

Navigating Zero Carbon Building Design and Construction



June 19, 2018



Agenda

- 1. The origins of evol^v1**
2. What is the process for NZE / NC design
3. How did we apply it
4. Final design solution



The Site
Waterloo, Ontario

The Stakeholder Team



Developer
(Building client)



Community Activators
(Feasibility client)



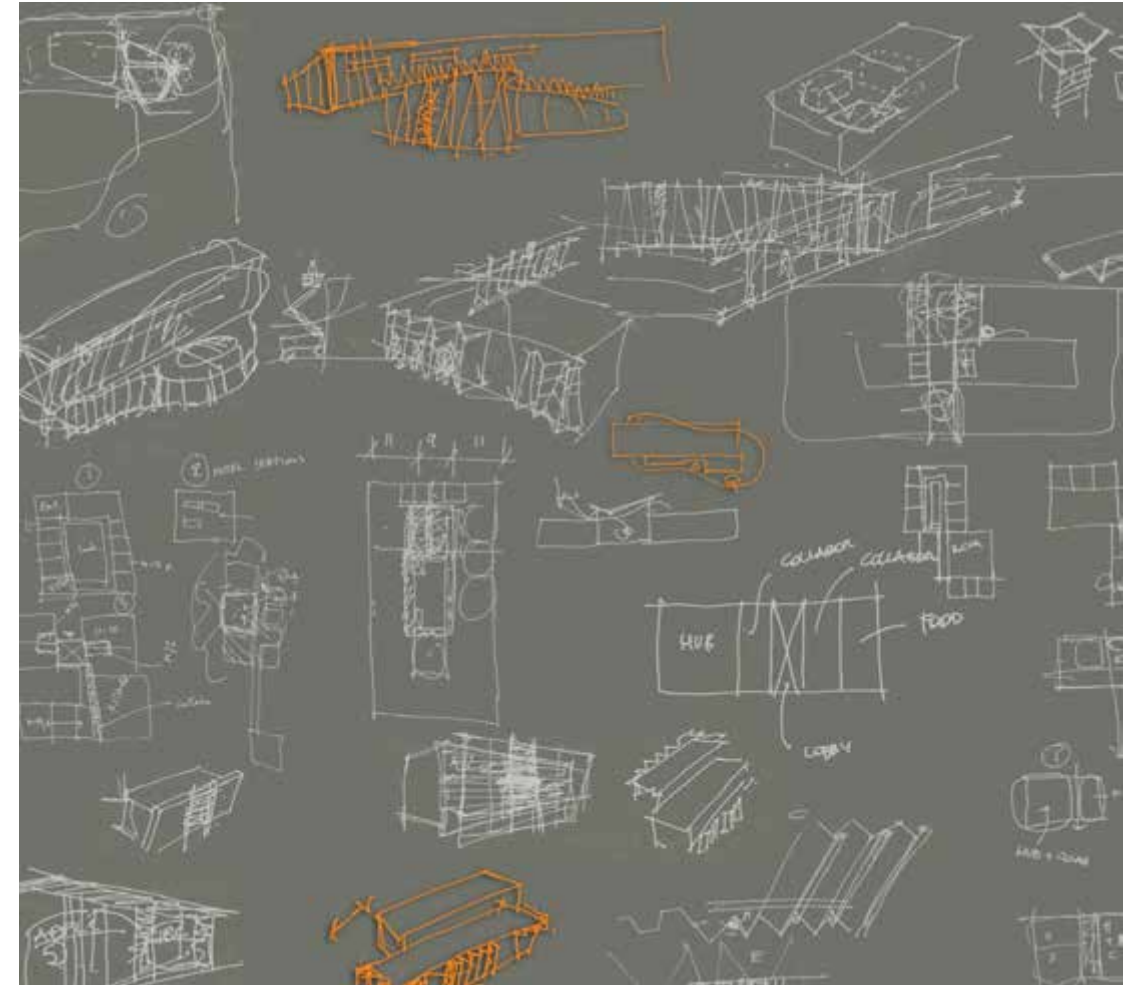
Prime Tenant



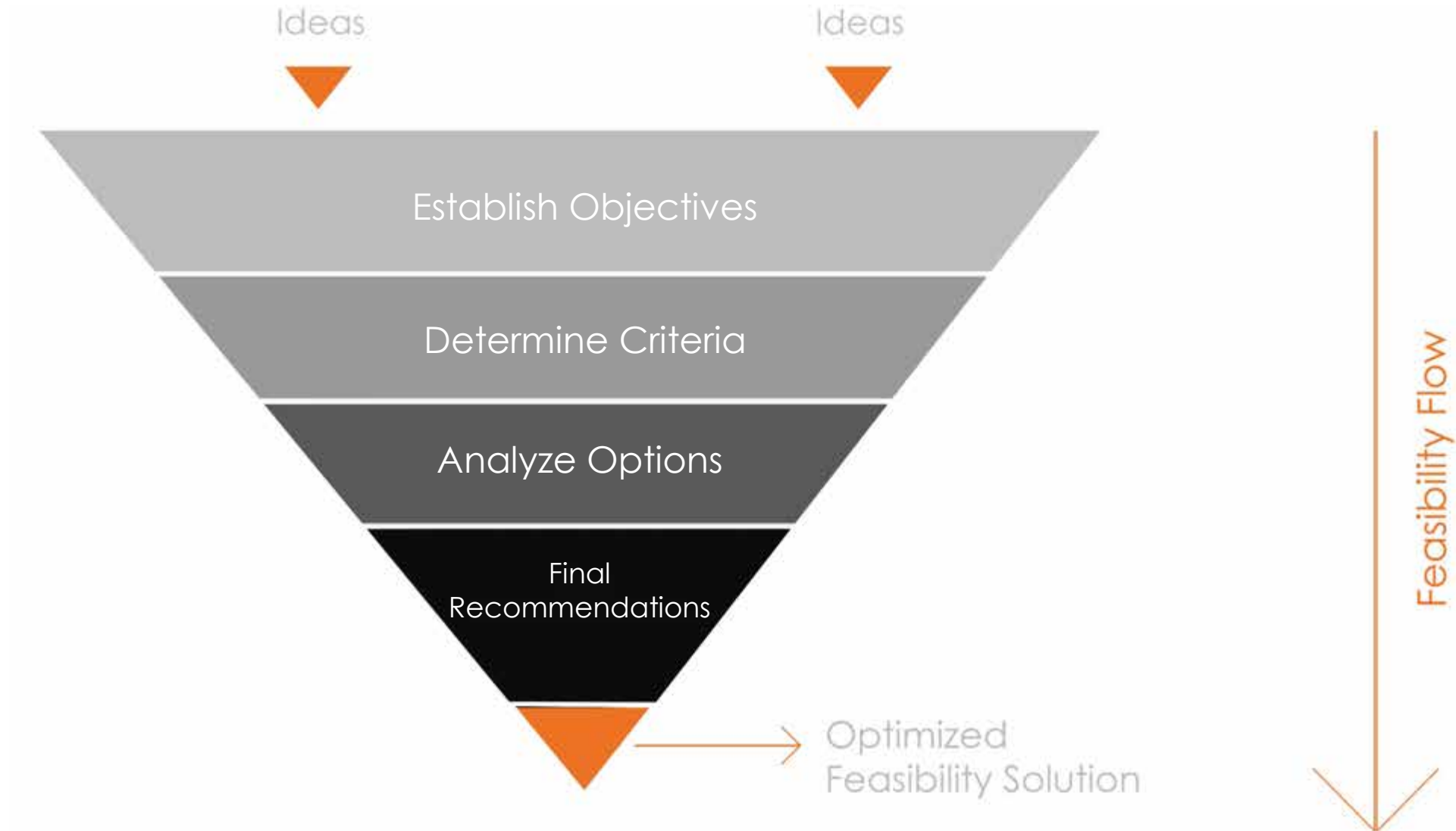
Neighbour/R&T Park
Owner

The Project Brief

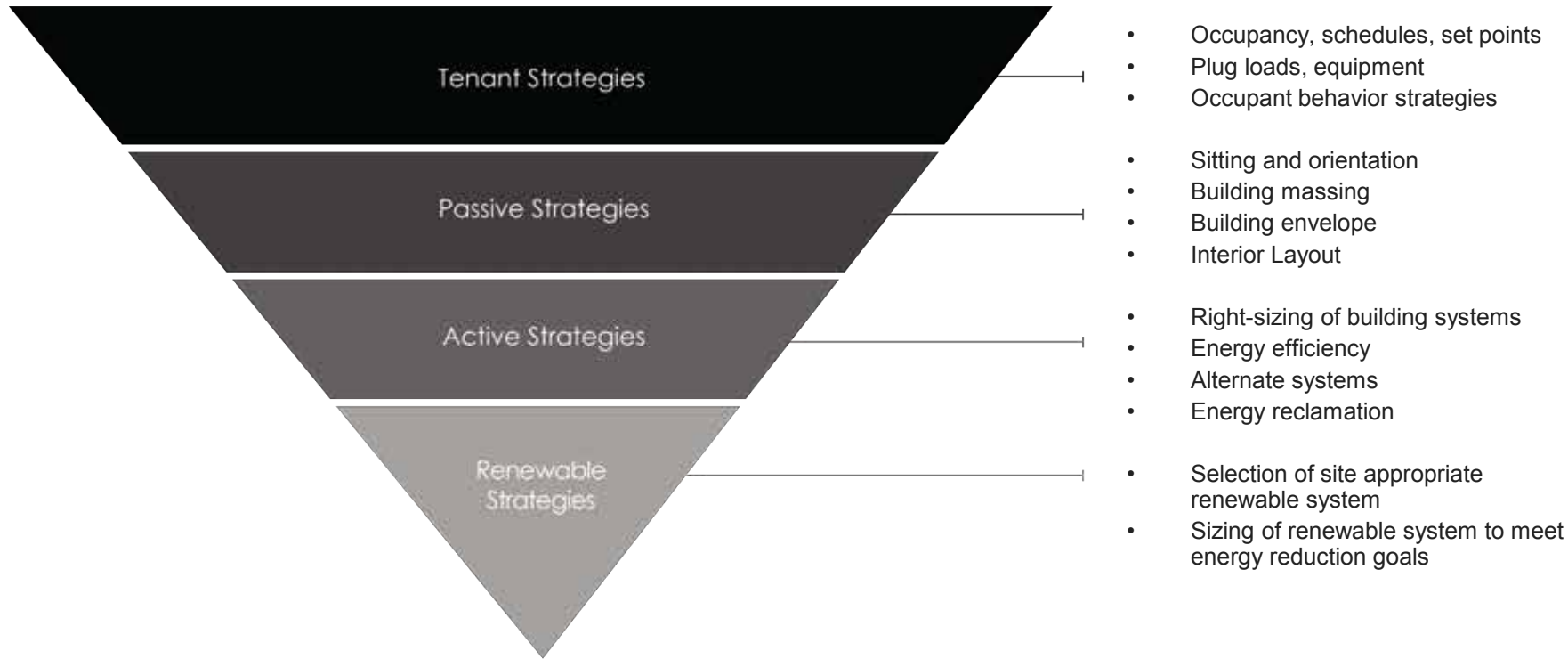
- Developer-led multi-tenant class - A office building
- 110,000 sf, three-storeys
- Leasable within current market rates and conditions, including parking demands
- Supportive of tech community as likely tenants – incubator to blue chip
- Sustainable model / living lab
- Net positive energy
- Net zero carbon, water, waste
- Design process
 - **Feasibility Study**
 - **Likely Full Building Design**



