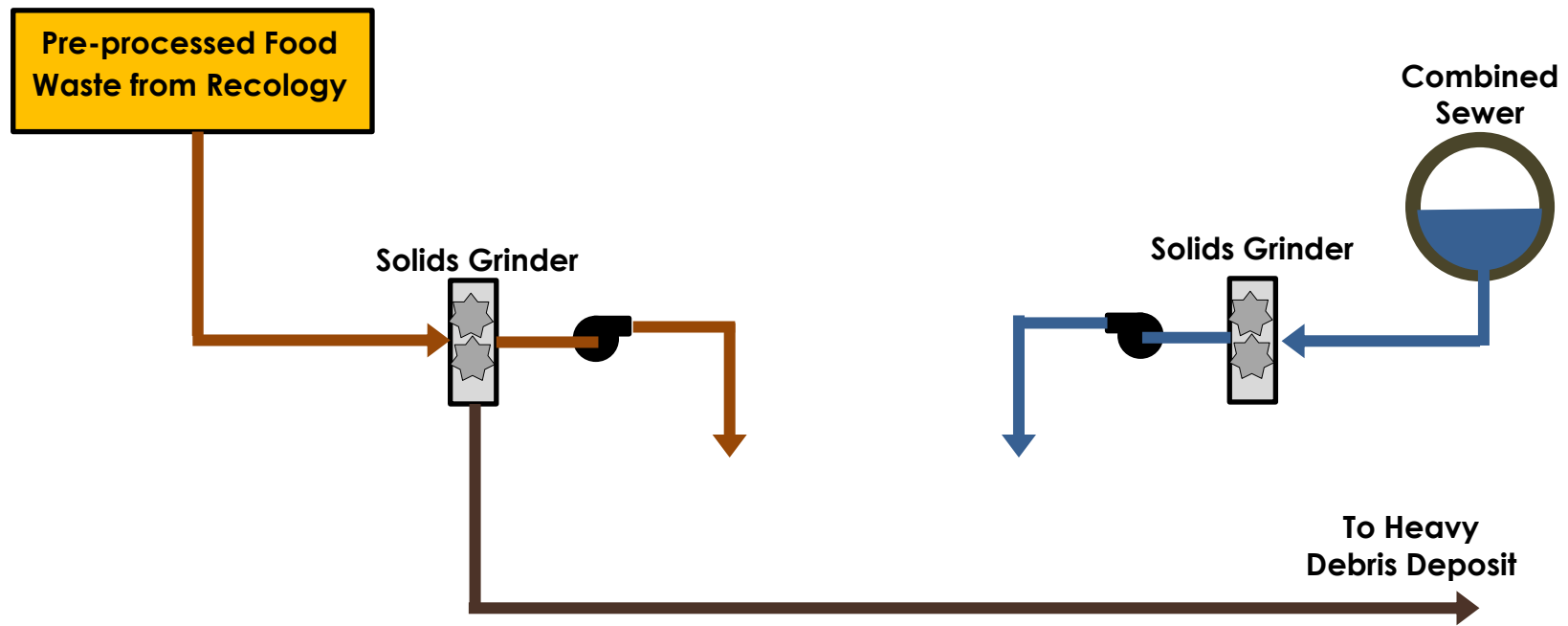
Sequencing

Performance Summary



Electrical  
Construction  
Mechanical  
Structural

# Waste from the municipal sewer, building and local compost was collected to create BioMethane and reclaimed water.



BIM

Reduce

Produce

Apply

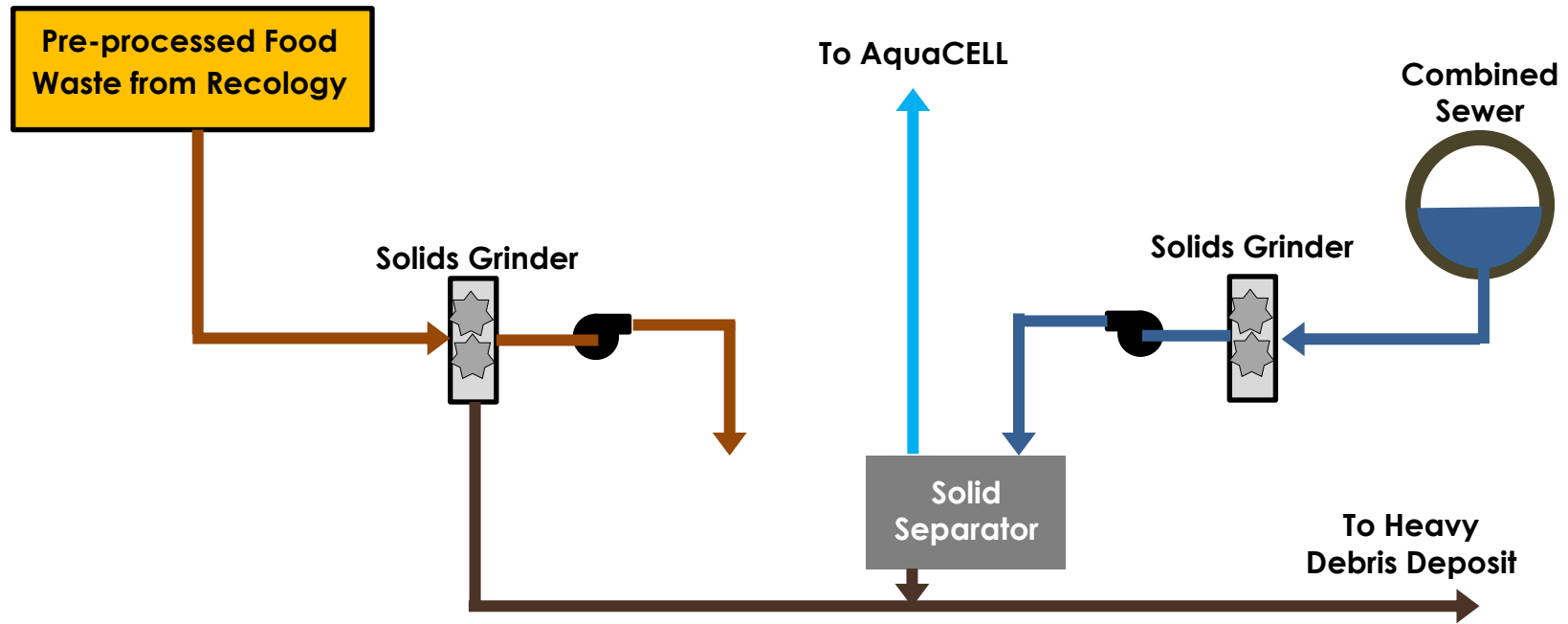
Sequencing

Performance Summary



Electrical  
Construction  
Mechanical  
Structural

# Waste from the municipal sewer, building and local compost was collected to **create BioMethane and reclaimed water.**



BIM

Reduce

Produce

Apply

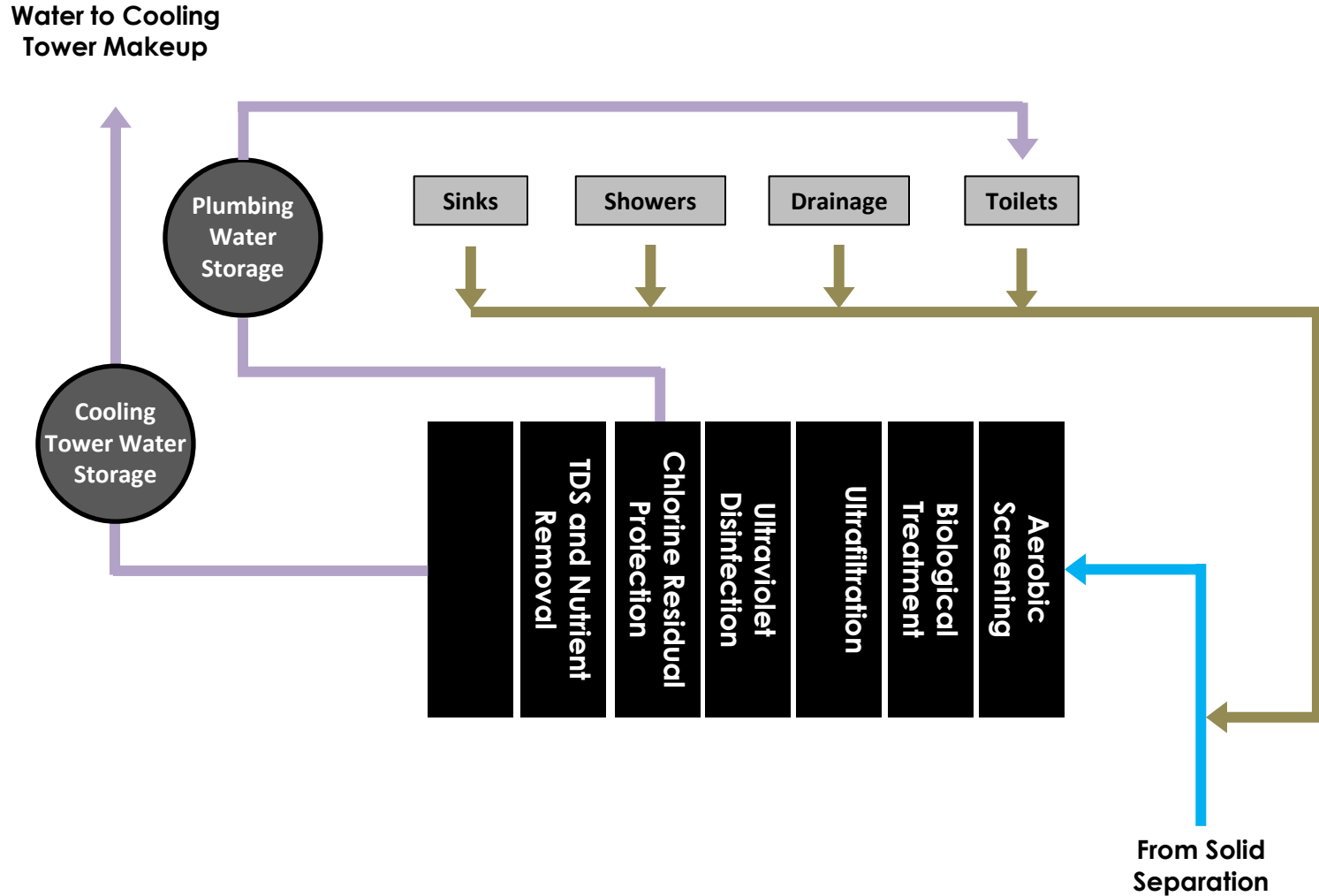
Sequencing

Performance Summary



Electrical  
Construction  
Mechanical  
Structural

# Wastewater is recycled and reused in building applications.



BIM

Reduce

Produce

Apply

Sequencing

Performance Summary



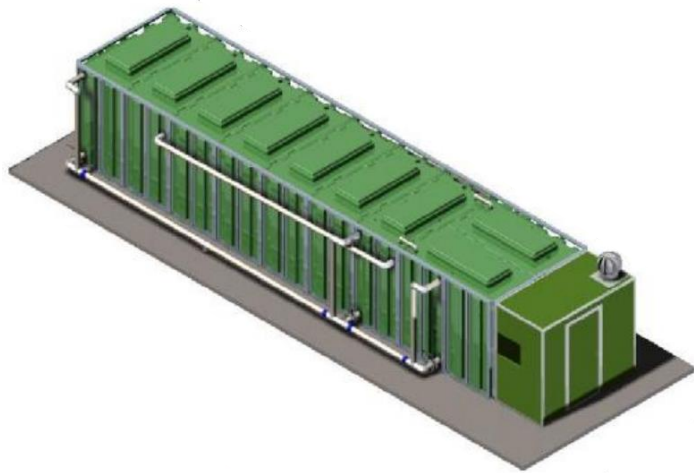
Electrical  
Construction  
Mechanical  
Structural



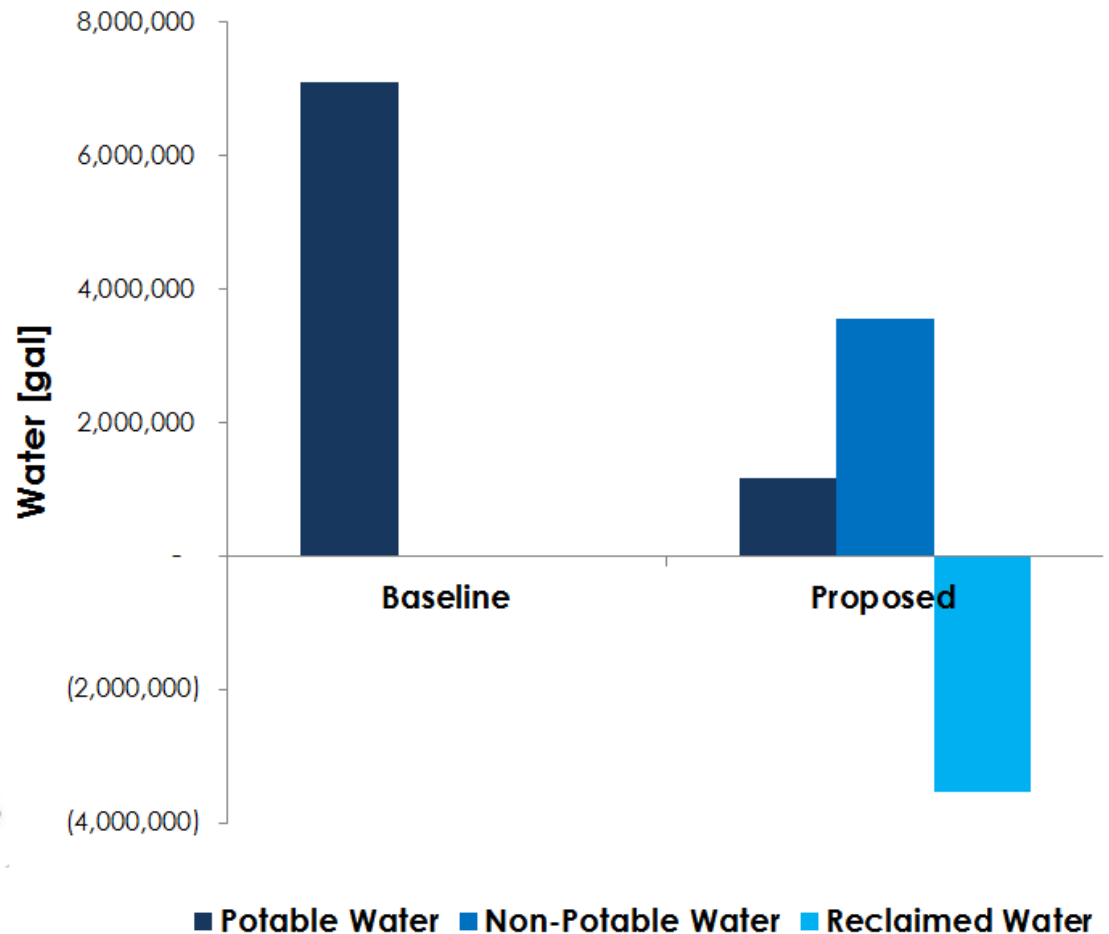
# Wastewater is recycled and reused in building applications.

14,115 gpd reclaimed

Potable water reduced by 84%



### 350 Mission Water Balance



BIM

Reduce

Produce

Apply

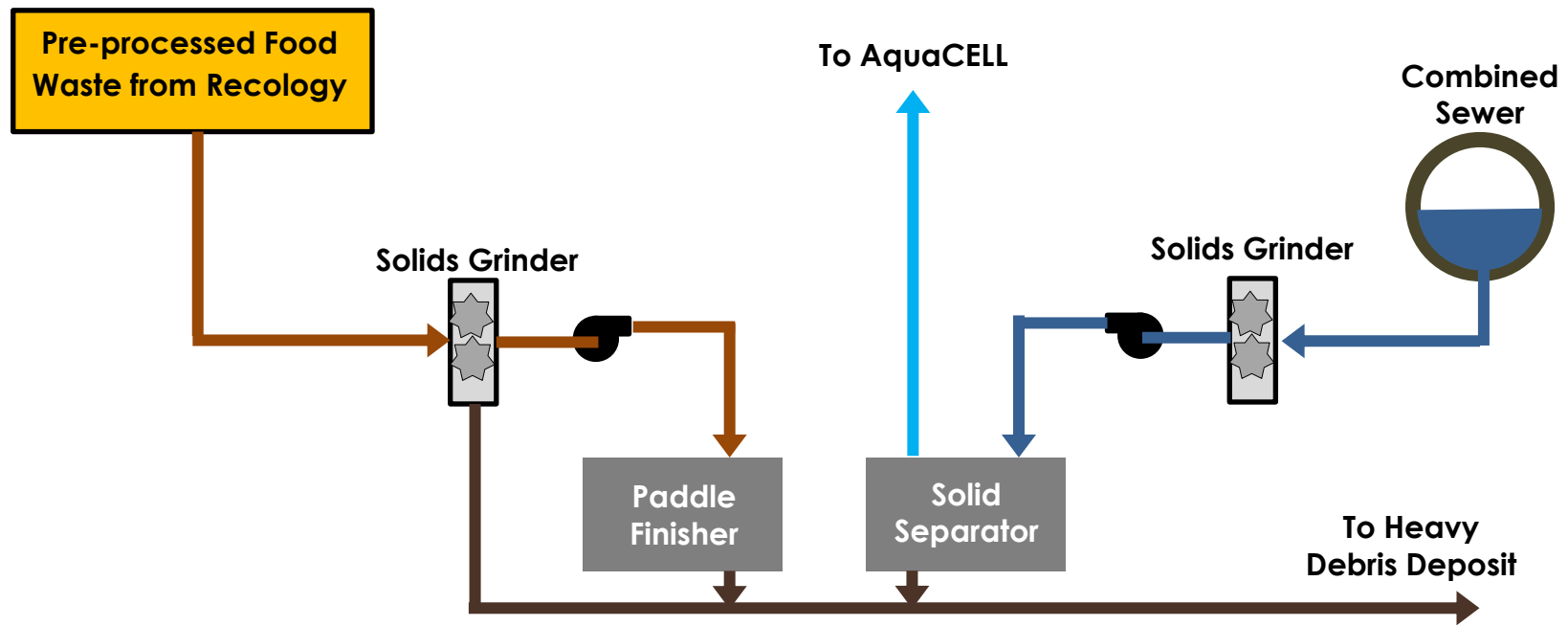
Sequencing

Performance Summary



Electrical  
Construction  
Mechanical  
Structural

# Waste from the municipal sewer, building and local compost was collected to **create BioMethane and reclaimed water.**



BIM

Demand Reduction

Resource Production

Plant Distribution & Application

Space Application

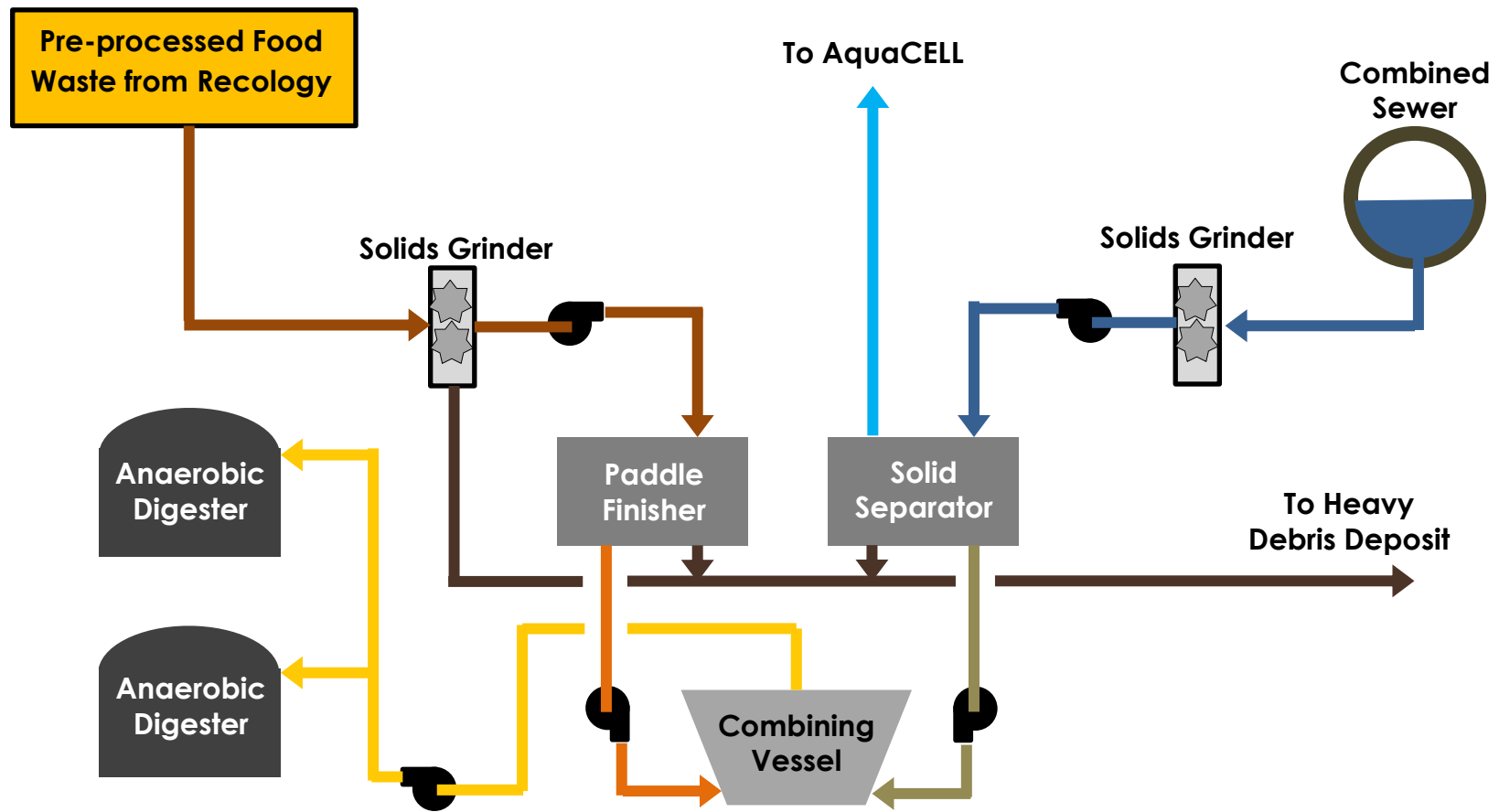
Sequencing

Performance Summary



Electrical  
Construction  
Mechanical  
Structural

# Waste from the municipal sewer, building and local compost was collected to create BioMethane and reclaimed water.



BIM

Reduce

Produce

Apply

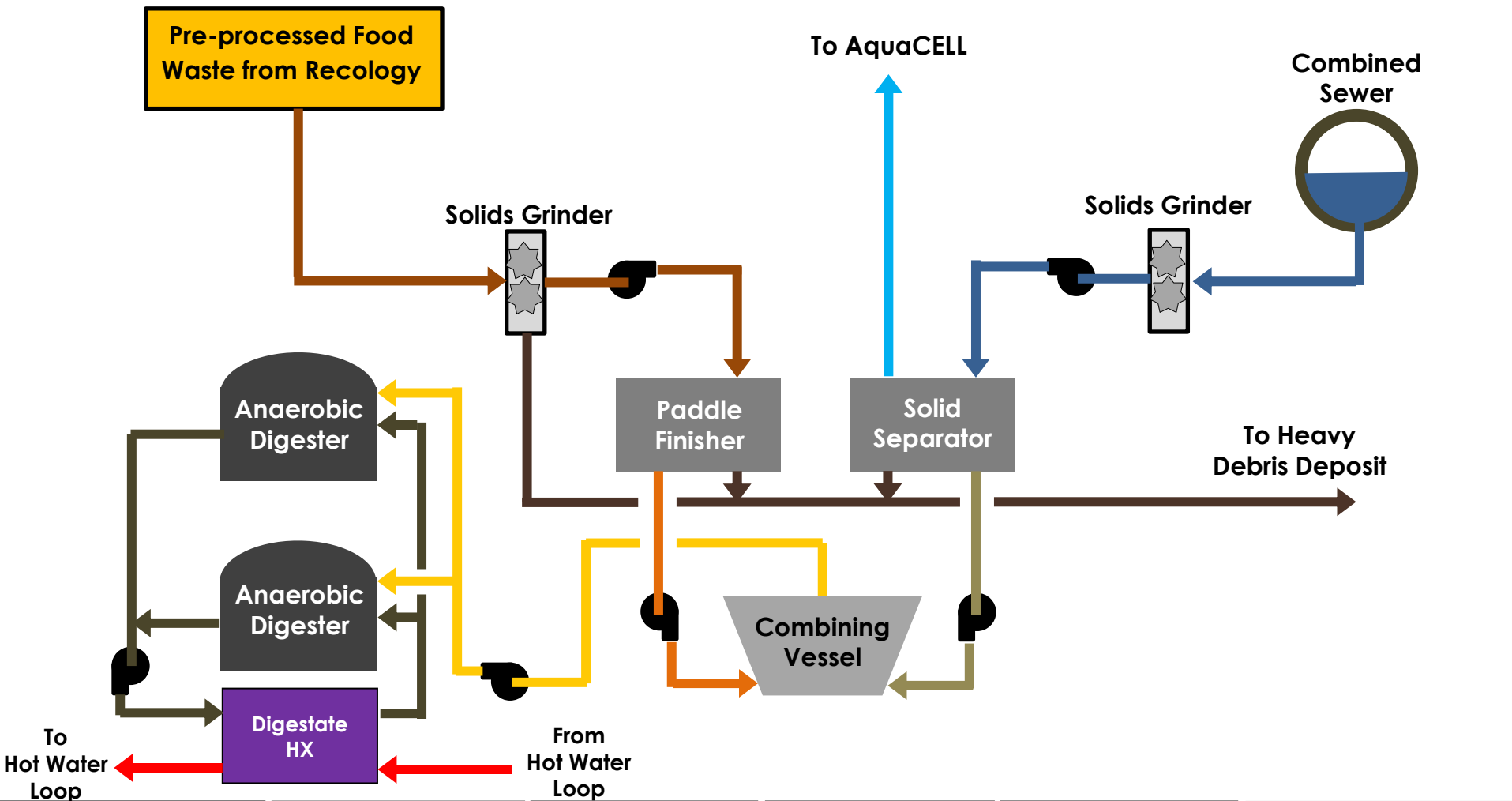
Sequencing

Performance Summary



Electrical  
Construction  
Mechanical  
Structural

# Waste from the municipal sewer, building and local compost was collected to **create BioMethane and reclaimed water.**



BIM

Reduce

Produce

Apply

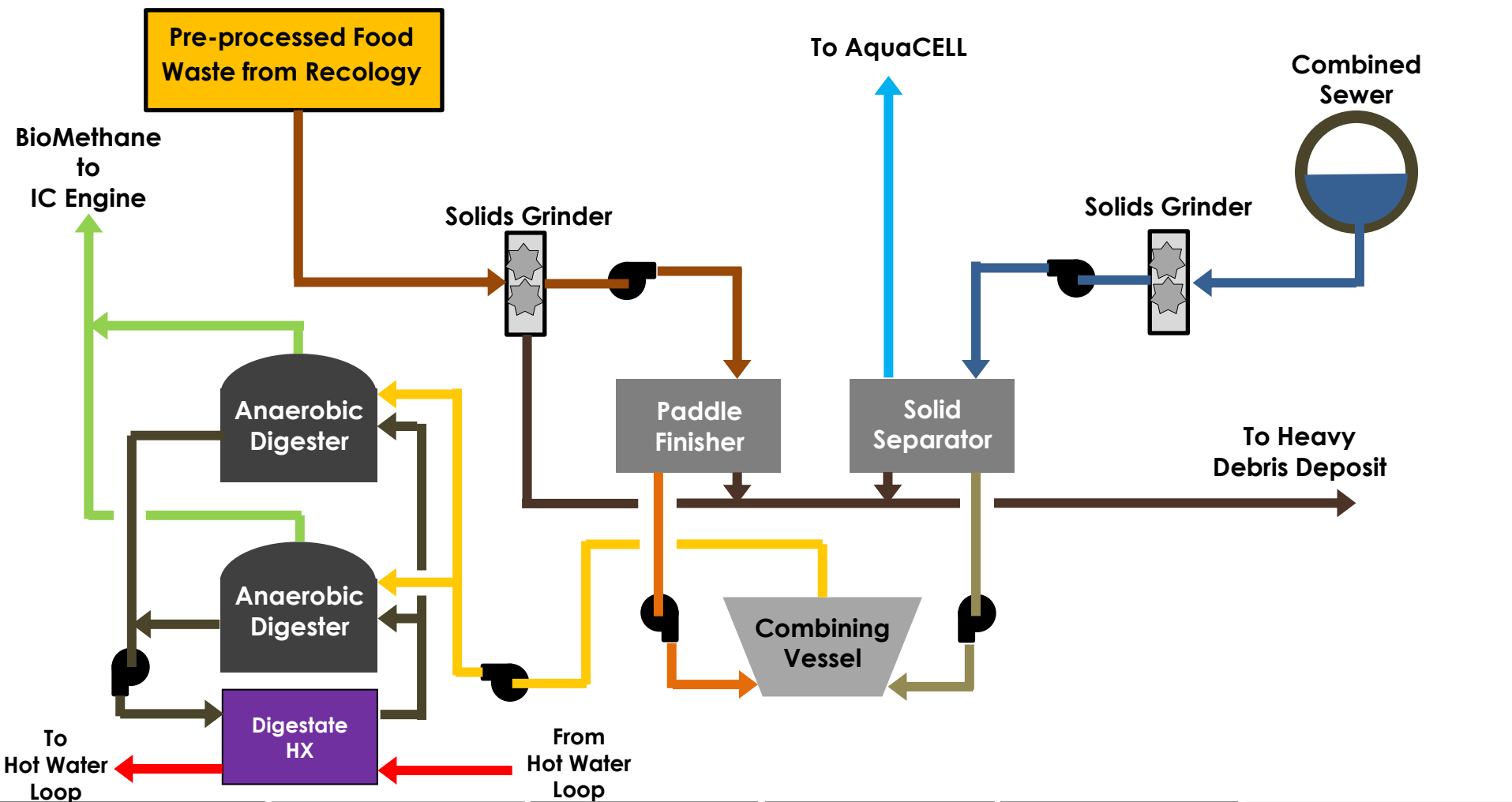
Sequencing

Performance Summary



Electrical  
Construction  
Mechanical  
Structural

# Waste from the municipal sewer, building and local compost was collected to **create BioMethane and reclaimed water.**



BIM

Reduce

Produce

Apply

Sequencing

Performance Summary



Electrical  
Construction  
Mechanical  
Structural

# Thermal and Electrical Energy are created by combustion of the methane generated on site.

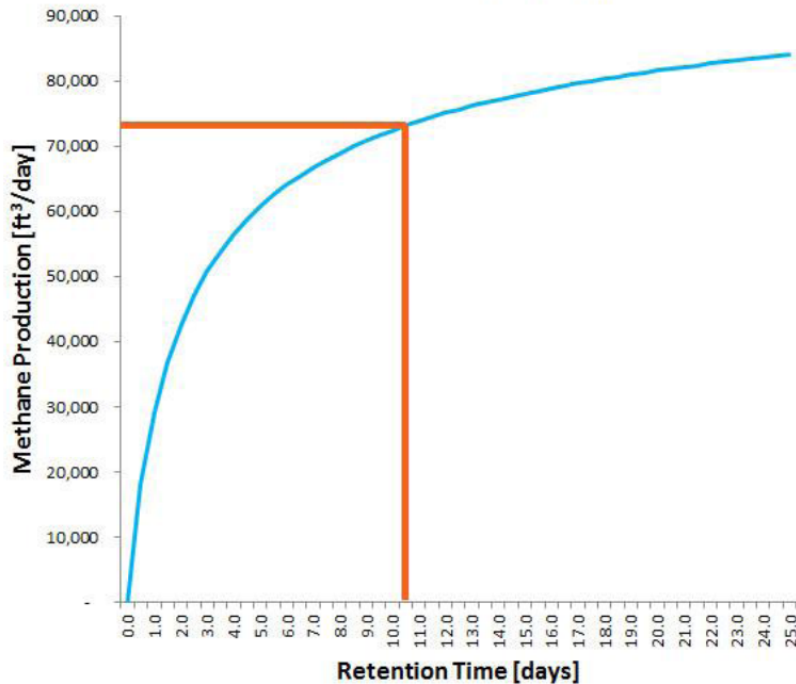
$$Q_{CH_4} = \left( \frac{V}{t^2} \int_0^t \frac{1}{\sqrt{c_1 + 2k' \cdot t}} \right) \left( 1 - \frac{1}{\sqrt{c_1 + 2k' \cdot t}} \right) MS_{T0}$$

1,500 gpm of wastewater  
32 tons of compost waste

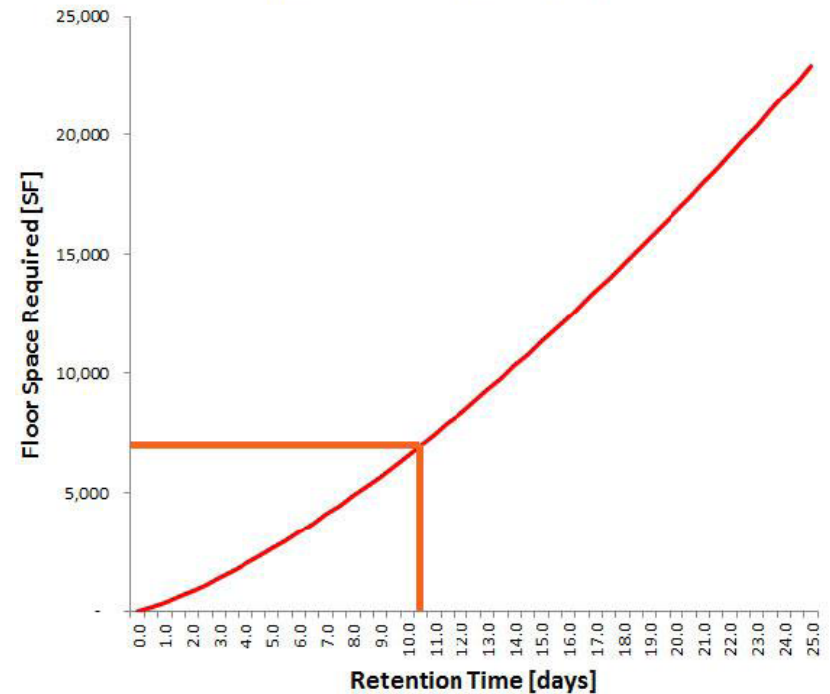


**112,500 ft<sup>3</sup> BioMethane per day**  
(equivalent to 72,300 ft<sup>3</sup> of CH<sub>4</sub> per day)

Methane Production [ft<sup>3</sup>/day]



Required Floor Space [SF]



BIM

Reduce

Produce

Apply

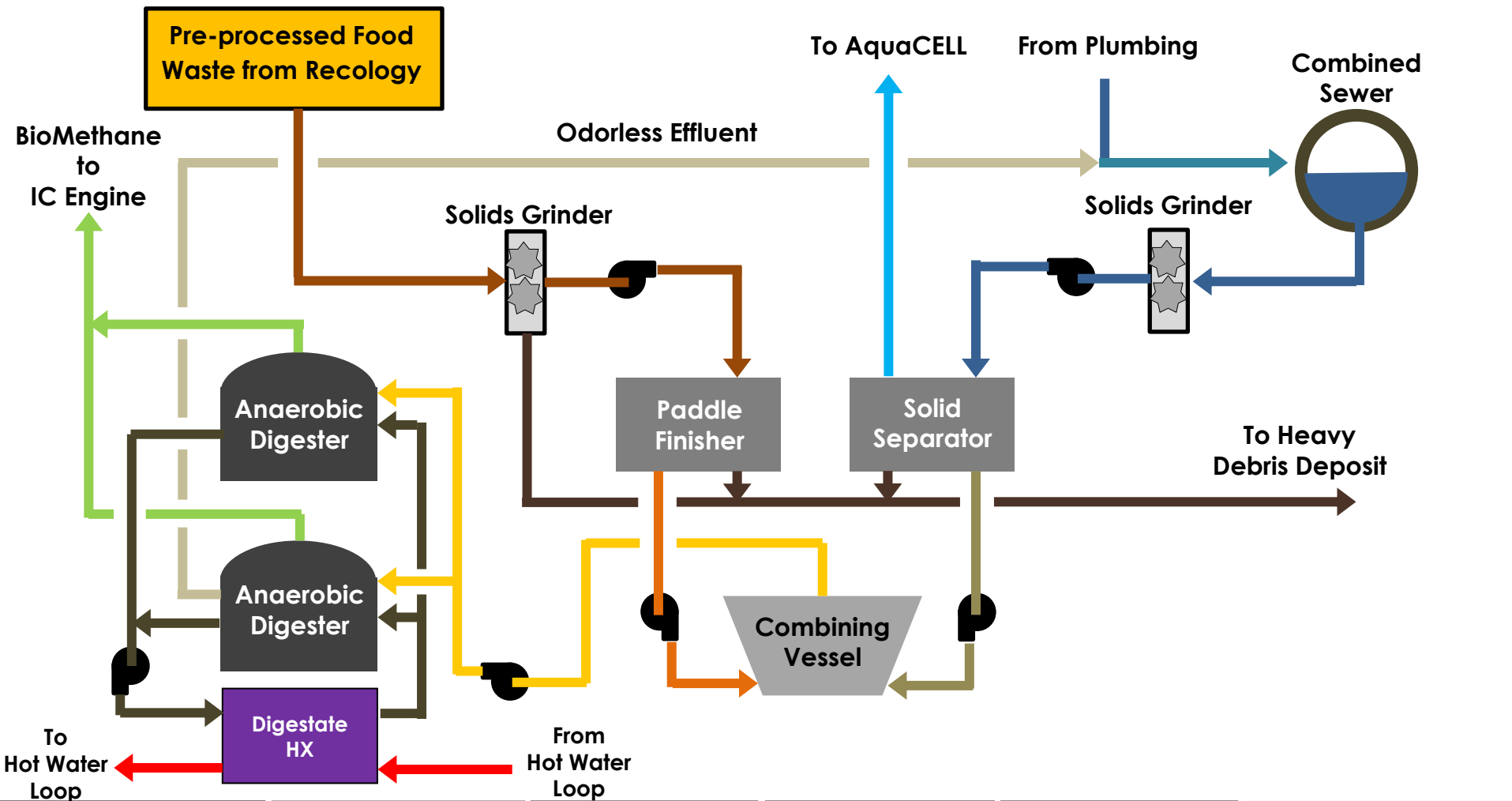
Sequencing

Performance Summary



Electrical  
Construction  
Mechanical  
Structural

# Waste from the municipal sewer, building and local compost was collected to **create BioMethane and reclaimed water.**



BIM

Reduce

Produce

Apply

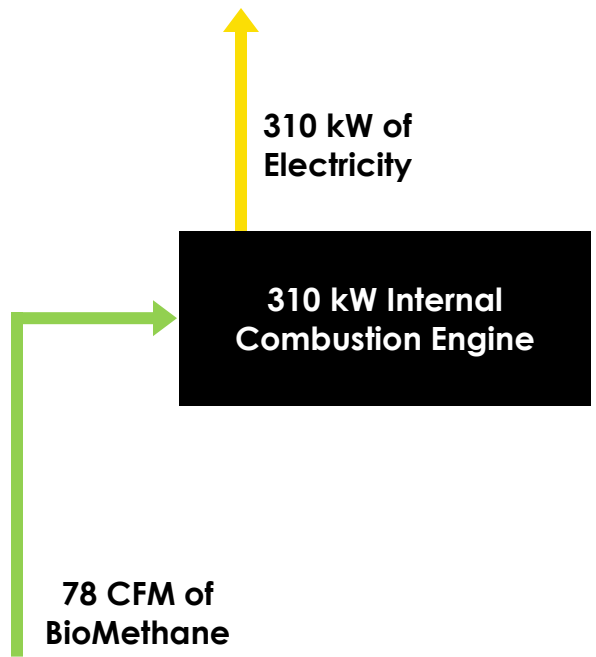
Sequencing

Performance Summary



Electrical  
Construction  
Mechanical  
Structural

# Thermal and Electrical Energy are created by combustion of the methane generated on site.



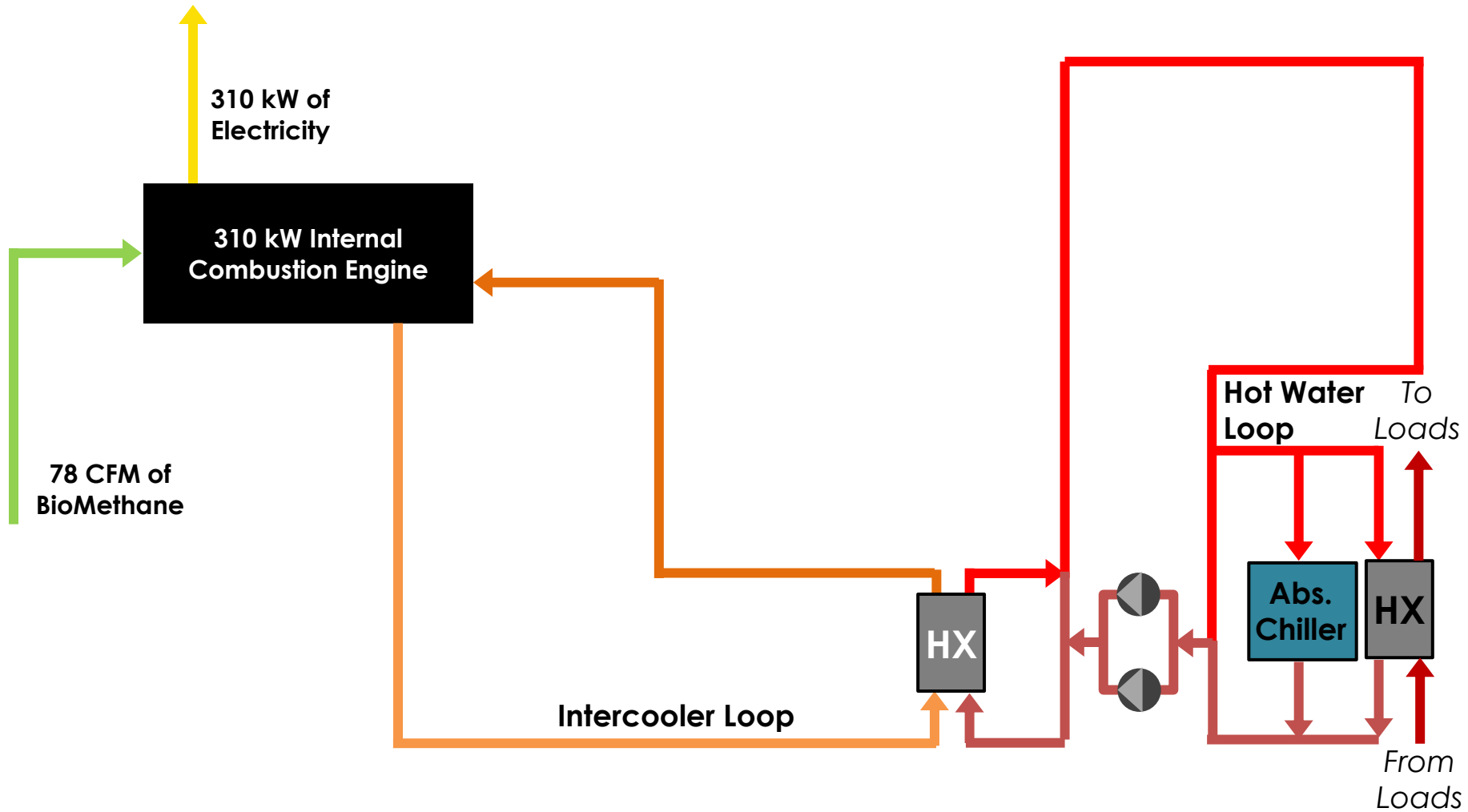
BIM	Reduce	Produce	Apply	Sequencing	Performance Summary
-----	--------	---------	-------	------------	---------------------



