QUEEN CITY | ISSUE_02

2-22-2022 | UNIVERSITY OF CINCINNATI | SOLAR DECATHLON OFFICE SUBMISSION

ISSUE_02 - 2/22/2022

SOLAR DECATHLON OFFICE SUBMISSION

Q+C

THE *FUTURE* OF SOLAR POWERED OFFICE SPACES



ELECTRICAL
Managing electrical gereration and stored energy (pg. 12)

ARCHITECTURE
Creating a shared methodology for resources (pg. 6)

PERFORMANCE
Where function and design breeds performance (pg. 14)

CORDOBA

PROJECT LOCATION AND DATA



VIEWS FROM SITE | GOOGLE STREET VIEW

BACKGROUND:

Formerly the Hipólito Yrigoyen Park, the site has generous views in all directions.
Having been a park, minimal site changes are required to implement the scheme.

SITE PLAN | PROPERTY LINE VIEW



WEATHER

	January	February	March	April	May	June	July	August	September	October	November	December
Avg. Temperature °C (°F)	23.8 °C (74.8) °F	22.4 °C (72.4) °F	20.2 °C (68.4) °F	17.1 °C (62.8) °F	13.3 °C (55.9) °F	10.6 °C (51.1) °F	9.8 °C (49.6) °F	12.1 °C (53.8) °F	14.9 °C (58.8) °F	18 °C (64.3) °F	20.7 °C (69.3) °F	22.9 °C (73.2) °F
Min. Temperature °C (°F)	18.7 °C (65.7) °F	17.9 °C (64.3) °F	16 °C (60.8) °F	13 °C (55.4) °F	9.3 °C (48.7) °F	6.1 °C (43) °F	5 °C (41) °F	6.6 °C (43.8) °F	9.1 °C (48.4) °F	12.6 °C (54.7) °F	15.3 °C (59.5) °F	17.6 °C (63.7) °F
Max. Temperature °C (°F)	29.1 °C (84.4) °F	27.4 °C (81.4) °F	25.2 °C (77.3) °F	22.2 °C (71.9) °F	18.3 °C (65) °F	16.6 °C (61.8) °F	16 °C (60.8) °F	19 °C (66.1) °F	21.5 °C (70.8) °F	24 °C (75.2) °F	26.7 °C (80.1) °F	28.5 °C (83.4) °F
Precipitation / Rainfall mm (in)	145 (5.7)	123 (4.8)	126 (5)	81 (3.2)	39 (1.5)	18 (0.7)	16 (0.6)	20 (0.8)	39 (1.5)	90 (3.5)	110 (4.3)	137 (5.4)
Humidity(%)	63%	70%	73%	71%	73%	70%	65%	58%	53%	59%	57%	59%
Rainy days (d)	10	9	9	7	5	2	3	2	4	8	9	10
avg. Sun hours (hours)	10.1	8.5	7.5	6.5	6.2	7.1	7.5	8.5	8.8	8.5	9.9	10.3

SUMMER:

Mid-November to Early March

Average temp: 81°F

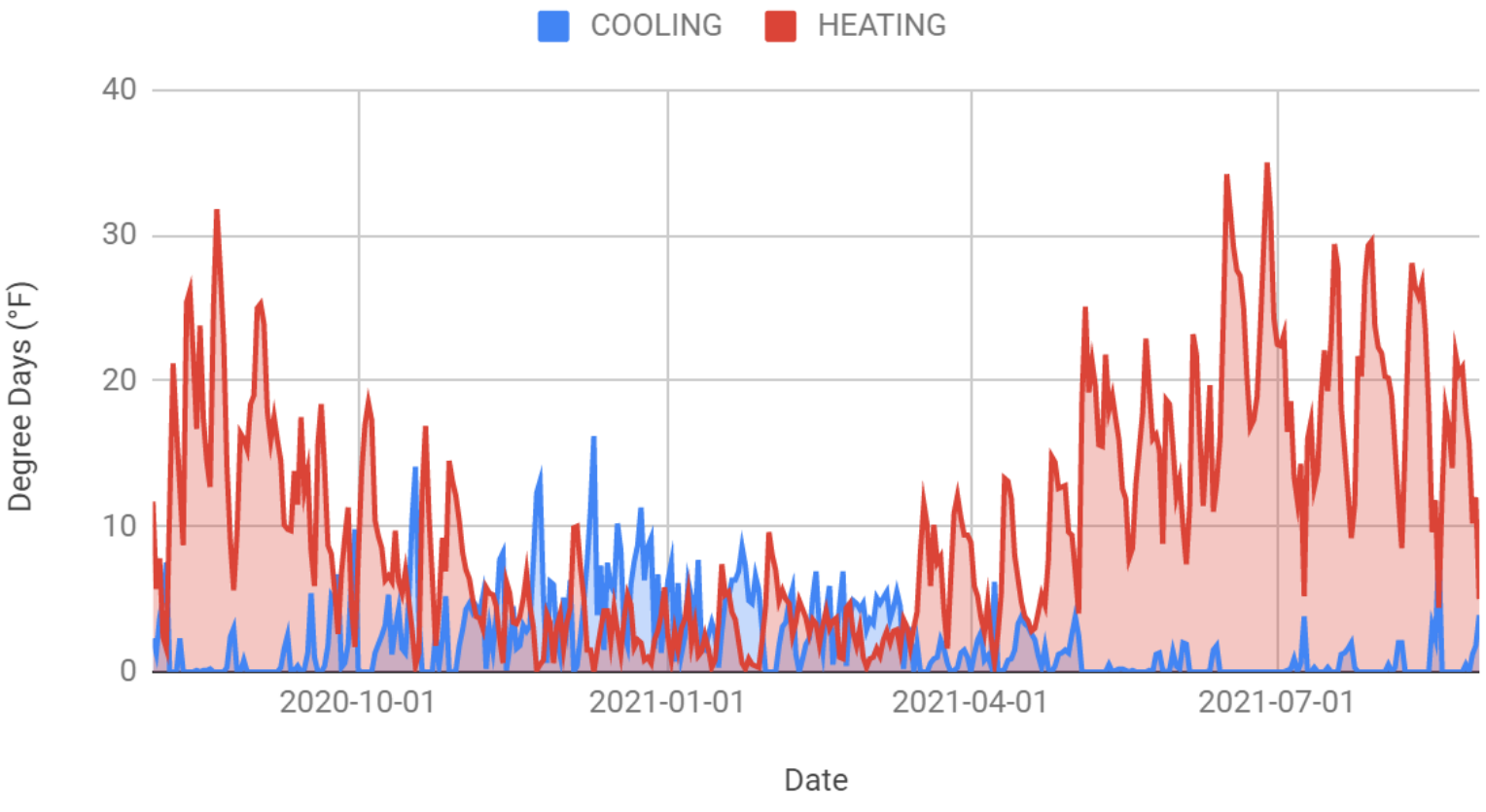
Average high/low: 86°F/66°F

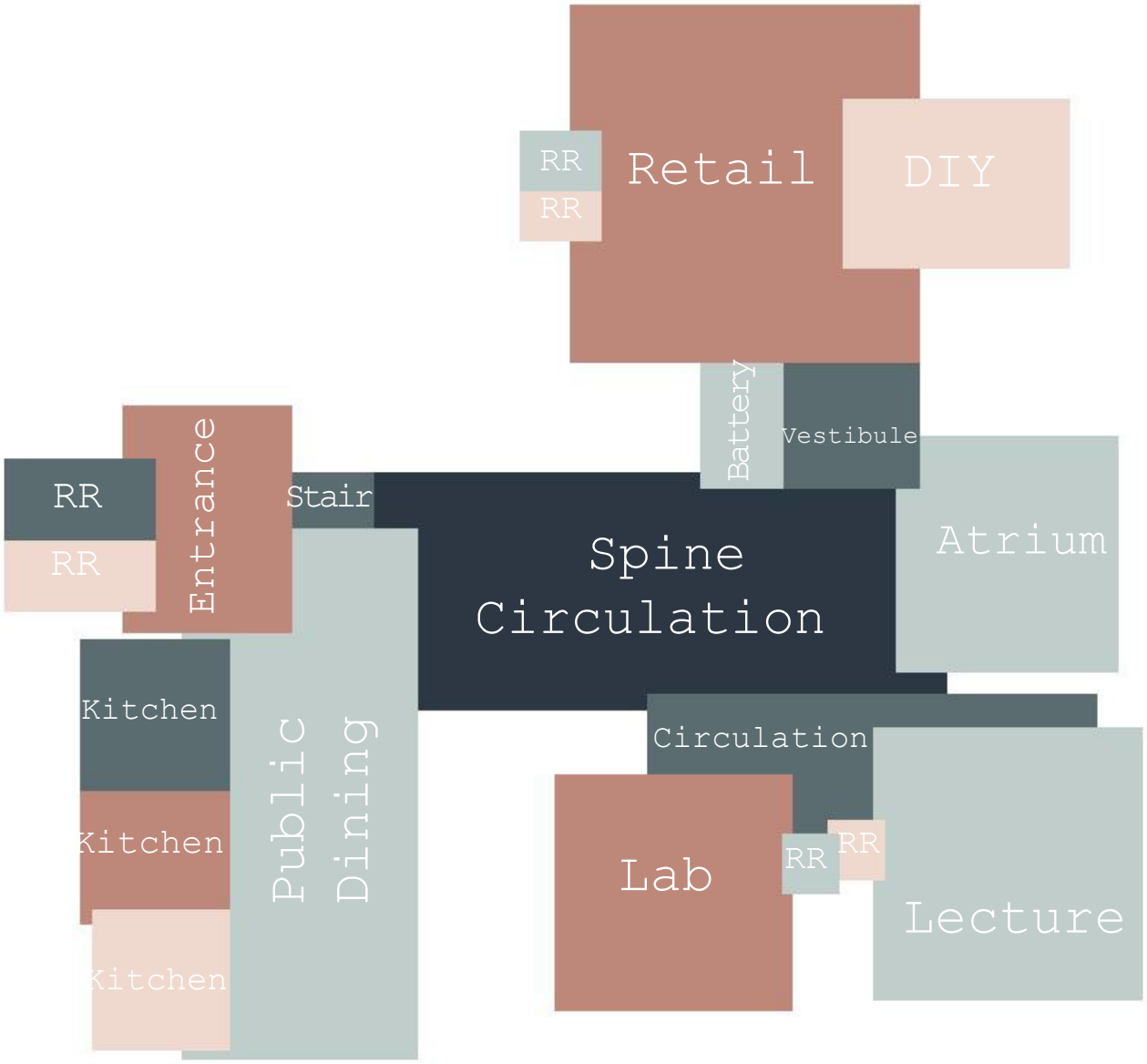
WINTER:

