CLIMATE
ACTION
WEBINARS

RESILIENCE AND THE EVOLVING STANDARD OF CARE SERIES PART 2:

New Standard of Care Includes Integrated Resilience Design

Wednesday 01.29.25 | 12:00P - 1:30P | 1.5 LU/HSW (live webinar attendees only)

AIA California

Learning Objectives

- Learn how the standard of care for design professionals is evolving as extreme weather and climate-related events impact life safety, property, and infrastructure.
- Understand the potential liability of design professionals and the need to incorporate resilience into their designs to better protect people and property.
- Review communication examples to clients and community how resilient design alternatives can better safeguard the public and reduce recovery time after a natural catastrophe.
- List the legal and insurance risks to practicing architects of failing to design beyond code minimum as climate impacts become more severe.

Housekeeping Reminders

Resources will be made available on our website

Qualifies for 1.5 AIA HSW/LU

Use Q&A to ask questions for today's presenters

Cultivate a positive learning environment

ARUP

Sustainable Development is Everything.

Moderator

Gail Napell, AIA, LEED AP, BD+C

Architect & Citizen at Large

Overview of AIA Hazard and Climate Risk Steps 01 to 05 & the AIA Hazard and Climate Risk Acknowledgement Form

Today’s Panel

Erin Feeney, AIA, LEED AP
Associate, David Baker Architects

Talking to Clients about Resilient Design Priorities and Strategies

Amanda Barton, AIA, RID, NCARB, LEED AP BD+C, WELL AP
Project Designer & Associate, HKS

Overview of AIA + HKS Toolkit Steps 01 to 05 [Part I of this Series]

Sammy Shams, AIA NCARB, LEED AP BD+C, WELL AP, Fitwel Ambassador, LFA
Resilience, Sustainability & Building Performance, HKS

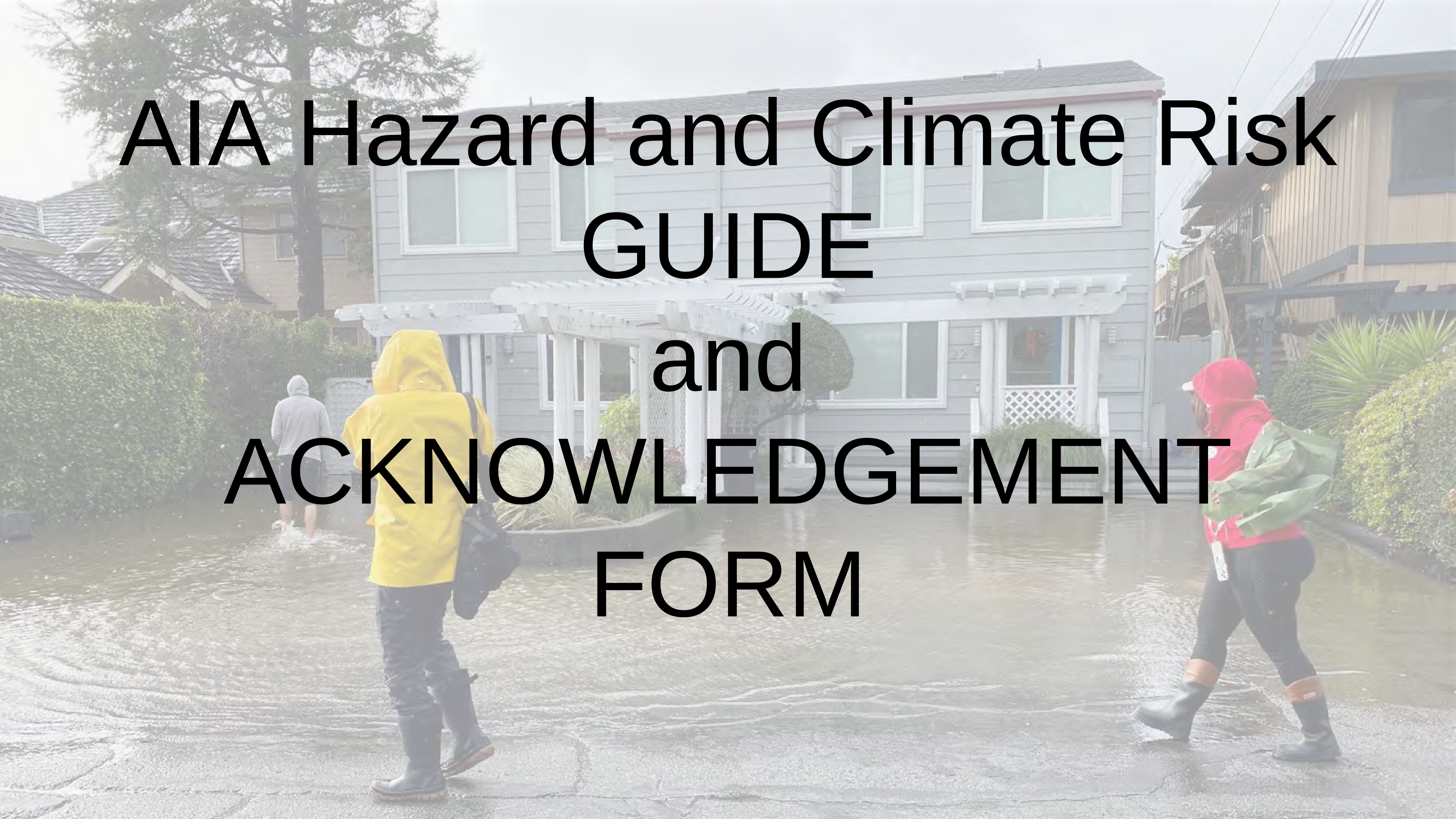
Case Study 1:
Johns Hopkins All Children’s Hospital
St Petersburg, FL

Tim Kohut, AIA
Director of Sustainable Design, National Community Renaissance

Case Study 2:
Rosecreek Villas: All-electric, Affordable Housing

Rives T. Taylor, FAIA, LEED Fellow
Principal & Director of Gensler Research Institute Resilience Center

Case Study 3:
Houston Advanced Research Center
Woodlands, Tx



AIA Hazard and Climate Risk GUIDE and ACKNOWLEDGEMENT FORM

AIA

Hazard and Climate Risk: a user's guide and form for acknowledging risk

This publication provides general information regarding the subject matter covered. It is published and distributed with the understanding that the publisher is not engaged in rendering professional services, and as such this resource is not intended to nor does it provide legal or other professional advice. If professional advice or other expert assistance is required, please seek the services of an appropriate professional.

https://www.aia.org/sites/default/files/2024-11/Hazard_and_Climate_Risk_Acknowledgement_Form.pdf

01: Building Service Life; Design Date

The BUILDING SERVICE LIFE is the assumed period for which a building or part of it is to be used for its intended purpose, WITH anticipated maintenance but WITHOUT major repair being necessary.

AIA recommended Building Design Lifespans

30 years	Market rate stick frame
50 years	Typical single family
100 years	Concrete, Steel, or Heavy timber
1000 years	Solid Masonry

note: EPD service life (stage B) is typically 50 years.

H01: Building Service Life; Design Date

Project details

1. Estimated building service life; design date ______________________________

2. Primary source(s) of hazard risk identification ____________________________

3. Hazard risk profile

Hazard type	Magnitude	Notes	Risk rating	Source and date

02: Primary Source(s) of Hazard Risk Identification

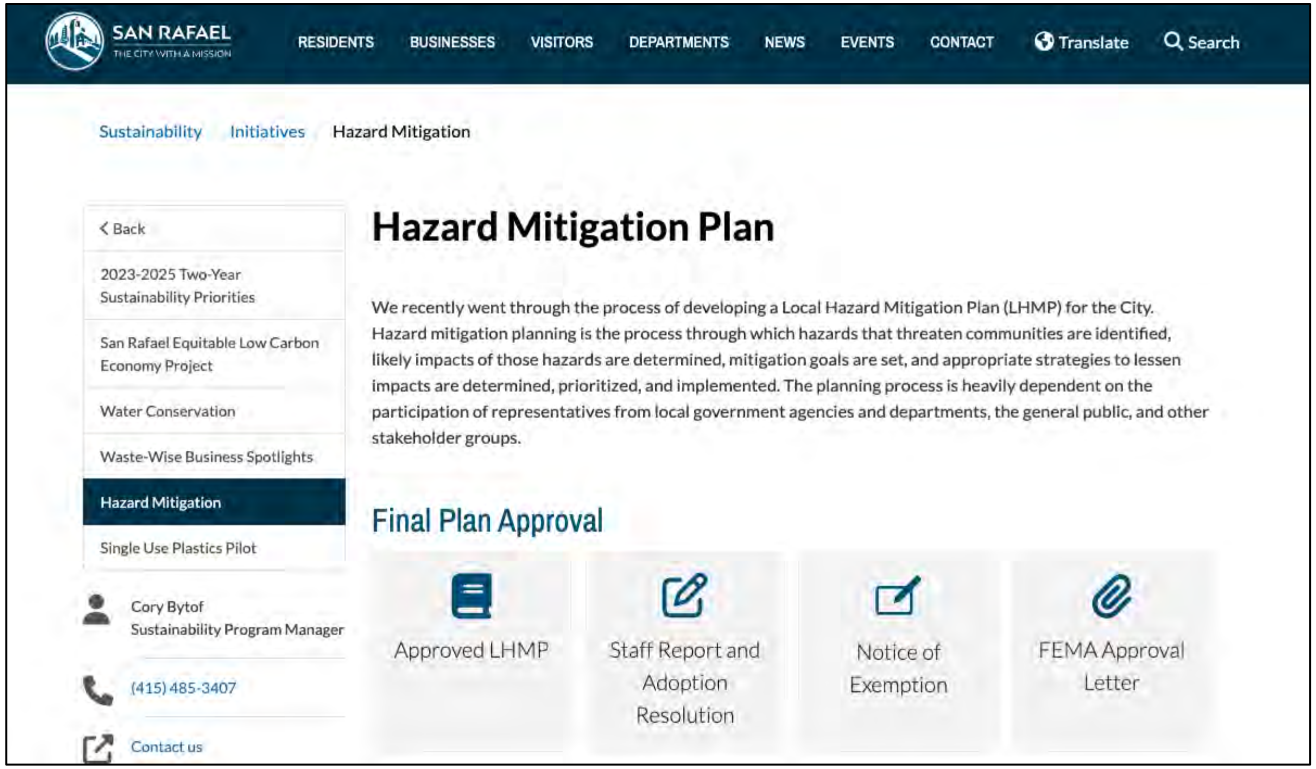


Table ES-2 San Rafael Hazard Identification Assessment

Hazard	Geographic Extent	Likelihood of Future Occurrences	Magnitude/ Severity	Significance	Climate Change Impacts
Climate Change	Extensive	Highly Likely	Limited	Medium	N/A
Coastal Flooding and sea level rise	Significant	Likely	Critical	Medium	High
Dam Failure	Limited	Unlikely	Negligible	Low	Medium
Drought and Water Shortage	Extensive	Likely	Critical	Medium	High
Earthquake	Extensive	Occasional/Likely	Catastrophic	High	Low
Earthquake: Liquefaction	Limited	Occasional/Likely	Catastrophic	High	Low
Flood: (100/500 year)	Significant	Occasional/Unlikely	Critical	High	High
Flood: Localized/Stormwater	Extensive	Highly Likely	Limited	Medium	High
Landslide, Mudslides, Hillside Erosion, and Debris Flows	Significant	Likely	Limited	Medium	Medium
Levee Failure	Significant	Occasional	Limited	Medium	High
Severe Weather: Extreme Heat	Extensive	Highly Likely	Critical	Medium	High
Severe Weather: Heavy Rains and Storms	Extensive	Highly Likely	Critical	Medium	Medium
Tsunami	Limited	Unlikely	Limited	Medium	High
Wildfire	Significant	Likely	Catastrophic	High	Medium

Geographic Extent
Limited: Less than 10% of City
Significant: 10-50% of City
Extensive: 50-100% of City
Probability of Future Occurrences
Highly Likely: Near 100% chance of occurrence in next year, or happens every year.
Likely: Between 10 and 100% chance of occurrence in next year, or has a recurrence interval of 10 years or less.
Occasional: Between 1 and 10% chance of occurrence in the next year, or has a recurrence interval of 11 to 100 years.
Unlikely: Less than 1% chance of occurrence in next 100 years, or has a recurrence interval of greater than every 100 years.

Magnitude/Severity
Catastrophic—More than 50 percent of property severely damaged; shutdown of facilities for more than 30 days; and/or multiple deaths
Critical—25-50 percent of property severely damaged; shutdown of facilities for at least two weeks; and/or injuries and/or illnesses result in permanent disability
Limited—10-25 percent of property severely damaged, shutdown of facilities for more than a week; and/or injuries/illnesses treatable do not result in permanent disability
Negligible—Less than 10 percent of property severely damaged, shutdown of facilities and services for less than 24 hours; and/or injuries/illnesses treatable with first aid
Significance
Low: minimal potential impact
Medium: moderate potential impact
High: widespread potential impact
Climate Change Impact:
Low: Climate change is not likely to increase the probability of this hazard.
Medium: Climate change is likely to increase the probability of this hazard.
High: Climate change is very likely to increase the probability of this hazard.

02: Primary Sources of Hazard Risk Identification

Project details

1. Estimated building service life; design date ______________________________

2. Primary source(s) of hazard risk identification ____________________________

3. Hazard risk profile

Hazard type	Magnitude	Notes	Risk rating	Source and date

03: Hazard Risk Profile

Hazard risk profile

The hazard risk profile format will vary by jurisdiction but will include hazard identification, assets, risk analysis, and a summary of vulnerability.

Hazard type	Magnitude	Notes	Risk rating	Source/date
Watershed Flooding	.2% (500-year)	Special flood hazard "A" BFE is to be determined Potential for dam failure	Moderate	FIRMette, August 19, 2020
Tornado		This is a low-probability/ high consequence event.	Moderate	NOAA/ NWS/Storm Prediction Center
Earthquake		Shaking, 10% chance of exceeding in 50 years	High	Seattle Hazard Explorer; November, 10, 2020
Liquefaction		Geotechnical assessment required	High	GIS map

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Medium: Climate change is likely to increase the probability of this hazard.
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03: Hazard Risk Profile

Atmospheric Climate and weather-related hazards	Flood, extreme rain event, flash flooding, ground saturation, severe storm (wind, rain, lightning, hail, severe winter weather), snow, ice, freezing temperatures, avalanche, hurricane, typhoon, tropical cyclone, storm surge, sea-level rise, tornado, wildfire, extreme heat, drought, avalanche, derecho
Geologic Geologic and seismic hazards	Earthquake, tsunami/seiche, volcanic eruption/lahar, landslide, mudflow/debris flow, liquefaction, land subsidence/sink hole/trough
Technological & anthropogenic Human-caused hazards	Power outage, fires, explosion, urban flooding, war, terrorism, civil unrest, infrastructure failure (grid failure, satellite/wireless failure, water supply failure, sewer system failure, levee failure, dam and bridge collapse, mine subsidence/collapse, structural failures), hazardous materials (HAZMAT) event, environmental pollution (air, water, soil, nuclear accident), sea-level rise, earthquakes due to certain fracking wastewater injection
Biological + pathogenic Global public health	Global pandemics, local outbreaks of deadly diseases, seasonal resurgences, biological contamination of shared water/air/soil resources, insect/reptile/rodent invasion, etc.

03: Hazard Risk Profile

Project details

1. Estimated building service life; design date ______________________________

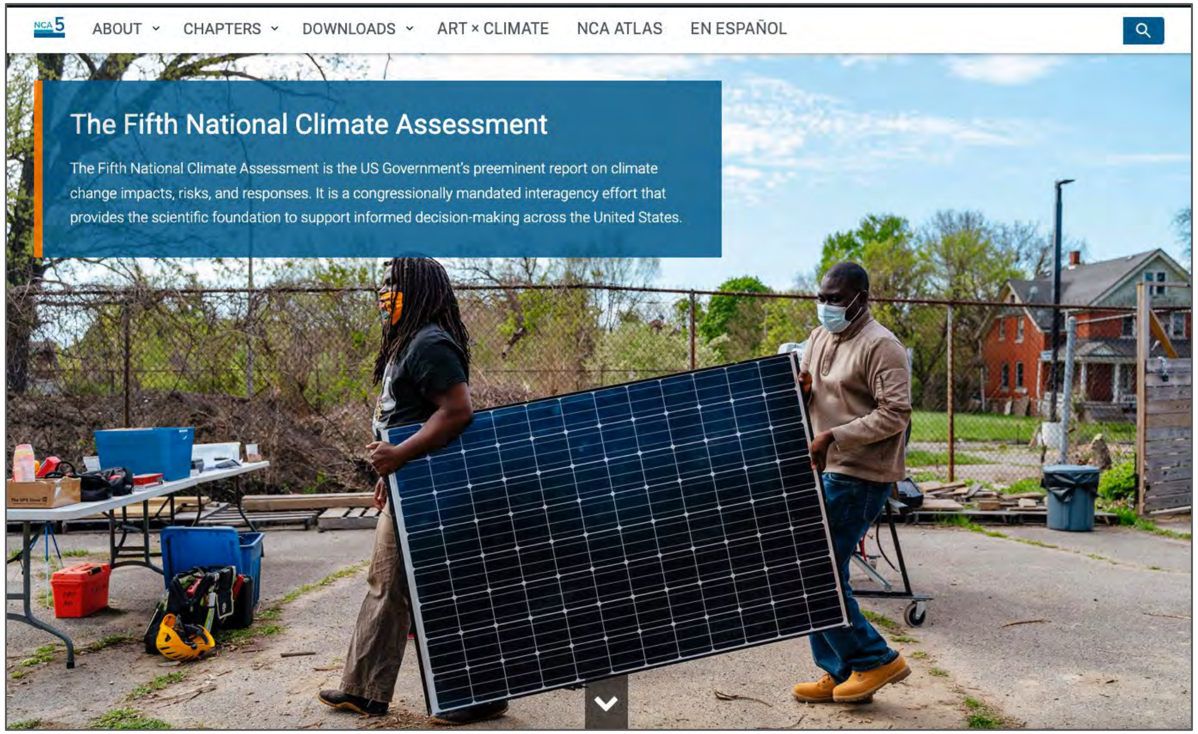
2. Primary source(s) of hazard risk identification ______________________________

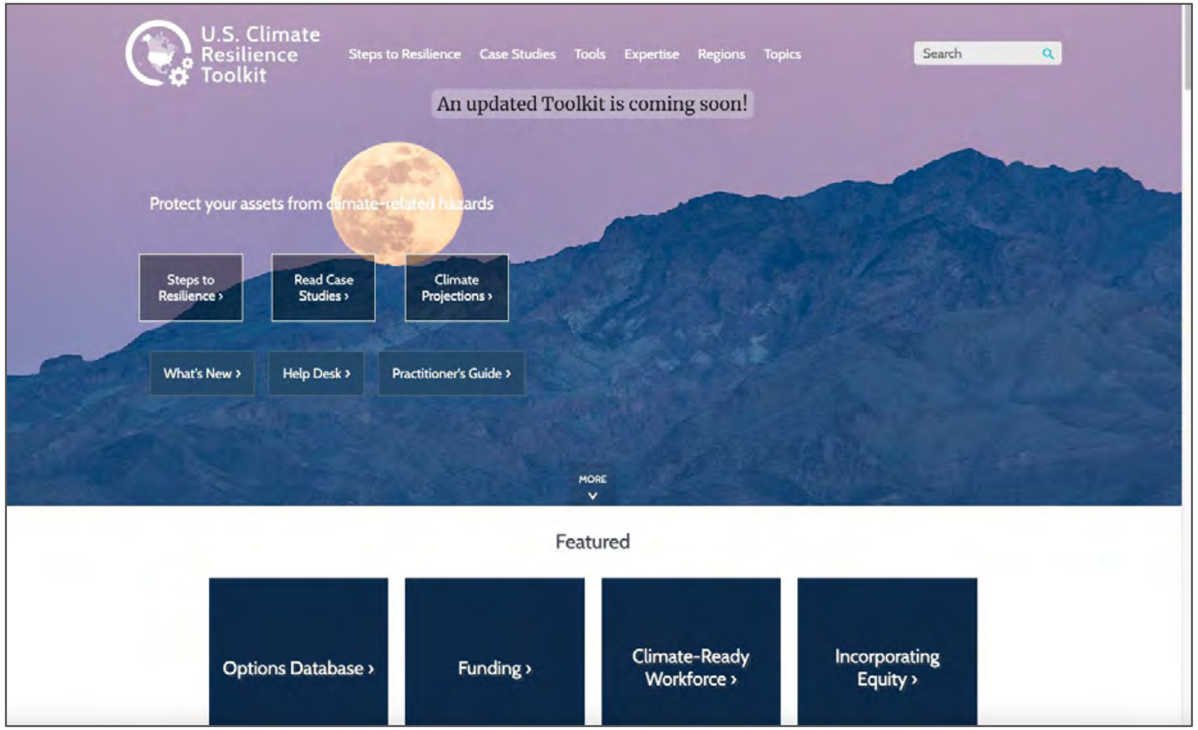
3. Hazard risk profile

Hazard type	Magnitude	Notes	Risk rating	Source and date

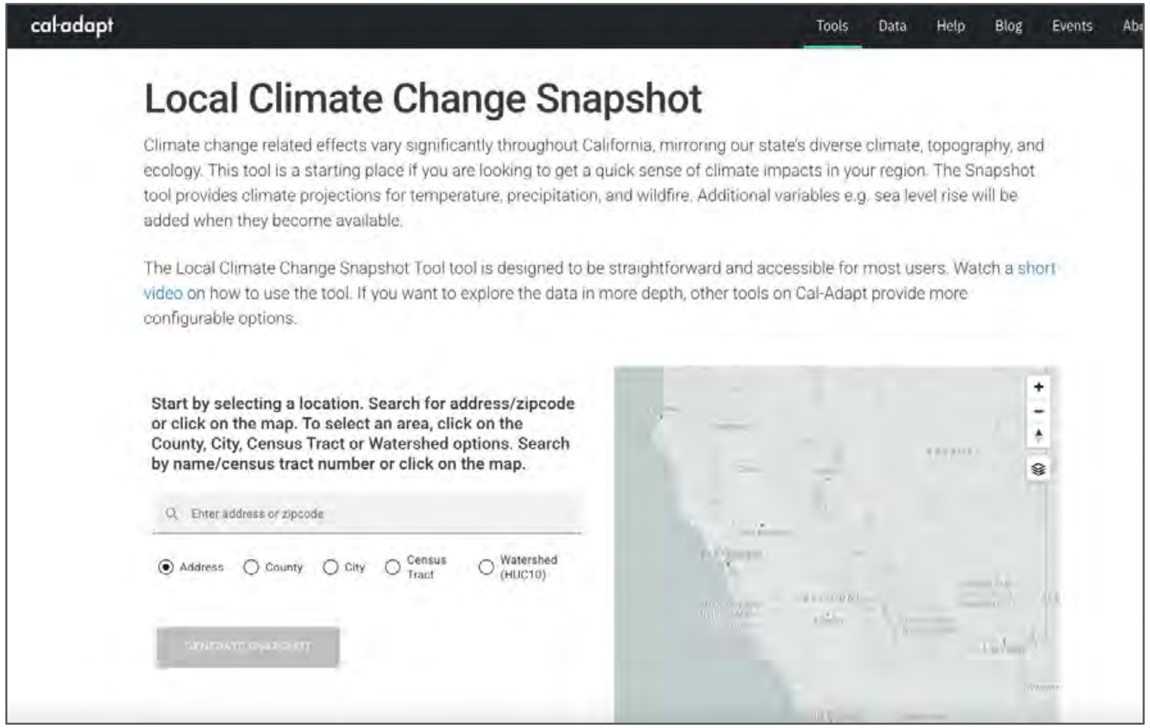
03: Hazard Risk Profile

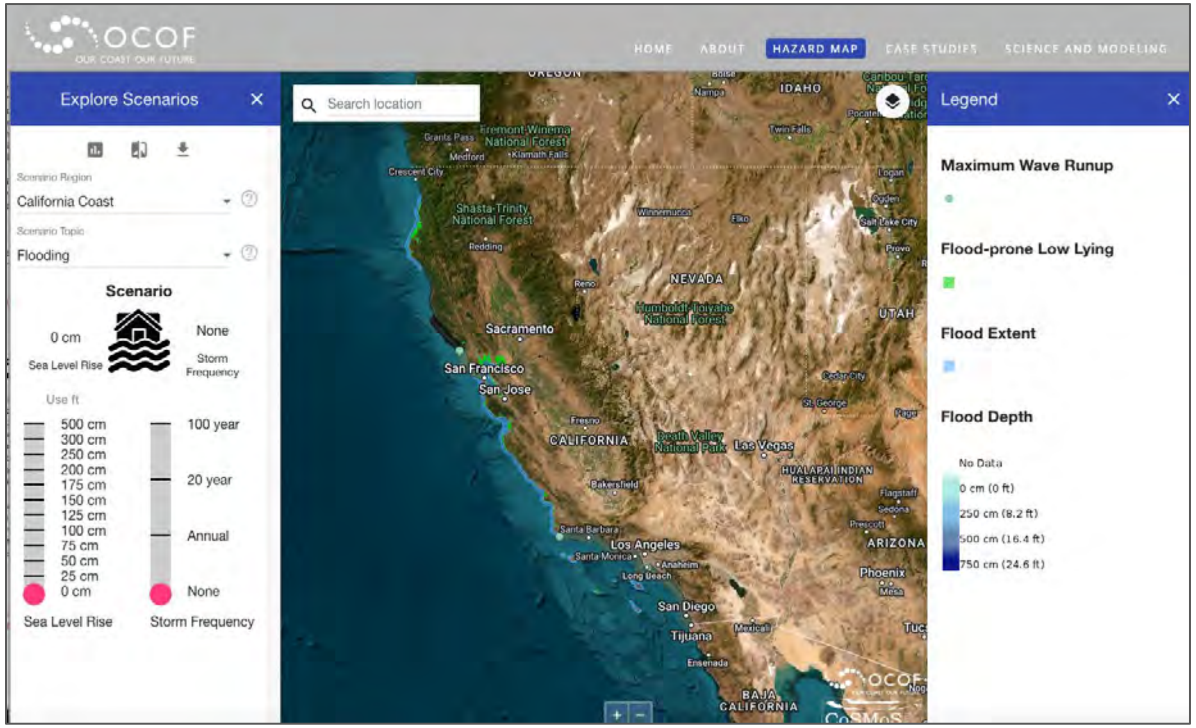
04: Future Climate Conditions (based on design year and mid-to-high risk future climate scenarios)





