The Experience

"A gathering space for STEM exploration and community"

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Location
West Pershing and South Dearborn Street

Zoning
PD 1143

Site area
3.13 acres / 136,400 sf
220’ x 620’

Building Size
64,982 sf (excluding green roof)
LL: 5,127 sf
Level 1: 33,569 sf
Level 2: 18,606 sf
Penthouse: 5,289 sf
Green Roof: 2,393 sf

Located at the intersection of West Pershing and State Street in Chicago’s Bronzeville neighborhood, NSBE Chicago - Bronzeville Center is designed to both reinforce NSBE’s mission ***“to increase the number of culturally responsible Black Engineers who excel academically, succeed professionally and positively impact the community”*** and encourage social interactions throughout the site and building. The dynamic experimentation at the heart of the NSBE Chicago - Bronzeville Center draws people in to build a stronger community.

The core concept is a “Ship in a Bottle” – A building enveloped in a protective “bubble” of greenery with sunlight introduced to the center through a glass atrium roof.

The site is strategically divided into three sections – 1) the photovoltaic-topped building anchoring the north with a landscaped entry plaza pulled back from State Street, 2) parking shaded by a solar canopy in the middle with access from both Dearborn and State, and 3) a meadow of moving, bifacial pv panels exhibiting on-site renewable energy on the south end. This variety of solar strategies works together to collect the abundant energy of the sun.

A thickened north wall addresses the city with a large digital display – continually changing to respond to exterior or interior program – the wall announces the presence of the building and NSBE to the community.

The main program components of STEM and Athletics are separated into two distinct volumes - 1) STEM with its crystalline, tessellated shroud protecting a lush explorable interstitial greenhouse and 2) Athletics – a regimented volume pulled away from State Street to create a protected landscaped entry plaza. Together both volumes define an exterior plaza for larger science experiments and communal gathering outside the building.

On the interior, program remains dense at the north and expands out towards the sun at the south in a pixilated dissolution of interior spaces. Springing up between the garden and the atrium, two-story wood volumes support the glass roof to evoke the life-giving baobab, creating space for community around it.

Greenery permeates through this membrane to connect the interstitial "greenhouse" with the southeast-facing atrium - the heart of the building. Trees and plants fill this vibrant zone to carry the feeling of growth into the corridors. The entry for both STEM and Athletics celebrates this moment of connection at the southeast corner, as visitors wander from the plaza through the "greenhouse" at the south to separate entry doors into STEM or Athletics.

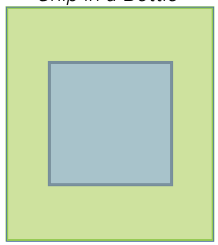
STEM spaces cluster to afford synergistic overlap between like activities, with spaces such as robotics, metal and wood working, and the maker space gathered at the base of the atrium, and gaming, vr, and dev studio perching at the top.

An open seating area and stair connect these rooms with the prominent auditorium and café, along with the podcast and recording studios for another key hub. Criss-crossing this open space between tree branches interior walkways bridge between classrooms and the meeting spaces atop the wood volumes.

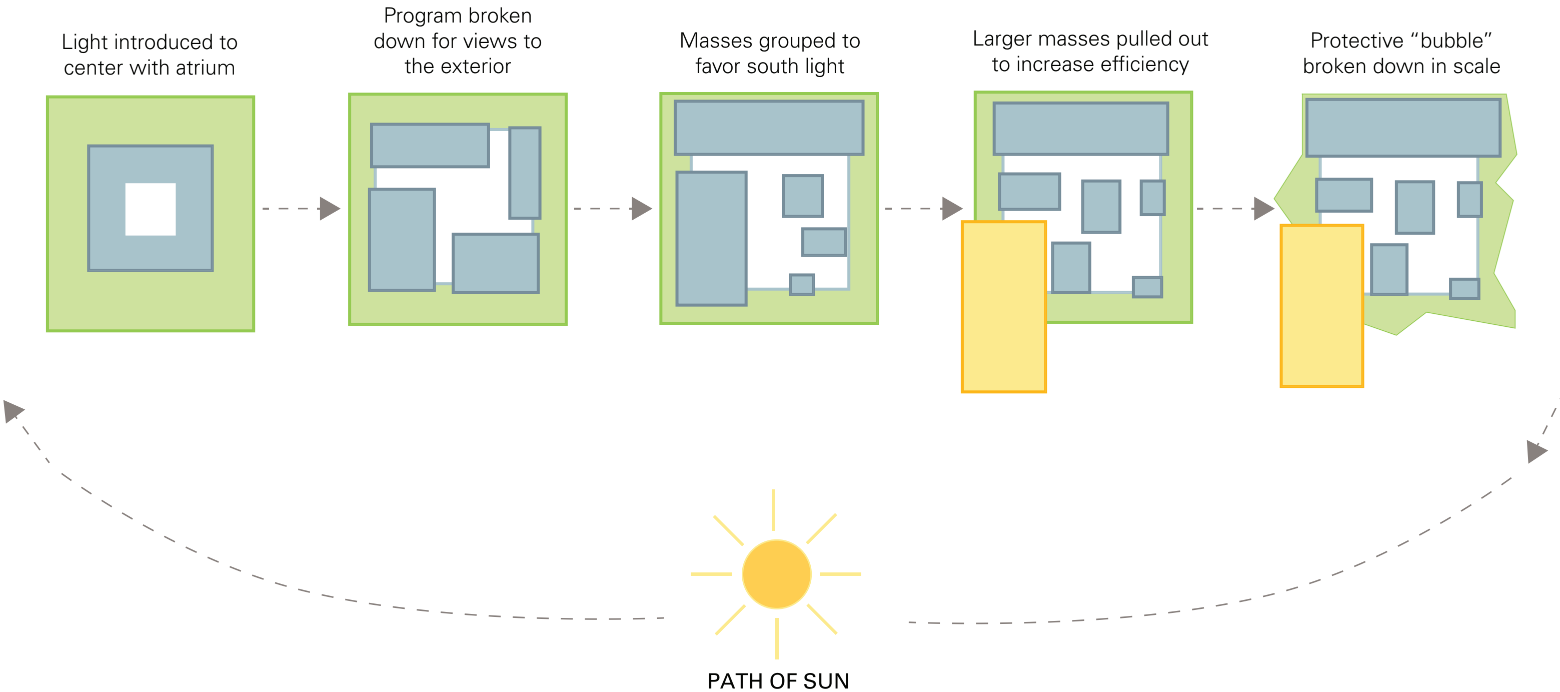
Nestled at the northwest corner, the demonstration kitchen stays close to the production greenhouse and lab above it, in a glassy penthouse. This greenhouse lab and the expansive interior grand lawn are located on the roof, looking out to the city skyline to the north and to accessible green roof to the south.