Feasibility Study: Ground rules



Feasibility Study: Ground rules





Project Team

Toronto | Waterloo | Markham
Mississauga | Vancouver

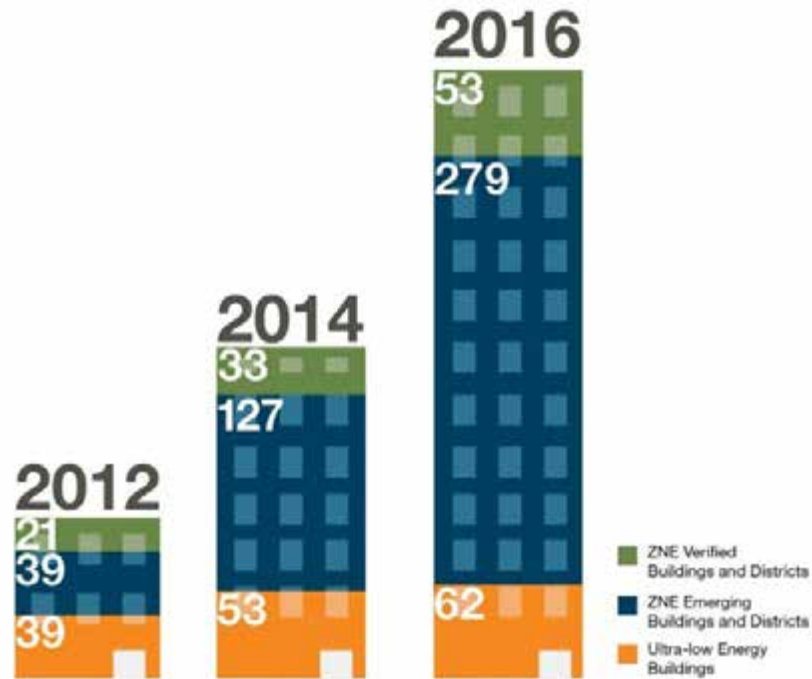
- Architecture, Interior Design
- Sustainability & Energy
- Mechanical, Electrical, Structural Building Engineering
- Photovoltaic Engineering
- Landscape Architecture
- Civil Engineering
- Geothermal Design
- Geotechnical Engineering
- Marketing and BD Team



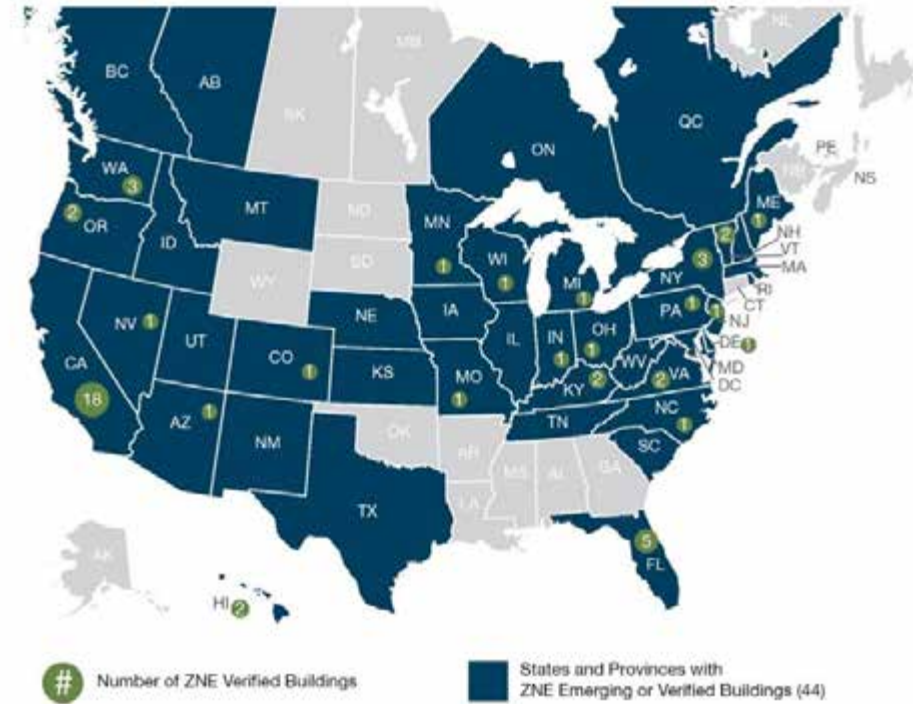
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Number of ZNE Projects



ZNE Building Locations in North America



Leadership in ZNE

ZNE projects have grown by 75% since 2015

Source credit: New Buildings Institute | newbuildings.org

Parametric Simulations

Building Design

The building energy design is characterized by the features that can affect **energy** use.

Parametric Simulations

- Investigate all design scenarios under consideration, no need to narrow down to a few cases.
- Work from targets to find all solutions that would meet the target.
- Include capital cost increment to identify most cost-effective option.
- More advanced costing calculations such as net-present value calculations can be included.

Building Energy Use

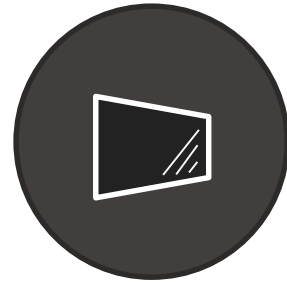
Building energy use is affected by design features and operational systems.



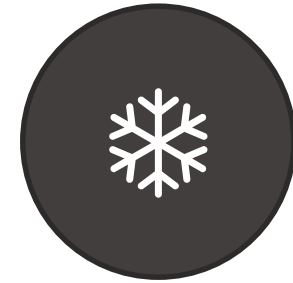
HOT WATER



HEATING



ENVELOPE



COOLING

Calculating Building Cost with Choices

The hard costs of the features and building systems affect the overall building construction cost.



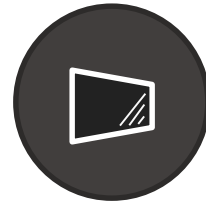
HOT WATER

- \$ Hot water use reduction
- \$\$ Efficient water heating
- \$\$\$ Solar thermal



HEATING

- \$ Standard gas boiler
- \$ Efficient gas boiler
- \$\$ Direct electric
- \$\$ Heat pumps
- \$\$\$ Solar thermal



ENVELOPE

- \$ Average performance double glazing
- \$\$ High performance double glazing
- \$\$ Triple glazing
- \$\$\$ Wall insulation
- \$\$\$ Roof insulation



COOLING

- \$ Solar shading
- \$ Natural ventilation
- \$\$ Reflective surfaces
- \$\$ Passive cooling
- \$\$\$ Chiller, standard performance
- \$\$\$ High performance chiller

Choosing Feature Options

Including capital and operational costs allow for informed choices.



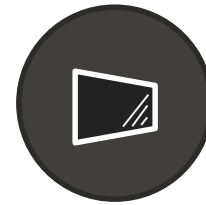
HOT WATER

\$	Hot water use reduction	\$\$\$
\$\$	Efficient water heating	\$\$
\$\$\$	Solar thermal	\$



HEATING

\$	Standard gas boiler	\$\$\$
\$	Efficient gas boiler	\$\$
\$\$	Direct electric	\$\$
\$\$	Heat pumps	\$\$
\$\$\$	Solar thermal	-\$



ENVELOPE

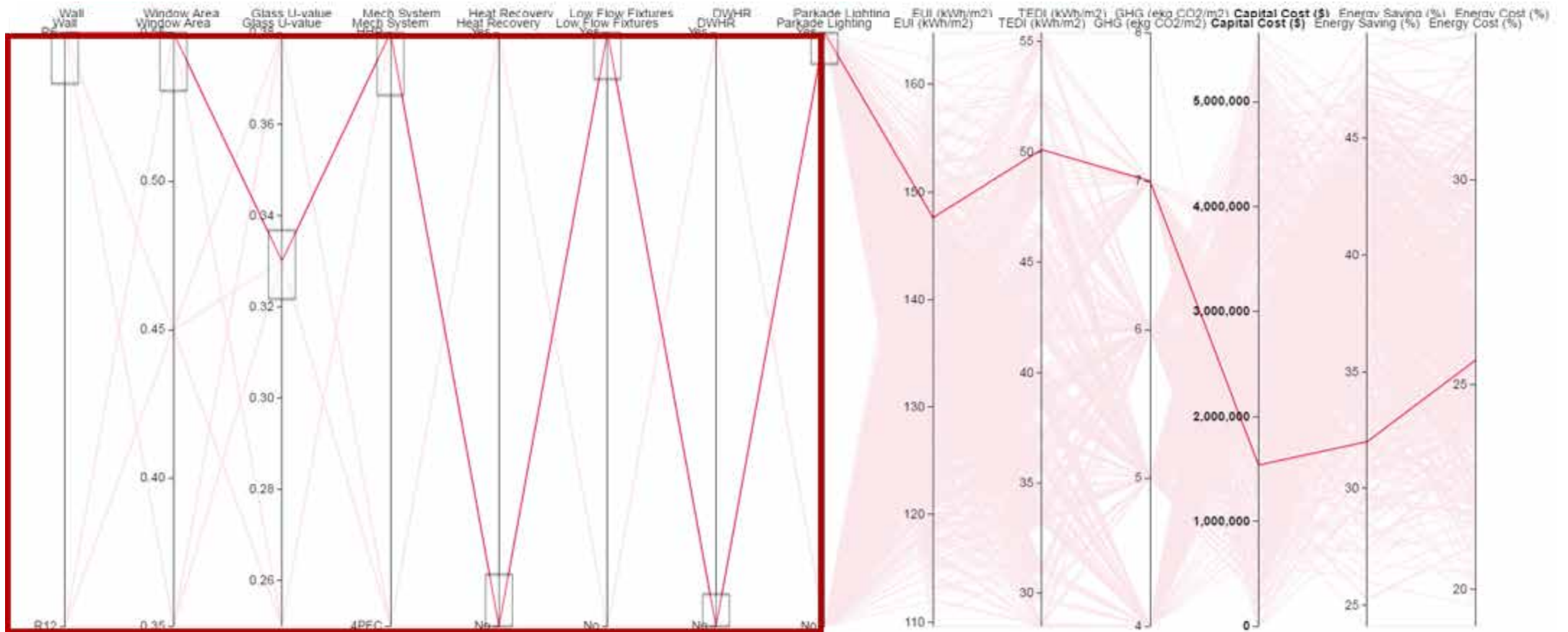
\$	Average performance double glazing	\$\$\$
\$\$	High performance double glazing	\$\$
\$\$	Triple glazing	\$\$
\$\$\$	Wall insulation	\$
\$\$\$	Roof insulation	\$