Electrical  
Construction  
Mechanical  
Structural



# Thermal and Electrical Energy are created by combustion of the methane generated on site.



BIM

Reduce

Produce

Apply

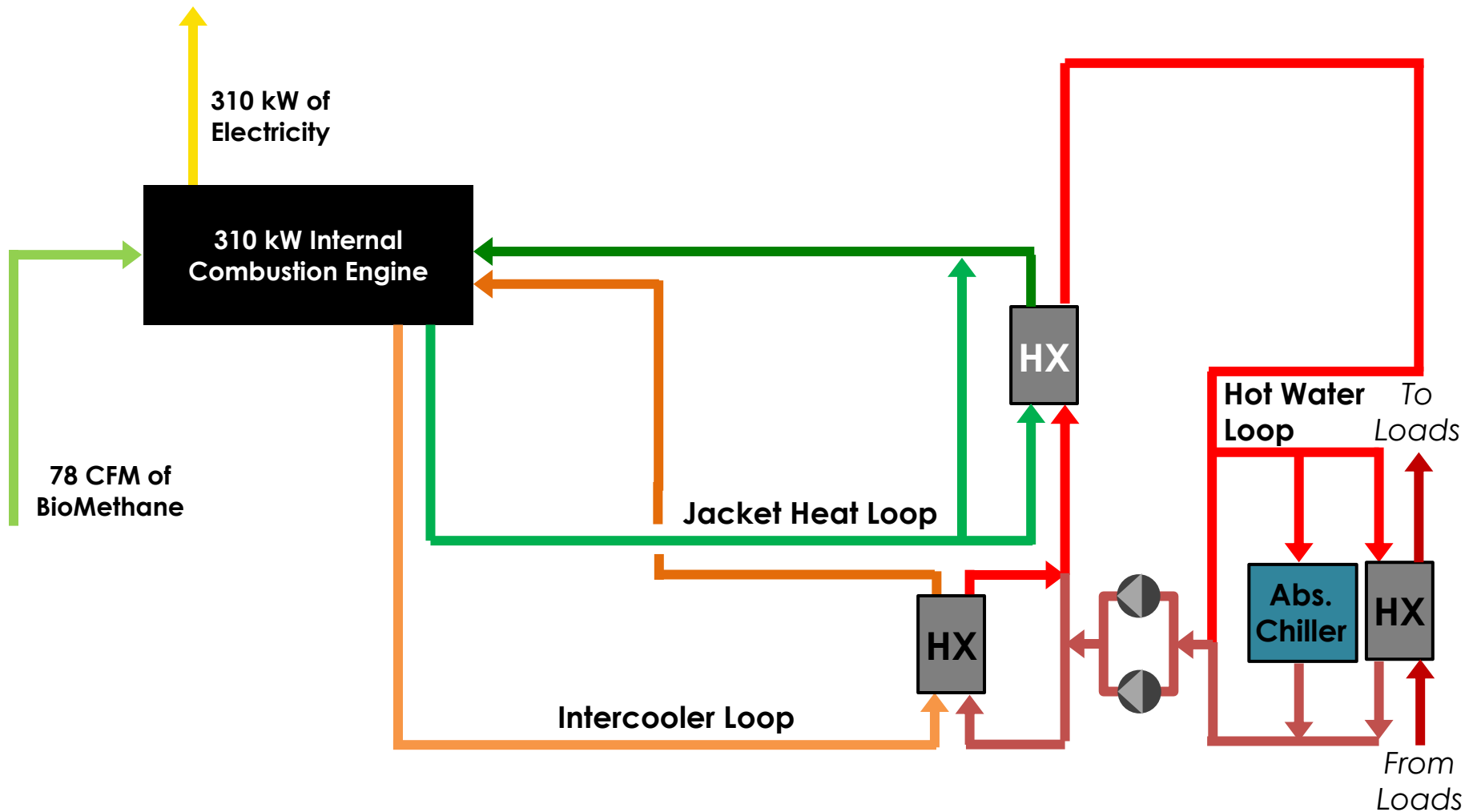
Sequencing

Performance Summary



Electrical  
Construction  
Mechanical  
Structural

# Thermal and Electrical Energy are created by combustion of the methane generated on site.



BIM

Reduce

Produce

Apply

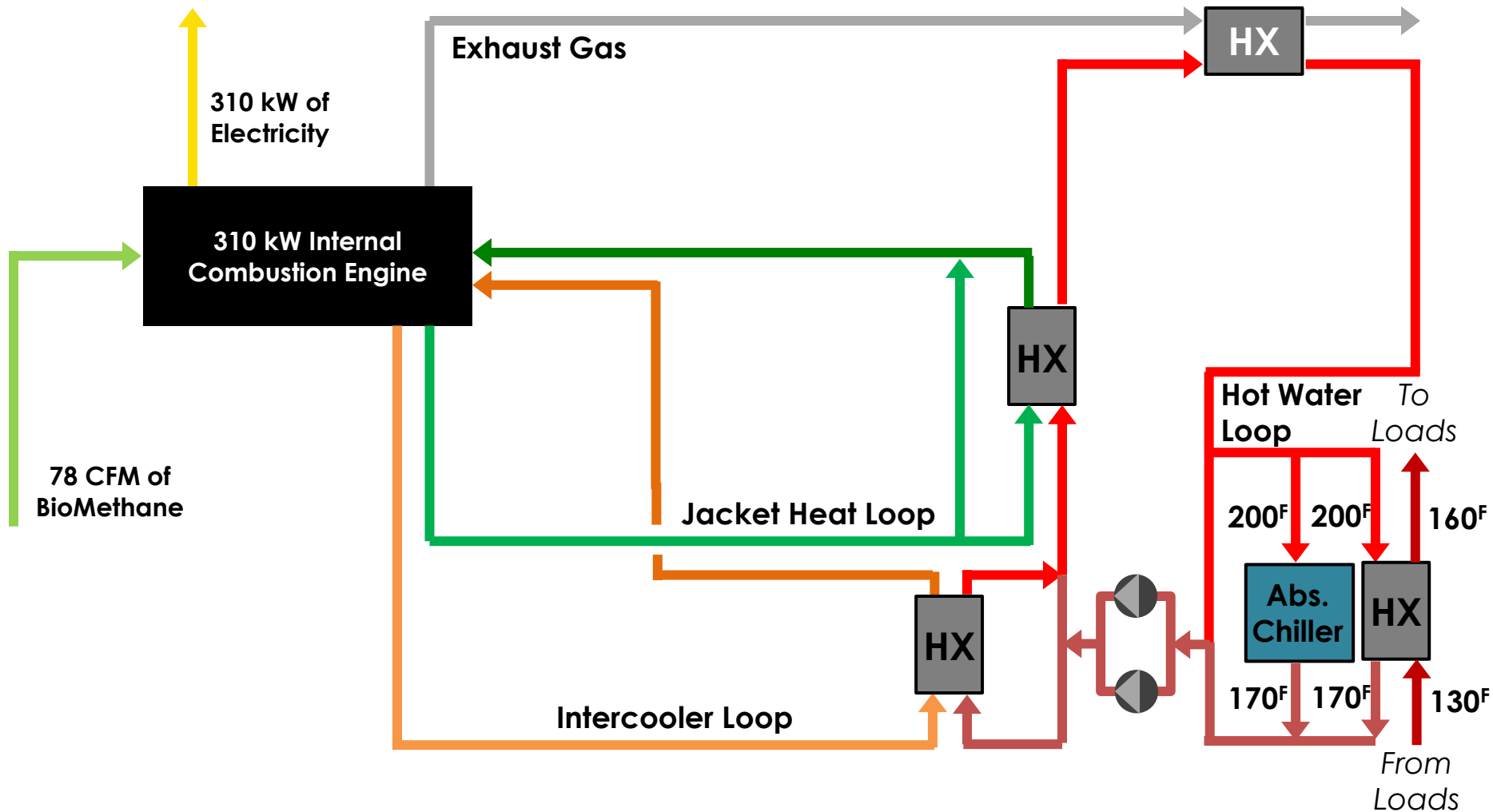
Sequencing

Performance Summary



Electrical  
Construction  
Mechanical  
Structural

# Thermal and Electrical Energy are created by combustion of the methane generated on site.



BIM

Reduce

Produce

Apply

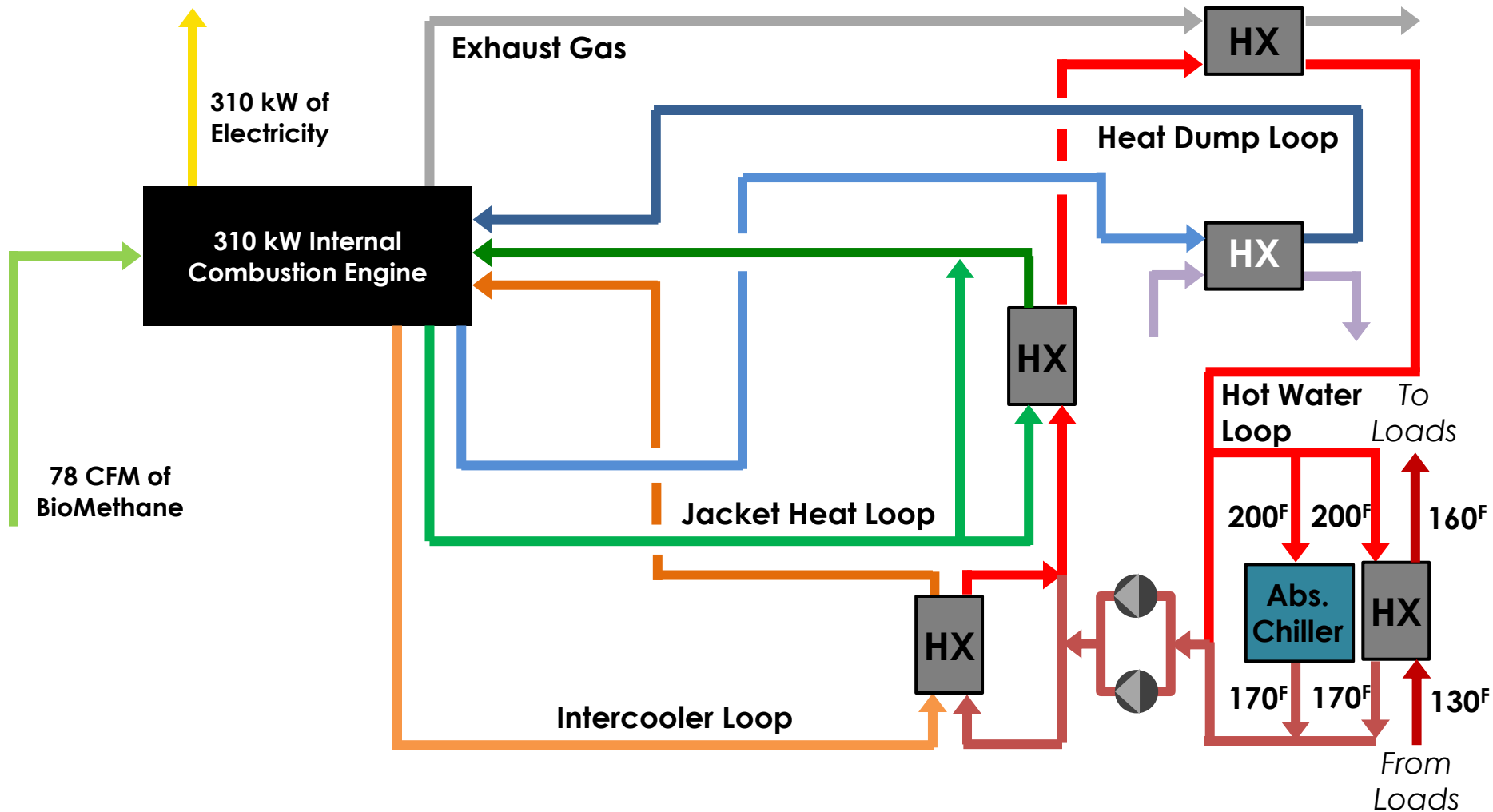
Sequencing

Performance Summary



Electrical  
Construction  
Mechanical  
Structural

# Thermal and Electrical Energy are created by combustion of the methane generated on site.



BIM

Reduce

Produce

Apply

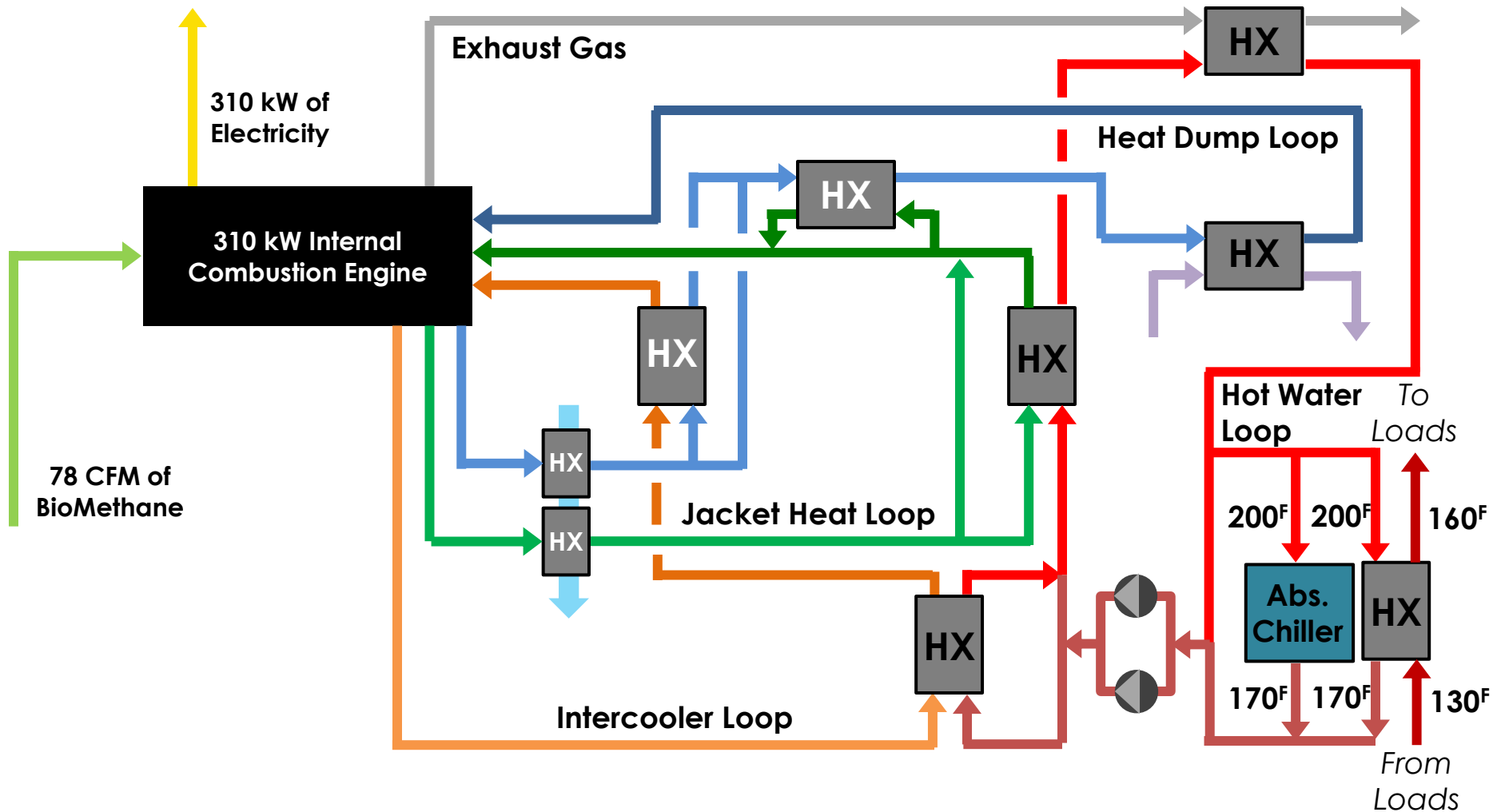
Sequencing

Performance Summary



Electrical  
Construction  
Mechanical  
Structural

# Thermal and Electrical Energy are created by combustion of the methane generated on site.



BIM

Reduce

Produce

Apply

Sequencing

Performance Summary



Electrical  
Construction  
Mechanical  
Structural

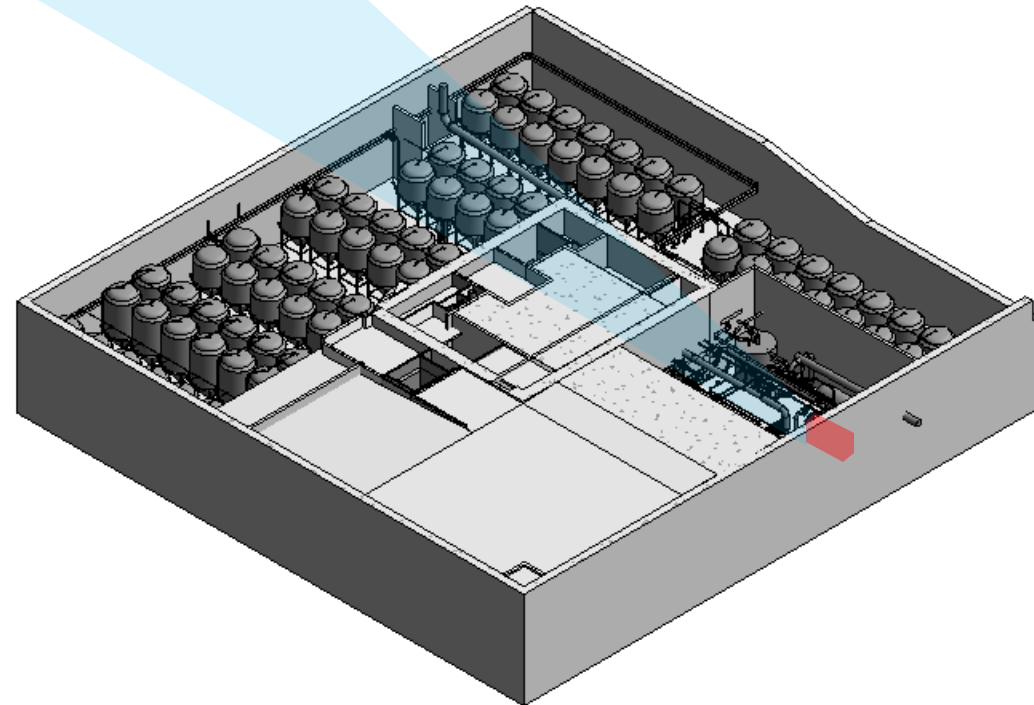
# An Internal Combustion Engine will use BioMethane from the Anaerobic Digesters to **Generate Power** on-site.

**78%** Full Load Efficiency

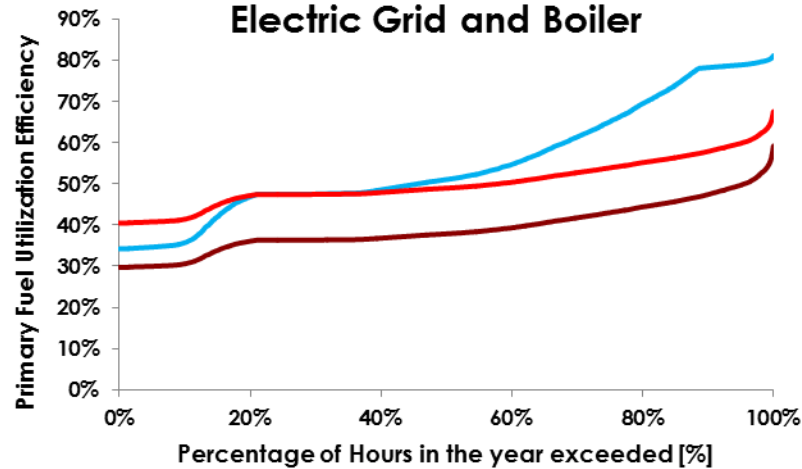
**310 kW** Electrical Output

**1,355 kBTU/h** Heat Output

Basement Level B4



### CHP Performance vs. Separate Electric Grid and Boiler



- Combined Heat and Power
- Worst Case Separate Heat and Power
- Best Case Separate Heat and Power

BIM

Reduce

Produce

Apply

Sequencing

Performance Summary



Electrical  
Construction  
Mechanical  
Structural

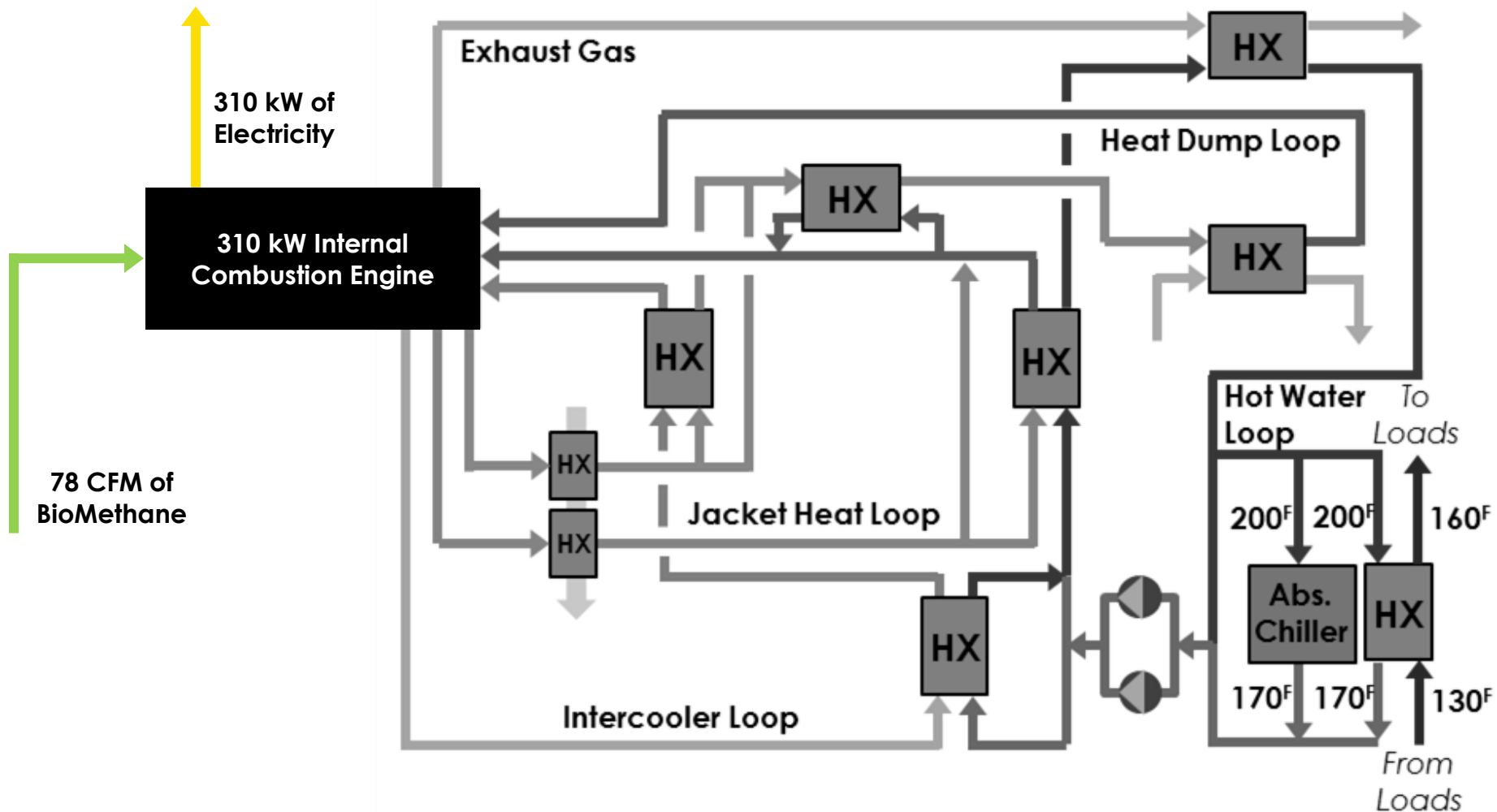
# Performance guided the sustainability and energy efficiency of 350 Mission



- BIM
- Reduce
- Produce
- **Apply**
  - Thermal and Electrical Plants
    - Electrical Subsystems
    - Heating & Cooling Plant
  - Detailed Space Designs
    - Lobby
    - Restaurant
    - Office
- Sequencing
- Performance Summary



# 350 Mission's primary source of **Electrical Energy** is the building's on-site generation.



BIM

Reduce

Produce

Apply

Sequencing

Performance Summary

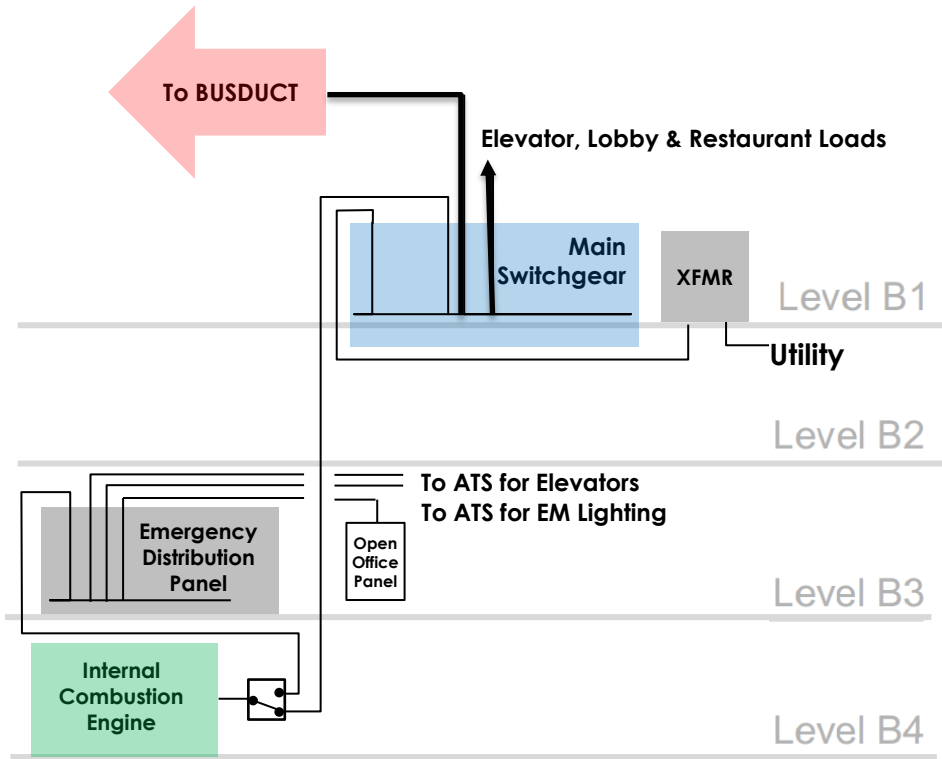


Electrical  
Construction  
Mechanical  
Structural

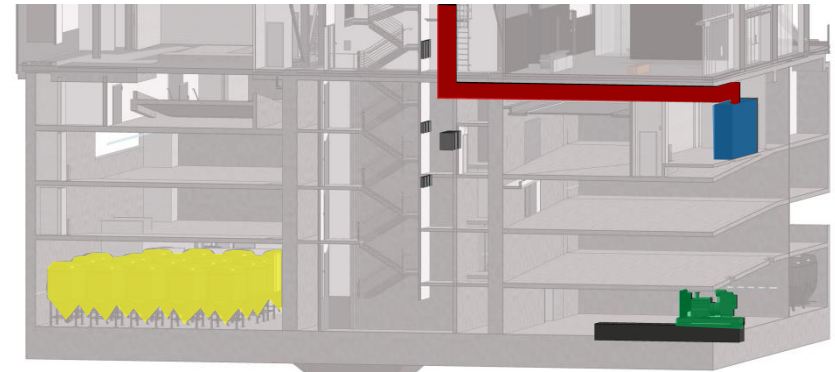


# Electrical Rooms will be located throughout the building for efficient **building power distribution** via a busduct.

## Section of Riser Diagram



## Isometric View of Basement



-  Digester Tanks
-  Bus Duct
-  Main Switchgear
-  IC Engine



BIM

Reduce

Produce

Apply

Sequencing

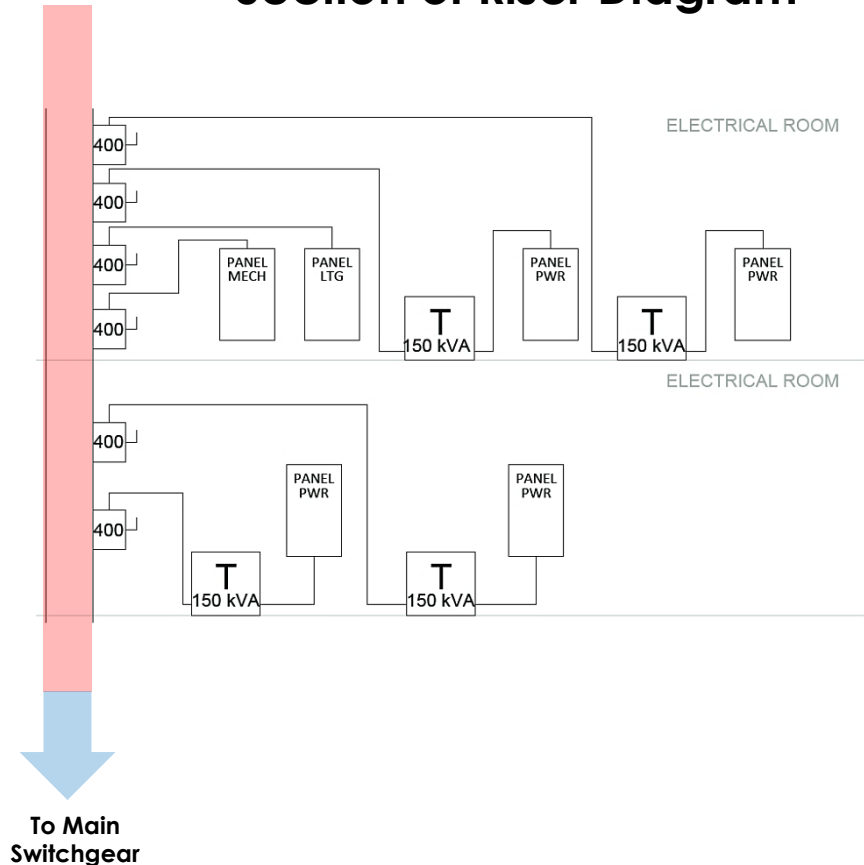
Performance Summary



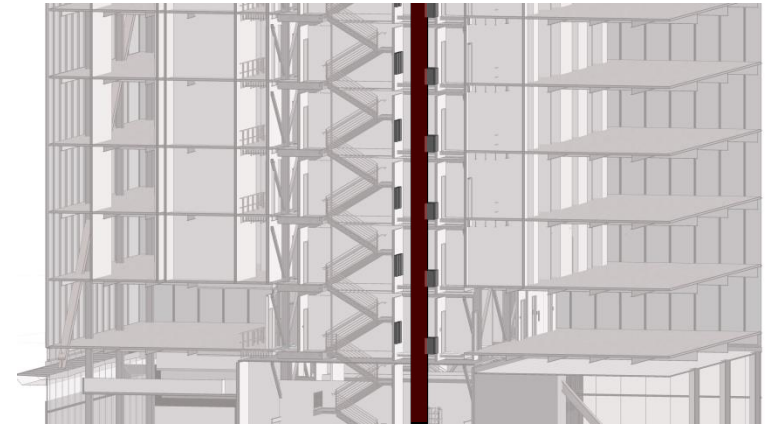
Electrical  
Construction  
Mechanical  
Structural

# Electrical Rooms will be located throughout the building for efficient **building power distribution** via a busduct.

## Section of Riser Diagram



## Isometric View of Office Floors



 Bus Duct



BIM

Reduce

Produce

Apply

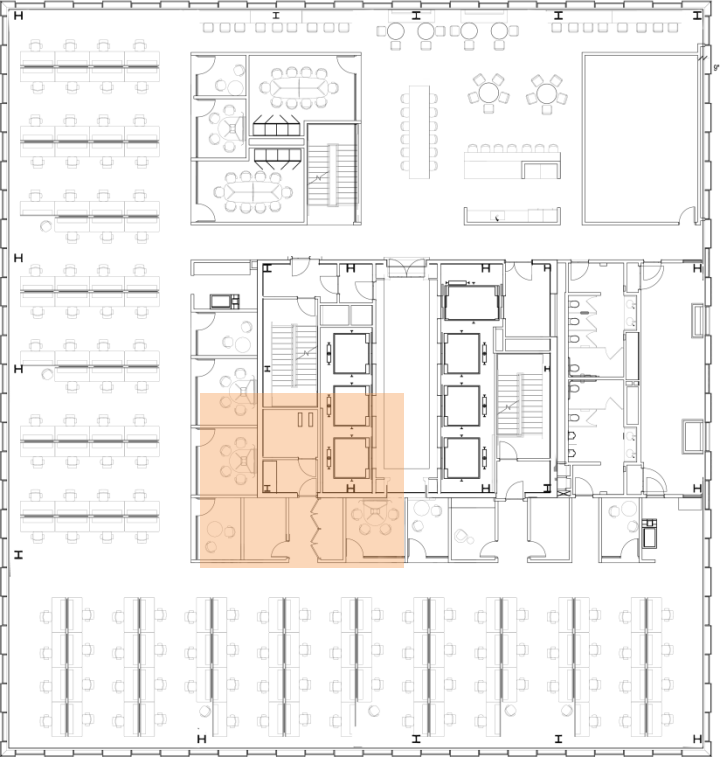
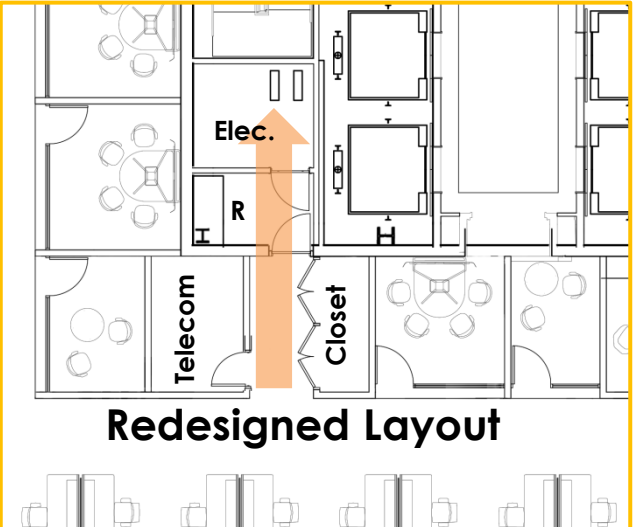
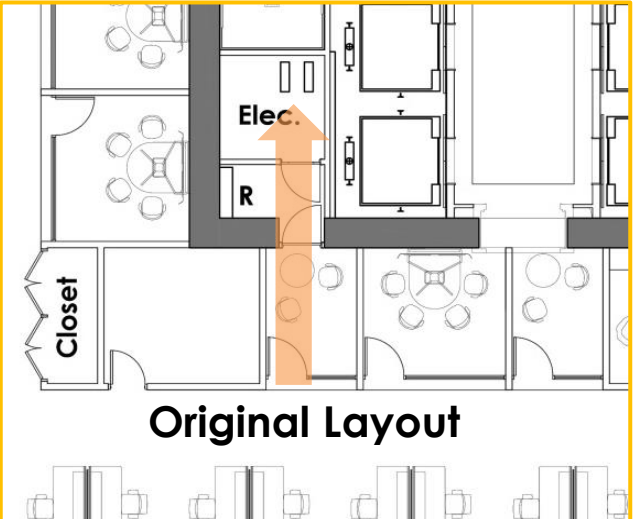
Sequencing