04: Future Climate Conditions (based on design year and mid-to-high risk future climate scenarios)





04: Future Climate Conditions

4. Future extreme conditions, based on design date and mid-to-high-risk future climate scenarios:

a. Estimated range of high temperature; estimated cooling degree days

b. Estimated range of low temperature; estimated heating degree days

c. Estimated maximum annual precipitation; max rain event

d. Estimated minimum annual precipitation

e. Notes on climate change impacts

05: Project resilience performance requirements

In step 05, you’ll document regulations that affect the project and review them with your client, included but not limited to:

- **Building Risk Category**
- **Code** enforced at time of construction / substantial alterations (for existing buildings)
- Local **building & zoning codes**
- Local **overlay district**
- Current **model code version**
- Other applicable state / local regulations - this is where local **CLIMATE CHANGE ACTION PLANS & LOCAL HAZARD MITIGATION PLANS** must be included
- Owner’s **performance based requirements**
    - Including business continuity, post-disaster reoccupancy, and functional recovery

05: Project Resilience Performance Requirements

5. Project resilience performance requirements:

a. ICC building risk category

b. For existing buildings, the code enforced for original construction and substantial alterations

c. Local building and zoning codes

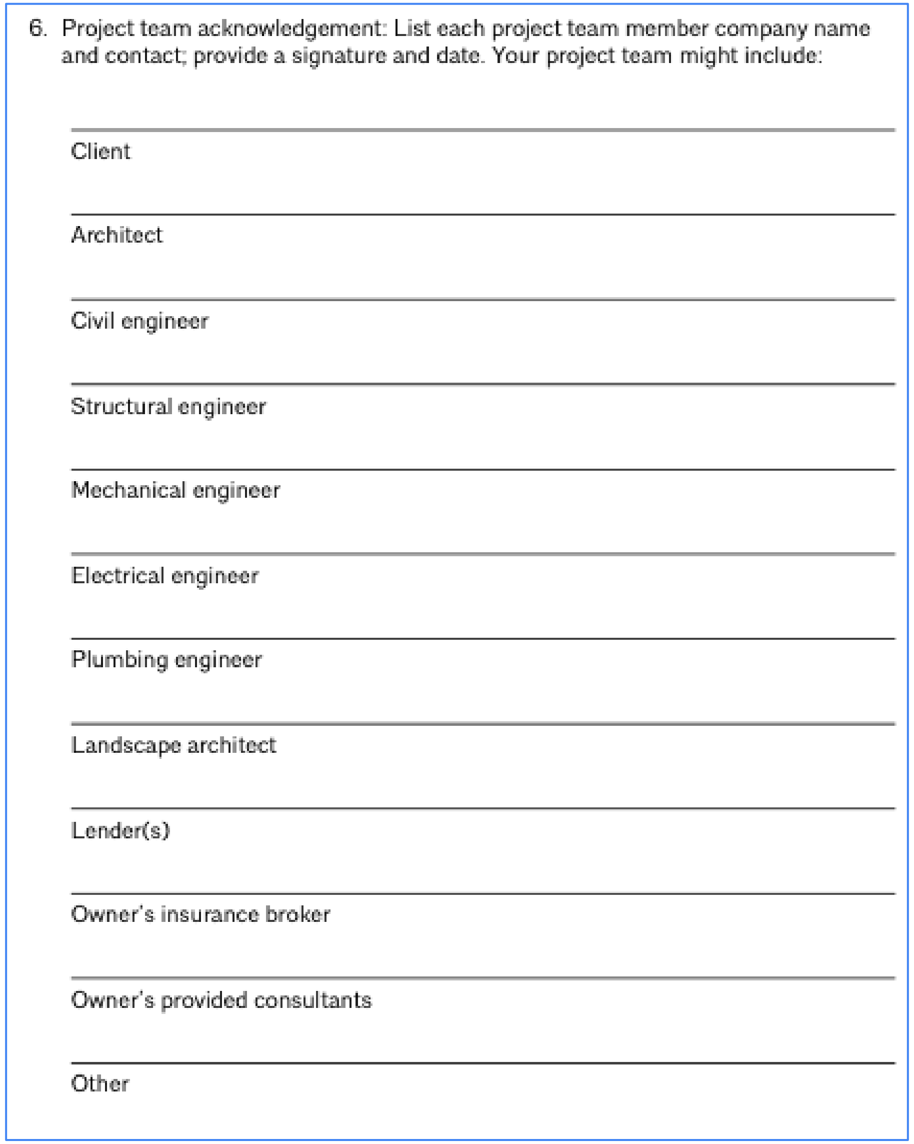
d. Local overlay district, if any

e. ICC current model code

f. Other state/local resilience regulations

g. Describe performance-based requirements (e.g., resilience requirements; note that these will be further defined elsewhere in the contract)

06: Project Team Acknowledgements



6. Project team acknowledgement: List each project team member company name and contact; provide a signature and date. Your project team might include:

Client

Architect

Civil engineer

Structural engineer

Mechanical engineer

Electrical engineer

Plumbing engineer

Landscape architect

Lender(s)

Owner's insurance broker

Owner's provided consultants

Other

07: Notes

At this time are additional consultants, studies, or information recommended or required to further understand project risks? Note: throughout the project process, additional consultation or service needs may be identified.

____

____

____

____

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Talking to Clients about Resilient Design Priorities and Strategies

Setting the Tone | How do we define resilient design?

- Extending the **useful life** of the building
- **Future-proofing**
- Keeping **buildings operating** and staff supported in a critical event
- Keeping **residents safe & well** in livable homes

Timing | When do we start these conversations?

Site selection & program?

Risk analysis & mitigation strategies

Document design measures for bid

Pre

Concept Design

Schematic Design

Design Development

Construction Documents

Construction Administration

Site risk analysis

Client priorities

Service continuity design decisions

Consultant coordination

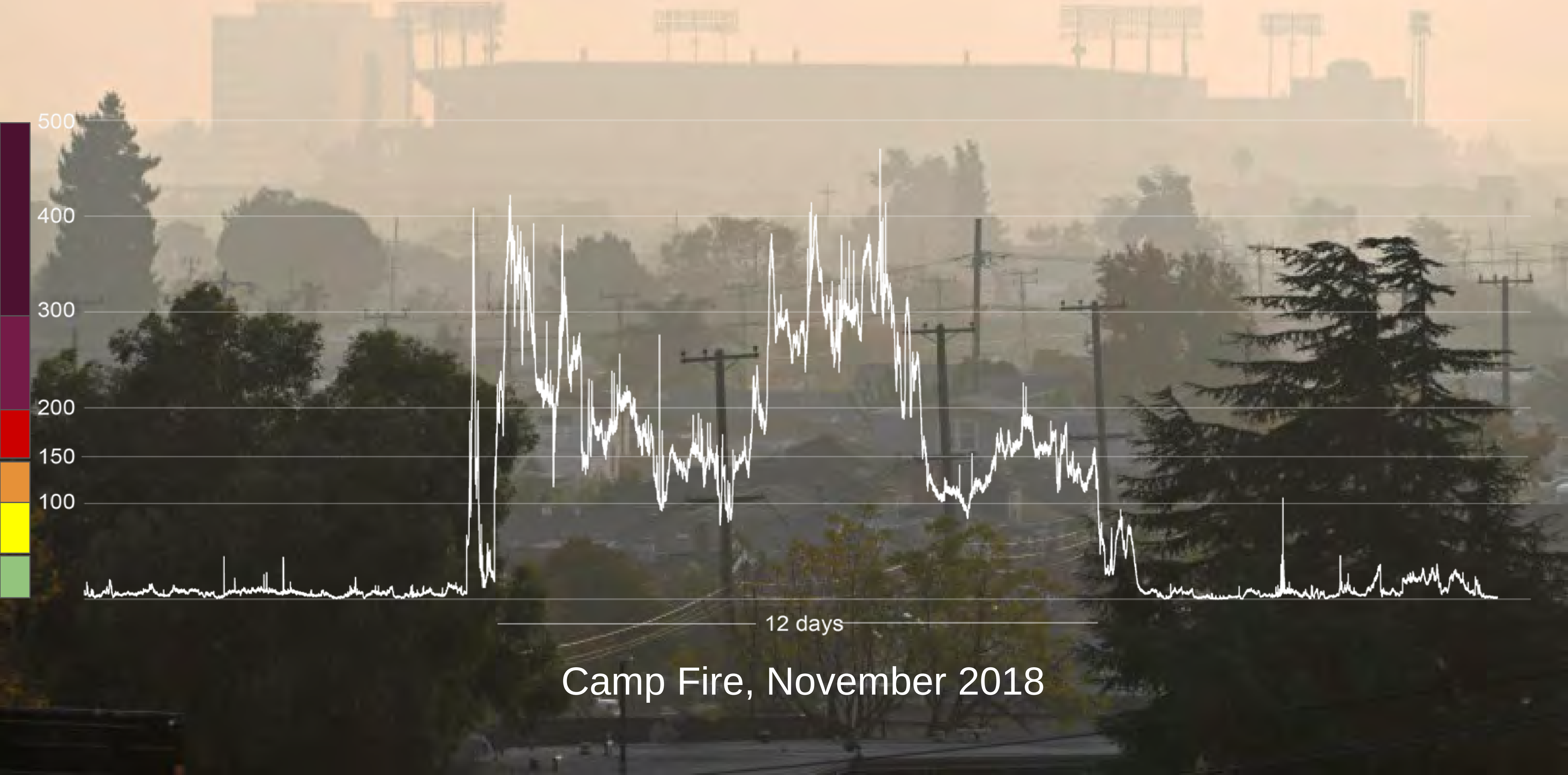
Revisit goals as needed to realize

Setting Priorities | How do we assess risk?

What risks are the **highest priority** for this building?

- Extreme heat
- Wildfires/air quality events
- Power outage
- Major earthquake & liquefaction
- Extreme rain and flooding
- Drought
- Hurricanes
- Tornadoes & extreme wind
- Severe storms & snow
- Civil Unrest

Air Quality Index (PM2.5) in Oakland During the Camp Fire



Setting Priorities | How do we assess risk?

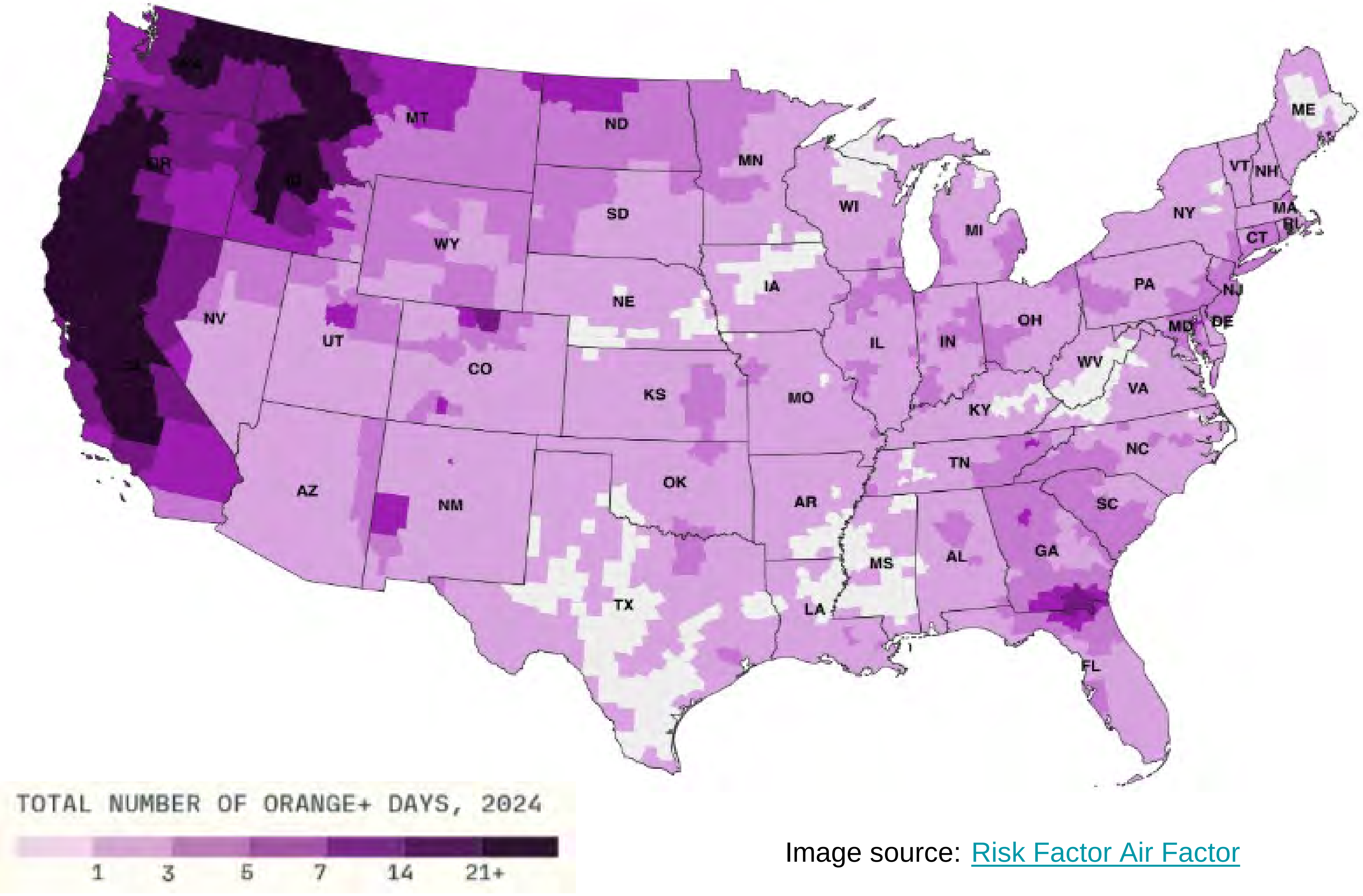


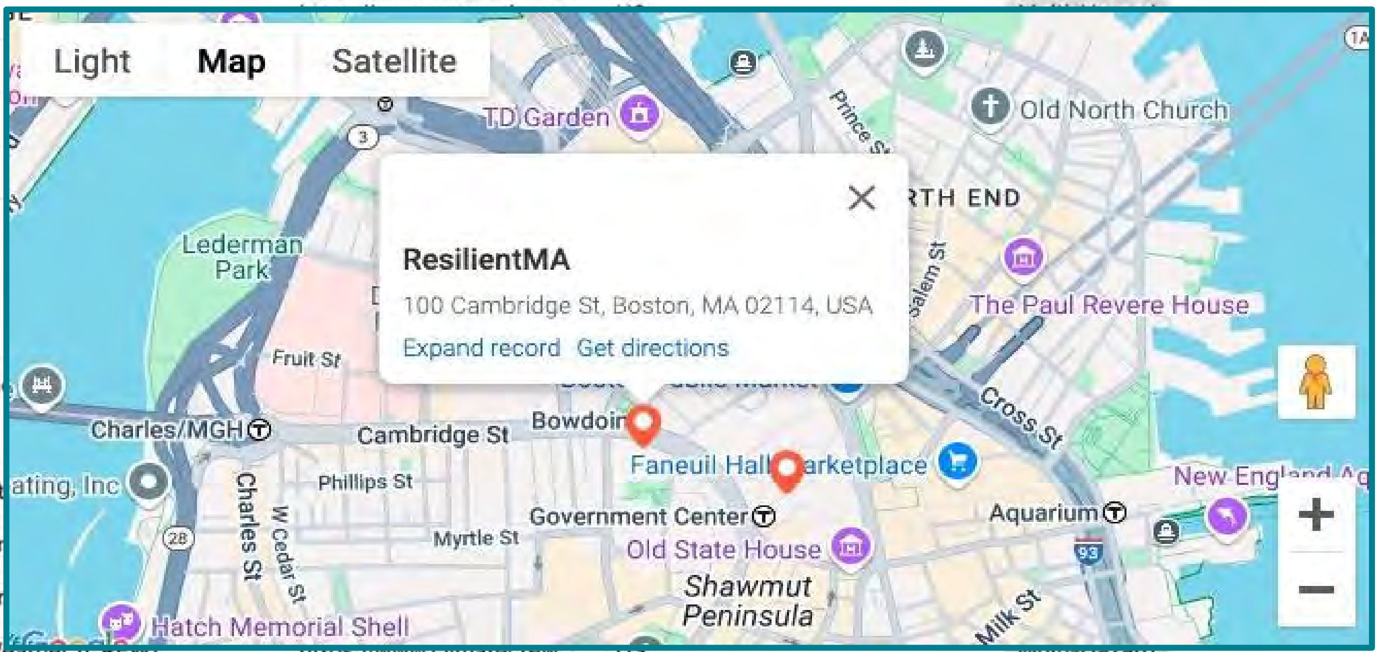
Image source: [Risk Factor Air Factor]

Setting Priorities | How do we manage data?

This growing database tracks resources for resilient design:

https://tinyurl.com/res-resource

Resource Name	Owner/Publisher	URL	State and Country	Type of Hazard
Resilience in Charleston County	Charleston County GIS	https://storymaps.arcgis....	Charleston County, SC	
Portfolio Protect	Enterprise Community Partners			
Resilient Land Mapping Tool	The Nature Conservancy			
Surging Seas	Climate Central			
Building Resilience Index	International Finance Corporation			
Charles River Flood Model	Charles River Watershed Association			
AIA Hazard Mitigation Design Resources	AIA			
Risk Footprint	Coastal Risk Consulting			
Virginia Flood Risk Information System	Virginia Department of Conservation an			
NOAA/NWS Storm Prediction Center	NOAA/NWS			
Annual Tornadoes Report	NOAA/National Centers for Environment			
BCDC Community Vulnerability and CBO ...	Bay Conservation and Development Cor			
Adapting to Rising Tides Roadmap	Bay Conservation and Development Cor			
CREW Resilience Hub Map	Communities Responding to Extreme Weather (CREW)	https://www.climatecrew....	US	Multi-Hazard
Enterprise Green Communities Checklist	Enterprise Community Partners	https://www.greencommu...	US	Multi-Hazard



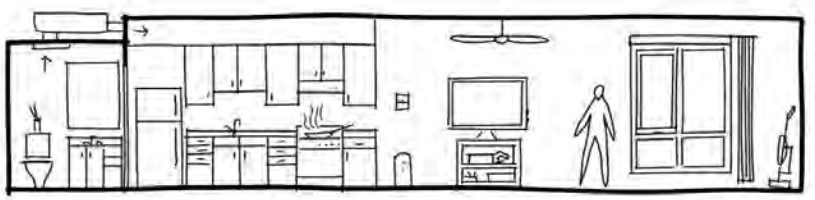
Setting Priorities | How do we manage data?

Use this link to submit case studies, policies, tools, information resources to the database:

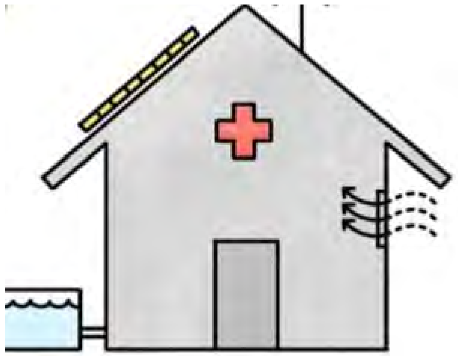
https://tinyurl.com/add-a-resource

Mitigation Strategies | How do we establish scale?

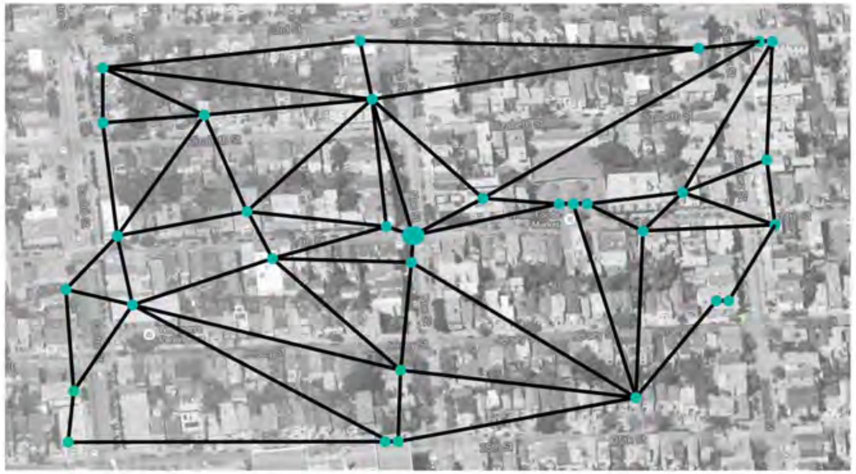
Residents in their homes



Residents in Common areas



Address a need in the neighborhood



Mitigation Strategies | How do we track decisions?

What **risks** are the highest priority for this building?

Risk/Hazard	Applicability	Priority (1-3)
Energy Disruption *short term outage (1-5 hours)*	**Highly Likely**	**1**
long term outage (1-3 days)	**Likely**	**2**

Mitigation Strategies | How do we track decisions?

What **strategies** are important for a successful response?

	Mitigation Measures		
	Included	Under Consideration	Not Included
Short-term battery inverter for emergency lighting (req'd)	☑	☐	☐
Temporary emergency generator or battery for elevator	☑	☐	☐
Provisions for PV-tied battery supporting "hub" emergency supplies, common area shelter needs	☐	☑	☐
Islandable PV-tied battery supporting tier 1 loads (see next tab)	☐	☑	☐

Mitigation Strategies | How do we track decisions?

What are the **most critical service continuities**?

How many hours do you want to target service continutity in a power outage? ☐ 12 ☐ 24 ☐ 48 ☐ 72

What on site services are needed during a power outage? **Critical** Ideal

Medications can be kept in the community room fridge if units lose power	
Staff have ability to open windows for ventilation if AC is out	
Tenants and staff can charge devices in the community room	

Mitigation Strategies | How do we track incentives?

What are **other incentives** to implement these strategies?

