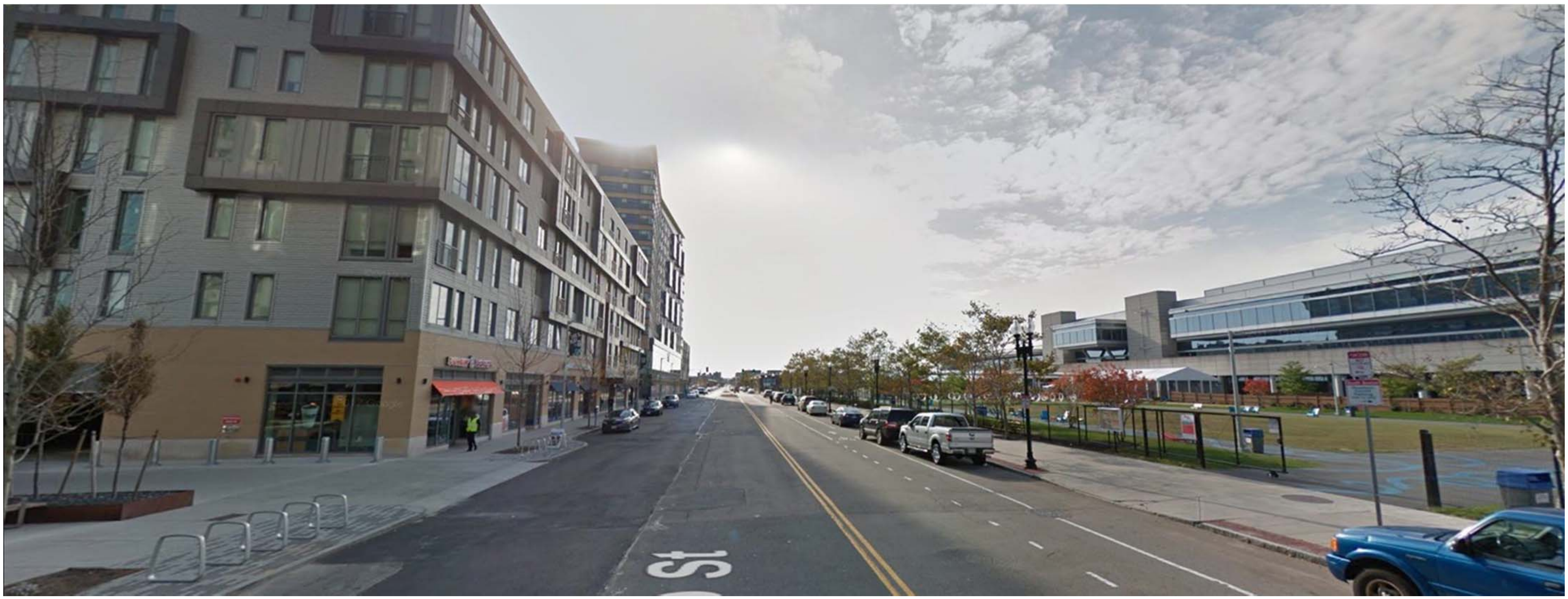

Boston Seaport District: Nathan Brown, Mario Giampieri, Ellie Jungmin Han, NJ Namju Lee

Overview

- Context / Project Goals
- Neighborhood Integration
  - 3 Protoblocks
- Efficiency: Protoblock Form
  - NV
  - Daylighting
  - PV/Energy Usage
- Resiliency: Block Distribution
  - Coastal Flooding
  - Climate Change
  - Permeable pavement / green roofs
  - park/ block distribution
- Livability: Access to Amenities
  - Walkability, parking, UTCI
  - Paths + 3rd Place
- Exploring Tradeoffs: PV vs. GR
- Conclusions


BOLTON ST
F St
South Boston
Resident
Permit
Parking
Street
Cleaning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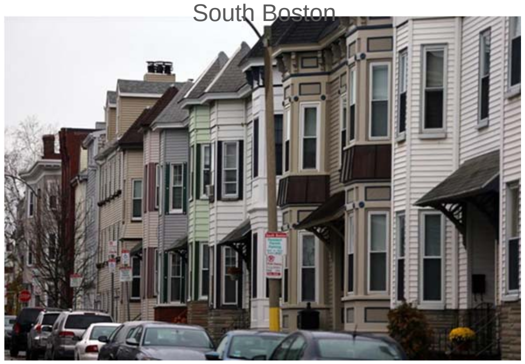
N

Urban Analysis

South Boston



Convention Center

Innovation District

Current Site

Efficiency

Energy

Daylighting

Natural ventilation

Renewables

Resiliency

Extreme events

Coastal flooding

Urban stormwater runoff

Risk- based zoning

Livability

Pedestrian-oriented

Green spaces

Access to amenities

Thermal comfort

Efficiency

Energy

Daylighting

Natural ventilation

Renewables

Resiliency

Extreme events

Coastal flooding

Urban stormwater runoff

Risk- based zoning

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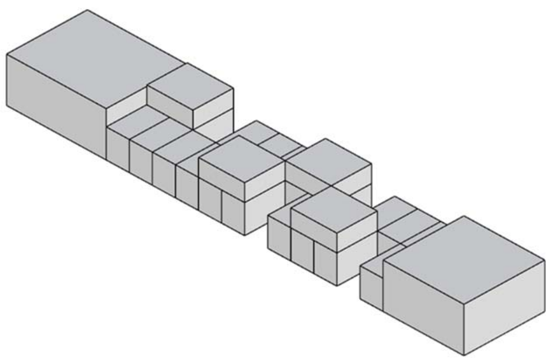
Protoblock Development

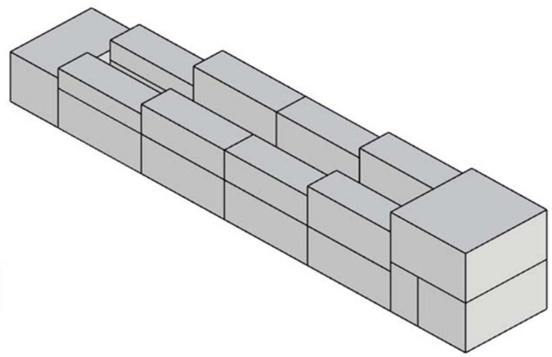
Protoblock Design



Houses and Corners

mostly residential + some commercial

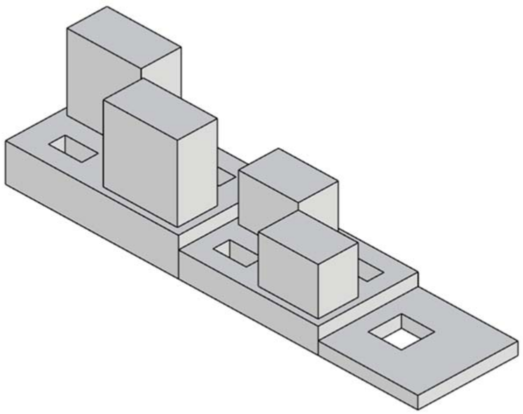
Protoblock 1



Stepped Mixed Use

residential above + commercial / retail below

Protoblock 2

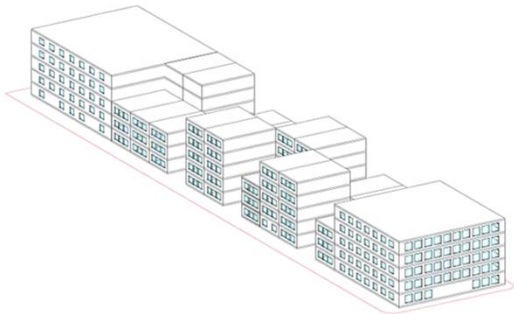


Environmental Mixed Use

Residential towers + commercial / retail below

Protoblock 3

Protoblock Design



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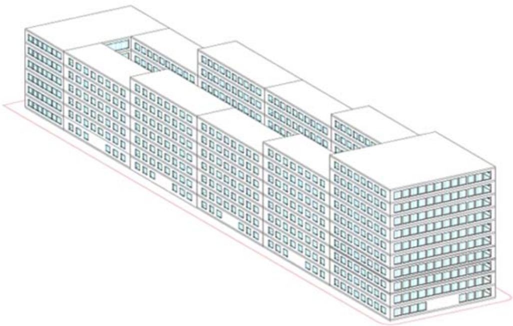
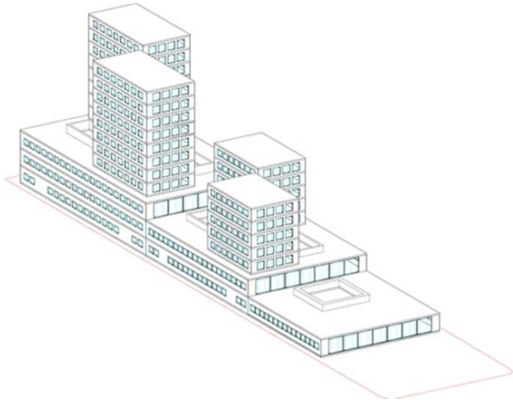
Protoblock 1



Stepped Mixed Use

residential above + commercial / retail below

Protoblock 2

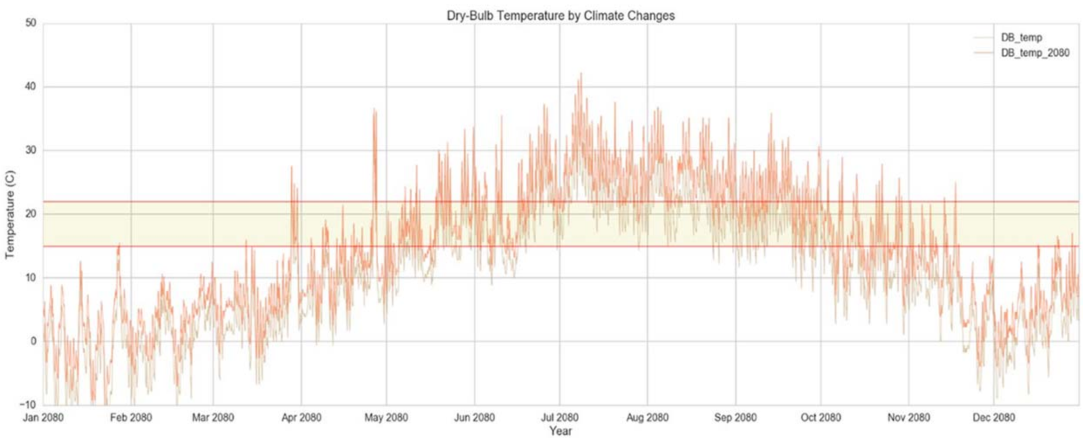


Environmental Mixed Use

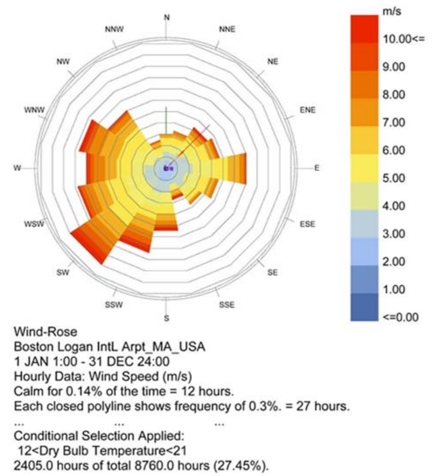
Residential towers + commercial / retail below

Protoblock 3

Climate Analysis



21% NV feasible days
Ave DB Temperature : 10.59 C
Ave Relative Humidity : 65.67 %



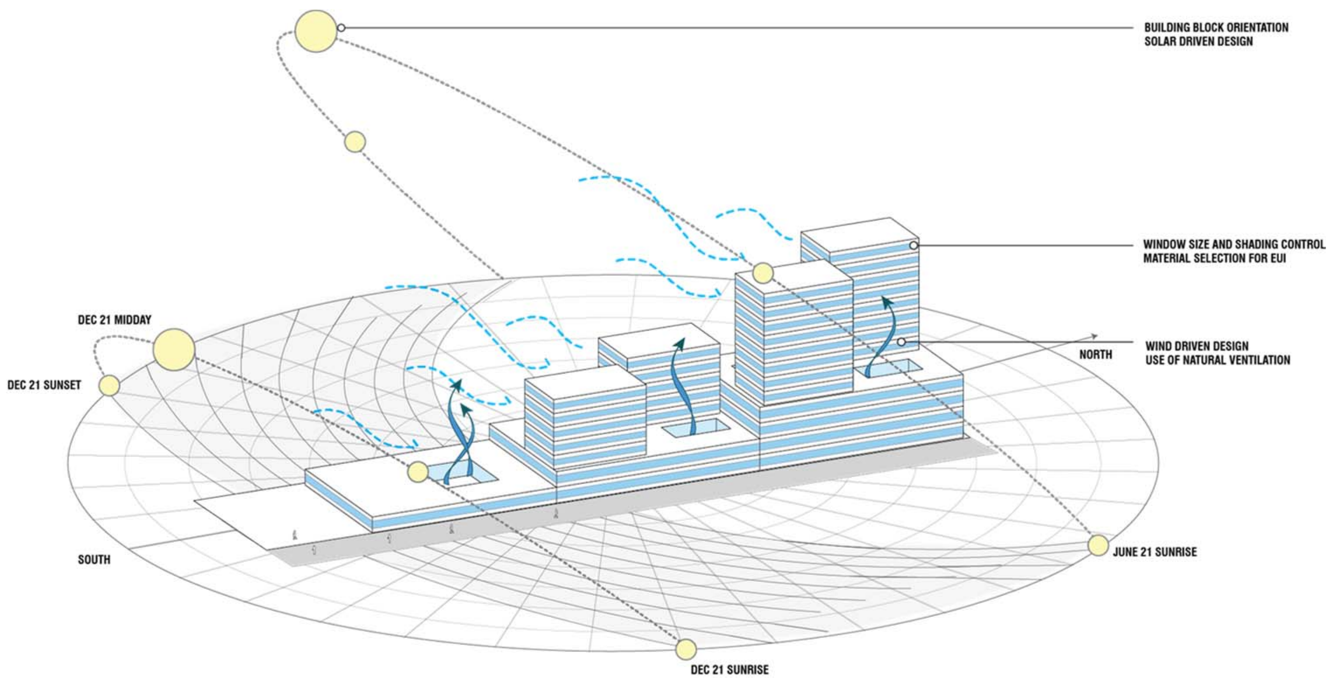
Ave Wind Direction : 219 from North
Ave Wind Speed : 5.48 m/s