Mid-May to Mid-August

Average temp: 68°F

Average high/low: 64°F/42°F





FIRST FLOOR | PROGRAM DIAGRAM

PRE-DESIGN

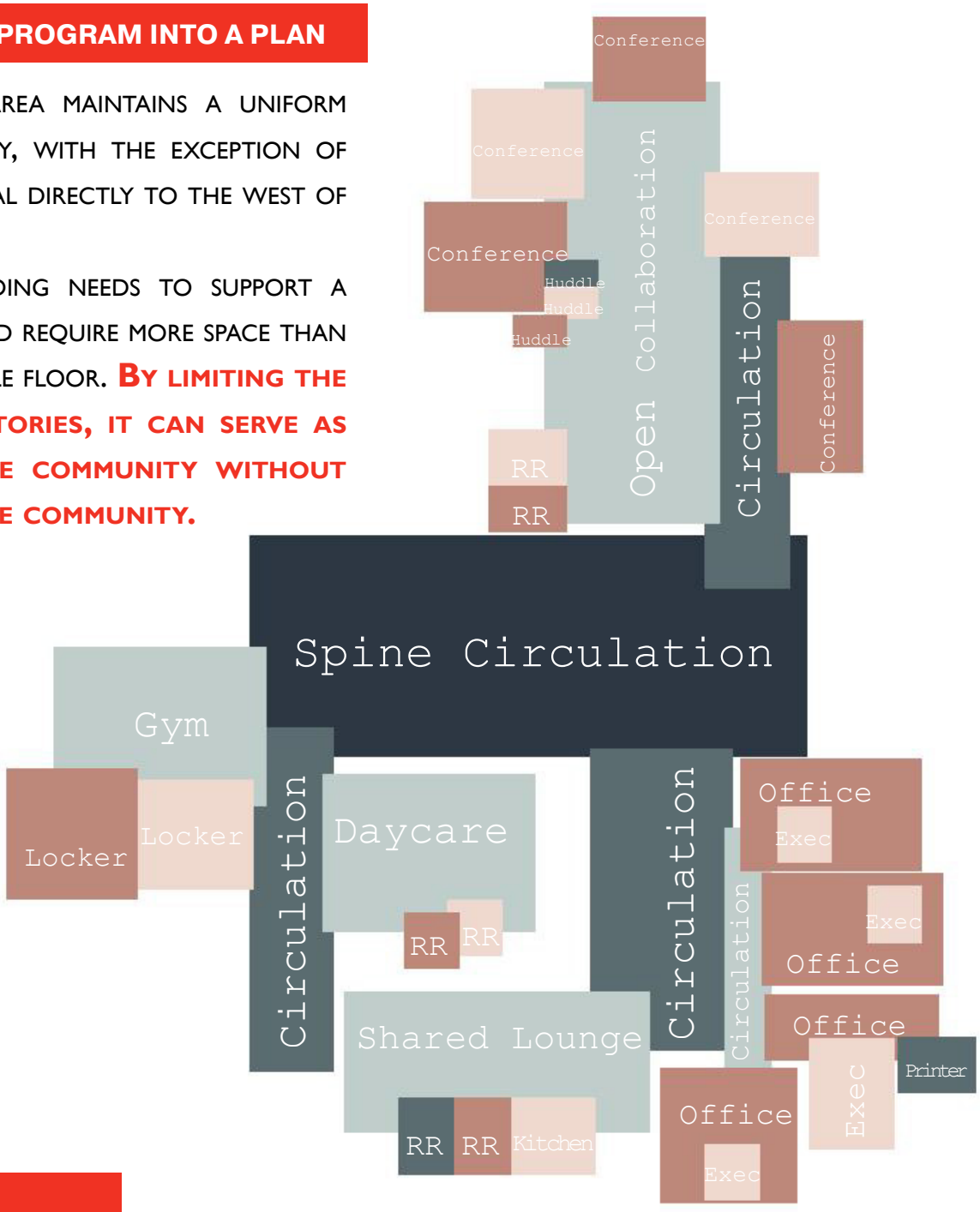
UNDERSTANDING THE PROGRAM

THE DESIGN WAS CENTERED AROUND THE CONCEPT OF A **SHARED NETWORK** AND HOW BEST TO IMPLEMENT THIS NETWORK OF SOLAR GENERATION AND BATTERY TECHNOLOGIES. OUR TEAM DESIGNED THE **SPINE BRIDGE** TO MEET THIS GOAL. WITH THE TARGET MARKET BEING THE CITY OF CORDOBA, WE SET OUT TO CREATE A BEACON OF THE COMMUNITY THE BUILDING WAS DESIGNED TO AID. WITH THE COMMUNITY OF CORDOBA, ALONG WITH THIS DEVELOPMENT, WE AIM TO EXPAND THE REGIONAL KNOWLEDGE OF SOLAR AND OTHER FORMS OF RENEWABLE ENERGY. IN ADDITION, THE BUILDING WOULD ALSO PROVIDE THE ADDITIONAL MATERIALS AND TRAINING TO FURTHER INTEGRATE THE BUILDING INTO THE COMMUNITY.

TRANSFORMING A PROGRAM INTO A PLAN

THE SURROUNDING AREA MAINTAINS A UNIFORM HEIGHT OF ONE STORY, WITH THE EXCEPTION OF THE 1.5 STORY HOSPITAL DIRECTLY TO THE WEST OF SITE.

HOWEVER, THE BUILDING NEEDS TO SUPPORT A PROGRAM THAT WOULD REQUIRE MORE SPACE THAN COULD FIT ON A SINGLE FLOOR. **BY LIMITING THE HEIGHT TO TWO STORIES, IT CAN SERVE AS A BEACON FOR THE COMMUNITY WITHOUT TOWERING OVER THE COMMUNITY.**



SECOND FLOOR | PROGRAM DIAGRAM

FOR THE REST OF THE SITE, OUR BUILDING STRIVES TO MAINTAIN AS MUCH OF THE COMMUNITY ASPECT AS POSSIBLE, SINCE IT IS CURRENTLY A PUBLIC PARK. ONE OF THE BUILDING'S FUNDAMENTAL PURPOSES IS TO **PROVIDE SUPPORT TO NEARBY RESIDENTS AND ALLOW THEM TO INSTALL SOLAR KITS ONTO THEIR OWN HOUSES AND BUSINESSES**. IN ADDITION, THE REMAINING OUTDOOR AREAS OF THE SITE WILL BE UTILIZED AS A CREATIVE PLAYGROUND AREA, INTERACTING WITH THE BUILDING'S STRUCTURE.

FIRST FLOOR PLAN



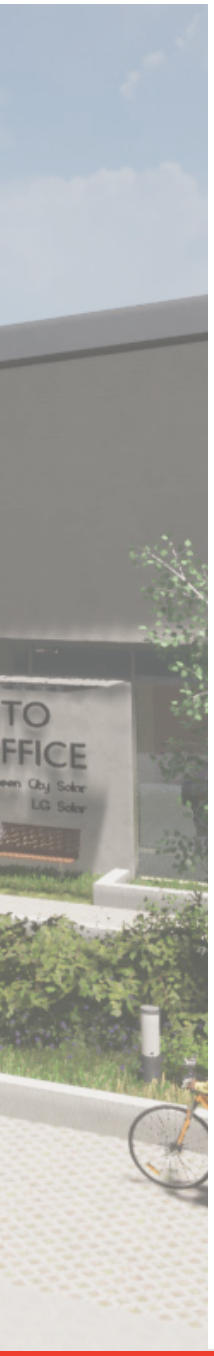


ARCHITECTURE

MUCH OF THE BUILDING'S FOOTPRINT TAKES ADVANTAGE OF THE SOUTHERN HEMISPHERE'S **NORTHERN DAYLIGHTING.**

BASED ON WHICH DIRECTION THE CURTAIN WALL IS FACING, THE **DEPTH OF THE MULLIONS** IS INCREASED OR DECREASED TO **EFFECTIVELY SHADE THE SPACE.**

THE CENTRAL BRIDGE LETS THROUGH AMPLE AMOUNTS OF SUNLIGHT. THIS NOT ONLY BRIGHTENS THE WALKWAY, BUT IT ALSO LETS THROUGH LIGHT TO THE SOUTHERN COURTYARD AREA.