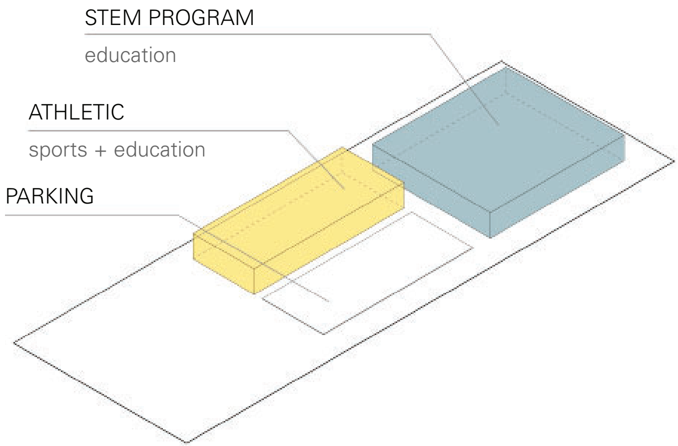
Concept

"Ship in a Bottle"

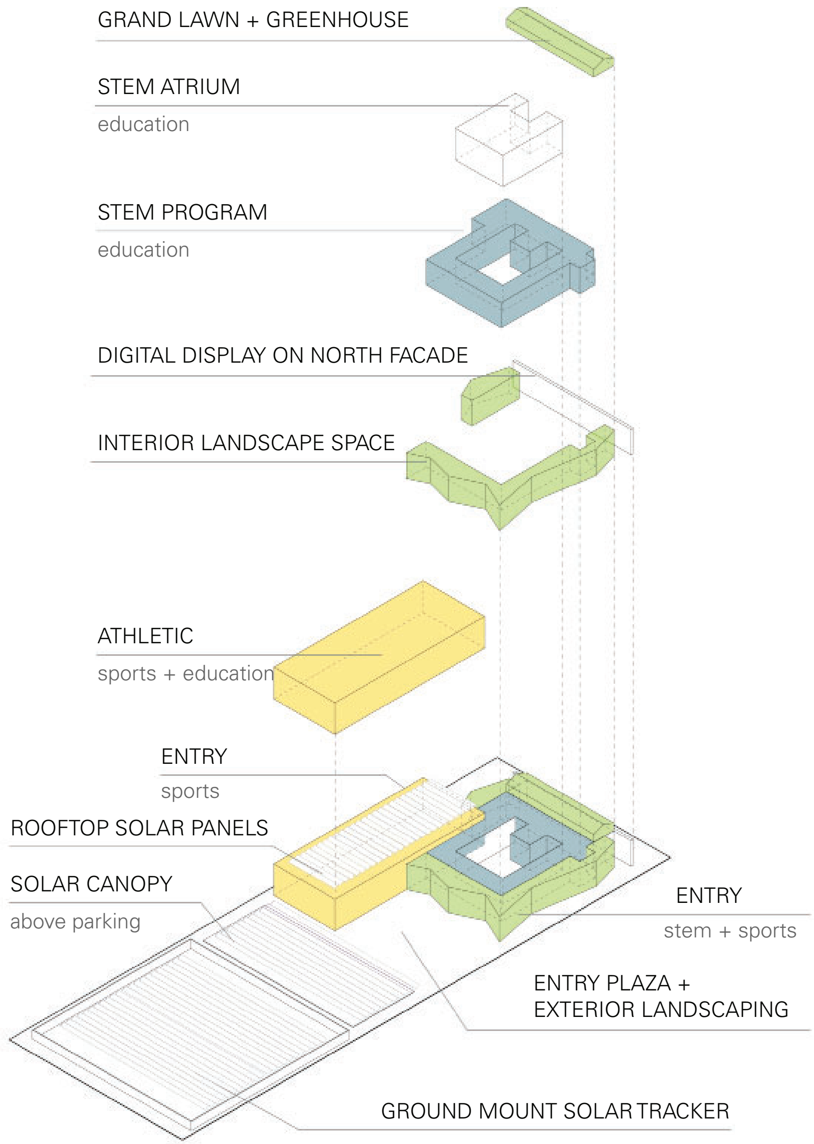


Building enveloped in a protective "bubble" of greenery

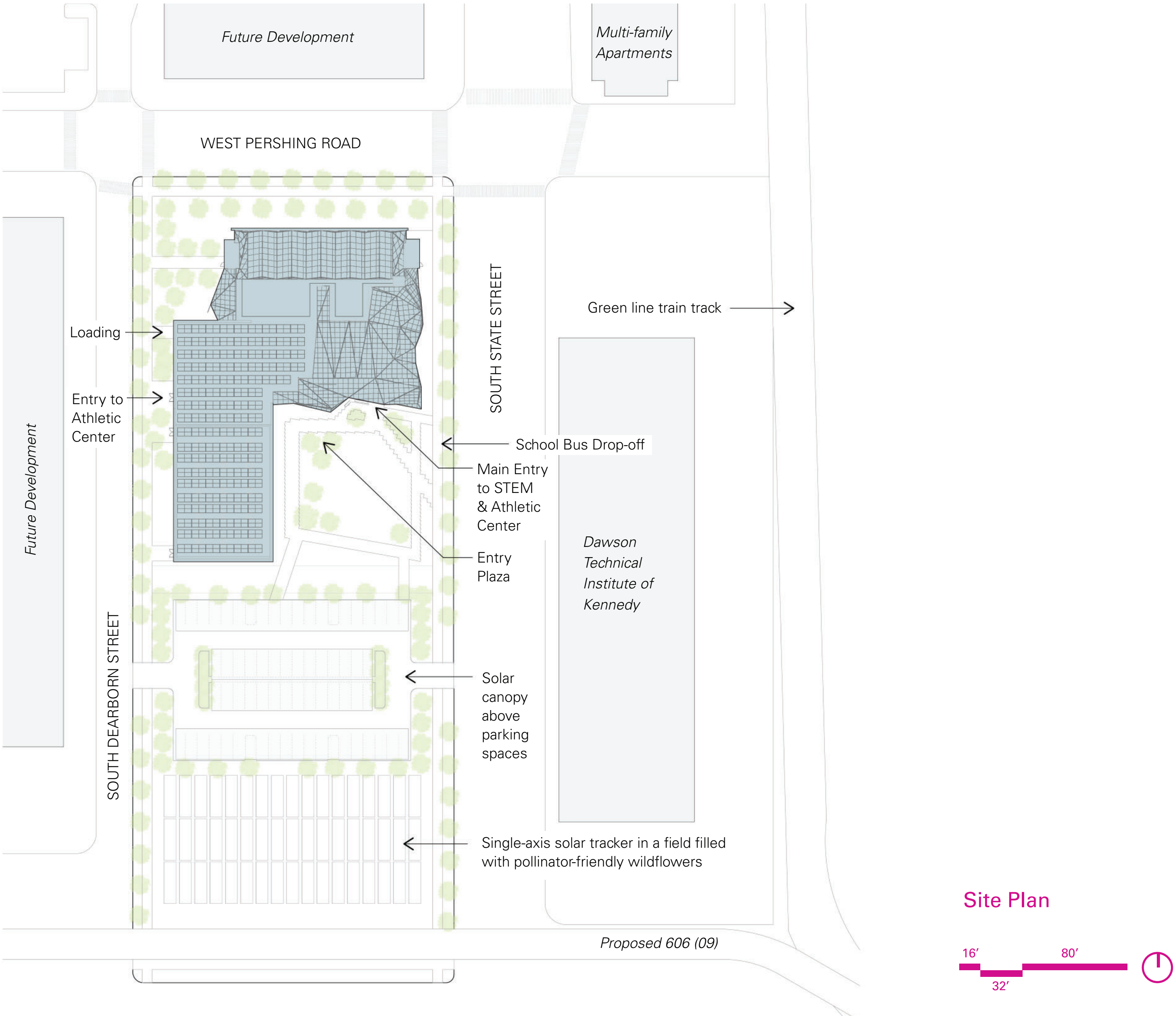




TOTAL SIZE OF PROGRAM REQUIRED ON SITE

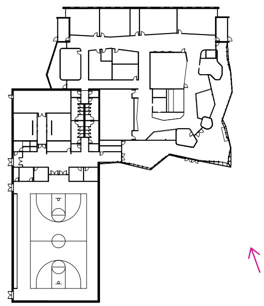


CONCEPT DIAGRAM

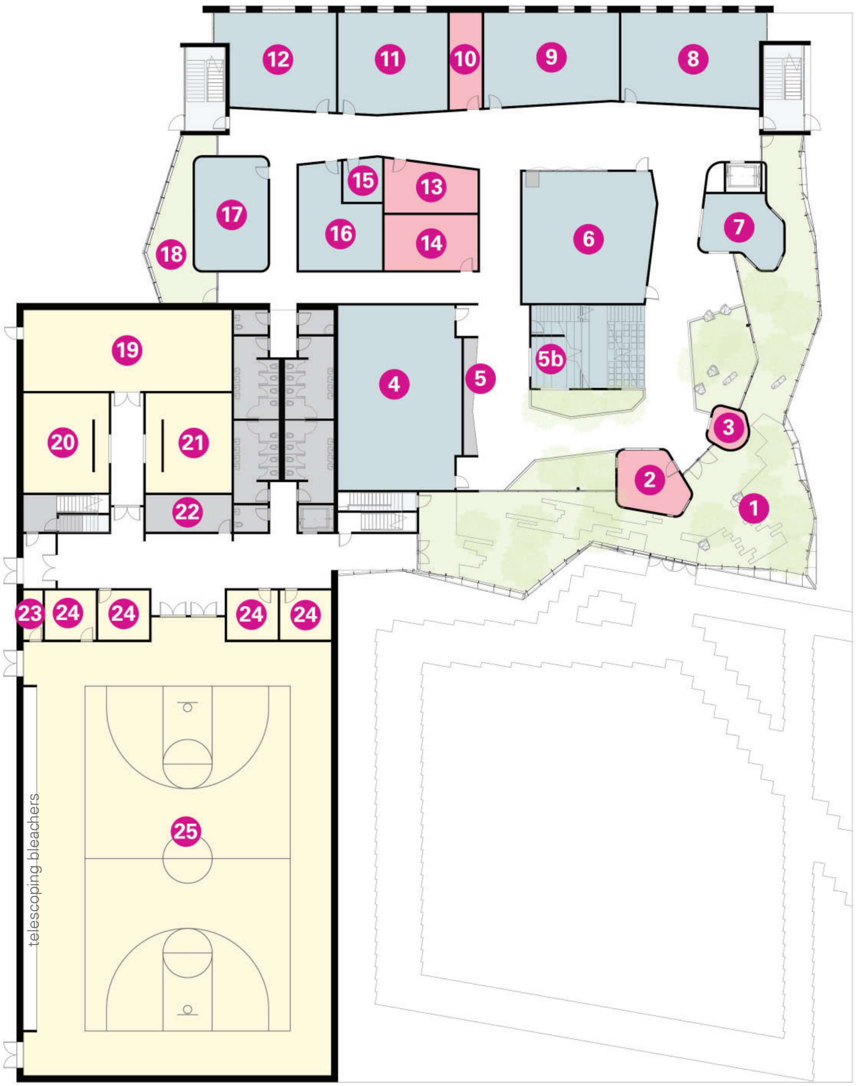

Future Development
Multi-family Apartments
WEST PERSHING ROAD
Green line train track
Loading
Entry to Athletic Center
Future Development
SOUTH STATE STREET
School Bus Drop-off
Main Entry to STEM & Athletic Center
Entry Plaza
Dawson Technical Institute of Kennedy
SOUTH DEARBORN STREET
Solar canopy above parking spaces
Single-axis solar tracker in a field filled with pollinator-friendly wildflowers
Proposed 606 (09)
16′
80′
32′

Site Plan

View towards the main entry facing North from the entry plaza on State Street.