Environmental Consideration

Envelope Design

Natural Ventilation

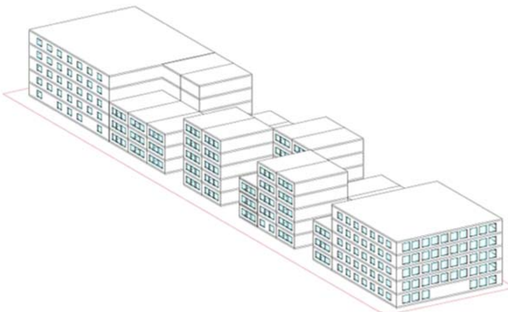
Daylighting



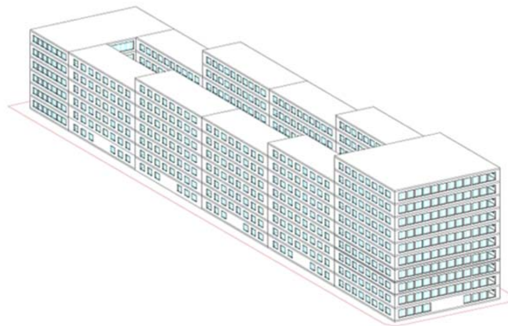
Sample Protoblock 2

Envelope Upgrade

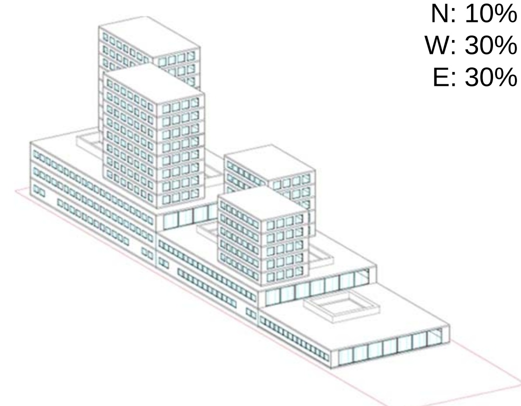
Optimized WWR
S: 50%
N: 10%
W: 30%
E: 30%



Protoblock 1

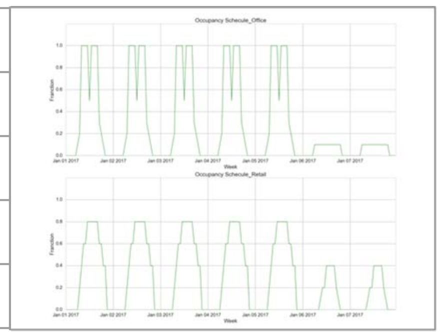


Protoblock 2

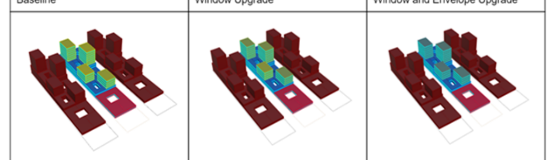


Protoblock 3

	Construction	U - value
Commercial Facade	Double-leaf brick + Insulation	0.073
Commercial Roof	Slate tile + Insulated concrete	0.040
Residential Facade	Double-leaf brick + Insulation	0.073
Residential Roof	Slate tile + Insulated concrete	0.045

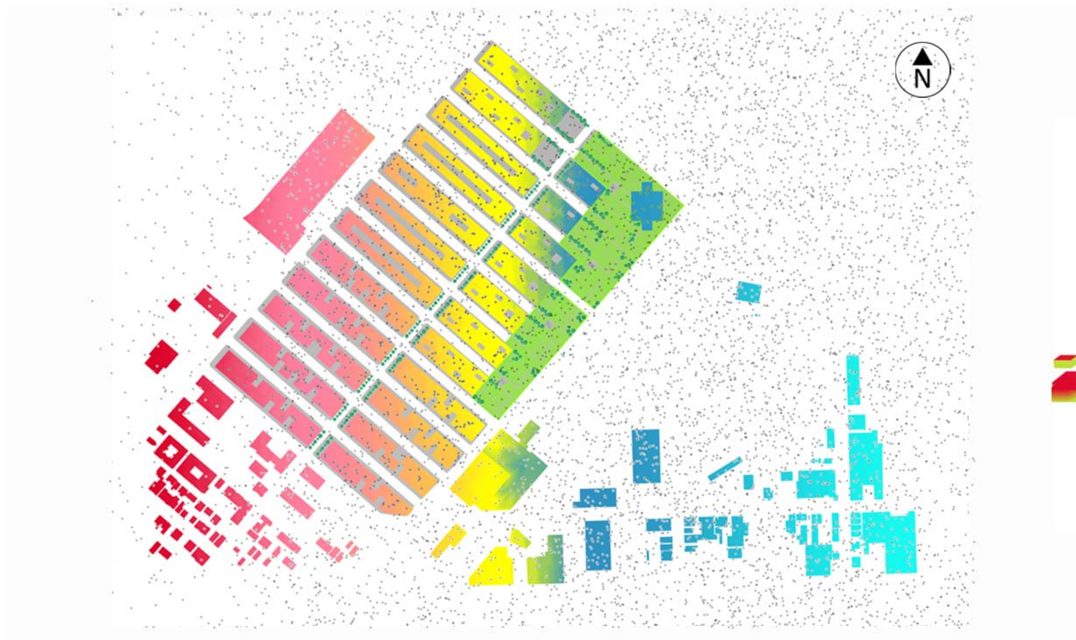


Baseline	Window Upgrade	Window and Envelope Upgrade

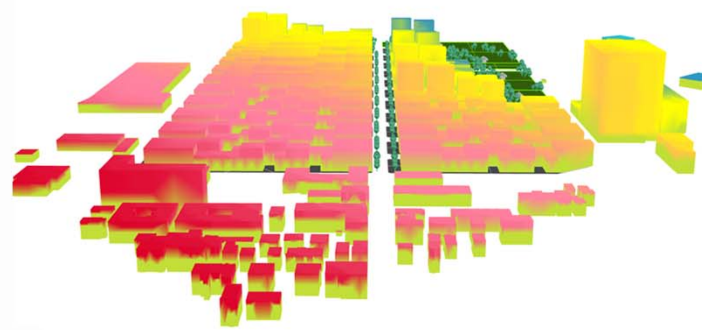


Ave. 125 kWh/m2	Ave. 119 kWh/m2	Ave. 117 kWh/m2
Residential High : 130	Residential High : 122	Residential High : 118
Residential Low : 130	Residential Low : 121	Residential Low : 118
Offices : 119	Offices : 115	Offices : 113
Retail : 141	Retail : 137	Retail : 135

Outdoor CFD



Running outdoor CFD On Protoblock

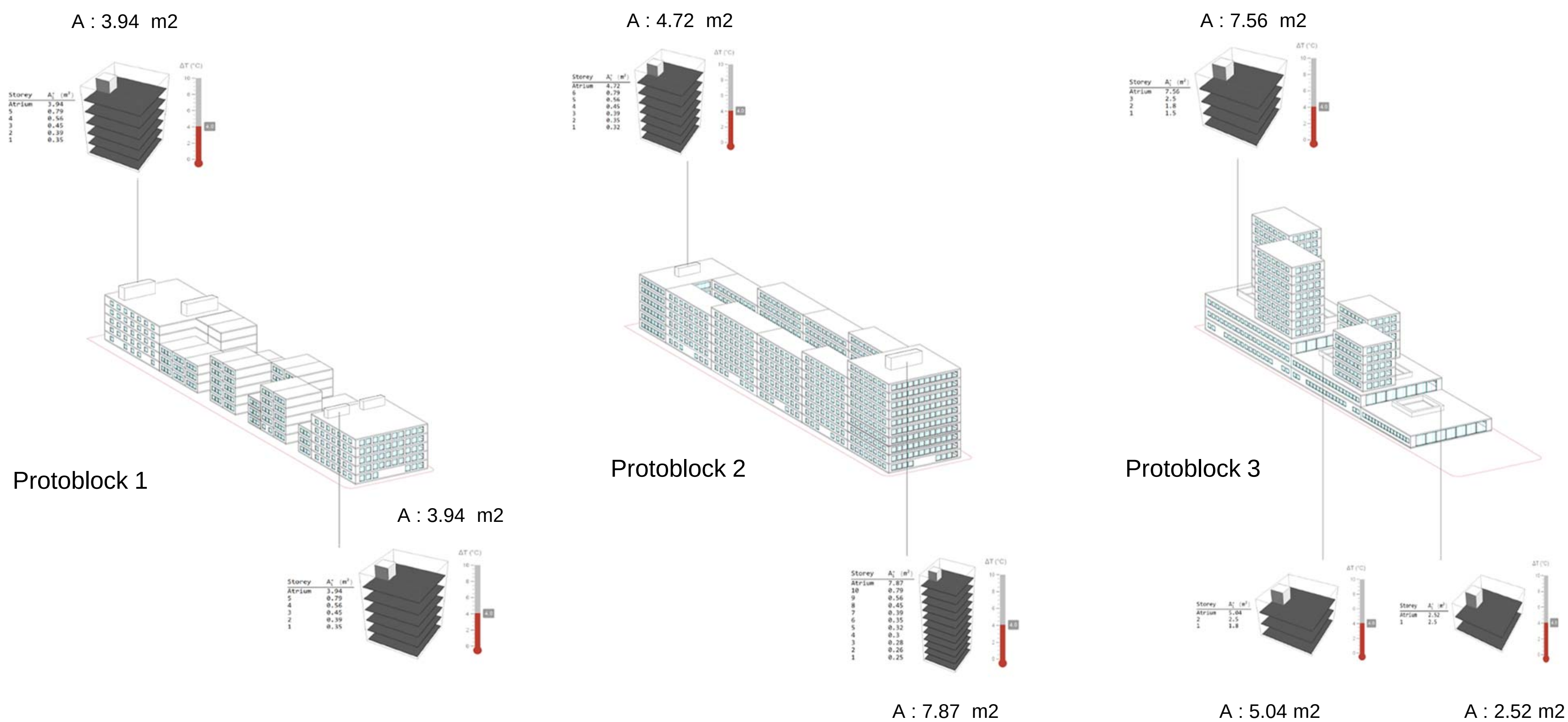


Wind Pressure Mapping On Protoblock

Openings and Chimneys
Buoyancy + Cross Ventilation

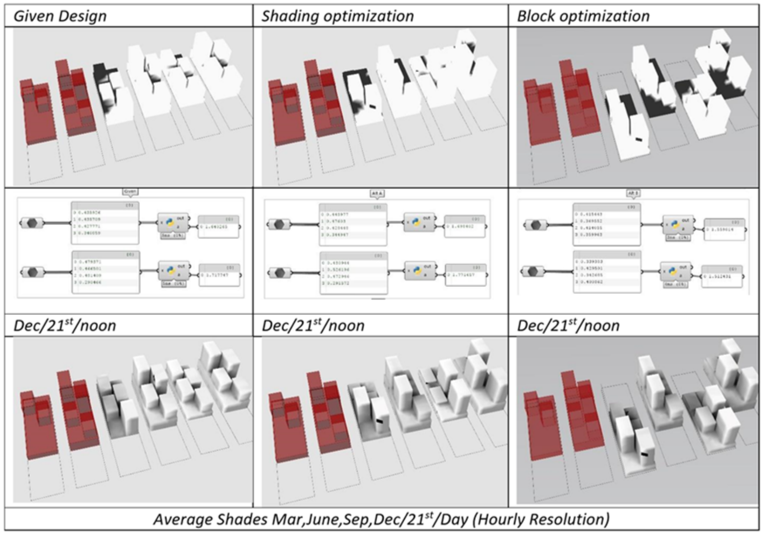
Adaptive Comfort :