SECOND FLOOR PLAN

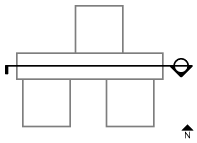


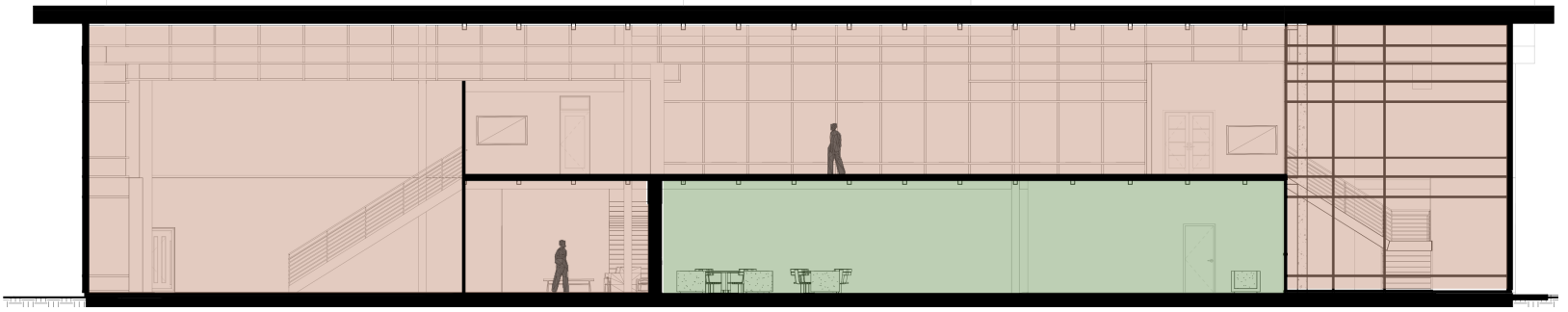
This mid-level office building stands as a representation of the future of the AEC industry moving forward with design that inspires innovation, modernized approaches to building operations, and high-performance design.

THE COURTYARD IS SURROUNDED BY A MODERATE AMOUNT OF GLAZING. THIS GLAZING IS STRATEGICALLY PLACED BY THE MAIN CIRCULATION PATHS INSIDE THE BUILDING, TO PROVIDE OCCUPANTS WITH A BRIGHT ENVIRONMENT INDOORS AND AN UNOBSTRUCTED VIEW OF THE OUTDOORS.

ON THE NORTH SIDE OF THE BUILDING, THE CORNER OF THE RETAIL AREA IS LINED WITH STOREFRONT GLAZING, CASTING A SPOTLIGHT ON THE STORE AND ITS PRODUCTS.

THE MAIN ENTRANCE ON THE NORTHEAST CORNER IS A **TWO-STORY ATRIUM ILLUMINATED BY THE SUN DURING THE DAY**. THE OPENNESS OF THIS KEY AREA GIVES A GRAND FEELING RIGHT AS OCCUPANTS ENTER THE BUILDING.





THESE SECTIONS OFFER A UNIQUE PERSPECTIVE INTO THE VERTICAL CIRCULATION WHILE INTRODUCING THE DISTRIBUTION NETWORK. ALL STAIRS AND ELEVATORS LEAD THROUGH THE SPINE BRIDGE, WHICH FORMS THE CORE OF THE BUILDING EVEN IN SECTION. PROGRAM SPACES BRANCH OFF THIS MAIN CORRIDOR IN EACH OF THE THREE TENANT SPACES. JUST LIKE IT WAS IN THE FLOOR PLAN, THE BUILDING IS DISTINCTLY DIVIDED BY USE IN SECTION. THE FIRST FLOOR CONTAINS THE PUBLIC AREAS, ACCENTUATED BY ITS WIDER HALLWAYS AND OPEN AREAS. THE SECOND FLOOR CREATES MORE PRIVATE ZONES WITH MORE CLOSED OFF ROOMS.

ARCHITECTURE SECTIONS

THE COMMUNITY PARK ASPECT OF THE SITE IS MAINTAINED BY THE CENTRAL COURTYARD. IT PROVIDES AN OUTDOOR SPACE TO GATHER AND RELAX. SURROUNDING EXTERIOR CURTAIN WALL BLURS THE TRANSITION BETWEEN INSIDE AND OUTSIDE, EXPANDING THE BOUNDARIES OF THE COURTYARD WHILE ALSO GRANTING OUTDOOR VIEWS FROM KEY INDOOR CIRCULATION AREAS.

"ALIGNING WITH THE *Hospital* EXTENDS THIS PROOF OF CONCEPT"

-Prof. Anton Harfmann

PUBLIC FOH

GENERAL BOH

OFFICE FOH

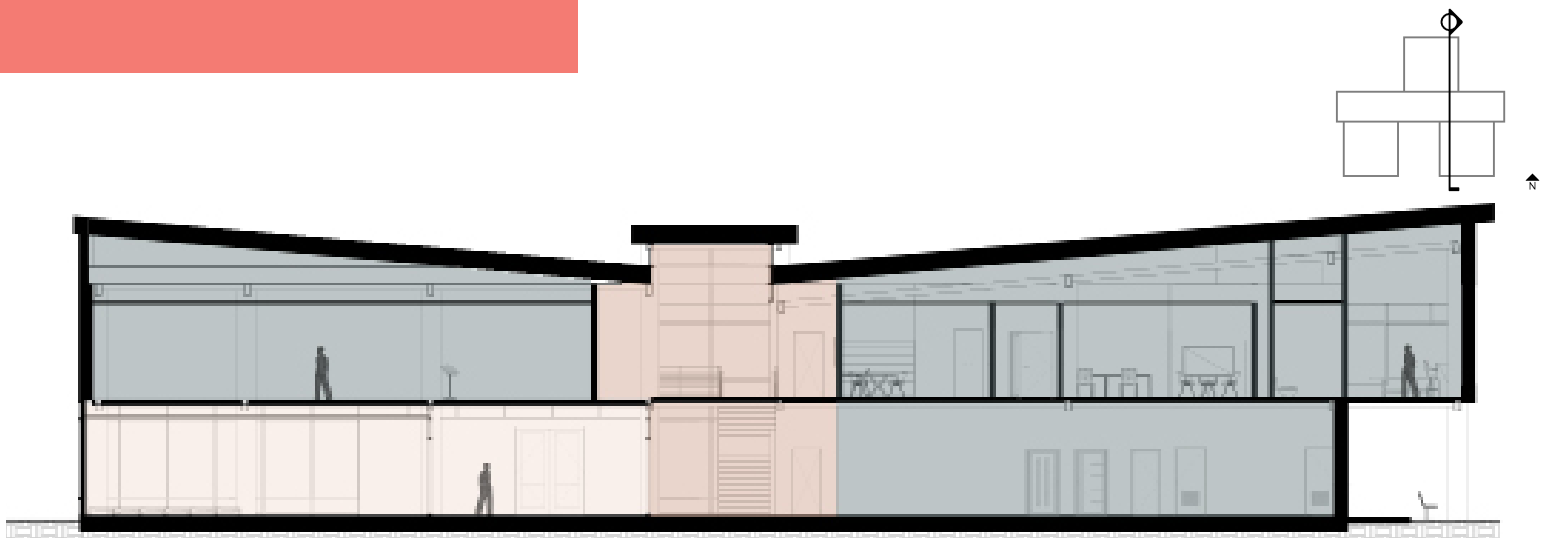
RESTROOMS

COURTYARD

CIRCULATION

AMENITIES





GROUPED INTO 3 MODULAR SECTIONS CALLED ***TENANT SPACES***, THIS BUILDING HAS THE ABILITY TO BE BUILT IN PHASES, PROVIDING AN OPTIMUM COST EFFECTIVENESS STRATEGY.

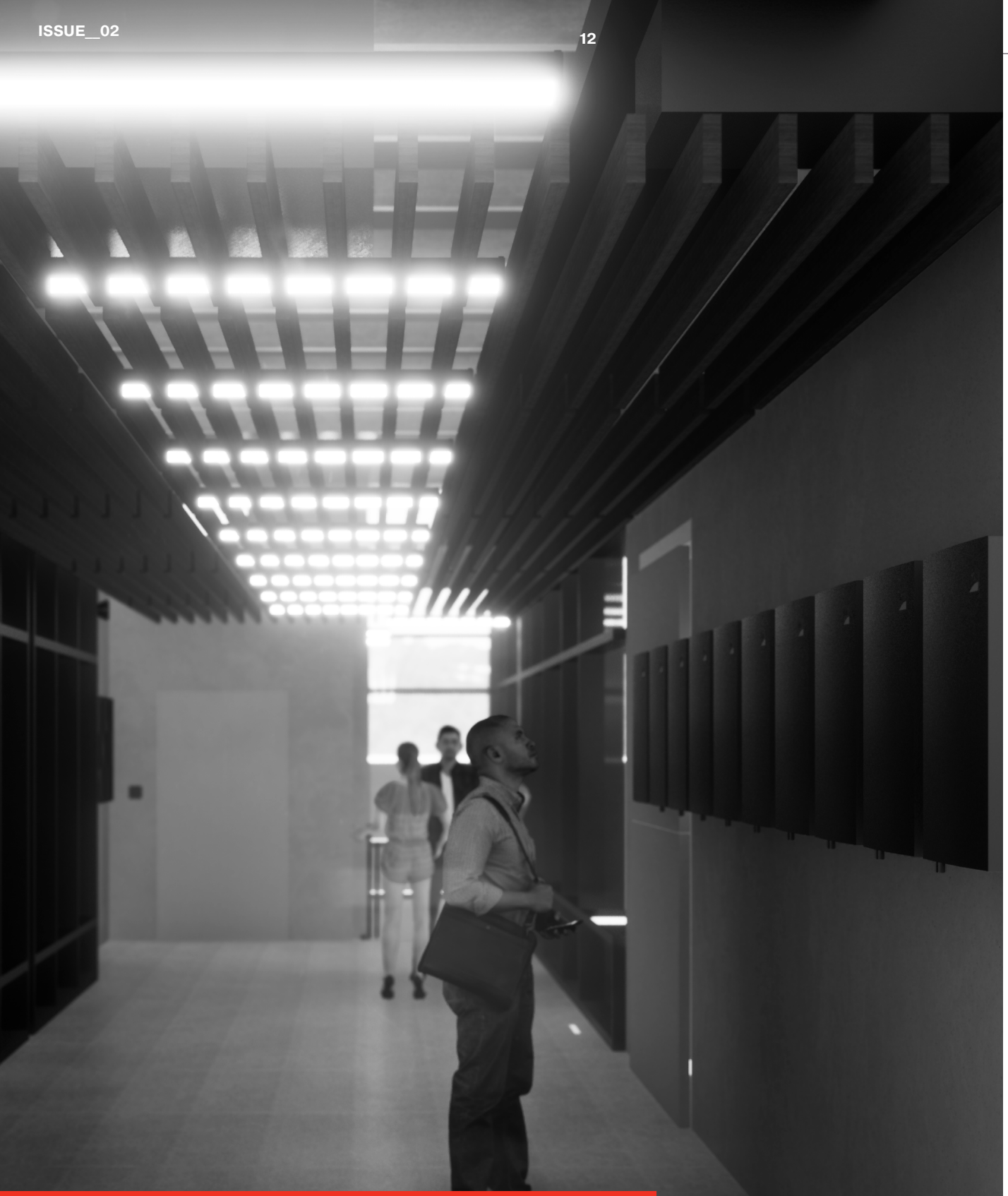
4 MAJOR COMPONENTS OF THE BUILDING:

OFFICES | RETAIL | AMENITY | *CENTRAL CIRCULATION SPINE*

VIEW OF COURTYEARD | TWINMOTION RENDER







ENGINEERING & PERFORMANCE

HOW DO YOU DESIGN A SUSTAINABLE OFFICE BUILDING AND ENSURE FLEXIBILITY FOR **CURRENT** AND ***FUTURE*** NEEDS?

SPINE BRIDGE | VIEW FROM TOP OF STAIRS

ELECTRICAL

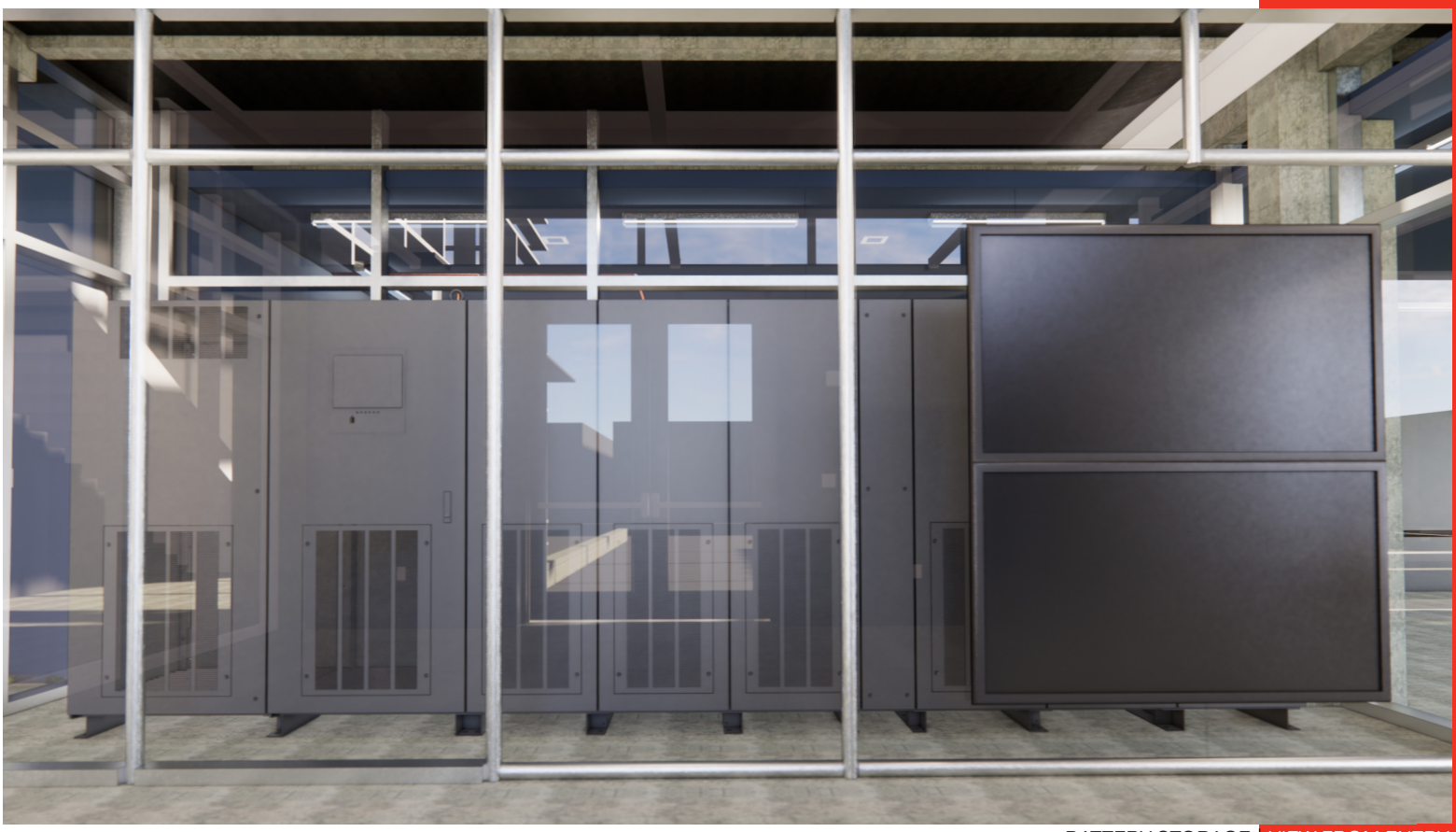
The electrical design is a mixture of solar power generation, battery storage solutions, and intelligent power distribution management.

The power generated from the photovoltaic solar panels located on each slanted roof is stored in a water cooled battery located at the building's entrance.

The smart bridge is meant to purposefully show all the electrical and mechanical structure that serves each tenant structure.

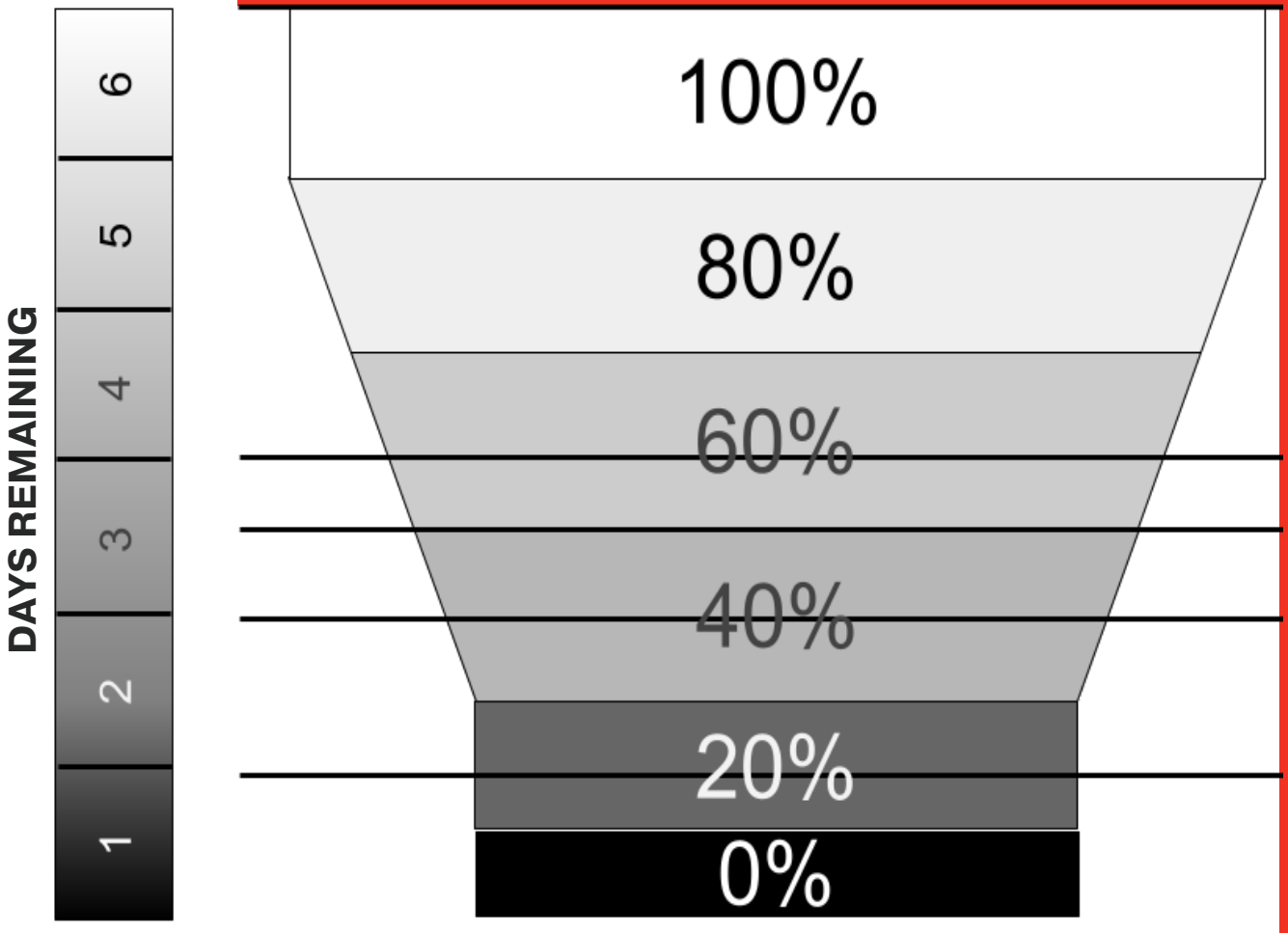
Within the bridge, are meters and screens hooked up to the Tesla powerwalls taking its data and transforming it into an understanding view of how each building is using energy over the course of the day.