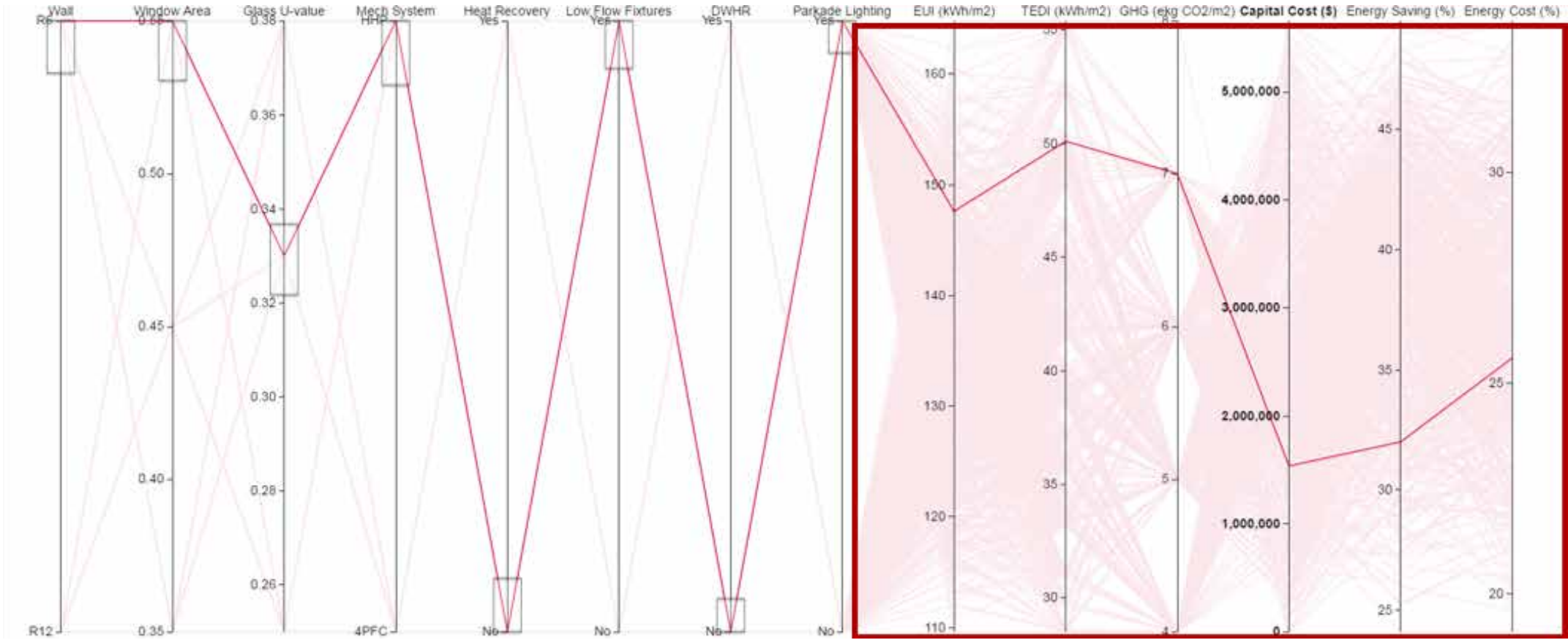
COOLING

\$	Solar shading	\$\$\$
\$	Natural ventilation	\$\$
\$\$	Reflective surfaces	\$\$
\$\$	Passive cooling	0
\$\$\$	Chiller, standard performance	0
\$\$\$	High performance chiller	-\$