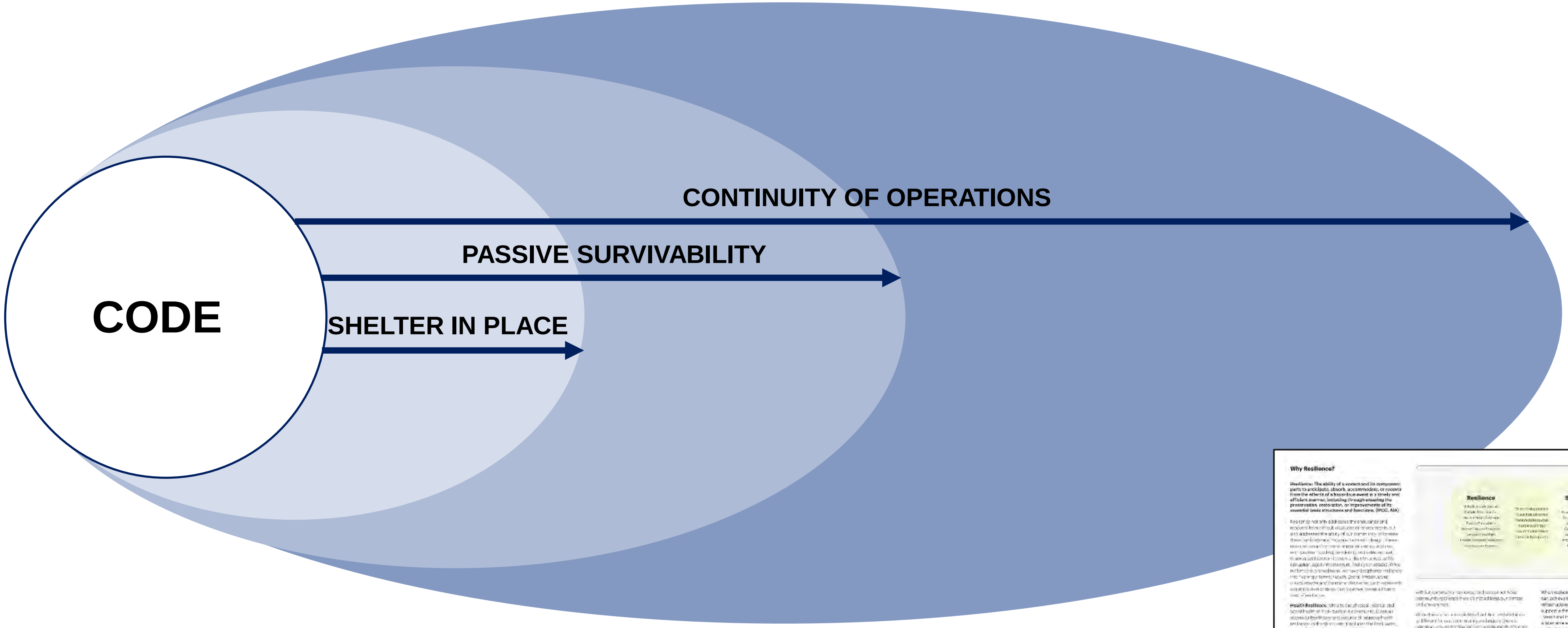
	Incentives		
	AHSC application	Greenpoint Rating	Fortified
Strategy A	☑	☐	☐
Strategy B	☑	☐	☑
Strategy C	☐	☑	☐
Strategy D	☐	☑	☐

Resilience Design Toolkit

Resilience Design Integration
For Architectural Projects

AIA HKS

Designing Beyond Code




Why Resilience?

Resilience

Sustainability

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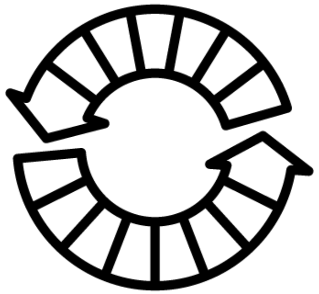
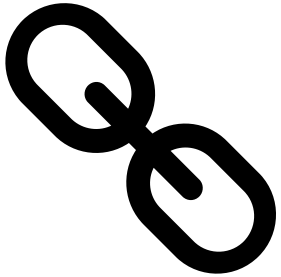


Sustainable design follows an additive model

The gains from each sustainable design choice are not explicitly dependent on all other choices.



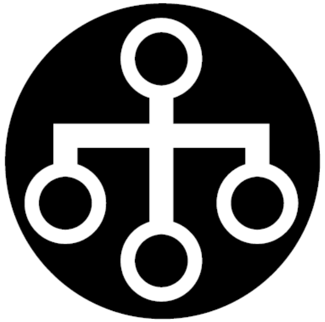
Resilient design follows a weak-link model

All systems work together to maintain the building’s essential functions across all aspects.

5-Forms of Resilience

Health Resilience *refers to the physical, mental, and social health of individuals of a place.*

Social Resilience *health of a community to maintain cultural and historical traditions that can define a sense of a place.*

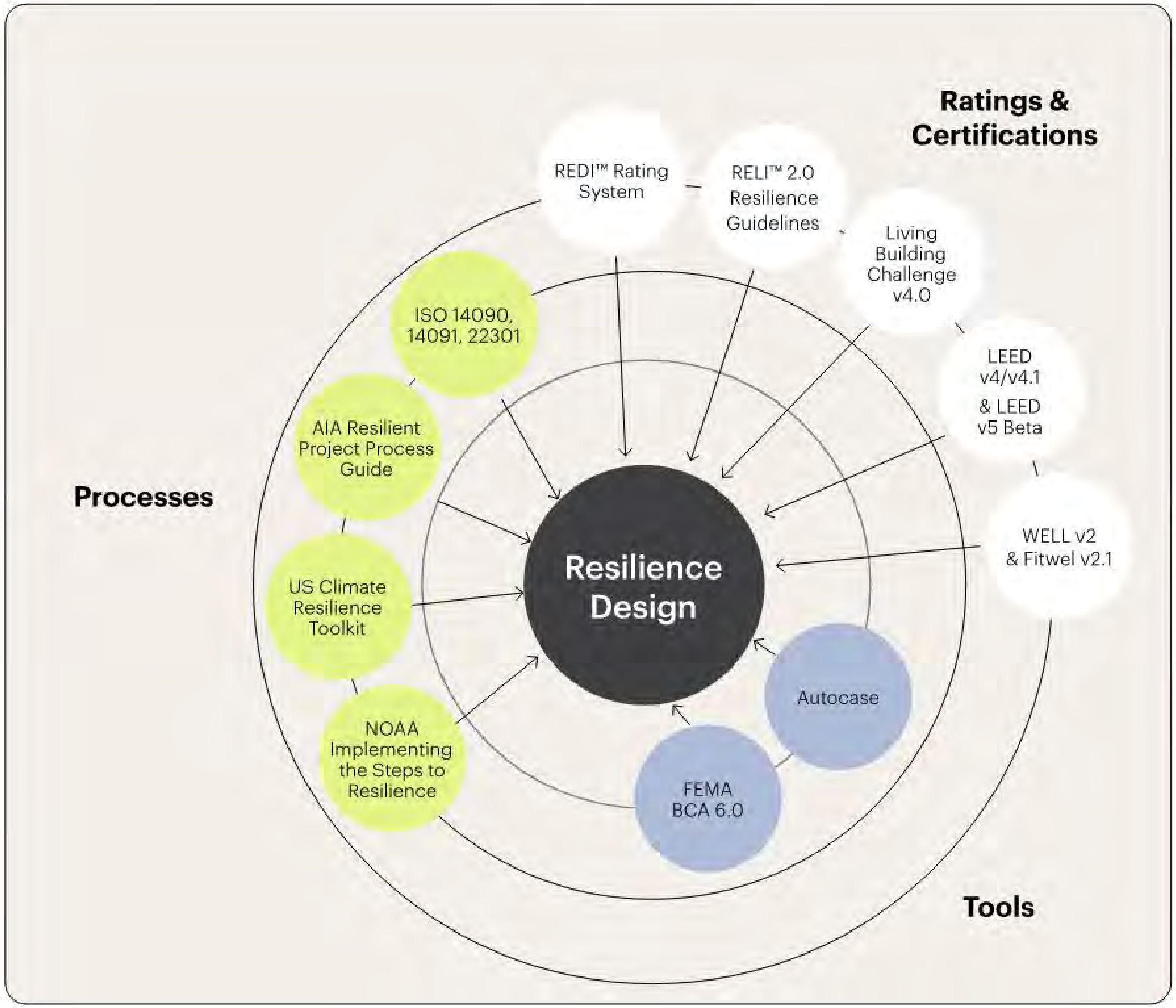


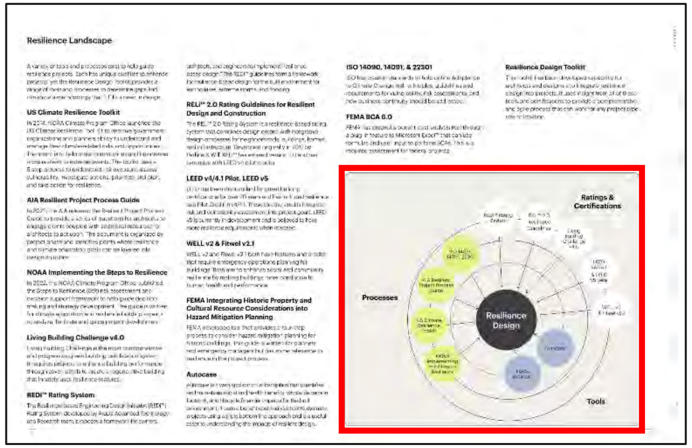
Infrastructure Resilience *focuses on the physical infrastructure of a place.*

Environmental Resilience *includes climate and weather impacts on an ecosystem as well as all the native flora and fauna species of a place.*

Economic Resilience *Ability to prepare, endure, and operate through adversity.*

Resilience Design Landscape





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Resilience Design Toolkit – 5 Steps

Pursuit	Planning	Pre-Concept	Design	Post-Construction

1. Resilience Scope

Determine the client's understanding of resilience and the owner's project requirements. Develop an appropriate resilience scope for the project.

Perform:

Identify Client Understanding of Resilience

Assess Resilience Scope

2. Team Alignment + Planning

Develop a plan to integrate resilience in the project by identifying appropriate talent and process by creating a resilience design work plan.

Perform:

Create Resilience Design Workplan

Assemble Project Team

Resilience Design

Kick-off, Visioning, and Work Sessions

3. Identify Hazards

After the plan is set, identify project hazards, then assess risk & vulnerability. Discuss results with project team and stakeholders.

Perform:

Hazard Study

Risk & Vulnerability Assessment

Determine Critical Hazards

Employ:

AIA Principles of Design Excellence Framework

4. Integrate Resilience Design

Mitigate project risk & vulnerability by integrating resilience design measures. Assess viability & feasibility of specific strategies through a Benefit Cost Analysis.

5. Evaluate + Nurture

Project close out and delivery. Assess building resilience performance and develop a case study after first year of operation.

Perform:

Post Occupancy Evaluation

Create:

Case Study & Apply Lessons Learned

Step 01 – Resilience Scope Assessment

Private Conversations	Embedded in an RFP/RFQ	Added to an Existing Project	Stakeholder Meeting

Client Characteristics

Unaware	Unaware of resilience as an issue Resilience may have not been mentioned in an RFP/RFQ or come up in conversation. Opportunity to lead with knowledge May not have an appetite for resilience
Exploring	Aware of resilience as a concern but may not know what it is totally about or how it is performed Needs guidance in understanding on how hazards might put their project at risk Could be an opportunity to lead with knowledge Need to understand client's position on resilience
Evaluating	Client has a position on resilience and understands base concepts Client has an idea on what they want in the project Project team needs to build confidence in the client that they can provide resilience design services
Embedded	Client is familiar with resilient design and knows what the final deliverable should be Project team should determine the capabilities of the team and ability to provide desired services for the client

Resilience Conversations

Private Conversation

Word-of-mouth work and leads are effective ways to maintain a business. Speaking at conferences and participating in your community are also effective methods to advertise, lead with knowledge, and reinforce firm values for business development. Architects often become trusted voices to clients. If a client is curious about resilience and wants to know more about how resilience design can be beneficial for their project, the architect should be able to provide a confident response.

Embedded in RFP/RFQ

Architects typically receive an RFP for potential new work. Usually, the scope of work is clearly defined and presented so that the architect can assemble the appropriate team and fee. In the wake of recent disasters, resilience design requirements are becoming more common. The Resilience Design Toolkit aims to equip architects with knowledge and strategies to confidently respond to RFP/RFQs with resilience design requirements.

Added to an Existing Project

Scope will develop and may change through the life of the project. Architects may also uncover a previously unknown hazard during a project. These should be brought to the client's attention with care and effective solutions discussed with the project team. A project change directive from the client could request a resilience design add service. To better serve the client, architects will need to be knowledgeable about resilience design.

Community Meeting

Community meetings can be an essential part of a project development and approval process especially for public projects. Community meetings may not be required for private projects, but community interests should be considered in design. We can learn what is important to a community from comments and statements provided at community meetings. Resilience may arise in public feedback and could impact how the client team addresses requests for resilience design.

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What Does This Mean For My Project?

Task 01 – Determine the Resilience Scope

Detect Resilience Scope from Client

- Private Conversations
- RFP/RFQ
- Added Scope
- Stakeholder Meetings

Define & Refine Resilience Scope

+

Task 02 – Assemble the Team

Determine

- Who to include?
- What is their task?
- How much fee needed?

Deliverables

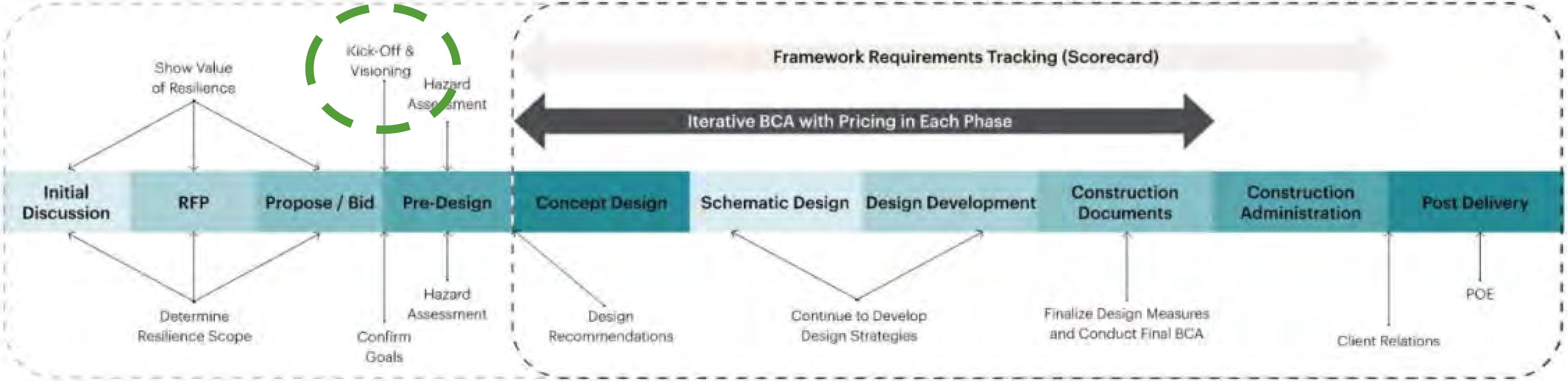
Work Plan

Job Cost

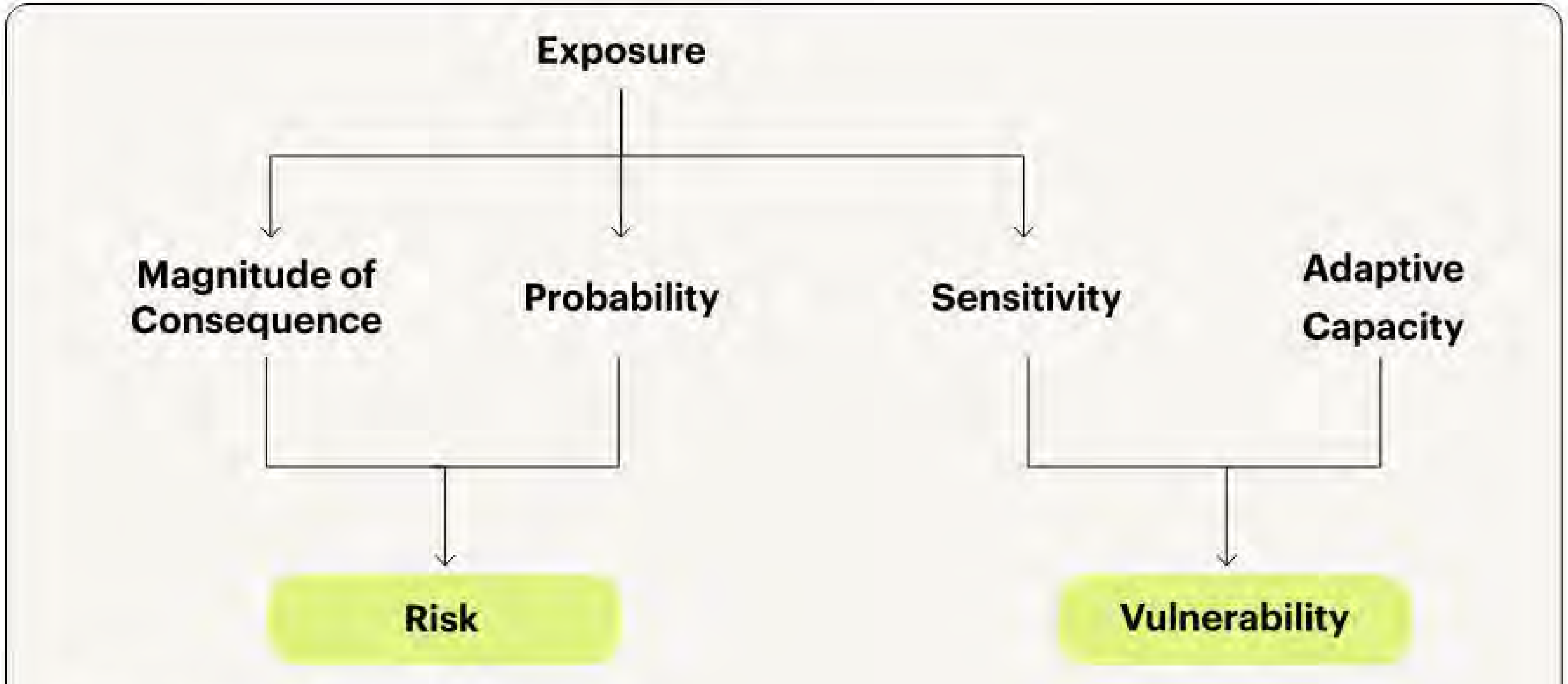
Manage Client Expectations

Aligning the Team

Meeting types	Time	Accomplishments
Kick-off	1-2 hours	Discuss Resilience Goals
Visioning	1-2 hours	Develop a Resilience Plan
Workshop	1-2 hours or Series of Meetings	Team Collaboration and Development of Resilience Strategies

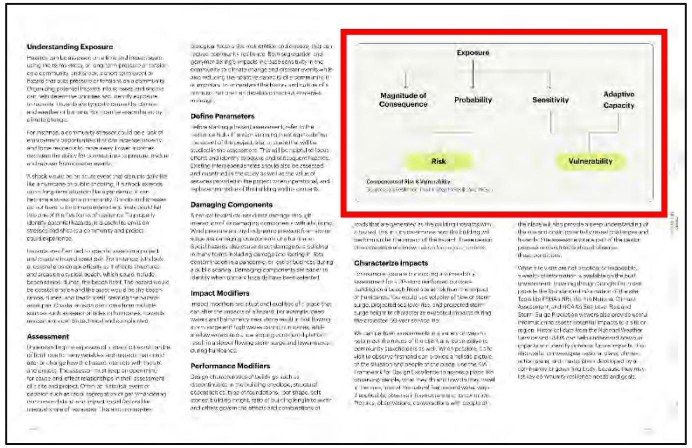


Step 03 – Hazard Assessment and Identifying Risk/ Vulnerability



Components of Risk & Vulnerability

Sources: US Resilience Toolkit, Step to Resilience, NOAA



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Step 03 – Identify Hazards

Avalanche

	A large mass of snow traveling down an inclined slope
Causes	Snowstorms, heavy snowfall, human activity, vibration, steep slopes, warm temperatures
Concerns	Recreational activity, property damage, burial
Damaging Components	Velocity, weight

Coastal Flooding

	Sea water flooding of coastal, low lying regions
Causes	Waves, tides, storm surge, heavy rainfall, sea level rise
Concerns	Reoccurring minor flooding, property / infrastructure damage, water contamination
Damaging Components	Depth of water, flood inundation duration, velocity of surge

Cold Wave

	A rapid fall in temperature within a 24-hour period affecting much larger areas than blizzards, ice storms, and other winter hazards
Causes	Winter temperatures, polar vortexes, shift in jet stream
Concerns	Pipes bursting, livestock harm, ice and frost, fuel and electric demands, dangerous roads, agriculture harm
Damaging Components	Rapid freezing, ice on roads, winter weather

Earthquake

	A sudden and violent shaking of the ground, due to tectonic movement
Causes	Volcanic Activity, Tectonic Movement, Geological Faults, Landslides, Explosions
Concerns	Structural Damage, Tsunami, Rockfalls, Liquefaction
Damaging Components	Landslides/Mudslides, Avalanches, Shaking Vertical/Horizontal Displacement, Compromised Adjacent Structures with Fall Risk

Hail

	Pellets of frozen rain
Causes	Strong updrafts, cold upper region of thunderstorm
Concerns	Vehicle/ roofing/ window/ gutter damage, agriculture, bodily harm
Damaging Components	Size of hail stone, frequency, amount in a given storm

Heat Wave

	A period of time where there are abnormally high temperatures compared to the average
Causes	Trapped air circulation, high pressure system, heated, stagnant air
Concerns	Lack of awareness, outdoor work related tasks/jobs, health issues
Damaging Components	High heat, extreme exertion on body, drought conditions

Ice Storms

	A storm of freezing rain that leaves a coating of ice
Causes	Freezing rain, near freezing temperatures
Concerns	Road conditions, weight on trees/roofs, utility damages
Damaging Components	Weight of ice, slick conditions for roads, freezing

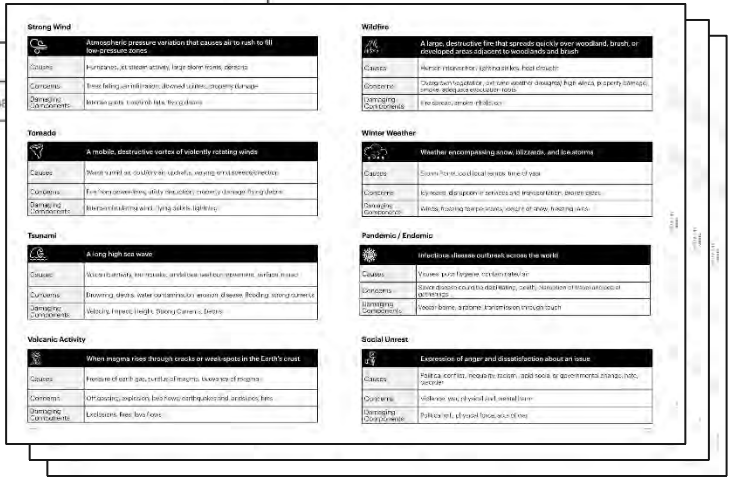
Landslide

	The sliding down of a mass of earth or rock from a mountain or cliff
Causes	Disturbances on slopes, rapidly accumulated water, destruction of vegetation
Concerns	Disruption of Utilities, Road Blockage, Rapidly Moving Water and Debris
Damaging Components	Mass and Velocity of Debris, Rockfalls

Lightning

	An electrical discharge caused by imbalances between storm clouds and the ground
Causes	Electrical imbalances, thunderstorms
Concerns	Fires, utility interruption
Damaging Components	Fires, direct strikes to humans, electrical m

+ 10 more Hazards in the FEMA National Risk Index



Pages 23-25

Earthquake

	A sudden and violent shaking of the ground, due to tectonic movement
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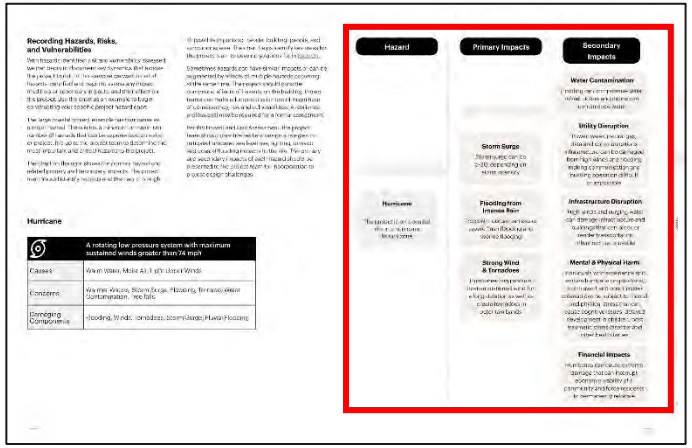
Damaging Components	Landslides/Mudslides, Avalanches, Shaking Vertical/Horizontal Displacement, Compromised Adjacent Structures with Fall Risk