Performance Summary



Electrical  
Construction  
Mechanical  
Structural

# Floor Plans Adjusted for Telecom & Electrical Systems



BIM

Reduce

Produce

Apply

Sequencing

Performance Summary

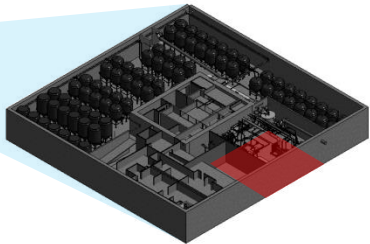


Electrical  
Construction  
Mechanical  
Structural

# The **Chilled Water and Heating Plant** is located in the basement adjacent to the BioMethane Facility.

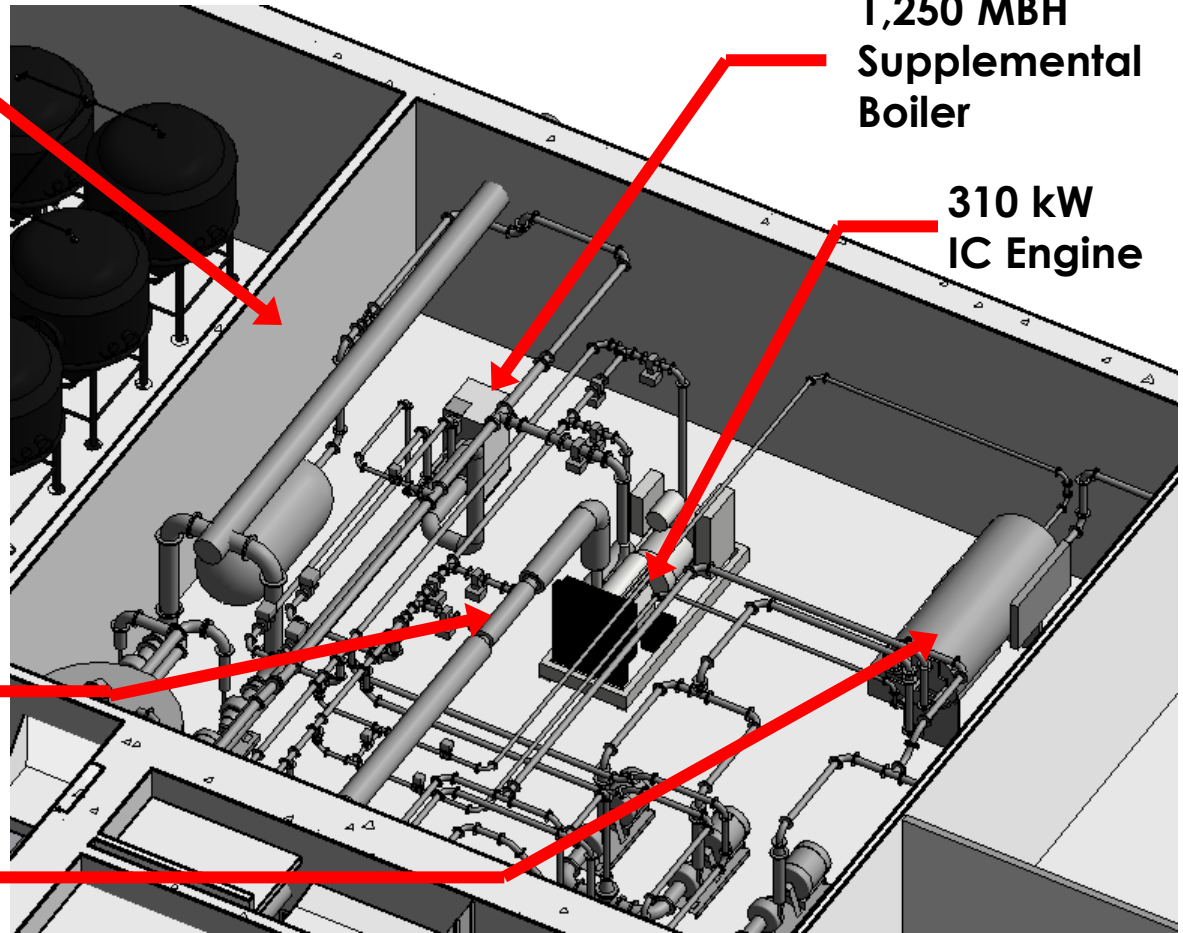


Methane production separated by concrete wall



Exhaust-to-Water Heat Exchanger

85-ton Absorption Chiller



1,250 MBH Supplemental Boiler

310 kW IC Engine

BIM

Reduce

Produce

Apply

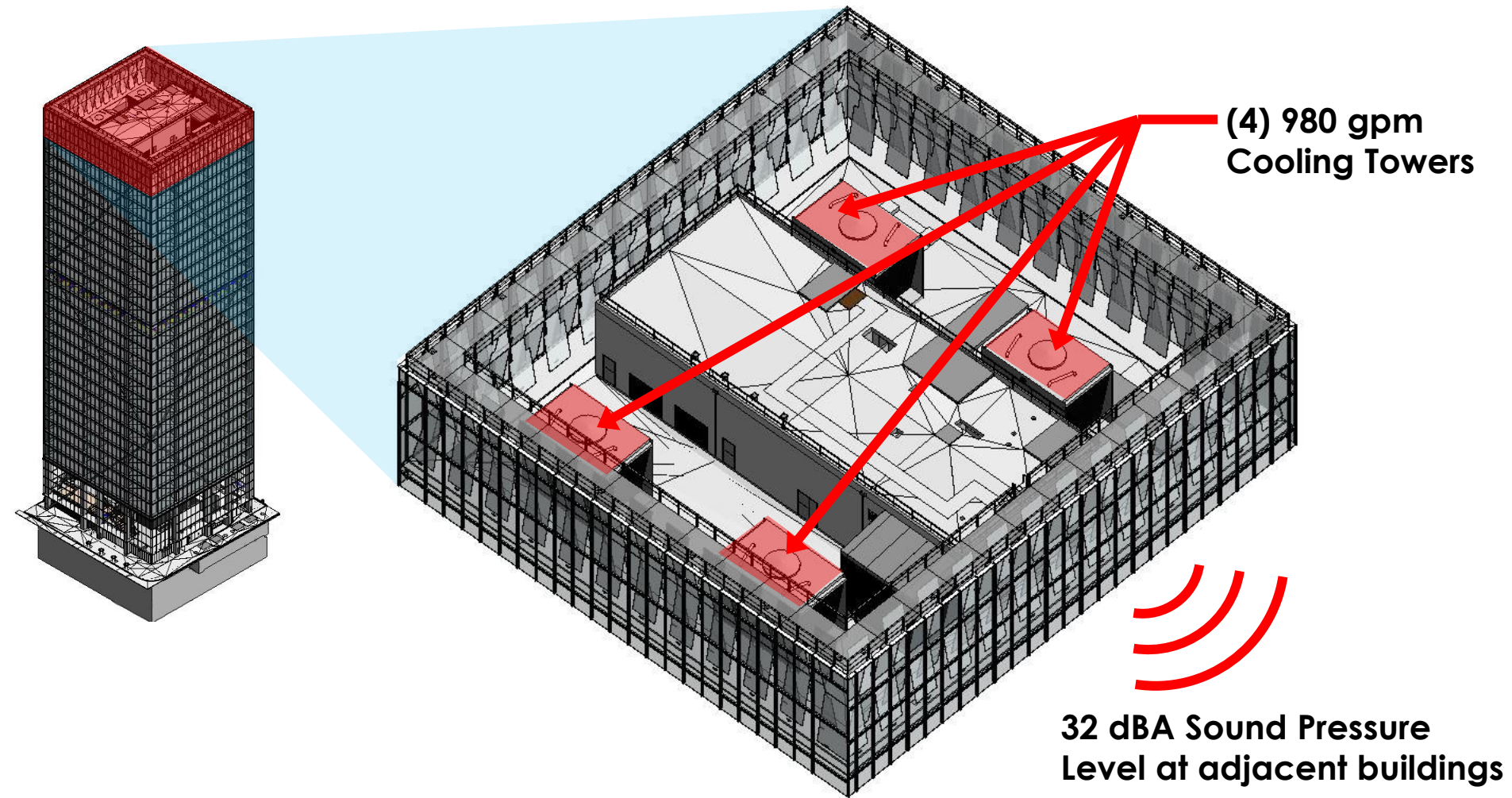
Sequencing

Performance Summary



Electrical  
Construction  
Mechanical  
Structural

# The **Chilled Water and Heating Plant** is located in the basement adjacent to the BioMethane Facility.



BIM

Reduce

Produce

Apply

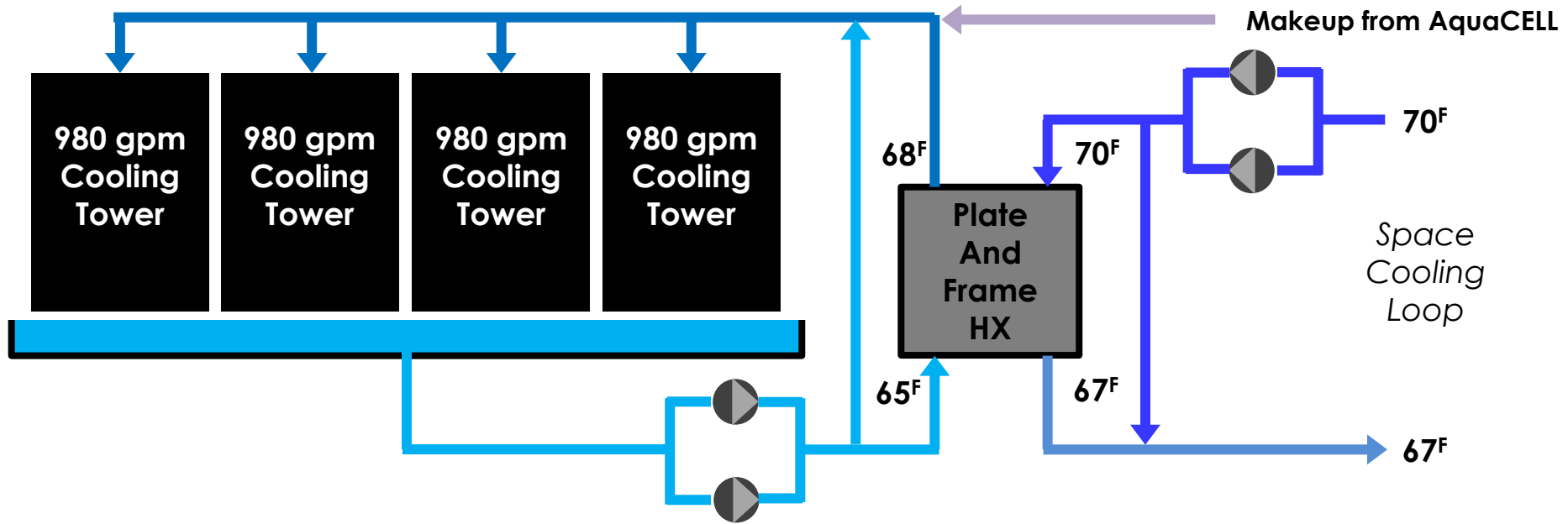
Sequencing

Performance Summary



Electrical  
Construction  
Mechanical  
Structural

# The Chilled Water Plant is divided to decouple space cooling and space dehumidification.



BIM

Reduce

Produce

Apply

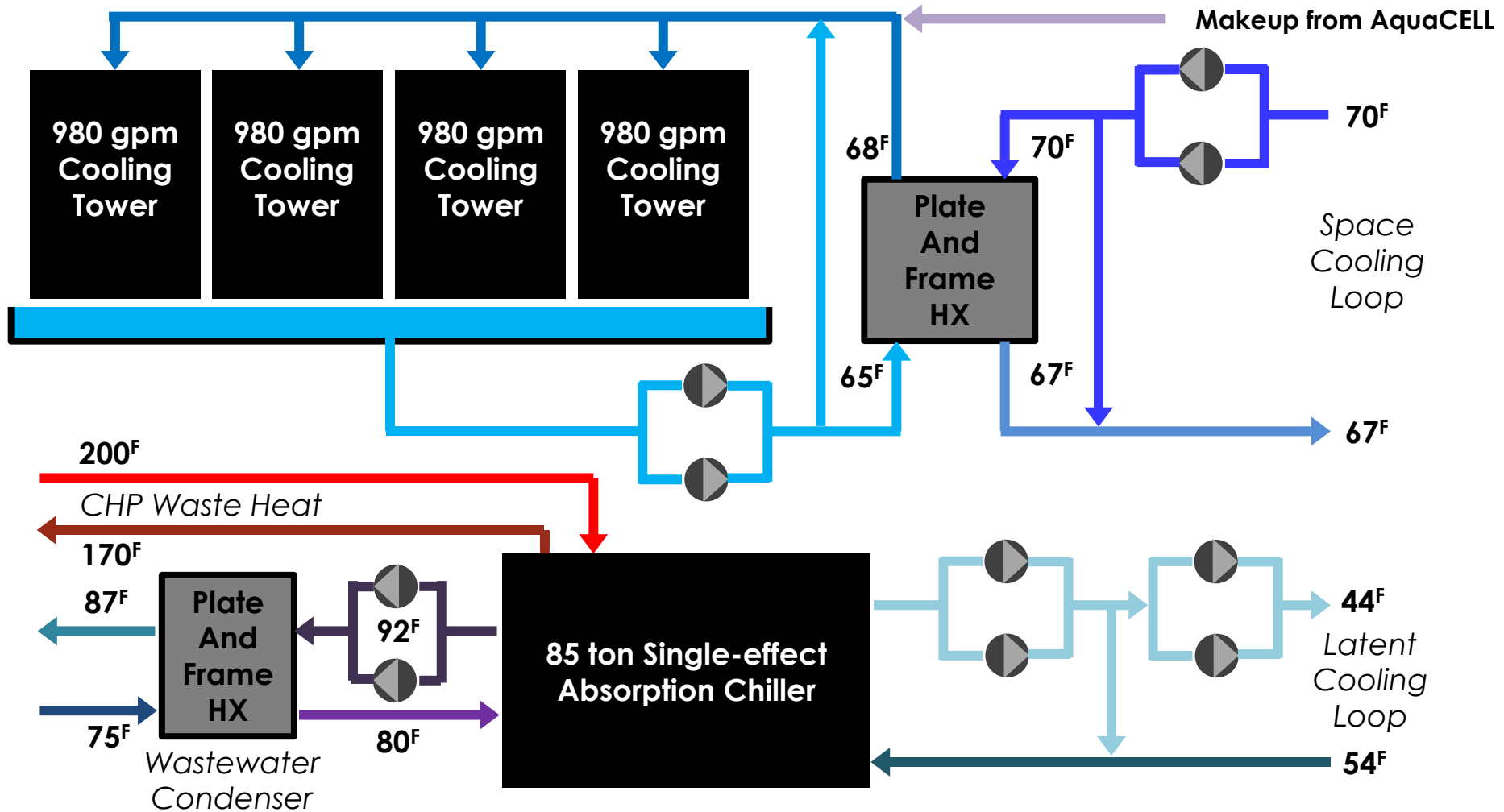
Sequencing

Performance Summary



Electrical  
Construction  
Mechanical  
Structural

# The Chilled Water Plant is divided to decouple space cooling and space dehumidification.



BIM

Reduce

Produce

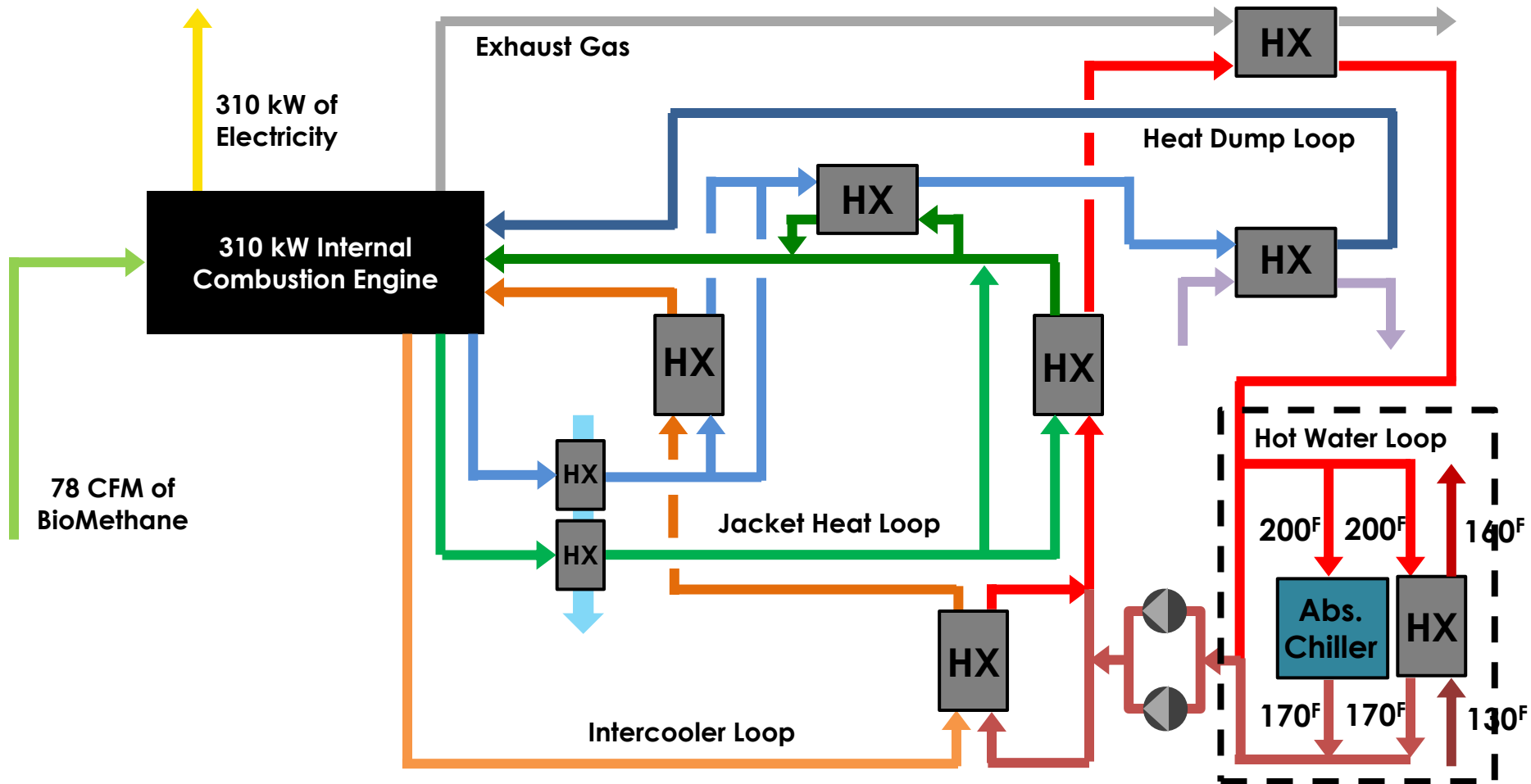
Apply

Sequencing

Performance Summary

Electrical  
Construction  
Mechanical  
Structural

# The Heating Plant is served by CHP waste heat and is supplemented by a gas-fired boiler.



BIM

Reduce

Produce

Apply

Sequencing

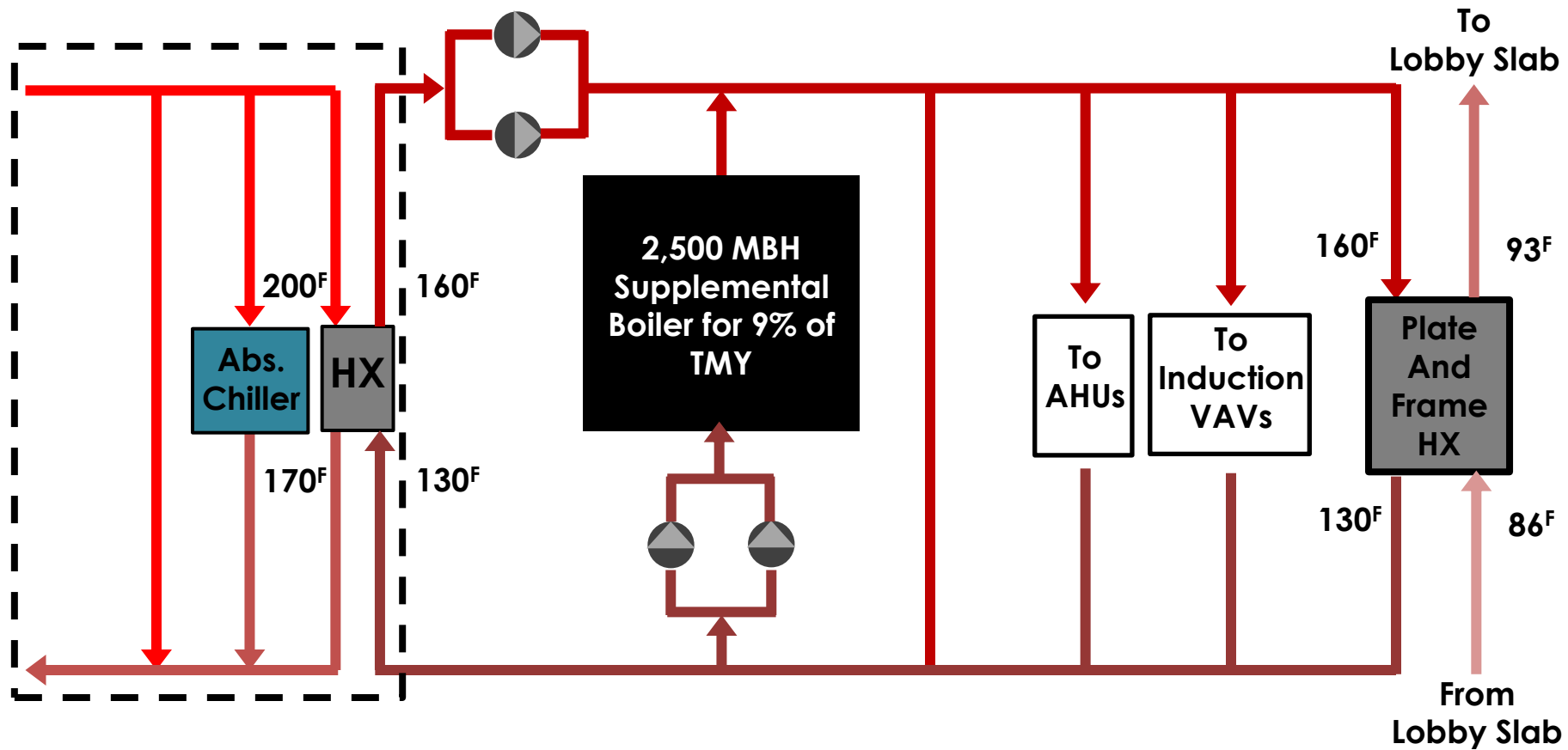
Performance Summary



Electrical  
Construction  
Mechanical  
Structural



# The Heating Plant is served by CHP waste heat and is supplemented by a gas-fired boiler.



BIM

Reduce

Produce

Apply

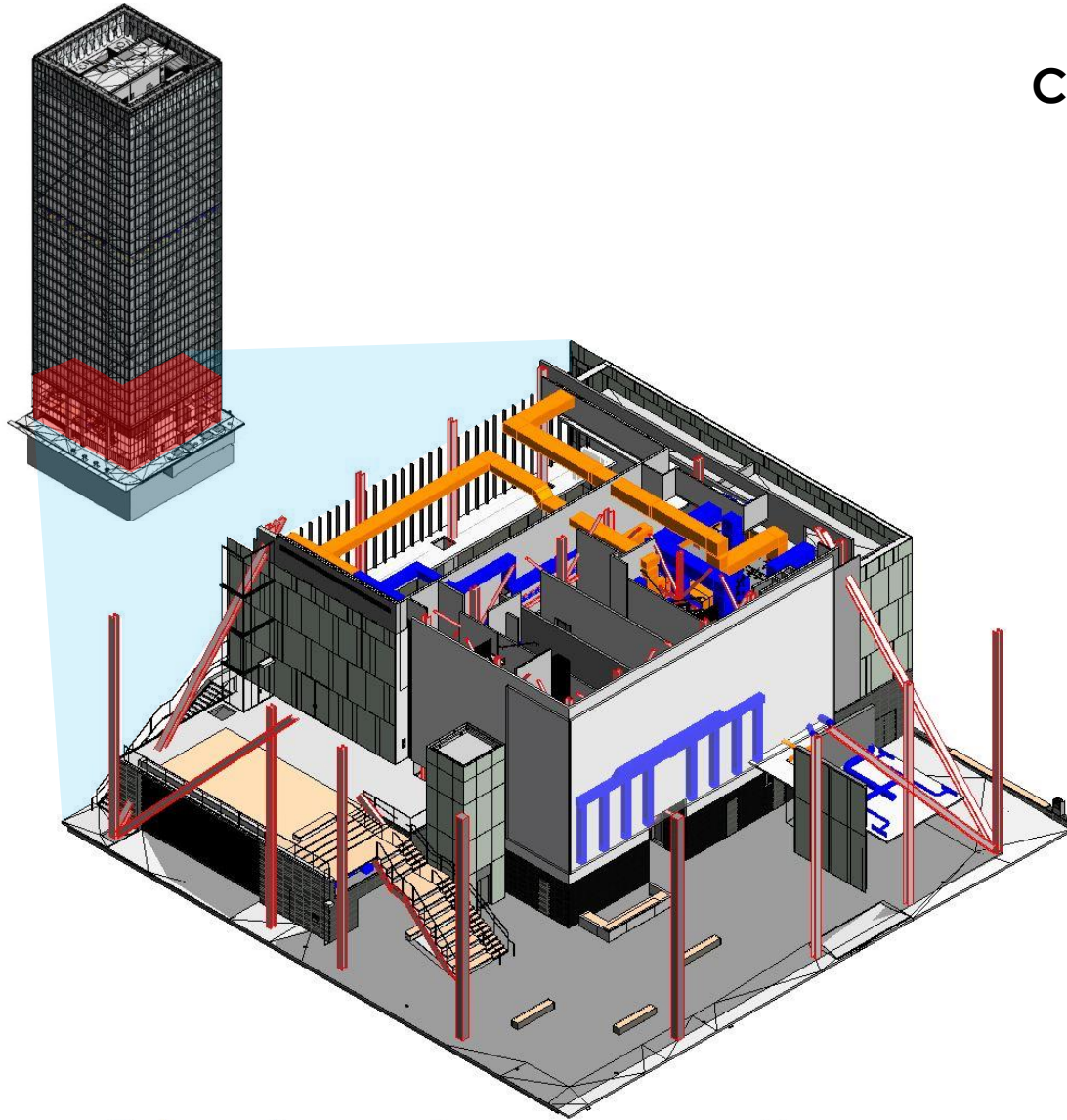
Sequencing

Performance Summary



Electrical  
Construction  
Mechanical  
Structural

# Several **integrative factors** were considered for the Lobby.



Create an **urban living room**  
for community

Merge high-performing  
solutions with **landmark  
architecture**

Maintain **connection with  
Transbay Terminal**

Allow for **tenant fit-out** in  
Restaurant space



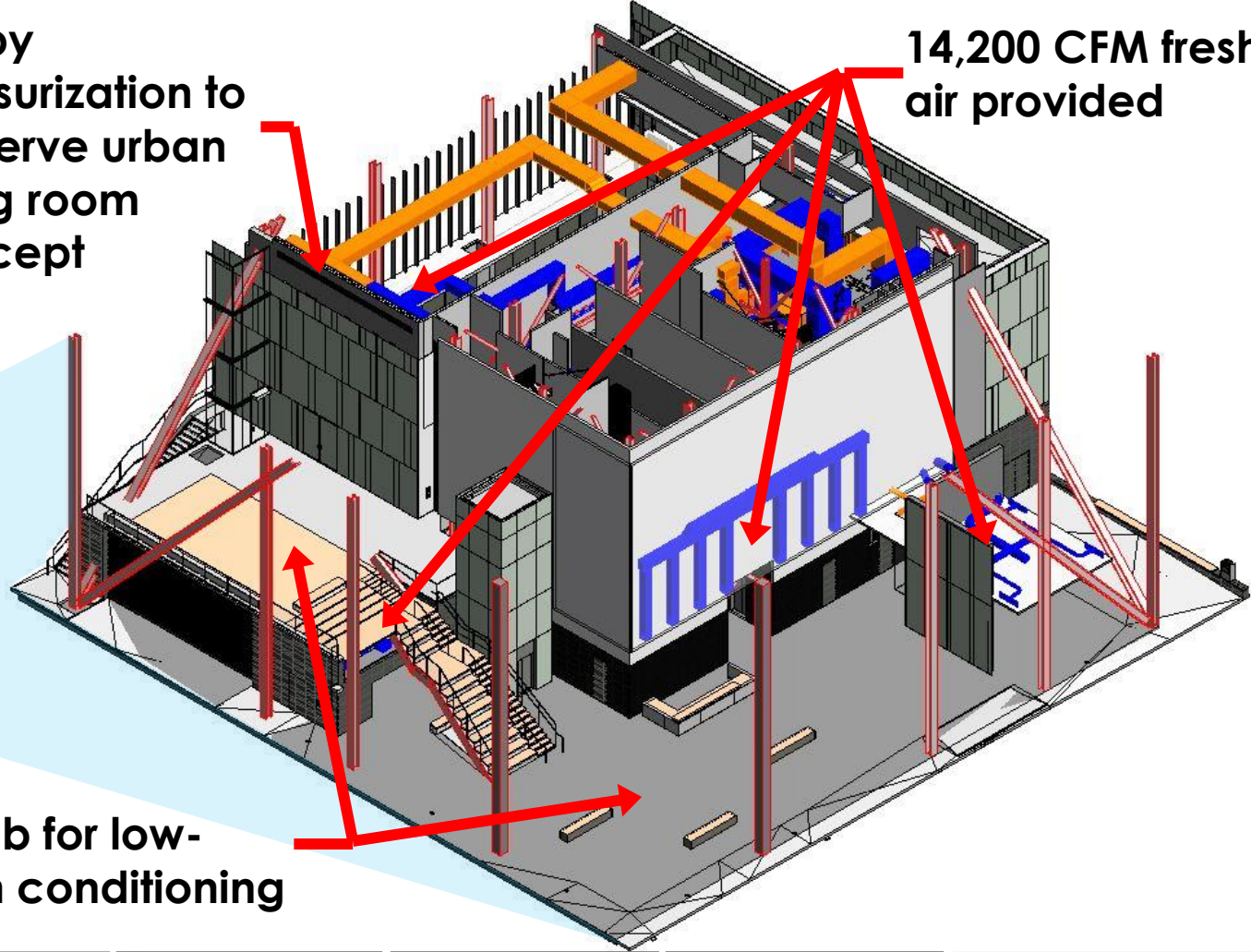
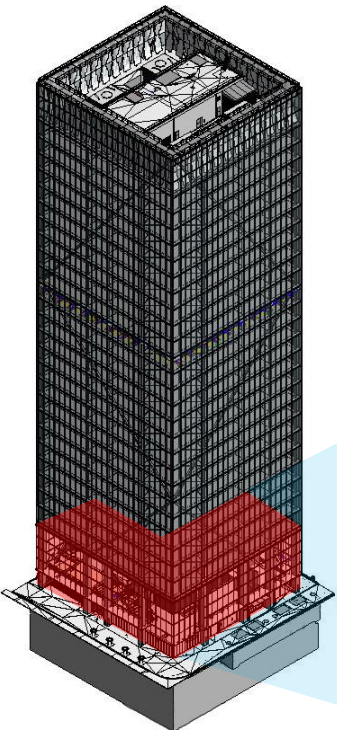
Electrical  
Construction  
Mechanical  
Structural

# The Lobby utilizes a **Thermally-active Slab** and a **100% Outside Air Handling Unit (AHU)**.

Lobby pressurization to preserve urban living room concept

14,200 CFM fresh air provided

Thermal slab for low-convection conditioning



BIM

Reduce

Produce

Apply

Sequencing

Performance Summary

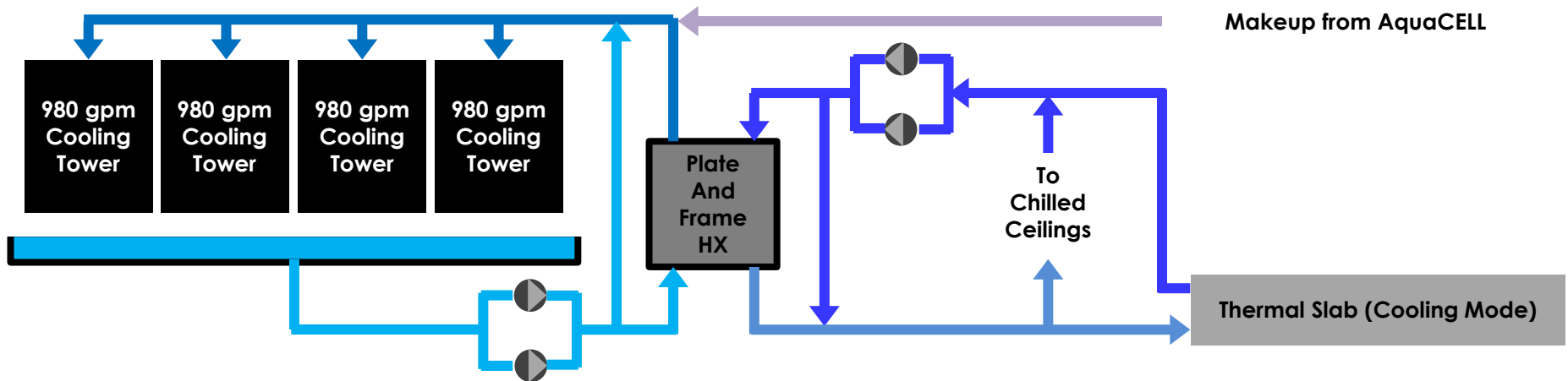
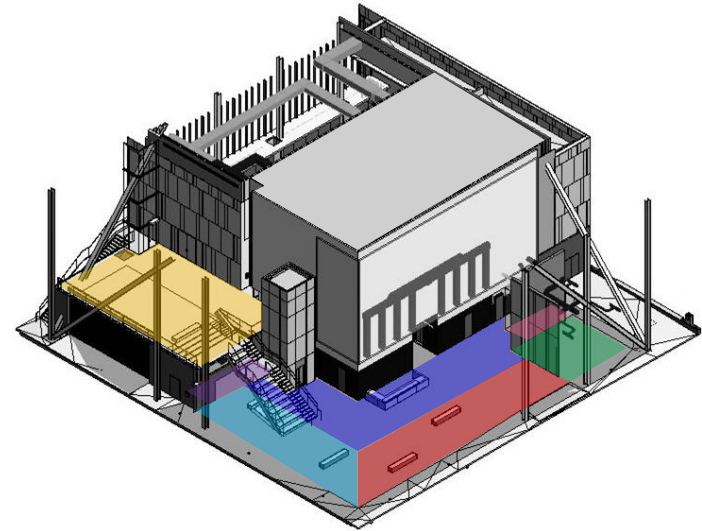


Electrical  
Construction  
Mechanical  
Structural

# Extensive analysis was performed on the **thermal slab** to integrate $m$ and $\Delta T$ with **cooling tower economizer**.

Thermal Slab Cooling Parameters			
$V_{design}$	1.5 gpm	$\Delta T$	3.3 F
$T_{CHW,in}$	67.0 F	$T_{avg,surface}$	68.9 F
$T_{CHW,out}$	70.3 F	$FLUX_{Cooling}$	14.6 BTUh/SF

Thermal Slab Heating Parameters			
$V_{design}$	1.5 gpm	$\Delta T$	6.9 F
$T_{HW,in}$	93.0 F	$T_{avg,surface}$	89.0 F
$T_{HW,out}$	86.1 F	$FLUX_{Heating}$	37.0 BTUh/SF



BIM

Reduce

Produce

Apply

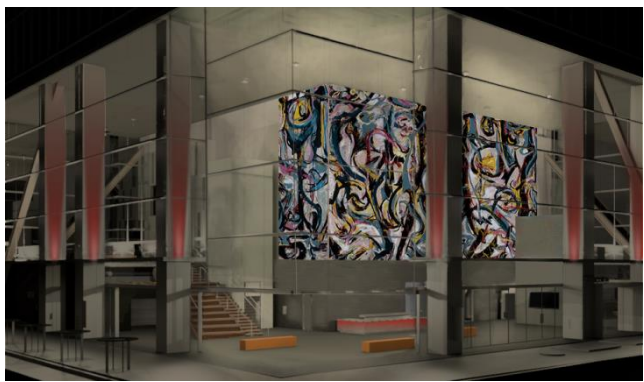
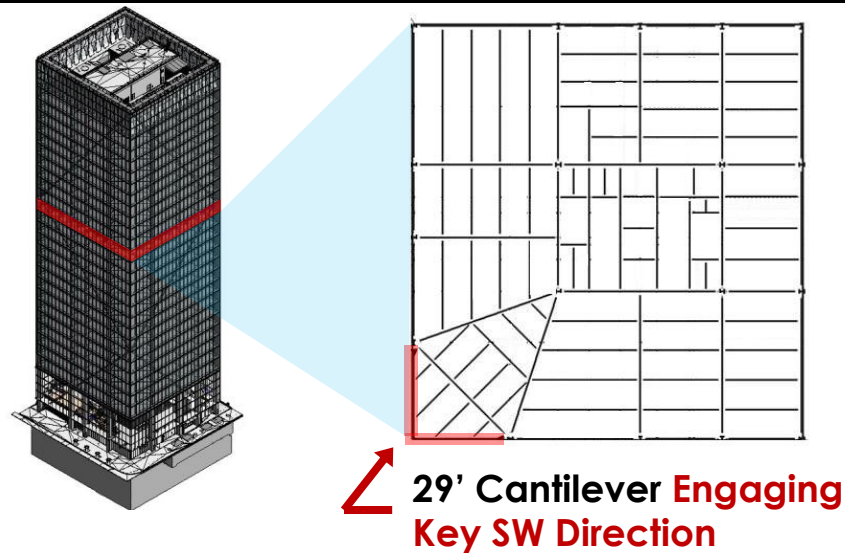
Sequencing

Performance Summary



Electrical  
Construction  
Mechanical  
Structural

# The important South West direction of the building space was preserved through **cantilever studies**.



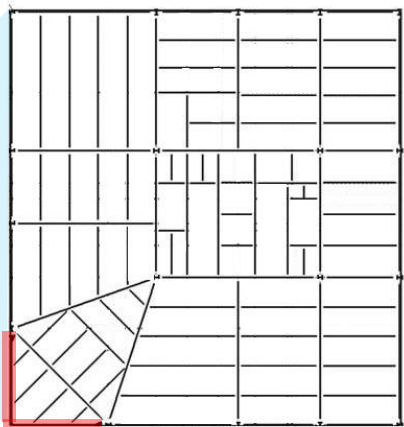
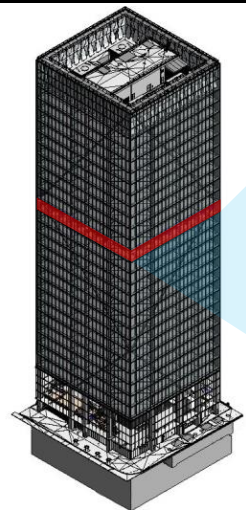
Night time rendering from key SW direction of Lobby

BIM	Reduce	Produce	<b>Apply</b>	Sequencing	Performance Summary
-----	--------	---------	--------------	------------	---------------------



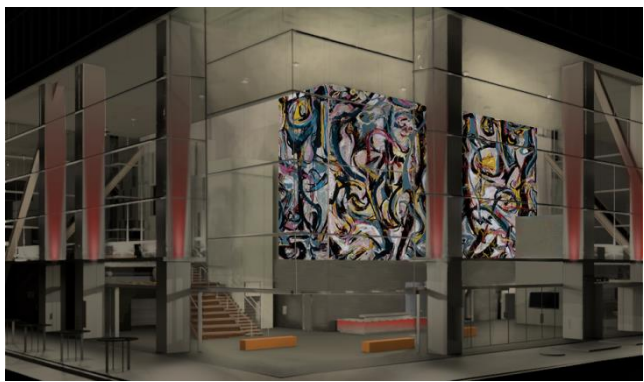
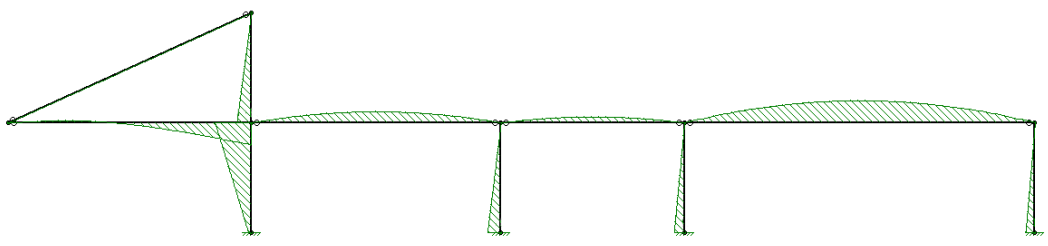
Electrical  
Construction  
Mechanical  
Structural

# The important South West direction of the building space was preserved through **cantilever studies**.



**29' Cantilever Engaging Key SW Direction**

Tension Hanger Study:



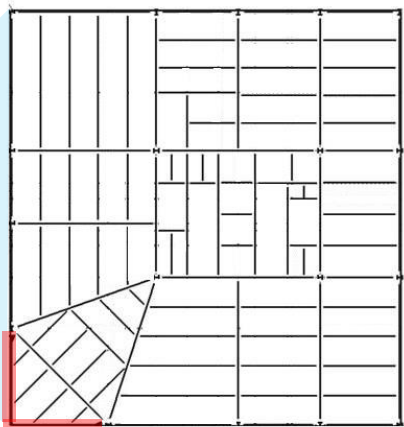
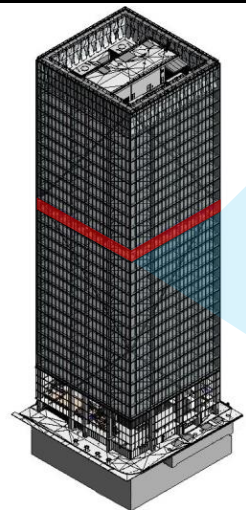
Night time rendering from key SW direction of Lobby

BIM	Reduce	Produce	<b>Apply</b>	Sequencing	Performance Summary
-----	--------	---------	--------------	------------	---------------------



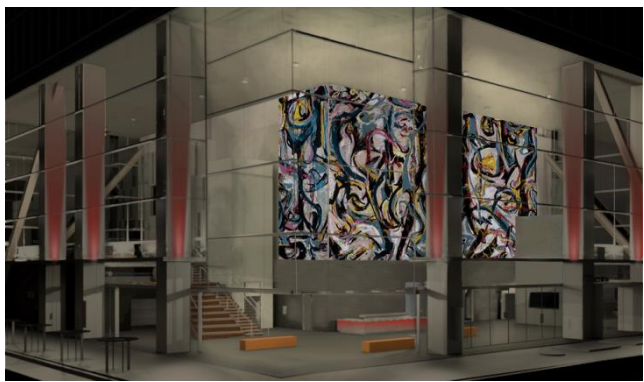
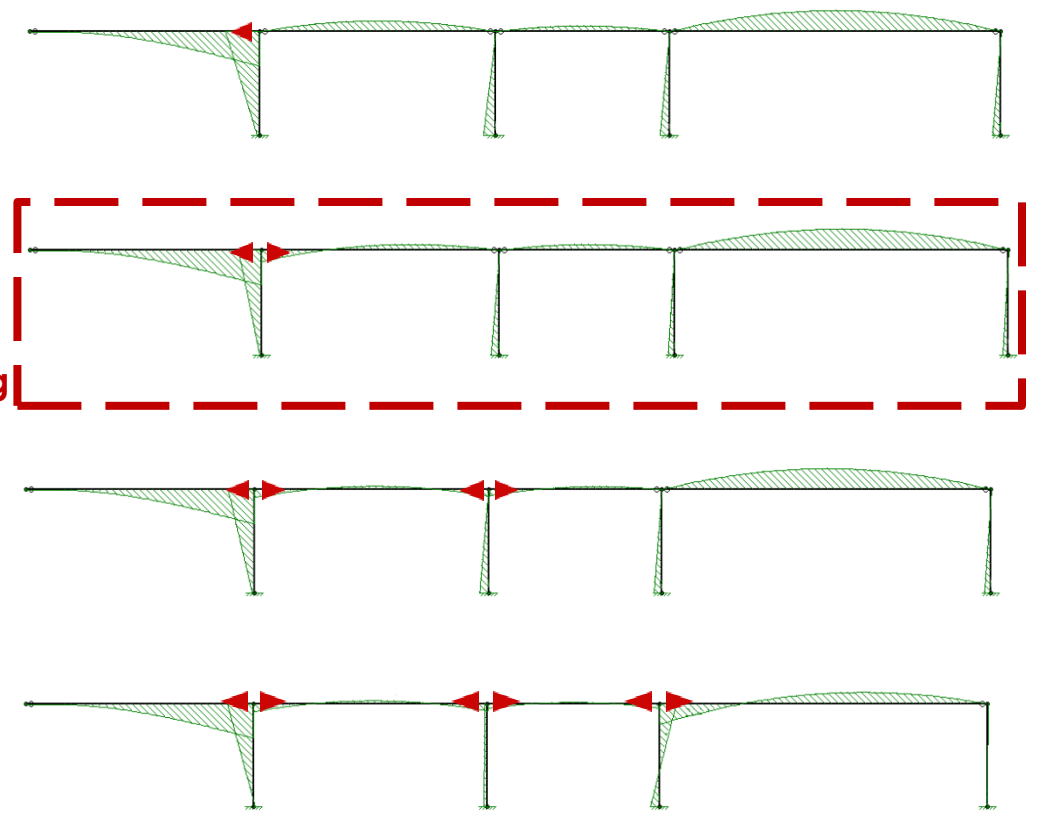
Electrical  
Construction  
Mechanical  
Structural

# The important South West direction of the building space was preserved through **cantilever studies**.



**29' Cantilever Engaging Key SW Direction**

## Moment Connection Study:



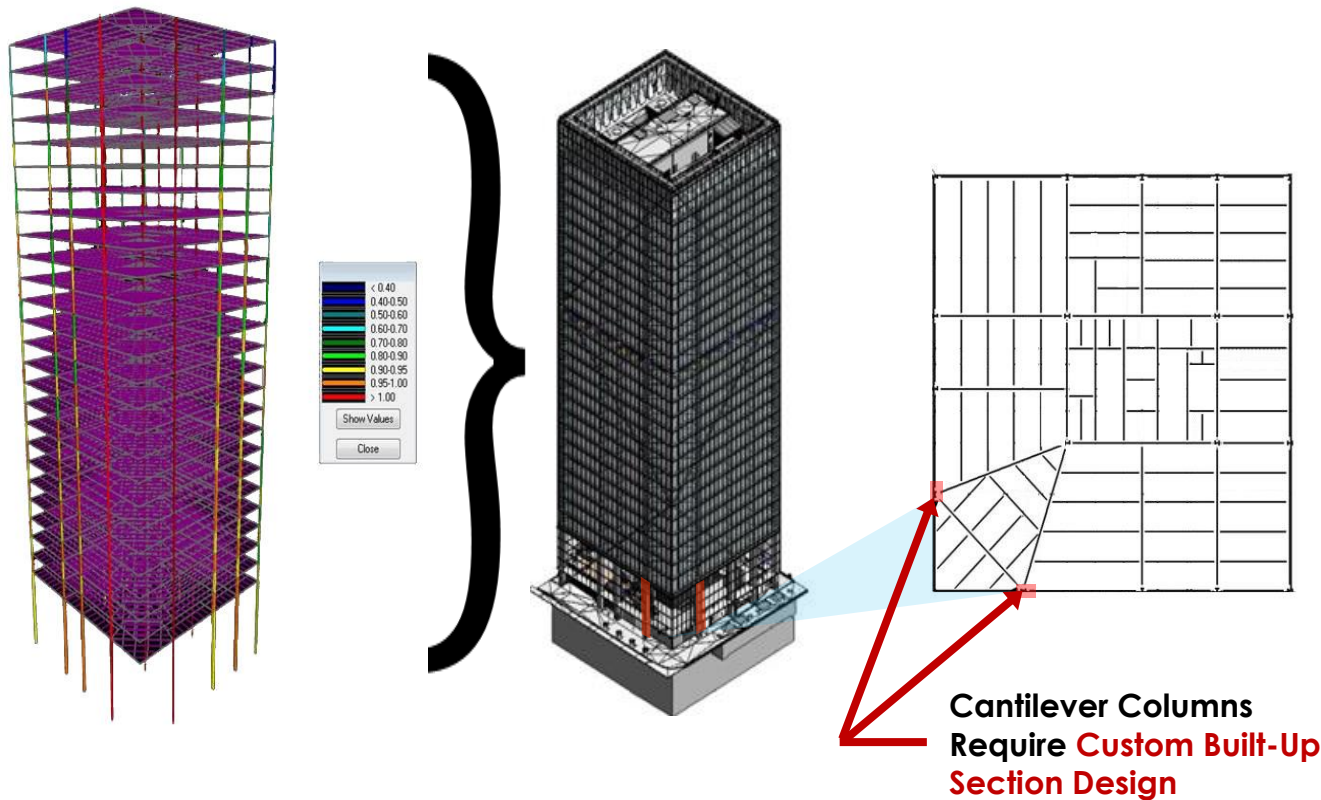
Night time rendering from key SW direction of Lobby

BIM	Reduce	Produce	<b>Apply</b>	Sequencing	Performance Summary
-----	--------	---------	--------------	------------	---------------------



Electrical  
Construction  
Mechanical  
Structural

# Important Lobby space called for **custom structural section design.**



BIM

Reduce

Produce

Apply

Sequencing

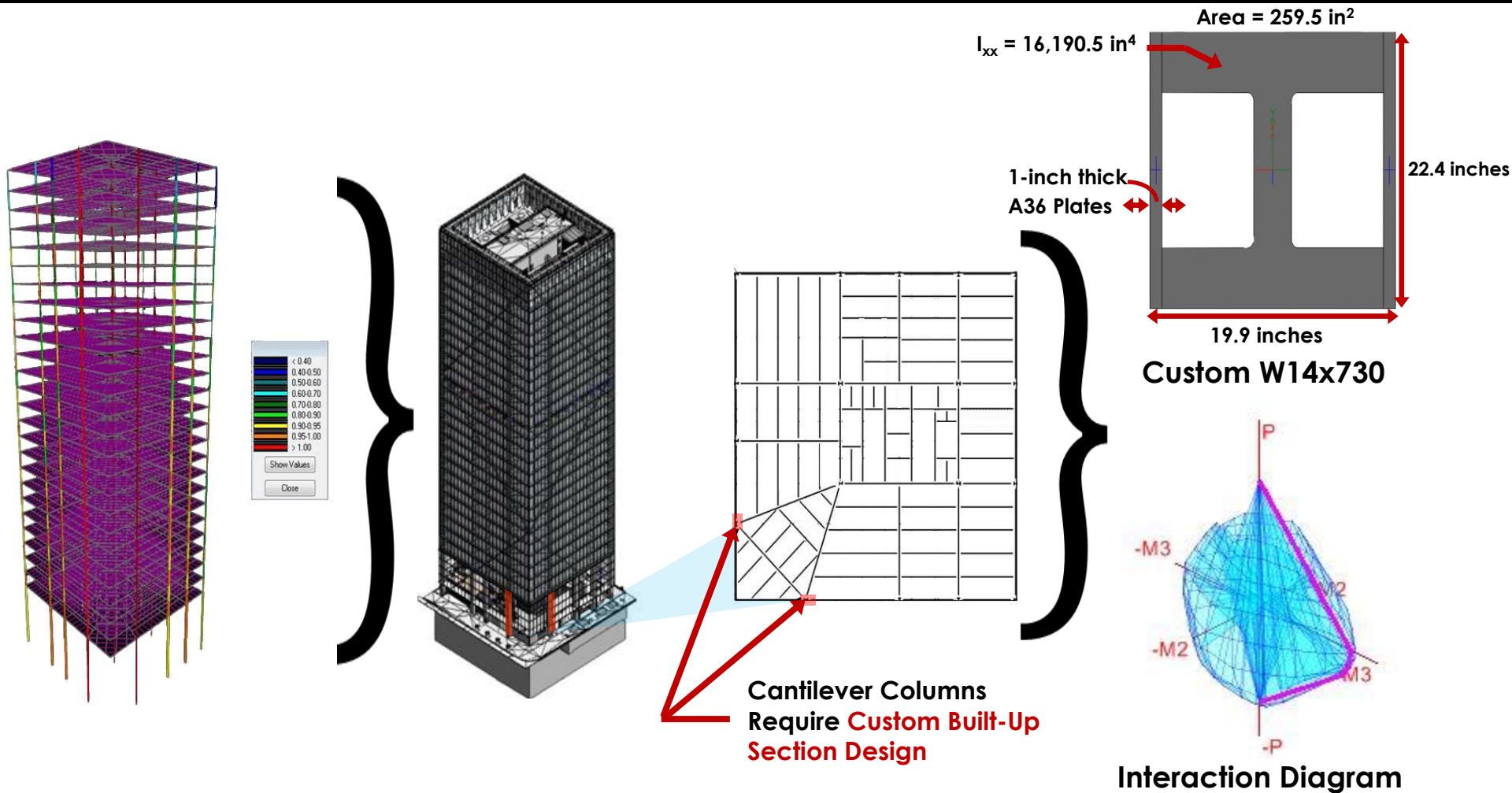
Performance Summary



Electrical  
Construction  
Mechanical  
Structural



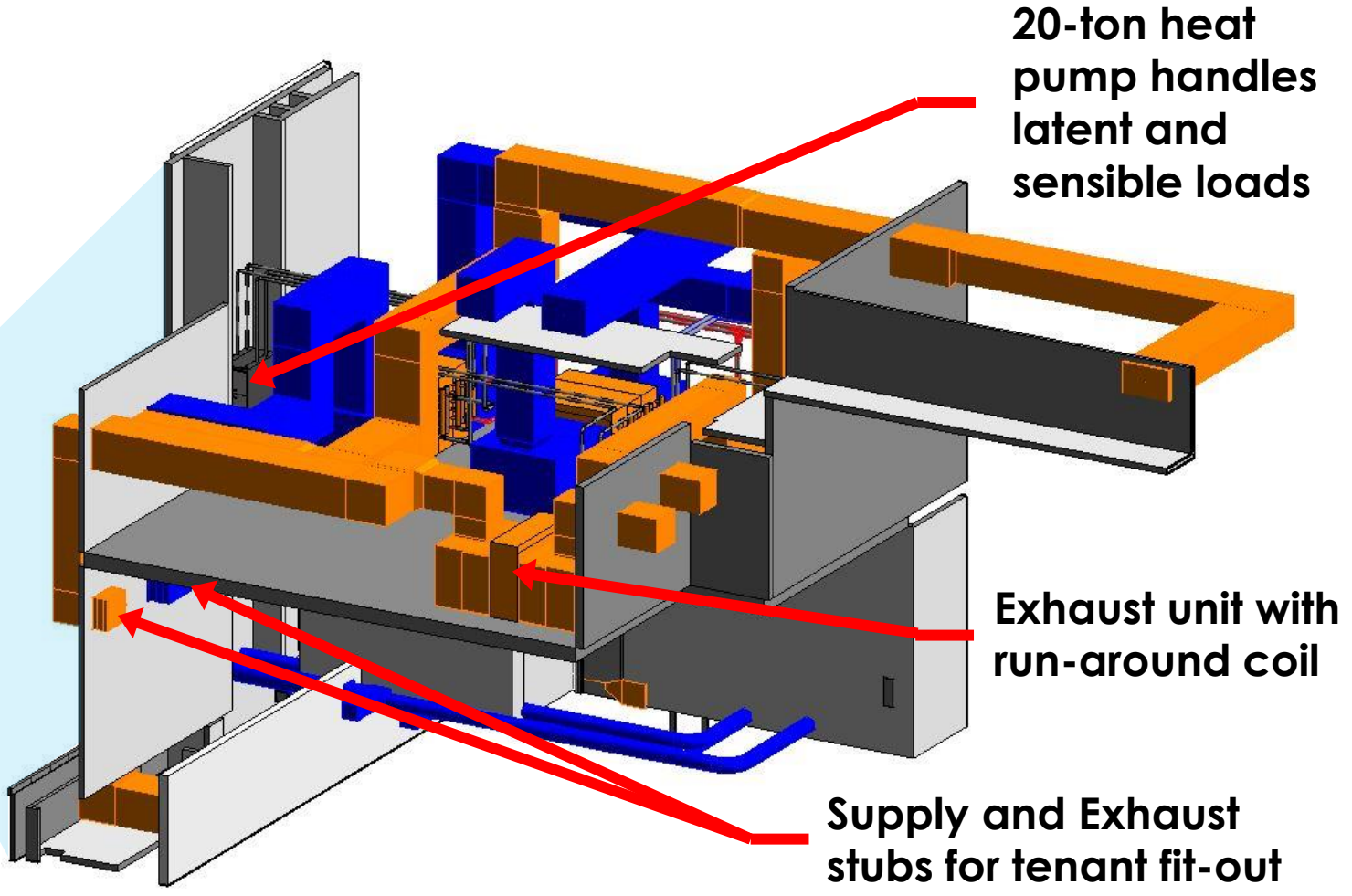
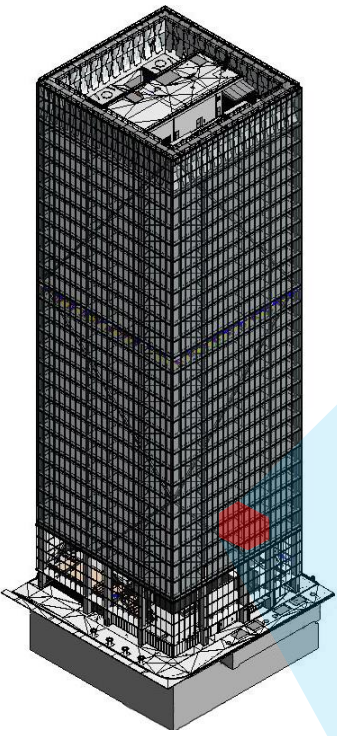
# Important Lobby space called for **custom structural section design.**



Cantilever Columns  
Require **Custom Built-Up  
Section Design**

BIM	Reduce	Produce	<b>Apply</b>	Sequencing	Performance Summary
-----	--------	---------	--------------	------------	---------------------

# The **Restaurant** was designed for tenant fit-out and has its own **Dedicated Heat Pump** and **100% Outside Air AHU**.