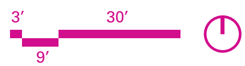


Location of rendering above

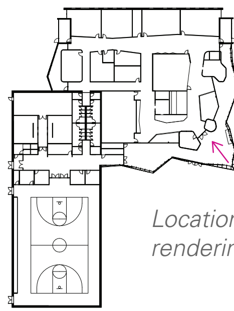


First Floor Plan

1	Entry / Green Space (2,898 sf)
2	Reception (228 sf)
3	Security / Coat Check (78 sf)
4	Small Auditorium (1,328 sf)
5	Coats (80 sf)
5b	Cafe
6	Maker Space (1,002 sf)
7	Kids Zone (287 sf)
8	Wood Metal Shop (762 sf)
9	Robotics (730 sf)
10	Storage (185 sf)
11	Dry Lab (648 sf)
12	Wet Lab (641 sf)
13	Medical (268 sf)
14	Security (307 sf)
15	Podcast (99 sf)
16	Sound Recording (431 sf)
17	Multi-use (487 sf)
18	Green Space (403 sf)
19	Fitness (1,003 sf)
20	Mens Lockers (500 sf)
21	Womens Lockers (503 sf)
22	Laundry (189 sf)
23	Utility (57 sf)
24	Office (150 sf)
25	Gymnasium (8,021 sf)



Main entry "green zone" facing North towards reception.



Location of rendering above

ADMIN

ATHLETIC

CIRCULATION

GREEN SPACE