Step 03 – Determine Critical Impacts

Hazard	Primary Impacts	Secondary Impacts
Earthquake	Shaking, Vertical / Horizontal Displacement	Utility Disruption
	Fault Rupture	Infrastructure Disruption
	Liquefaction	Building Damage
	Landslides	Mental & Physical Harm
	Tsunami	Financial Impacts



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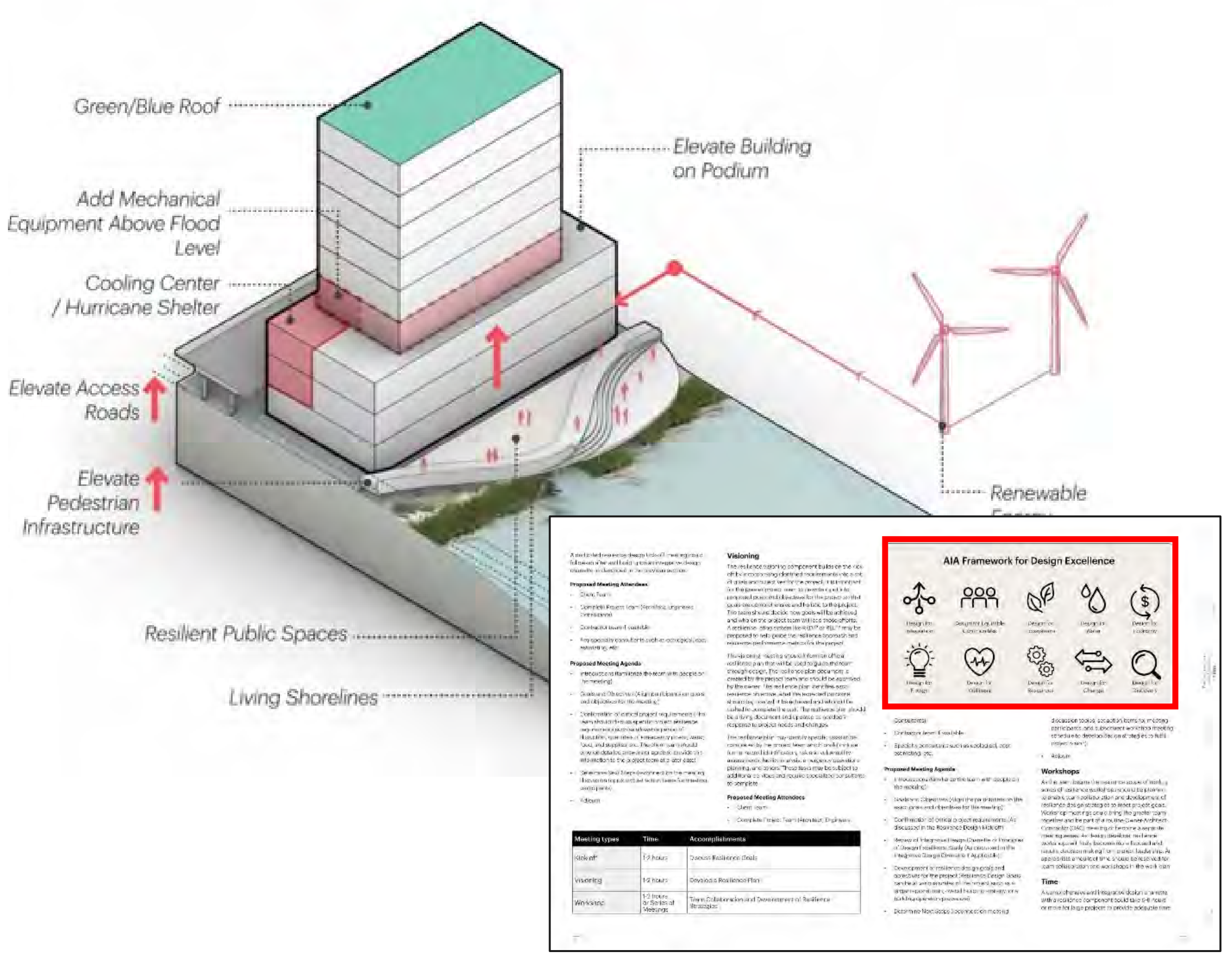
Step 04 – Knowledge of Place in Design



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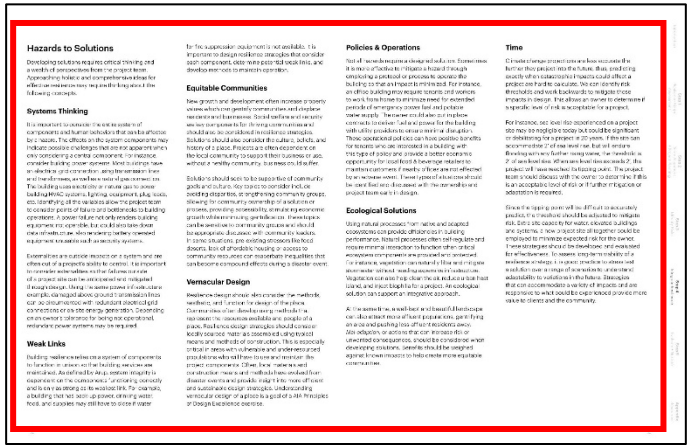
Step 04 – When Developing Solutions….

7 Topics to Consider

- Systems Thinking
- Vernacular Design
- Weak Links
- Policies & Operations
- Equitable Communities
- Ecological Solutions
- Time


Hazards to Solutions

Systems Thinking

Weak Links

Equitable Communities

Vernacular Design

Policies & Operations

Ecological Solutions

Time

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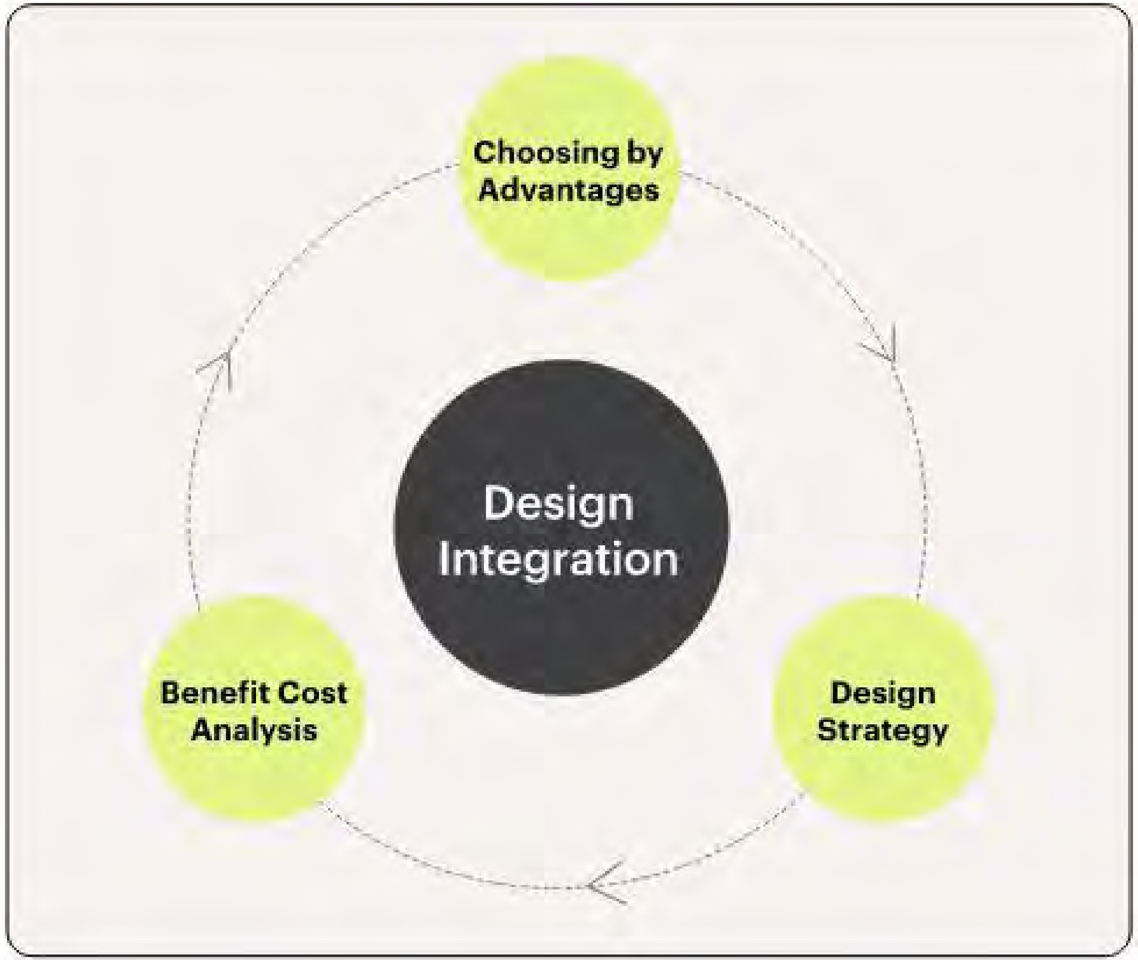
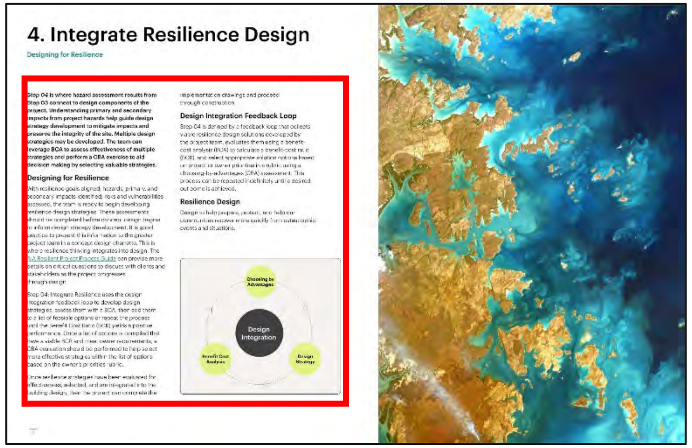
Step 04 – Resilience Design Feedback Loop





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Step 04 – Benefit Cost Analysis

Benefit Cost Analysis (BCA) Steps

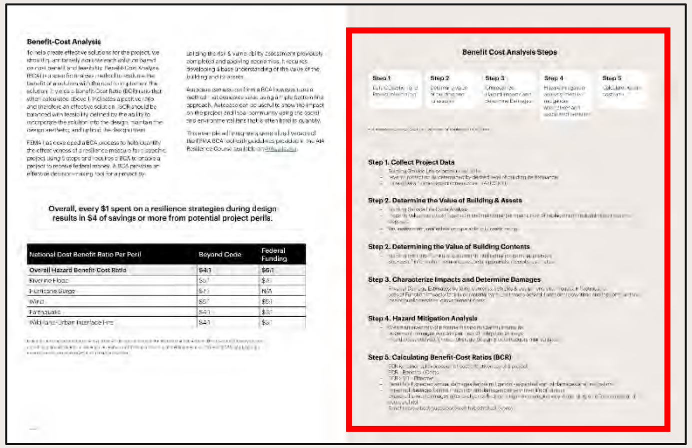
Step 1
Data Collection and Project Information

Step 2
Determine value of building and its assets

Step 3
Characterize Hazard Impacts and determine Damages

Step 4
Identify mitigation alternatives and associated benefits

Step 5
Calculate Benefit Cost Ratio (BCR)



Benefit-Cost Analysis

Overall, every $1 spent on a resilience strategies during design results in $4 of savings or more from potential project perils.

National Cost Benefit Ratio Per Peril	Beyond Code	Federal Funding
Overall Hazard Benefit-Cost Ratio	$4:1	$6:1
Riverine Flood	[illegible]	[illegible]
Hurricane Surge	[illegible]	N/A
Wind	[illegible]	[illegible]
Earthquake	[illegible]	[illegible]
Wildland-Urban Interface Fire	[illegible]	[illegible]

Benefit Cost Analysis Steps

Step 1 Step 2 Step 3 Step 4 Step 5

Step 1. Collect Project Data

Step 2. Determine the Value of Building & Assets

Step 2. Determining the Value of Building Contents

Step 3. Characterize Impacts and Determine Damages

Step 4. Hazard Mitigation Analysis

Step 5. Calculating Benefit-Cost Ratios (BCR)

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AIA Resilience Course, Module 7 “Business of Resilience” (AIA 2018)

Step 04 – Benefit Cost Analysis

Damages from Potential Hazards > **Cost for Resilience Strategies**

$$\frac{\text{Damages}}{\text{Cost of Resilience Strategies}}$$

Benefit Cost Ratio (BCR) >1.0 → **The Resilience Strategy Should be Considered**

5. Evaluate + Nurture

Step 05 - Evaluate + Nurture is where the relationship with the client and the performance of the project come together, hopefully in a positive form. We should always seek to know failures and successes of our past projects so that we can learn and perform better on the next project.

Post Construction

Successfully achieving the project's resilience goals presents post occupancy opportunities. After the certificate of occupancy has been earned and the contract requirements have been fulfilled, the project likely is considered complete. This is a perfect time to follow up on Return-on-Investment (ROI) of the project as appropriate with the client and stakeholders. This could be assessed more comprehensively through a Post-Occupancy Evaluation (POE). Lessons learned in the POE may be useful content for a project case study or other publication that describes both failures and successes.

It is incredibly valuable to be able to assess project performance so that we can determine which design strategies functioned as intended or were not worth the investment. The comprehensive yet highly specific design strategies that could be developed for resilience design may be unique to the project and site. Design elements could be used in subsequent projects and a database of successful and not so successful strategies can help provide direction in the future.

Case studies are a great vehicle for documenting project work and the resilience design strategies included in the design. Developing a case study template that is clear and direct helps make project work highly sharable and can also be used for marketing and business development.

Clear and tangible building operations and maintenance manuals are critical for the building to function as designed and maintain its resilience features. Building operations manuals are developed and building operations staff are trained on how to properly operate the building. This is typically performed by commissioning agents and MEP engineers on the project. These training manuals should have sections on building resilience systems.

Through this process, it also provides an opportunity to remain in a trusted position with the client. Maintaining a relationship with a client and their organization may provide opportunities for future work and the ability to follow-up on past projects.

Post Occupancy Evaluation

Within the first year of operation, it is best practice to engage the owner with the opportunity to perform a post occupancy evaluation (POE) for the project.

"Post occupancy evaluation" is a term widely accepted and used across the industry for evaluating design after it has been put into service. The depth of analysis and tools used can vary quite widely in a POE.

POE is an evaluation conducted during the operations phase of a project after completion of design and construction. The scope of POE can differ dramatically by project type, client interest, and the skills and experience of the design team. A POE is executed to answer crucial questions about a building's performance. It can address questions such as:

Does the building perform as it was designed?

Does the building meet the users' needs?

What corrective measures can be implemented to improve performance?

How can building features be designed more effectively in the future?

Quantitative and qualitative measurements taken in a POE study ultimately allow designers and clients to review the effectiveness of design features and building performance.

When

It's important to give the operations team sufficient opportunity to calibrate the building after it is fully occupied, which typically occurs 10-18 months after project completion. Also, work teams, managers and individuals need to adapt to their new spaces, discover what works and doesn't work for them, and run through all processes.

You should start thinking about a POE at the very beginning of the project. A similar evaluation can also be provided prior to the start of a project to document a baseline condition, identify issues or concerns to be addressed with the new design, or help the owner and design team identify project goals and priorities.

Who

Simple tutorials can be provided to help project team members gather quantitative data. When it comes to interviews, surveys, and other qualitative responses, careful consideration in phrasing questions or input prompts will help collect unbiased and more useful responses. In identifying user groups and respondents to the POE, the first consideration is the type of information or feedback desired. Typical stakeholders could include building engineers and facility mangers, residents, team leaders, tenants, specialized work groups, students, faculty, nurses, patients, managers, staff, and executives. There are external tools and resources available to help define a more customized POE to address specific concerns or client needs.

Why

The POE provides validation of design strategies and/or construction implementation, and helps track to meet initial goals. Evidence from previous projects, including examples and impacts, makes it even easier to justify or bolster design solutions on future projects.

For the client, the POE proves the value of design and performance enhancements (daylight, biophilia, acoustic control, lighting, individual control, thermal comfort, etc.). The end user gains better understanding of the physical space they occupy and the design considerations.

A POE could also be used to demonstrate to an owner the impact of higher quality design features, including higher quality materials.

Follow-up After a Disaster

Inevitably when a disaster occurs, we should all lend a helping hand where we can. After the situation has stabilized, a discussion with an owner may be welcomed on how the building or project endured the disaster event and how the project team can help navigate issues with the building. This may help reveal how the owner has perceived resilience design features which may provide both objective and subjective responses. Having a relationship with the owner can help make these conversations more fluid and may reveal feedback on resilience performance. Sometimes the conversation may not be welcomed, it is up to the project team to assess the situation.

Other Ways to be Involved

The AIA Disaster Assistance Committee provides organization and training for architects to help their communities after a disaster event. The Safety Assessment Program (SAP) uses the California Office of Emergency Services training program for structure assessments after earthquakes, flooding, and extreme windstorms. Architects and Engineers can complete the training and be placed on a list of volunteers to help with damage assessments after a disaster event. This program can provide firsthand experience of the potential damage and hazards, relief process, and protocols that can affect communities, which can help with resilient design development.

Wesley Chapel Campus

Johns Hopkins All Children's Hospital

Resilience & Sustainability Design & Planning

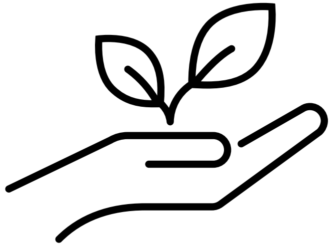
HKS

26491.000

January 29, 2025

Authentic

Use an objective approach to make informed decisions that add value for the overall project.



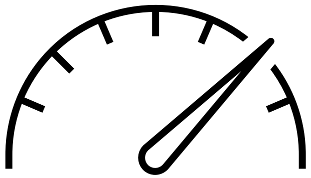
Comprehensive

Consider full components and systems when developing design concepts and strategies.

BPRS

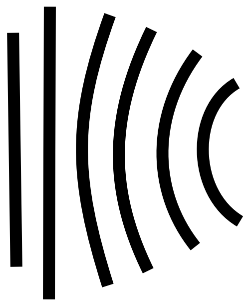
Building Performance

Metrics to measure value in design; operational, financial, social.



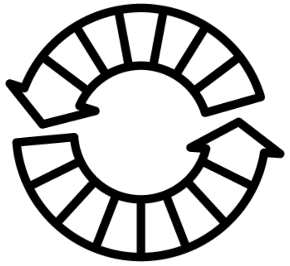
Resilience

Ability to prepare, withstand, and recover from adverse events.



Sustainability

Making decisions that minimize negative impact for future generations.



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Owner’s Project Requirements (OPR)

Document that outlines the project's scope, goals, and requirements, including the desired end state.

Details the functional requirements of a project and the expectations of the building’s use and operation as it relates to building systems.

Assessment Rubric

Criteria to assess the effectiveness of proposed design strategies to meet the project requirements and goals.

List of 5-10 criteria with weighted ranking.

Pairs with cost information if available.

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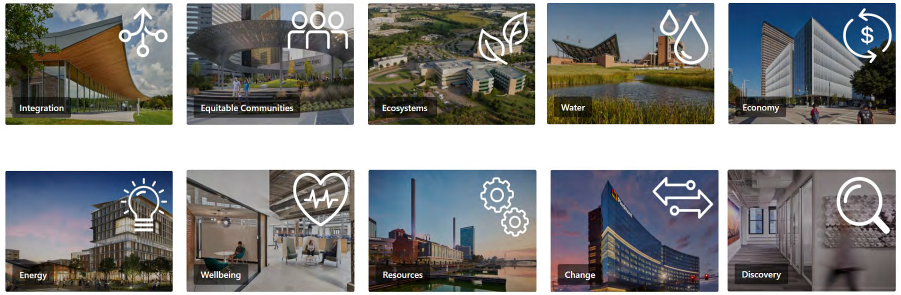
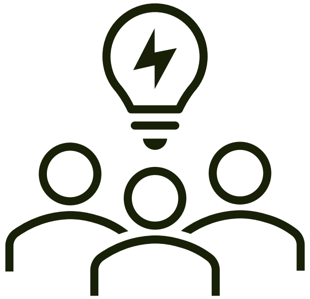
Nature of Place

Comprehensive site analysis using the AIA Framework for Design Excellence. This framework uses 10 specific measures to evaluate a place.



Integrative Design Charrette

Project team charrette to first distill potential opportunities and then develop design strategies that help meet project goals.



Green Building Certifications

Create accountability for design strategies to produce meaningful impact.

INTERNATIONAL WELL BUILDING INSTITUTE™

LIVING BUILDING CHALLENGE

High-Value Design

Leverage these strategies to balance budget and intent.

Programming/Discovery

Site Design Meetings

01 Site Plan Drivers

July 30

- Site Plan Prioritization Drivers Established

02 Programming Mtg. 1

Nature of Place Concepts Distillation

August 12

- Site Plan Prioritization Drivers Reviewed
- Site Plan Scenarios Draft 1
- Major Building Blocks
- Key Traffic Patterns
- Owner’s Project Requirement Follow-up

03 Programming Mtg. 2

Integrative Design & Budget Charrette

August 26

- Site Plan Scenarios Draft 2
- Adjusted Building Blocks and Traffic Patterns
- Parking Strategy Developed
- Integrative Design Charrette with Project Team

04 Programming Mtg. 2

Building Performance, Resilience, Sustainability

September 16

- Site Plan Scenarios Draft 3
- Final Revisions to Campus Massing and Traffic Patterns + Parking Strategy
- Set Project BPRS Goals

Stakeholders

CLIENT / INVESTOR

Johns Hopkins Health, other entities investing capital in the project

CLIENT / USER

Patients, family / visitors, staff, and anyone interacting with the built environment

CO-CREATORS

Project Team (architect, engineers, consultants, contractor, etc.)

COMMUNITY

Members of the public, local community groups, neighbors

EARTH

Environmental advocacy groups, ecological and natural systems

Measures of Success

CLIENT / INVESTOR

1. Very Efficient > Focus on Operational Cost
2. Water Efficiency
3. Evaluation of Total Cost of Ownership
4. Maintain operational requirements without sacrificing program
5. Balance efficiency and sustainability
6. Long-term efficiency
7. Lifecycle impact of products and materials

CLIENT / USER

1. Retention and recruitment of staff
2. Patient and family experience
3. Operational Efficiency
4. Reduce injuries
5. Resilience, Patients can shelter in place
6. PVC-Free products in buildings.
7. Products durable to disinfectants
8. State of the art Facilities
9. Large loading docks to facilitate building operations

CO-CREATORS

1. Project Team: We want to say "I want to work with that team again"
2. Quick project close-out and punch-list!
3. All parties and disciplines feel heard

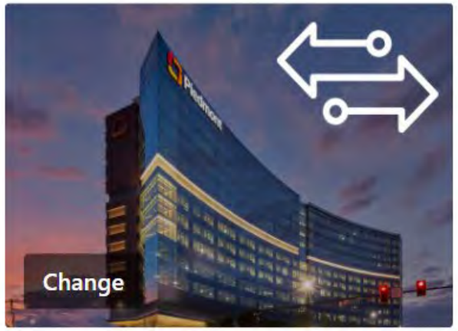
COMMUNITY

1. Patient-family advisory group (monthly) > Engage this group and account for feedback during in formed decision making
2. Rural preservation / nature preservation for the area

EARTH

1. Avoid Stripping and waxing floors / VCT - Sustainable flooring can incorporate sustainable rubber flooring for instance
2. Preserve natural beauty of the site

AIA Measures of Design Excellence

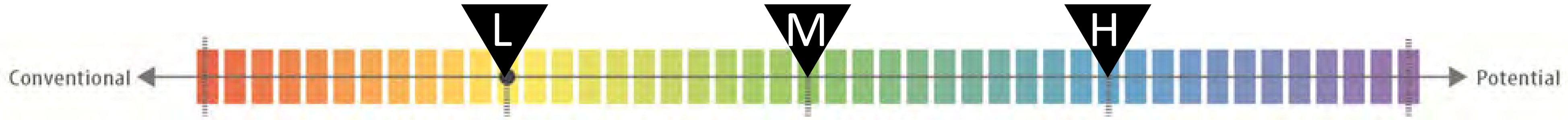


The Design Measures guide our work, help define our shared principles, and drive beauty, performance, innovation, and impact.