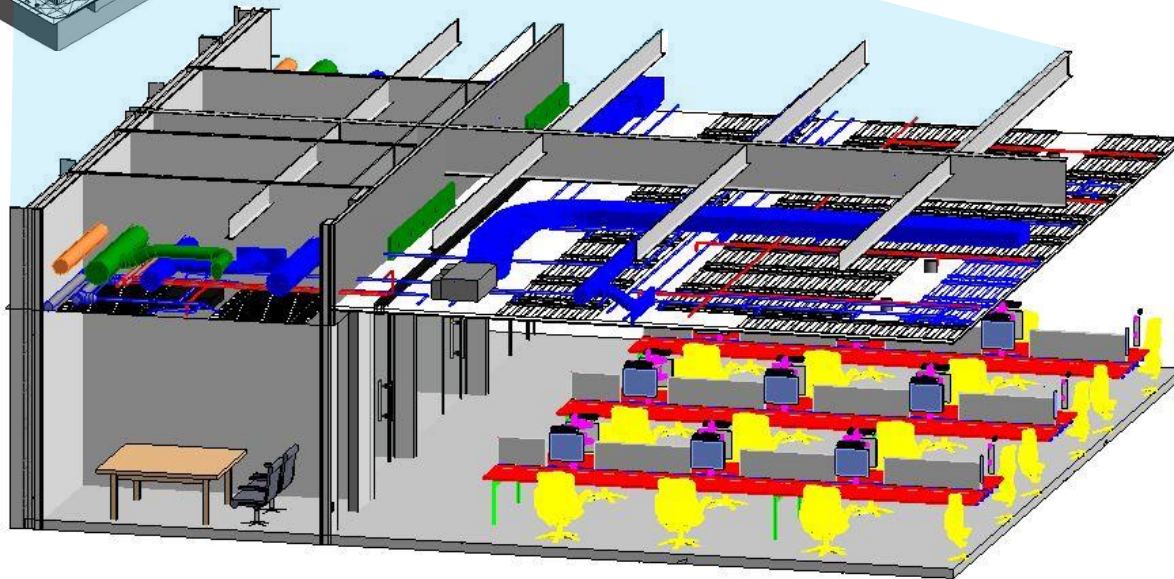
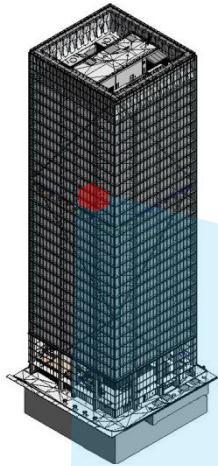


BIM	Reduce	Produce	<b>Apply</b>	Sequencing	Performance Summary
-----	--------	---------	--------------	------------	---------------------



Electrical  
Construction  
Mechanical  
Structural

# Several **integrative factors** were considered for the Typical Office Floor.



**Beam depth effects** on MEP plenum and floor-to-floor height

**Visual clutter** of building services

**Coordination** of trades at ceiling

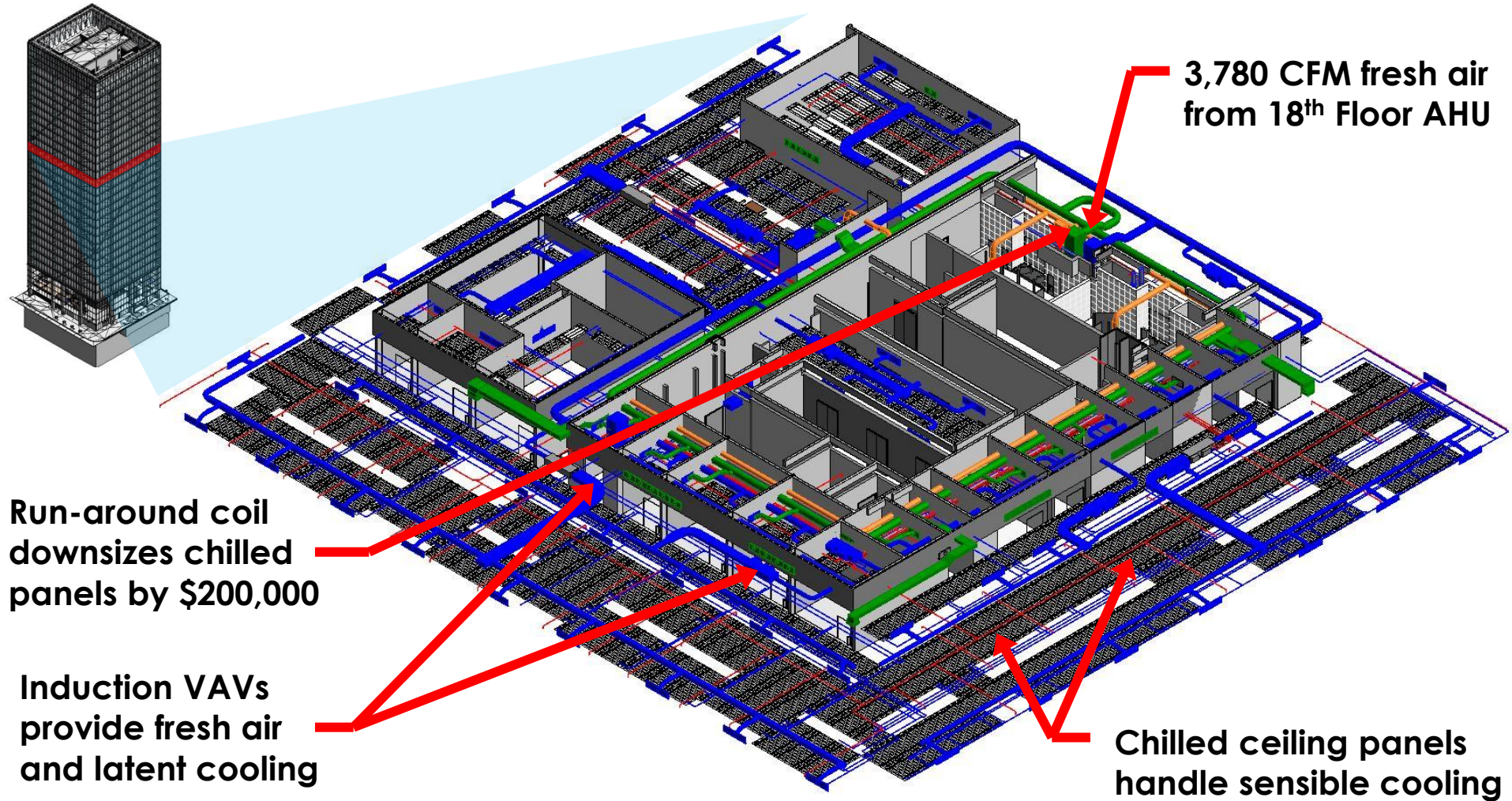
**Maintain views** of surroundings

Utilize large **resource-saving potential**



Electrical  
Construction  
Mechanical  
Structural

# The Office uses a strategy which enables **Simultaneous Heating and Cooling** while providing **100% Outside Air**.



BIM

Reduce

Produce

Apply

Sequencing

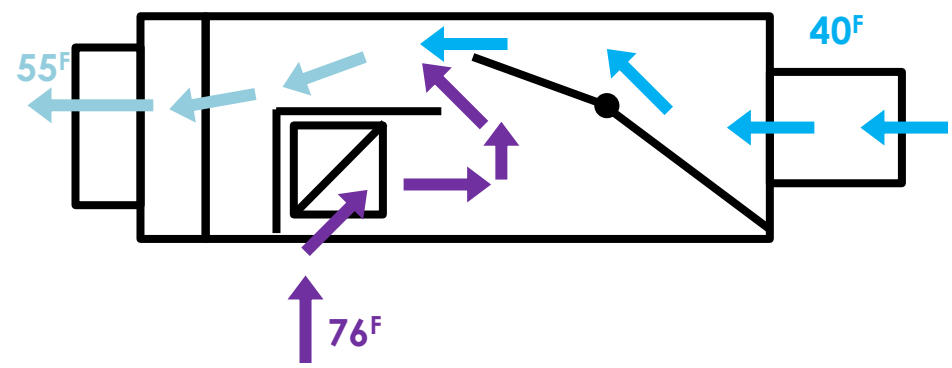
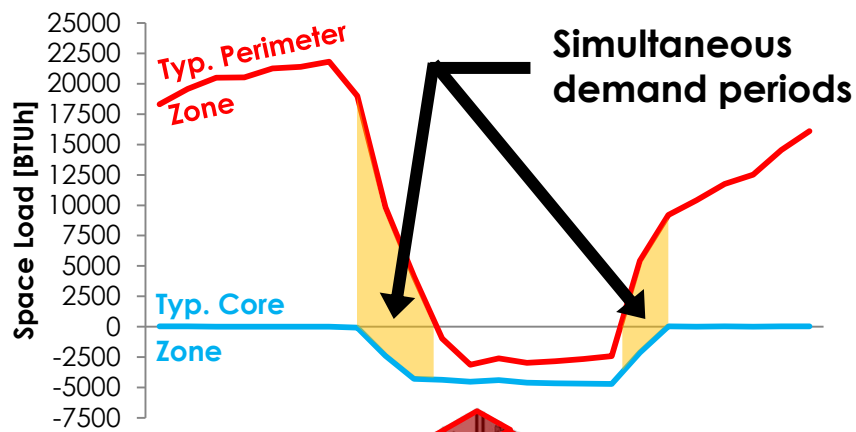
Performance Summary



Electrical  
Construction  
Mechanical  
Structural

# Induction VAV Terminals ensure proper ventilation while allowing for simultaneous heating and cooling.

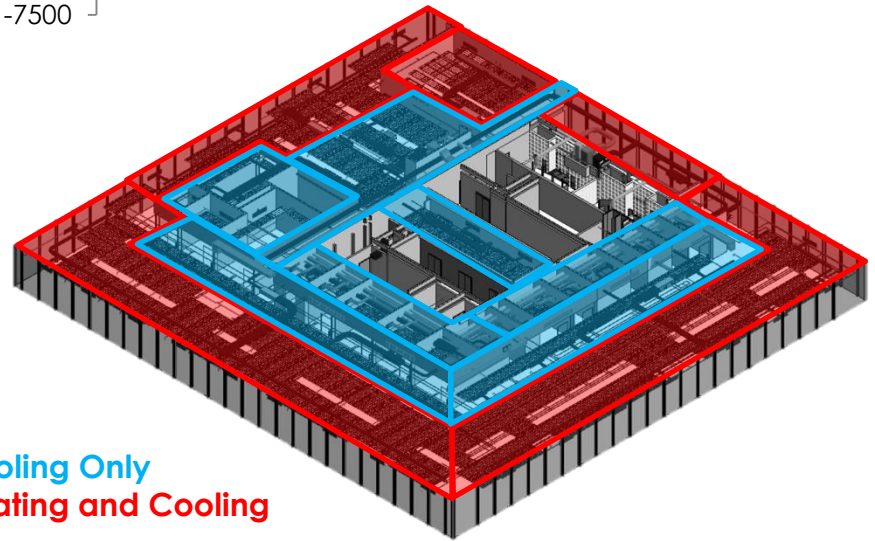
Space Load at Core/Perimeter Zones



Constant airflow with variable demand-controlled fresh air

Increased economizer hours

Hot water heating at zone-level



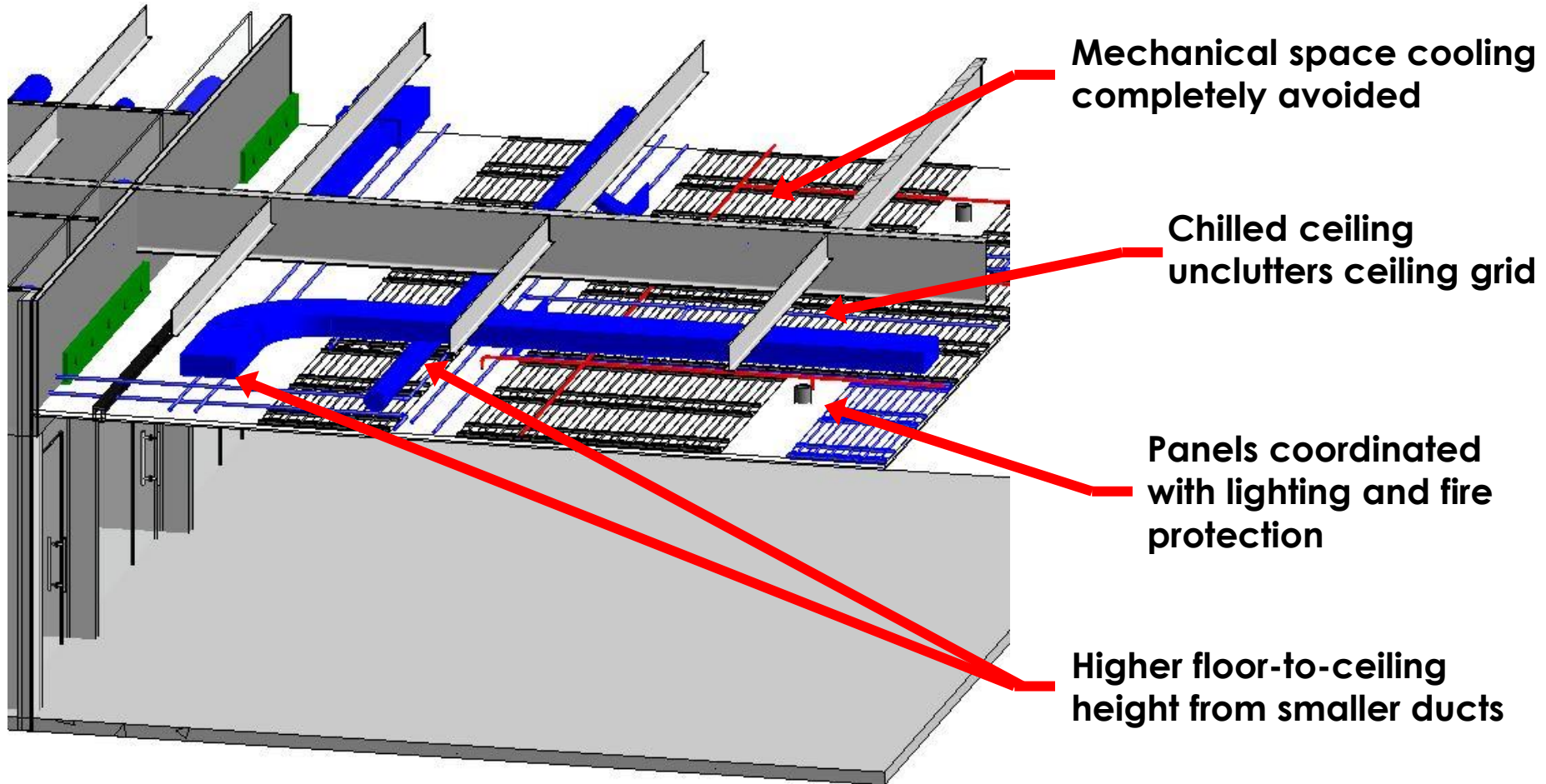
Cooling Only  
Heating and Cooling

BIM	Reduce	Produce	<b>Apply</b>	Sequencing	Performance Summary
-----	--------	---------	--------------	------------	---------------------



Electrical  
Construction  
Mechanical  
Structural

# Chilled ceiling panels provide thermal comfort without mechanical refrigeration.



BIM

Reduce

Produce

Apply

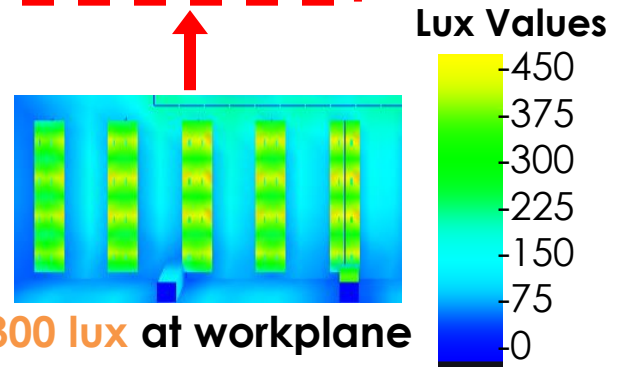
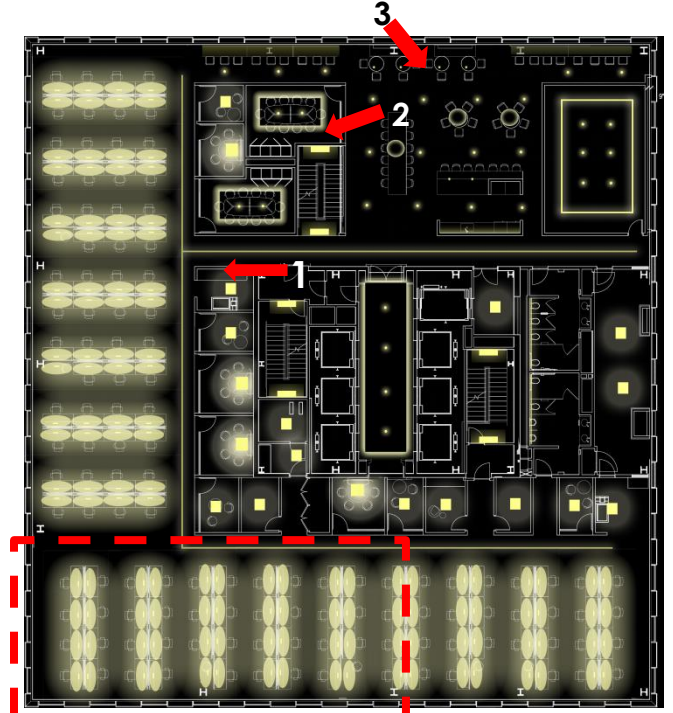
Sequencing

Performance Summary



Electrical  
Construction  
Mechanical  
Structural

# Office Lighting Design facilitates collaboration.



BIM

Reduce

Produce

Apply

Sequencing

Performance Summary



Electrical  
Construction  
Mechanical  
Structural

# Performance guided the sustainability and energy efficiency of 350 Mission



- BIM
- Reduction
- Production
- Application
- **Sequencing**
  - Process
- Performance Summary





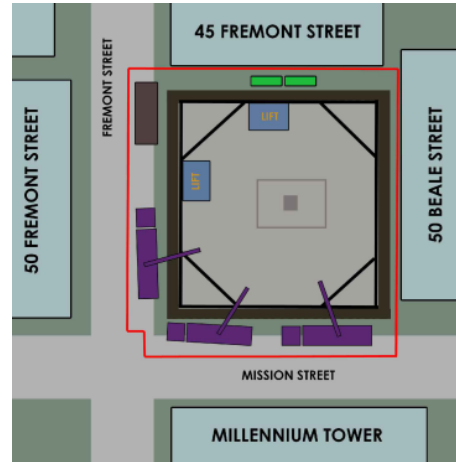
# Construction sequencing was specifically designed to enhance project schedule

## Subterranean Construction - 7 Months

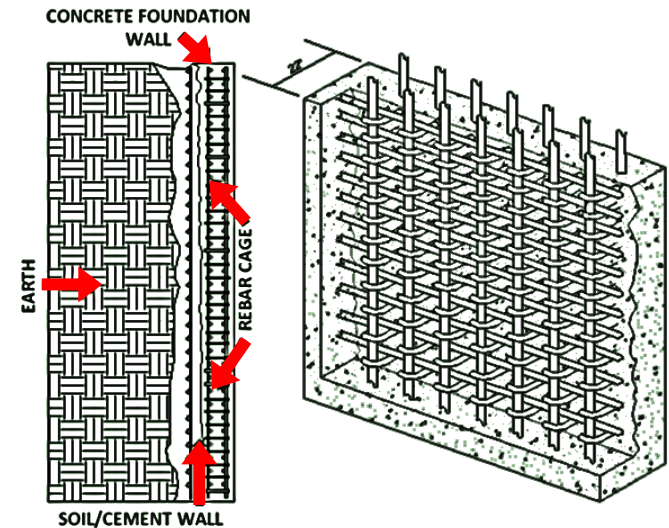
1



2



3



22 inch thick outside wall

Part of 2-wall system

Pre-fab rebar cage installed

BIM

Reduce

Produce

Apply

Sequencing

Performance Summary



Electrical  
Construction  
Mechanical  
Structural

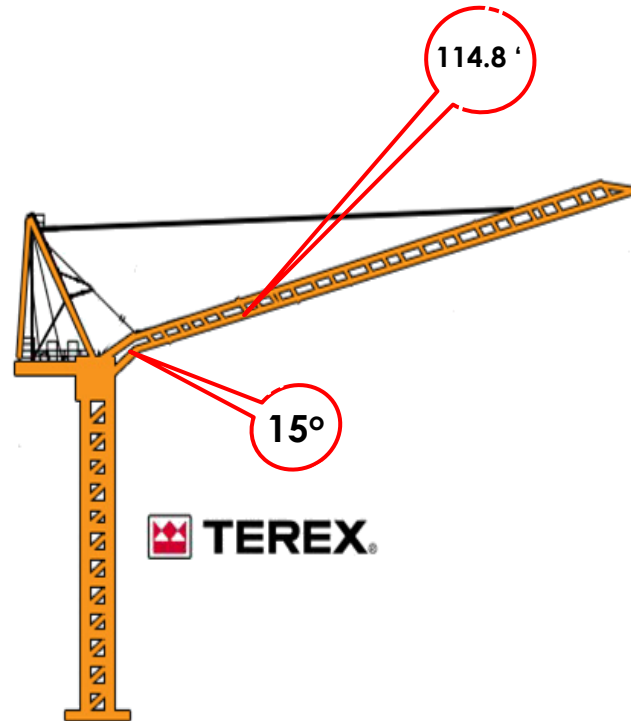
# A centrally-organized plan was created for vertical construction surrounding the building's core

4

Central crane location

Luffing Jib Tower Crane

Critical path key to construction sequencing



BIM

Reduce

Produce

Apply

Sequencing

Performance Summary



Electrical  
Construction  
Mechanical  
Structural

# Construction sequencing was specifically designed to enhance project schedule

## Above-Ground Construction - 14 Months

5

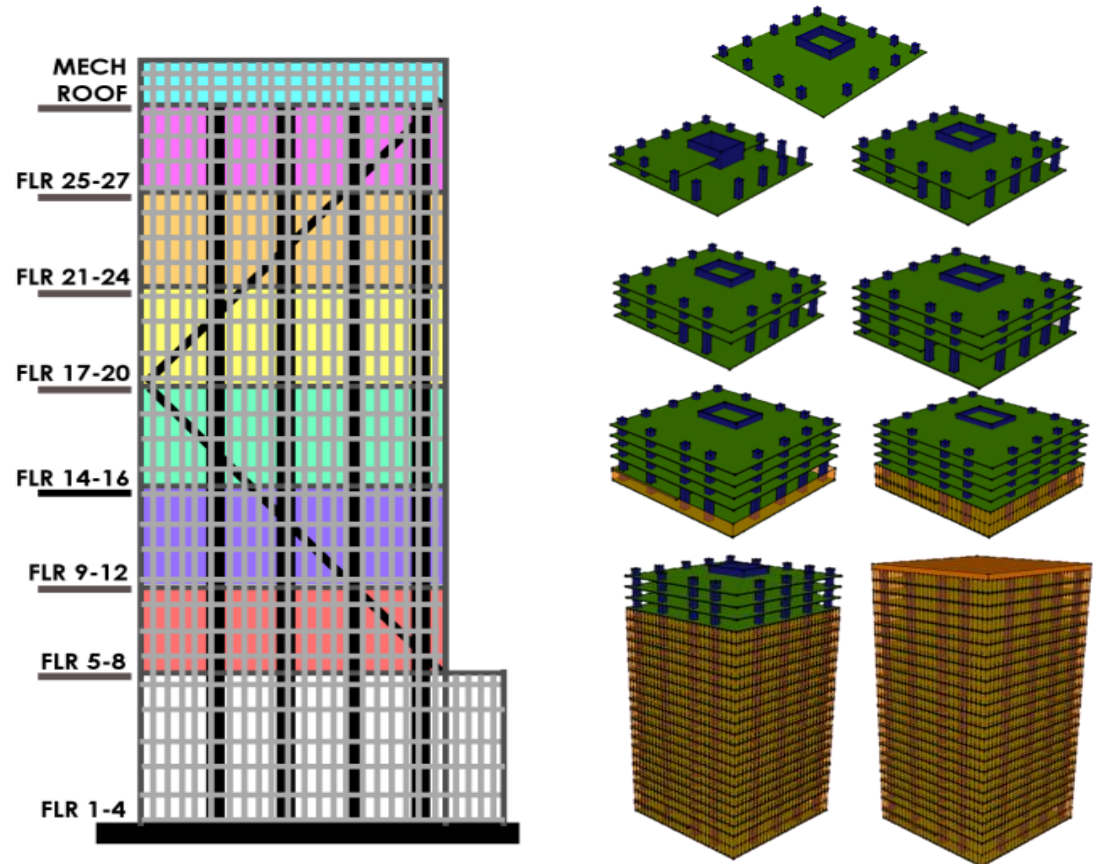
“Psuedo-SIPS”

4-floor above-ground phasing

Core rises ahead of floors

Beams follow columns; façade follows steel erection

Mega-bracing



BIM

Reduce

Produce

Apply

Sequencing

Performance Summary



Electrical  
Construction  
Mechanical  
Structural

# Performance guided the sustainability and energy efficiency of 350 Mission



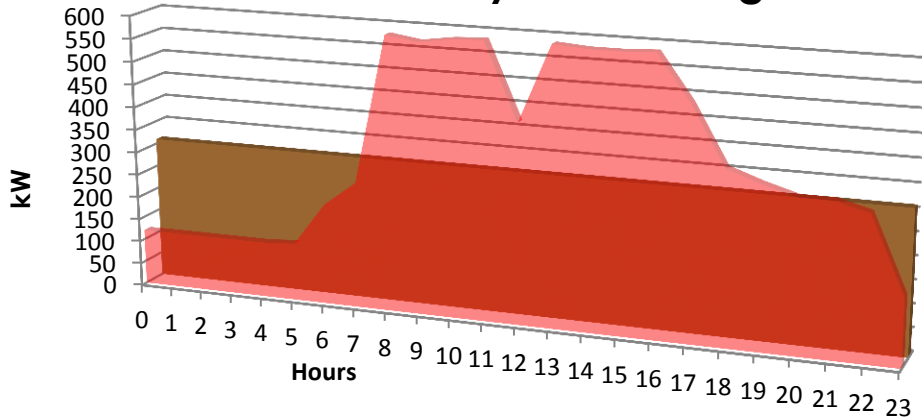
- BIM
- Demand Reduction
- Resource Production
- Plant Distribution & Application
- Space Application
- Sequencing
- **Performance Summary**



# Daily **Electrical profiles** were created to predict electrical demand at each hour of the day.

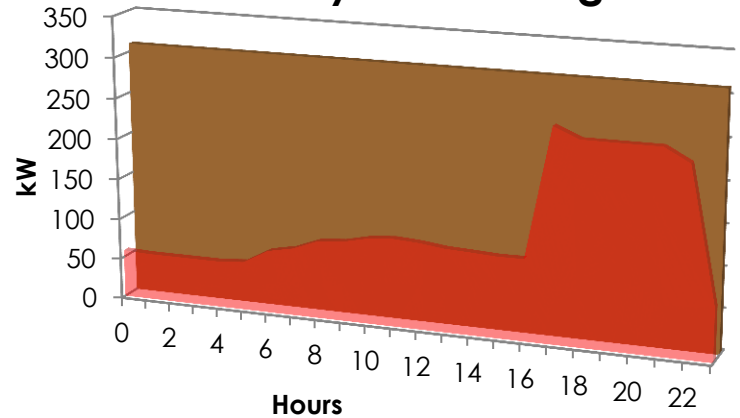
- Power Used
- Power Produced By Internal Combustion Engine

### Weekday Power Usage

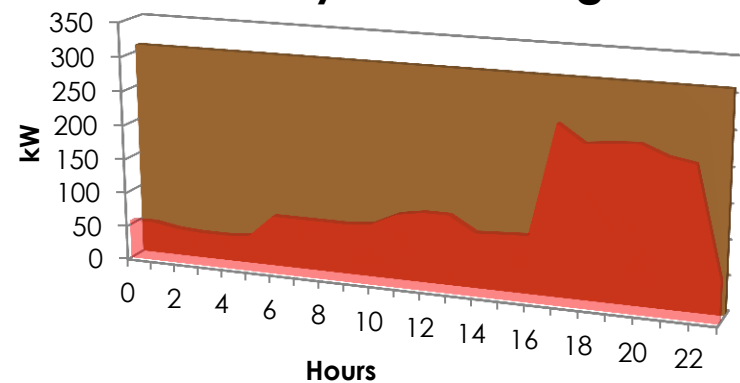


- Weekday Power Used
- Power Produced By Internal Combustion Engine

### Saturday Power Usage



### Sunday Power Usage



BIM

Reduce

Produce

Apply

Sequencing

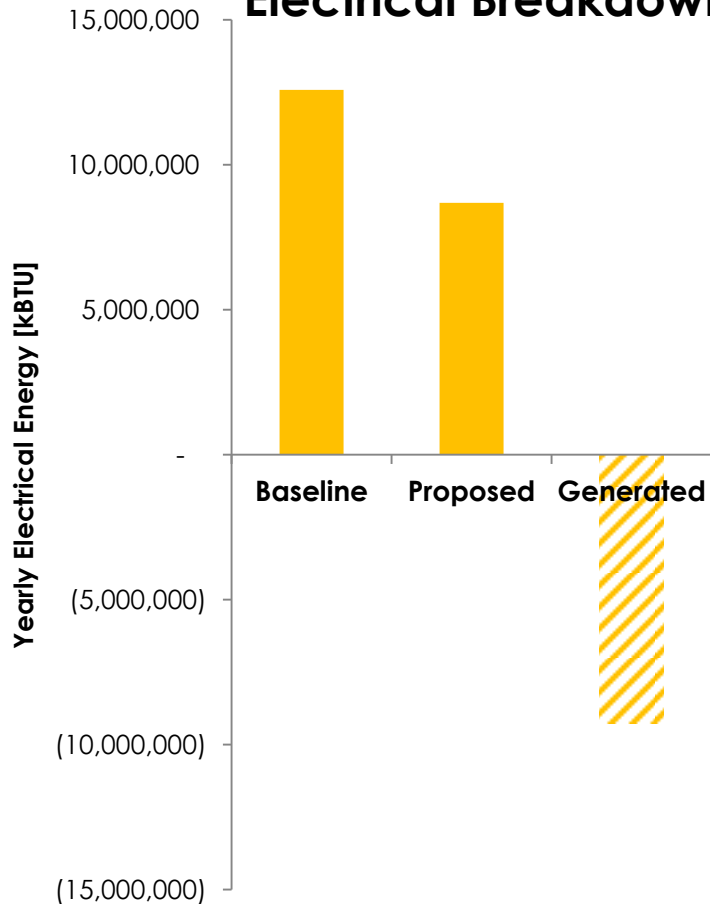
Performance Summary



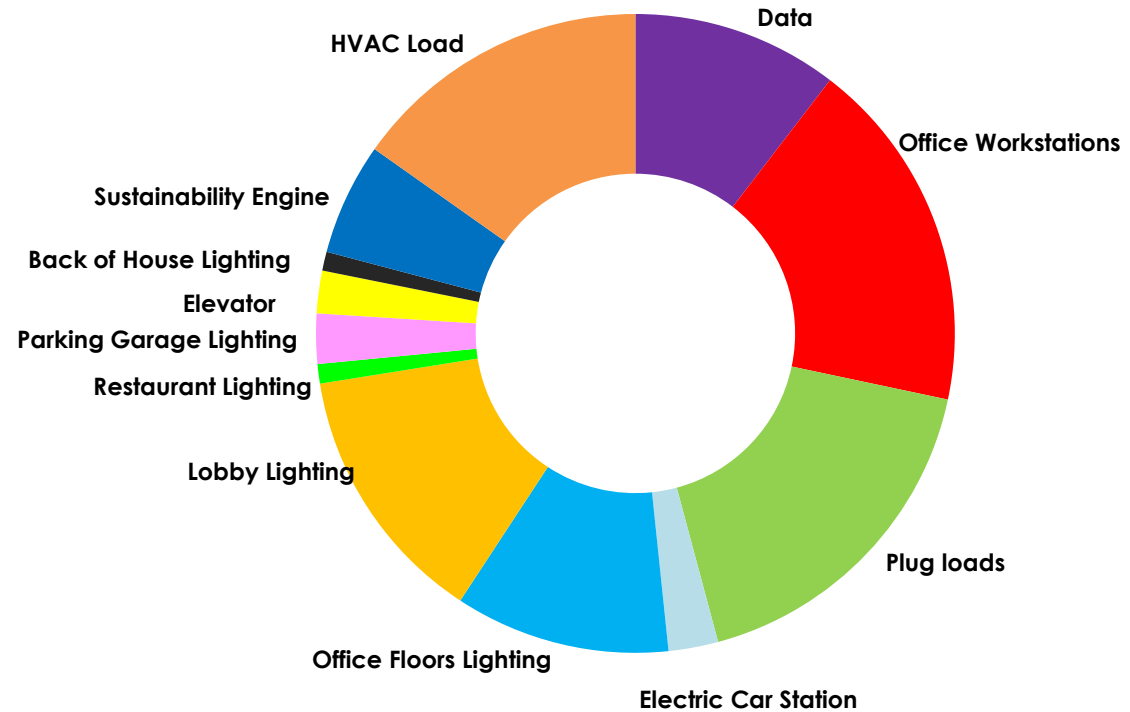
Electrical  
Construction  
Mechanical  
Structural

# Internal combustion electricity production will exceed building **electrical consumption** over the course of the year.

## Electrical Breakdown



## Building Electrical Usage per Year



BIM

Reduce

Produce

Apply

Sequencing

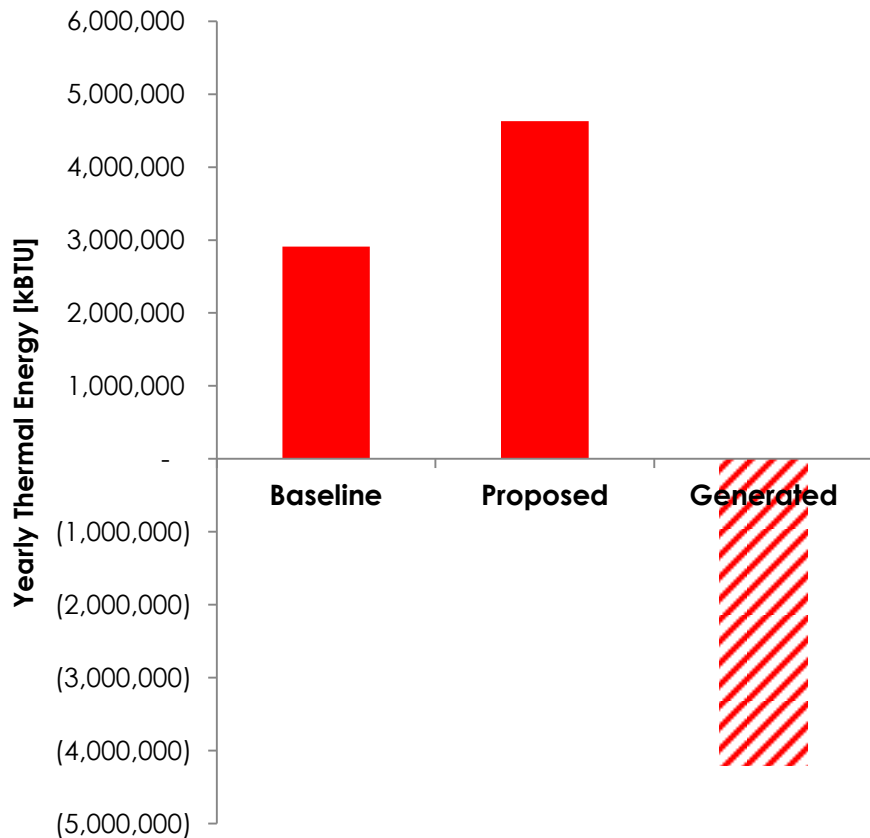
Performance Summary



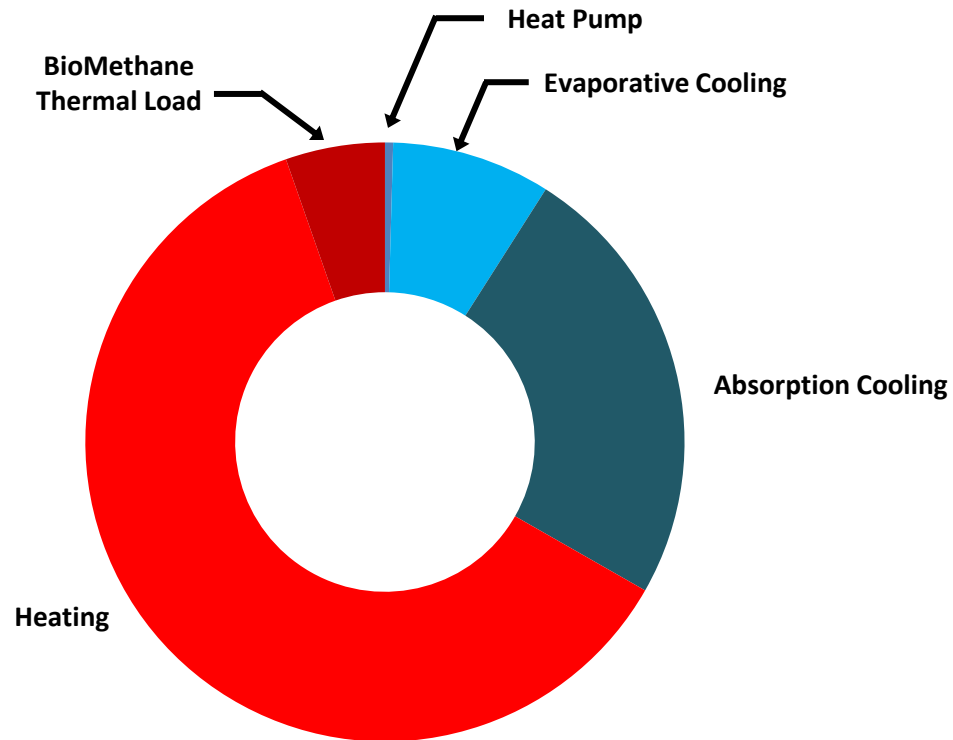
Electrical  
Construction  
Mechanical  
Structural

# Internal combustion electricity production will exceed building **electrical consumption** over the course of the year.