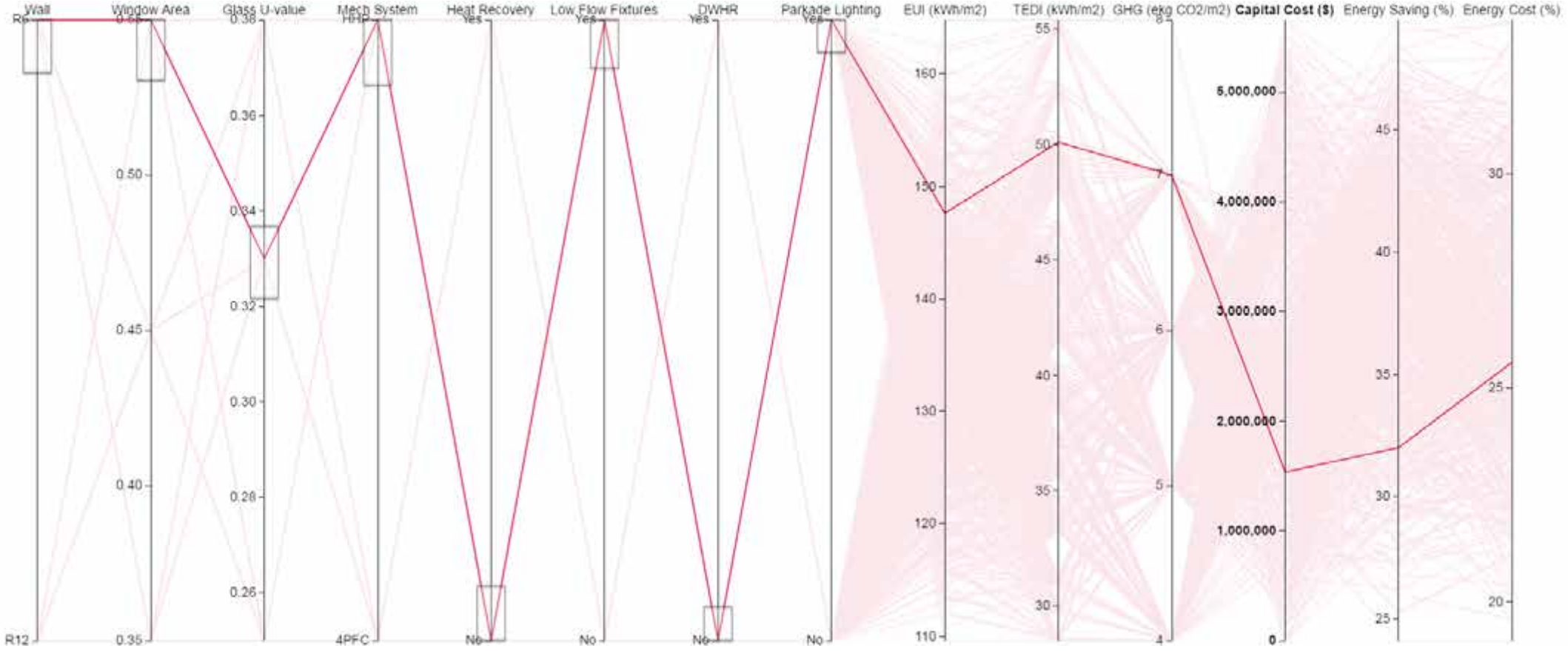
Input Parameters



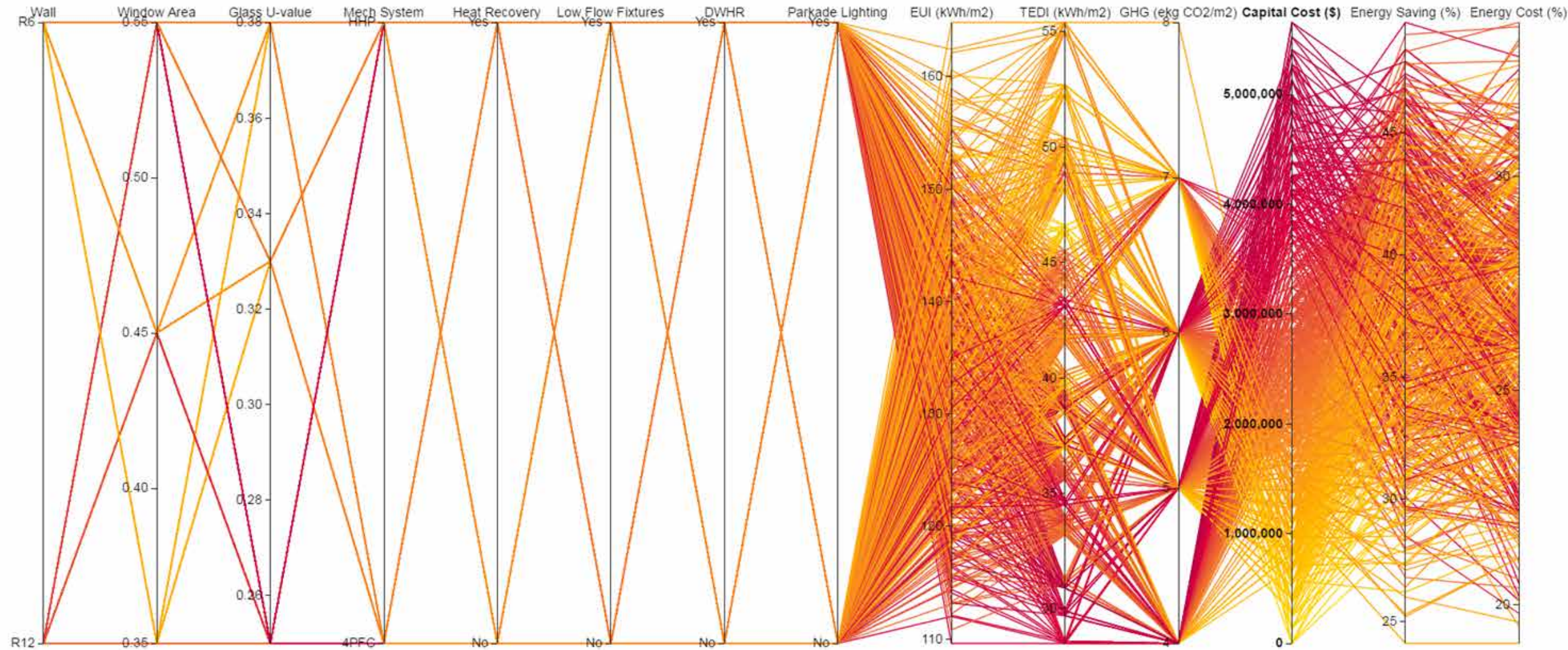
Input Parameters



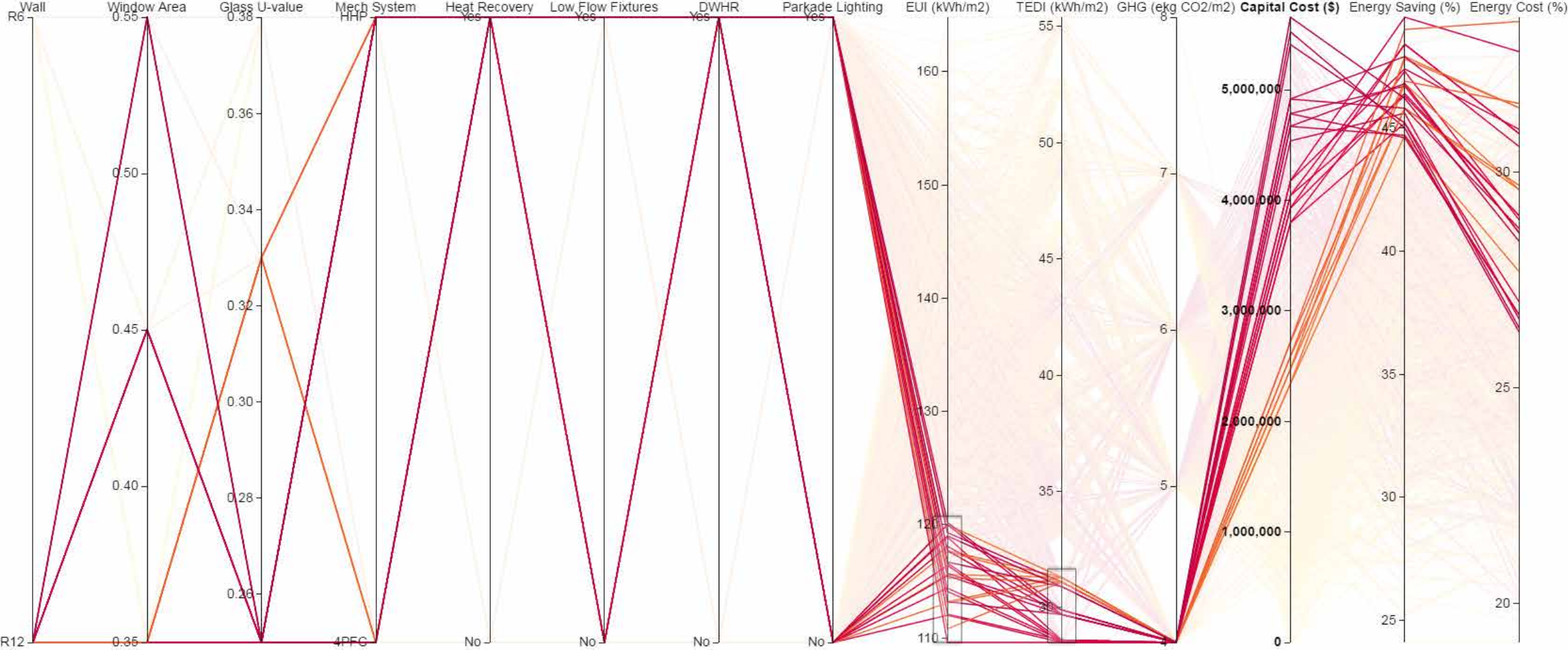
One Single Simulation



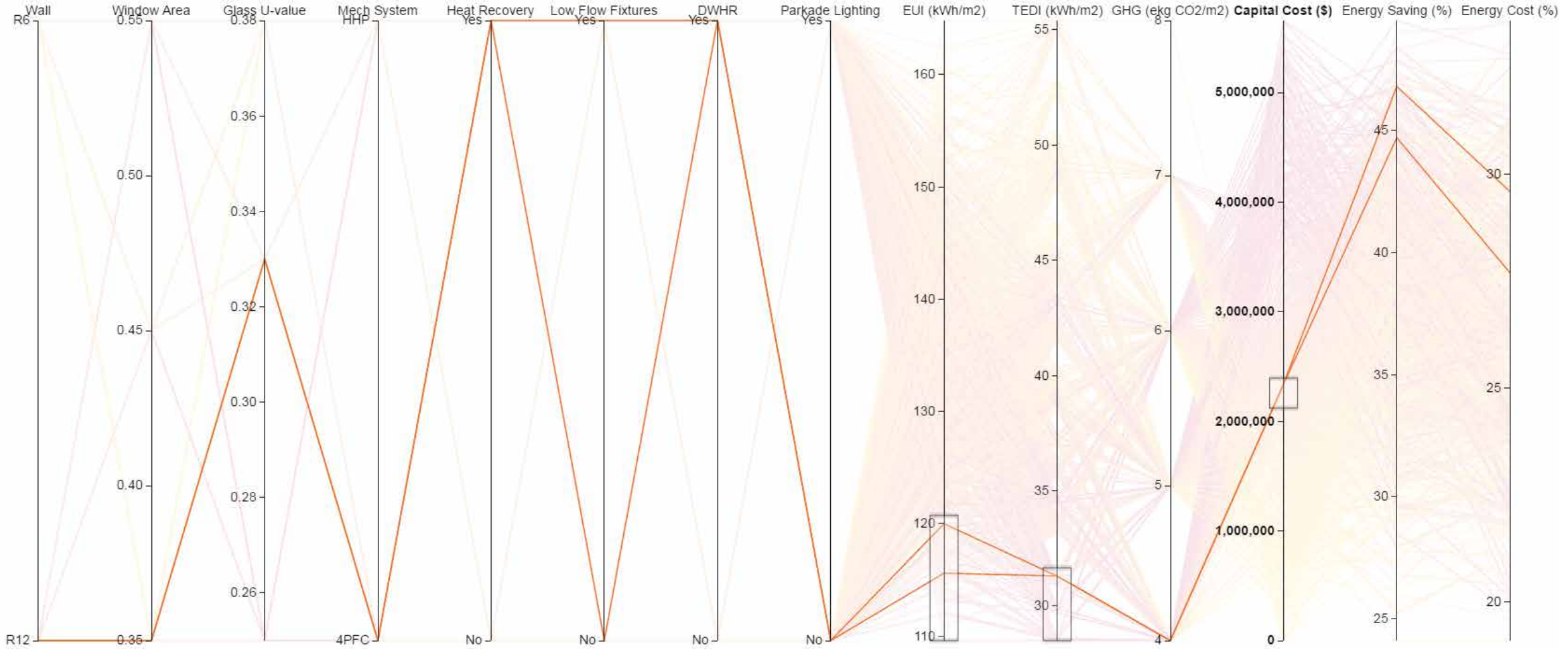
Full Data Set



New CoV Rezoning Requirements



Lowest Cost Option

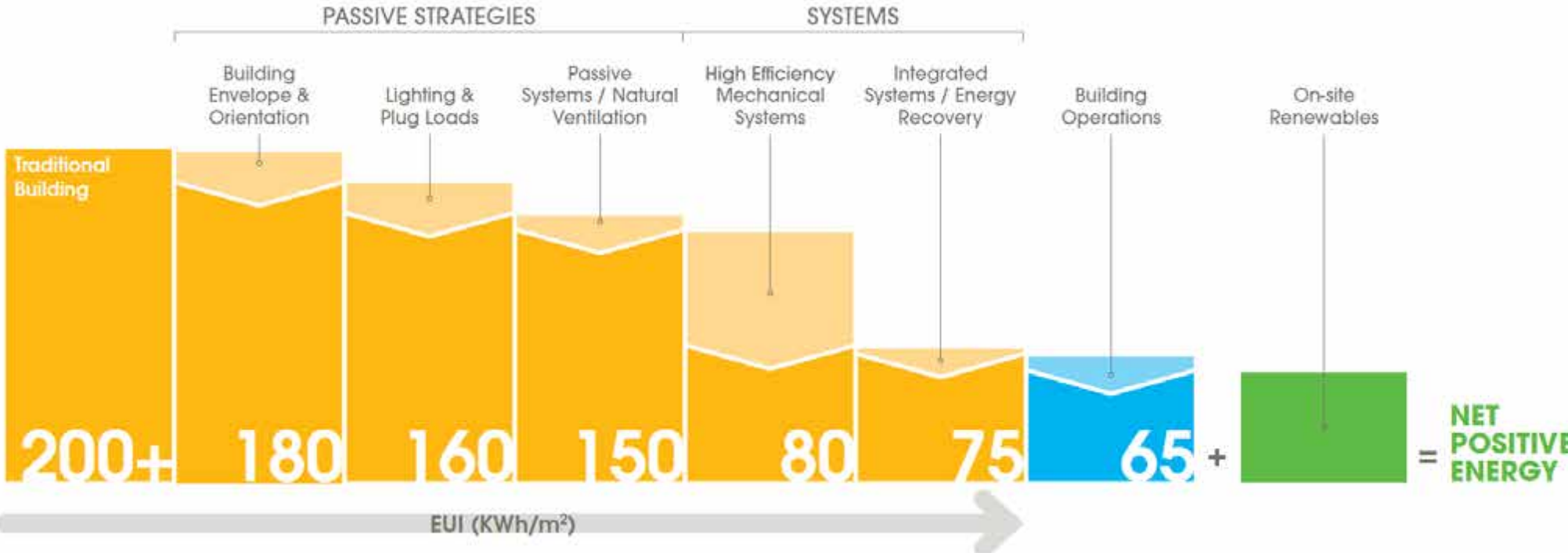




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Reducing Loads