Building & Design Strategies Activity

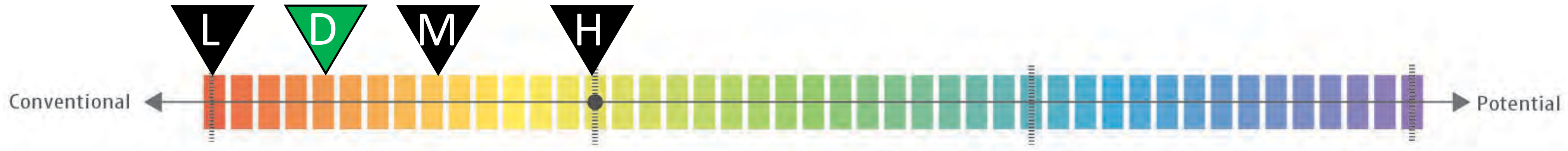
Strategy Topic

Strategy definition. Think about the context and provide feedback on where the project should aim regarding this topic.



Greenhouse Gas Emissions

The campus will reduce GHG emissions from a determined baseline design.



ASHRAE 90.1-2019 – 3% Improved over Min Code

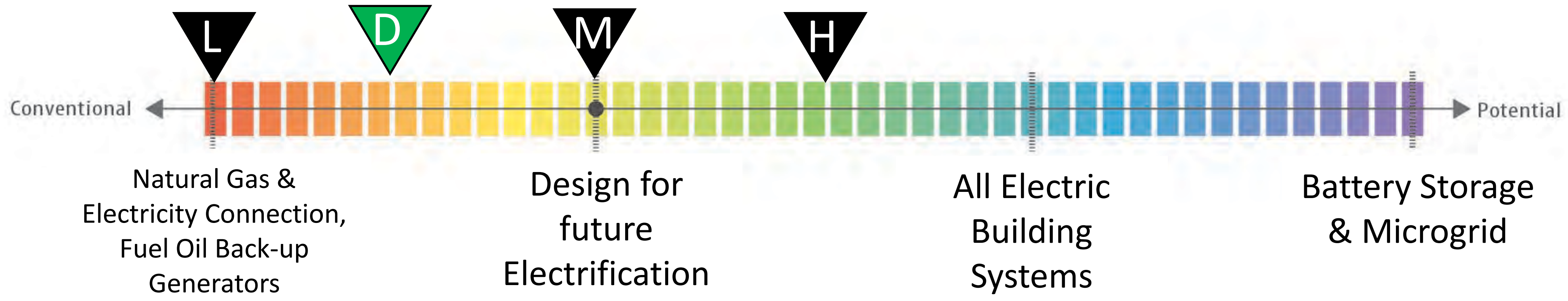
Embodied Carbon, 10% Reduction, MEP 2040, 20% Reduction

HHS Climate Pledge, 50% reduction by 2030, 100% by 2050

JHU, 20% reduction by 2030, 100% by 2045, 100% renewable energy purchase by 2030, All new buildings to be all electric or AE ready

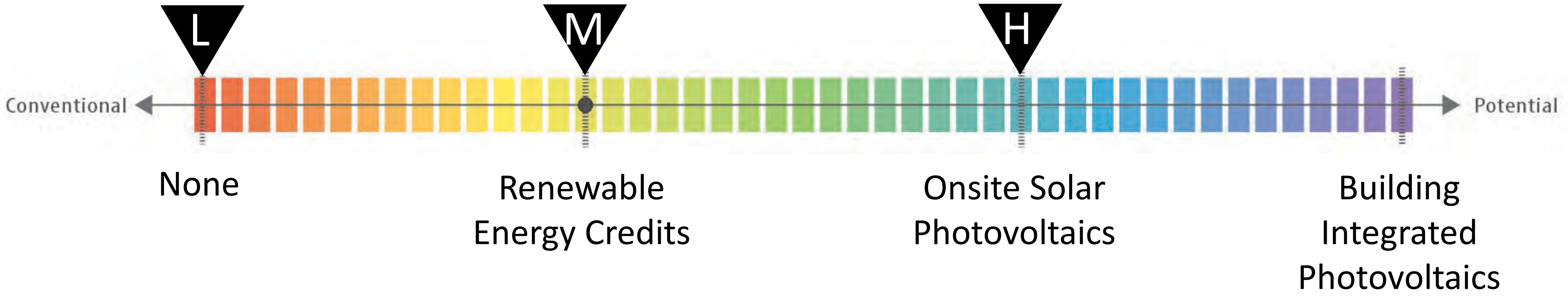
Building Energy

The facility will accommodate future energy grid transformation.



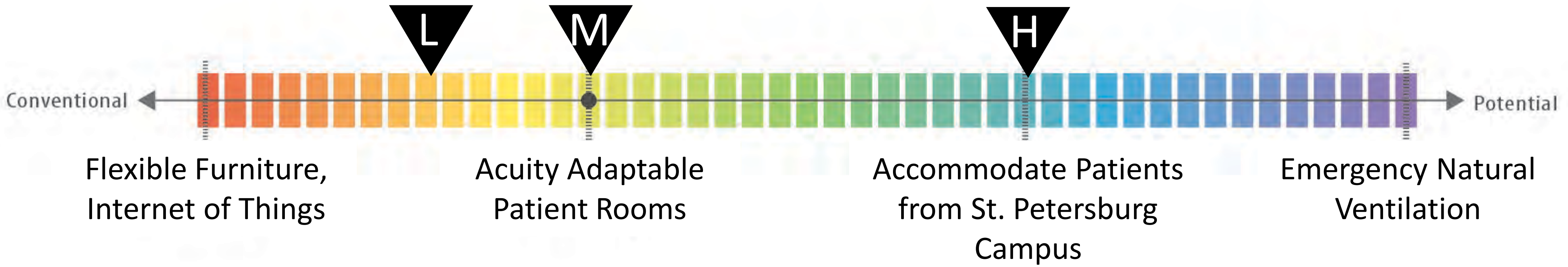
Renewable Energy

The facility will leverage alternative and renewable energy in the building operation and design.



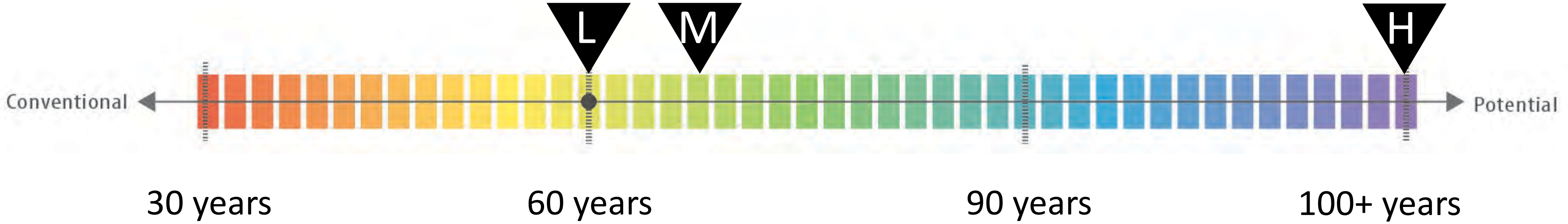
Flexibility

The facility will provide the flexibility for opportunities for future use. Consider modularity (walls, furniture), standardization, future expansion, etc.

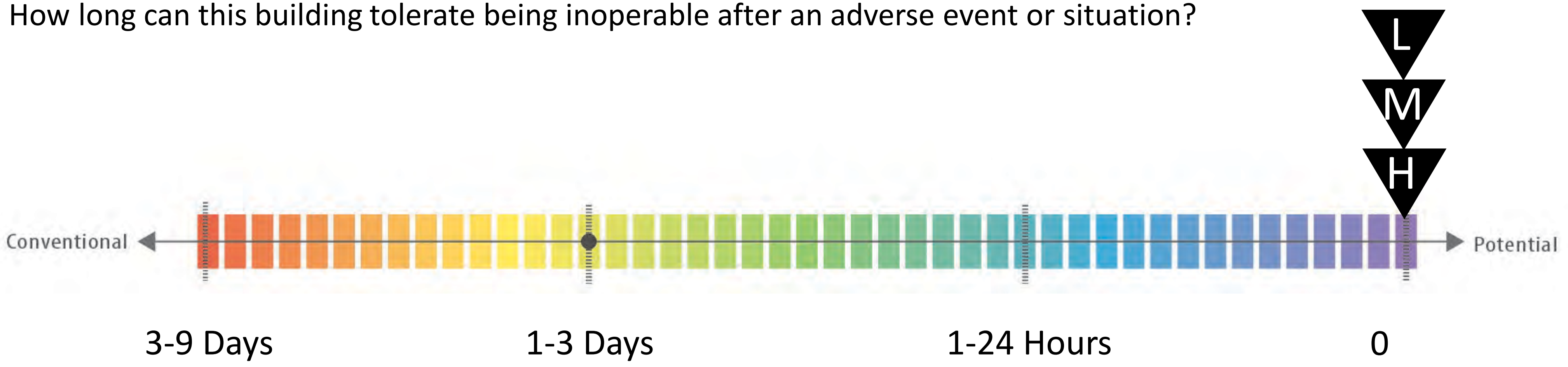


Building Lifespan

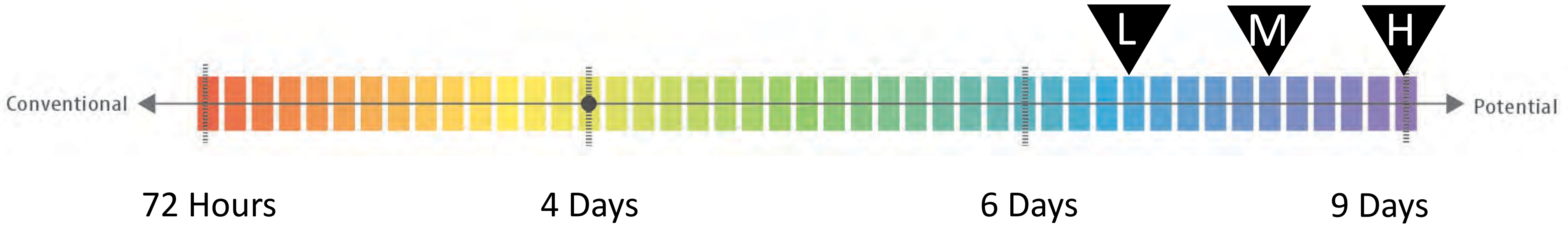
Expected lifespan of the building to operate and serve the community on this site.



Inoperability
How long can this building tolerate being inoperable after an adverse event or situation?



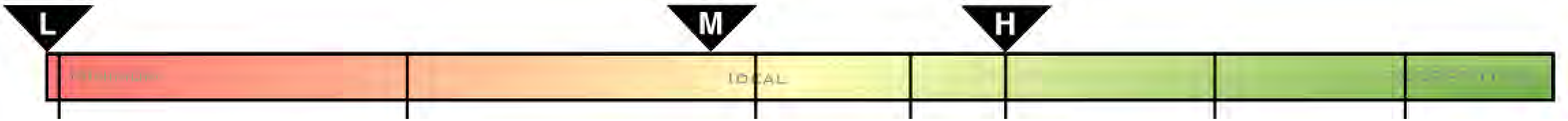
Emergency Power
How much emergency power reserves are needed for the building and site?



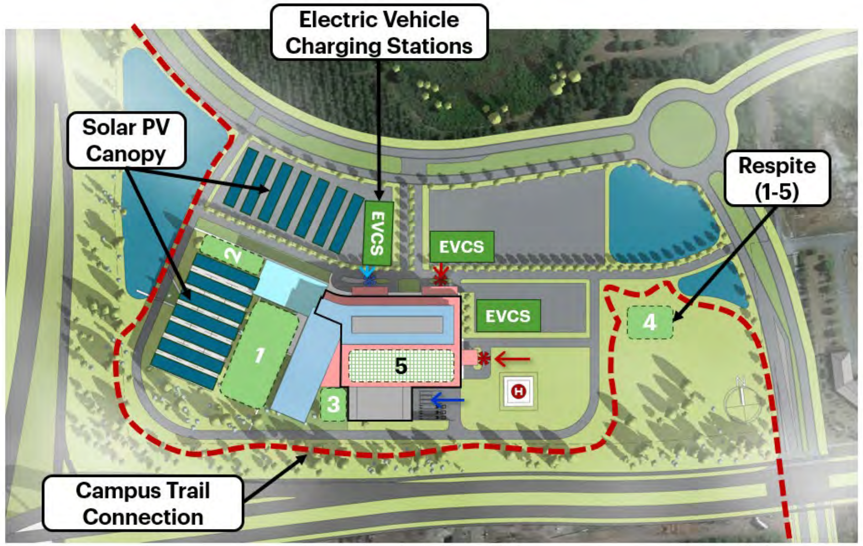
OPR to Design

Design Evaluation Process

1. Determine Appropriate Range of Performance for the Project



2. Develop Strategies to connect OPR to Design



3. Assess Design Strategies for Effectiveness

	4	3	2	1
Weight	**Excellent**	**Satisfactory**	**Adequate**	**Poor**
20%	0-5 Years	6-10 Years	11-15 Years	16+ Years
20%	20% +	11-19%	0-10%	Negative Impact
20%	20% +	11-19%	0-10%	Negative Impact
15%				
5%				
20%	20% +	11-19%	0-10%	Negative Impact

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Sustainability & Resiliency Priorities

Priority Summary

1. Design Utilizes Resources Efficiently
    - *Balances monetary resources with energy and water efficient design within reason; minimizes carbon impact*
    - *Evaluate total cost of ownership and prioritize operational cost*
2. Enhances Wellbeing and Superior Healthy Environments
    - *Retain and attract top staff talent*
    - *Positive health outcomes for patients*
3. Resiliency
    - *Maintains operation through adverse events*
    - *Patients can shelter in place*
4. Durable and Reliable Systems and Finishes
    - *No VCT / stripping floors required; sustainable flooring*
    - *Durable to cleaning and disinfectants*

→ More Discussions in Design Development

HKS

Strategies Overview

Resource Efficiency

- Massing / Form
- Loads (internal gains) / Envelope
- System Selection

Site & Wellbeing

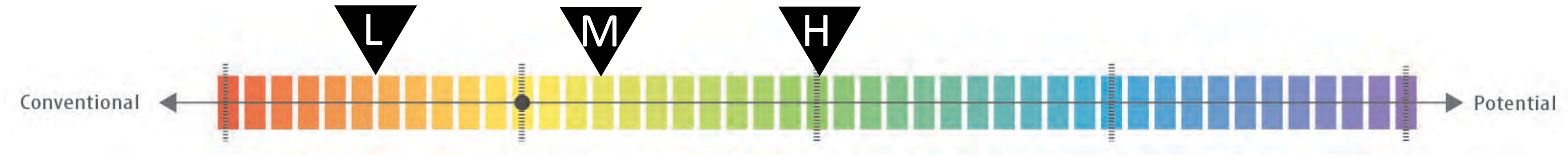
- Respite Spaces (Inside & Outside) (Playgrounds, Fitness)?
- Walkway Protection (Solar PV)?
- Trail connections / Bike Storage Facilities?
- EV Charging (10+% Spaces, Locations)?

Resilience

- Place for emergency water, materials (food, medicine, toiletries, etc.)?
- Generators and Equipment Inside or Outside?
- Building Articulation for Daylighting?
- Stormwater Control & Storage (Bioswales, Porous Paving)?

Energy Efficiency

The facility will be energy efficient. Consider the energy target for the new design and discuss possible technologies and features, including:



ASHRAE 90.1-2019
(FL Energy Code)

ASHRAE 90.1-2022
(Future Energy Code)

10% Improvement
from 90.1-2022

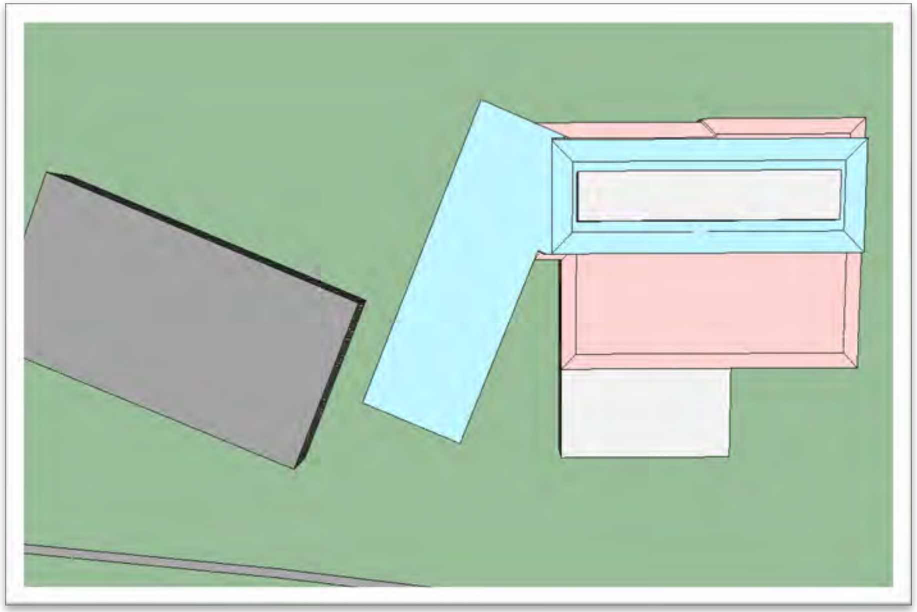
15% from 90.1-2022
w/ Renewables

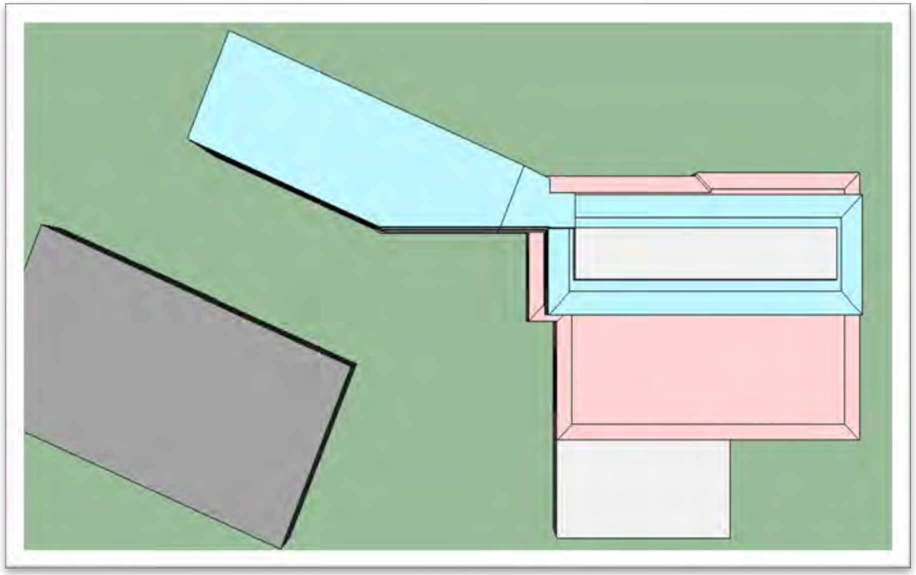
Zero-Energy Ready
ENERGY STAR 100
EUI Target Depends on Design and massing for PV feasibility

Building Form

How Form Impacts Energy

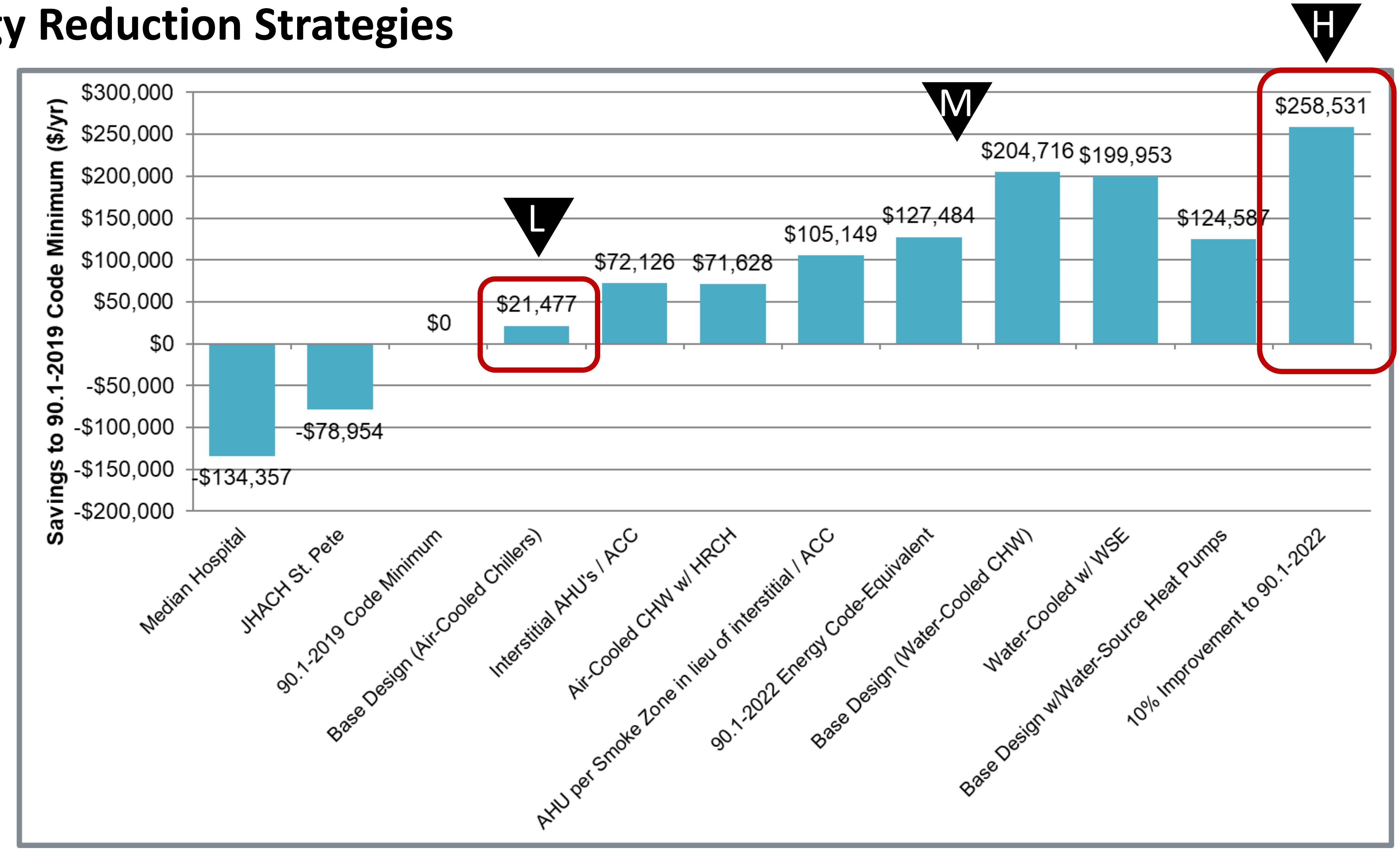
1. E-W axis allows for greater access to daylighting while controlling solar glare (bottom image)
2. Cooling Load 1% reduction = equipment size reduction (Roughly 13 tons and $100,000)
3. Energy Reduction of 2% Annually (Roughly $50,000 for future build-out)