## Thermal Breakdown



## Building Thermal Usage per Year



BIM

Reduce

Produce

Apply

Sequencing

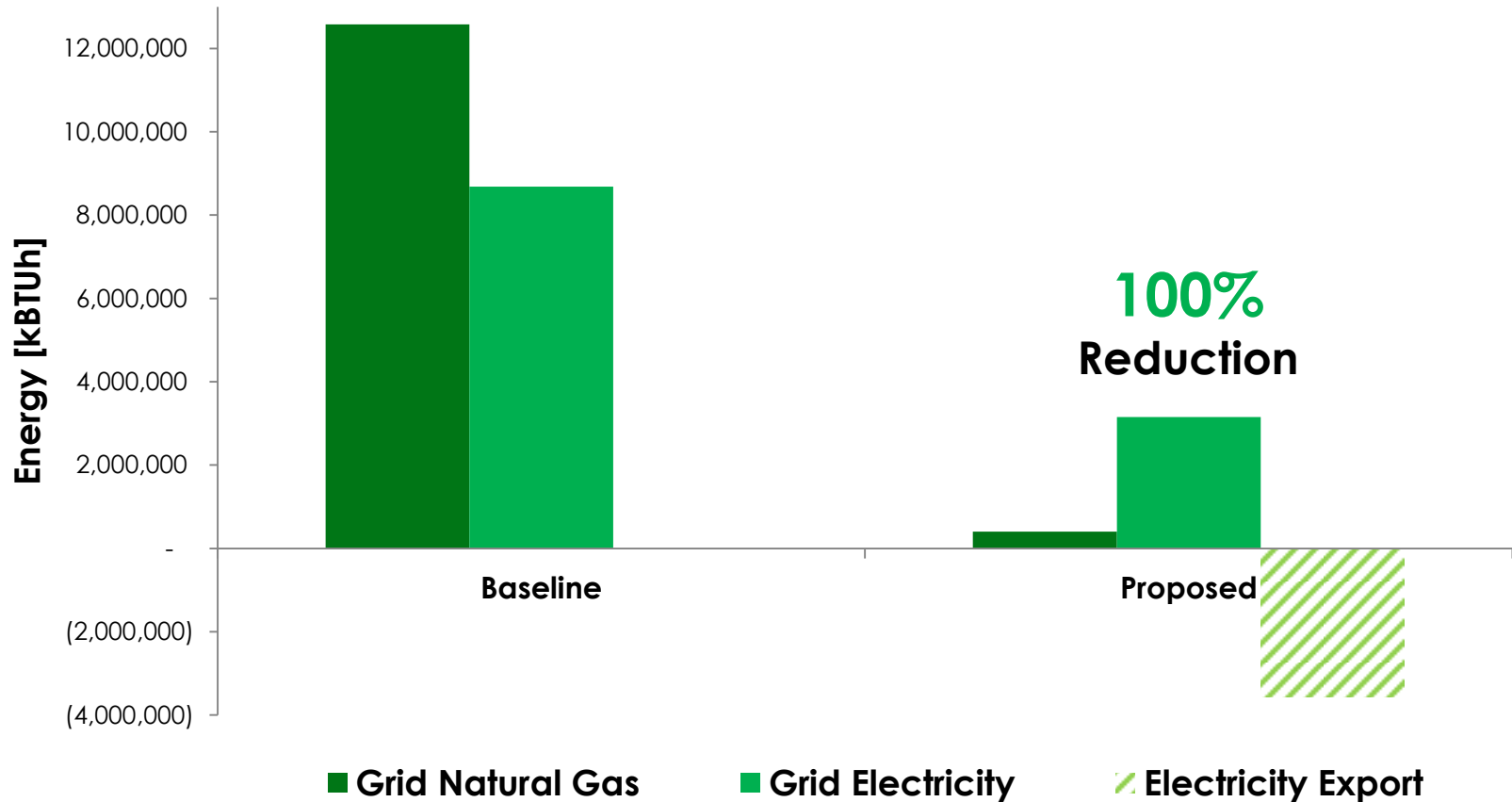
Performance Summary



Electrical  
Construction  
Mechanical  
Structural

Overall, **350 Mission exports more energy than it consumes.**

### 350 Mission Grid Energy Balance



BIM

Reduce

Produce

Apply

Sequencing

Performance Summary

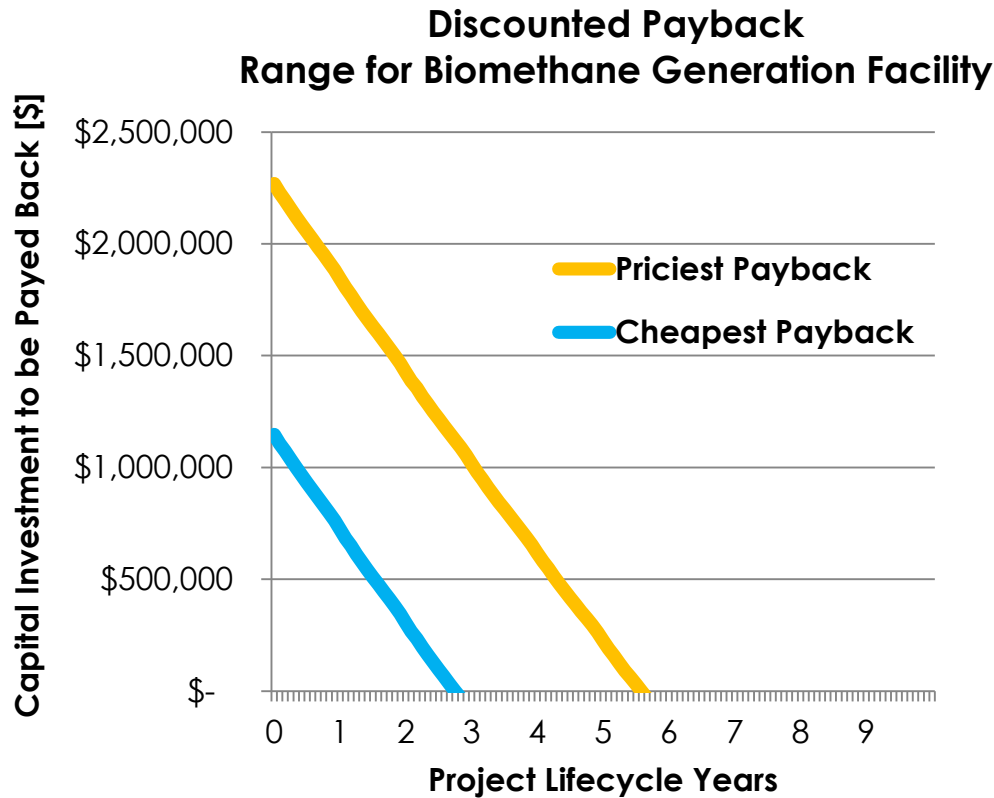


Electrical  
Construction  
Mechanical  
Structural



Over the life of the building, the energy-efficient technologies used will **save money and resources.**

Capital Investment Premium of **\$1,147,000 – \$2,270,00**



Detailed Monthly Profiles from IES

PG&E Utility Rates

NIST fuel escalation factors and discount rate

EPA Operations and Maintenance

BIM

Reduce

Produce

Apply

Sequencing

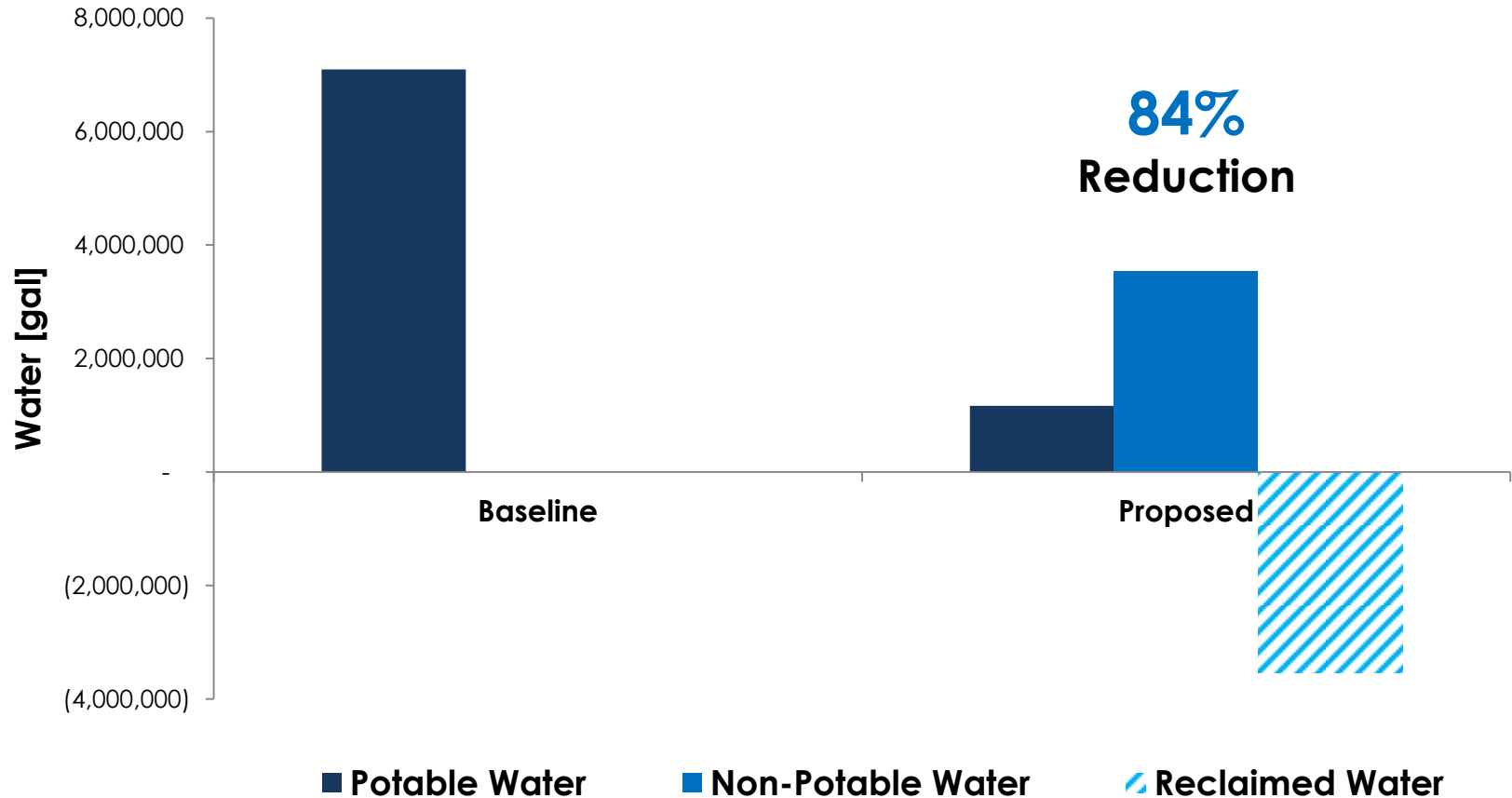
Performance Summary



Electrical  
Construction  
Mechanical  
Structural

The **overall resource use** of 350 Mission was significantly reduced.

### 350 Mission Water Balance



BIM

Reduce

Produce

Apply

Sequencing

Performance Summary



Electrical

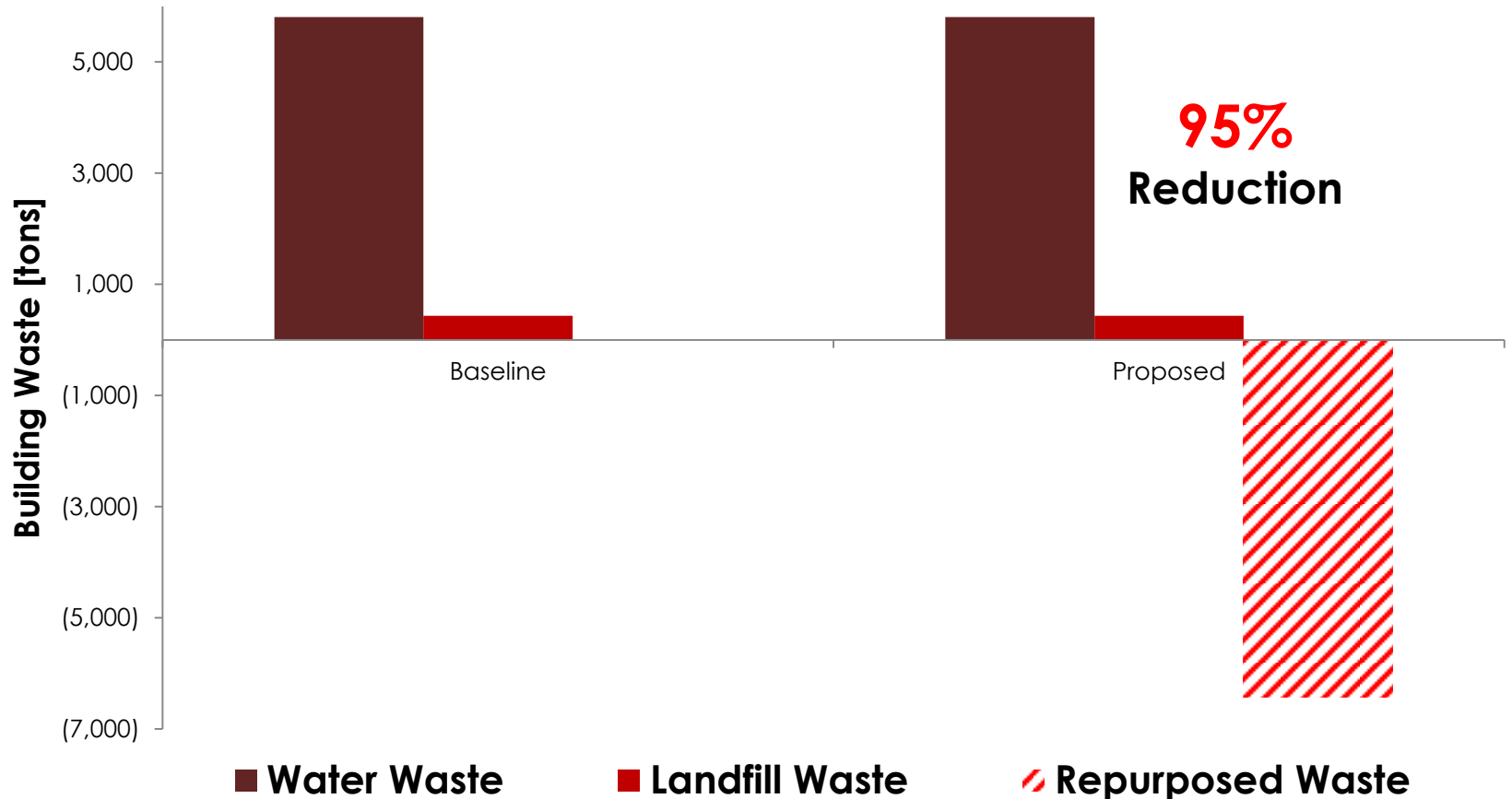
Construction

Mechanical

Structural

The **overall resource use** of 350 Mission was significantly reduced.

### 350 Mission Waste Balance



BIM

Reduce

Produce

Apply

Sequencing

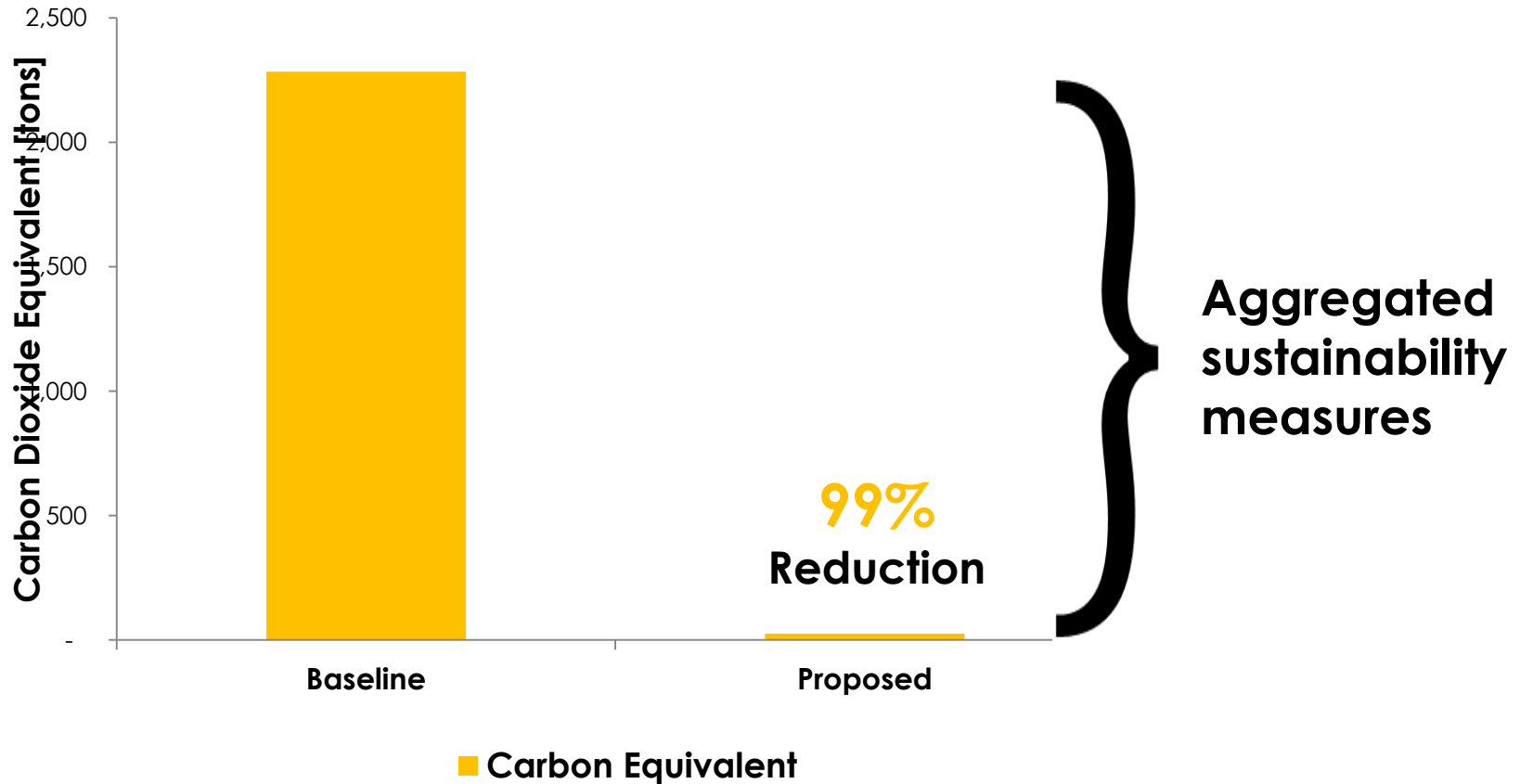
Performance Summary



Electrical  
Construction  
Mechanical  
Structural

The **overall resource use** of 350 Mission was significantly reduced.

### 350 Mission Emissions Balance



BIM

Reduce

Produce

Apply

Sequencing

Performance Summary



Electrical  
Construction  
Mechanical  
Structural

The **overall resource use** of 350 Mission was significantly reduced.

**100%** Energy Use Reduction

**84%** Water Use Reduction

**95%** Building Waste Reduction

**99%** Building Emissions Reduction

BIM

Reduce

Produce

Apply

Sequencing

Performance Summary



Electrical  
Construction  
Mechanical  
Structural

# **Endurance** guided the resilient design of 350 Mission



- **Near Immediate Occupancy**
- **Reliable Operation**
- **Enhanced Life Safety**
- **Indoor Air Quality**
- **Quality Control**

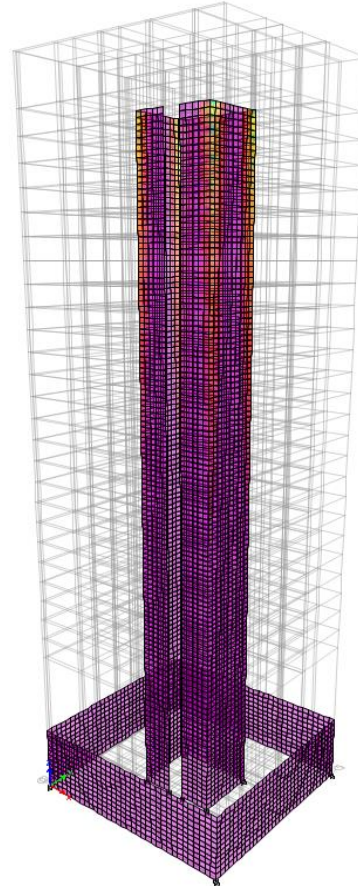
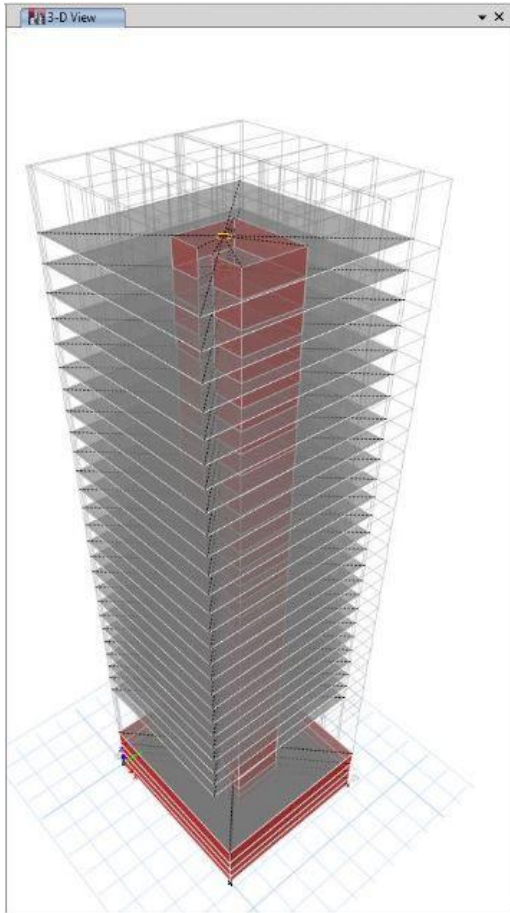




- **Near Immediate Occupancy**
  - Lateral System Design
  - MEP Resiliency
- Reliable Operation
- Enhanced Life Safety
- Indoor Air Quality
- Quality Control



**Preliminary analysis** of existing system gave a comparative baseline.



**Decision:**

**Seismic Weight Reduction** of Steel System

**Usable Space Gain** of Steel System

**Drift Reduction**

Near Immediate Occupancy

Reliable Operation

Enhanced Life Safety

Indoor Air Quality

Quality Control



Electrical  
Construction  
Mechanical  
Structural



# Extensive research and empirical evaluation narrowed down applicable systems.



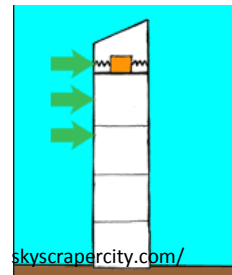
Steel Plate Shear Walls



Concentric/Eccentric Brace



Belt Truss



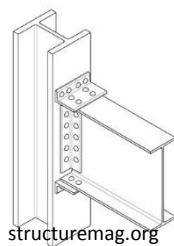
Tuned Mass Damper



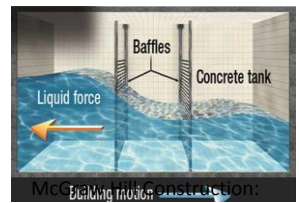
Buckling Restrained Brace Frames



Base Isolation



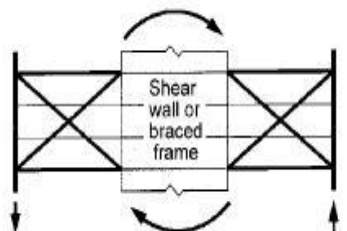
Special Steel Moment Frame



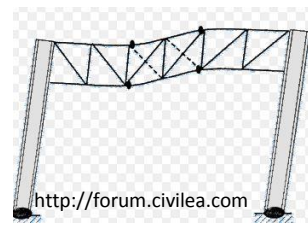
Tuned Liquid Damper



Concrete Shear Wall



Core & Outrigger



Special Steel Truss Moment Frame



Viscous Dampers

Near Immediate Occupancy

Reliable Operation

Enhanced Life Safety

Indoor Air Quality

Quality Control



Electrical  
Construction  
Mechanical  
Structural

# Extensive research and empirical evaluation narrowed down applicable systems.



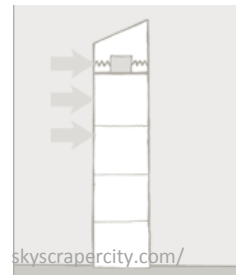
Steel Plate Shear Walls



Concentric/Eccentric Brace



Belt Truss



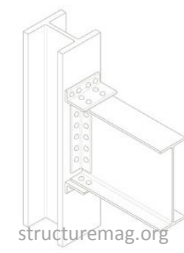
Tuned Mass Damper



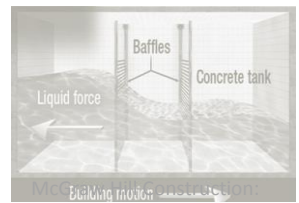
Buckling Restrained Brace Frames



Base Isolation



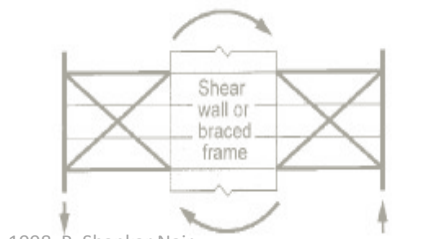
Special Steel Moment Frame



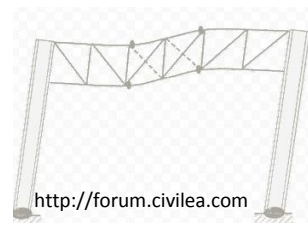
Tuned Liquid Damper



Concrete Shear Wall



Core & Outrigger



Special Steel Truss Moment Frame



Viscous Dampers

Near Immediate Occupancy

Reliable Operation

Enhanced Life Safety

Indoor Air Quality

Quality Control



Electrical  
Construction  
Mechanical  
Structural

# Re-examining goals leads to collaborative decision.

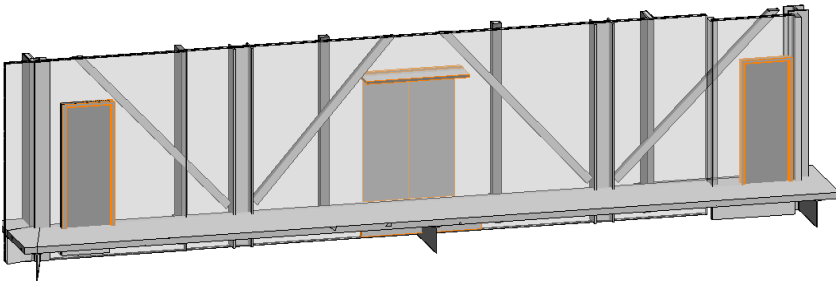
	Concrete Shear Wall with Post-Tension Slab	Base Isolation and Steel Plate Shear Walls	Braced Frame Core with Viscous Dampers
Pros	<ul style="list-style-type: none"> <li>- Contractor Familiarity</li> <li>- Ease of Construction</li> <li>- Cost Effective</li> <li>- Slab Thickness</li> </ul>	<ul style="list-style-type: none"> <li>- Durable and Reliable</li> <li>- Reduced Overturning Moment</li> <li>- Decreased Drift</li> <li>- Speedy Construction</li> <li>- Decreased Building Weight,</li> <li>- Increased Square Footage</li> </ul>	<ul style="list-style-type: none"> <li>- Reduced Seismic Weight</li> <li>- Steel Floor – Tenant Benefits</li> <li>- Coordination with MEP</li> <li>- Overturning Moment</li> <li>- Passive System Possibilities</li> <li>- Decreased Repair</li> </ul>
Cons	<ul style="list-style-type: none"> <li>- Slab Weight and Drift</li> <li>- Overturning Moment</li> <li>- Tenant Limitations</li> <li>- Slow Construction</li> <li>- Post-Event Occupancy</li> </ul>	<ul style="list-style-type: none"> <li>- Buffer Zone Required</li> <li>- Flexible Utility Entries</li> <li>- Unjustifiable Over-Design</li> <li>- MEP Coordination</li> <li>- Fabricator Issues</li> </ul>	<ul style="list-style-type: none"> <li>- Increased Initial Cost</li> <li>- Special Connections</li> <li>- Architectural Clashes</li> </ul>

Near Immediate Occupancy      Reliable Operation      Enhanced Life Safety      Indoor Air Quality      Quality Control

Electrical  
Construction  
Mechanical  
Structural

# Re-examining goals leads to collaborative decision.

	Concrete Shear Wall with Post-Tension Slab	Base Isolation and Steel Plate Shear Walls	Braced Frame Core with Viscous Dampers
Pros	<ul style="list-style-type: none"> <li>- Contractor Familiarity</li> <li>- Ease of Construction</li> <li>- Cost Effective</li> <li>- Slab Thickness</li> </ul>	<ul style="list-style-type: none"> <li>- Durable and Reliable</li> <li>- Reduced Overturning Moment</li> <li>- Decreased Drift</li> <li>- Speedy Construction</li> <li>- Decreased Building Weight,</li> <li>- Increased Square Footage</li> </ul>	<ul style="list-style-type: none"> <li>- Reduced Seismic Weight</li> <li>- Steel Floor – Tenant Benefits</li> <li>- Coordination with MEP</li> <li>- Overturning Moment</li> <li>- Passive System Possibilities</li> <li>- Decreased Repair</li> </ul>
Cons	<ul style="list-style-type: none"> <li>- Slab Weight and Drift</li> <li>- Overturning Moment</li> <li>- Tenant Limitations</li> <li>- Slow Construction</li> <li>- Post-Event Occupancy</li> </ul>	<ul style="list-style-type: none"> <li>- Buffer Zone Required</li> <li>- Flexible Utility Entries</li> <li>- Unjustifiable Over-Design</li> <li>- MEP Coordination</li> <li>- Fabricator Issues</li> </ul>	<ul style="list-style-type: none"> <li>- Increased Initial Cost</li> <li>- Special Connections</li> <li>- Architectural Clashes</li> </ul>



Core Opening Coordination

0	+1	+1

+1	+2	+1	+1
Electrical	Construction	Mechanical	Structural

Near Immediate Occupancy	Reliable Operation	Enhanced Life Safety	Indoor Air Quality	Quality Control
--------------------------	--------------------	----------------------	--------------------	-----------------

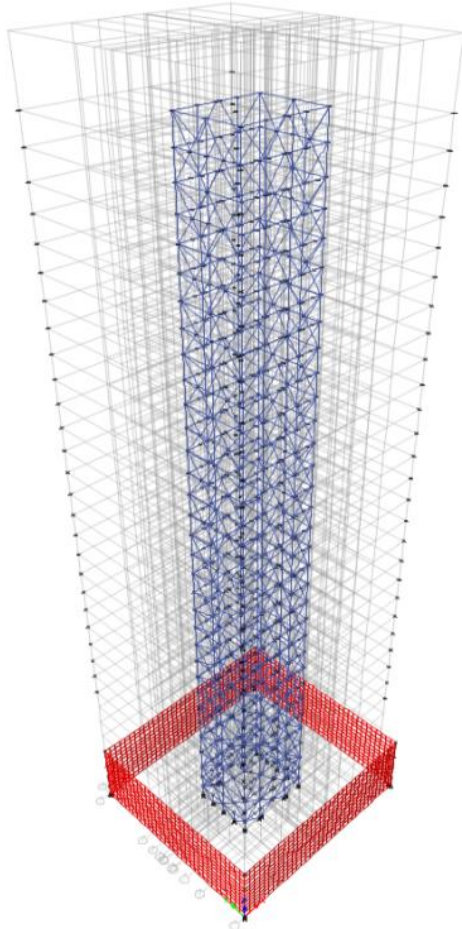
Electrical

Construction

Mechanical

Structural

# Continual evaluation of Concentrically Braced Frame Core shows room for improvement.



$$T_y = 3.863s$$

$$T_x = 2.339s$$

$$T_x = 2.433s$$

Smallest Brace: **W12x96**

Largest Brace: **W36x652**

**UNACCEPTABLE**

Near Immediate Occupancy

Reliable Operation

Enhanced Life Safety

Indoor Air Quality

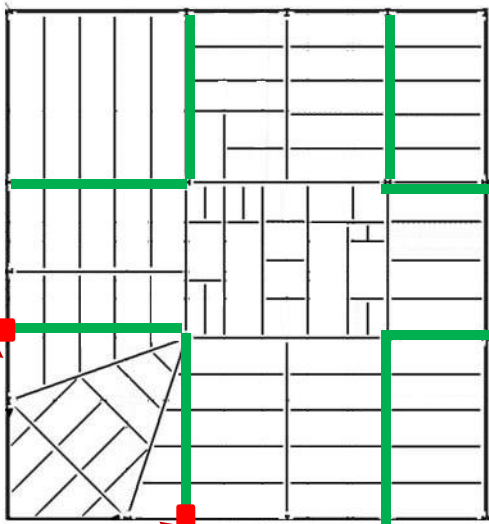
Quality Control



Electrical  
Construction  
Mechanical  
Structural

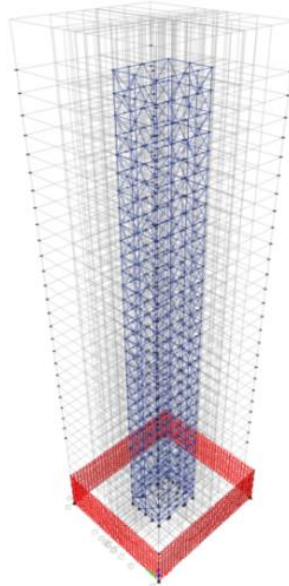
# Again re-evaluation of team goals leads to **integrated decision.**

Outrigger Location Schematic

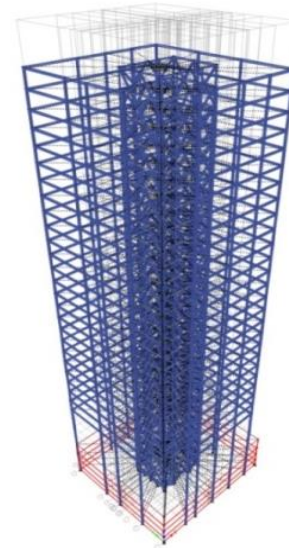


Not column locations!

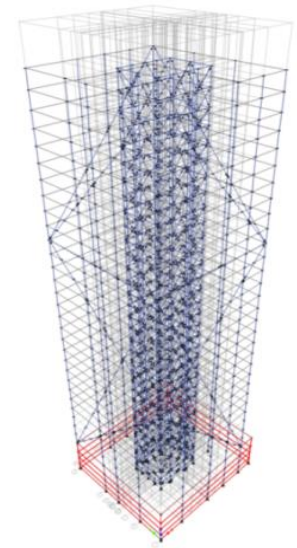
Braced Frame Core



Perimeter Moment Frame



Exterior Mega Braces



Near Immediate Occupancy

Reliable Operation

Enhanced Life Safety

Indoor Air Quality

Quality Control

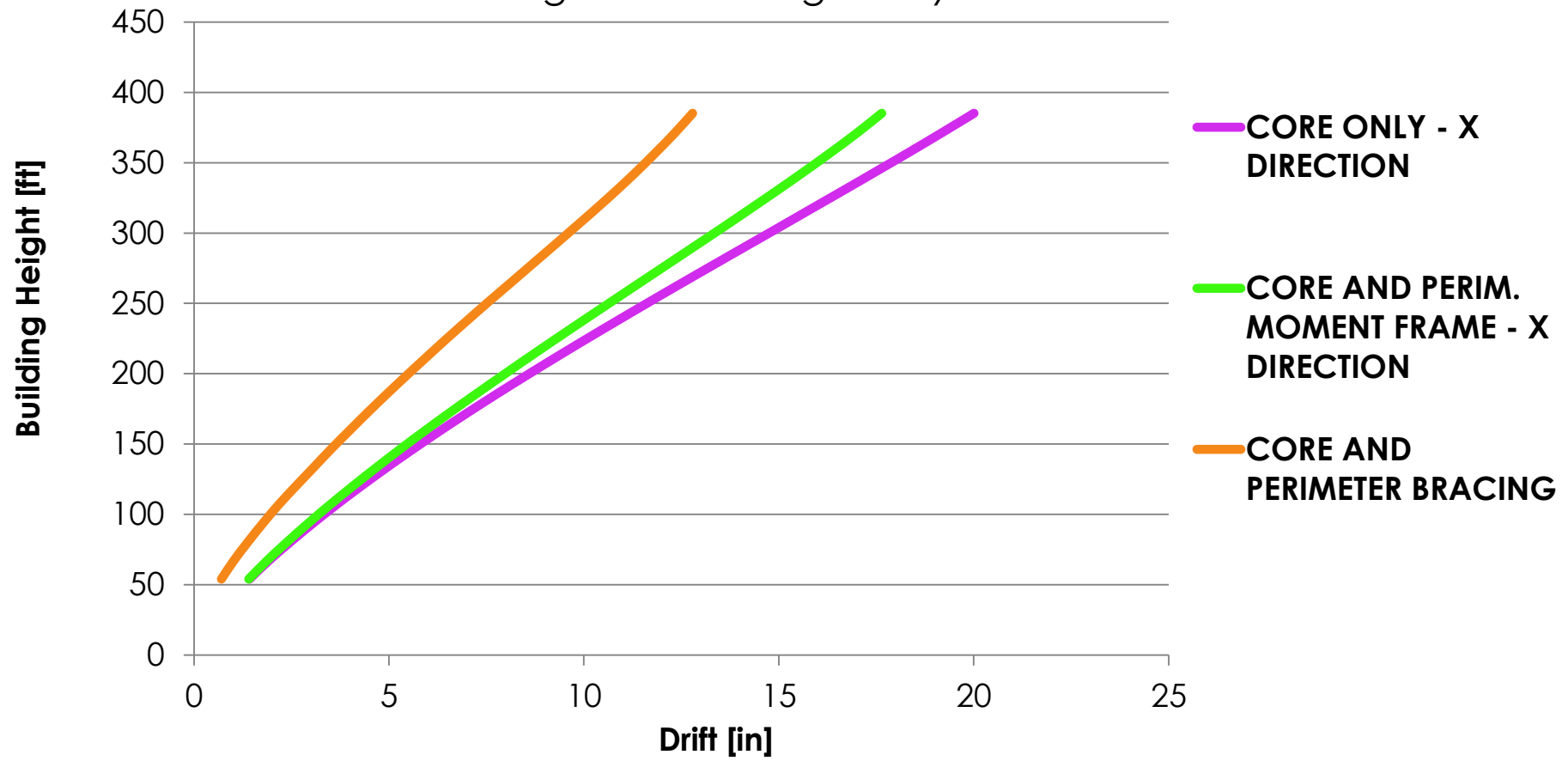


Electrical  
Construction  
Mechanical  
Structural

# Again re-evaluation of team goals leads to **integrated** decision.

### Drift vs. Building Height

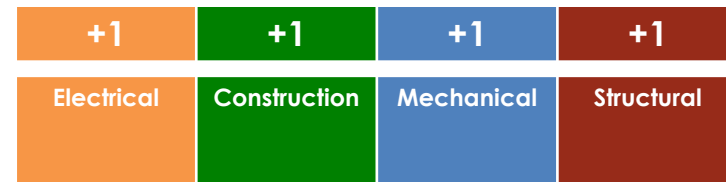
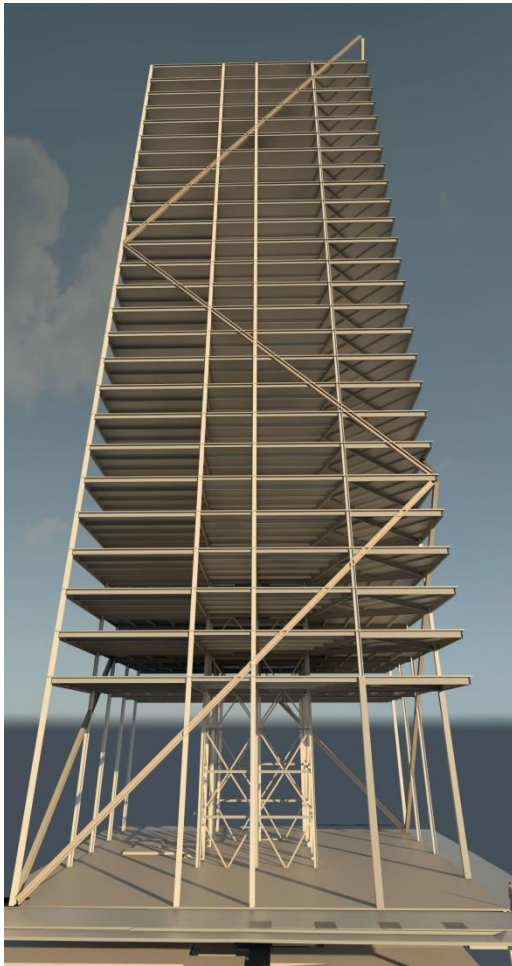
*Designed for strength only*



Near Immediate Occupancy	Reliable Operation	Enhanced Life Safety	Indoor Air Quality	Quality Control
--------------------------	--------------------	----------------------	--------------------	-----------------

Electrical  
Construction  
Mechanical  
Structural

# Re-evaluation of team goals led to an **integrated decision.**



*Good drift control*

*Good MEP coordination*

*Good for rapid constructability*

*Good for seismic resilience*

*Good for Architectural Enhancement*

Near Immediate Occupancy

Reliable Operation

Enhanced Life Safety

Indoor Air Quality

Quality Control



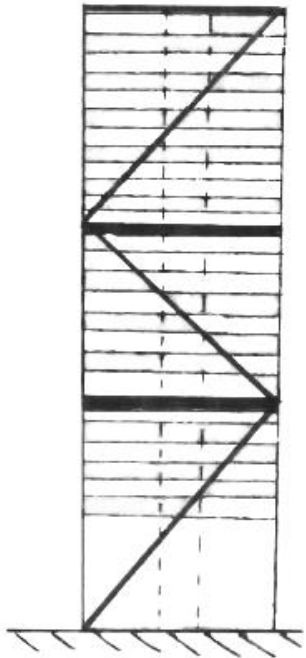
Electrical  
Construction  
Mechanical  
Structural



First the **load path** of the complete lateral system was identified.

## LOAD PATH SKETCH

PRIMARY  
SYSTEM



Near Immediate Occupancy

Reliable Operation

Enhanced Life Safety

Indoor Air Quality

Quality Control

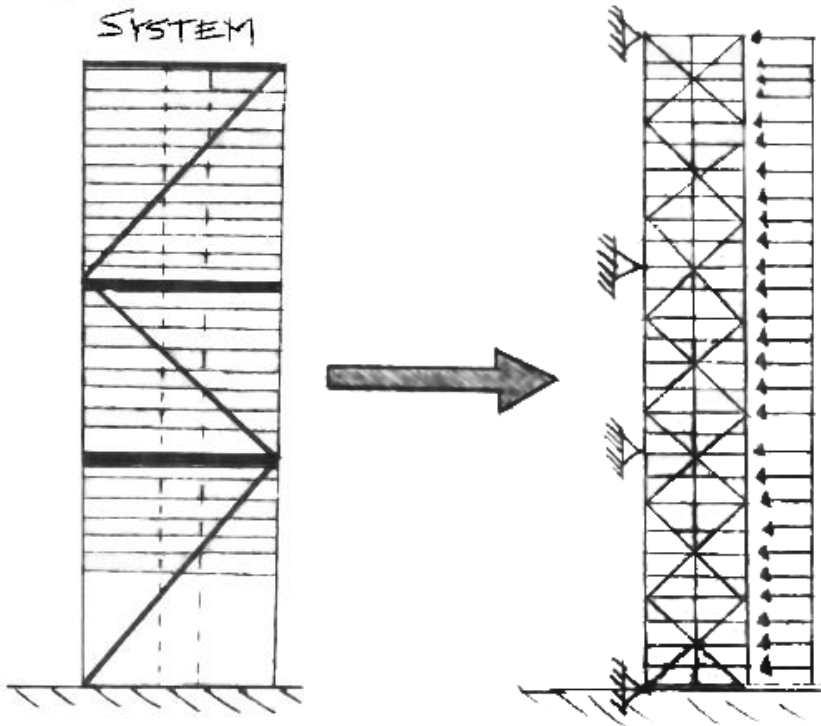


Electrical  
Construction  
Mechanical  
Structural

First the **load path** of the complete lateral system was identified.