Extra power produced by the solar panels after the main building battery is sufficiently charged will then provide power to the **hospital across the street**. This extra power generation to the hospital helps shave the peak demand and load for the hospital during the day while still maintaining the power supply for our office building.

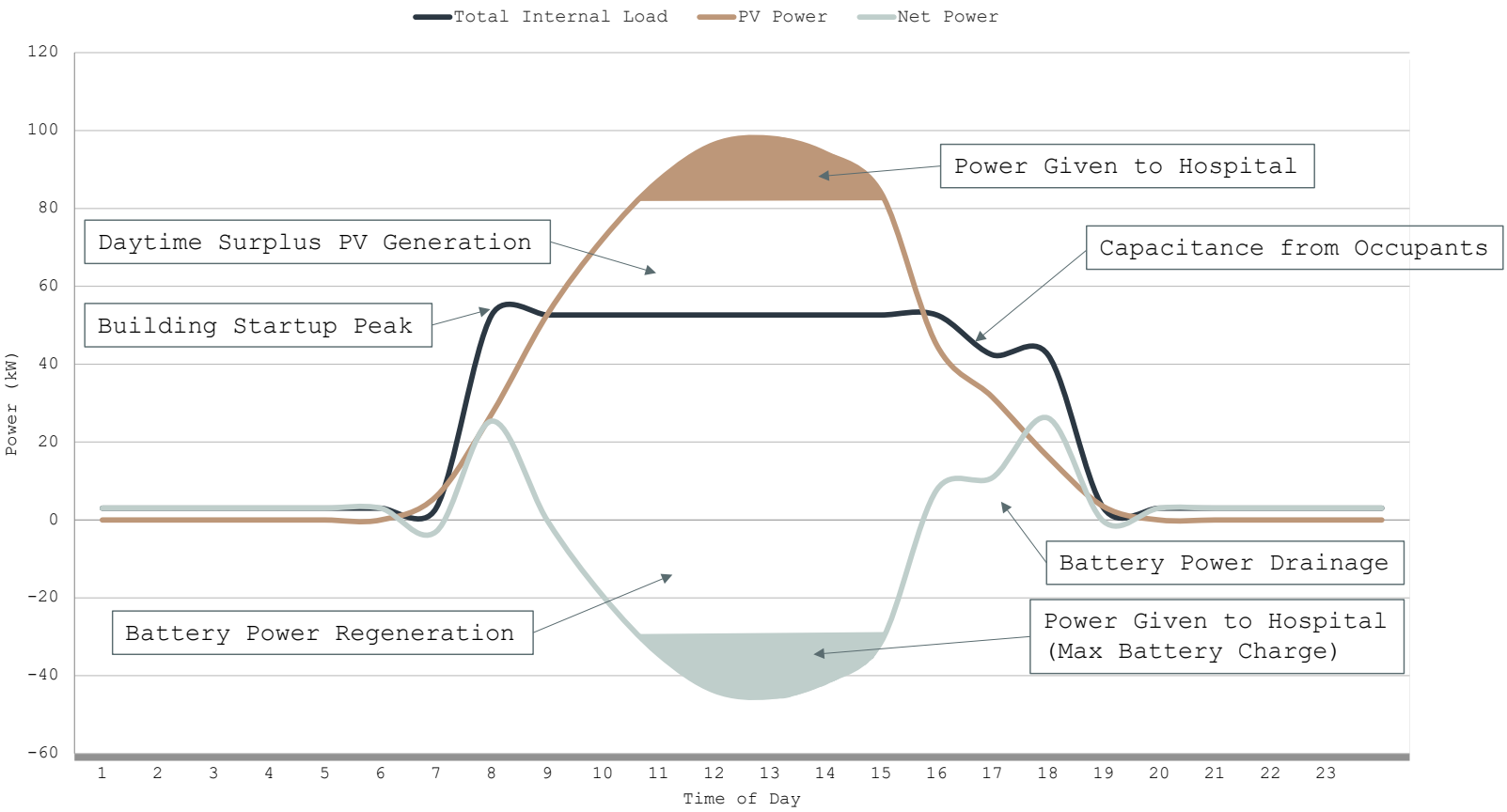


BATTERY STORAGE | VIEW FROM ENTRY

BATTERY CAPACITY CALCULATION



TYPICAL WEEKDAY LOAD CONSUMPTION VS. PV GENERATION



MAXIMUM CAPACITY:
All rooms can operate at full load with 6 days of reserve power.

SOLAR DECATHLON SPECIFICATION:
All rooms are powered for 3 days of operation.

LOW POWER MODE:
All rooms except offices, conferences, and lecture are shut down to reduce power draw.

CRITICAL POWER MODE:
All rooms except offices are shut down to reduce power draw.

MINIMUM OPERATION: Battery allocates all power to cooling itself, while powerwalls handle loads.

Despite their separation, each tenant building follows the same methodology. The structure dictates the sector's circulation and function with the north-to-south column lines. The forms were built around having communal, public spaces on the first floor, and more program specific spaces on the second floor.

The structure of the central bridge is separate from the other three main tenant structures due to the use of the spaces, and structure. The bridge ties the three tenant structures together, just like the core circulation space that it provides.

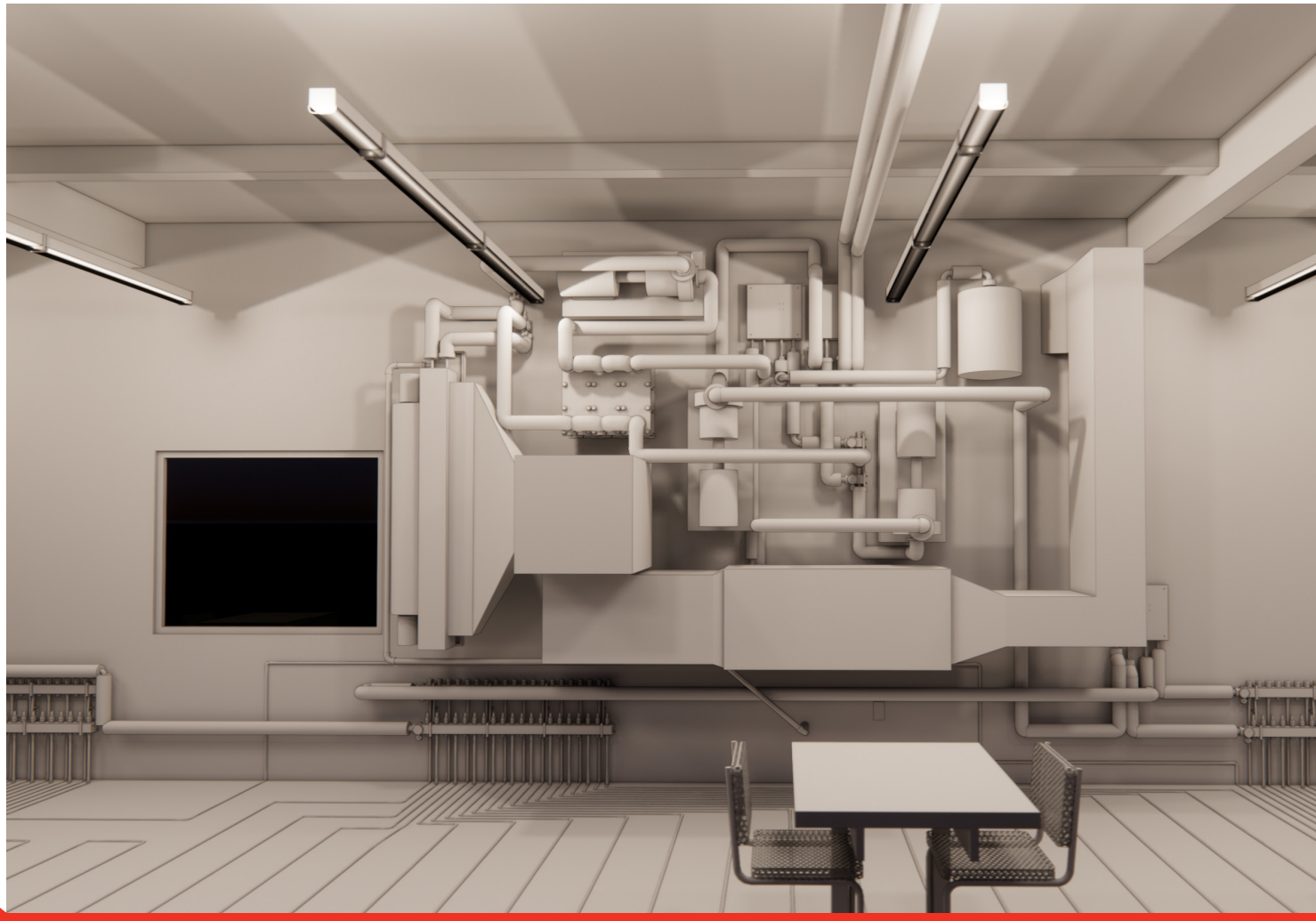
Concrete was chosen for the structural material due to the location of the project in Cordoba, Argentina. In this city, most of the commercial buildings are constructed out of concrete due to the availability of the material. Although in some countries steel could be faster, or cheaper, in this city concrete is the main material. Since there are little to no natural disasters that will hit Cordoba, the structure of the building is focused more on the surrounding environment and what is best for the location of the site.