96 days out of 8760 was out of adaptive comfort zone 80% boundary



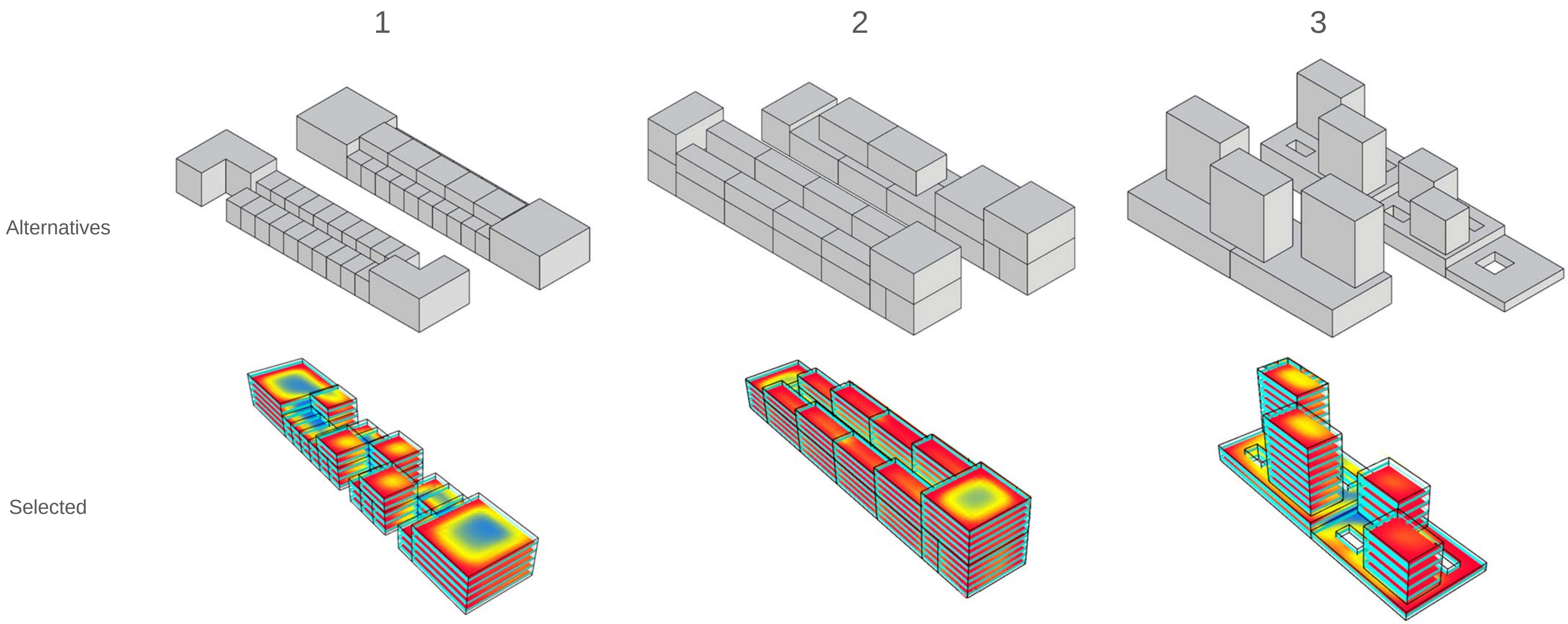
Solar-Driven Design

Daylighting Simulation



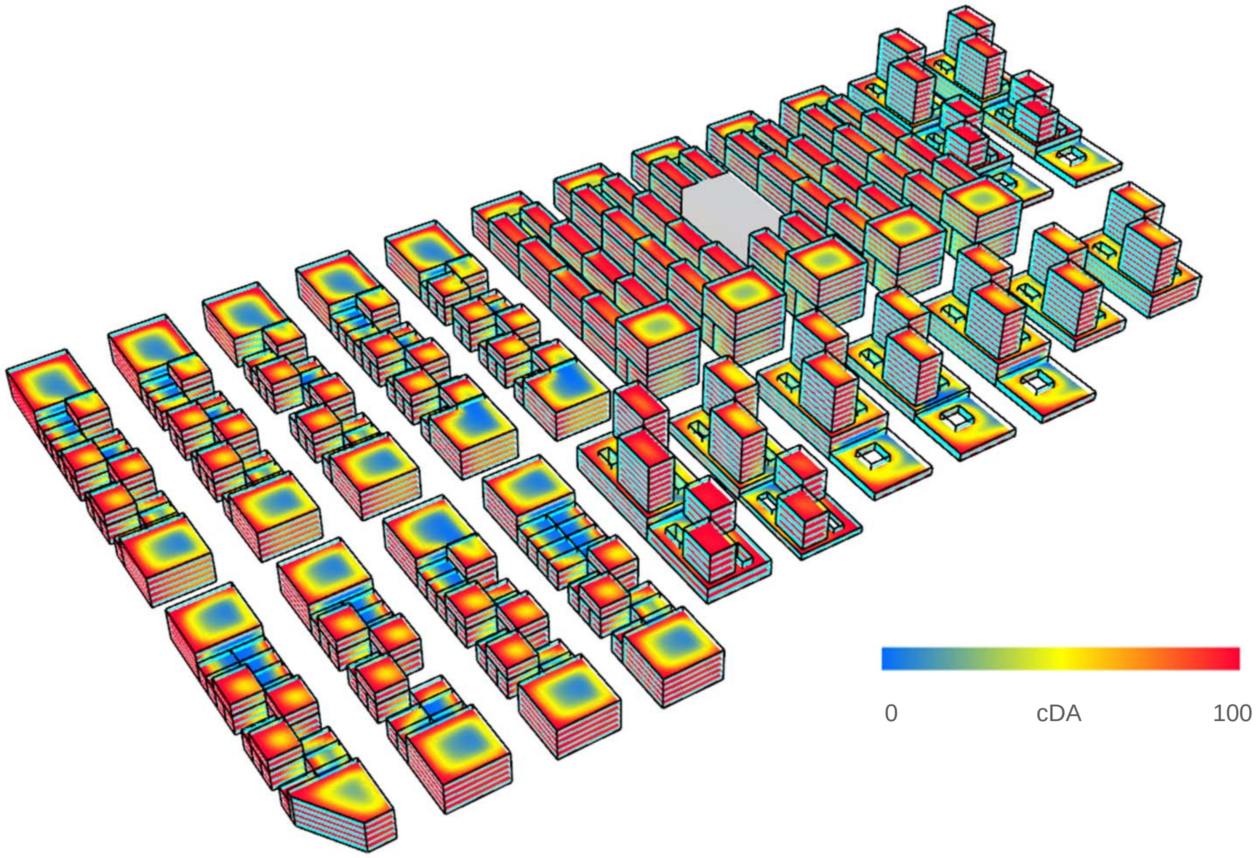
Massing Optimization

Protoblock Design Development - Daylighting



Urban Block Development

Protoblock Design Development - Daylighting

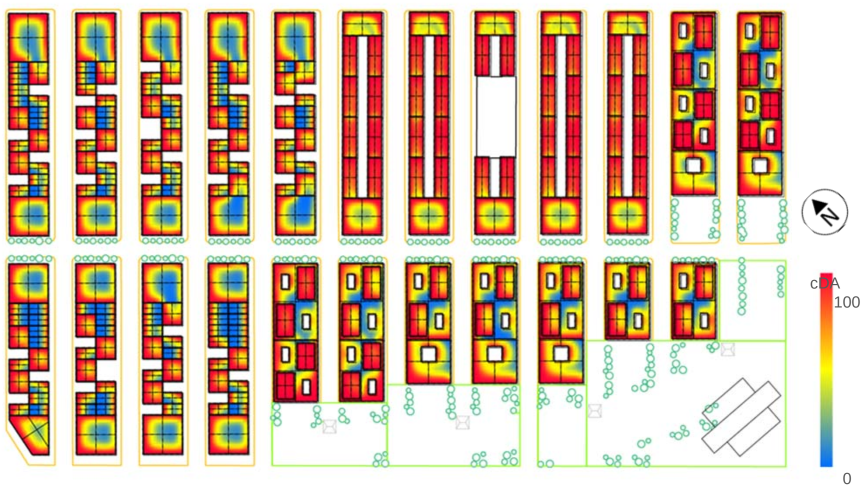


Average sDA: 28

Average cDA: 49

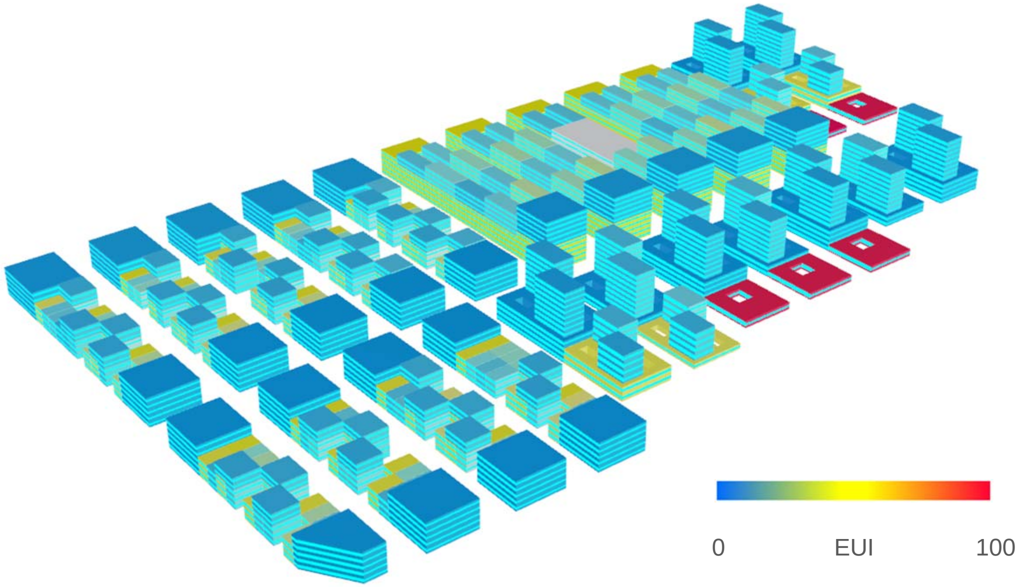
Result of Analysis

Natural Ventilation Design



Daylighting Design

Protoblock Design Development - Energy Efficiency



Design upgrades (from typical neighboring building stock):

Facade upgrades (wall/roof insulation)

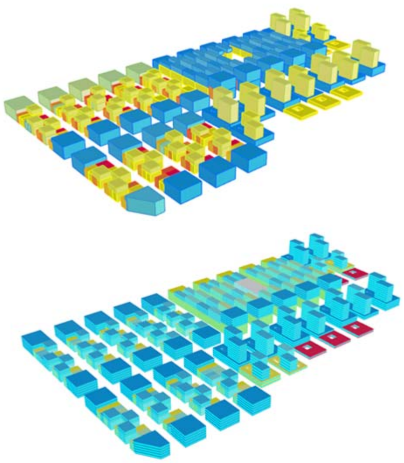
Window upgrades

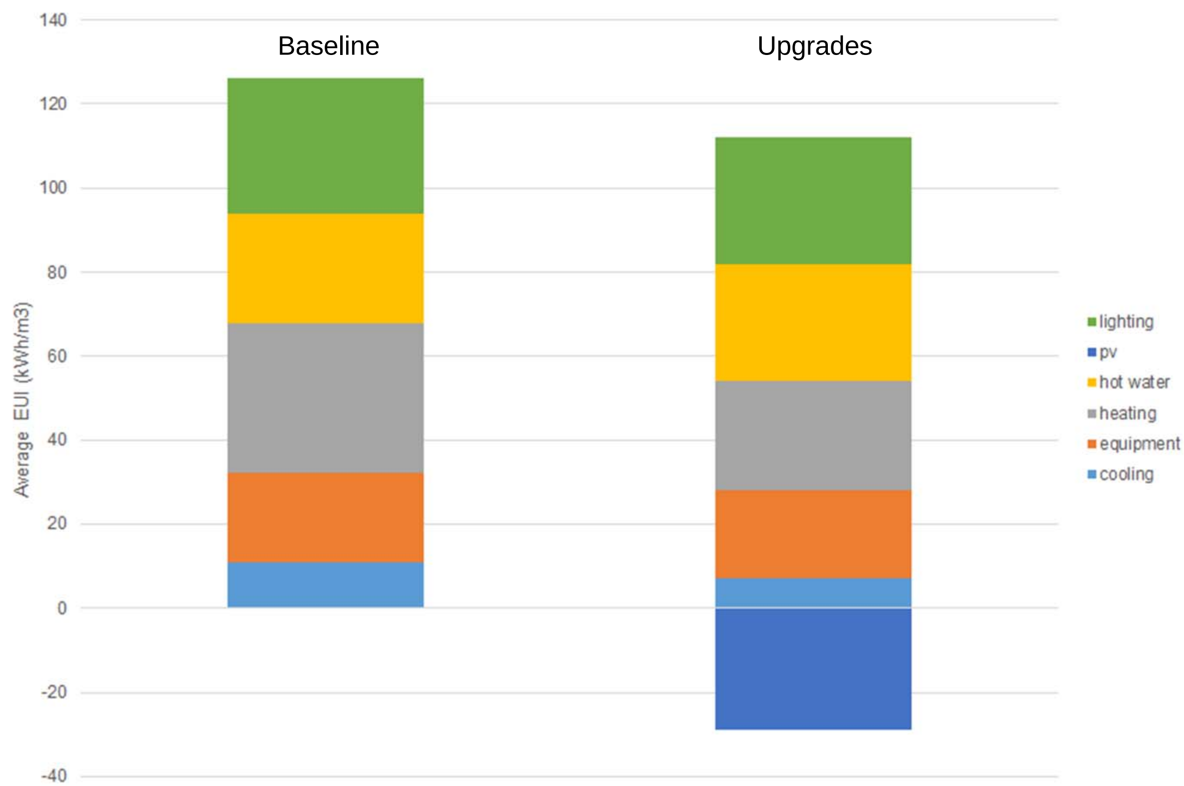
\+ Savings from natural ventilation, photovoltaics