What Evolv1 Achieved with Energy

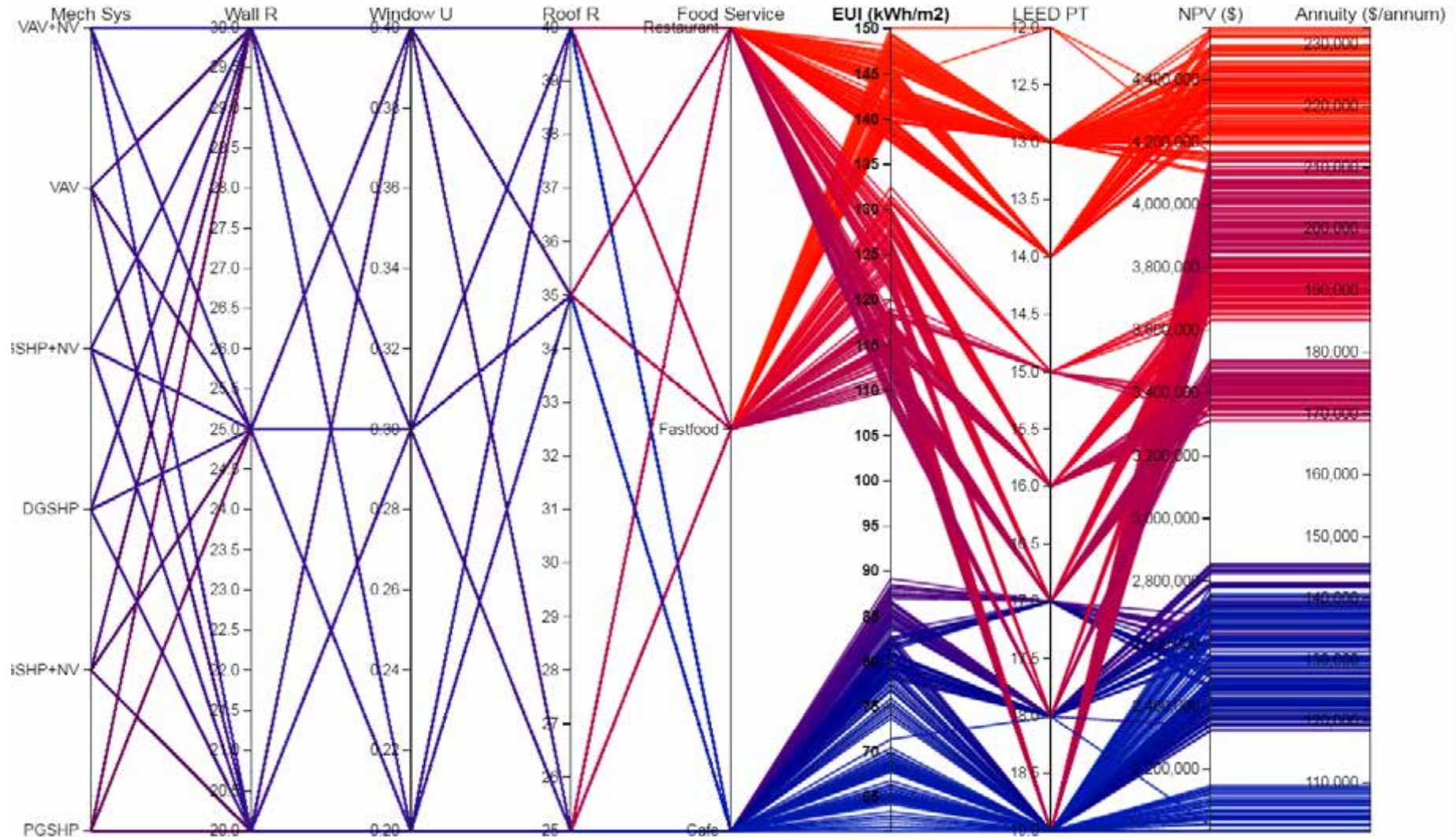
TEDI targets for ZCB-Design certification

Climate Zone	TEDI target (kWh/m ² /year)
4	30
5	32
6	34
7	36
8	40

TEDI	24 kWh/m ² -a
EUI	81 kWh/m ² -a
Peak	386 kW

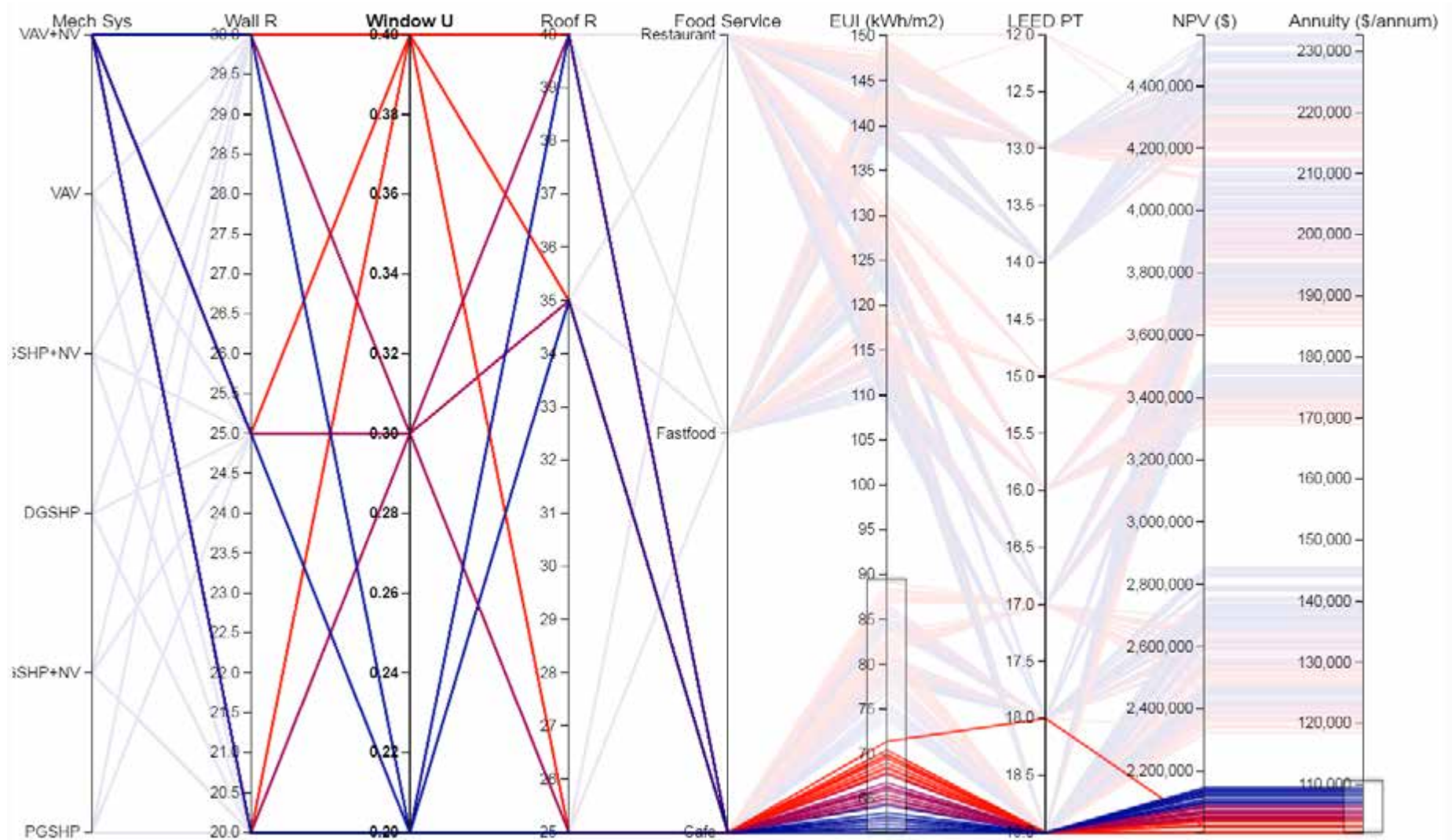
Space Usage

Food Service



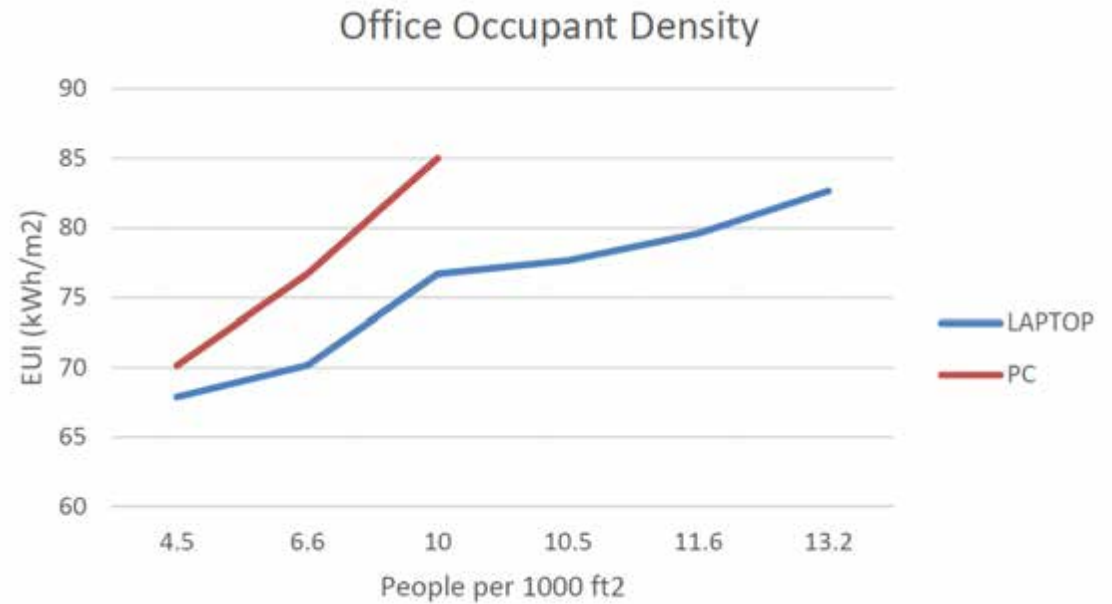
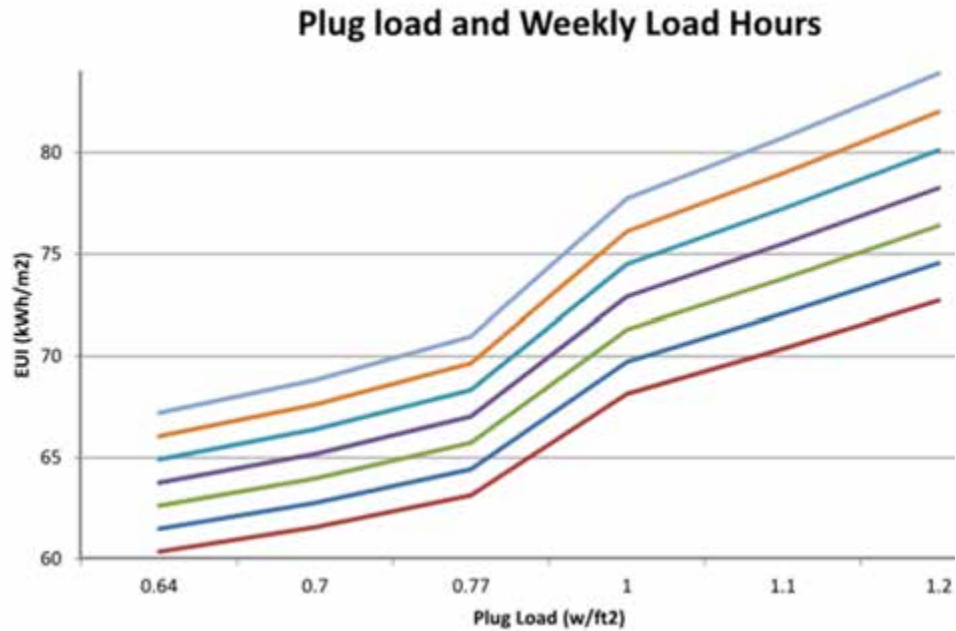
Space Usage