A SHARED STRUCTURAL METHODOLOGY

STRUCTURAL



SECTION PERSEPECTIVE | VIEW FROM BRIDGE



EXPOSED MECHANICAL SYSTEM | VIEW FROM PUBLIC DINING

A MECHANICAL DESIGN THAT TAKES ADVANTAGE OF THE ENVIRONMENT

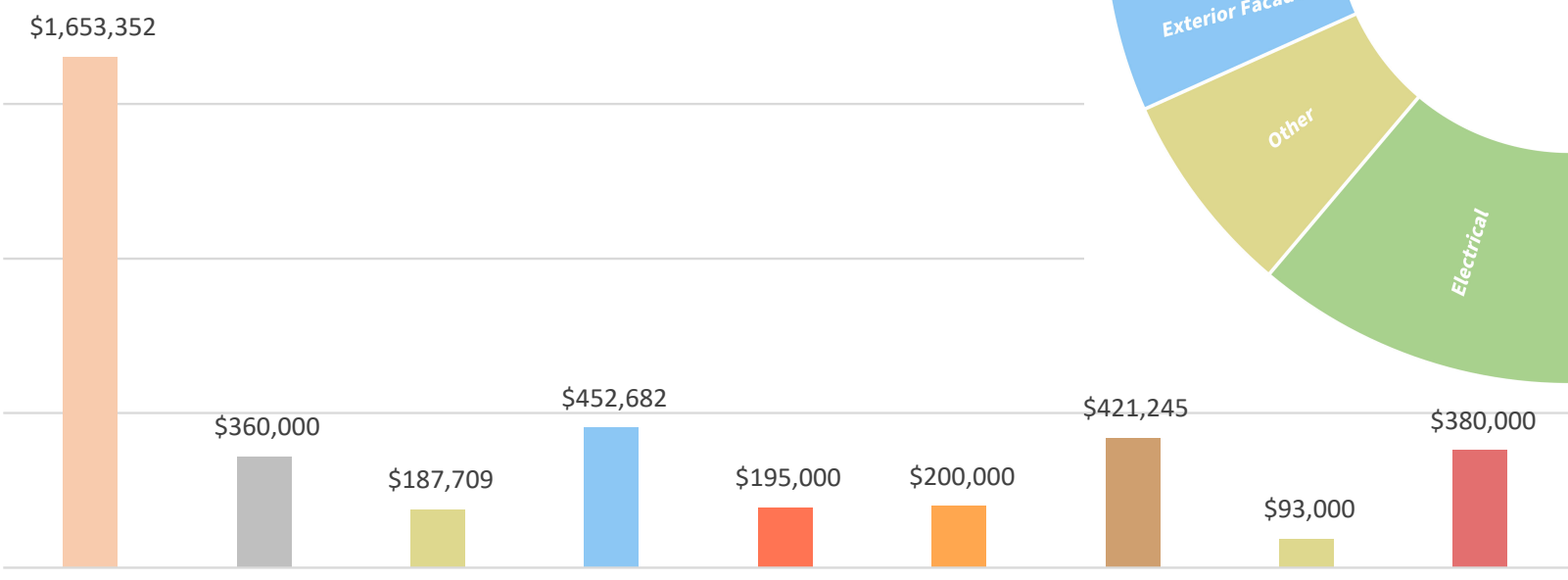
MECHANICAL

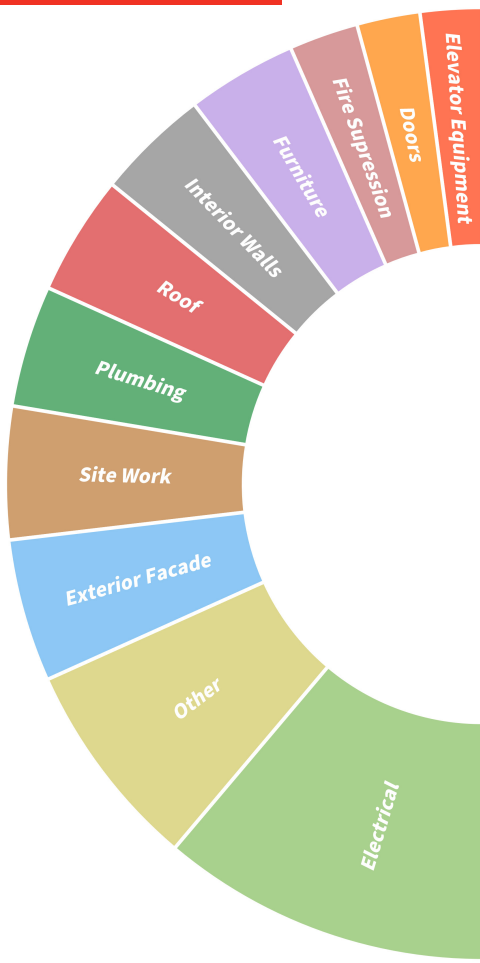
The mechanical design for the office building was a **central hydronic loop** that can be “tapped” into by tenant structures. While one connection to the loop provides the tenant structure with radiant zoned manifolds, an additional connection is made for a heat pump. This heat pump services its preassigned spaces, while a parallel radiant system services the large open areas, typically with glazing or large exposure.

This approach offers a versatile HVAC solution that can be designed with each space use in mind. This reduces the wasted energy on large open spaces by only servicing the occupancy height of 7 ft, rather than the ceiling height of 10-12 ft. By calculating room loads based on this design methodology and in conjunction with Trace 3D, we can achieve a low operating cost for the building’s heating and cooling needs.

Total Building Cost	**$9,977,900**
Total Building Cost with Labor	**$10,576,600**
Total Cost of Solar	**$850,000**
Total Building Cost Per SF	**$415**
Total Building Cost Per SF with Labor	**$480**