STEM

SUPPORT

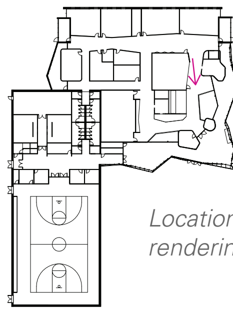
Second Floor Plan

26 Conference (228 sf)
27 Study (78 sf)
28 Gaming (515 sf)
29 Hologram (470 sf)
30 Conference (287 sf)
31 Dev Studio (713 sf)
32 Classroom (565 sf)
33 Classroom (545 sf)
34 Kitchen (251 sf)
35 Teaching Kitchen (891 sf)
36 Staff (487 sf)
37 E01 (80 sf)
38 E02 (136 sf)
39 E03 (138 sf)
40 E04 (137 sf)
41 R01 (100 sf)
42 R02 (101 sf)
43 E08 (80 sf)
44 E07 (80 sf)
45 E06 (80 sf)
46 E05 (80 sf)
47 Utility (51sf)
48 R03 (101 sf)
49 R04 (100 sf)
50 R05 (100 sf)
51 Storage (240 sf)
52 R06 (101 sf)
53 Aerospace (721 sf)
54 Sports Lab (2,503 sf)
55 Classroom (505 sf)
56 Utility (107 sf)
57 Film 303 (sf)

3′ 30′

9′

View of Makerspace and Kids Zone facing South towards main entry/reception.



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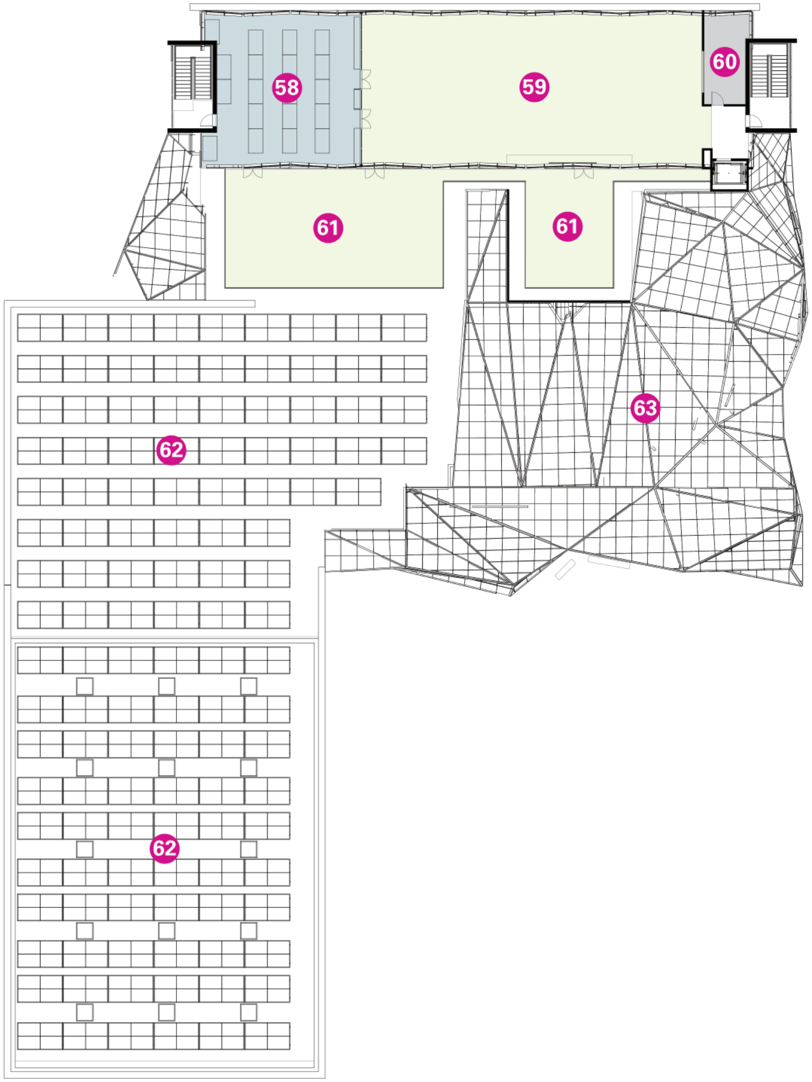