Protoblock Design Development - Energy Efficiency

Baseline

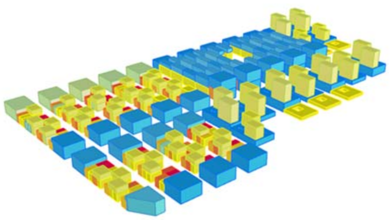
Upgrades



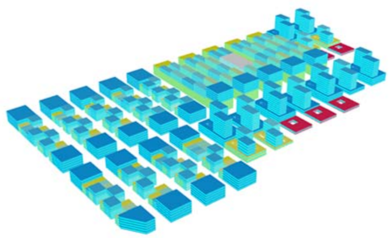


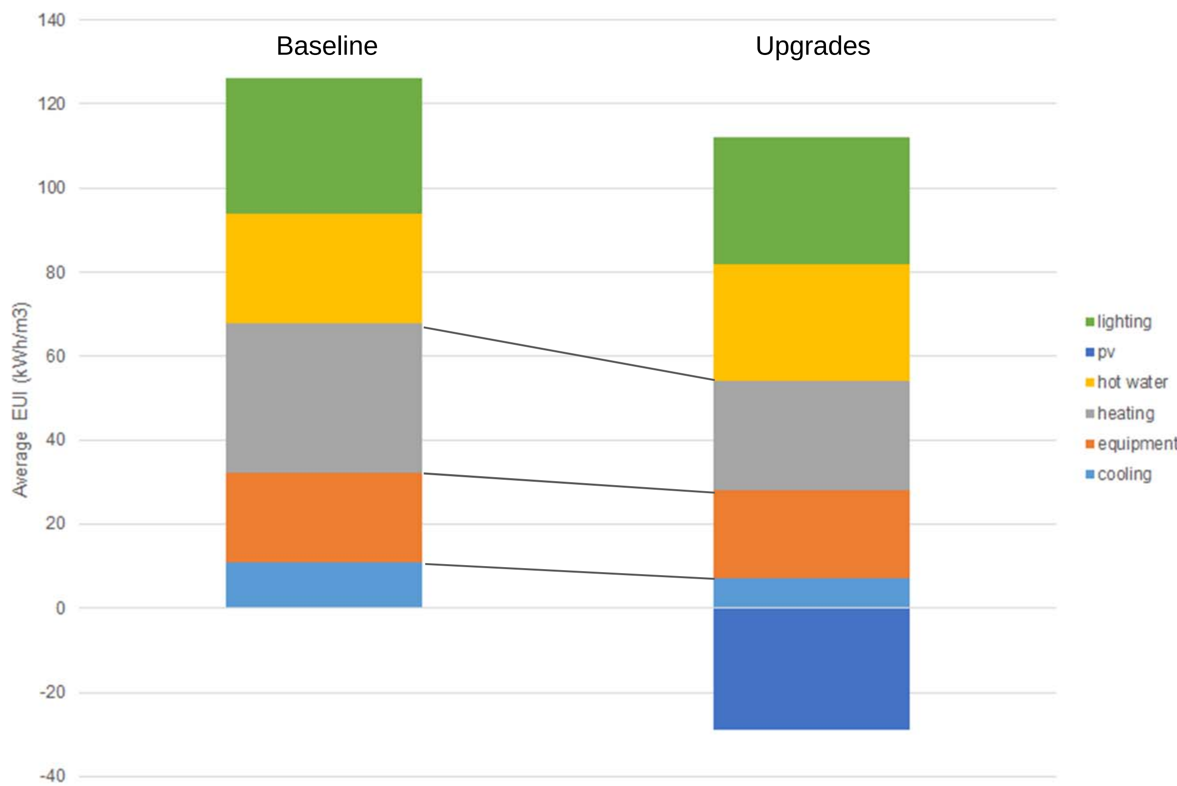
Protoblock Design Development - Energy Efficiency

Baseline



Upgrades





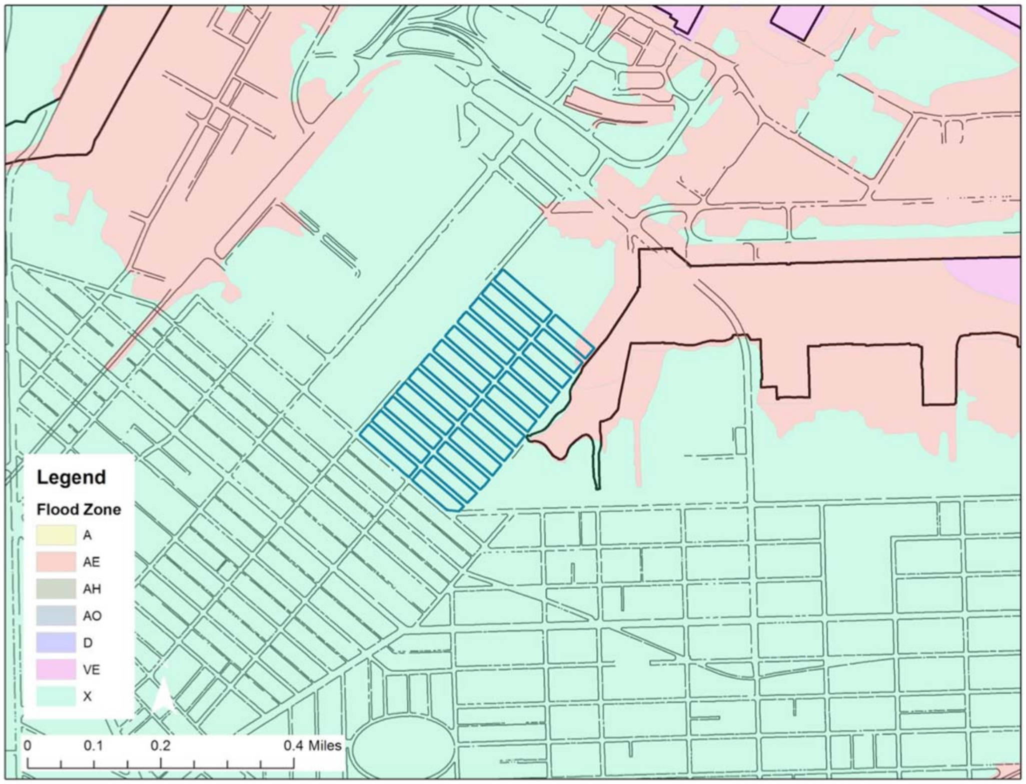
Results:

10% Savings on heating / cooling

26% Potential savings through PV

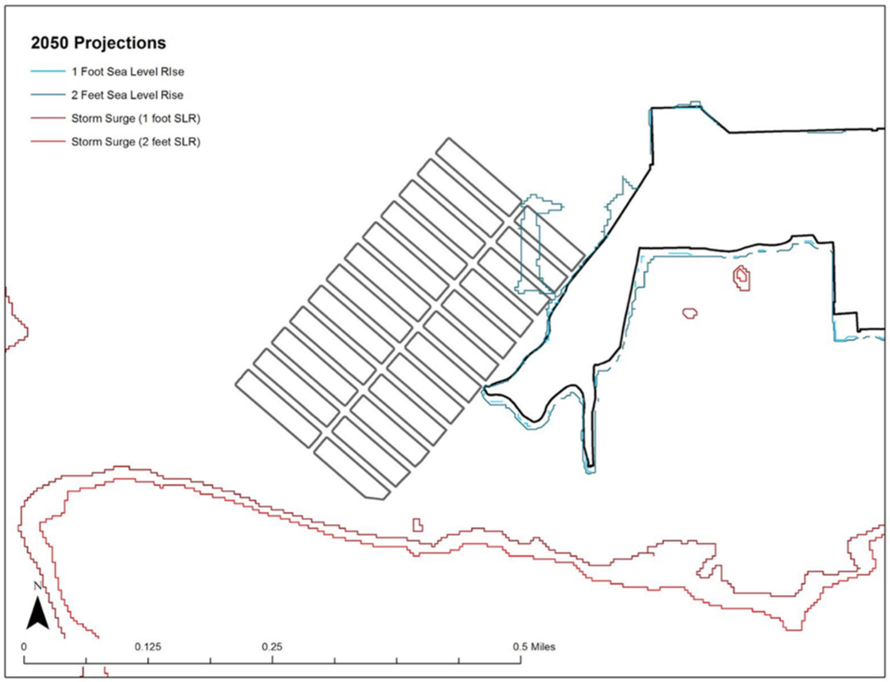
Efficiency	**Resiliency**	Livability
Energy	Extreme events	Pedestrian-oriented
Daylighting	Rising temperatures	Green spaces
Natural ventilation	Coastal flooding	Access to amenities
Renewables	Urban stormwater runoff	Thermal comfort