COST ESTIMATE



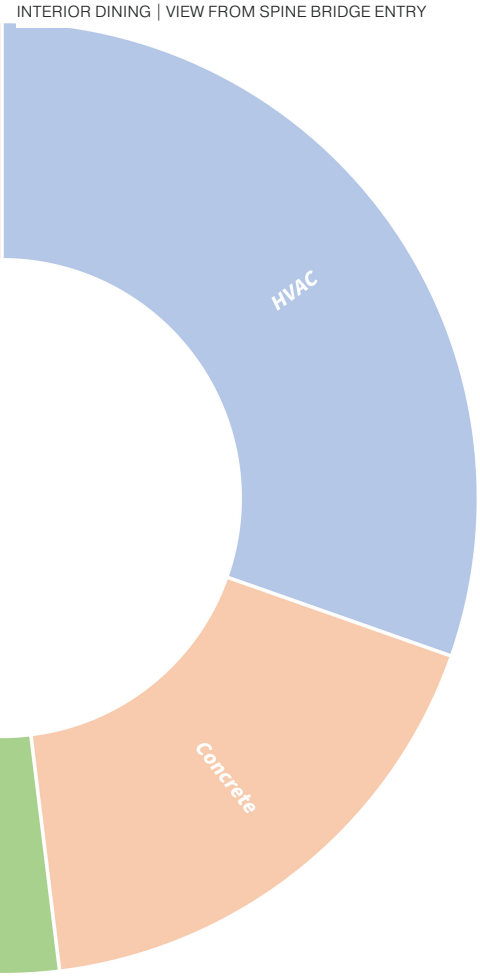




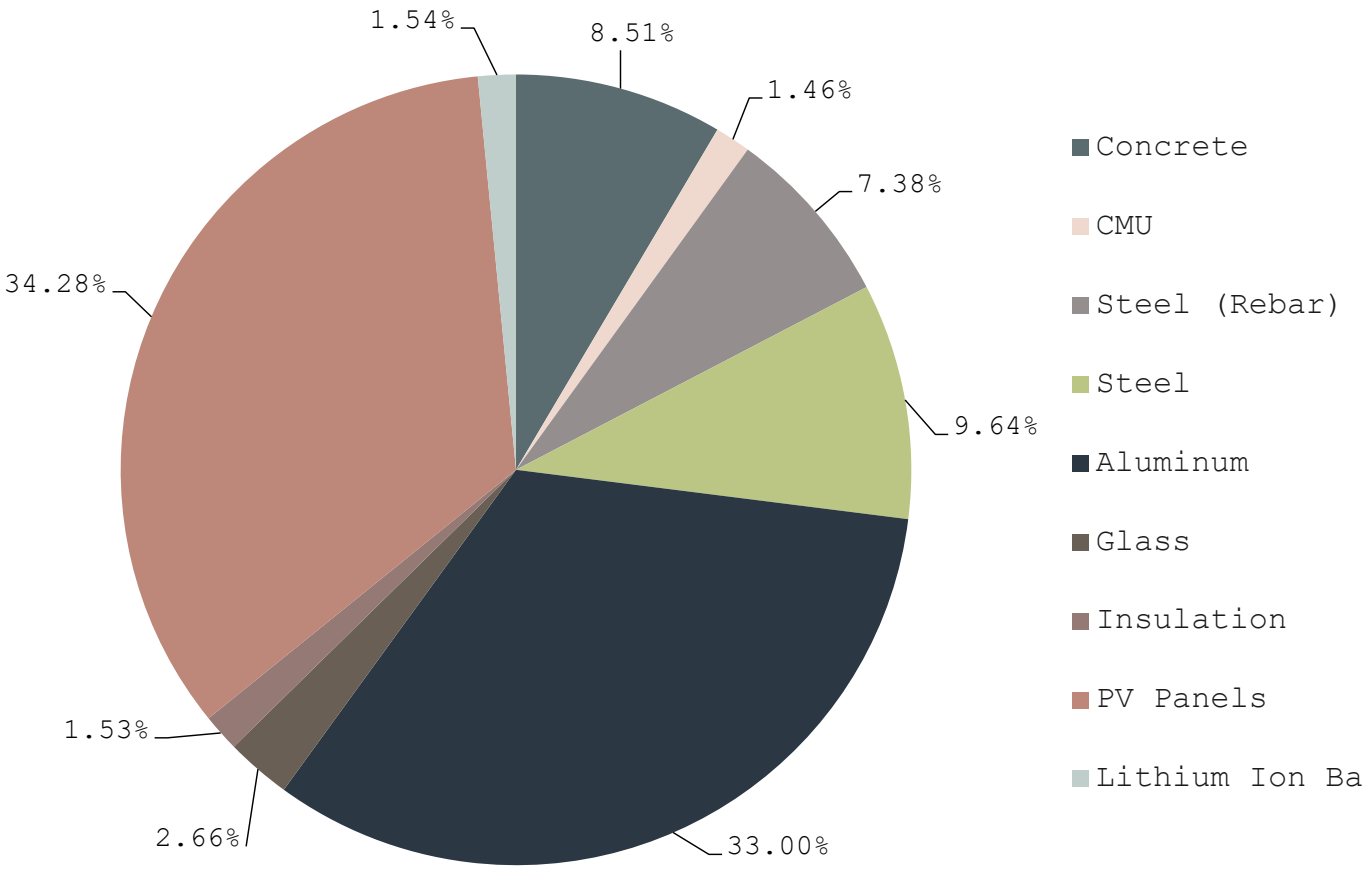
INTERIOR DINING | VIEW FROM SPINE BRIDGE ENTRY

No Grid Tie for Electrical Source

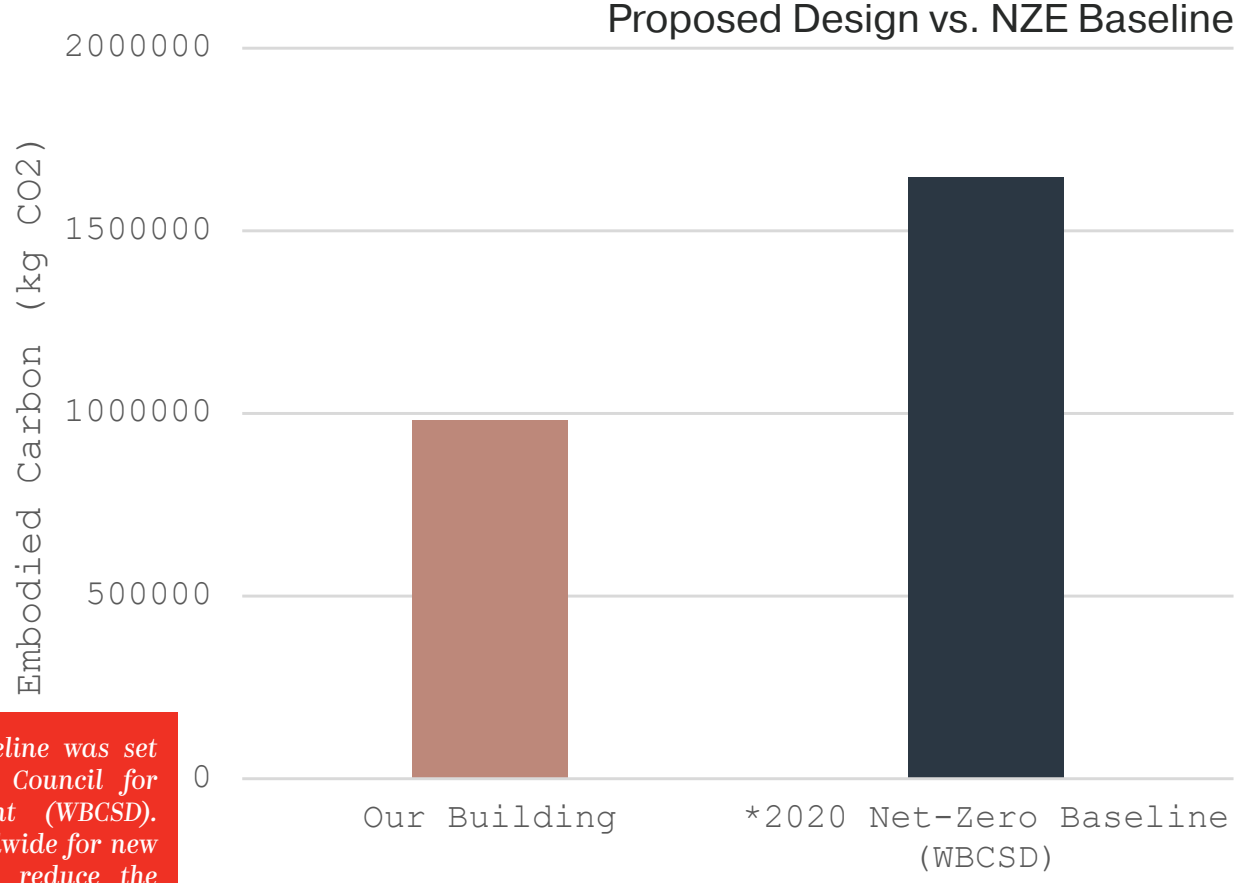
Voltages:
Single Phase: 220V
Three Phase: 380V
Frequency: 50Hz
Wire Type: 3-4 wire
Plug: C/I
Transport:
500kV/220kV/132kV/66kV/33kV



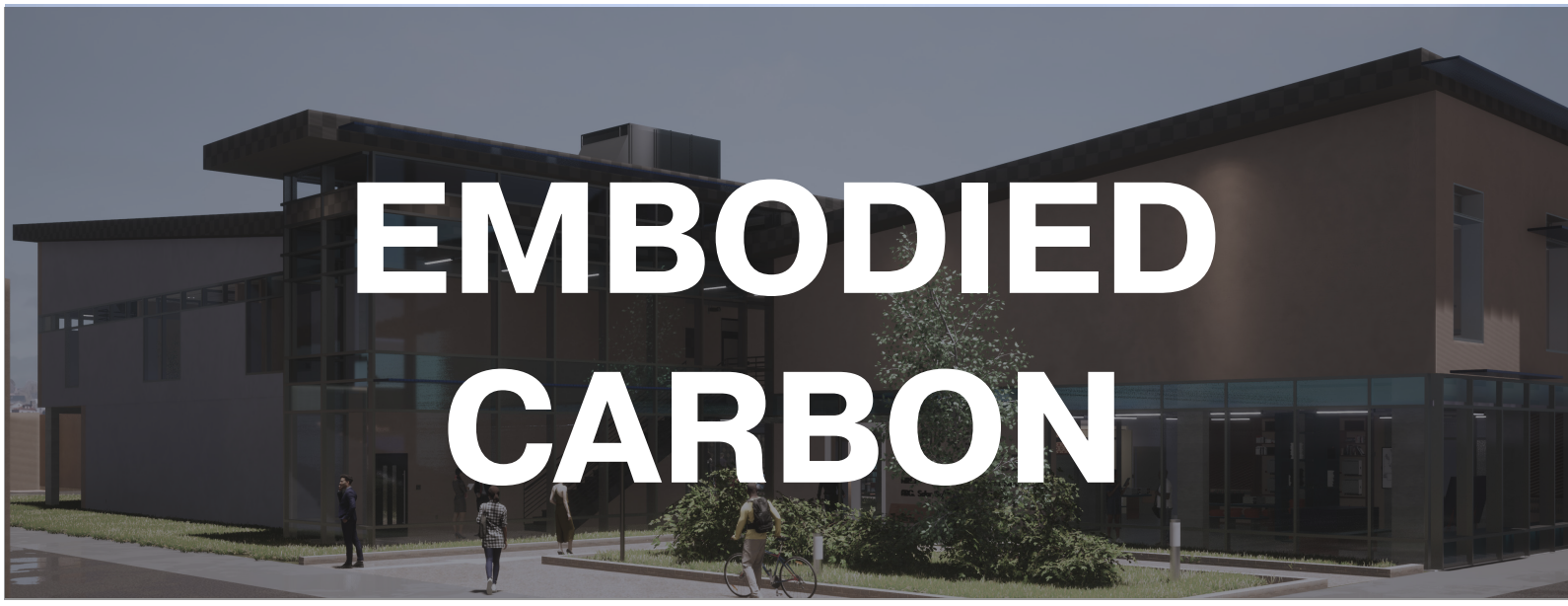
EMBODIED CARBON PER MATERIAL (KG of CO^2)



Proposed Design vs. NZE Baseline



**The 2020 Net-Zero Baseline was set by the World Business Council for Sustainable Development (WBCSD). This metric was set worldwide for new NZE office buildings to reduce the embodied carbon emissions.*



EMBODIED CARBON

LEED SCOREBOARD

LEED SILVER CERTIFICATION

SUSTAINABLE SITES CATEGORY CAN BE COMPLETED BY REPLANTING AT LEAST 40% OF THE SITE WITH INDIGENOUS PLANTS TO CONTROL RAINWATER ENERGY AND ATMOSPHERE CATEGORY CAN BE COMPLETED WITH THE INCORPORATION OF SOLAR GENERATION INDOOR ENVIRONMENTAL QUALITY CATEGORY CAN BE COMPLETED WITH PROPER VENTILATION AND OUTDOOR AIR