ADMIN
ATHLETIC
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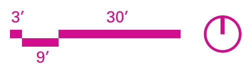
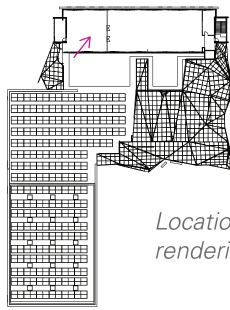
GREEN SPACE
STEM
SUPPORT

Penthouse Floor Plan

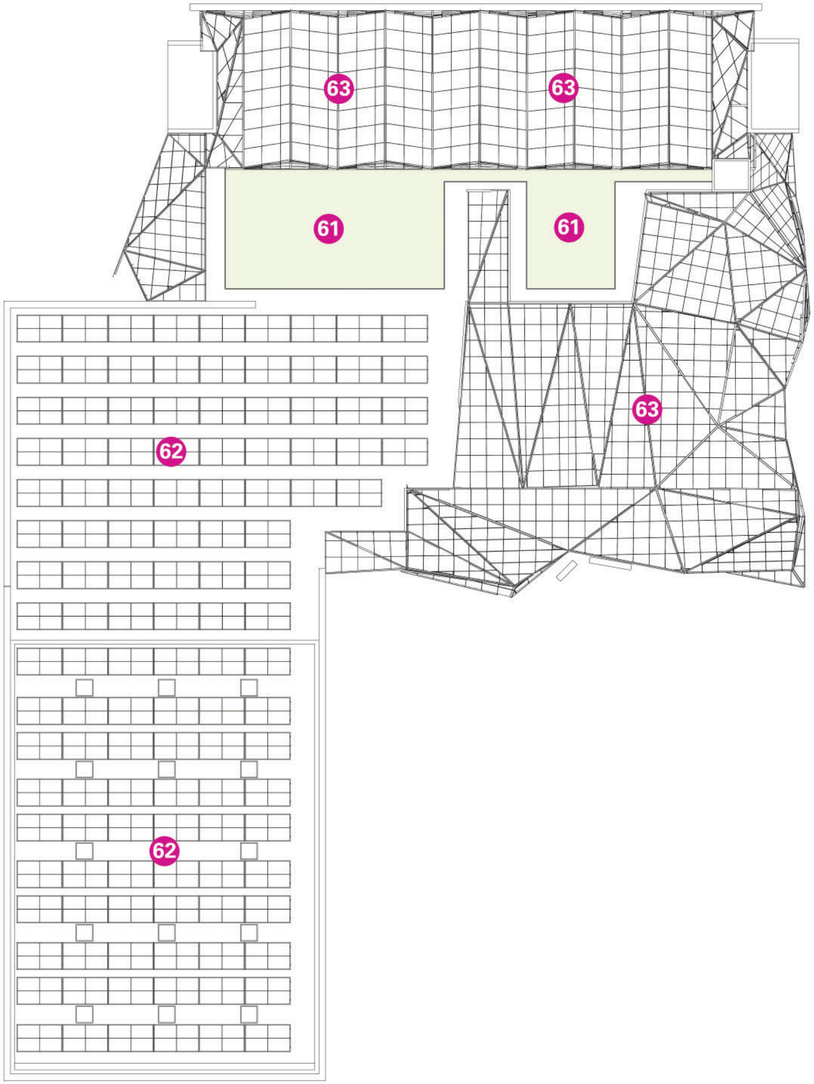
58 Greenhouse Lab (1,404 sf)
59 Grand Lawn (3,196 sf)
60 Catering Kitchen (241 sf)
61 Green Roof
62 Solar Panels
63 Bifacial Solar Panels



Greenhouse lab facing East towards the Grand Lawn.



Location of rendering above



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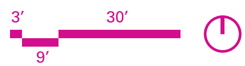
GREEN SPACE