Lowest EUI and NPV



Occupant Behavior

Densities, schedules and equipment



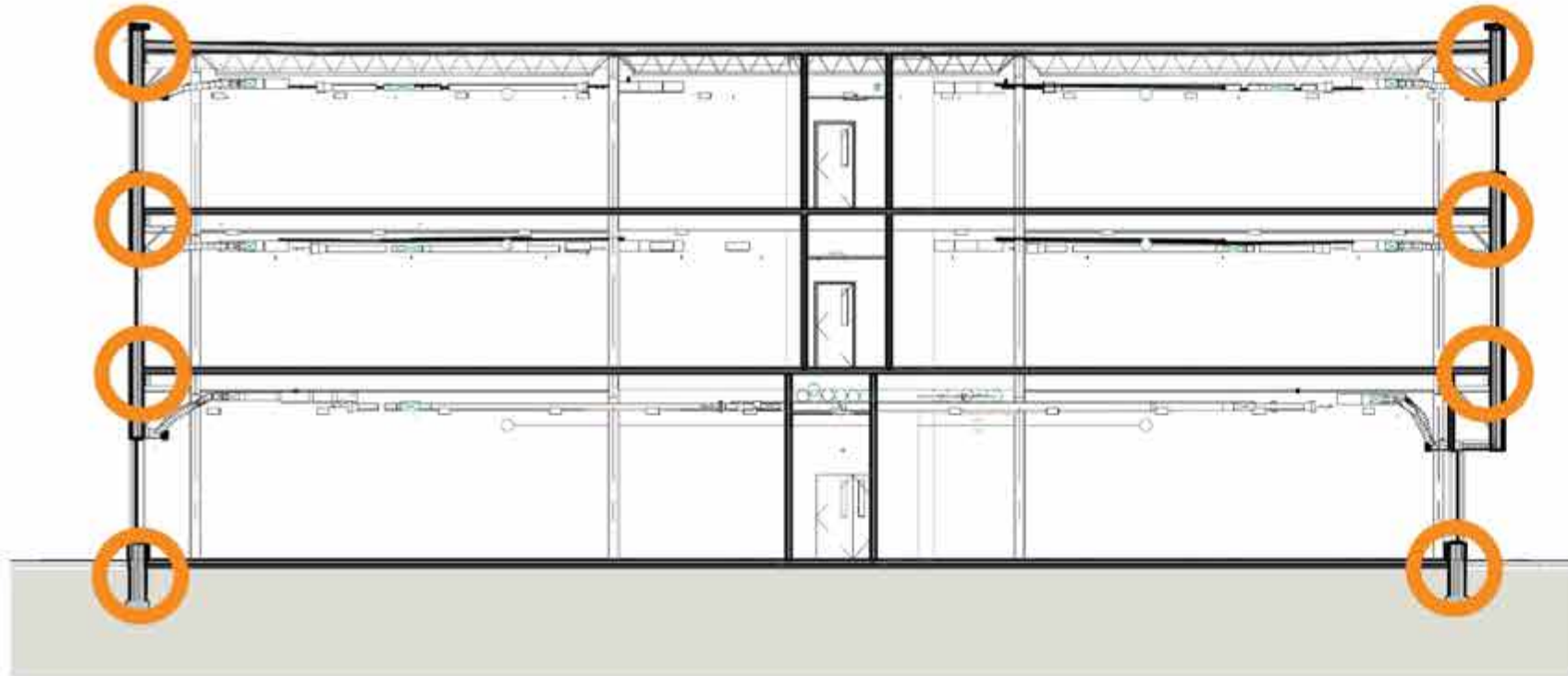
Energy Analysis Results Envelope

Densities, schedules and equipment

- R-30 walls
- Solar wall on part of the southern façade
- U-0.2 windows
- WWR <40%
- R-40 roof
- R-15 perimeter insulation for slab on grade

Thermal Bridges

R-value is reduced by 65% relative to the clear field value.



Energy Analysis Results

HVAC Systems - GSHP and VRF

- VRF system, condenser tied into geo-exchange field
- Perimeter heating system serving the ground floor
- Heat recovery ventilation, 70% efficiency
- DOAS sized to deliver free cooling and dehumidification
- Demand control ventilation
- Central heat pump plant with COP > 3.1
- Geo-exchange field
- Fluid cooler
- Back-up boiler

Energy Analysis Results

Electrical Systems

- LED lighting (6 W/m²)
- Reduced workstation plug loads through use of laptops, centralized printers, fax
- High efficiency UPS power backup for data centre/LAN room and critical loads
- Battery backup for life safety systems – excludes diesel generator
- Solar energy PVs – small DC motors are powered directly

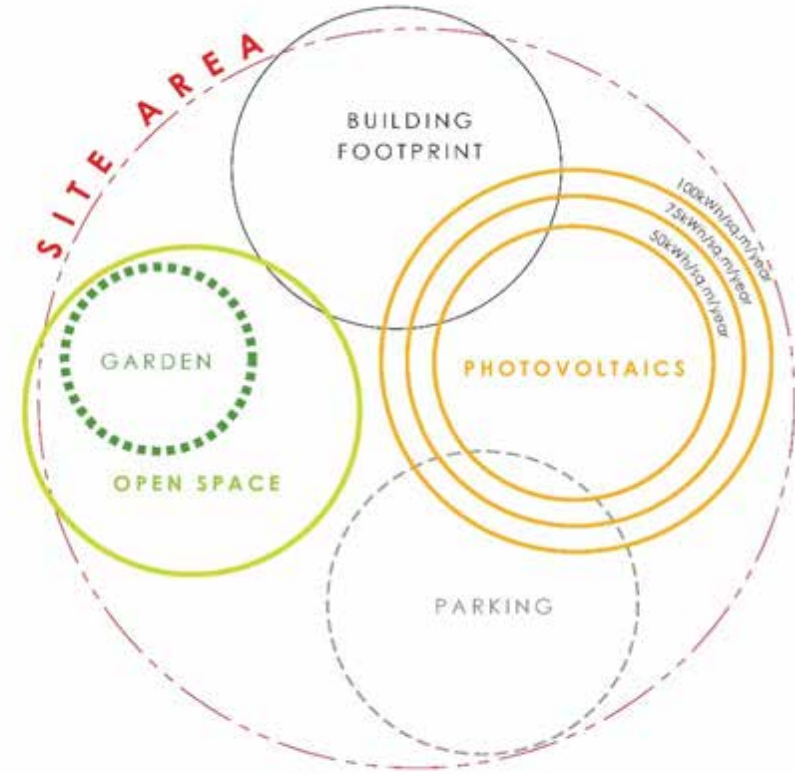
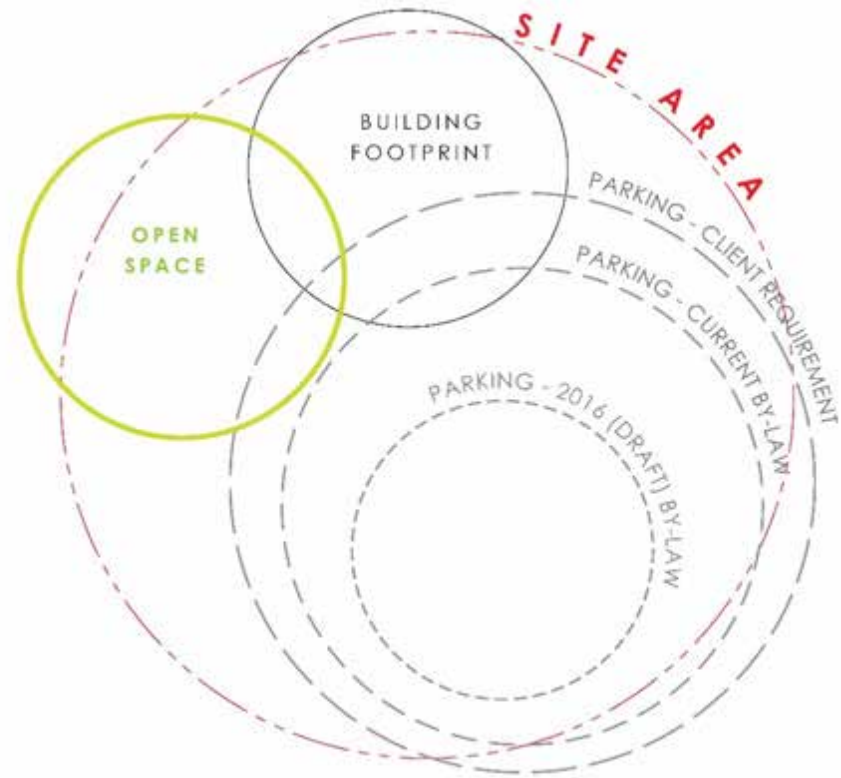
Energy Analysis Results

Control Systems

- Occupancy sensors
- Daylight sensors
- Programming – commissioning – training for users
- Outdoor lighting controlled by timers and photocell