HKS

Energy Reduction Strategies

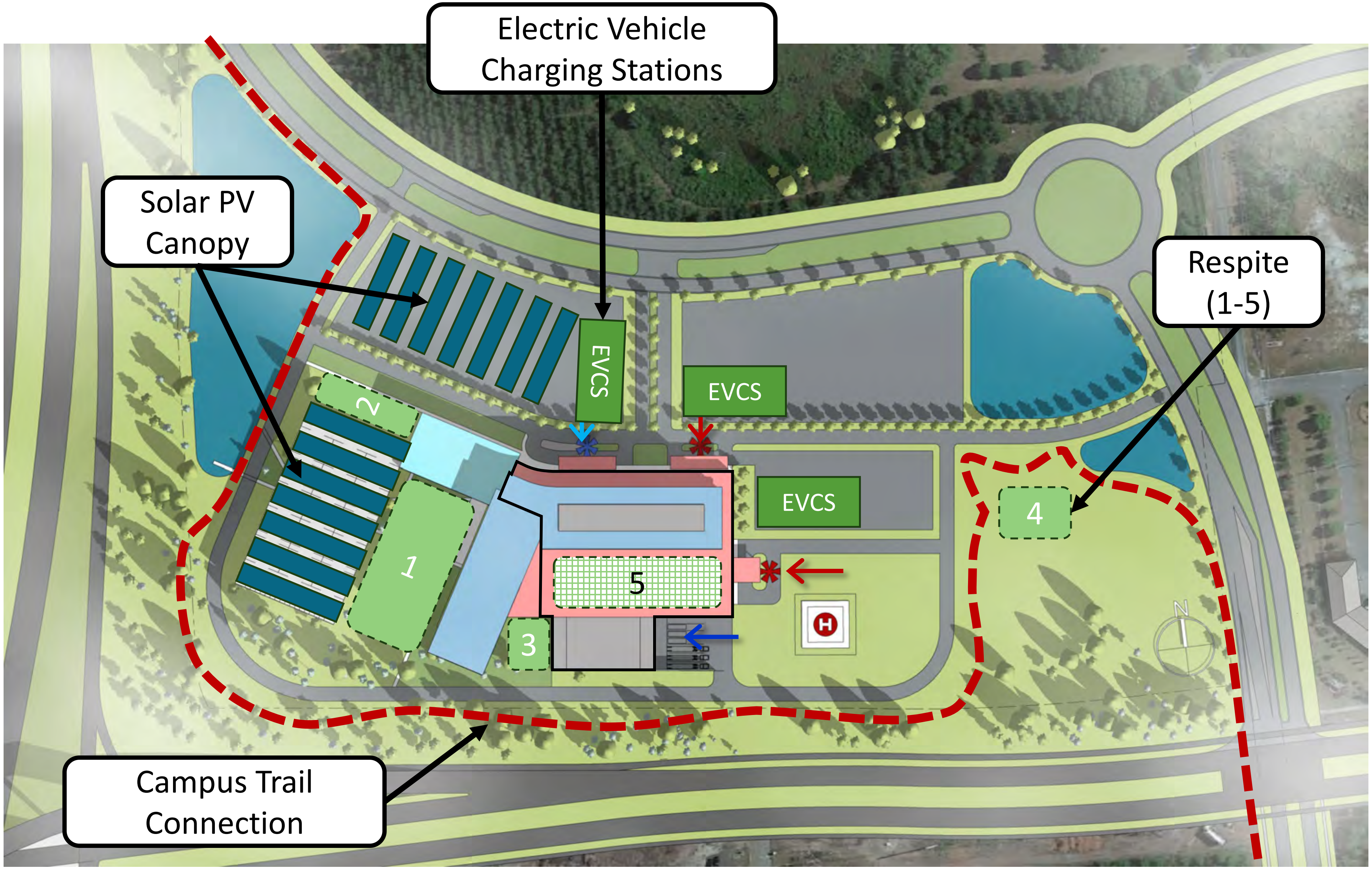


HKS

Site & Wellness Strategies

05 | Pocket Garden

- Respite Spaces (Inside & Outside) (Playgrounds, Fitness)?
- Walkway Protection (Solar PV)?
- Trail connections / Bike Storage Facilities?
- EV Charging (10+% Spaces, Locations)?
- 35,000 sq. Ft. Of flat thin-film panel = 5.5% phase 1 site energy



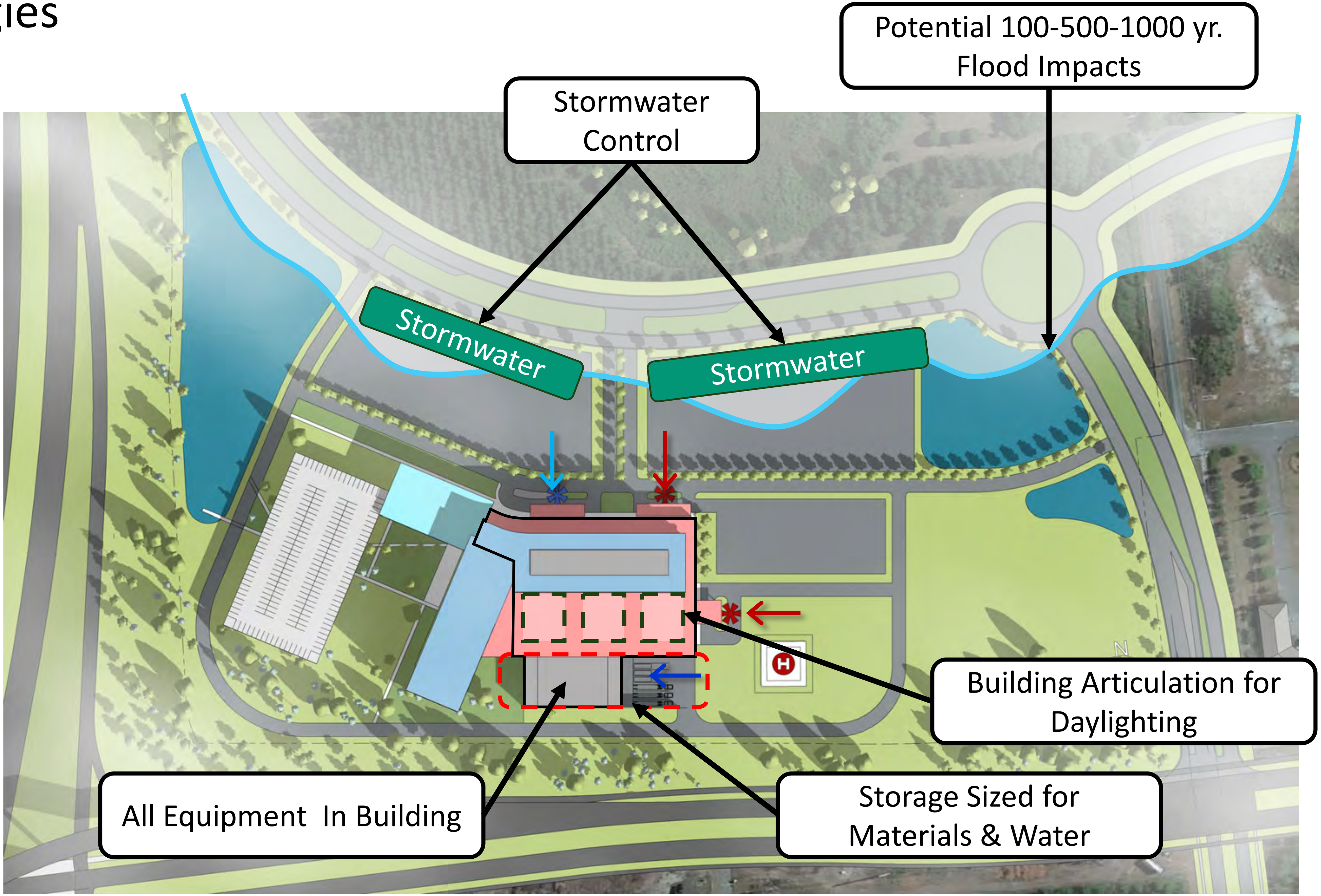
Diagnostics + Treatment
Inpatient Beds
Medical Office
Central Energy Plant

HKS

Resilience Strategies

05 | Pocket Garden

- Place for emergency water, materials (food, medicine, toiletries, etc.)?
- Generators and Equipment Inside or Outside?
- Building Articulation for Daylighting?
- Stormwater Control & Storage (Bioswales, Porous Paving)?



Diagnostics + Treatment
Inpatient Beds
Medical Office
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Rubric Assessment

Introduction

Main	Criteria	Weight	Excellent	Satisfactory	Adequate	Poor
Economics	First Costs	25%	Below Budget	On Budget	0-10%	11% +
Carbon	Embodied Carbon Reduction	10%	20% +	11-19%	0-10%	Negative Impact
Environmental	Carbon/Energy Reduction per LEED Reduction Metrics	25%	20% +	15-19%	10-14%	5-9%
Environmental	Water Reduction per LEED Reduction Metrics	15%	30% +	20-29%	11-19%	0-10%
Operational	Operational Cost & Labor Reduction	25%	20% +	11-19%	0-10%	Negative Impact

- Assess design strategies or packages with rubric to determine effectiveness for project.
- Guides decision making and strategy development.
- Comparative options would select the highest score
- Yes / No decision would set a minimum score of at least 3.0 (Satisfactory)

Strategy Evaluation Summary

Resource Efficiency
Building Systems

Site & Wellbeing
Site Systems

Organizing Concepts

Strategy	Score	Yes	No	Study Further
1.1 Heat Recovery System - Domestic Hot Water	2.9			
1.2 Heat Recovery System - Heating Right-Sized	3.1			
2.0 Solar Thermal w/ Storage	2.75			
3.0 Decoupling of DHW & Heating	2.9			
4.0 Water Loop & Management Plan	3.15			
5.0 Fan Power Design Level	2.95			
6.1 DOAS Dehumidification - No ERV	3.2			
6.2 DOAS Dehumidification - ERV	2.9			
7.1 Steam Generation - Steam Boiler	2			
7.2 Steam Generation - Electric POU	2.85			
8.0 Level of Potable Water, Energy, & Materials Storage	3.6			
9.0 Envelope Sensitivity	NS			
10.0 Window to Wall Ratio (WWR)	NS			
1.0 Stormwater Management Plan	3.5			
2.0 Pervious Surfaces	3.1			
3.0 Activity Canopy	3.3			
1.1 LEED Certification	3.8			
1.2 Design to LEED Standards	3.2			

HKS

8. Level of Potable Water, Energy, & Materials Storage

Initial Cost: $$-$$$

Lifecycle Cost: $$$

7 Days

Pros

- Self-sufficient operations
- Shelter-in-Place
- Continuous Operations
- Minimal Revenue Disruption

Cons

- Additional area and specific locations needed for equipment
- First Cost

7-9 Days

Notable Characteristics

- Specific spaces requirements for drinking water, medicine, toiletries, food, and personal item storage per person. (2-3 CF per person, per day)
- Dedicated program or designated dual-purpose space to accommodate storage (flex space).
- Equipment to hold extended water and energy on site.

8. Level of Potable Water, Energy, & Materials Storage

Initial Cost: $$

Lifecycle Cost: $$$

7 Days 7-9 Days

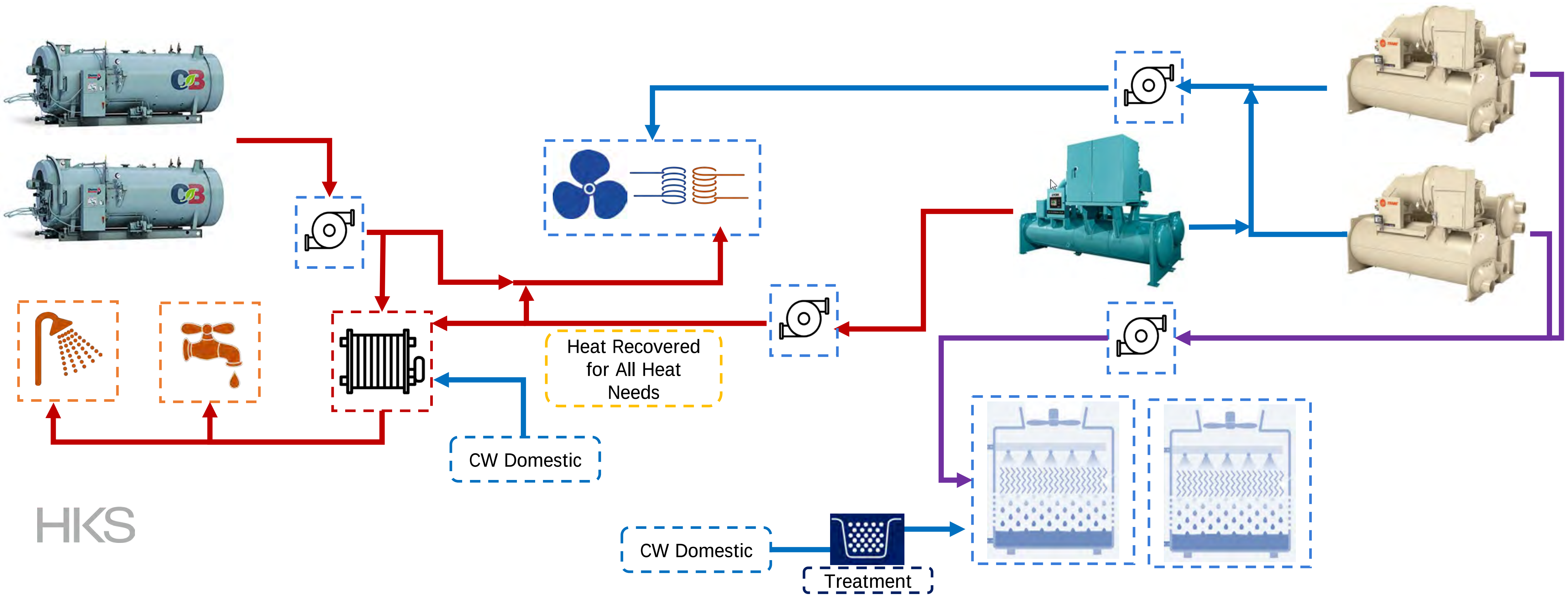
8.0 Level of Potable Water, Energy, & Materials Storage			4	3	2	1	
Main	**Criteria**	**Weight**	**Excellent**	**Satisfactory**	**Adequate**	**Poor**	**Score**
Financial Resilience	Minimize economic disruption	20%	0	$	$$	$$$+	**4**
Economics	First Cost	20%	Below Budget	On Budget	0-10%	11% +	**2**
Social	Promotes user satisfaction (Patient, Staff, Visitor)	20%	20% +	11-19%	0-10%	Negative Impact	**4**
Environmental	Carbon/Energy Reduction	15%	20% +	11-19%	0-10%	Negative Impact	**4**
Environmental	Water Reduction	5%	20% +	11-19%	0-10%	Negative Impact	**4**
Operational	Minimize operational disruption	20%	0 Hours	1-2 Days	2-6 Days	6+ Days	**4**
						Final Score	**3.6**

1. Heat Recovery System

Initial Cost: $$$

Lifecycle Cost: $

Heat Recovery System – Optimized Sizing for Heat (12% CHW)



HKS

1. Heat Recovery System

Initial Cost: $$

Lifecycle Cost: $$

Heat Recovery System

Pros

- Recover energy that would otherwise be rejected to the cooling tower
- Reduce simultaneous heating and cooling by disparate systems

Cons

- Added first cost
- Need to keep system loaded for proper operation

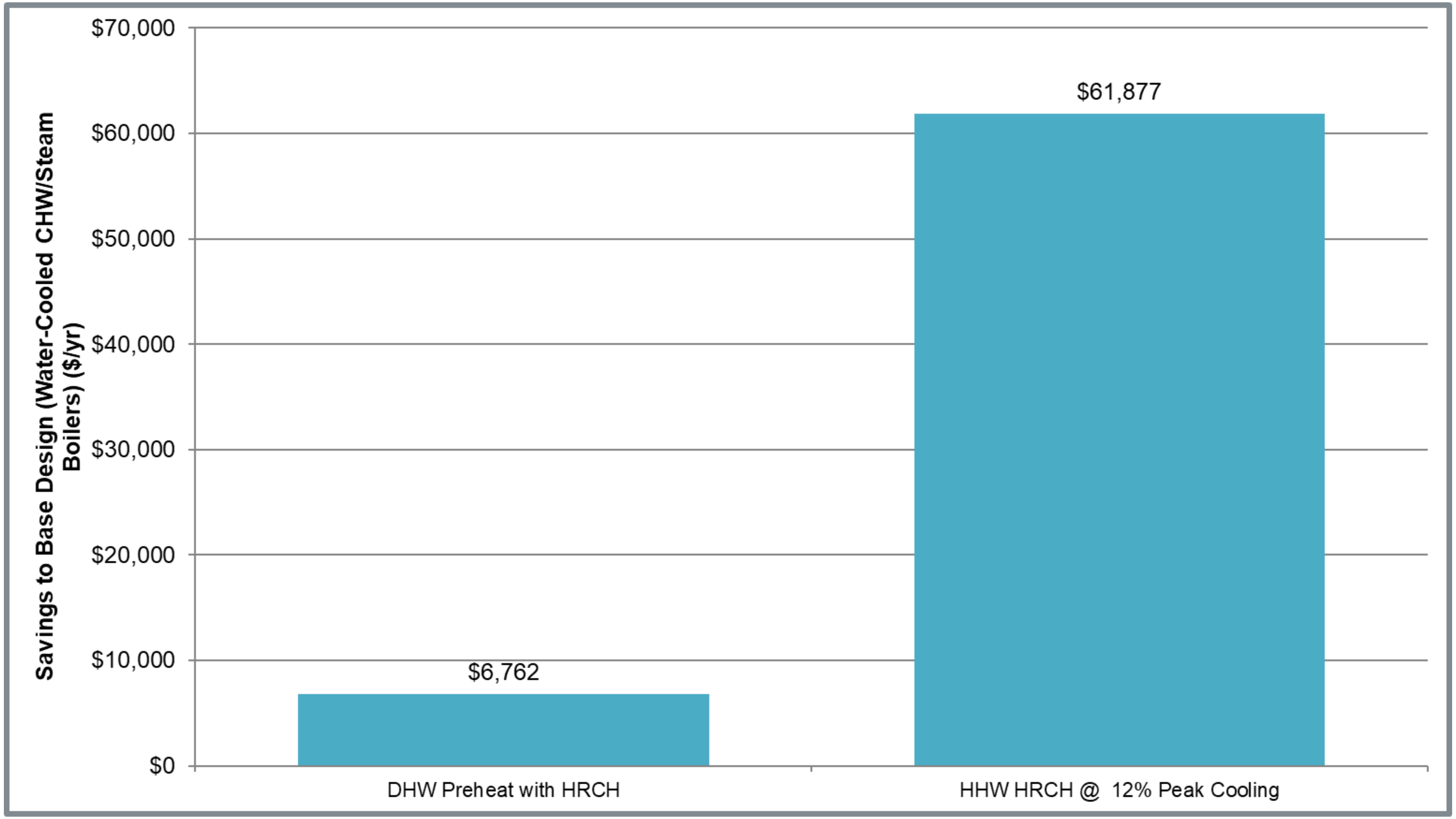
Notable Characteristics

- A small DHW preheat system is typically required by the energy code
- Larger systems that offset heating in lieu of DHW can provide greater savings with more predictable load profiles
- Several size options with various first cost and operational savings

1. Heat Recovery System

Initial Cost: $$

Lifecycle Cost: $$



1. Heat Recovery System

Initial Cost: $$ to $$$

Lifecycle Cost: $ to $$

1.0 Heat Recovery System - Domestic Hot Water			4	3	2	1	
Main	Criteria	Weight	Excellent	Satisfactory	Adequate	Poor	Score
Economics	First Costs	20%	Below Budget	0-10%	10%-15%	15% +	3
Carbon	Operational Carbon Reduction (LEED Reduction Metric)	10%	5% +	2-5%	0-2%	Negative Impact	2
Environmental	Energy Savings Absolute (LEED Reduction Metrics)	25%	5% +	2-5%	0-2%	Negative Impact	3
Environmental	Water Reduction / Savings	10%	10% + Savings	No Change	-10%-0%	<10%	3
Economics	Energy Cost - Operational	15%	5% +	1-4%	No Change	Negative Impact	3
Operational	O&M Cost to Maintain and Difficulty	20%	Easy / Low Cost	Standard / Standard	Learning Curve	New / High	3
						Final Score	2.9

1.0 Heat Recovery System - Heating Right-Sized			4	3	2	1	
Main	Criteria	Weight	Excellent	Satisfactory	Adequate	Poor	Score
Economics	First Costs	20%	Below Budget	0-10%	10%-15%	15% +	2
Carbon	Operational Carbon Reduction (LEED Reduction Metric)	10%	5% +	2-5%	0-2%	Negative Impact	3
Environmental	Energy Savings Absolute (LEED Reduction Metrics)	25%	5% +	2-5%	0-2%	Negative Impact	4
Environmental	Water Reduction / Savings	10%	10% + Savings	No Change	-10%-0%	<10%	4
Economics	Energy Cost - Operational	15%	5% +	1-4%	No Change	Negative Impact	4
Operational	O&M Cost to Maintain and Difficulty	20%	Easy / Low Cost	Standard / Standard	Learning Curve	New / High	2
						Final Score	3.1

Strategy	Score	Study	Yes	No	M	Notes
1.1 Heat Recovery System - Domestic Hot Water	2.9	C		X		40T Unit (Energy Code Min.) Cost study needed
1.2 Heat Recovery System - Heating Right-Sized	3.1	C	X			150T Unit (Beyond Energy Code)
2.0 Solar Thermal w/ Storage	2.75	C		X		
3.0 Decoupling of DHW & Heating	2.9	C			X	Base Price (Coupled)
4.0 Water Loop & Management Plan	3.15	X	X			To be studied further
5.0 Fan Power Design Level	2.95	X			X	Adjust Fan Power in design
6.1 DOAS Dehumidification - No ERV	3.2	C		X		Base Price, Central vs multiple DOAS units.
6.2 DOAS Dehumidification – Dual Path	2.9	C		X		Not in Base Price
6.3 DOAS ERV					X	
7.1 Steam Generation - Steam Boiler	2	C		X		Large Boilers being phased out
7.2 Steam Generation - Electric POU	2.85	C	X			Base Case
8.0 Level of Potable Water, Energy, & Materials Storage	3.6	X	X			To be studied, is a well available? Well for Cooling Tower. Additional Capacity with a Buffer tank.
9.0 Envelope Sensitivity	NS	X				Glazing location to be studied further
10.0 Window to Wall Ratio (WWR)	NS					To be studied further in SD's
11.0 Geothermal		X			X	Waiting on Site Survey
12.0 EV Charging Stations		X			X	Determine the amount of charging needed, metering recommended.
13.0 Solar PV		X			X	To be updated after building systems types selected. Location(s) to be determined.
14.0 Micro-Grid System w/ Batter Back-up for Resiliency		X		X		Additional Redundancy for Back-up Power, Generators still needed.
15.0 Condenser Domestic Pre-Heat		C		X		Recommended Option if not using HRC.
1.0 Stormwater Management Plan / Strategies	3.5	X				Potentially add pervious surfaces
2.0 Pervious Surfaces	3.1	X				Not critical path
3.0 Activity Canopy	3.3	X				Size / location / scope to be determined
1.1 LEED Certification	3.8	C		X		Official certification not pursued
1.2 Design to LEED Standards	3.2	C	X			Track project alignment with LEED

A3 #	Title	Champion	Collaborators	Sign Off
SR101	Water-side Heat Recovery Option Evaluation	SSR (Andy Brophy)	R&M (Kyle Davis)	Name of Final Approver(s)
	Wesley Chapel	Date Opened: 10.22.24	HKS (Sammy Shams)	Status: Defined
	Johns Hopkins All Children's Hospital	Issued: 11.19.24	SSR (Kyle Selvy)	

BACKGROUND: The base pricing budget did not include any provisions for the prescriptive energy code requirement for condenser heat recovery. Condenser heat recovery is a good strategy for realizing energy cost savings and there are two options with different levels of energy cost savings but different implementation costs. A decision needs review to determine which water-side heat recovery system should be incorporated into the project.

The recommendation will conclude with the 150-ton supplemental heat-recovery chiller (HRCH) option due to the relatively low simple payback and positive impact on energy consumption.

(CURRENT STATE) DESCRIPTION OF BASELINE AND OPTIONS:
The project at its current state would not include any heat recovery. There are multiple options available to incorporate heat-recovery into the chilled water system:

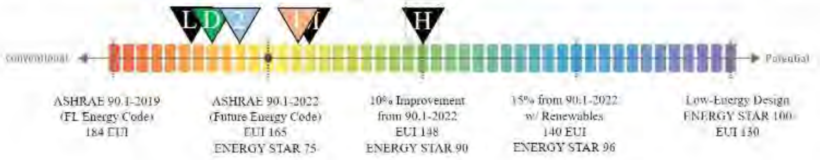
1. Condenser bundle heat exchanger: A heat exchanger and additional piping, controls and valving are provided to pull warm condenser water off of the condenser and use it to pre-heat incoming water for the domestic heating system. This diverts flow from the cooling towers to use the warm 95 degree condenser water to preheat incoming 65-75 degree potable city water.
2. Heat-recovery chiller (150 tons): An additional small chiller sized at 150 tons is provided along with additional piping, valving, and controls set up as a base load chiller where it generates chilled water that feeds into the chilled water loop and the resulting higher temperature heat rejection water is utilized on the heating hot water side (in summer months the heat recovery chiller provides most of the heating). This system is piped in sidecar

(ROOT CAUSE ANALYSIS) EVALUAITON CRITERIA AND ASSUMPTIONS:
An energy model has been developed by SSR to outline the building heating and cooling load expectations and anticipated energy consumption for the future hospital. The model was developed with the base budget design systems with additional iterations for the water-side systems outlined in each option. The heat-recovery chiller option was evaluated against multiple potential sizes for an optimal selection point (150 tons). Optimal was determined by the highest amount of energy cost savings. A second iteration was then simulated to reflect the domestic hot water preheat on the incoming city water. This provision will take

Measure	Energy Cost Savings	ROM Cost Impact	Simple Payback
#1: 150-ton HRCH	$59,800	$345,000	5.9 years
#2: Condenser HR	$11,200	$92,000	8.2 years

By providing chilled water and heating water at a greater capacity than the limited heat transfer at the heat exchanger for the condenser DHW preheat, there are much greater savings for nominal cost comparatively with an improved simple payback for the heat recovery chiller than the simple condenser heat exchanger.