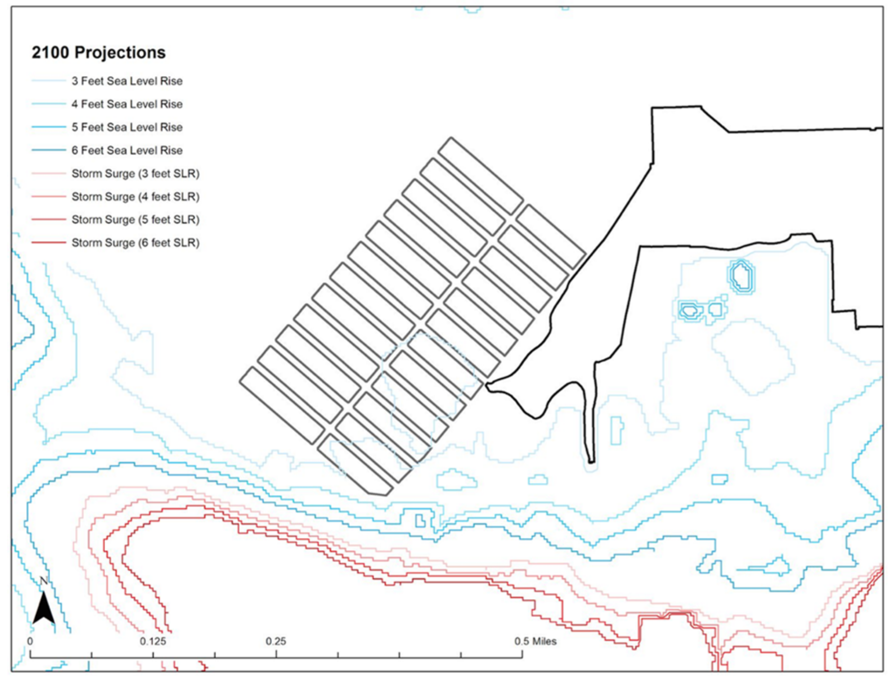
Flooding Scenario

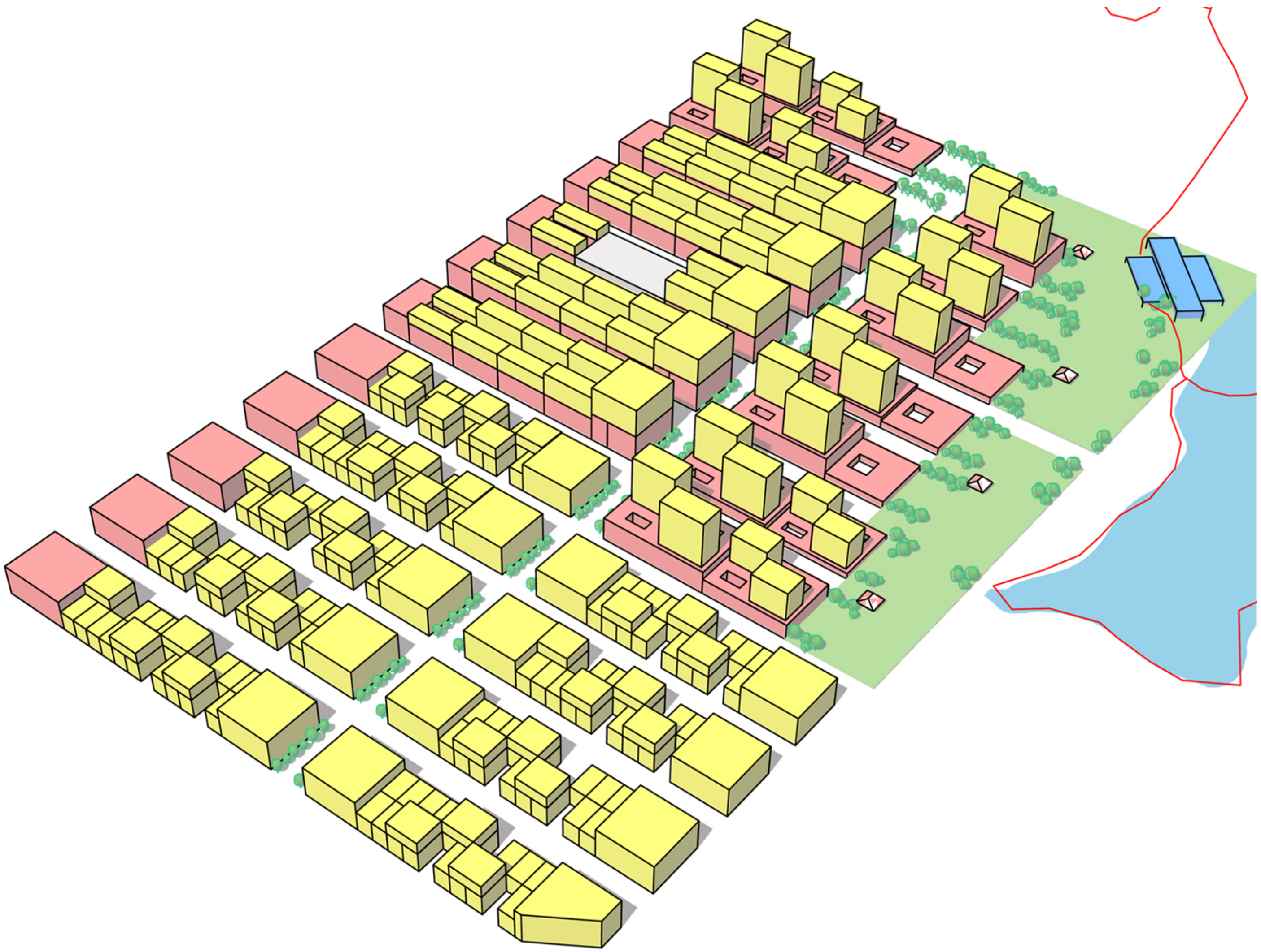


Zone ID	Description
AE	Flood risk
X	No current flood risk

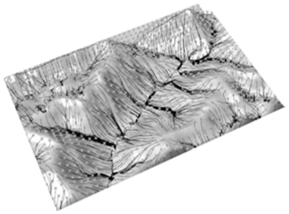
Climate change

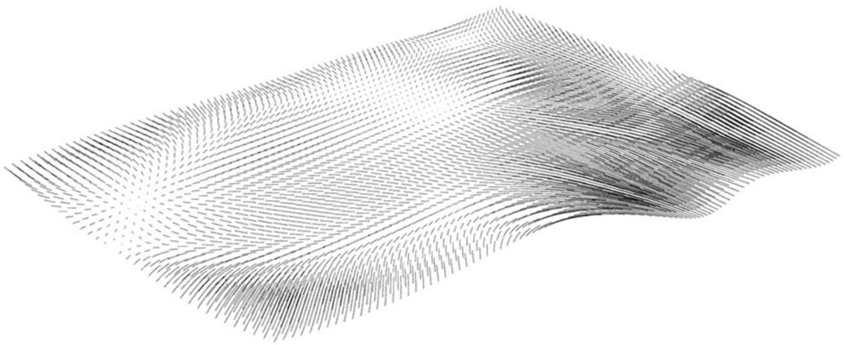


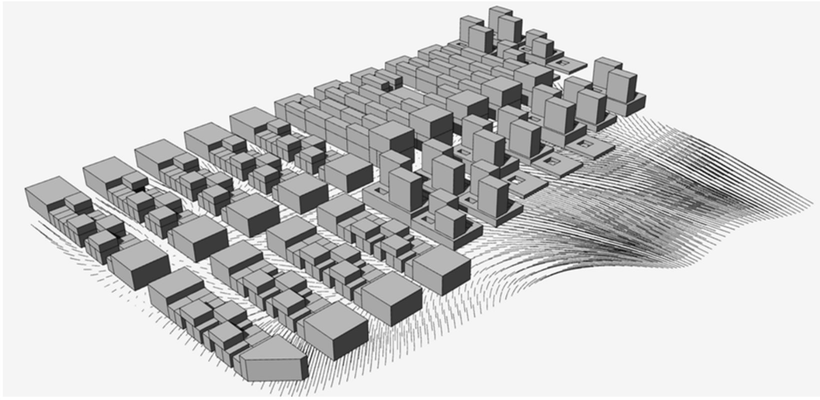




Stormwater Runoff

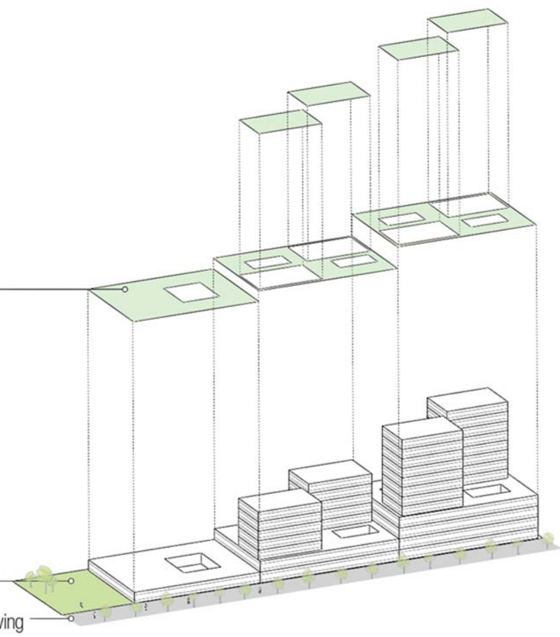


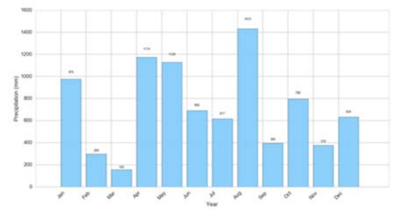




Waterflow Scenario

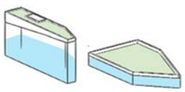
Low Impact Development (LID Practice)



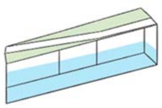


Percentile Data (95th) : 38.6 mm

Street Planters



Rainharvesting Cistern



Infiltration Basins

Annual Average Rainfall : 41.92 (inches)
Annual Average Runoff : 23.34 (inches)
Max rainfall Retained : 1.58 (inches)

Total Rainfall : 1577.89 M3

Stormwater Runoff Design

Urban Surface Typical Design

		Areas	Runoff
Roofs	Asphalt	68532 (40%)	74%
Open Space	Good Grass 75%	25392 (15%)	Infiltration
Impervious Paving	Curbs & Sewers	33721 (20%)	15%
	Road	40780 (25%)	Evaporation
Total		168425	11%

Total Runoff : 1167.64 M3

Stormwater Runoff Design

Urban LID Practical Design 1

		Areas	Runoff
Roofs	Asphalt	39754	56%
	Green roofs	28778 (17%)	Infiltration
Open Space	Good Grass 75%	25392 (15%)	31%
Impervious Paving	Road	18710	Evaporation
Permeable Pavement		22070 (13%)	13%

Total Runoff : 883.24 M3

Stormwater Runoff Design

Urban LID Practical Design 2

		Areas	Runoff
Roofs	Green roofs	68532 (40%)	30%
Open Space	Bioretension	25392 (15%)	Infiltration
Impervious Paving	Road	18710	38%
Permeable Pavement		55791 (23%)	Evaporation 15%

Total Runoff :466.8 M3

Stormwater Runoff Design

Equivalent Residential Unit (ERU)

	LID 1		LID 2	
	Capital Cost	Maintenance	Capital Cost	Maintenance
Green roofs	$ 750,600 - $ 1,512,400	$ 8,400 - $ 84,300	$ 1,761,700 - $ 3,542,000	$ 19,800 - $ 198,300
Bioretension	$ 24,400 - $ 50,300	$ 900 - $ 21,500	$ 58,900 - $ 122,600	$ 2,400 - $ 57,400
Street Platers	$ 145,600 - $ 353,000	$ 2,400 - $ 56,400	$ 145,600 - $ 353,000	$ 2,400 - $ 56,400
Permeable Pavement			$ 1,910,400 - $ 2,547,800	$ 22,800 - $ 124,300
Total	$ 920,600 - $ 1,915,600	$ 11,700 - $ 162,200	$ 3,842,100 - $ 6,493,100	$ 45,800 - $ 400,600

ERU cost for Typical design : $ 16,787 (143,033 m2)