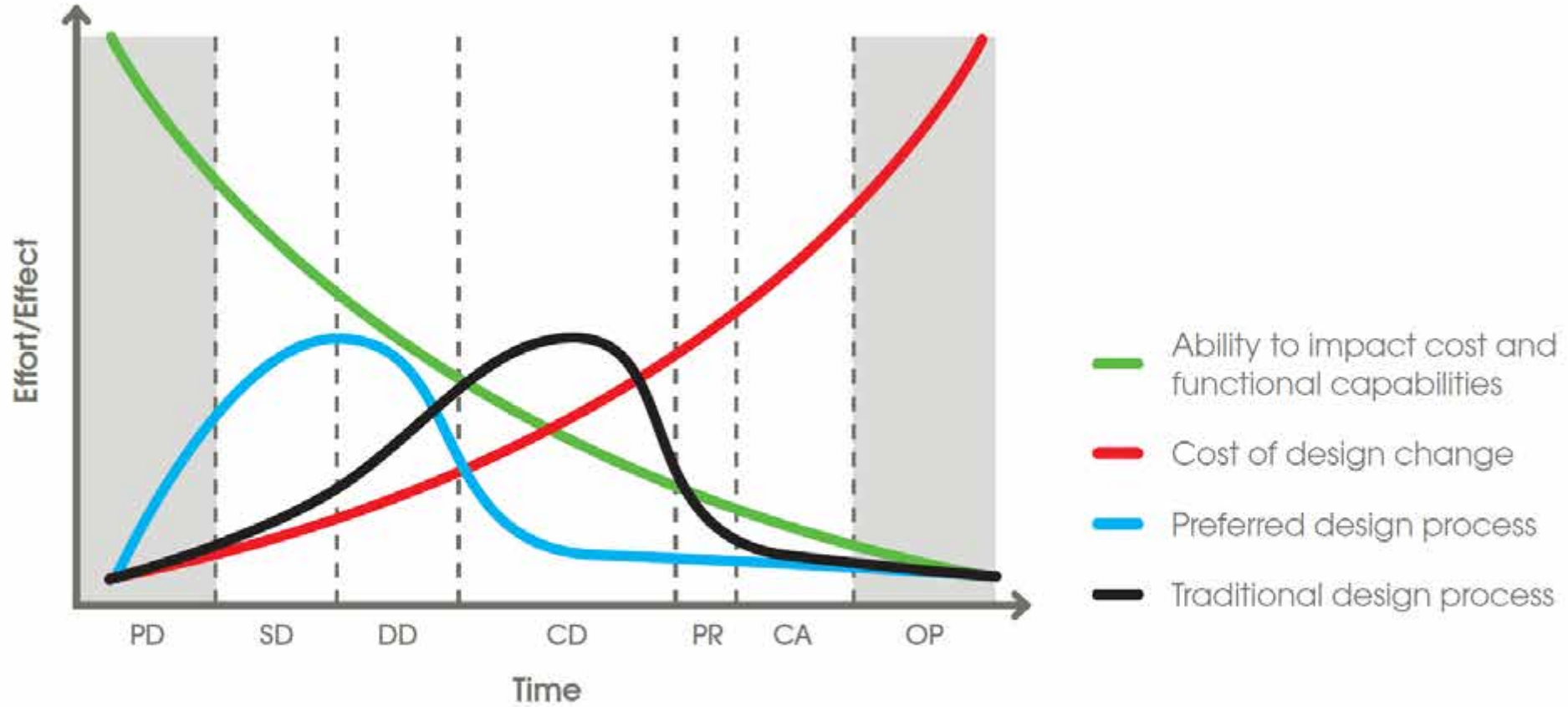
Site Usage

Parking vs. Green Space vs. Renewables



Lessons Learned

Integrated Design



Project Effort and Impact

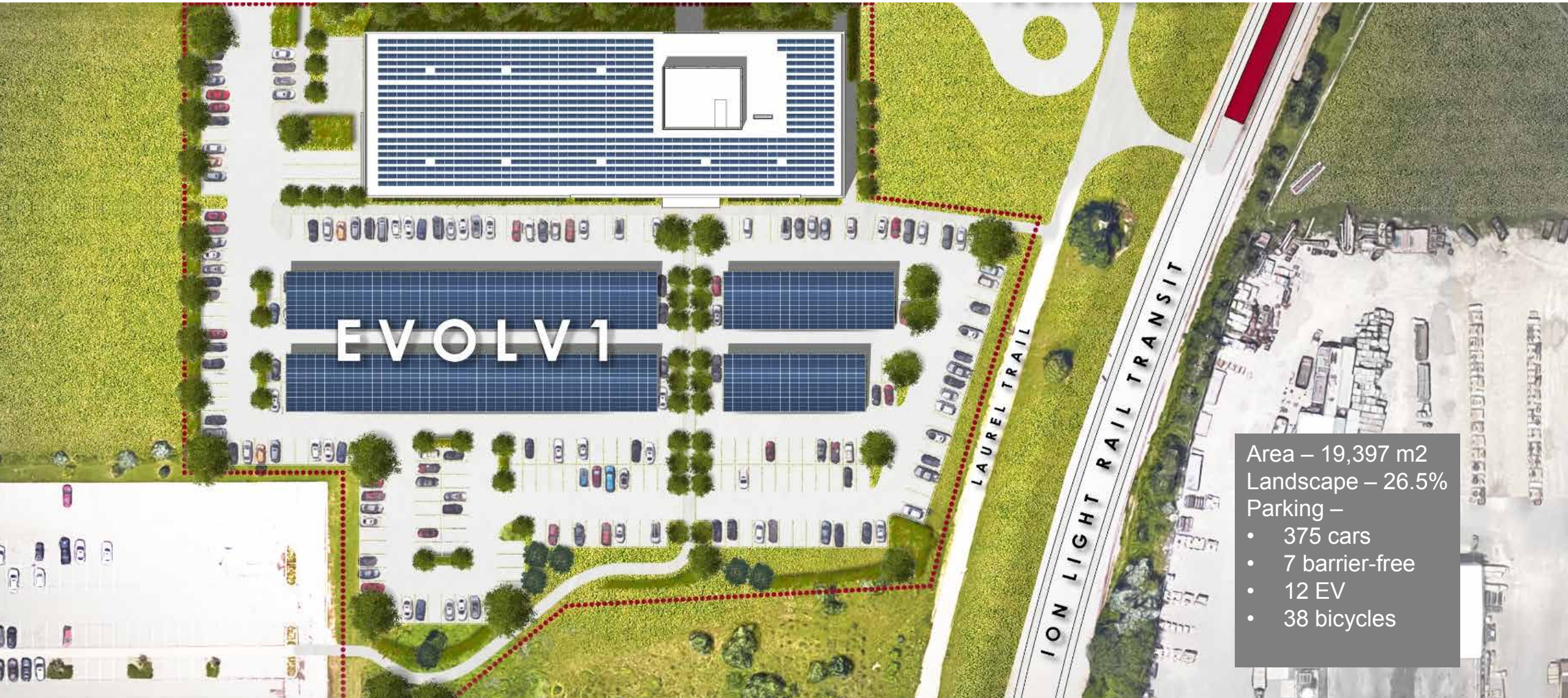


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Development

Site Plan



EVOLV1

LAUREL TRAIL

ION LIGHT RAIL TRANSIT

- Area – 19,397 m²
- Landscape – 26.5%
- Parking –
 - 375 cars
 - 7 barrier-free
 - 12 EV
 - 38 bicycles