## LOAD PATH SKETCH

PRIMARY SYSTEM



Near Immediate Occupancy

Reliable Operation

Enhanced Life Safety

Indoor Air Quality

Quality Control

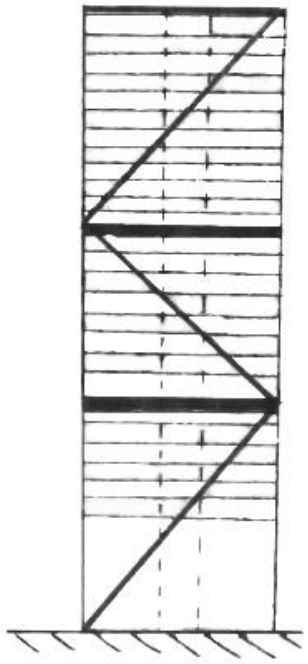


Electrical  
Construction  
Mechanical  
Structural

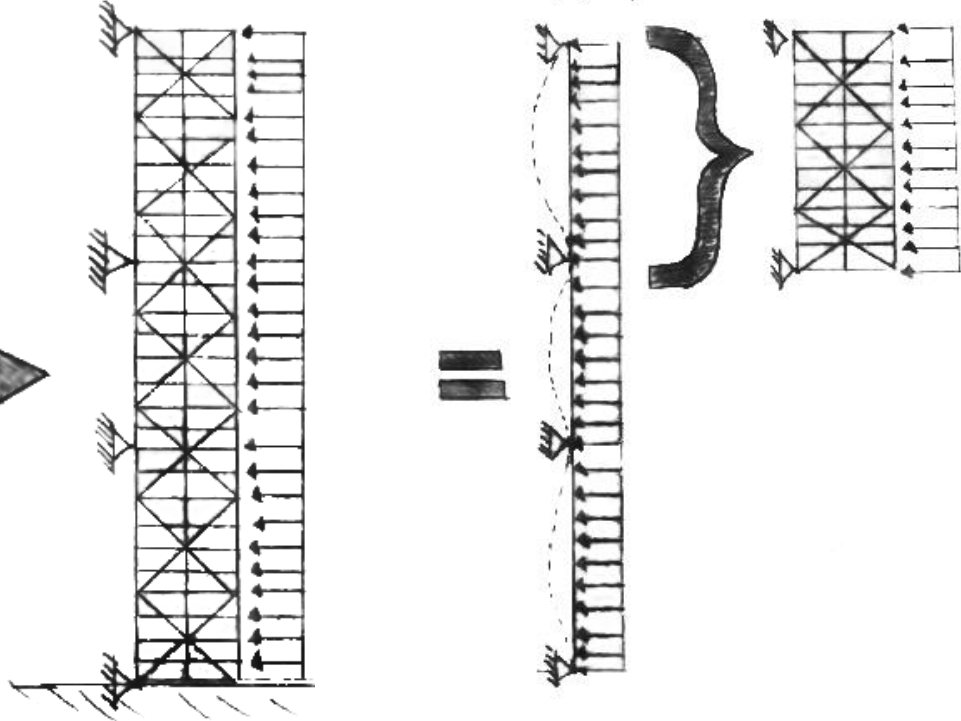
First the **load path** of the complete lateral system was identified.

# LOAD PATH SKETCH

PRIMARY SYSTEM



SECONDARY SYSTEM



Near Immediate Occupancy

Reliable Operation

Enhanced Life Safety

Indoor Air Quality

Quality Control

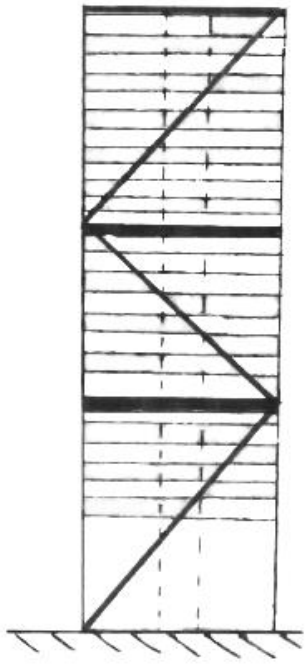


Electrical  
Construction  
Mechanical  
Structural

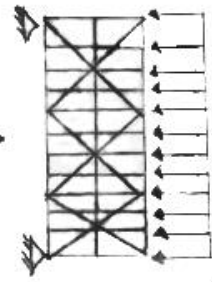
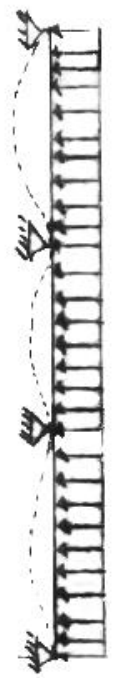
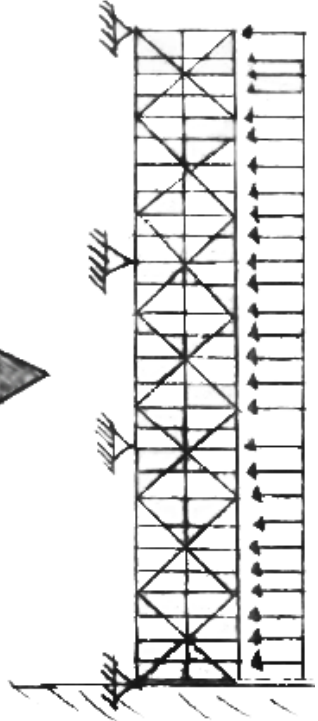
First the **load path** of the complete lateral system was identified.

# LOAD PATH SKETCH

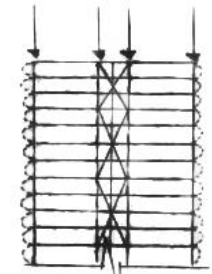
PRIMARY SYSTEM



SECONDARY SYSTEM



GRAVITY LOADS



K=1 FOR PERIMETER COLUMNS

Near Immediate Occupancy

Reliable Operation

Enhanced Life Safety

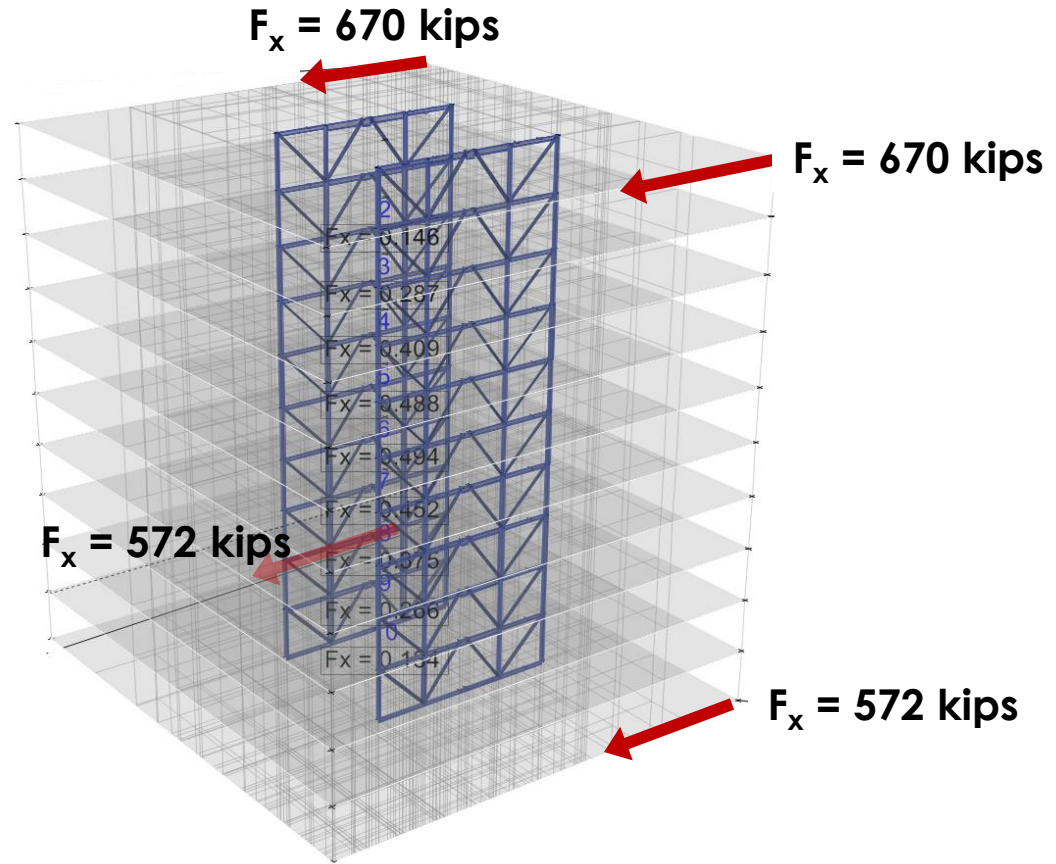
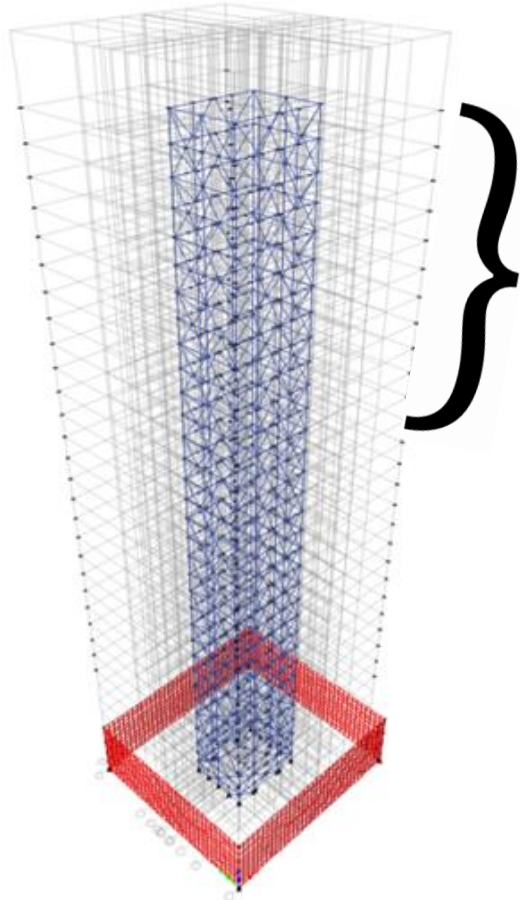
Indoor Air Quality

Quality Control



Electrical  
Construction  
Mechanical  
Structural

# Preliminary sizes obtained with restrained **Core Design** Modules.



Near Immediate Occupancy

Reliable Operation

Enhanced Life Safety

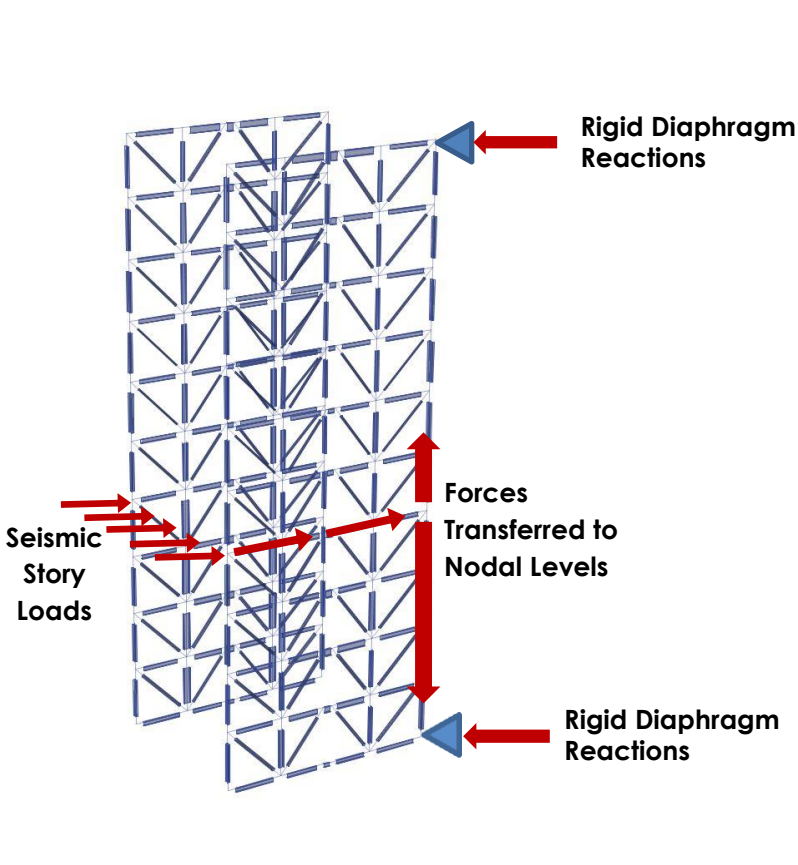
Indoor Air Quality

Quality Control



Electrical  
Construction  
Mechanical  
Structural

# Preliminary exterior mega brace sizes obtained with Core Design Module **Reactions.**



### Tension

Input	
$\phi_y =$	0.9
$\phi_r =$	0.75
$F_y =$	50 ksi
$F_u =$	65 ksi
$P_u =$	5057.27 kips
$A_g =$	147 in <sup>2</sup>
$A_e =$	110 in <sup>2</sup>
Output	
Rupture:	$\phi P_n = 5362.5$
Yield:	$\phi P_n = 6615$
Use:	W14X500

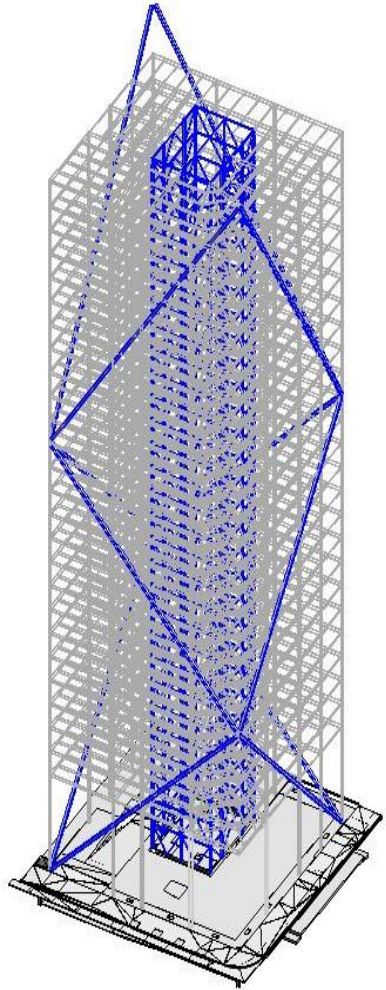
### Compression

Input	
$A_g =$	134 in <sup>2</sup>
$k =$	1
$L =$	209.64 in
$r_y =$	4.38 in
$P_u =$	5057.27 kips
Output	
$kL/(r_y) =$	47.863
$F_e =$	124.939 ksi
$4.71(E/F_y)$	113.432
$F_{cr} =$	42.2887 ksi
$\phi P_n =$	5100.02 kips
$P_u < \phi P_n?$	YES

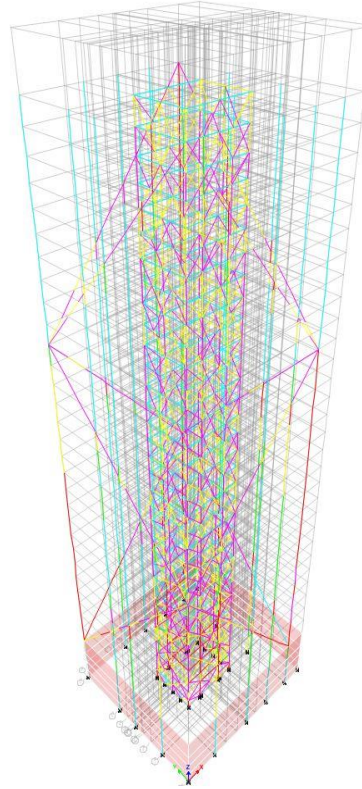
| Green = Input | Red = Output |

Core Seismic Force Schematic

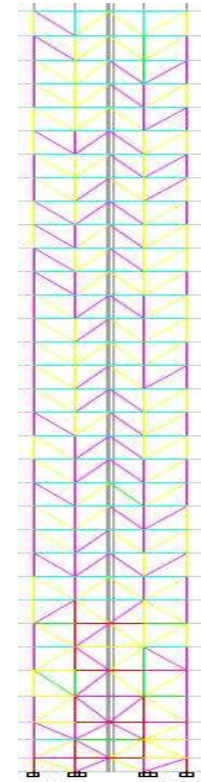
# Total lateral system was put back together and reanalyzed.



Structural Revit Model

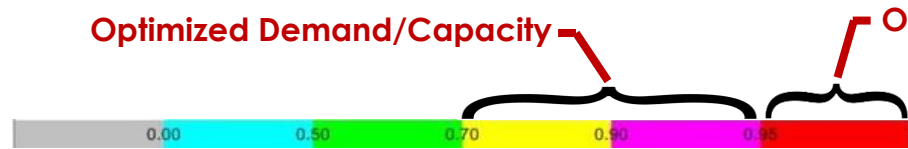


Lateral System ETABS Model  
3D View



Lateral System ETABS Model  
North Core Elevation

Optimized Demand/Capacity Overstressed



Near Immediate Occupancy

Reliable Operation

Enhanced Life Safety

Indoor Air Quality

Quality Control



Electrical  
Construction  
Mechanical  
Structural

# Total lateral system was put back together and reanalyzed.

## Core Only vs. Core with Mega Braces

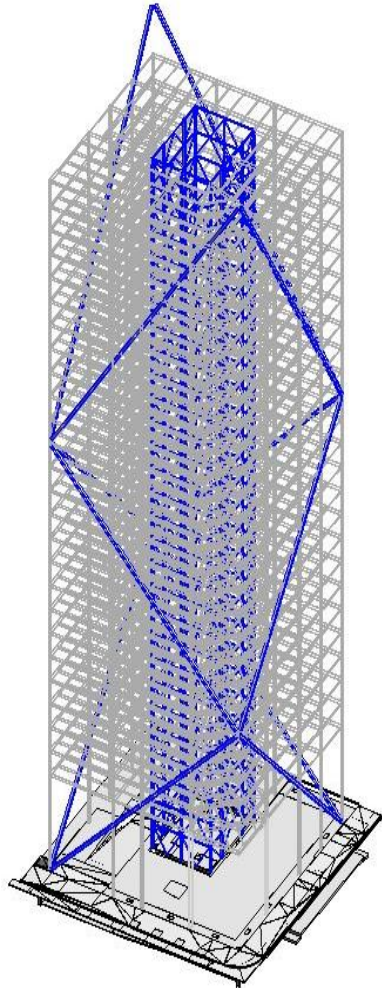
Successfully met 50% High Performance Drift Requirement

48% Reduction in steel weight

\$8,600,000 savings

24-inch core thickness reduction

9,100 SF rentable space increase



Structural Revit Model

Near Immediate Occupancy

Reliable Operation

Enhanced Life Safety

Indoor Air Quality

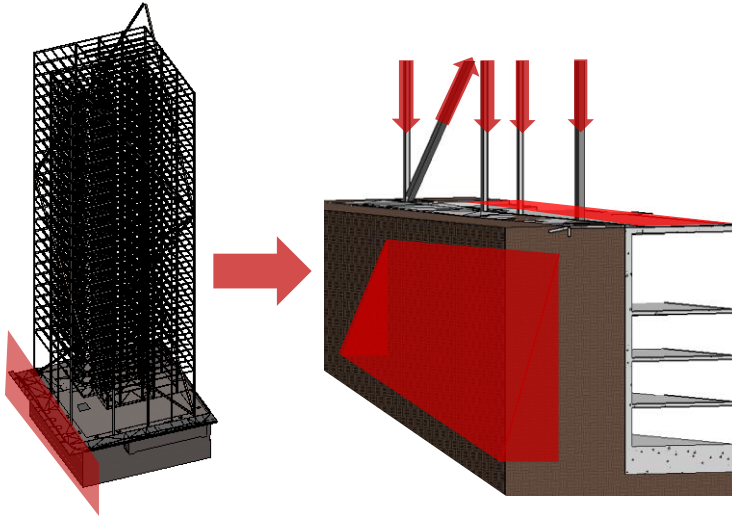
Quality Control



Electrical  
Construction  
Mechanical  
Structural



**Perimeter foundation walls** complete the load path as shear and retaining walls.



Near Immediate Occupancy

Reliable Operation

Enhanced Life Safety

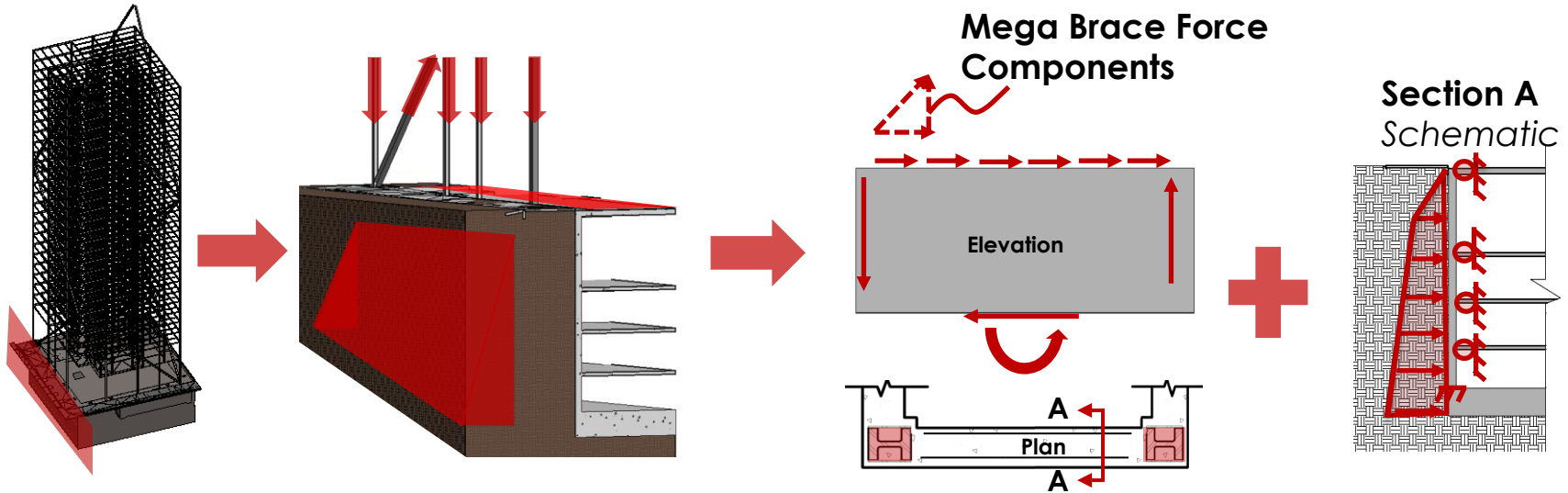
Indoor Air Quality

Quality Control



Electrical  
Construction  
Mechanical  
Structural

# Perimeter foundation walls complete the load path as shear and retaining walls.



Near Immediate Occupancy

Reliable Operation

Enhanced Life Safety

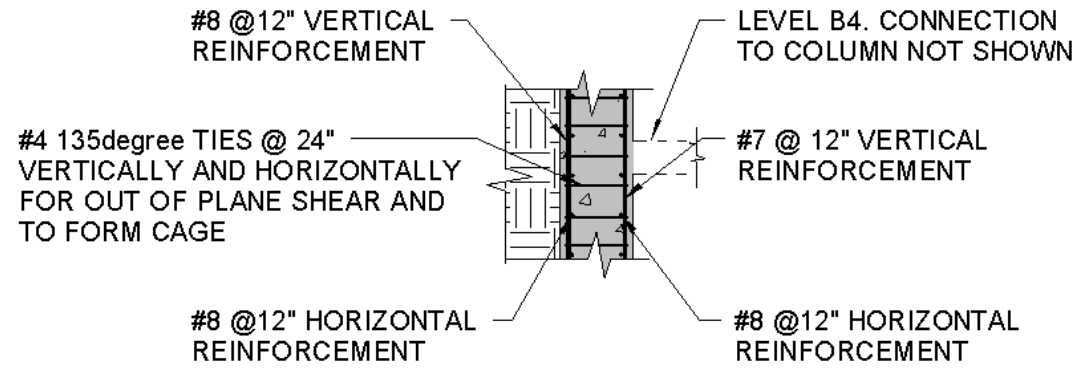
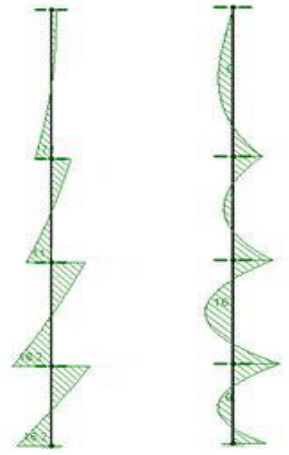
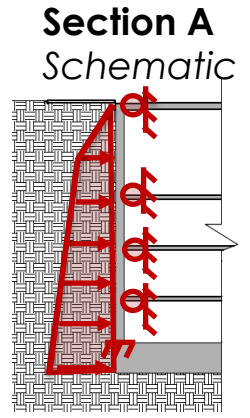
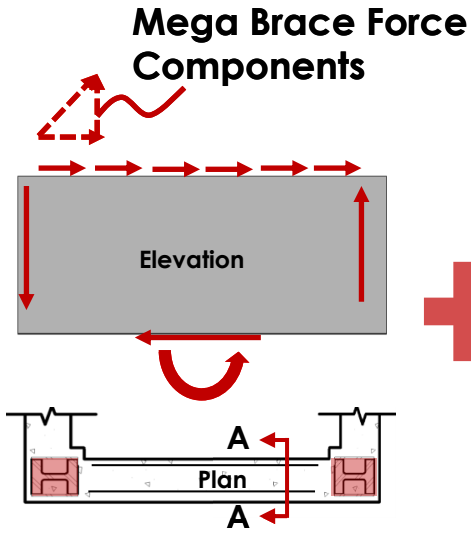
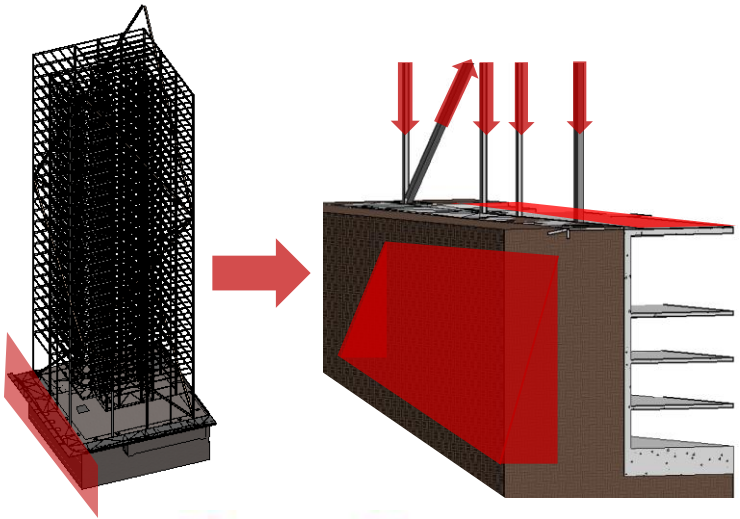
Indoor Air Quality

Quality Control



Electrical  
Construction  
Mechanical  
Structural

# Perimeter foundation walls complete the load path as shear and retaining walls.



**Foundation Wall Shear and Moment Diagrams**

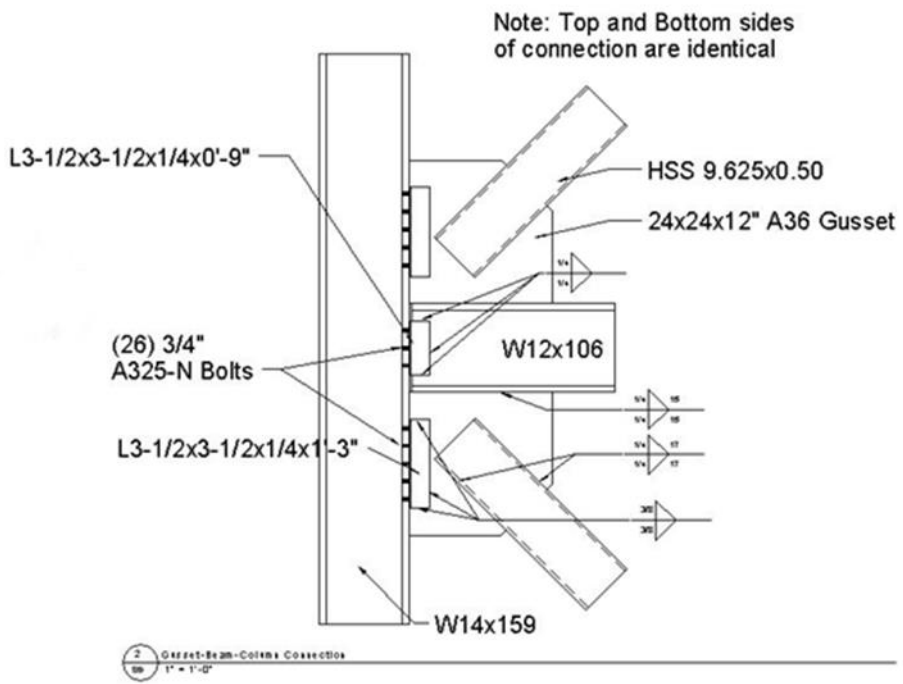
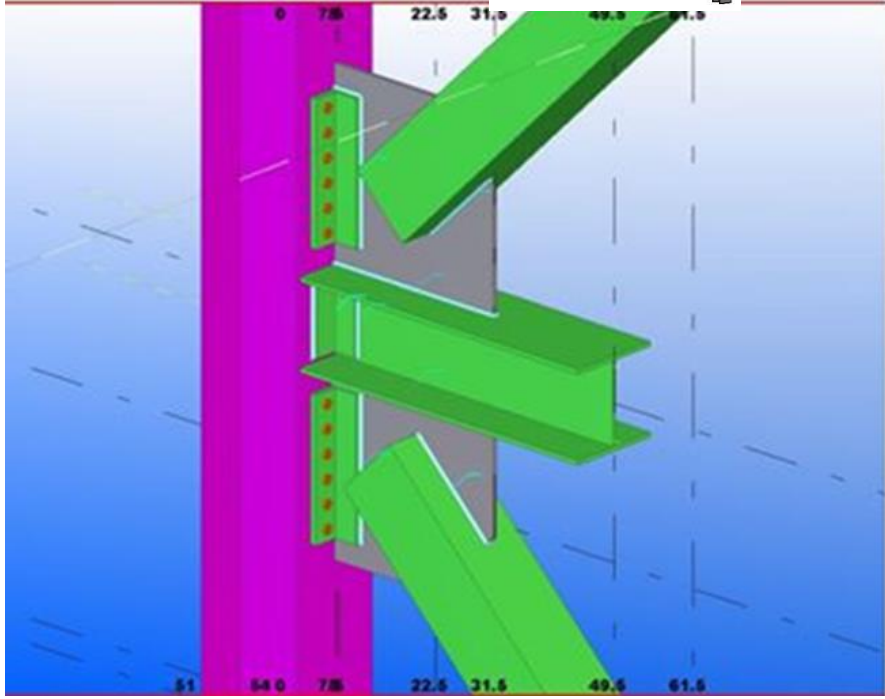
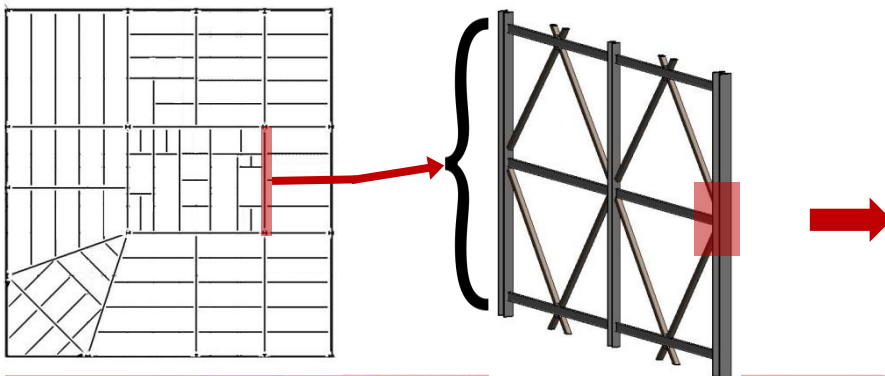
**Foundation Wall Detail**

Near Immediate Occupancy	Reliable Operation	Enhanced Life Safety	Indoor Air Quality	Quality Control
--------------------------	--------------------	----------------------	--------------------	-----------------



Electrical  
Construction  
Mechanical  
Structural

# Lateral connections were detailed and modeled in TEKLA.



Near Immediate Occupancy

Reliable Operation

Enhanced Life Safety

Indoor Air Quality

Quality Control

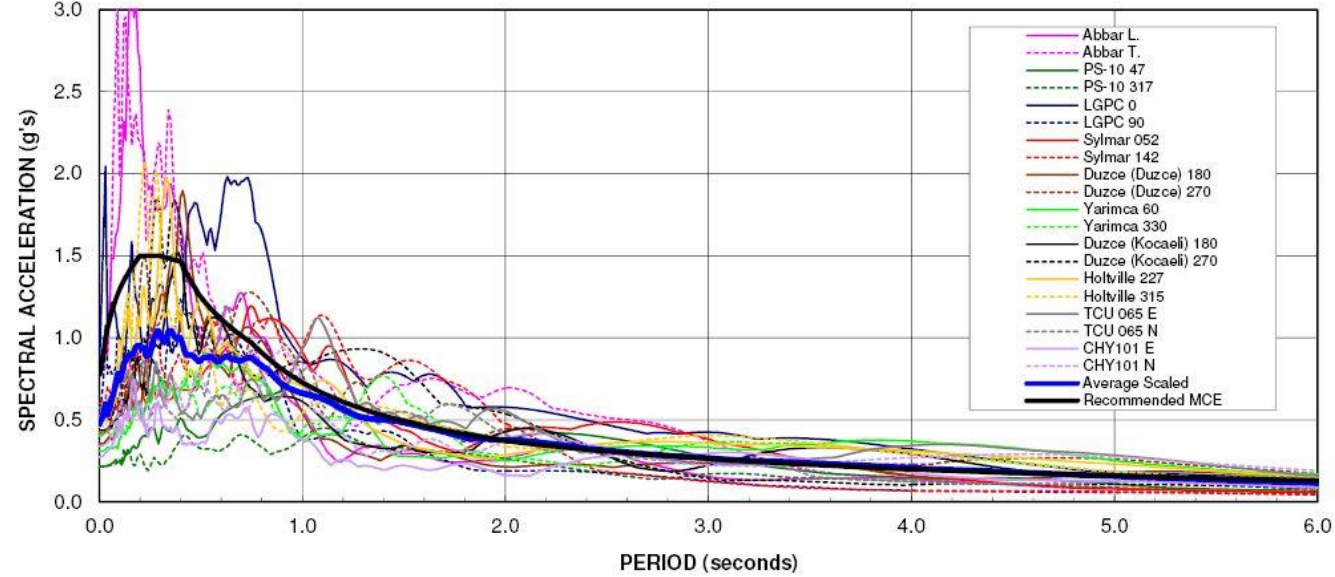


Electrical  
Construction  
Mechanical  
Structural

# Additional Linear Time History Analysis confirms and reveals areas for improvement.



Sample Response Spectra Scaled and Brought into ETABS



Scaled MCE Spectra Provided by Geotechnical Report

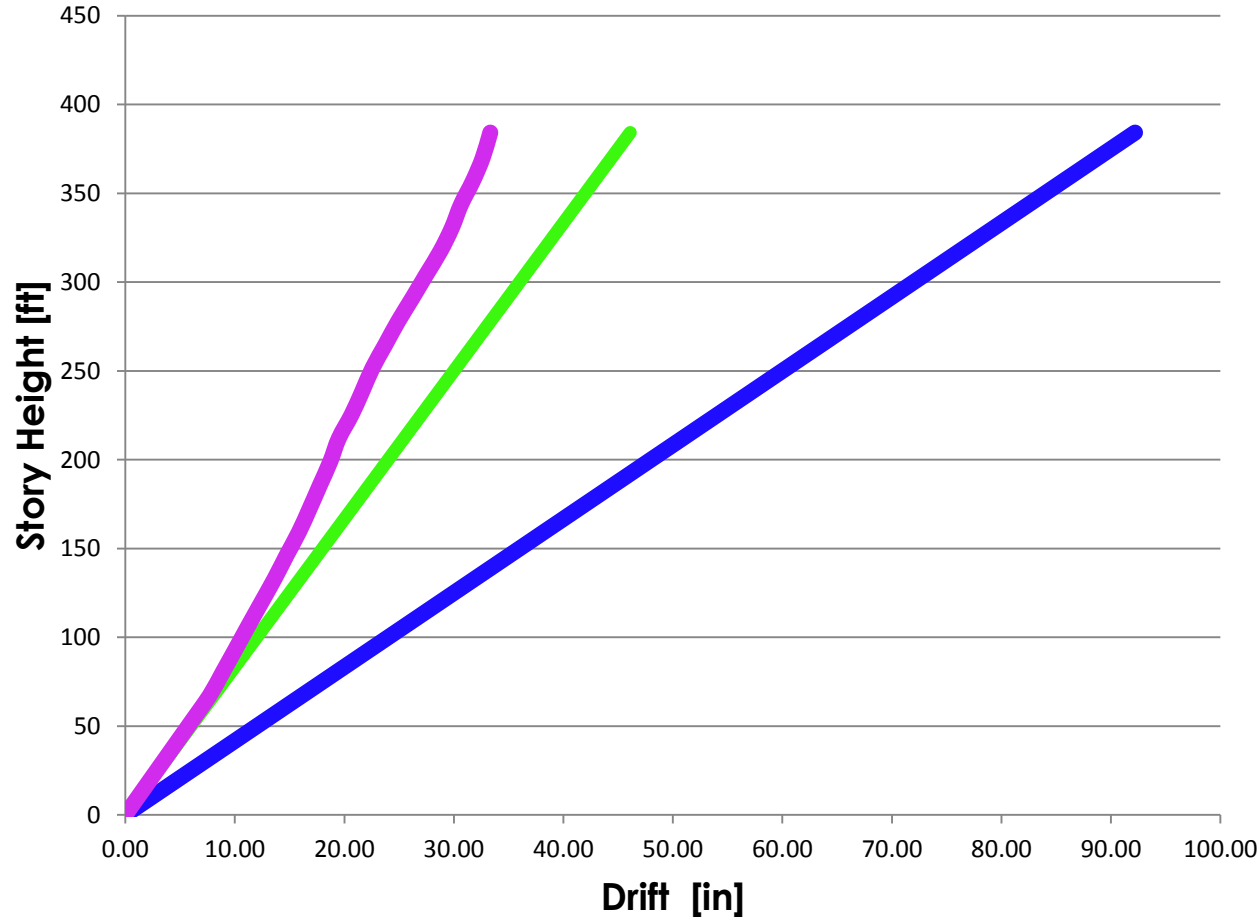
Near Immediate Occupancy | Reliable Operation | Enhanced Life Safety | Indoor Air Quality | Quality Control



Electrical  
Construction  
Mechanical  
Structural

# Additional Linear Time History Analysis confirms and reveals areas for improvement.

## Drift Comparison Verification



- Code Allowable Drift
- High Performance Allowable Drift
- MRSA Drift

Near Immediate Occupancy

Reliable Operation

Enhanced Life Safety

Indoor Air Quality

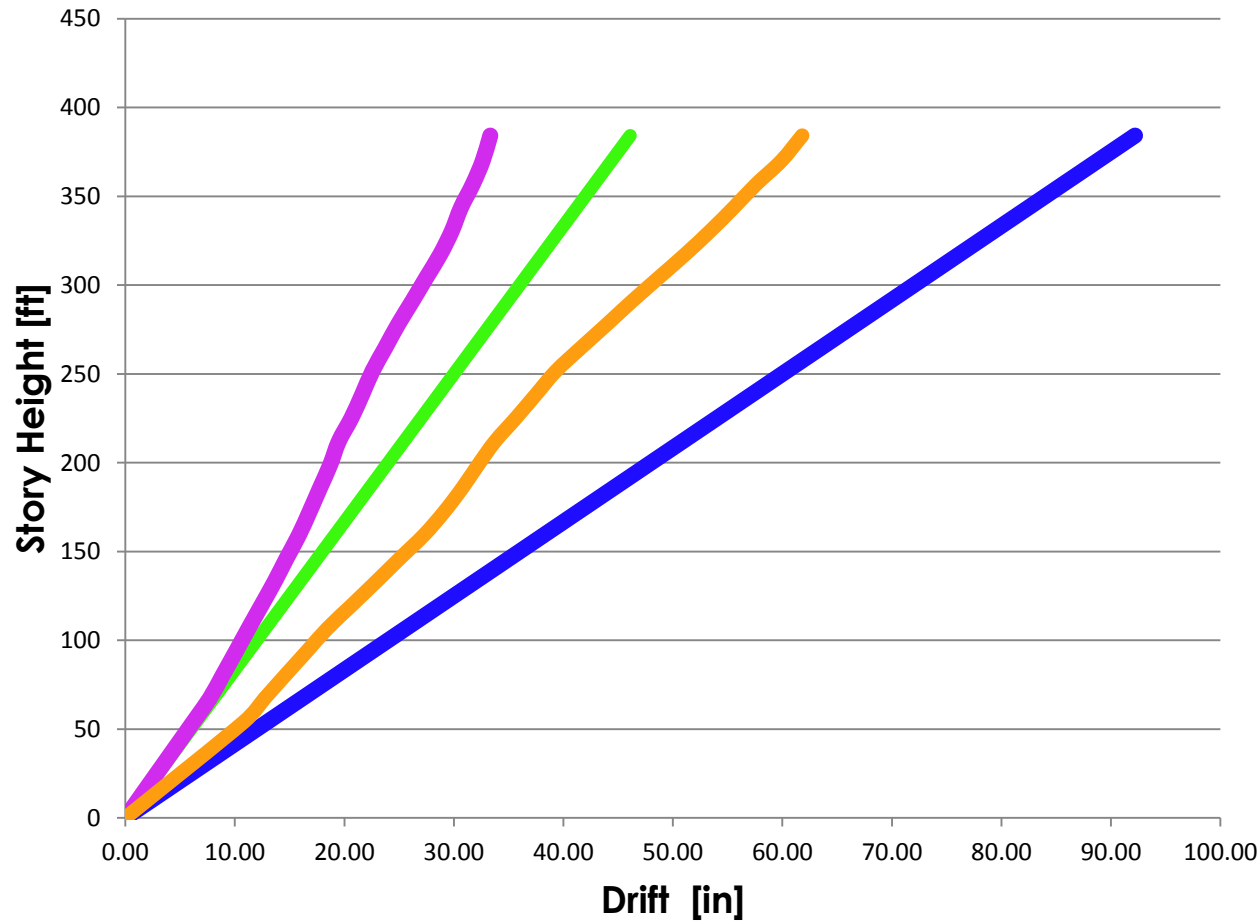
Quality Control



Electrical  
Construction  
Mechanical  
Structural

# Additional Linear Time History Analysis confirms and reveals areas for improvement.

### Drift Comparison Verification



- Code Allowable Drift
- High Performance Allowable Drift
- MRSA Drift
- LTH Drift

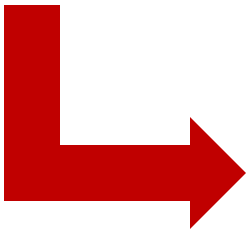
Near Immediate Occupancy | Reliable Operation | Enhanced Life Safety | Indoor Air Quality | Quality Control



Electrical  
Construction  
Mechanical  
Structural

# Additional Linear Time History Analysis confirms and reveals areas for improvement.

X-Direction - Modal Properties per Mode								
Property		Mode						SRSS
		1	2	3	4	5	6	
Damping Properties	$D_{mM}$	0.622857	6.31838	5.382534	1.636179	1.057322	0.917886	8.59762
	$W_m(k)$	3367.2	3367.2	3367.2	3367.2	3367.2	3367.2	8247.922
	$\beta_1$	30	30	30	30	30	30	
	$\beta_{HD}$	74.85445	78.75197	79.75331	157.04	219.4036	236.1687	
	$\beta_{HM}$	15.5866	16.39816	16.60666	32.69972	45.68541	49.17632	
	$\beta_{Vm,req}$	0.159155	0.159155	0.159155	0.159155	0.159155	0.159155	
	$\Sigma W_{m,j}$	4293.766	3816.252	6791.079	4225.699	4607.596	4386.693	11723.84