OBTAINING THE **GOLD LEVEL** CAN BE ACHIEVED WITH SOURCING ENVIRONMENTALLY FRIENDLY AND LOCAL MATERIALS DURING THE CONSTRUCTION PHASE

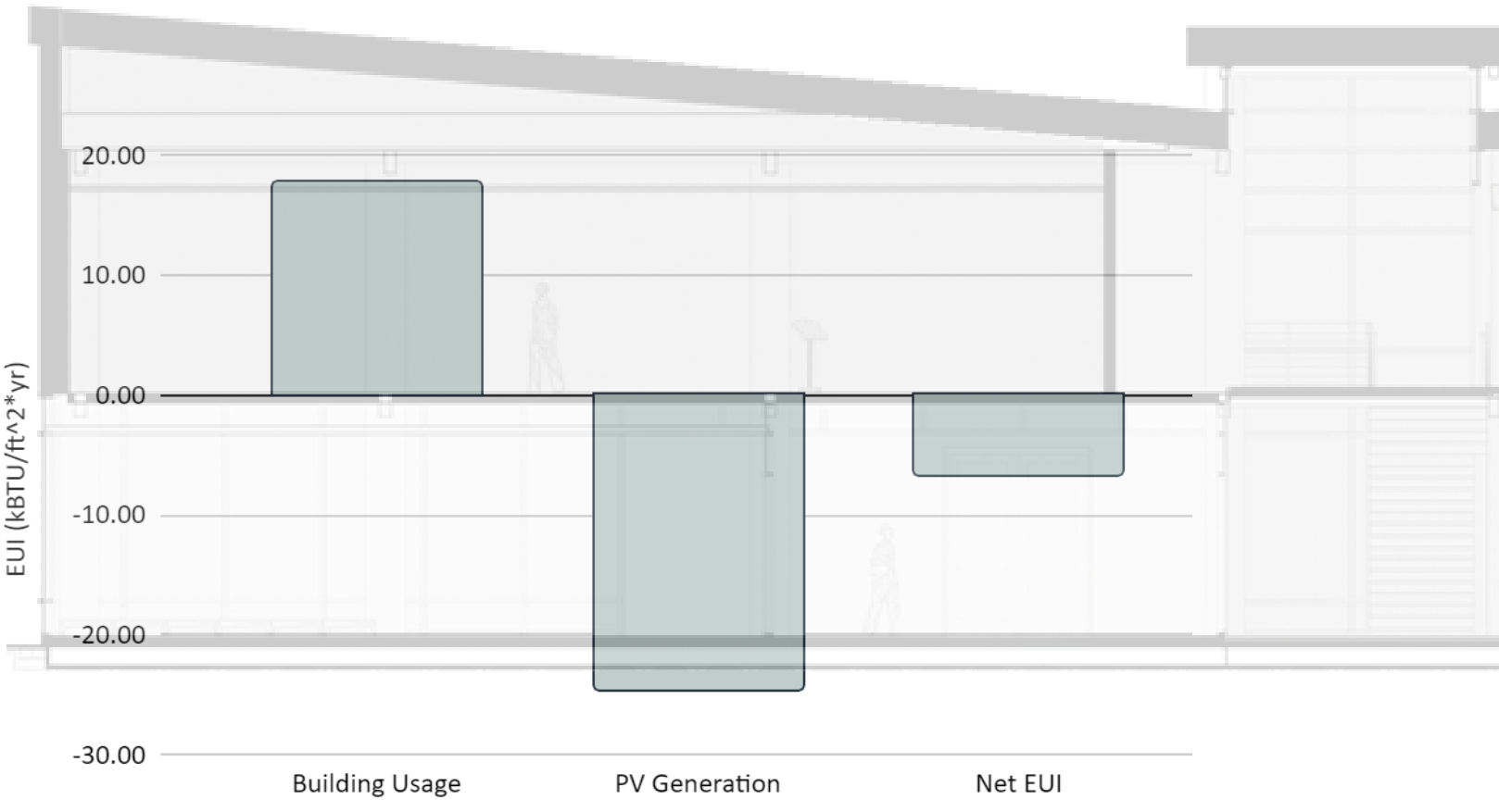
SOLAR GENERATION

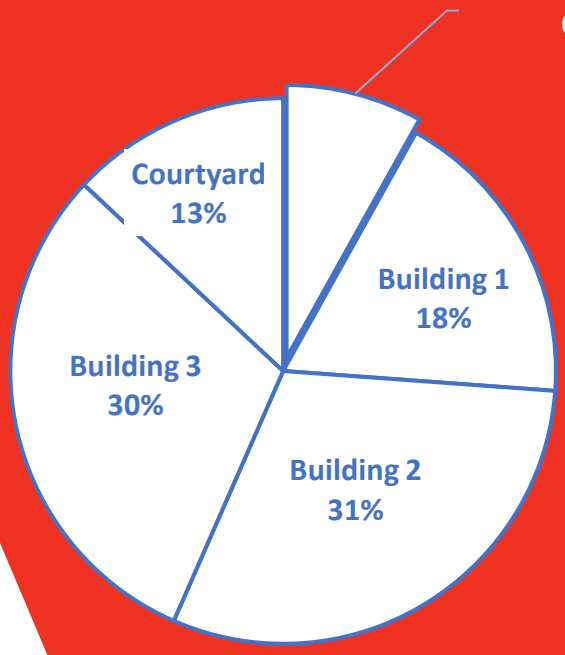
SITE EUI:

WITHOUT PV = **19.71 KBTU/FT^2/YR**

WITH PV = **-7.34 KBTU/FT^2/YR**

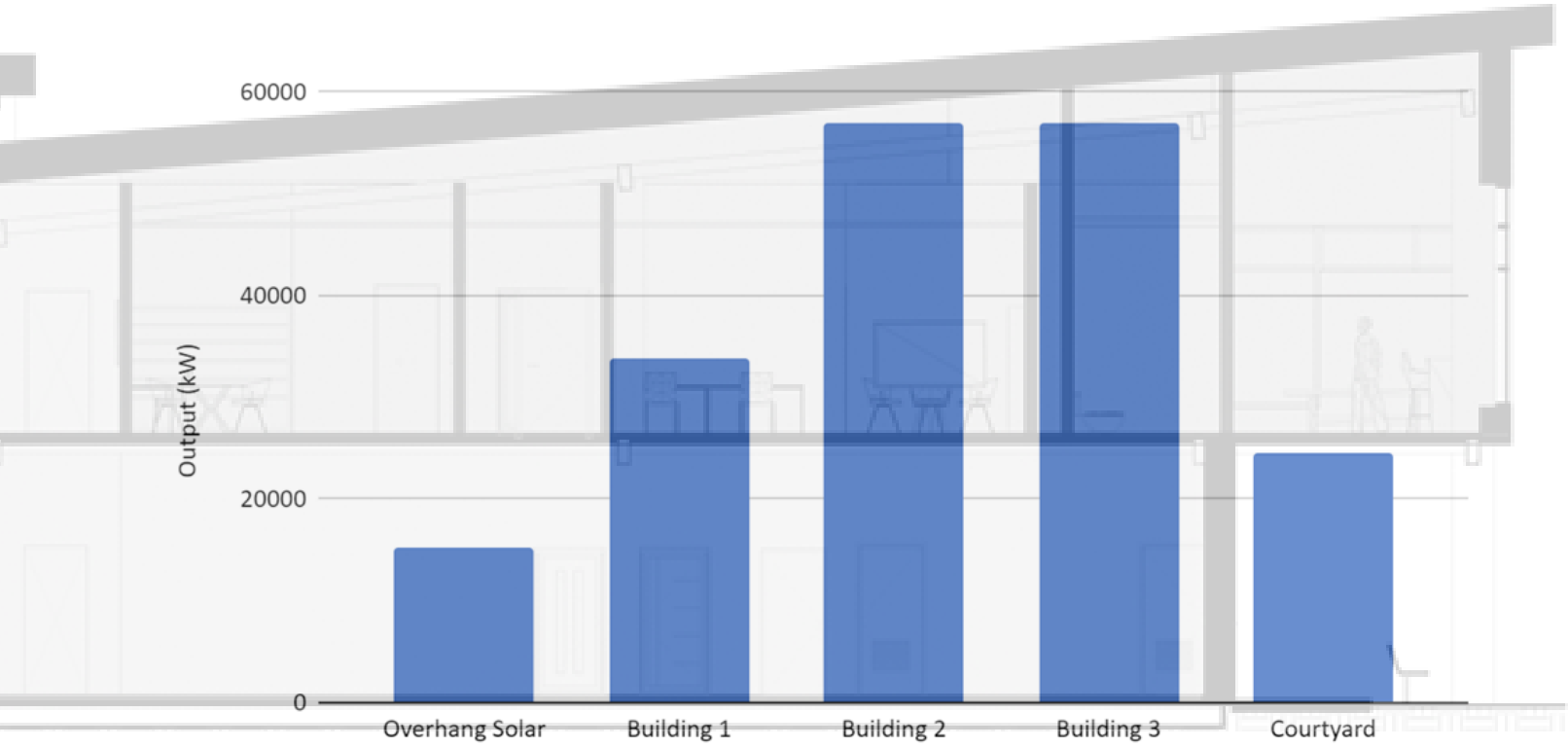
Building Net Energy Usage





% PV SOLAR GENERATION

Building Net Energy Usage



UNIVERISTY OF CINCINNATI | OFFICE CAPSTONE

SOLAR DECATHLON

Laith Bouizar - project lead

Danielle Hall - architectural lead

Terri Hughes - mechanical engineer

Michael Stearns - electrical lead

Nathan Tong - architectural engineer

Allison Flavin - structural lead

Blake Zanders - electrical engineer

Kevin Wermuth - landscape architect