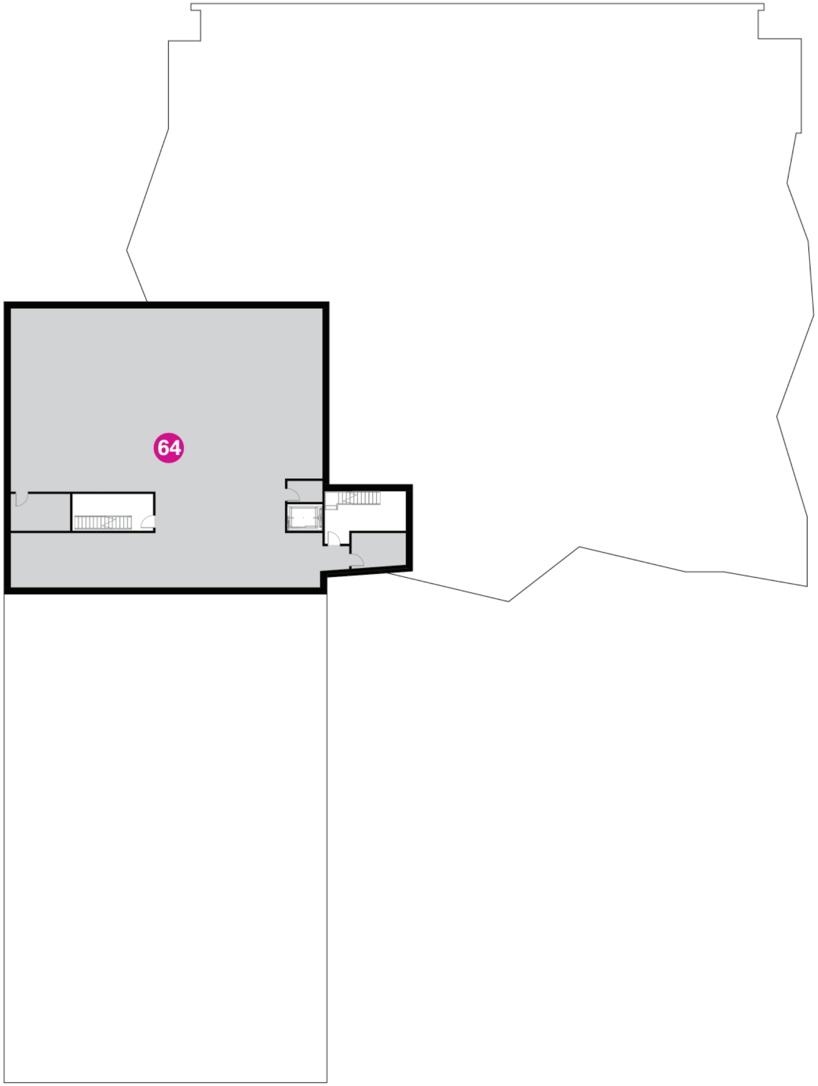
STEM

SUPPORT

Roof Plan

61 Green Roof
62 Solar Panels
63 Bifacial Solar Panels





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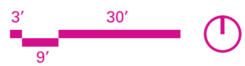
Basement Plan

64 Mechanical (4,692 sf)



Energy Positive Feasibility - Summary

The scale, location, orientation, and site planning for the NSBE Chicago - Bronzeville Center contribute to a development that can achieve an energy-positive building and site. This creates an opportunity to guarantee not just that the building will operate in a carbon neutral way, but that the site energy generation will reduce carbon emissions from other buildings as a way of offsetting the embodied carbon from building the NSBE Chicago - Bronzeville Center. The path to an energy-positive development includes the following key steps:

- Establishing an energy budget based on available site energy,
- Refining the design to minimize energy use and maximize the amount of site energy,
- Modeling the building performance to confirm that the energy use will fall within the energy budget.

As part of the feasibility analysis, WKA and DataBased+ (dbHMS) followed an iterative process that used building performance modeling to inform and respond to the programming and building design process at each stage. The sections that follow show the results for the final design iteration.

EnergyBudget

The NSBE Chicago - Bronzeville Center affords four different opportunities for integrating on-site energy generation using photovoltaic (PV) panels: roof-mounted, semi-transparent, building-integrated solar photovoltaic (BIPV) in the façade, a solar canopy over the parking lot, and a ground-mounted system at the south edge of the site. Supplementing these systems with battery storage will provide a combination of resilience and grid management that integrates well with ComEd's Bronzeville microgrid. The microgrid supports buildings that deliver value to the community and integrate renewable energy into the electricity supply mix.

Fixed solar roof-mount 10°

290 kW
363 MWh

Semi-transparent

7 kW
8.75 MWh

Parking canopy fixed 20°

320 kW
435 MWh

Ground-mount 2-axis

560 kW
1,020 MWh

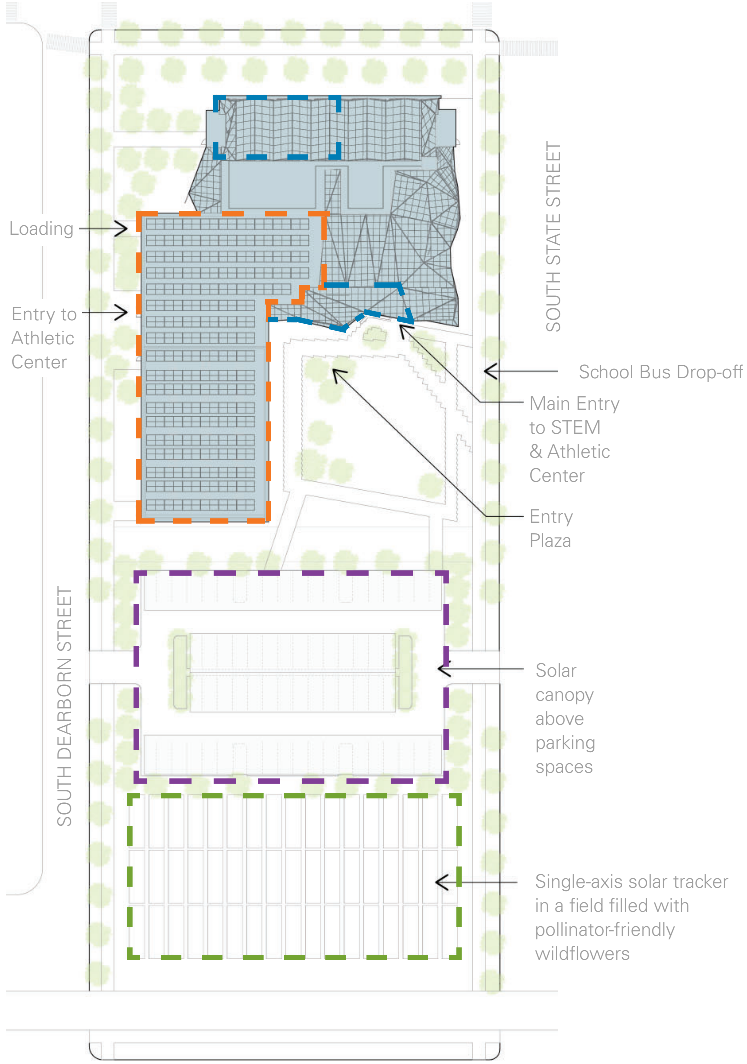


Figure: Energy Budget Based on Four Zones of Solar Potential

Using the proposed building and site footprint as noted in the figure, the four solar options include:

- Roof mounted solar tilted at 10 degrees and facing due south; includes 660 panels at 440 W for an estimated total installation of 290 kW. Using a production factor of 1,250 kWh/kW – which factors in some improvements in technology between feasibility and installation – this means approximately 363,000 kWh of potential annual generation.
- Semi-transparent, building-integrated solar photovoltaic (BIPV) consisting of about 50 solar glass panes with 140 W per pane of solar capacity blended with fully transparent sections. Using a production factor of 1,250 kWh/kW, the means around 8,750 kWh of potential annual generation,
- Solar panels integrated into a parking canopy including up to 730 panels at 440 W for a total installation of 320 kW. Using a production factor of 1,250 kWh/kW, this means around 435,000 kWh of potential annual generation,
- Ground-mounted, two-axis solar panels consisting of a total of about 560 kW of solar panels producing at a factor of about 1,800 kWh/kW due to the improved solar access, even with self-shading. This estimate of about 1,020,000 kWh sets an upper bound for the opportunity, but even with a combination of single-axis tracking panels, bi-facial panels, and integrated landscaping, the potential annual generation remains in the neighborhood of 1,000,000 kWh.

Figure: Solar Options (Top L to Bottom L) Fixed roof-mounted, semi-transparent, parking canopy, and 2-axis tracking

From all these options, the building has a target energy use index (EUI) of:

1. 19.4 kBtu/ft2/year based on matching the building energy use to just the fixed solar,
2. 19.9 kBtu/ft2/year based on matching the building energy use to all the building solar,
3. 43.2 kBtu/ft2/year based on matching the building energy use to all the building solar plus the maximum amount of parking canopy solar,
4. 97.8 kBtu/ft2/year based on matching the building energy use to all the building solar plus the maximum amount of parking canopy solar plus the maximum production from the ground-mount system.

Given the additional cost per kWh of the semi-transparent, canopy, and two-axis ground-mount systems, the building energy budget should encourage the design team to pursue strategies that do not require the ground-mount system and a minimum of the canopy system to meet the building energy needs. This frees up these systems for two purposes: integration into the Bronzeville microgrid to provide more solar options for the local community, and the opportunity to use the added solar production to offset the carbon impact of constructing the building and site.

As a starting point, the building design should target an EUI of 20 kBtu/ft2/year, with a commitment to pursue strategies that lower that to 18 kBtu/ft2/year in future stages of development pending program changes.

Note that this does not include a recommended twenty-percent (20%) buffer between solar generation and predicted building energy use to allow for variability in building operation as well as variability in solar production due to weather. The eventual canopy solar design should provide this buffer.

Energy Performance

We developed an energy model based on the building design shown previously, and the following assumptions:

SIMULATION ASSUMPTIONS

	PREVIOUS DESIGNS (EUI 16 & EUI 18)	CURRENT DESIGN
Window Wall Ratio	15%(3,684 SF OPENING), 24% (4,900 SF OPENING)	26% (11,200 SF OPENING)
Wall	U - 0.04 Btu/hr. sf. °F (R – 25)	
Roof	U - 0.025 Btu/hr. sf. °F (R – 40)	
Fenestration Properties	U value - 0.38 Btu/hr. ft^2. °F SHGC – 0.38	
Lighting Power Density	20% reduction compared to ASHRAE 90.1 – 2016 Building Area Method MAIN BUILDING: 0.65 WATTS/SF GYM: 0.56 WATTS/SF	
Equipment Power Density	CLASSROOM: 15 WATTS/PERSON LAB: 40 WATTS/PERSON OFFICE: 150 WATTS/PERSON LOBBY: 0.5 WATTS/SF GYM: 0.2 WATTS/SF	
Occupancy	EUI 16- 461 TOTAL EUI 18 - 507 TOTAL	490 TOTAL
Primary System Type	AIR COOLED VRF WITH DEDICATED MAU	
Heating System	AIR COOLED VRF (HEATING COP: 5.5)	
Cooling System	AIR COOLED VRF (COOLING COP: 5.3)	
DHW Use	+3 to EUI (GYM SHOWERS, KITCHEN, GYM LAUNDRY)	

Table: Energy Modeling Assumptions

The proposed building design achieves a total EUI of around 26 kBtu/ft2/year. This falls outside the target value of 20 kBtu/ft2/year, due in large part to an assumption that the great lawn and entryway spaces get conditioned to standard temperatures of 72F in the winter and 74F in the summer. In the chart, the column to the left of the solar production (DESIGN W/O GLASS ENCLOSED SPACES) shows that if the design team can find creative solutions to maintain the programmatic requirements of these spaces with energy already utilized for other building services, the energy use can approach the design target of 20 kBtu/ft2/year. The next section discusses additional energy efficiency measures that can lower the building energy consumption.