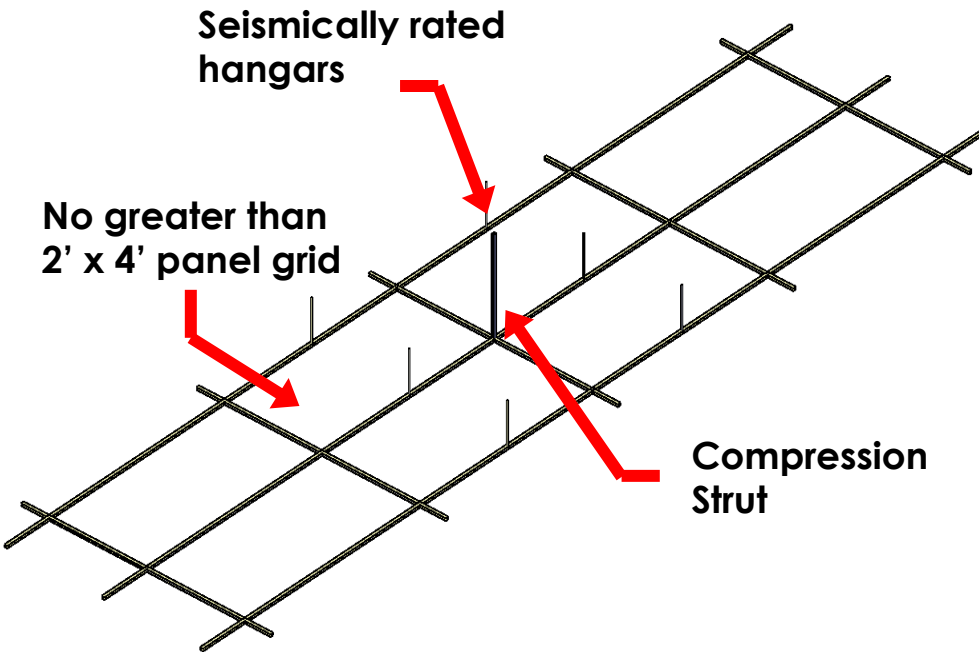
X-Direction - Damper Forces, Level 30						
Total Required Damping Force per Story = $Sf_{30} =$						3158.512 kips
Frame #	Bay	# of dampers ( $n_i$ )	$q_i$ (deg)	$N=n_i \cos(q_i)$	$F_{pseudo} (k) = Sf_{30}/SN$	$F_i(k) = F_{pseudo} * (16.3342' / 9.667')$
1		1	0	1	394.8141	667.112
2		2	0	2		667.112
3		1	0	1		667.112
4		1	0	1		667.112
5		2	0	2		667.112
6		1	0	1		667.112

Near Immediate Occupancy      Reliable Operation      Enhanced Life Safety      Indoor Air Quality      Quality Control

Electrical  
Construction  
Mechanical  
Structural



# Seismic design of MEP components allow for all systems to remain in operation during a seismic event.



Seismically-braced suspended ceiling



Seismically-decoupled lighting

Near Immediate Occupancy

Reliable Operation

Enhanced Life Safety

Indoor Air Quality

Quality Control



Electrical  
Construction  
Mechanical  
Structural

# Endurance guided the resilient design of 350 Mission



- Near Immediate Occupancy
- **Reliable Operation**
  - Equipment Maintainability
  - Power Distribution
  - Building Enclosure
- Enhanced Life Safety
- Indoor Air Quality
- Quality Control



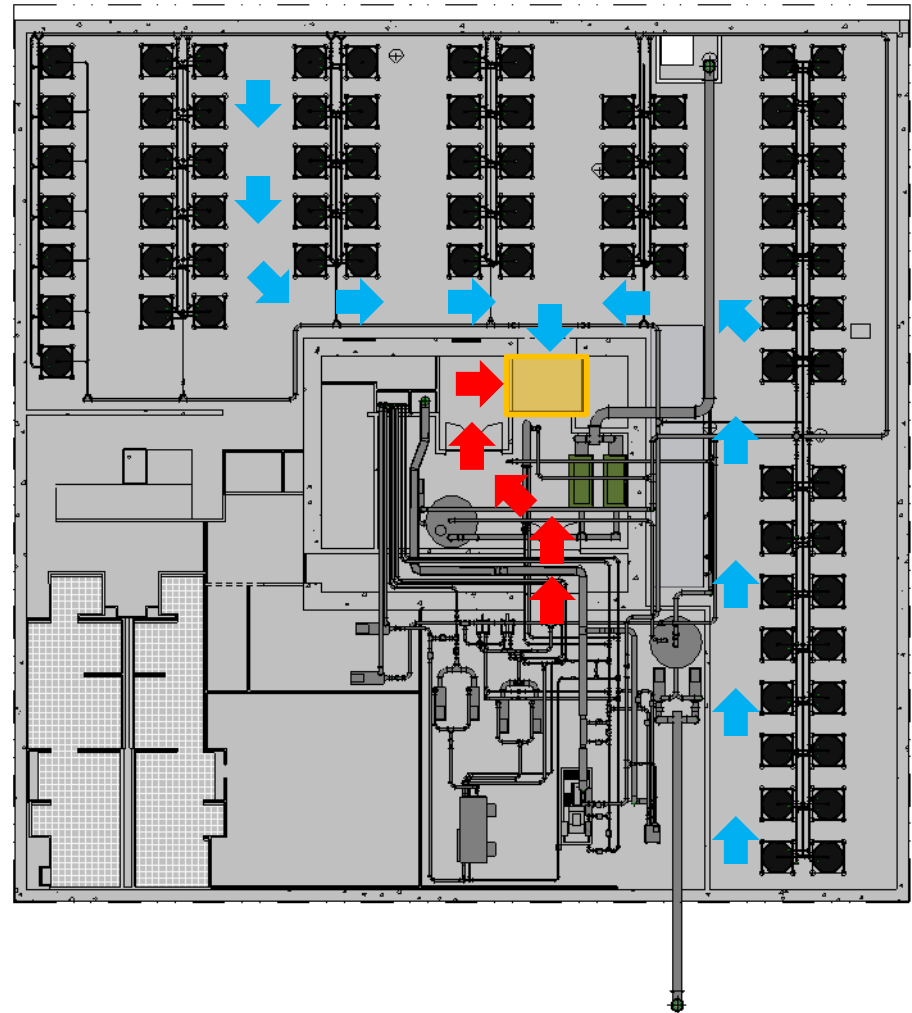
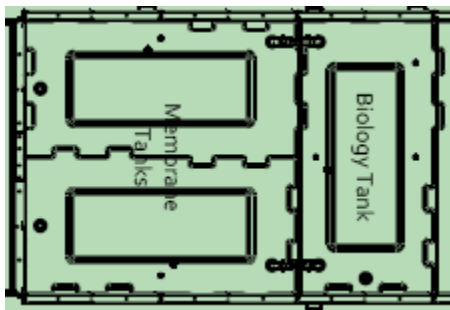
# The BioMethane Plant and Mechanical Plant were designed for ease of maintainability.

Designed for off-site service

Modular digesters fit on elevator

3-sided service elevator

AquaCELL modules fit on elevator



Near Immediate Occupancy

Reliable Operation

Enhanced Life Safety

Indoor Air Quality

Quality Control



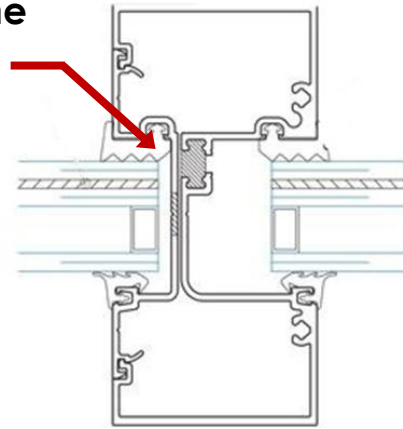
Electrical  
Construction  
Mechanical  
Structural

# The **building enclosure** was also designed to endure a major seismic event.

## 1. Preliminary Research

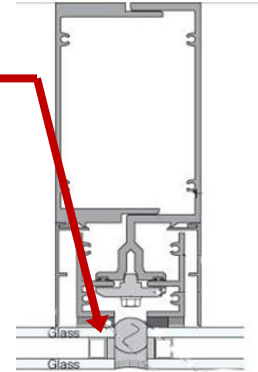


Neoprene Rubber Gasket



VS.

Structural Sealant



Testing shows as much as a **50 – 90% increase in Drift Capacity with Rounded Corner Glass**

Testing shows as much as a **146% increase in Drift Capacity with 4-side Structural Sealant Glazed**

Near Immediate Occupancy

Reliable Operation

Enhanced Life Safety

Indoor Air Quality

Quality Control



Electrical  
Construction  
Mechanical  
Structural

# The **building enclosure** was also designed to endure a major seismic event.

1. Preliminary Research



2. Movements and Tolerance Report

	Expansion	Contraction
Live Load Deflection	1.183"	1.183"
Thermal Movement	.052"	.058"
Installation/Manufacturer	.25"	.25"
<b>Total</b>	<b>1.485"</b>	<b>1.491"</b>

Near Immediate Occupancy

Reliable Operation

Enhanced Life Safety

Indoor Air Quality

Quality Control



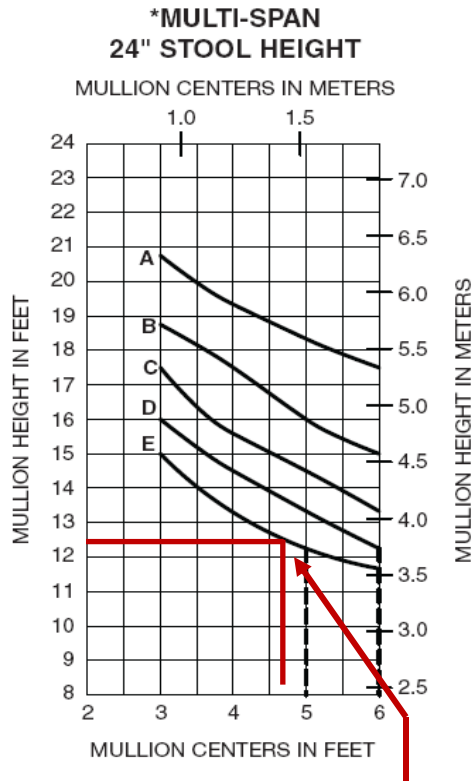
Electrical  
Construction  
Mechanical  
Structural

# The **building enclosure** was also designed to endure a major seismic event.

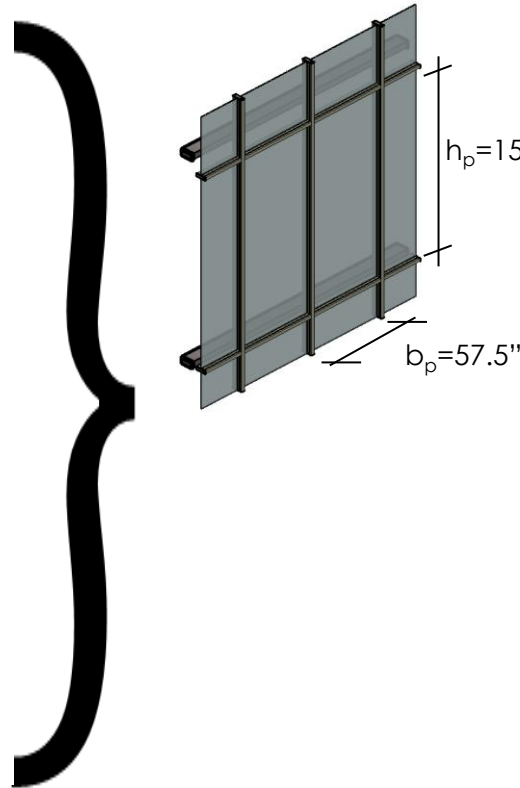
1. Preliminary Research

2. Movements and Tolerance Report

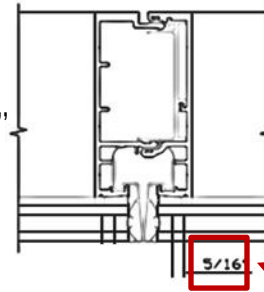
3. Product Selection



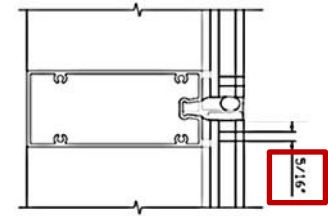
**E = 60psf > MWFRS Study = 37psf**



**Vertical Mullion Section**



**Horizontal Mullion Section**



**5/16" = .3125"**

**Typical Structural Silicon Sealant Pocket**

**$c_1 = c_2 = .3125''$**

$$D_{clear} > 1.25I_p D_p$$

$$2c_1 \left( 1 + \frac{h_p c_2}{b_p c_1} \right) > 1.25I_p D_p$$

**OK**

**Kaweneer 2500 PG Unitwall  
verified for drift capacity**

Near Immediate Occupancy

Reliable Operation

Enhanced Life Safety

Indoor Air Quality

Quality Control



Electrical  
Construction  
Mechanical  
Structural

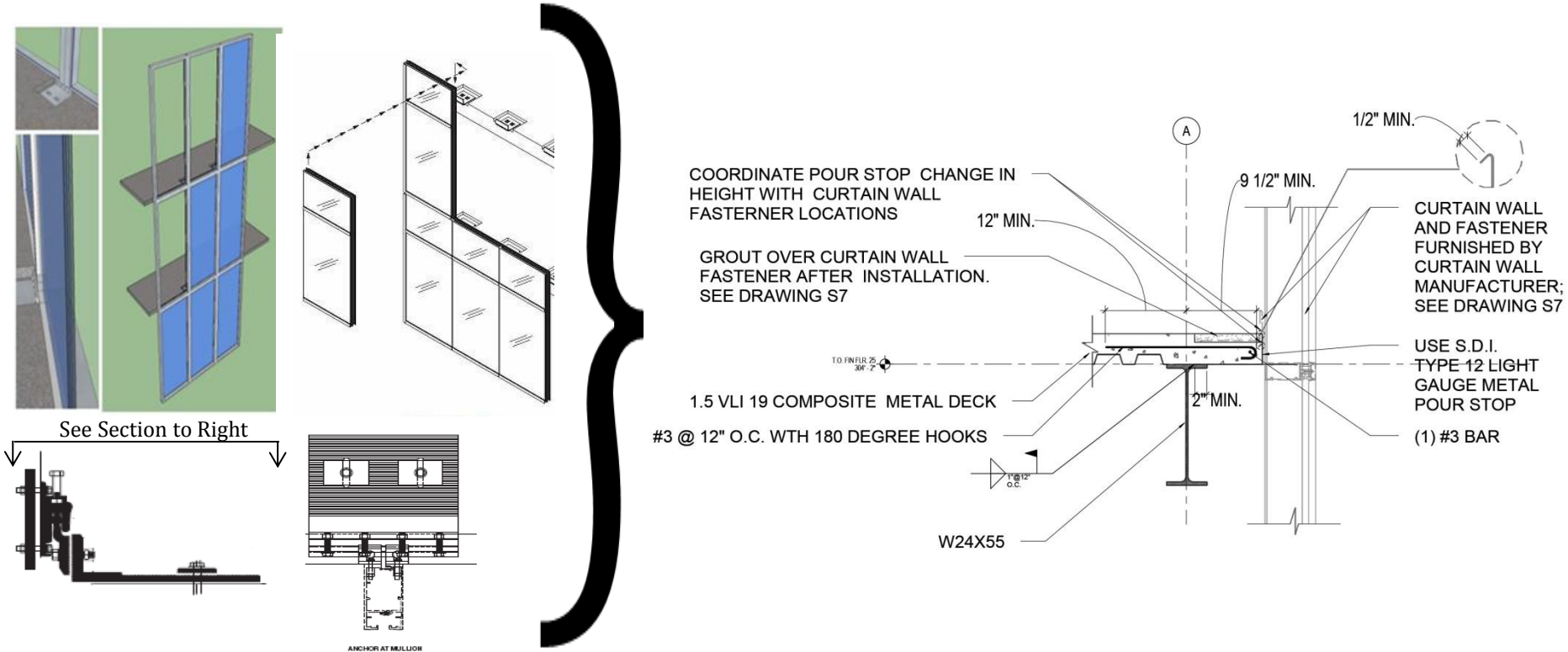
# The **building enclosure** was also designed to endure a major seismic event.

1. Preliminary Research

2. Movements and Tolerance Report

3. Product Selection

4. Anchoring Design and Summary



Near Immediate Occupancy

Reliable Operation

Enhanced Life Safety

Indoor Air Quality

Quality Control



Electrical  
Construction  
Mechanical  
Structural

# Endurance guided the resilient design of 350 Mission

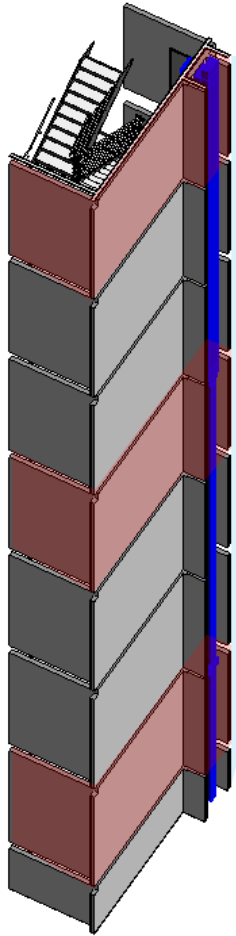


- Near Immediate Occupancy
- Reliable Operation
- **Enhanced Life Safety**
  - Emergency Power
  - Fire Protection
- Indoor Air Quality
- Quality Control

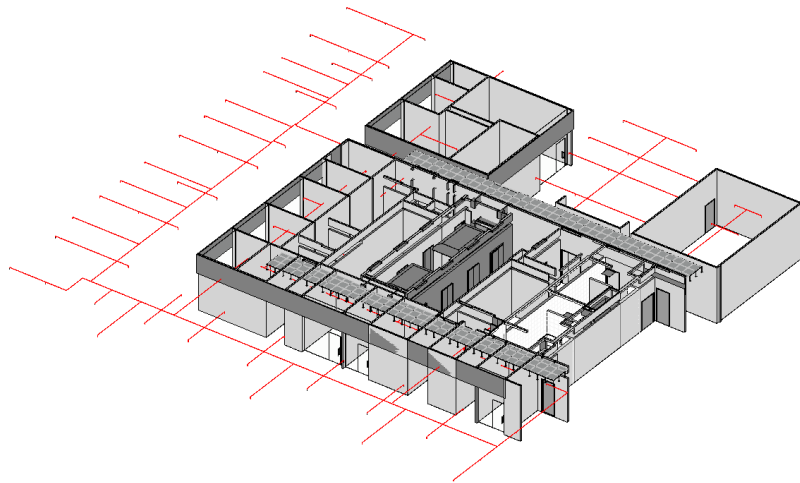




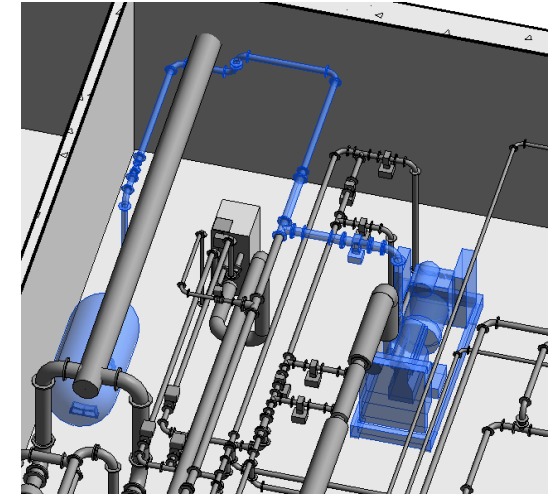
# Enhanced **Life-Safety** measures will be in place to protect occupants during emergencies.



Duct run pressurizes stairwell every third floor to **0.15 in wg**



**Sprinkler Layout**



Compressed Natural Gas feeds 310kW IC Engine for **emergency power**

Near Immediate Occupancy

Reliable Operation

Enhanced Life Safety

Indoor Air Quality

Quality Control



Electrical  
Construction  
Mechanical  
Structural

# Endurance guided the resilient design of 350 Mission



- Near Immediate Occupancy
- Reliable Operation
- Enhanced Life Safety
- **Indoor Air Quality**
  - Lobby Analysis
  - Construction Conditions
- Quality Control

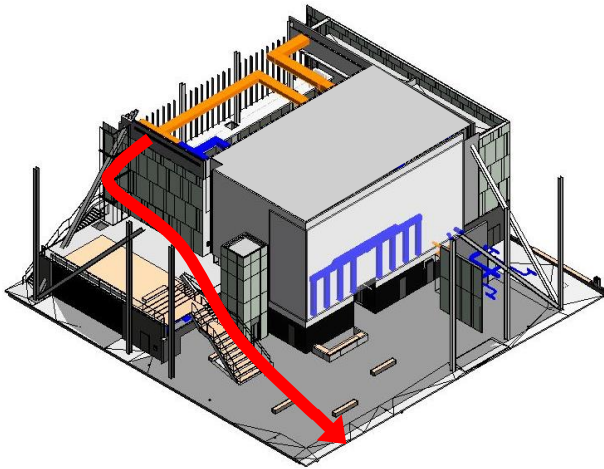


# Indoor Air Quality Studies were performed in order to ensure Occupant Endurance.

## Without Pressurization

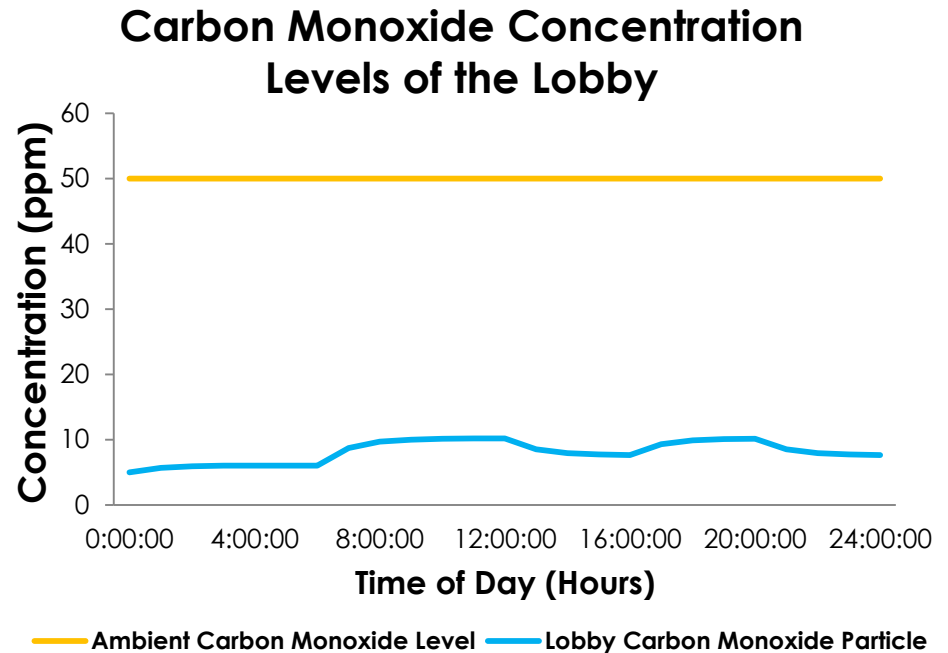
Individual cancer risk increase is **1%**

Aggregate risk increase is **41%**



## With Pressurization

Risk increase is **0%**



Near Immediate Occupancy

Reliable Operation

Enhanced Life Safety

Indoor Air Quality

Quality Control



Electrical  
Construction  
Mechanical  
Structural

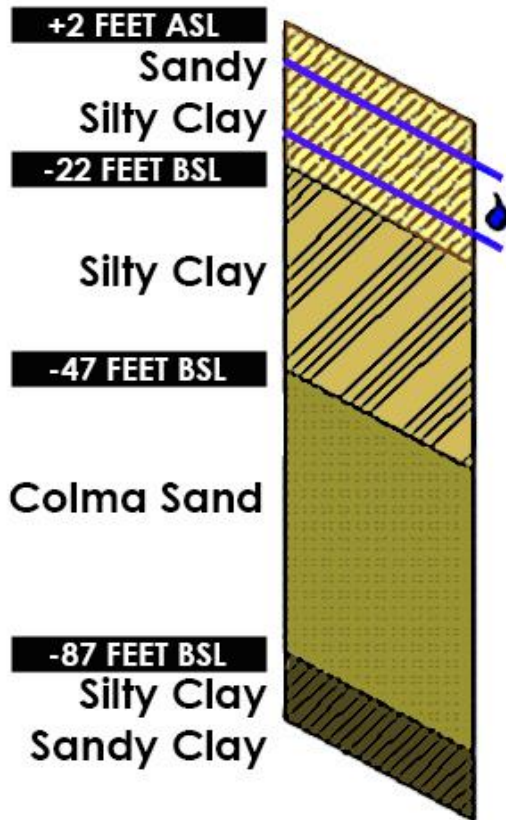
# Endurance guided the resilient design of 350 Mission



- Near Immediate Occupancy
- Reliable Operation
- Enhanced Life Safety
- Indoor Air Quality
- **Quality Control**
  - Design Practicality



# Sub-grade research was performed to ensure **long-term stability in foundation development**

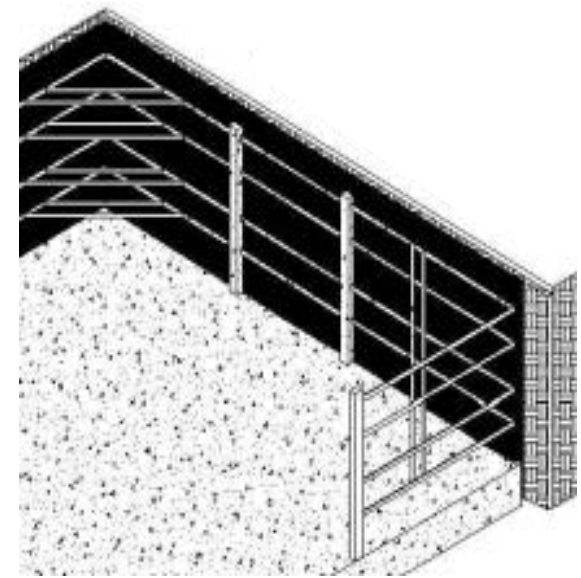


Constrained,  
vulnerable project site

Solution:  
**Braced soil-cement walls**

Pros:  
Site specific

Cons:  
Cost & schedule impacts



Braced excavation  
illustration

Near Immediate Occupancy

Reliable Operation

Enhanced Life Safety

Indoor Air Quality

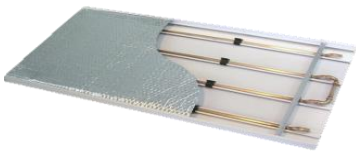
Quality Control



Electrical  
Construction  
Mechanical  
Structural

# Emphasis on sustainable and near net-zero goals reflected a positive impact of added costs

Radiant Ceiling Panels



Tambient Desk Fixtures



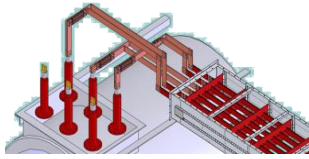
Prefabricated Core Members



Modular Digester Tanks



Electrical Bus Duct



Unitized Curtain Wall



Prefabricated Rebar Cage



Near Immediate Occupancy	Reliable Operation	Enhanced Life Safety	Indoor Air Quality	Quality Control
--------------------------	--------------------	----------------------	--------------------	-----------------



Electrical  
Construction  
Mechanical  
Structural

# Emphasis on sustainable and near net-zero goals reflected a **positive impact of added costs**

Radiant Ceiling Panels



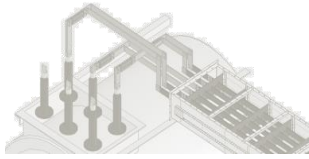
Tambient Desk Fixtures



**Prefabricated Core Members**

**Modular Digester Tanks**

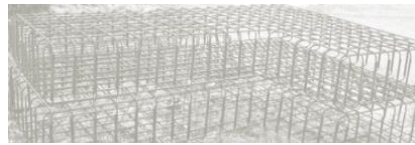
Electrical Bus Duct



Unitized Curtain Wall



Prefabricated Rebar Cage

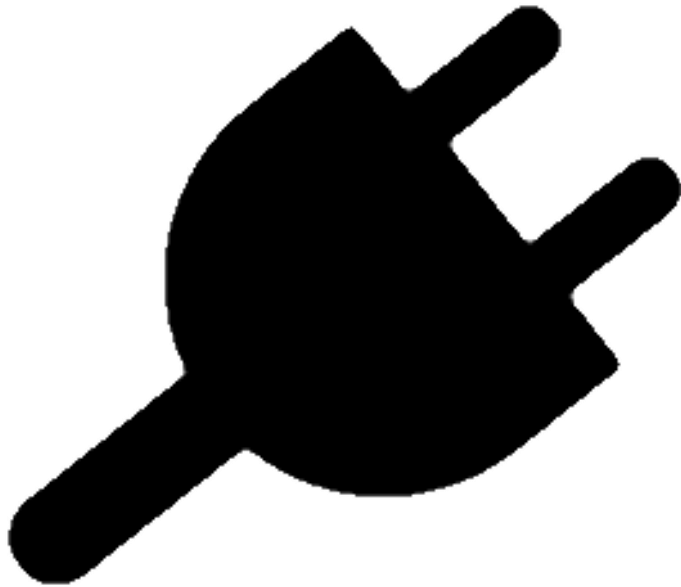


- Near Immediate Occupancy
- Reliable Operation
- Enhanced Life Safety
- Indoor Air Quality
- Quality Control



Electrical  
Construction  
Mechanical  
Structural

**Connectivity** guided the ability of 350 Mission to engage the urban environment in which it resides.

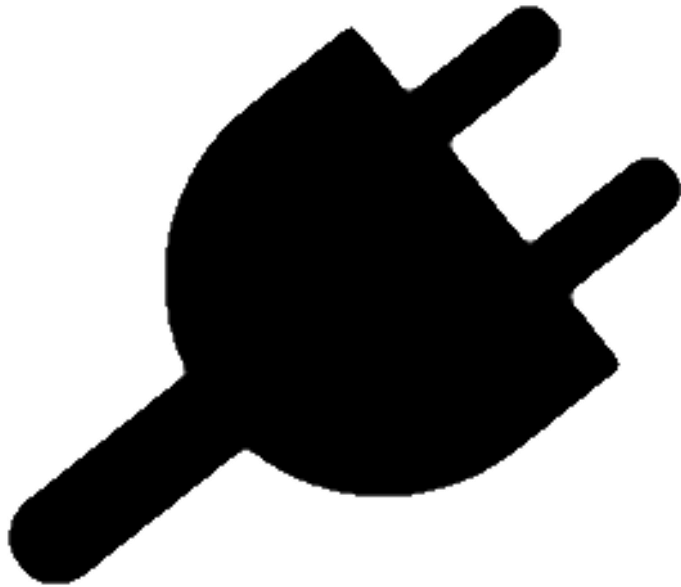


- Occupant Interactivity
- Architectural Enhancement
- Community Level sustainability
- Site Utilization





**Connectivity** guided the ability of 350 Mission to engage the urban environment in which it resides.



- **Occupant Interactivity**
  - Construction Publication
  - Energy Dashboard
  - System Transparency
- Architectural Enhancement
- Community Level sustainability
- Site Utilization



Electrical  
Construction  
Mechanical  
Structural

# A *Public Restroom* in the Lobby enables *operational transparency*.

Electrochromic glazing creates interest

Sustainability participation

Access monitored by front desk



Occupant Interactivity

Architectural Enhancement

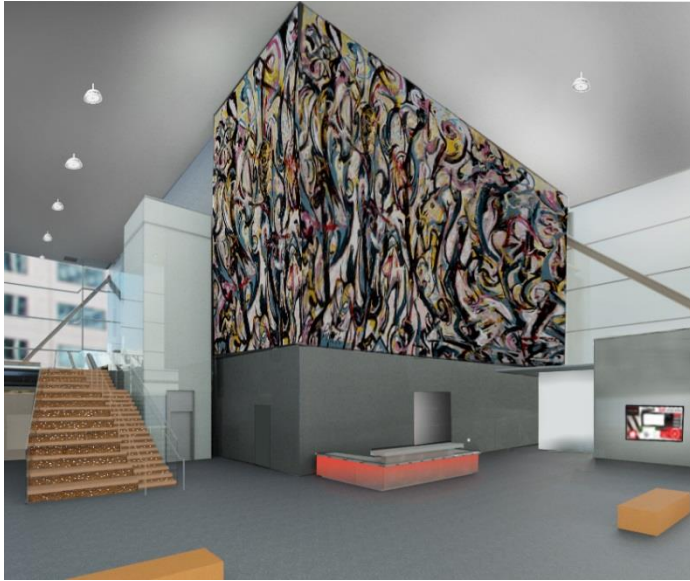
Community-Level Sustainability

Site Utilization



Electrical  
Construction  
Mechanical  
Structural

# The Lobby Lighting Design will create a interactive public space.



- Entertain
- Inspire
- Educate

Occupant Interactivity

Architectural Enhancement

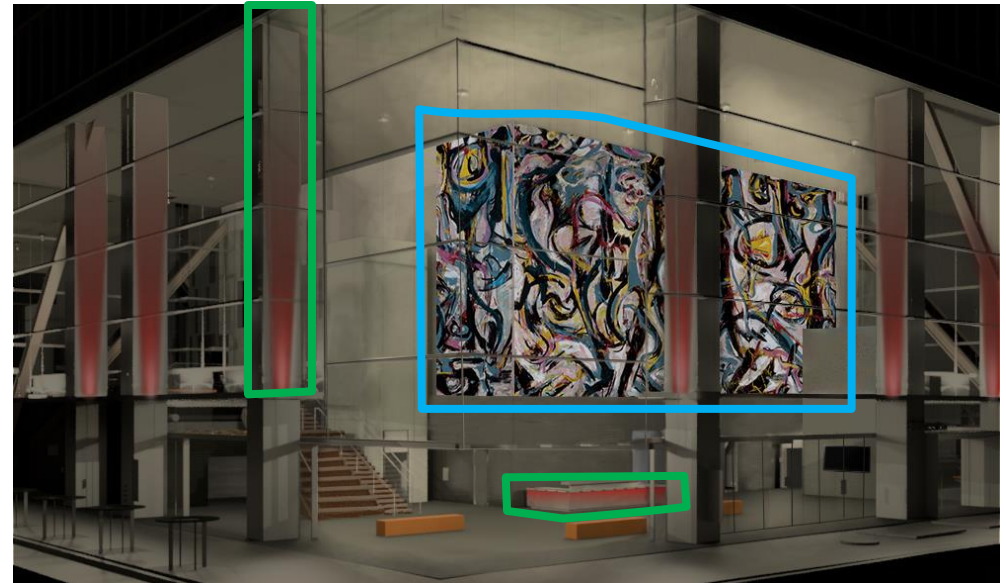
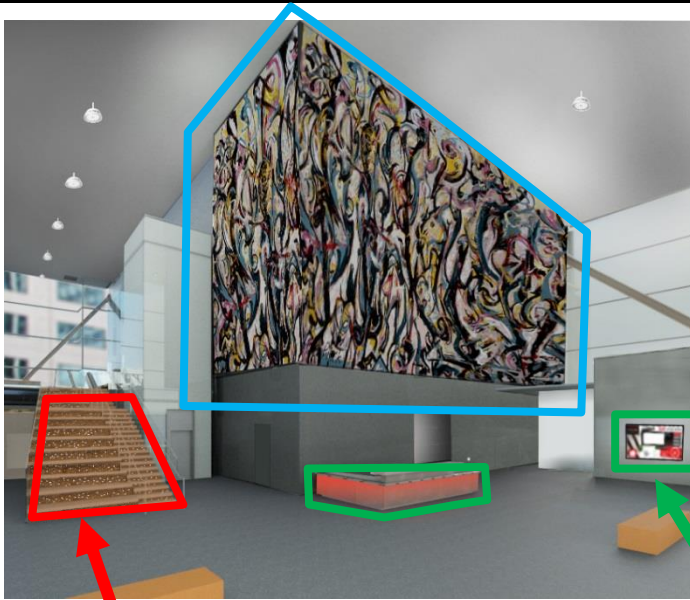
Community-Level Sustainability

Site Utilization



Electrical  
Construction  
Mechanical  
Structural

# The Lobby Lighting Design will create a interactive public space.



- Entertain
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Occupant Interactivity

Architectural Enhancement

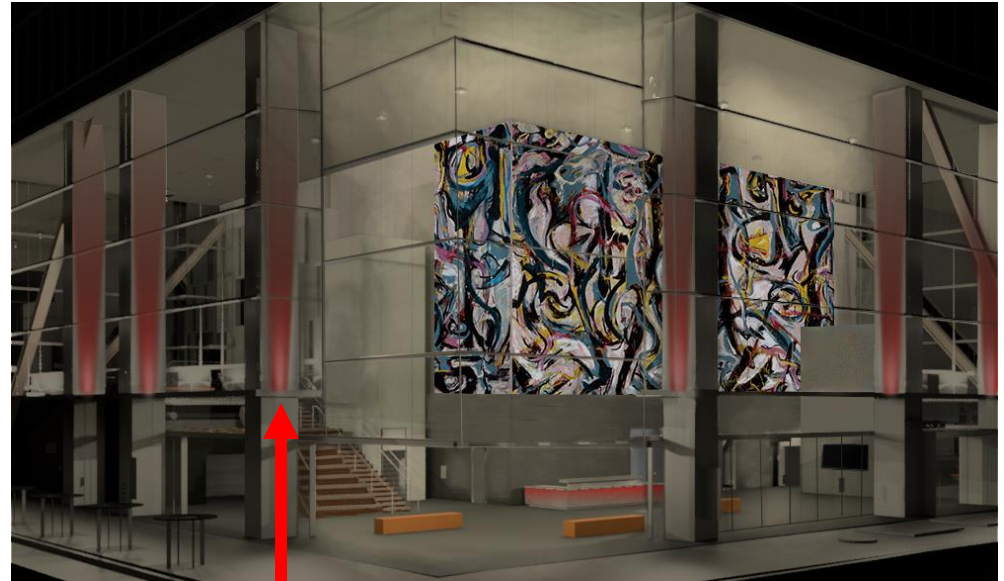
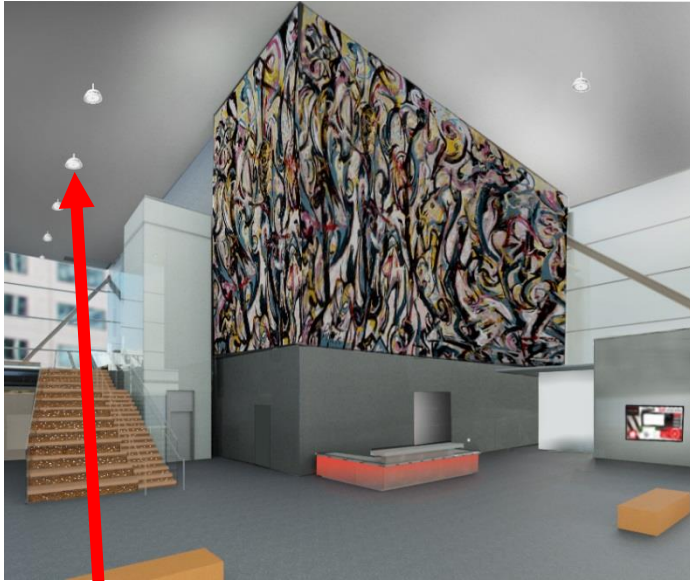
Community-Level Sustainability

Site Utilization



Electrical  
Construction  
Mechanical  
Structural

# The Lobby Lighting Design will create a interactive public space.



140W LED  
277V  
3500K



28W RGBW LED  
277V  
6 Degree Beam Spread

Occupant Interactivity

Architectural Enhancement

Community-Level Sustainability

Site Utilization




Electrical  
Construction  
Mechanical  
Structural

# 350 MISSION

**New Office Building**  
- 27 Floors  
- Open, public lobby

**Innovation at the Forefront**  
- Net Zero Operations  
- Fueled by Waste Energy  
- Structurally robust

**Center of the Community**  
- Public function space  
- Open cafe  
- Accessible via subway



## OPENING SUMMER 2014

# 350 MISSION

1. Recycle: Please place recyclables in the appropriate bins.

**DO YOUR PART:**  
... We make an **IMPACT**.  
How can you be a **TEAM PLAYER?**



2. Carpool! Alone we produce 2.64 tons of carbon by just driving to work!

3. Keep the site clean! Waste debris may inadvertently pollute our neighborhood!

5. Spread the word! Keep it green!

4. Use on-site restroom facilities. We, along with compost, help full 350 Mission's operations!



3382: Eye & face protection is required when there is risk of flying particles, chemicals, or harmful rays.



3385: Foot protection is required in circumstances exposed to heat, corrosion, water, or falling objects.



1528: Hand protection is required for workers exposed to cuts, burns, electrical current, or chemicals.



1522: Body protection is required for workers exposed to injurious material.



5096: Hearing protection is required per certain time period any time activity exceeds 90 dBA.



3381: Head protection will be required at all times.



5144: Respiratory protection is required where workers are exposed to harmful airborne contaminants.