FUTURE STATE/ANALYSIS:
Adding heat recovery contributes to achieving the OPR targets for energy savings / GHG Reduction. D represents the base design. 1 represents measure #1 150-ton HRCH, 2 represents Condenser HR.



- 150-ton HRCH results in an EUI of 159.8
- Condenser heat exchanger results in an EUI of 169.5
- The base design without water-side heat recovery is 174.5

IMPLEMENTATION PLAN/RECOMMENDATION:
It is recommended the project includes provisions to add the 150-ton heat-recovery chiller option to the design.

FOLLOW-UP/HOMEWORK:

What	Who	When
Finalize CEP space impact and design requirements	SSR	
Confirm ROM price with design update for final cost impact	R&M	

PARTICIPANTS:

Client Name
Name
Name

HKS
Name
Name

SIGNATURE:

Approver

Thank you!

All-Electric, High-Perfomance, and Resilient The Affordable Housing Playbook for the All-Electric Solution

Tim Kohut, AIA, CEA
Director of Sustainable Design
COREvolution / National CORE
tkohut@corevolution.org

COREvolution

All-Electric, High-Perfomance, and Resilient The Affordable Housing Playbook for the All-Electric Solution

…a guide for California (and beyond)...

…economics, technology, budget...

…lean into the future

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tkohut@corevolution.org

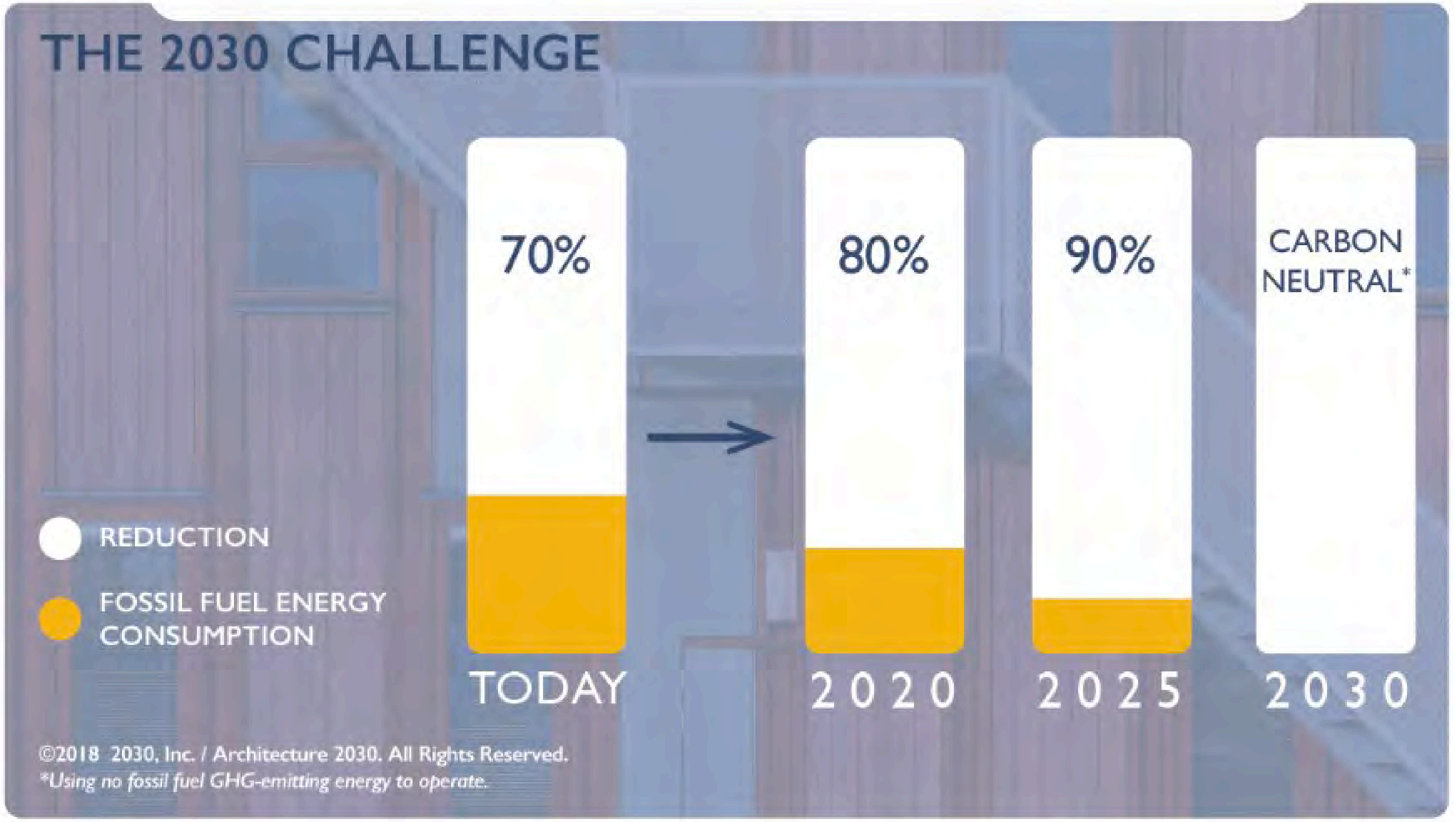
COREvolution

Why economics drive the design process?

...the importance of economic resilience.

Our Commitment to Sustainability…

The **urban built environment** is responsible for **75% of annual global GHG emissions**: buildings alone account for 39%. Eliminating these emissions is the key to addressing climate change and meeting Paris Climate Agreement targets.



COREvolution

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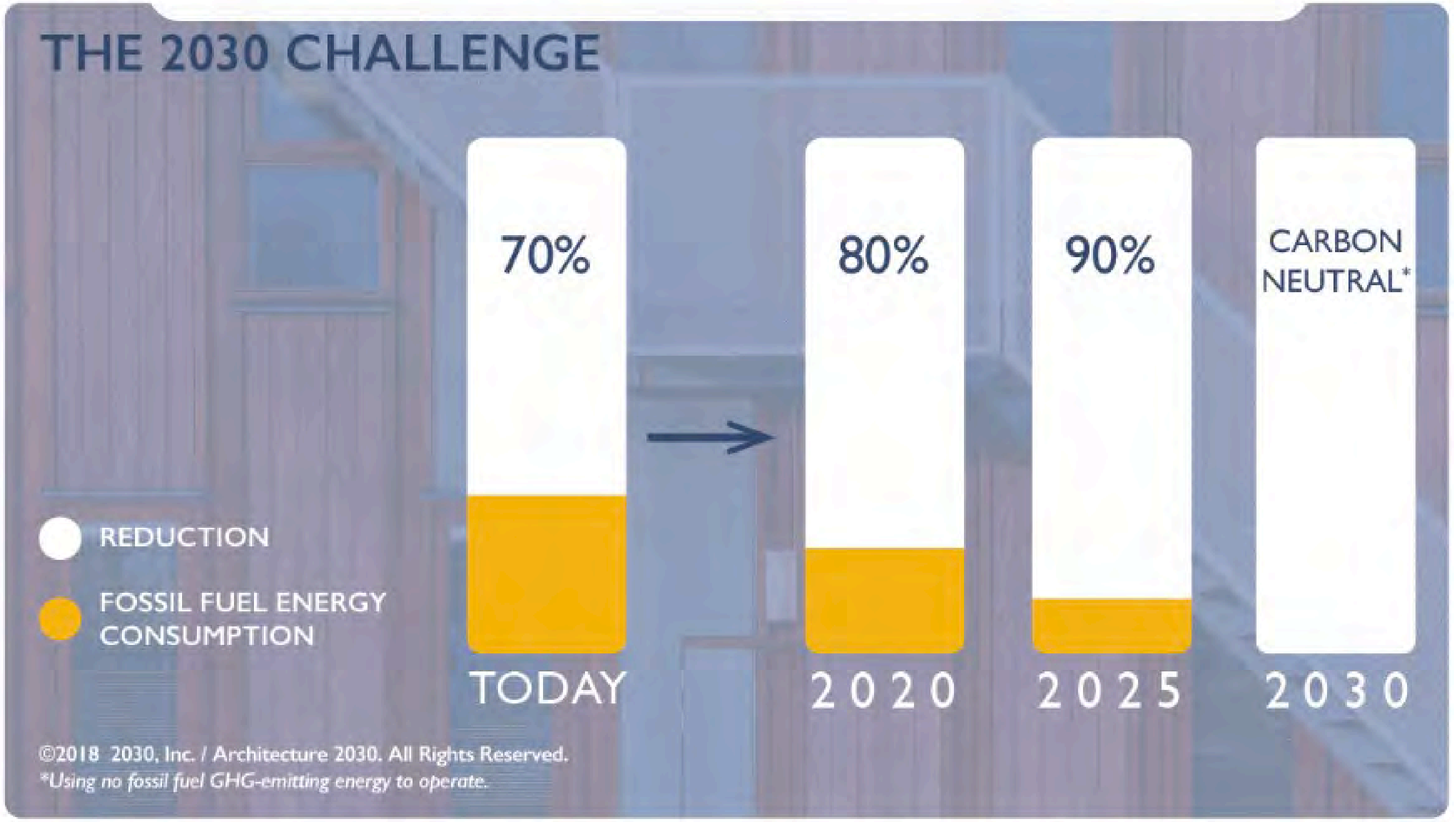

National Community Renaissance becomes first developer to sign onto AIA's 2030 Commitment

Apr 16, 2019

WASHINGTON – April 16, 2019 – The American Institute of Architects (AIA) is welcoming National Community Renaissance (National CORE), one of the nation's largest nonprofit developers of affordable housing, as the first developer to sign the AIA 2030 Commitment. AIA's...

read more

Our Commitment to Sustainability…

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About Us • What We Do • News • Awards • Portfolio • Contact •

National CORE Leads U.S. in Sustainable Design

Rancho Cucamonga, Calif. – National CORE, one of the top 10 affordable housing developers in the nation, has been named a 2024 LEED for Homes Power Builder by the U.S. Green Building Council (USGBC) for the sixth consecutive year. This recognition places National CORE in an elite group of just five builders, and it remains the only nonprofit to achieve this prestigious ranking consistently.

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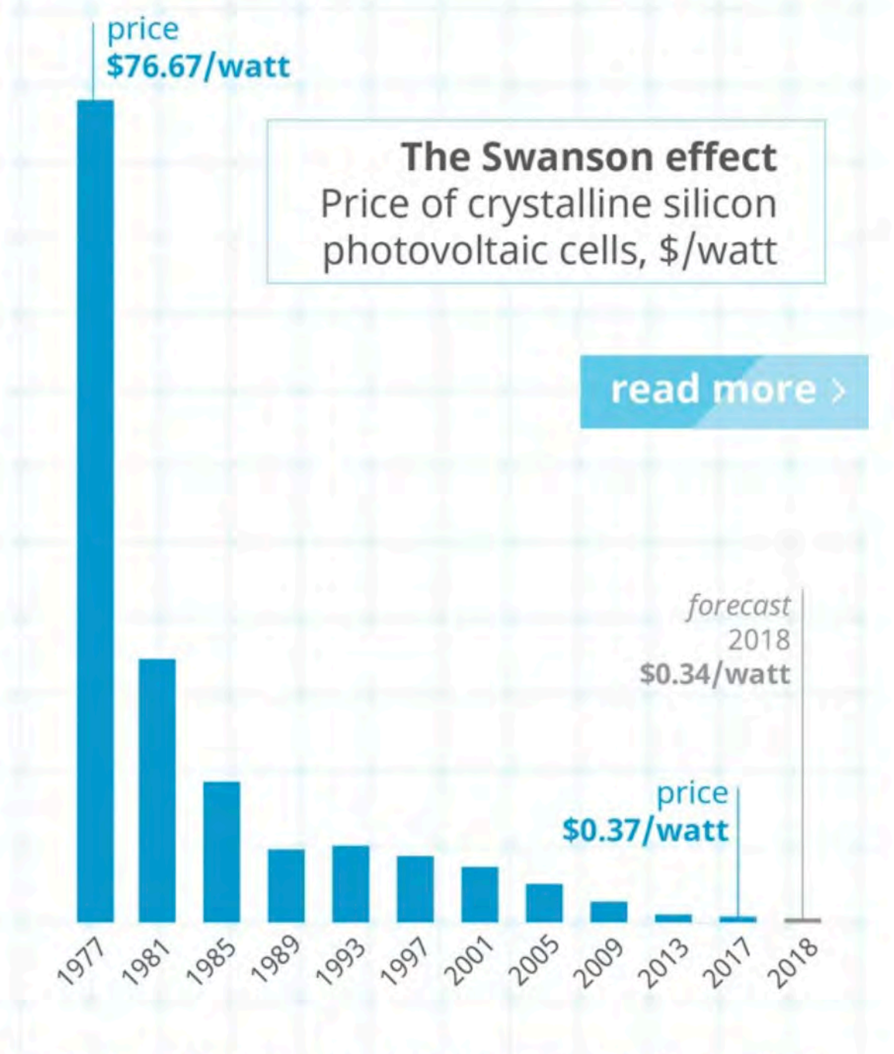
National CORE awarded Power Builder distinction by U.S. Green Building Council's 2018 LEED Homes Awards

Jun 20, 2019

Annual awards honor prominent projects, developers, and builders in residential sustainability Rancho Cucamonga, Calif. – June 20, 2019 – National Community Renaissance (National CORE) has been named a Power Builder by the U.S. Green Building Council (USGBC) as a part...

read more

Energy Efficiency + Renewables – Why is this important now?



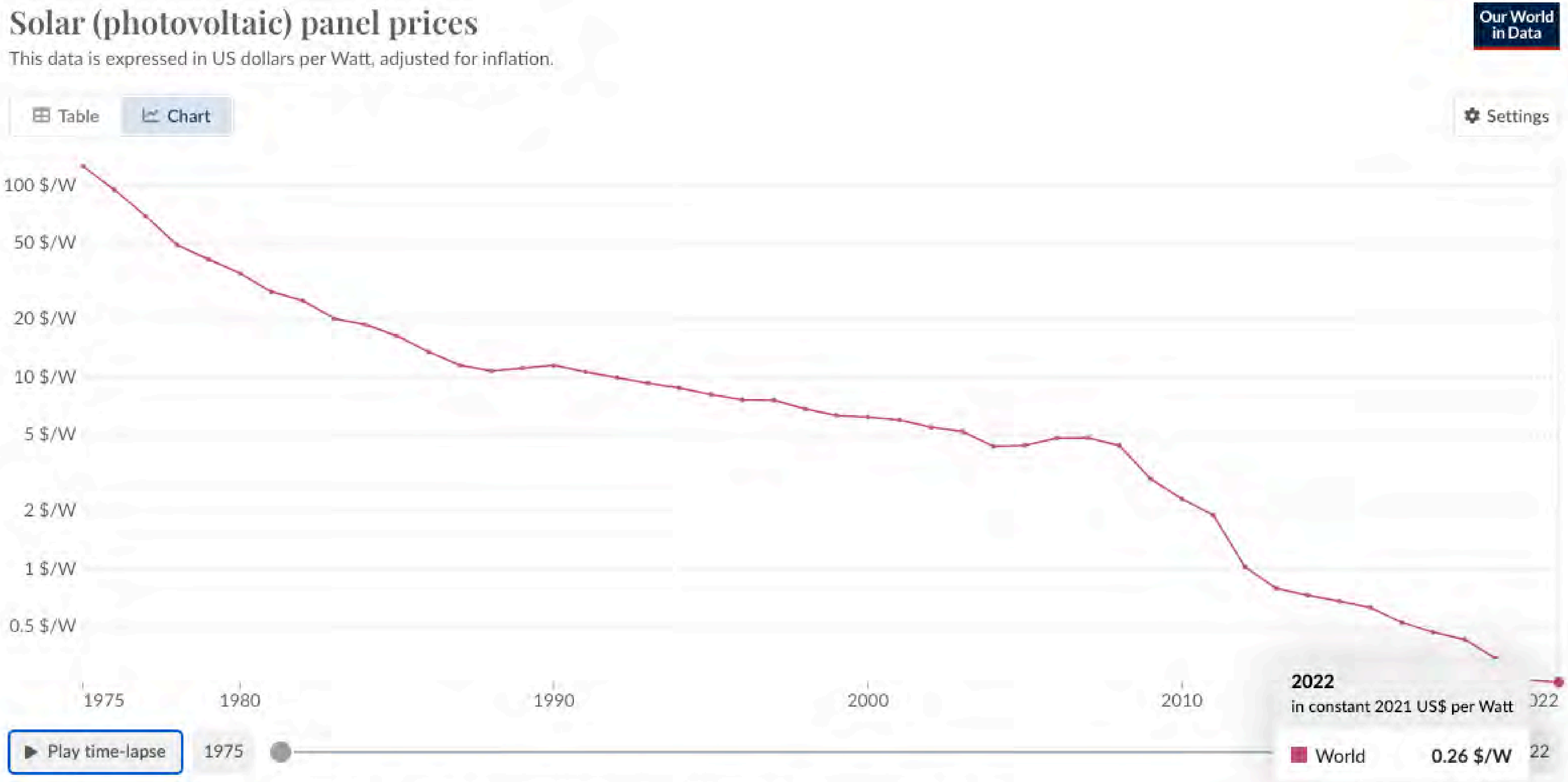
https://cleantechnica.com/2014/02/04/current-cost-solar-panels/

The Dropping Cost of PV

1. These are real savings
2. We see this playing out on every project.
3. Affordable housing developers must take advantage of this (there is too much at stake not to)
4. National CORE is way way ahead of the curve on this

Solar (photovoltaic) panel prices

This data is expressed in US dollars per Watt, adjusted for inflation.



Data source: International Renewable Energy Agency (2023); Nemet (2009); Farmer and Lafond (2016) – Learn more about this data

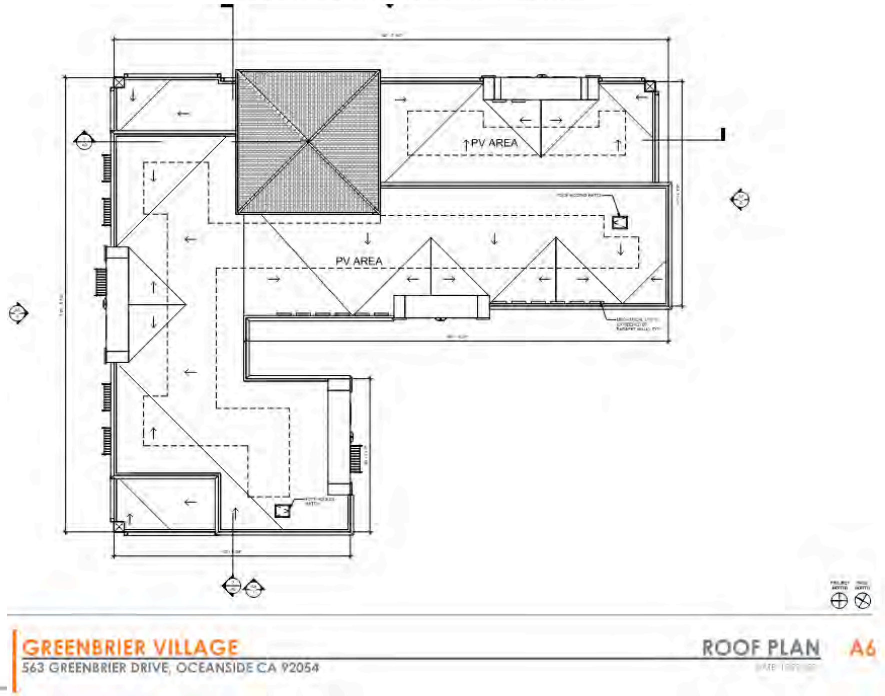
Note: Data is expressed in constant 2022 US$ per Watt.

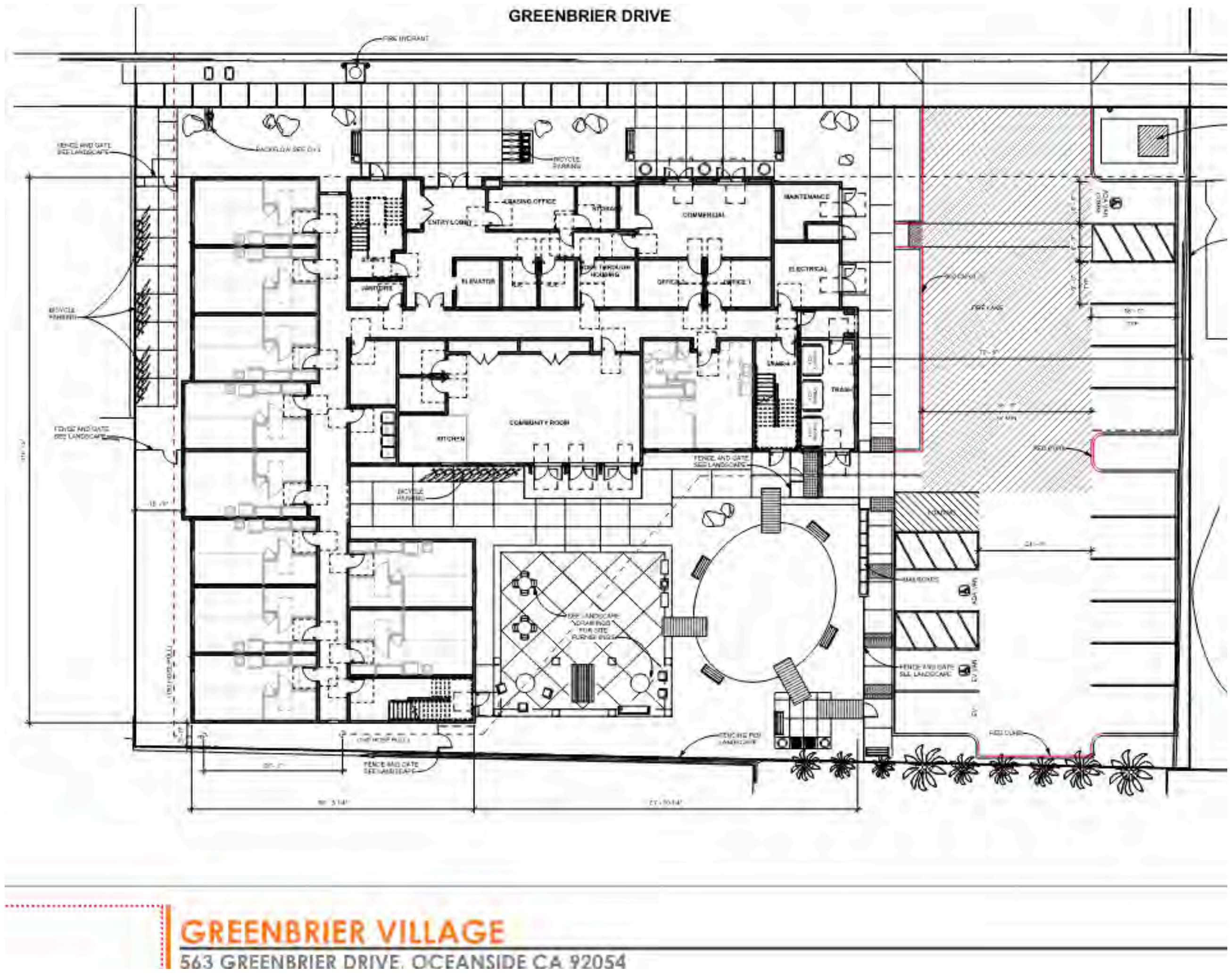
OurWorldInData.org/energy | CC BY

Download Share Enter full-screen

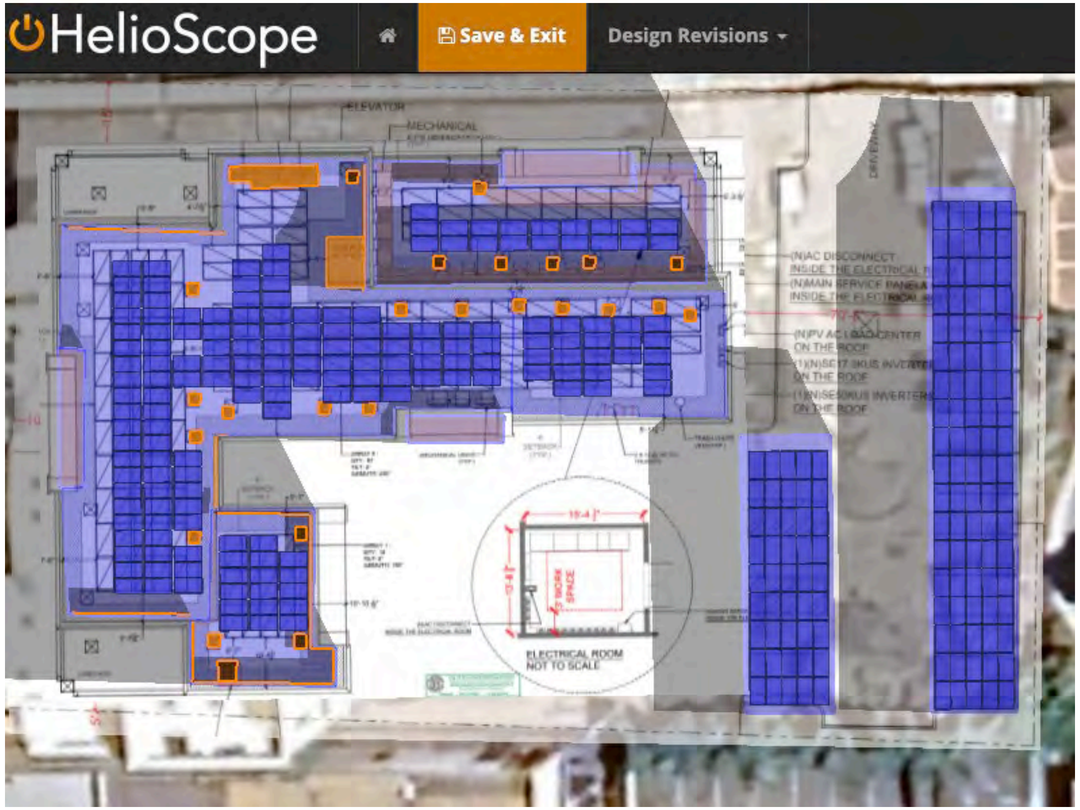
GREENBRIER VILLAGE

563 GREENBRIER DRIVE, OCEANSIDE CA 92054





SOMAH



HelioScope
Save & Exit
Design Revisions
ELEVATOR
MECHANICAL
DRIVEWAY
ELECTRICAL ROOM
NOT TO SCALE