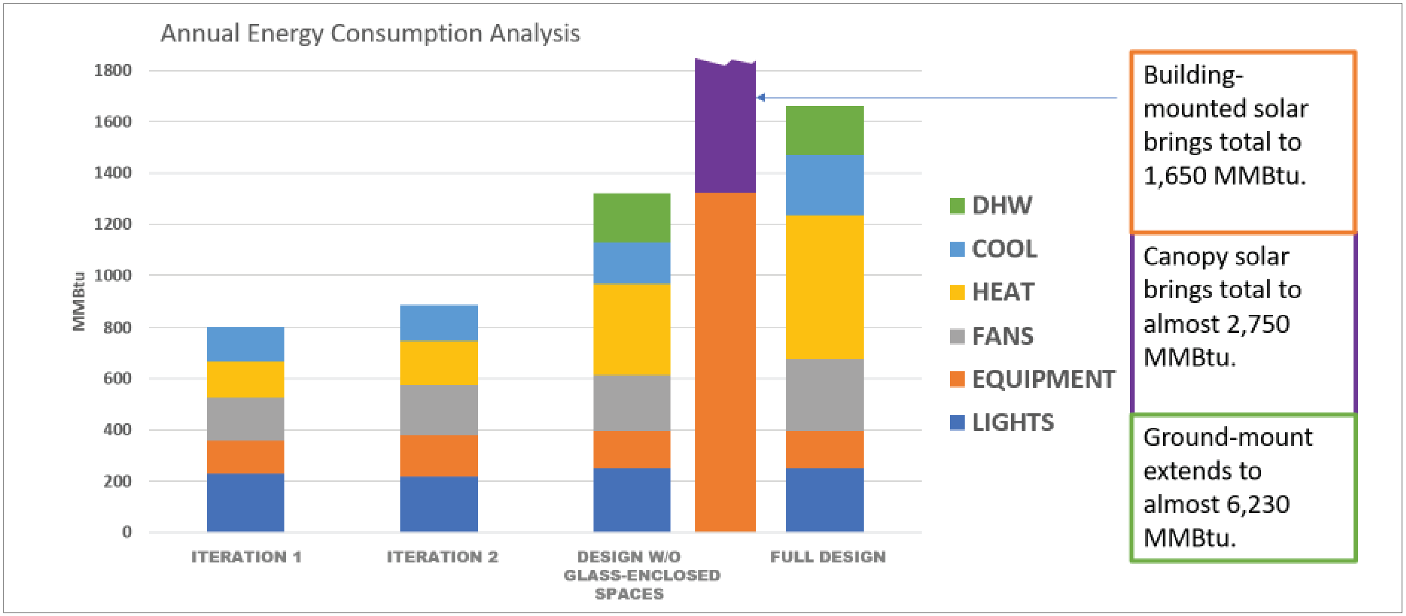


Figure: Annual Energy Consumption Analysis

Recommended Strategies for Cost-Optimization Analysis

In the next design phase, once NSBE and WKA have affirmed the program and building use, DataBased+ (dbHMS) will run a cost-optimization analysis that looks at the incremental cost of solar against a battery of energy reduction strategies to identify whether an investment in energy efficiency has better value than utilizing the solar potential of the site. At a minimum, the analysis will include the following strategies:

- **Passive strategies/Shared energy strategies for the glass-enclosed spaces:** These spaces offer a unique opportunity to implement passive design strategies, including adaptive comfort, to minimize energy use for thermal comfort. In addition, as more lightly-occupied or transient spaces, the building services providing comfort and quality in the space can share resources with other spaces in the building so as to require little to no additional energy.

- **Enhanced envelope tightness:** The current model assumes a standard level of infiltration/air-tightness. Passive House buildings have shown a fifty to ninety-percent reduction in air leakage, which can significantly reduce the heating energy need in the building. As heating accounts for a little over a quarter of the building energy use, implementing Passive House design strategies for air tightness coupled with building envelope commissioning can have a significant impact on energy use.

- **Enhanced windows:** With an assumed window performance near code-minimum levels, the design provides an opportunity to greatly impact both the energy use and visual comfort with higher-performing windows that can lower thermal transmittance by as much as fifty percent (50%) and solar heat gain by forty percent (40%).

- **Integrated smart-building technology:** With so many of the loads dependent on the number of occupants and their activities, an integrated smart-building system that monitors the level of occupancy in real time and communicates with occupants on the relative comfort in the spaces can optimize the building automation system to deliver only the amount of service necessary at any one time. Coupled with an automation system that learns and adapts, the building energy use could drop by anywhere from an additional five to fifteen percent and provide additional ancillary benefits to the user and operator including management of plug-loads, evaluation of the efficacy of building programs, and increased capacity for communication in an emergency.

- **Innovative ventilation strategies:** Integrated smart-building design can also minimize ventilation needs while still maintaining a healthy environment. For times when the building needs significant ventilation, strategies like earth tubes, solar walls, and total energy recovery wheels can lower the energy for heating and cooling outside air entering the building.

All these strategies, as well as the solar and other energy efficiency concepts included in the proposed design, fall within incentive programs that can offset some of the additional costs. As some of these incentives come with significant requirements, the cost-optimization analysis will evaluate the strategies with and without these incentives to provide NSBE with the clearest picture of the opportunities. In addition, the analysis will include evaluation of innovative financing structures such as energy-as-a-service and power-purchase agreements which can deliver the benefits of enhanced energy systems without NSBE directly taking the risk for those investments.

Resilience and Climate Change

An energy-positive building offers an opportunity to address the impact of the building development on the climate as well as an opportunity to mitigate some of the risks of climate change. Future design stages will identify options for battery storage that, when paired with the on-site generation, offer NSBE the chance to:

- Maintain building operations even during a local grid-loss event,
- Export energy to the surrounding microgrid during a wider grid-loss event in combination with other sources of generation,
- Expand the amount of solar “behind the meter” to lower operating costs,
- Monetize the above strategies to lower operating costs.

wkarch

Wheeler Kearns Architects

NSBE PROFESSIONALS

National Society of Black Engineers

CHICAGO

DATA BASED+

db HMS