Efficiency

Energy

Daylighting

Natural ventilation

Renewables

Resiliency

Extreme events

Coastal flooding

Urban stormwater runoff

Risk- based zoning

Livability

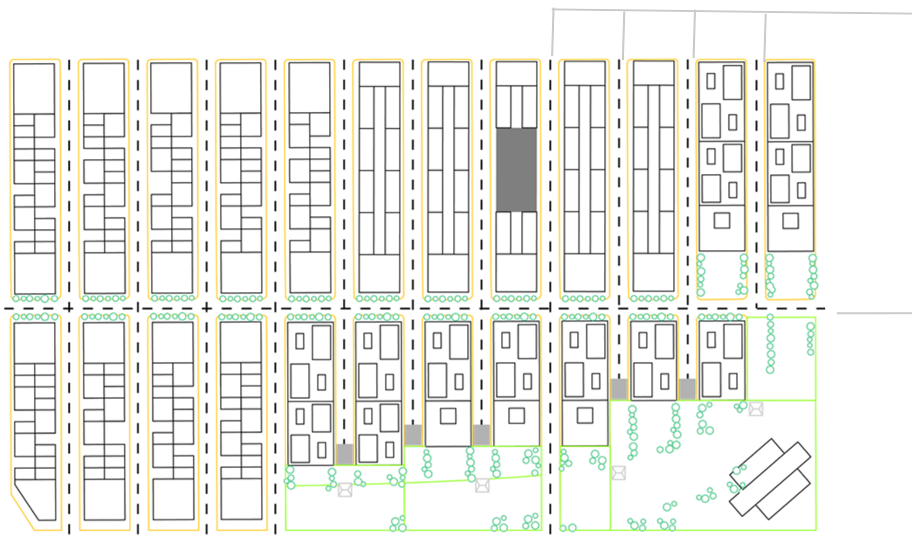
Pedestrian-oriented

Green spaces

Access to amenities

Thermal comfort

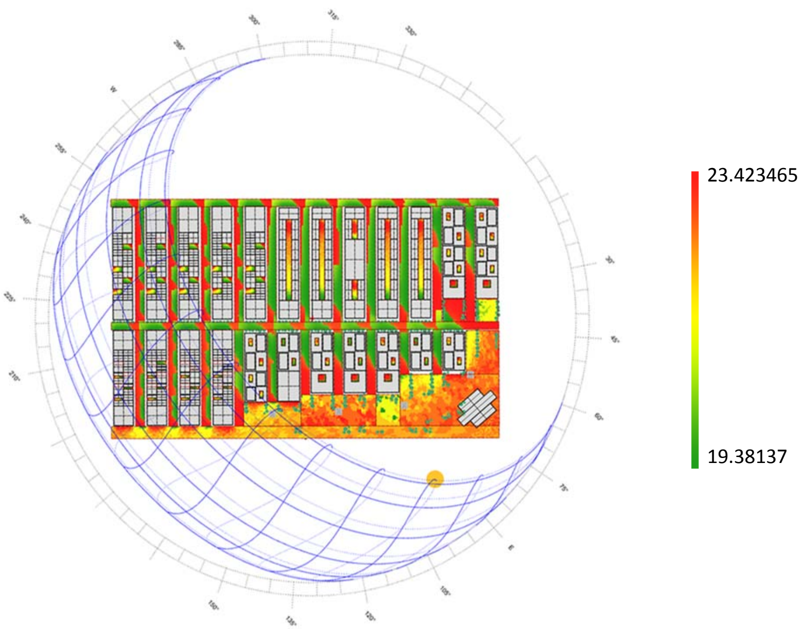
Street Design

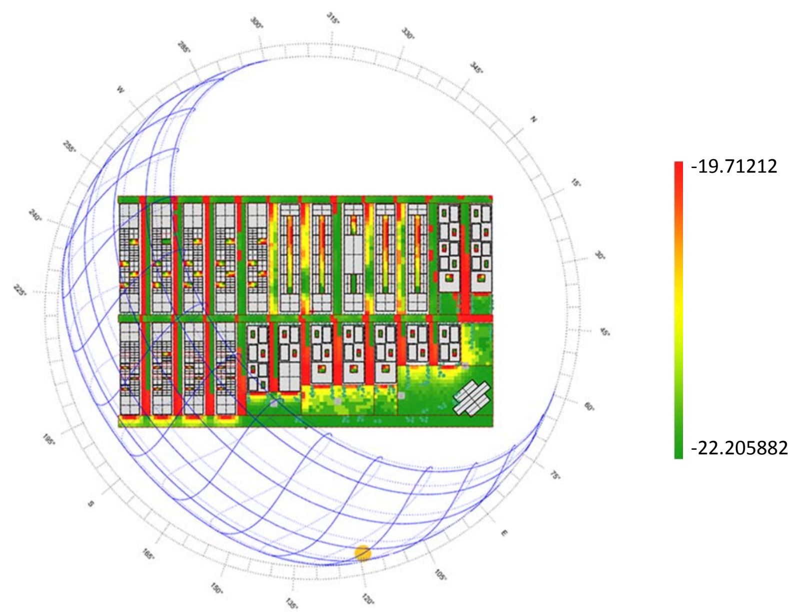


	Residential	Retail	Office
Required Parking	800	450	160
On-street	1150	Garage	260

Outdoor Thermal Comfort

UTCI Universal Thermal Climate Index





3rd Place Analysis

Facilities

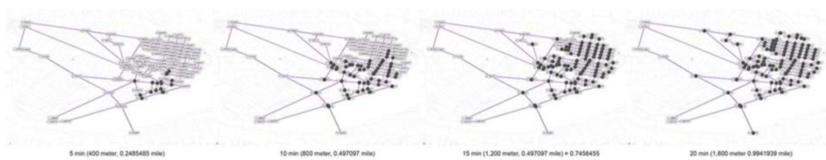
Amusement

Health

Sotre

Food

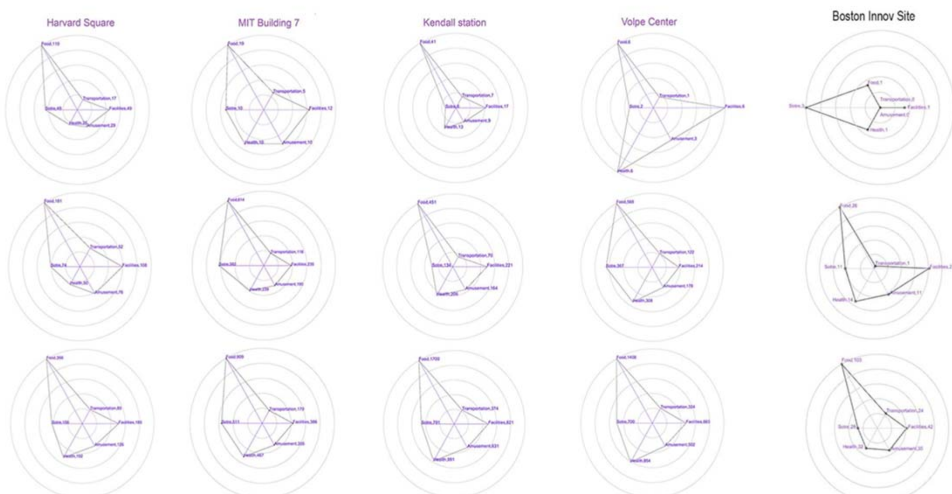
Transportation

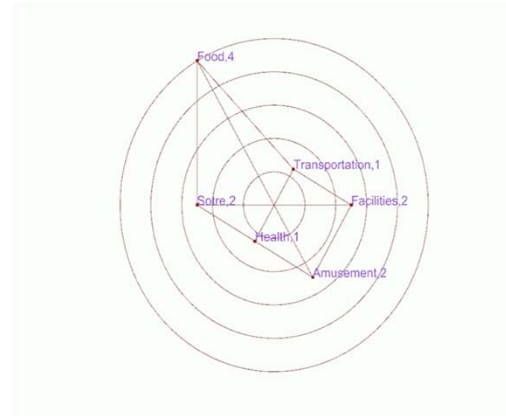


5 mins

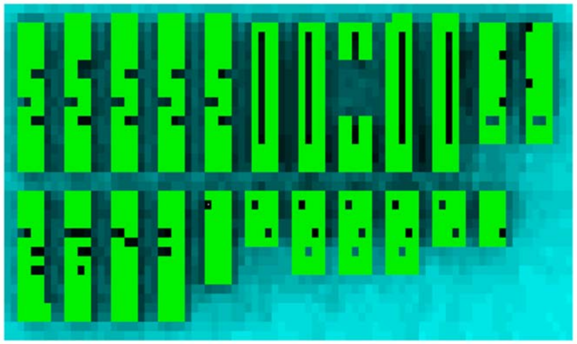
10 mins

15 mins



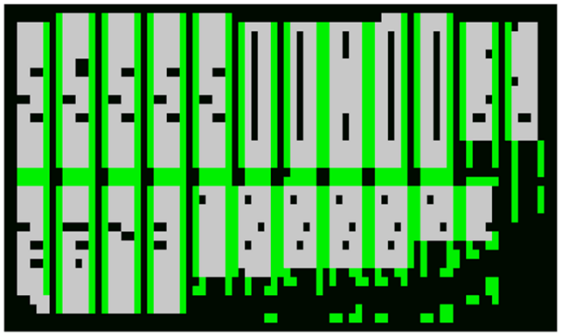


Urban Exploration

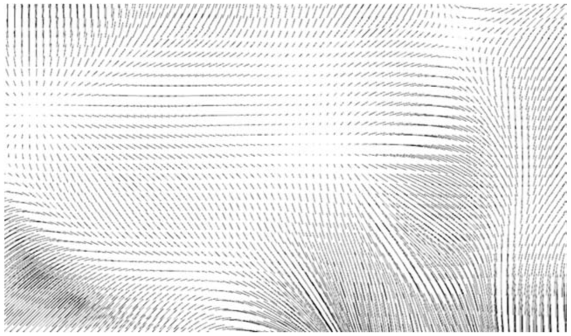


View analysis

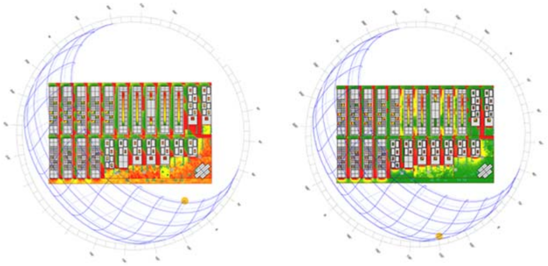
Amenities on map



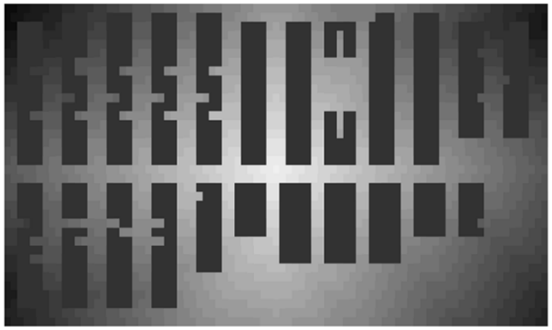
Trees on map



Slope analysis

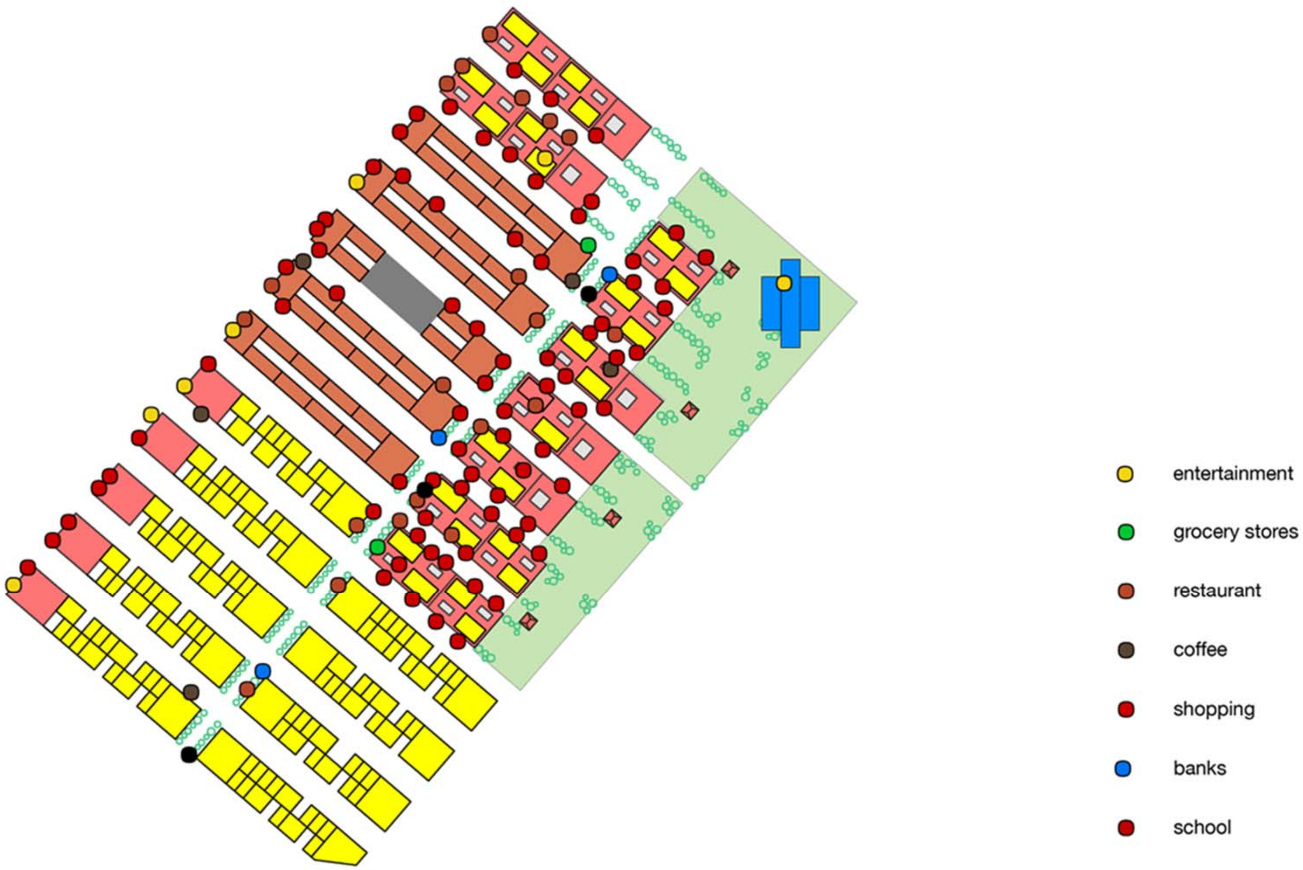


UTCI on map



All on map

Walk Score: 82



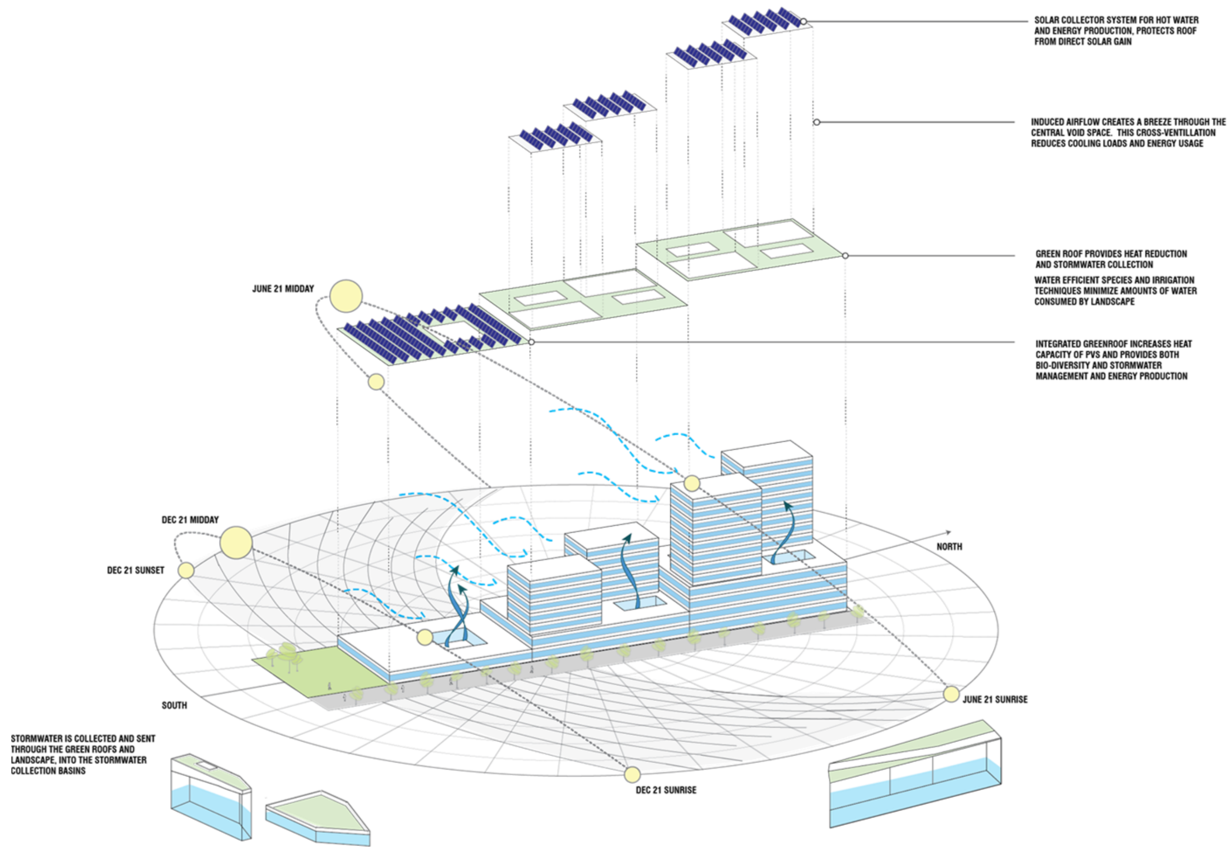
Efficiency

Resiliency

Livability

Efficiency	Resiliency	Livability
Energy	Extreme events	Pedestrian-oriented
Daylighting	Coastal flooding	Green spaces
Natural ventilation	Urban stormwater runoff	Access to amenities
Renewables	Risk- based zoning	Thermal comfort

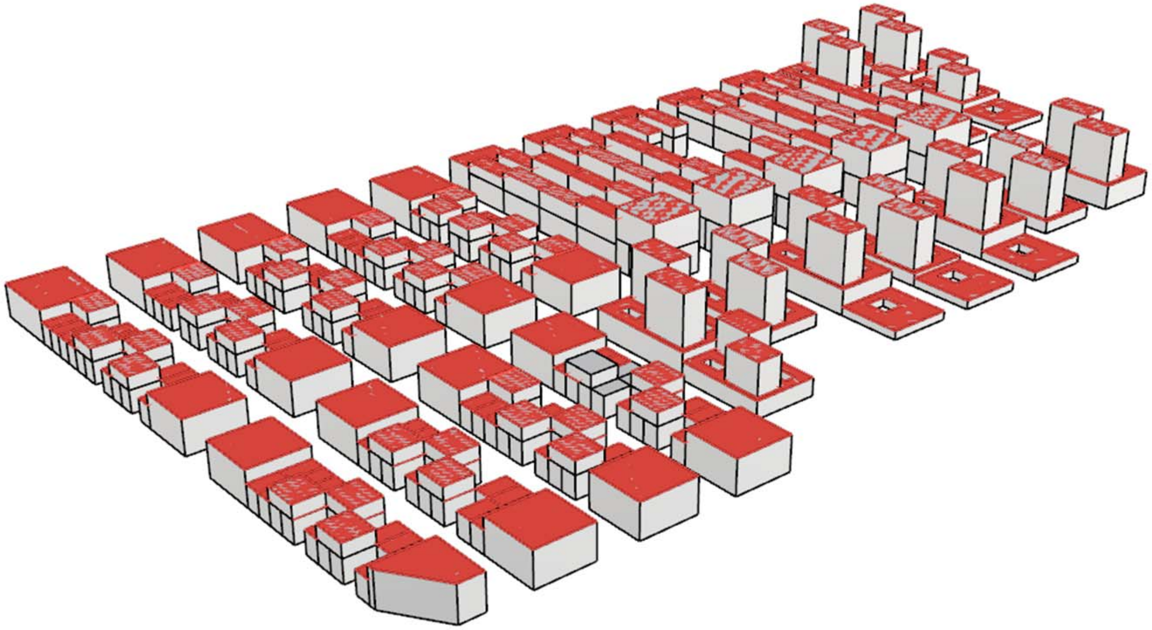
Integrated Design



Horizontal Surfaces - PV or GR?