Feasibility

Southeast View



Feasibility

Collaborative Hub

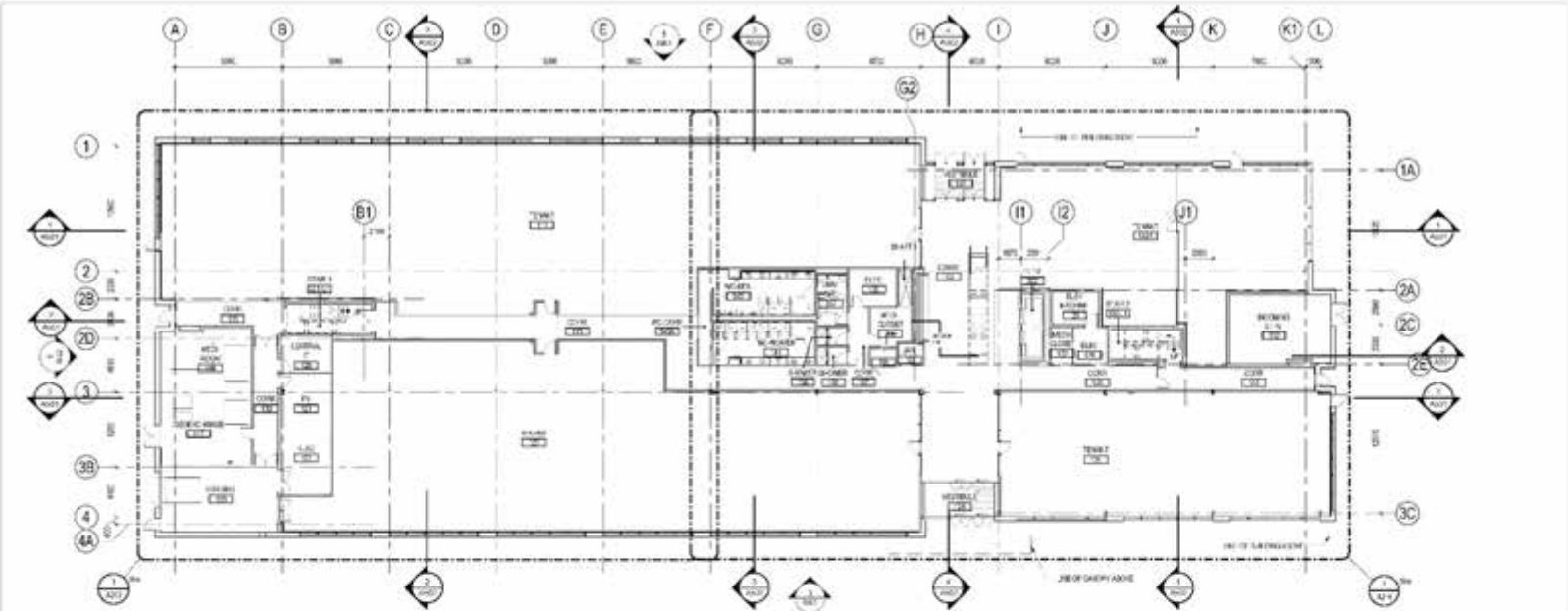


Feasibility to Development

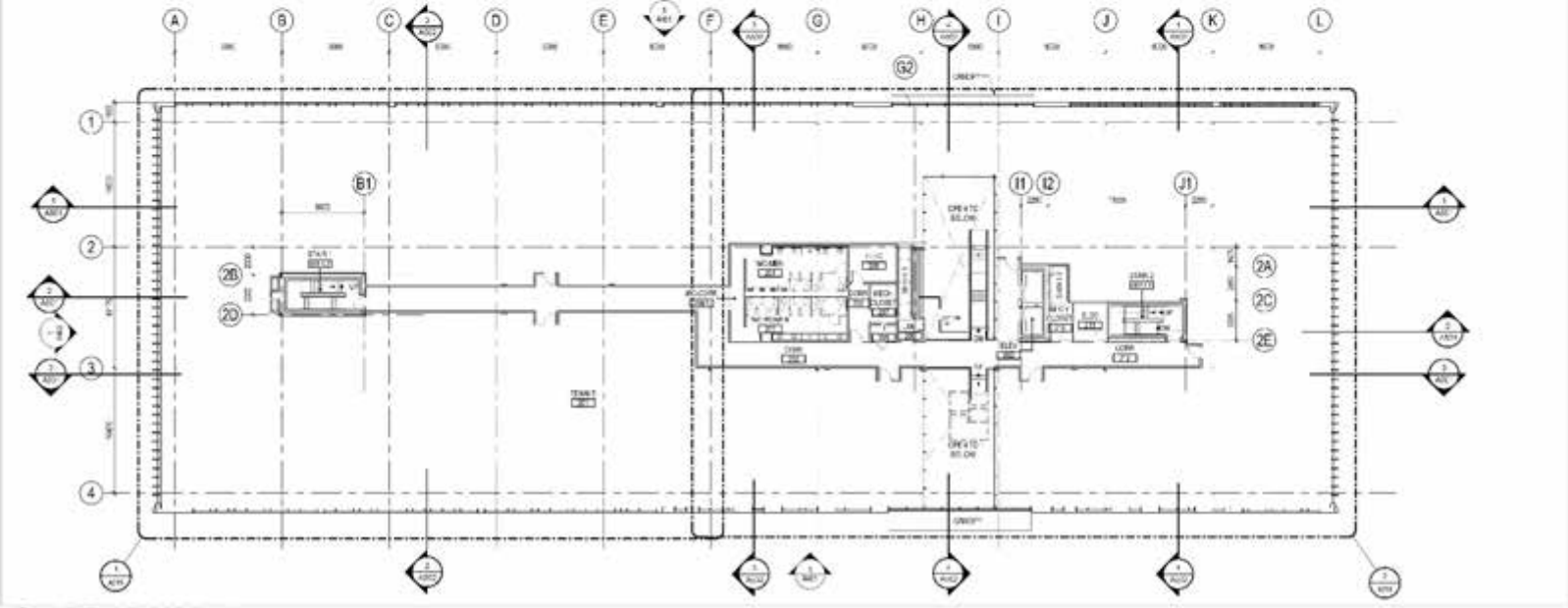


Development

Floor Plans



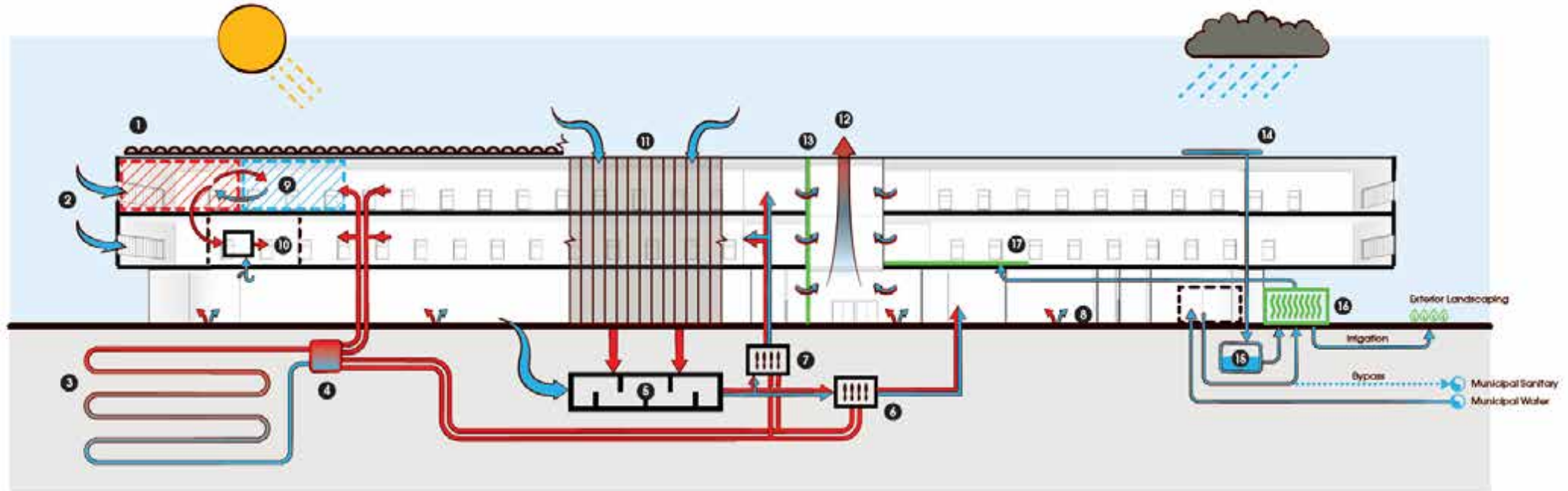
1 LEVEL 1 (GROUND) FLOOR PLAN
A301 1/32



2 LEVEL 2 FLOOR PLAN
A301 1/32

Feasibility

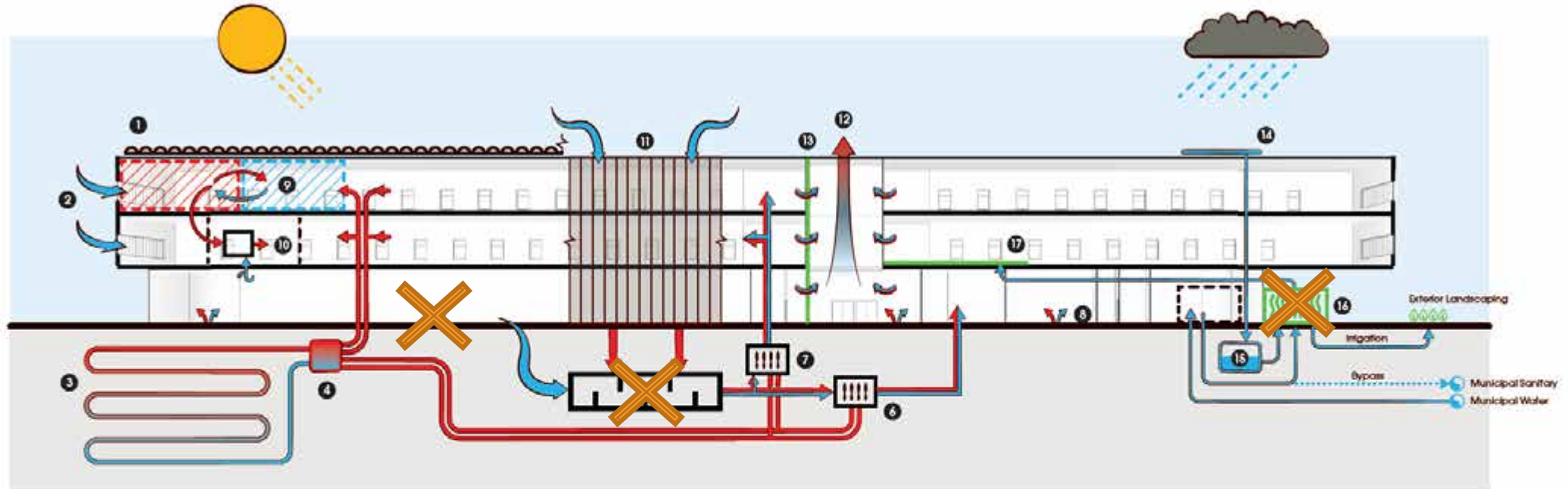
Integrated Systems



- | | |
|--|---|
| 1 PV Array to provide 105% of energy demands | 9 Water Cooled VRF for heating and cooling across 2nd and 3rd floors |
| 2 Operable Windows to introduce ventilation air | 10 Domestic Hot Water generated from recovered heat in VRF system |
| 3 Geo-Exchange Field for heating and cooling | 11 Solar Wall to pre-condition ventilation air |
| 4 Heat Exchange to tie into geo-exchange field | 12 Atrium/Stack Effect to naturally draw air through the atrium and spill air from each floor |
| 5 Labyrinth to pre-condition ventilation air | 13 Living Wall for natural filtration |
| 6 Displacement Ventilation for ground floor | 14 Rain Water Collection |
| 7 Pre-Conditioned Ventilation for 2nd and 3rd floors | 15 Rain Water Cistern |
| 8 Displacement Ventilation through floor | 16 Living Machine to naturally filter grey and black water |
| | 17 Green Roof Canopy |

Development

Integrated Systems



1 PV Array to provide 105% of energy demands

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17 Green Roof Canopy

Development

Southeast



Development

Northeast





Collaboration Hub

From Feasibility to Final Design

- Defining the occupants
- Profile of density and energy patterns
- Ensuring leas-ability
- Spaces for interaction





Collaboration Hub

Achievements



- It is being built!
- Certified by CaGBC - Net Zero Carbon – First in Canada
- Net Positive Energy – 105% of energy used, annually
- LEED Platinum – targeting
- Core & Shell completion – July 2018
- small DC motors are powered directly

Reinventing the Way You Build

By Adrian Conrad, President and
CEO Cora Development Inc.

"...With a shared project goal in hand, the team then set out to find a design firm that would share and deliver on our vision. By sheer chance, that firm happened to be located literally under our noses in the R+T Park. Stantec, a global professional services firm had all we were looking for; cross disciplinary expertise in sustainability, solar, architecture, hydrogeology, geothermal, mechanical engineering - you name it they had it - all under the same roof. And beyond that, the people on the Stantec team represented the rock stars of their respective disciplines. *These folks truly thought outside of the box; sharing our vision for doing something truly disruptive in the industry.*"

An aerial photograph of a rugged mountain landscape. The foreground shows a rocky, light-colored slope with a small waterfall. In the middle ground, there is a small settlement with buildings and a road. The background features a steep, forested mountain peak partially obscured by mist or clouds.

Thank You

Questions?



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