**Connectivity** guided the ability of 350 Mission to engage the urban environment in which it resides.

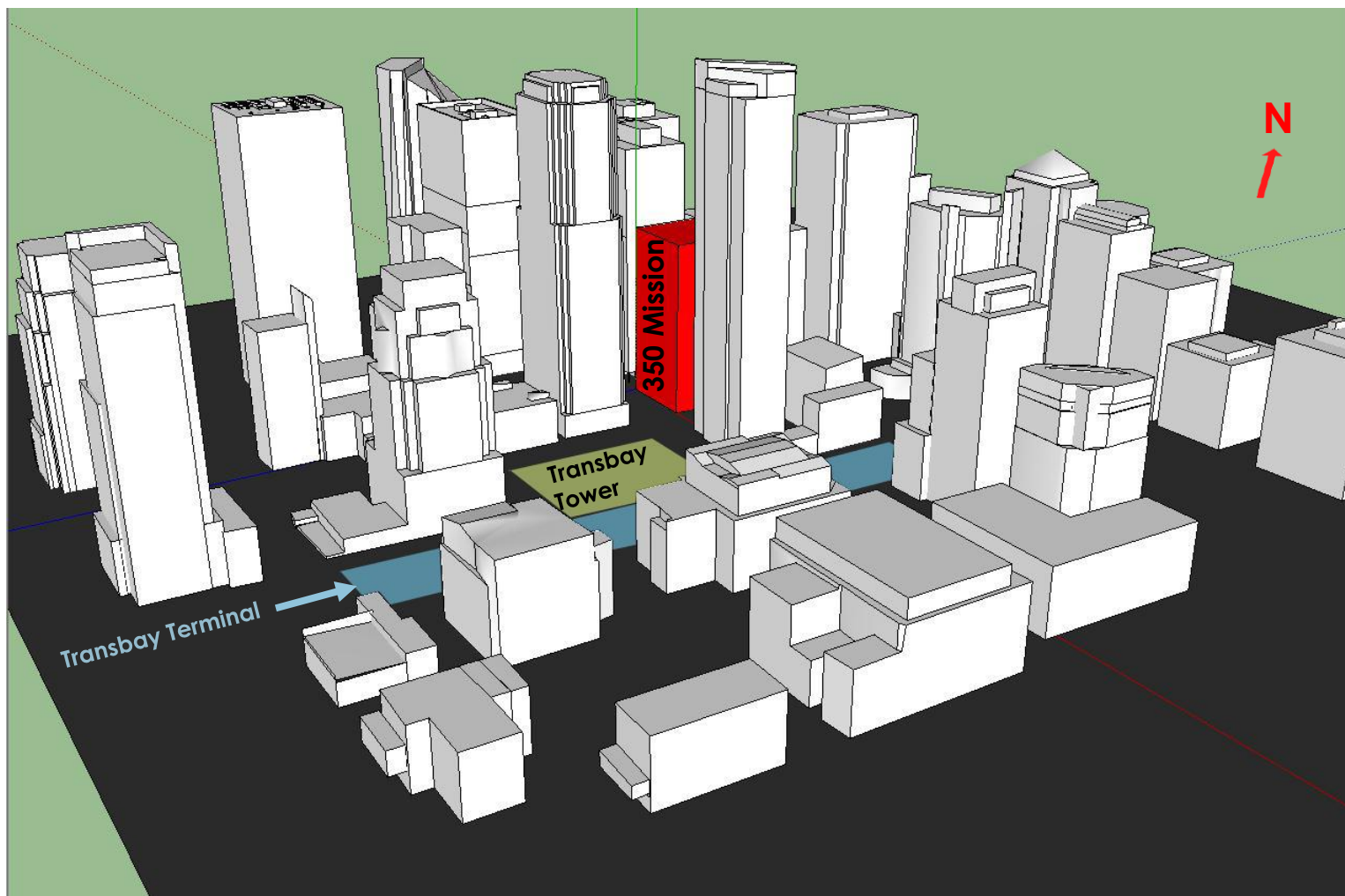


- Occupant Interactivity
- **Architectural Enhancement**
  - Structural Framing
  - Building Enclosure
- Community Level sustainability
- Site Utilization



Electrical  
Construction  
Mechanical  
Structural

# Structural system layouts continuously sought to provide opportunities for **Architectural Enhancement**.



Occupant Interactivity

**Architectural Enhancement**

Community-Level Sustainability

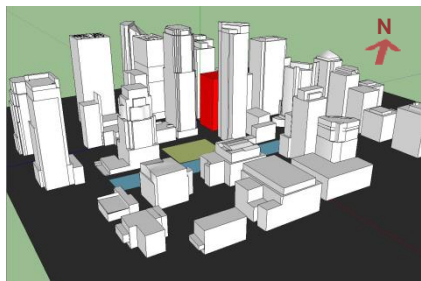
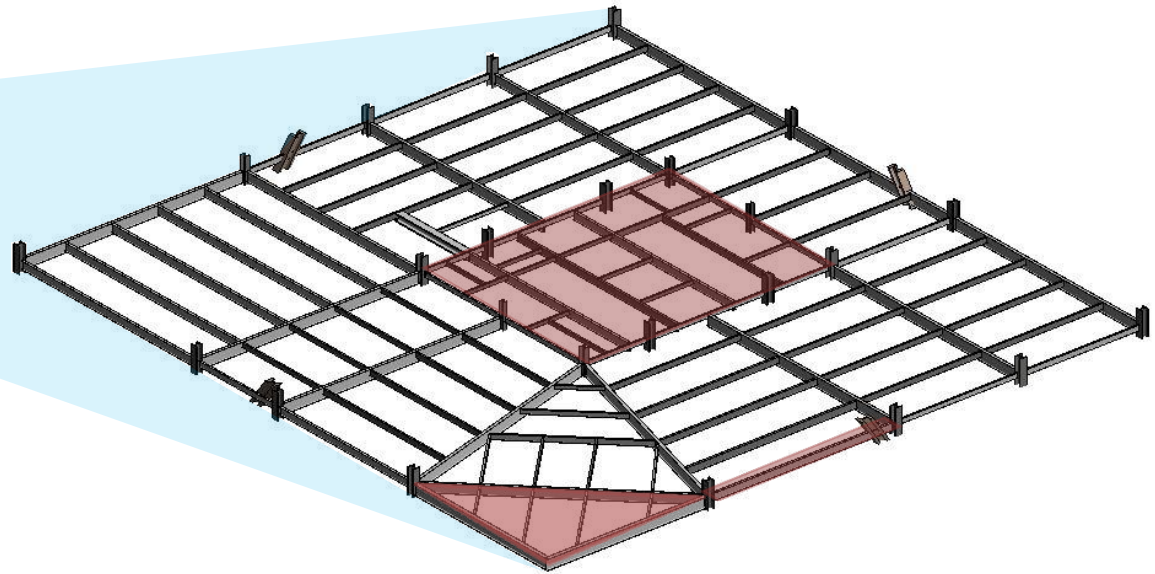
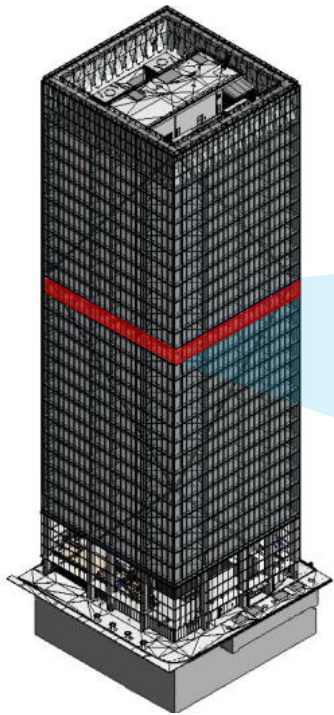
Site Utilization



Electrical  
Construction  
Mechanical  
Structural



# Structural system layouts continuously sought to provide opportunities for **Architectural Enhancement**.



Occupant Interactivity

**Architectural Enhancement**

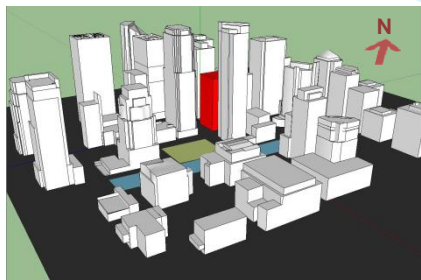
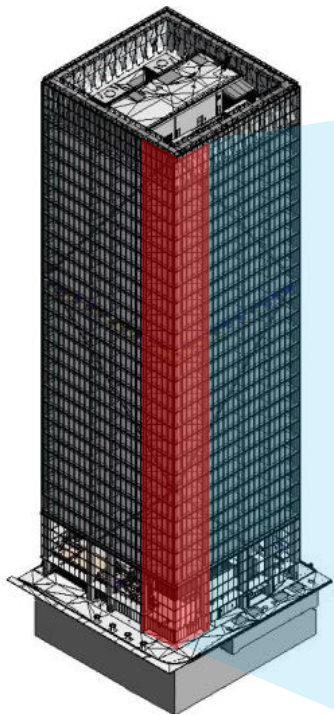
Community-Level Sustainability

Site Utilization



Electrical  
Construction  
Mechanical  
Structural

# Structural system layouts continuously sought to provide opportunities for **Architectural Enhancement**.



Occupant Interactivity

Architectural Enhancement

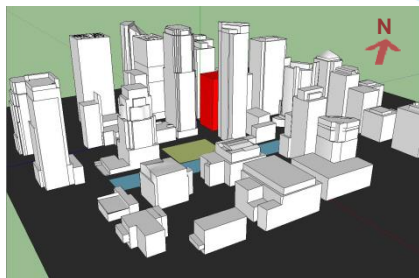
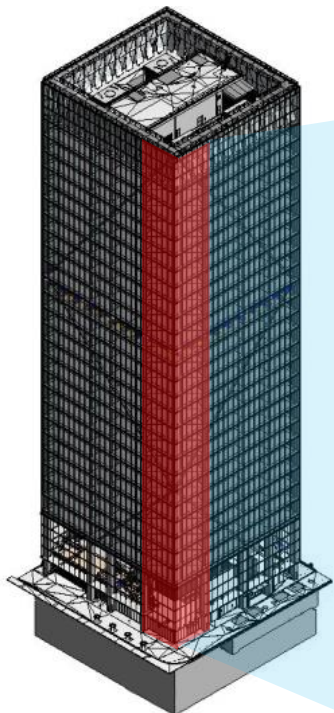
Community-Level Sustainability

Site Utilization



Electrical  
Construction  
Mechanical  
Structural

# Structural system layouts continuously sought to provide opportunities for **Architectural Enhancement**.



Occupant Interactivity

Architectural Enhancement

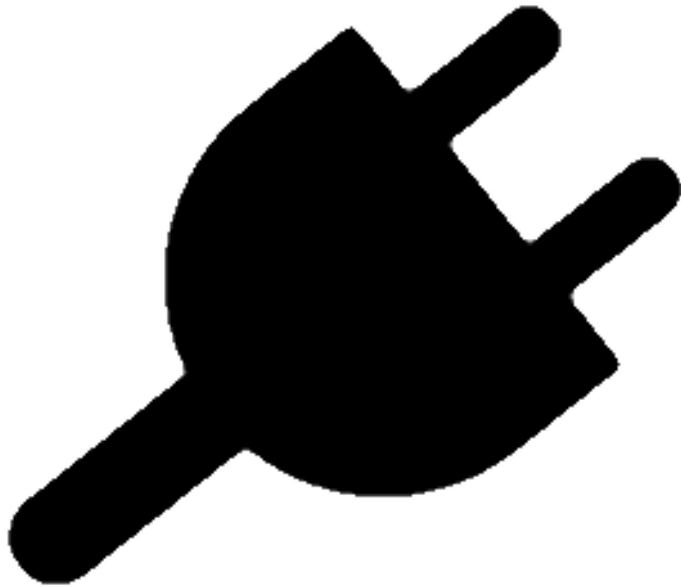
Community-Level Sustainability

Site Utilization



Electrical  
Construction  
Mechanical  
Structural

**Connectivity** guided the ability of 350 Mission to engage the urban environment in which it resides.



- Occupant Interactivity
- Architectural Enhancement
- **Community Level sustainability**
  - Local Sourcing of Fuel
- Site Utilization



Electrical  
Construction  
Mechanical  
Structural

**Local resource collection enables connectivity with the surrounding urban ecology.**

# Biomimicry

(n.) bi · o · mim · ic · ry

The **imitation of nature** for the purpose  
of **solving complex human problems**

Occupant Interactivity

Architectural Enhancement

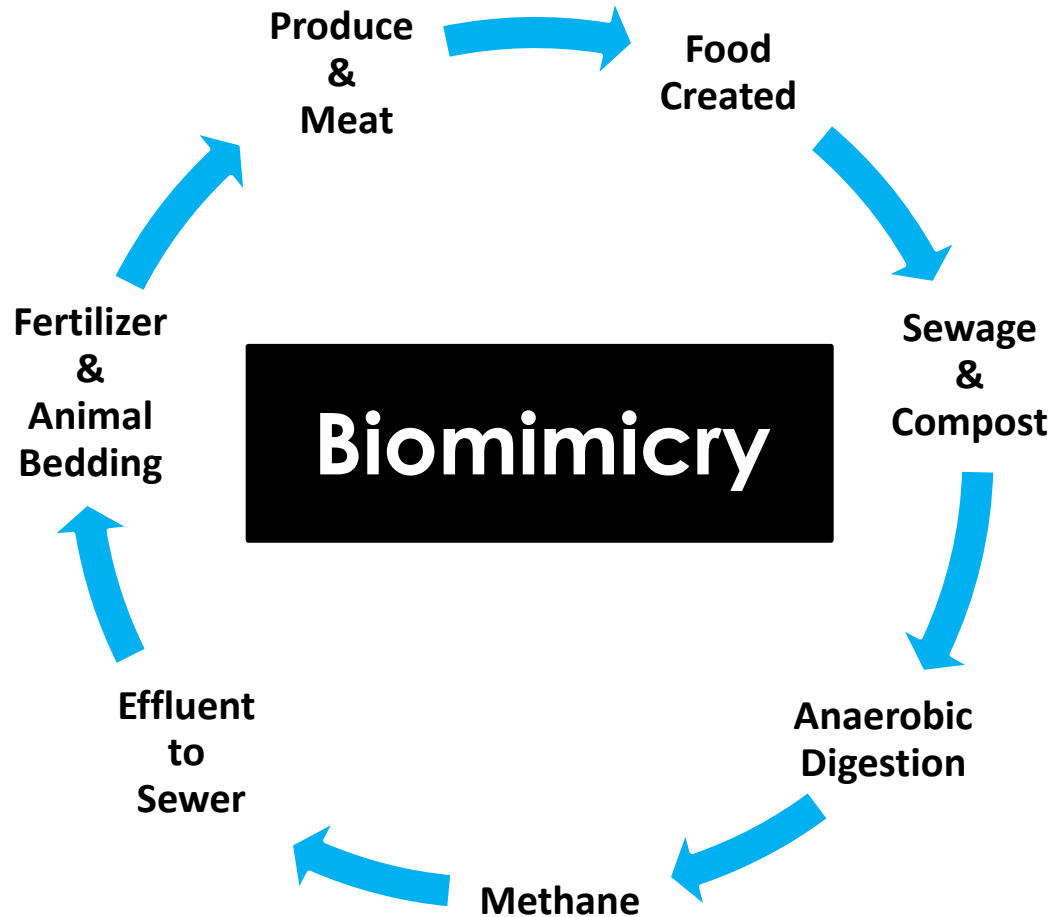
Community-Level Sustainability

Site Utilization



Electrical  
Construction  
Mechanical  
Structural

# Local resource collection enables connectivity with the surrounding urban ecology.



Occupant Interactivity

Architectural Enhancement

Community-Level Sustainability

Site Utilization



Electrical  
Construction  
Mechanical  
Structural

**Connectivity** guided the ability of 350 Mission to engage the urban environment in which it resides.

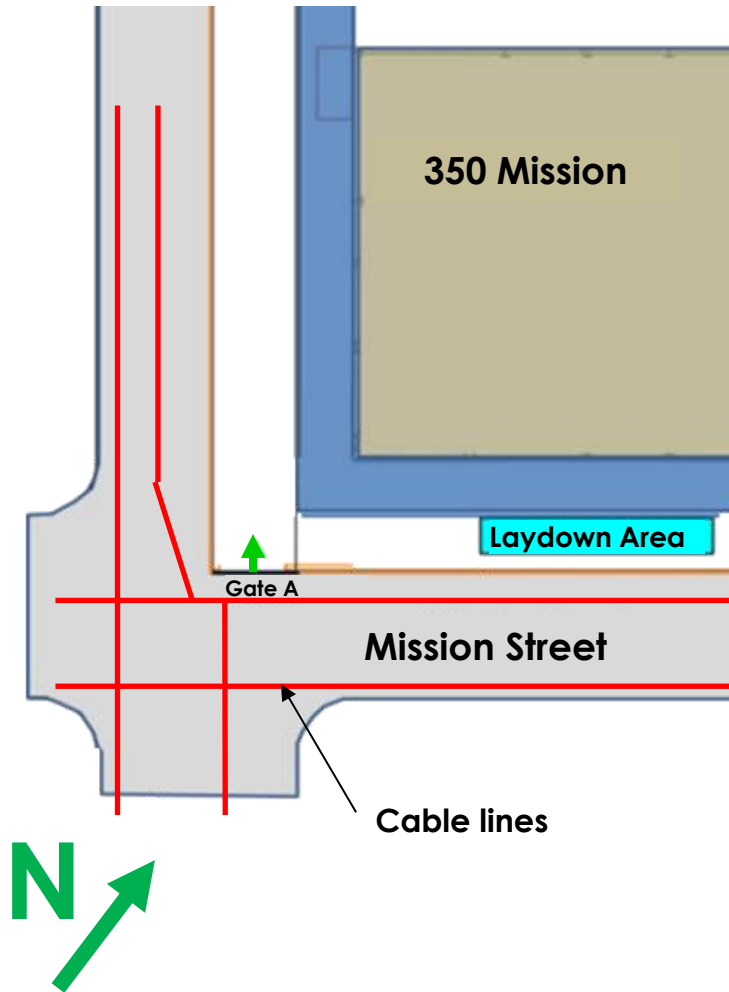


- Occupant Interactivity
- Architectural Enhancement
- Community Level sustainability
- **Site Utilization**
  - Construction Logistics
  - Environmental Impacts
  - Public and Personnel Safety



Electrical  
Construction  
Mechanical  
Structural

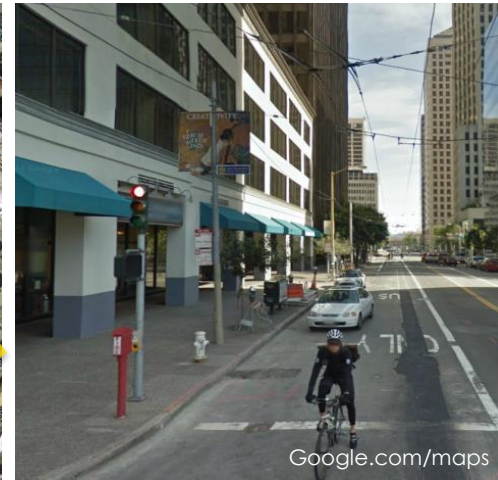
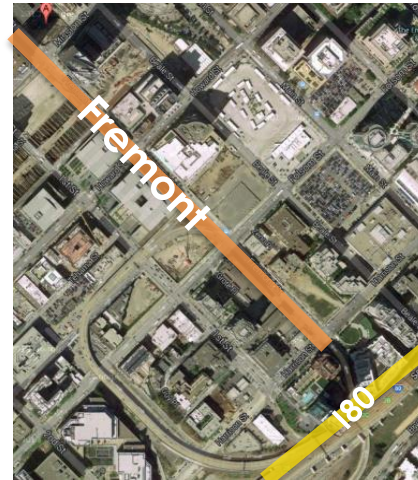
# Site specific planning drove **logistical innovation**



**Minimize impacts** to Fremont & Mission streets

Avoid cable car lines along Mission Street

Primary **southwest corner** entrance



Occupant Interactivity

Architectural Enhancement

Community-Level Sustainability

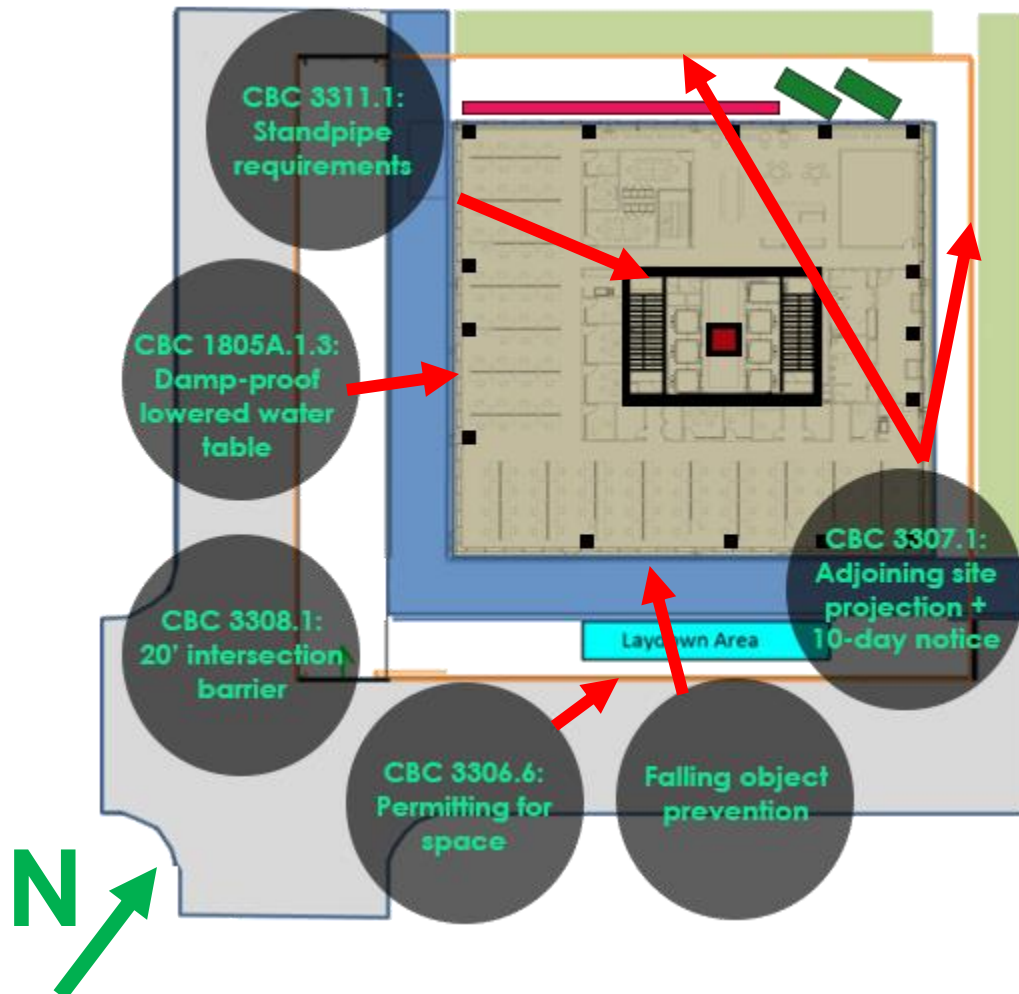
Site Utilization



Electrical  
Construction  
Mechanical  
Structural



# Site planning was considerate of **code impacts**



Public & personnel safety

Material hazards

Impact to surrounding buildings

Permitting

Traffic interference

Occupant Interactivity

Architectural Enhancement

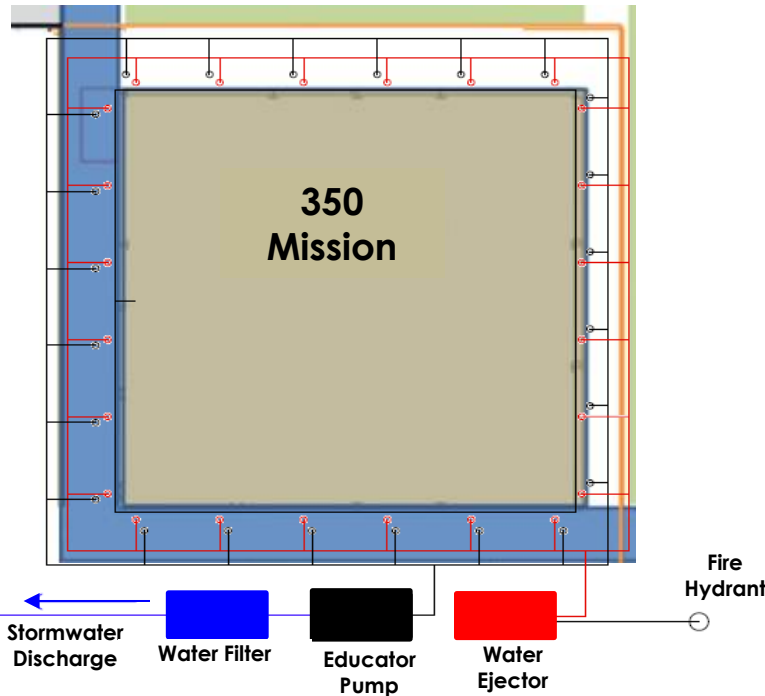
Community-Level Sustainability

Site Utilization



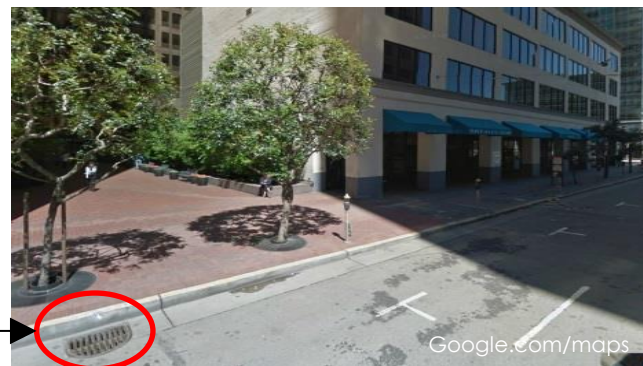
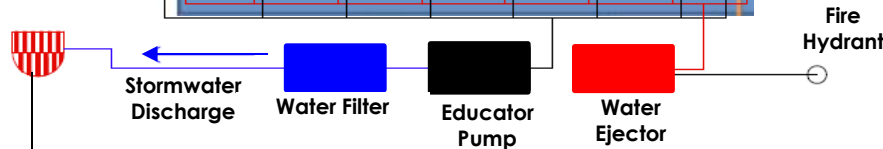
Electrical  
Construction  
Mechanical  
Structural

# Site planning was considerate of **environmental-impacts**



Groundwater carefully disposed of through **Eductor Dewatering**

Met **LEED Certification** for **Construction Indoor Air Quality Management**



Occupant Interactivity

Architectural Enhancement

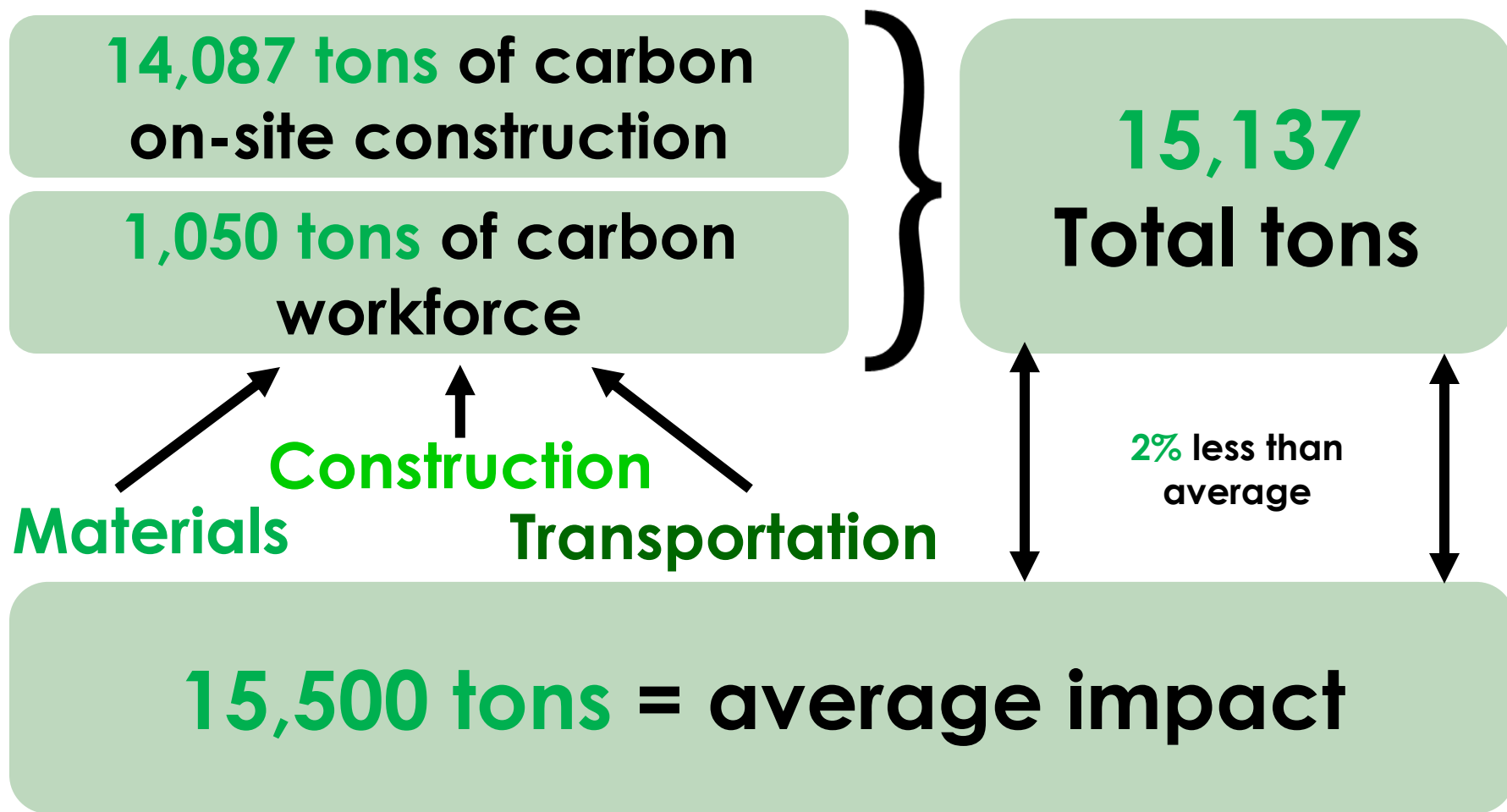
Community-Level Sustainability

Site Utilization



Electrical  
Construction  
Mechanical  
Structural

# Avant investigated the carbon impacts of 350 Mission construction & related activities



Occupant Interactivity

Architectural Enhancement

Community-Level Sustainability

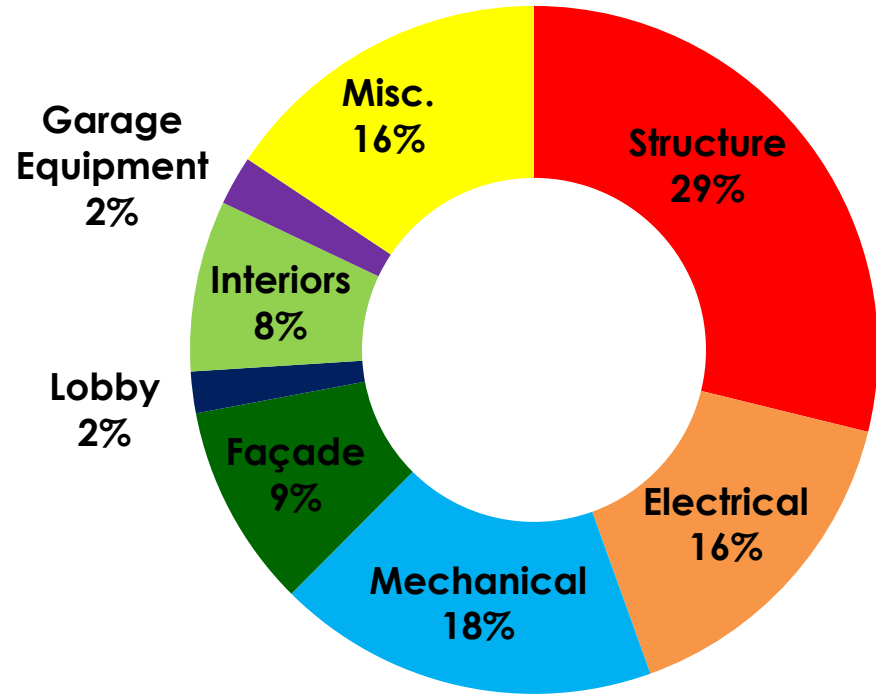
Site Utilization



Electrical  
Construction  
Mechanical  
Structural

# A full **construction budget** was developed for Avant's design for 350 Mission

Cost Call Out	
Structure	\$35,322,500
Mechanical	\$23,240,400
Electrical	\$20,295,400
Exterior Facade	\$12,409,800
Basic Office Floor	\$2,300,800
Lobby Finishes	\$252,690



Avg. Cost / SQFT (San Francisco 2014)  
\$199.79

Cost / SQFT (Our Design)  
\$264.11

## Total Cost: **\$131,213,000**

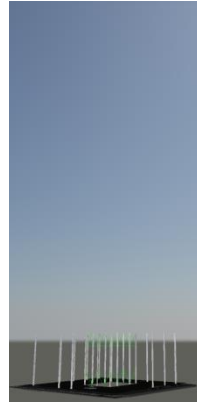


Electrical  
Construction  
Mechanical  
Structural

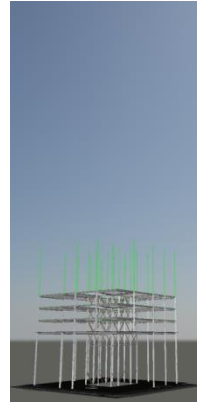
# The project schedule began on January 1, 2013



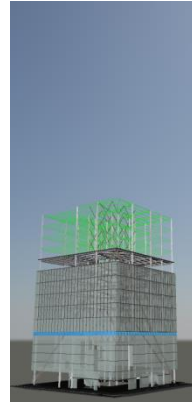
13 JAN 1



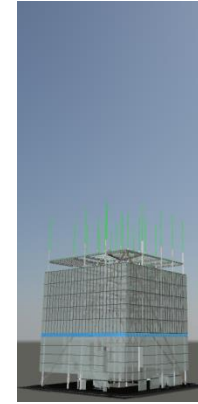
13 JULY 17



13 SEPT 23



13 OCT 29



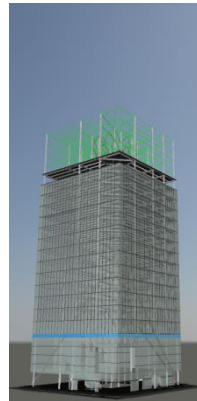
13 DEC 4

JAN  
2013

JULY  
2014



14 JAN 30



14 FEB 27



14 APR 19



14 APR 30



14 JULY

## Project Schedule: 19 Months



Electrical  
Construction  
Mechanical  
Structural

A practical building design was produced to reflect the **building's lifecycle** potential

**\$20 million** added  
capital investment

**\$3.35 million** in  
Maintenance savings  
Over **50** years

Near Immediate Occupancy

Reliable Operation

Enhanced Life Safety

Indoor Air Quality

Quality Control



Electrical  
Construction  
Mechanical  
Structural

**350 Mission shows life-cycle environmental benefits.**

**\$13,600,000** operational savings

**52,830** tons of CO2 avoided

**296,300,000** gallons of potable water saved



**Equivalent to carbon sequestration of**  
**115,900** trees





# PLATINUM

88

21



Sustainable Sites

05



Materials & Resources

10



Water Efficiency

12



Indoor Environmental Quality

33



Energy & Atmosphere

04



Innovation & Design Process

03



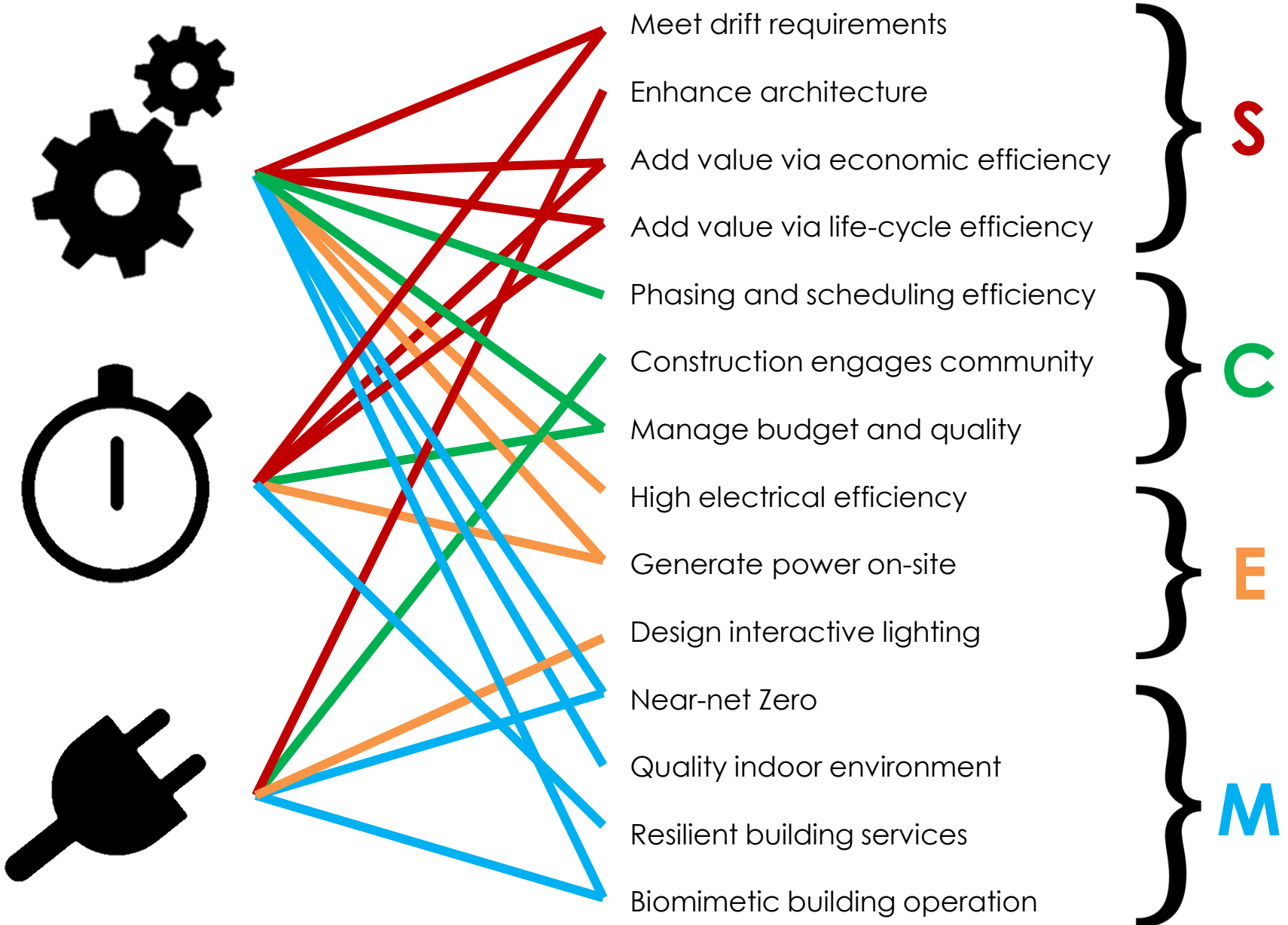
Regional Priority



Electrical  
Construction  
Mechanical  
Structural



# All disciplines defined goals and tied them to the project principles, integrating our process into our solutions.



# 350 Mission's **Electrical** accomplishments are the following:

## Goals

High electrical efficiency

Generate power on-site

Interactive lighting

## System Components

Tambient Lighting

Virtual Desktop Infrastructure

Automated Shading System

Interactive Lobby Lighting

IC Engine

Paralleling Switchgear

## Results

**37% energy savings with Thin Client**

**46% Lighting Power reduced from Baseline**

**2,715,600 kWh generated on site**

**Lobby energy dashboard that interfaces with building automation network**



# 350 Mission's **Construction** accomplishments are the following:

## Goals

## System Components

## Results

- High performance construction
- Practical cost control
- Minimize negative Impact to surroundings
- Educate in safety & Sustainability
- Time-aware scheduling

Prefabrication

Local Materials

“PSUEDO-SIPS” Phasing

Centrally-Focused Construction

Code-Impact Analysis

Construction Publications

15,137 tons of carbon produced – just under average

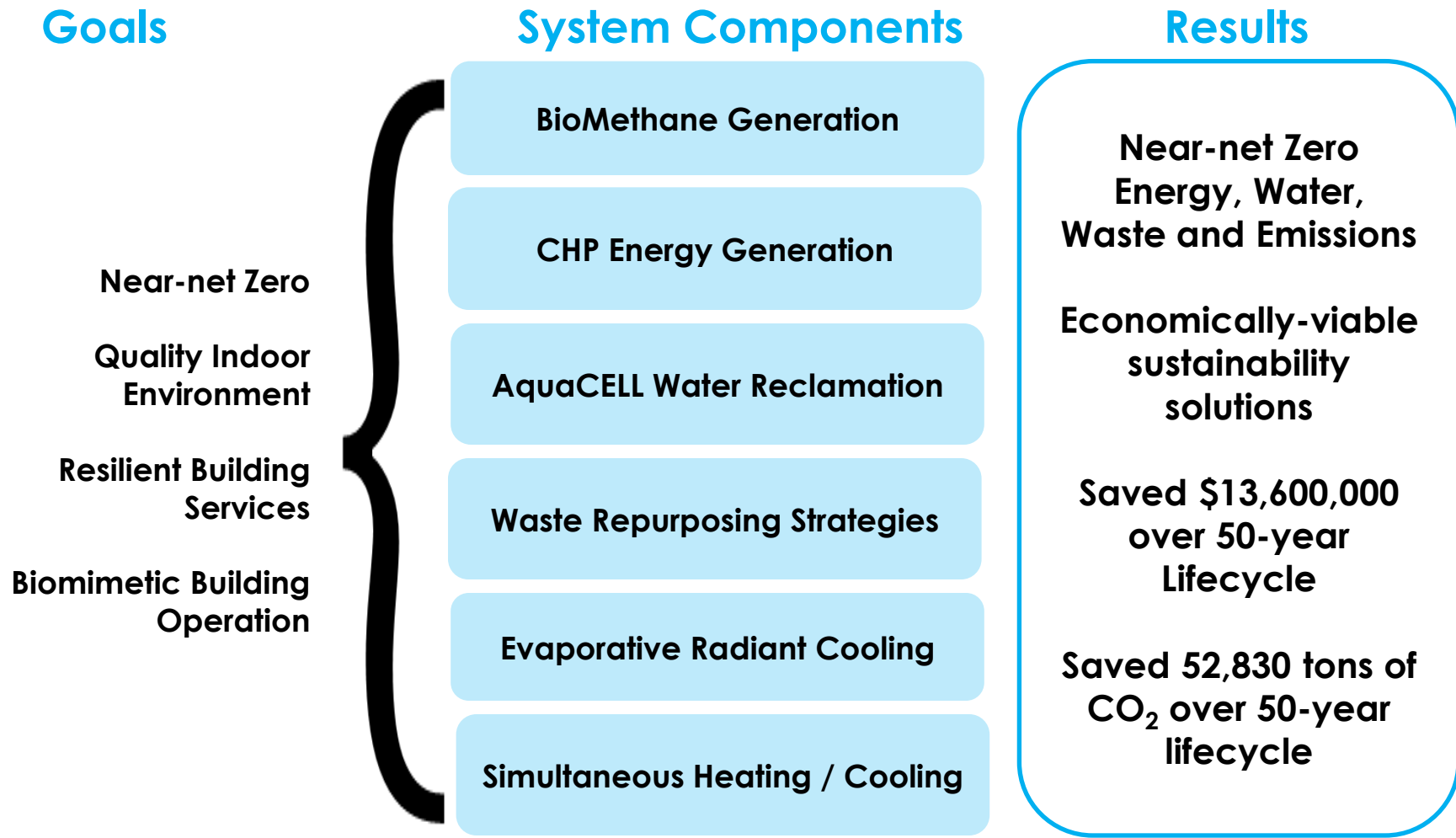
\$131,213,180 budget

\$3.35 million saved in maintenance

19-month schedule



# 350 Mission's **Mechanical** accomplishments are the following:



# 350 Mission's **Structural** accomplishments are the following:

## Goals

## System Components

## Results

Architectural Enhancement

Economic Gravity System

Added value with Resilient Lateral System

High Performance Drift Requirement

Efficient Composite Beam Floor Layout

Braced Frame Core Alleviated by Mega Bracing

29' Southwest Cantilever Maintained

Lightweight Thinner Core

Reduced Mat Slab Thickness

Locally Produced Steel

1.28" Average Inter Story Drift < 1.58" High Performance Requirement

6 ft Mat Slab Thickness for MEP Coordination

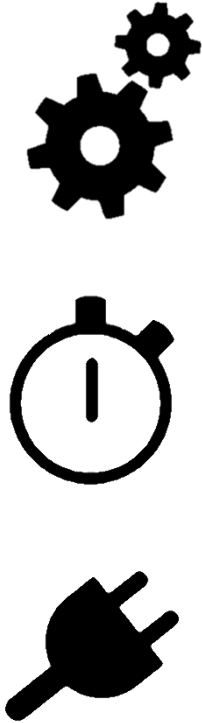
60% Estimated Reduction in Seismic Weight

9,100ft<sup>2</sup> Increase in Rentable Space

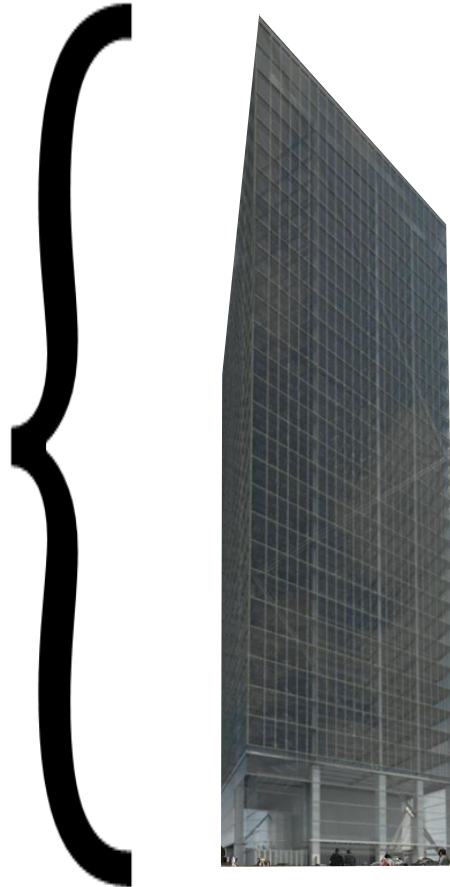


# Avant conceived 350 Mission as an integrated, holistic solution.

## Goals



## Systems



## Results

**Avant designed a high quality, holistic building that will radiate within the city of San Francisco.**



**Avant is grateful for the support they have received.**



**ASCE | Charles Pankow Foundation | Skidmore Owings & Merrill | Penn State AE Faculty | Industry Advisors**

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