PV

Green Roofs



PV vs. GR

Initial Cost ($)

Annual Savings ($)

Environmental Benefits: Renewable energy
Zero emissions

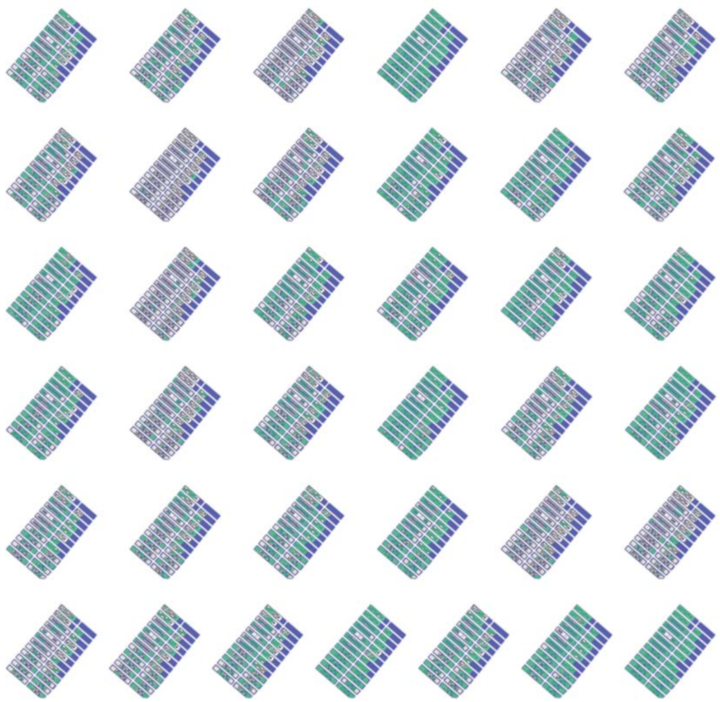
Initial Cost ($)

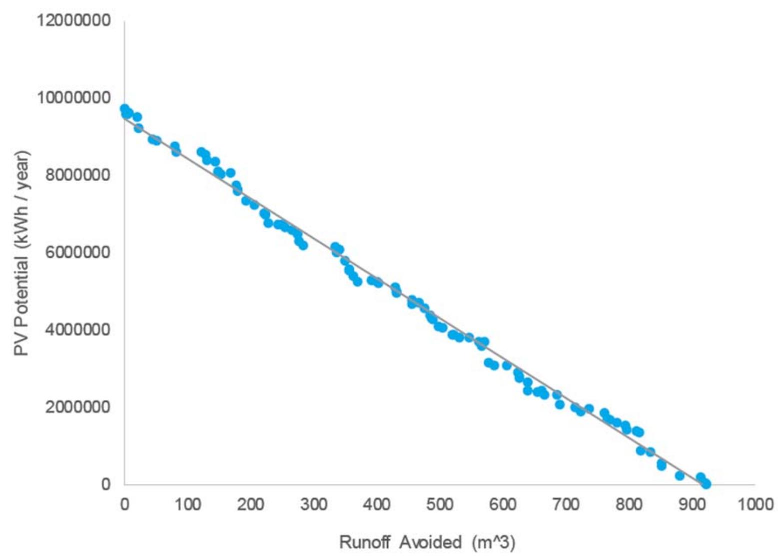
Annual Savings ($)

Environmental Benefits: Lowers cooling loads
Mitigates urban heat island
Captures carbon
Captures fine particles
Stormwater retention + purification

Based on NREL (2014) and Blackhurst (2010)

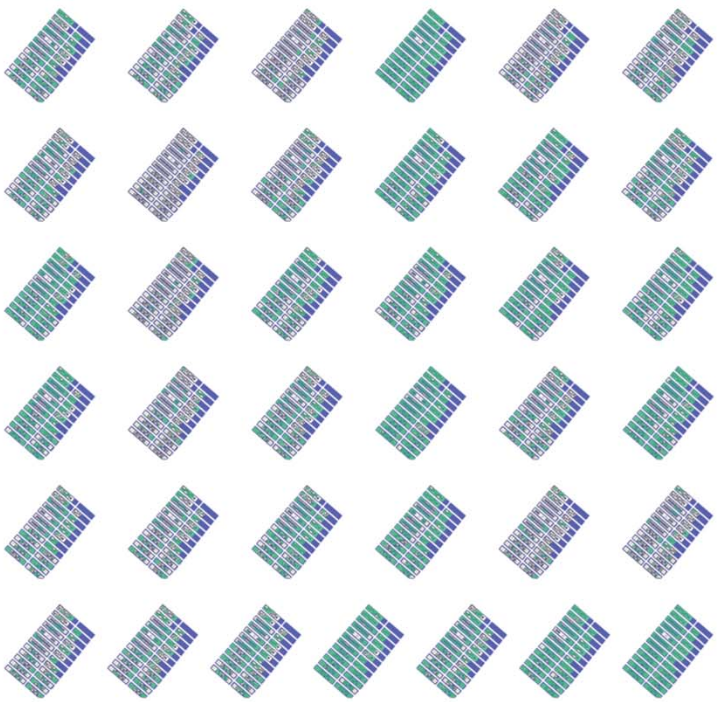
PV vs. GR

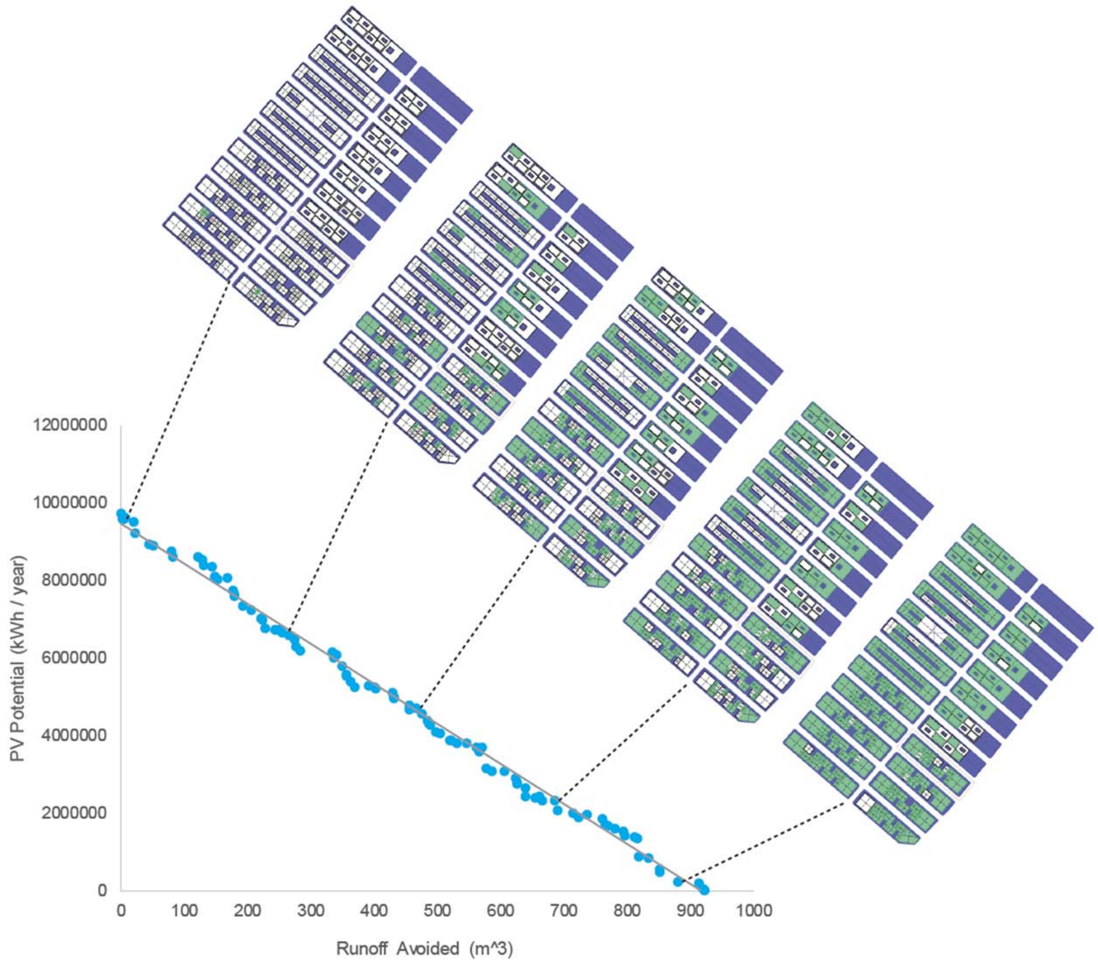




12000000
10000000
8000000
6000000
4000000
2000000
0
PV Potential (kWh / year)
0
100
200
300
400
500
600
700
800
900
1000
Runoff Avoided (m^3)

PV vs. GR





12000000
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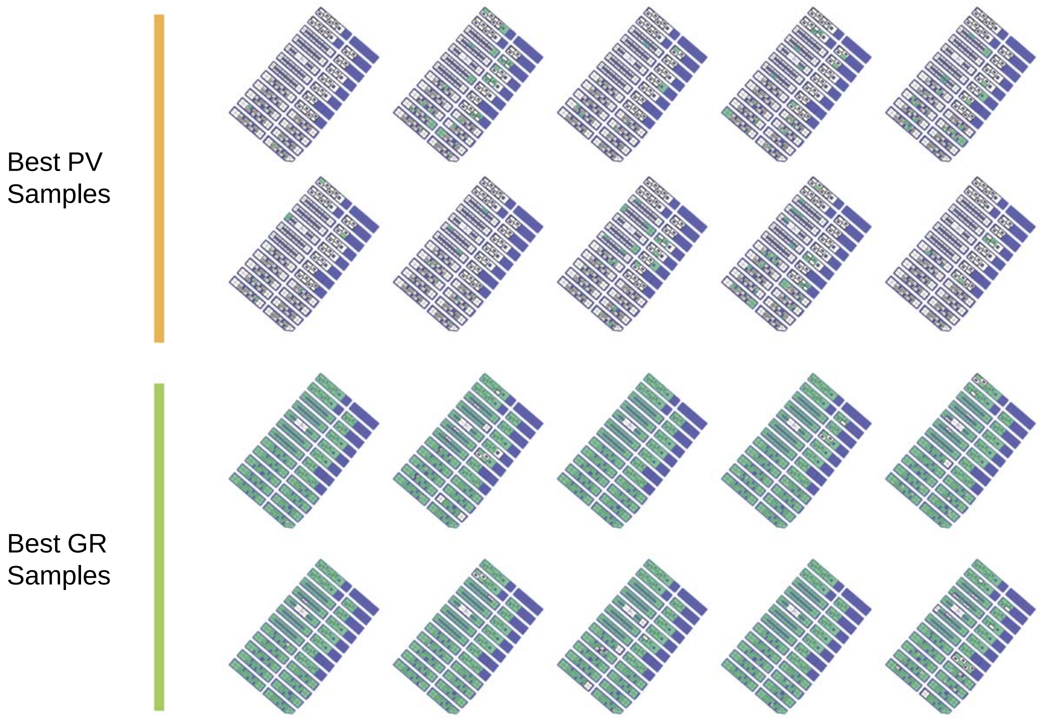
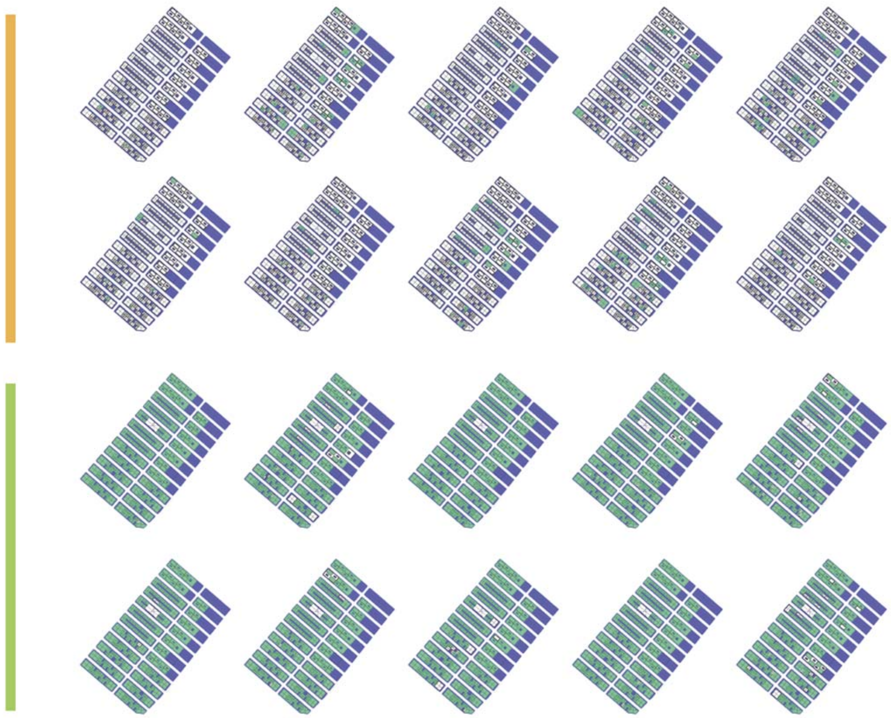
PV vs. GR



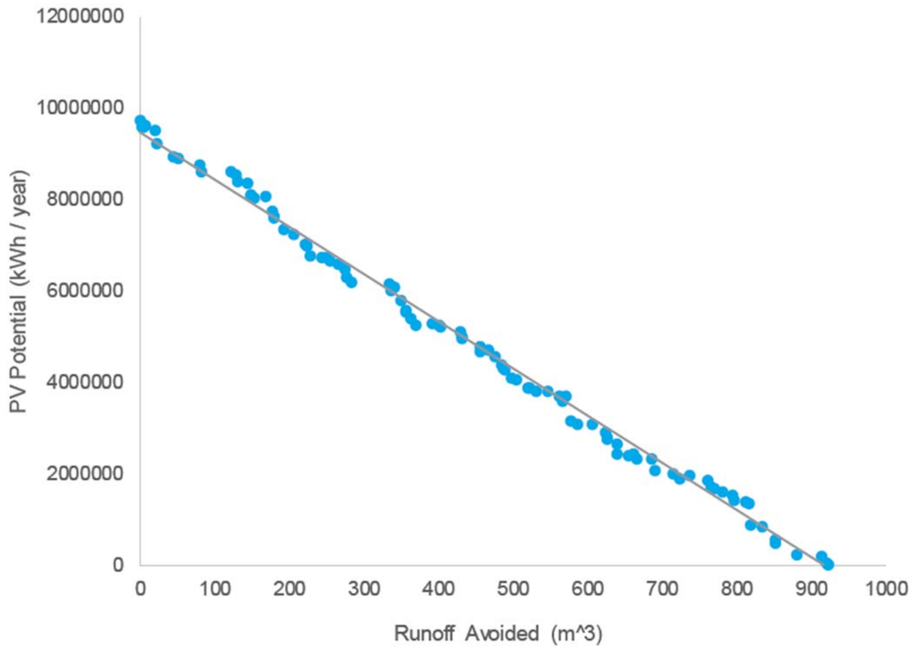
PV vs. GR

Best PV Samples

Best GR Samples

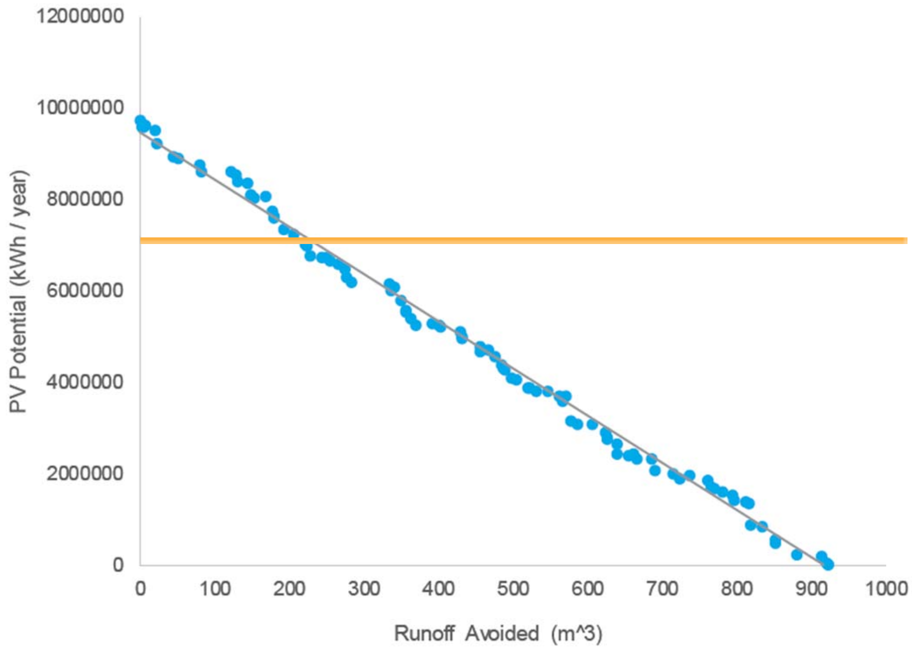


PV vs. GR



Design Goals:

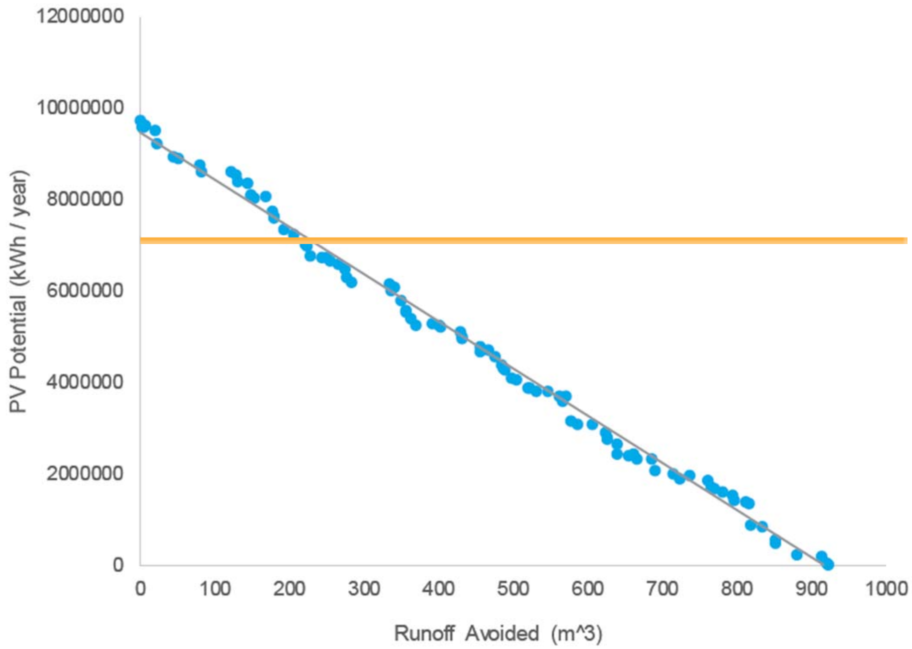
PV vs. GR



Design Goals:

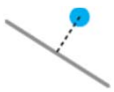
Offset at least 20% of energy loads

PV vs. GR

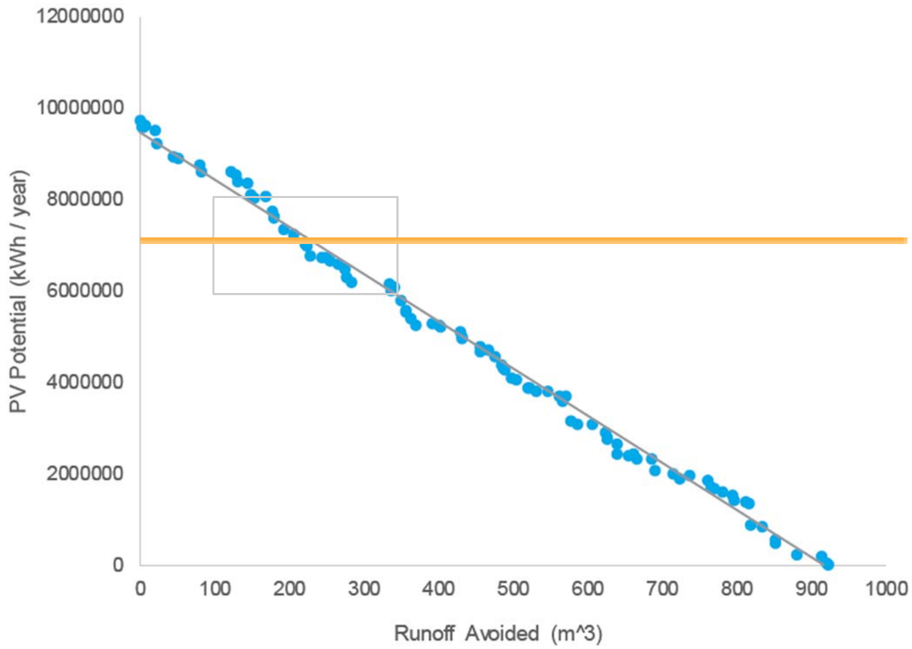


Design Goals:

Offset at least 20% of energy loads

Select design that outperforms curve 

PV vs. GR

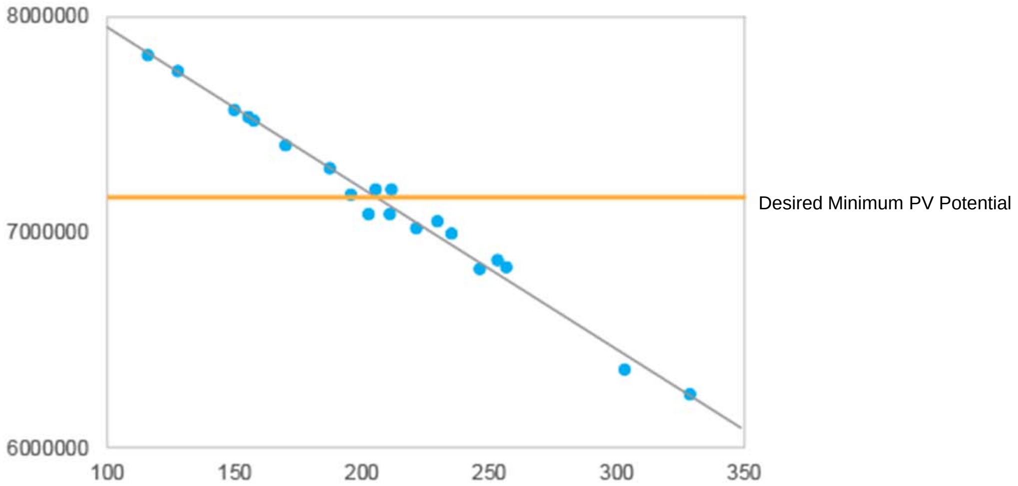


Design Goals:

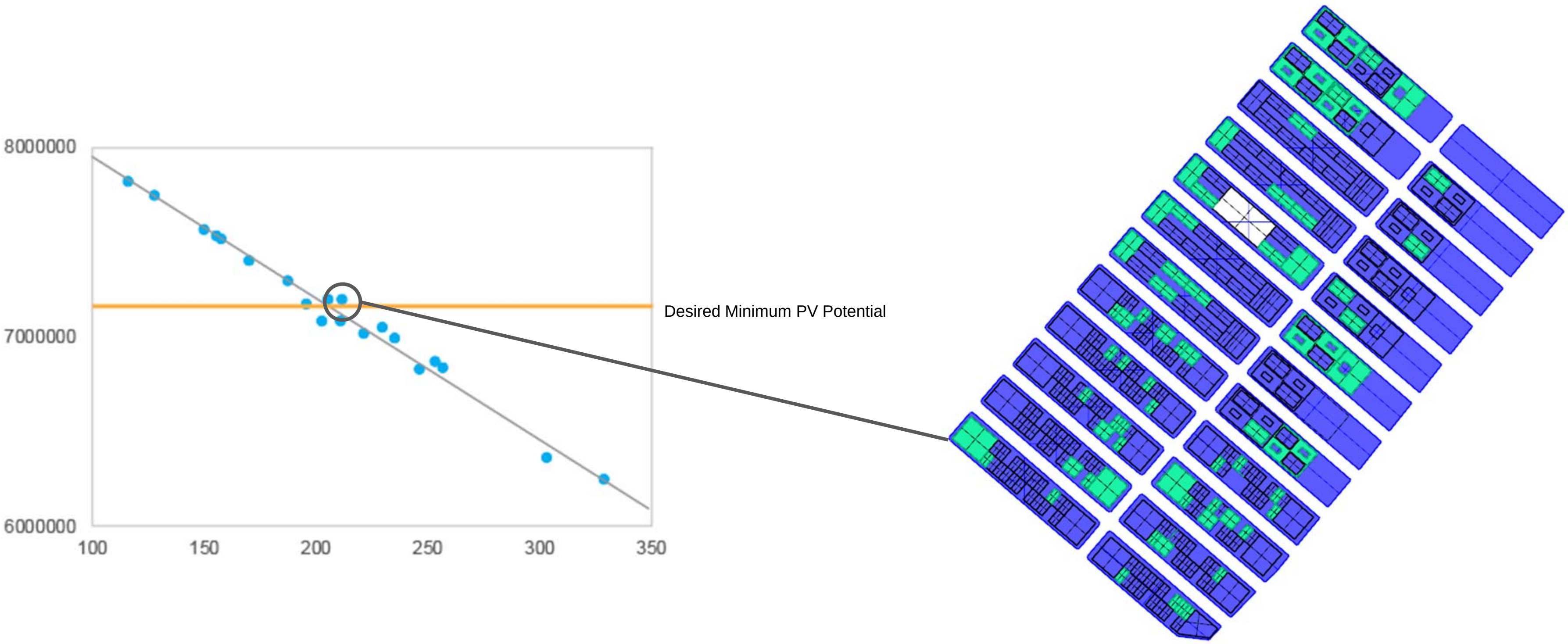
Offset at least 20% of energy loads

Select design that outperforms curve

PV vs. GR


8000000
7000000
6000000
100
150
200
250
300
350
Desired Minimum PV Potential

PV vs. GR



8000000
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100
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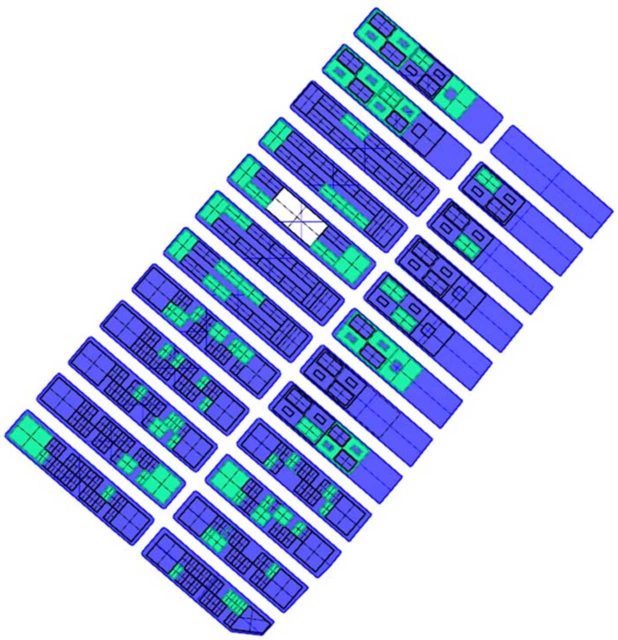
Desired Minimum PV Potential

PV vs. GR



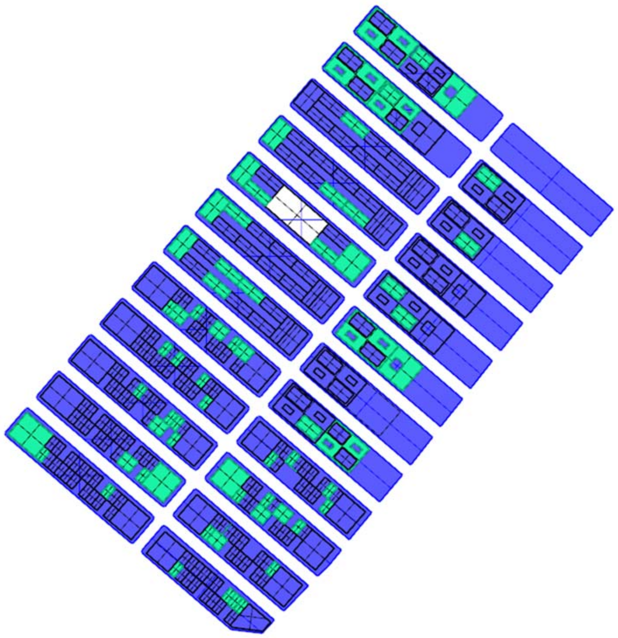
~ 70% PV / 30% GR

Offsets 20% of energy loads

Stores 3% of runoff from 3 hr storm

~ $15.3 million cost / 1.4 million annual savings

PV vs. GR



~ 70% PV / 30% GR

Offsets 20% of energy loads

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~ $15.3 million cost / 1.4 million annual savings

Financial Analysis

	Residential	Retail	Office	PV/GR	**Total**
Initial construction costs (m $)	454.6	188.5	93	15.3	**751.4**
Annual Revenue (m $)	78.8	81	29.7	1.4	**190.9**
Investment Yield	**19.978%**				

Energy	Daylighting	EE/EC	Runoff	Walkability	Finance
114 kWh/m2	49 cDA	105 kg CO2/m2	56%	82 %WA	19.98%

Urban Energy Modeling

Boston Seaport District: Nathan Brown, Mario Giampieri, Ellie Jungmin Han, NJ Namju Lee