Energy Toolbase – Run the Report…

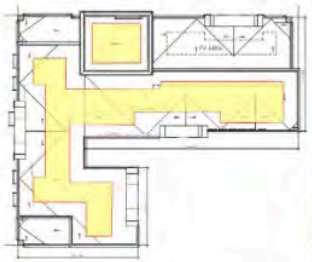
Economic Analysis for Greenbrier

ENERGY TOOLBASE™

NATIONAL CORE

Prepared For
Randy Slabers, NCORE
909-244-3444
rslabers@nationalcore.org

Greenbrier Village - Rooftop PV



The Energy Toolbase provides comprehensive cost analysis for commercial, municipal, and residential renewable energy projects. We provide the tools that professionals need to compete in the fast paced renewable energy market by leveraging our first

Prepared By
Tim Kohut, AIA, CEA
310-869-9706
tkohut@nationalcore.org

1/6/22

Important Economic Info

1 Project Summary

Payment Options	Cash Purchase
IRR - 10 Year	18.4%
IRR - 20 Year	22.6%
IRR - Term	23.1%
LCOE Before	$0.719 /kWh
LCOE After	$0.334 /kWh
LCOE PV Generation	$0.079 /kWh
Net Present Value	$807,424
Payback Period	4.6 Years
ROI	766.7%
Total Payments	$297,998
Total Incentives	$39,780
Net Payments	$258,218
Electric Bill Savings - Year 1	$54,314
Electric Bill Savings - Term	$2,238,081
Blended Savings per kWh from PV	$0.437 /kWh
Total Project Costs	$297,998
Upfront Payment	$297,998

Combined Solar PV Rating
Power Rating: 81,000 W-DC
Power Rating: 72,363 W-AC-CEC

Energy Toolbase – Run the Report…

Economic Analysis for Greenbrier

ENERGY TOOLBASE™

Prepared For
Randy Slabers, NCORE
909-244-3444
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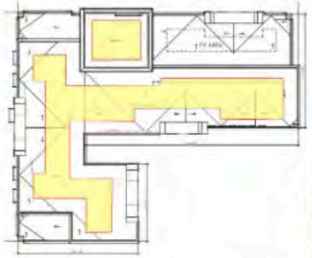
NATIONAL CORE

Greenbrier Village - Rooftop PV



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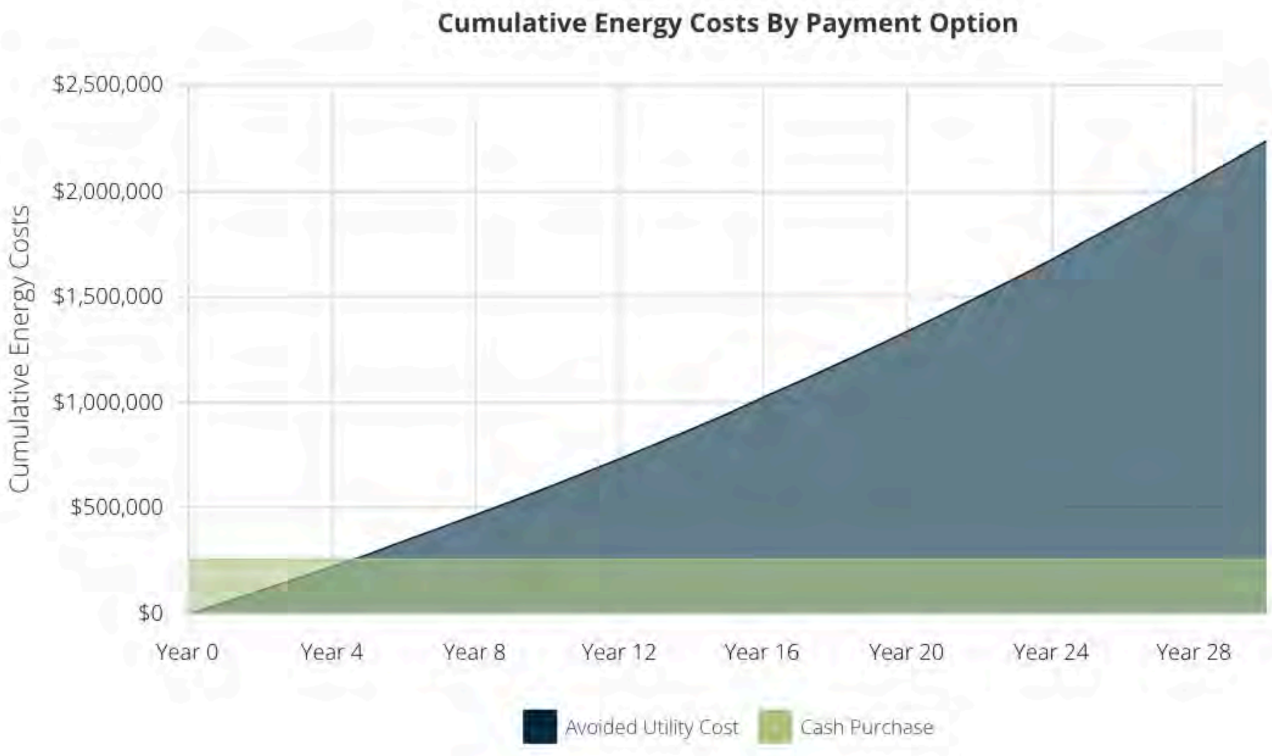
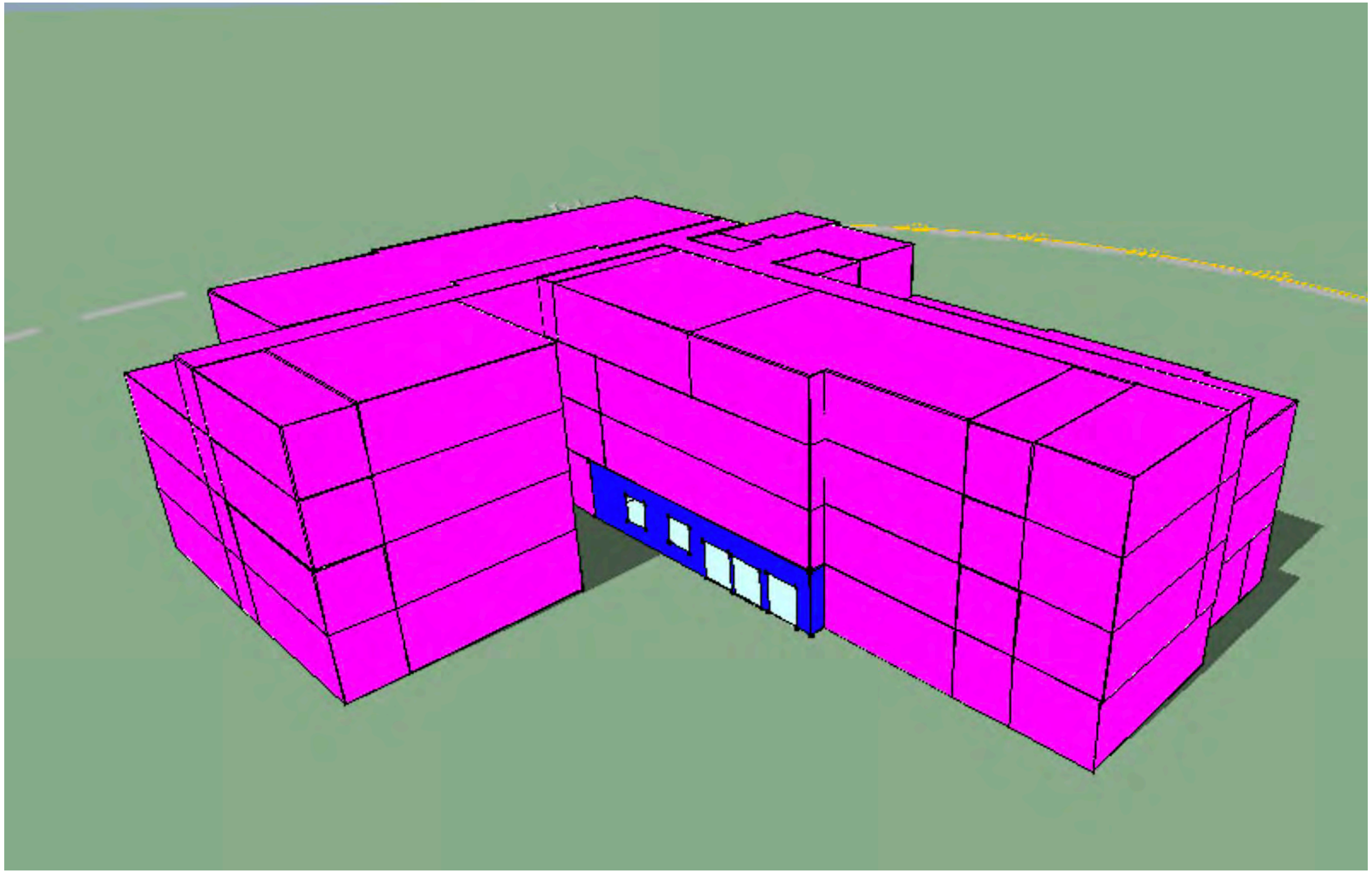
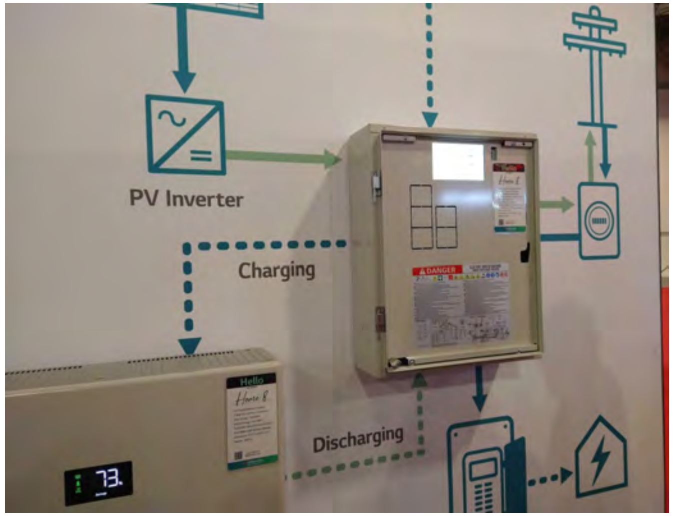





PV Inverter
Charging
Discharging

Critical Load

Energy Sources and Meters

	No	Name	CO2 Emission Factor (kgCO2/kWh)	Source/Primar Factor (kWh
☐	0	Natural Gas	0.180100	1.090000
☐	1	LPG	0.214000	1.150000
☐	2	Biogas	0.025000	1.100000
☐	3	Oil	0.247100	1.190000
☐	4	Coal	0.315800	1.050000
☐	5	Biomass	0.317100	1.100000
☑	6	Electricity	0.617500	3.150000
☐	7	Waste Heat	0.018000	1.100000
☐	8	Anthracite	0.350100	1.050000
☐	9	Smokeless Fuel (inc Coke)	0.345000	1.100000
☐	10	Dual Fuel Appliances (Minera...	0.187000	1.100000
☐	11	Grid Displaced Electricity	0.617500	3.150000
☐	12	Grid Displaced Electricity PV	0.617500	3.150000
☐	13	House Meter - Elevator	0.617500	1.100000

☐ Derive default location from ApLocate

Region: USA Grid Territory: National Average

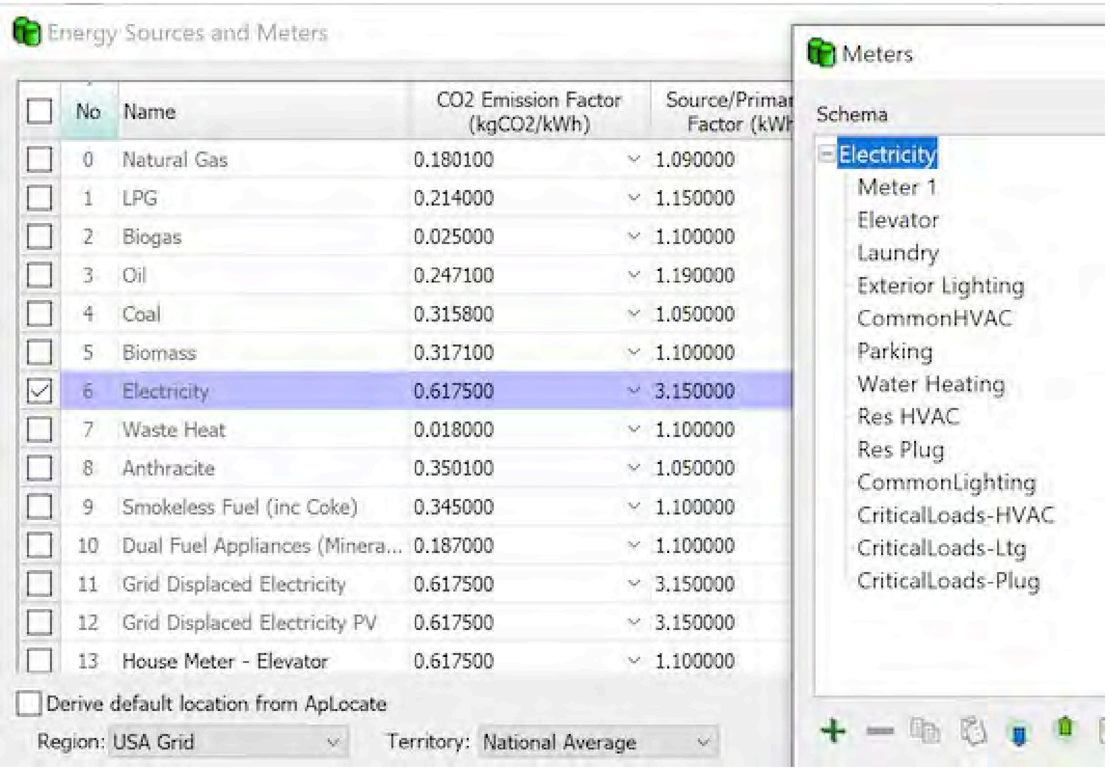
Meters

Schema

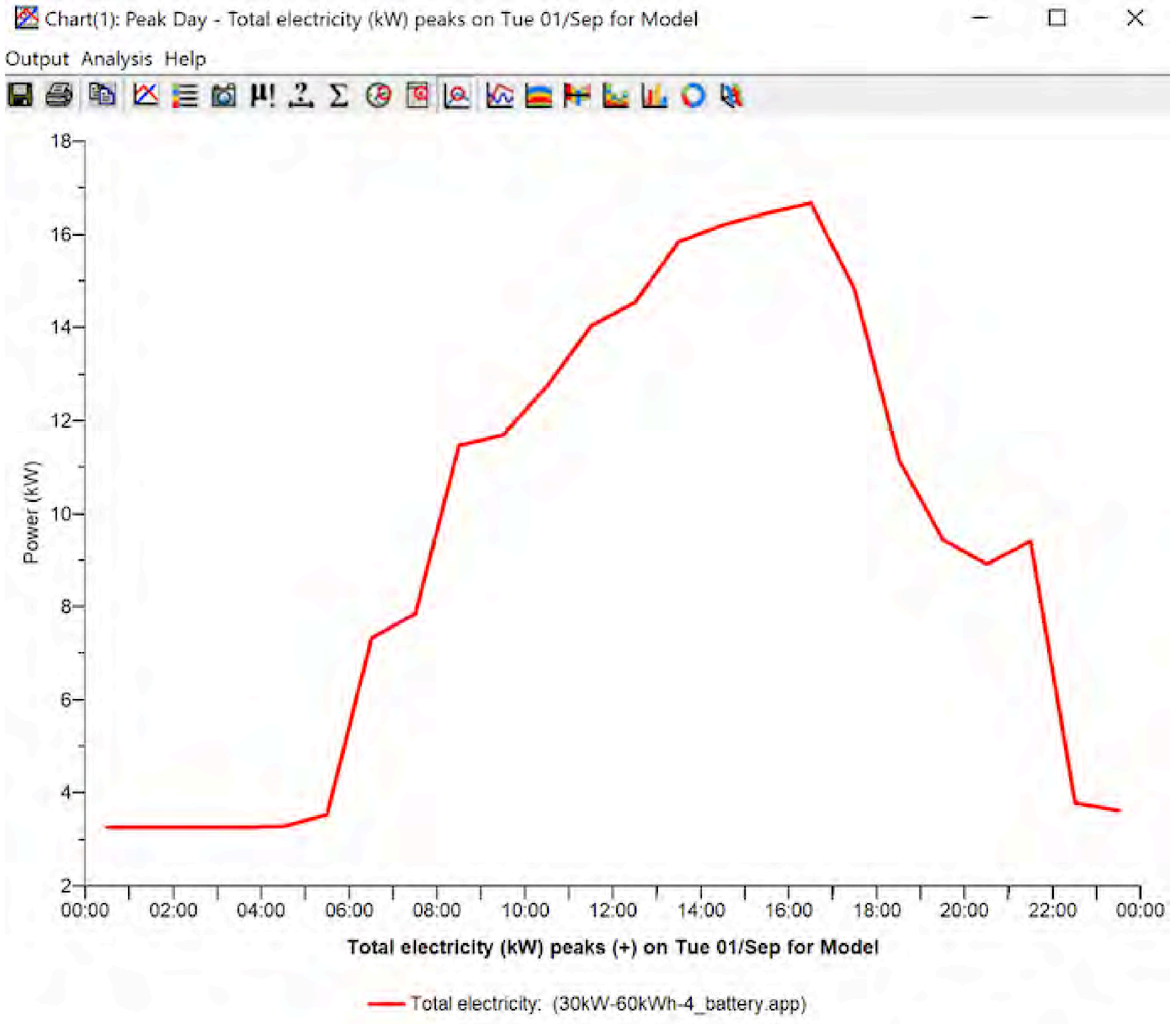
- Electricity
  - Meter 1
  - Elevator
  - Laundry
  - Exterior Lighting
  - CommonHVAC
  - Parking
  - Water Heating
  - Res HVAC
  - Res Plug
  - CommonLighting
  - CriticalLoads-HVAC
  - CriticalLoads-Ltg
  - CriticalLoads-Plug

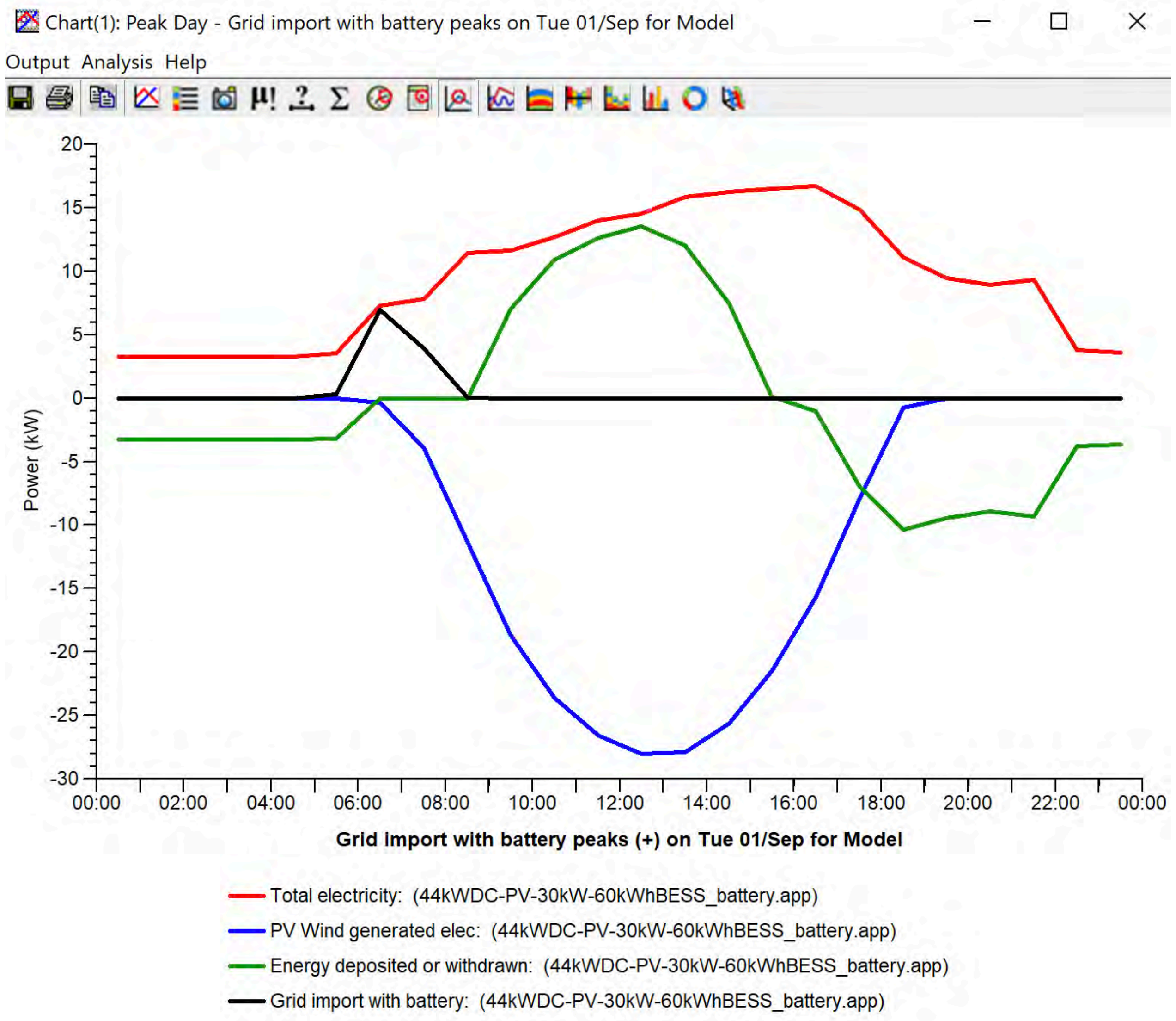
		Total electricity (kW)
Date	Time	30kW-60kWh-4_battery.app
Tue, 01/Sep	00:30	3.2613
	01:30	3.2613
	02:30	3.2613
	03:30	3.2613
	04:30	3.2768
	05:30	3.5401
	06:30	7.3413
	07:30	7.8616
	08:30	11.4729
	09:30	11.6933
	10:30	12.7546
	11:30	14.0335
	12:30	14.5404
	13:30	15.8460
	14:30	16.2067
	15:30	16.4686
	16:30	16.6838
	17:30	14.8270
	18:30	11.1562
	19:30	9.4414
	20:30	8.9329
	21:30	9.4155
	22:30	3.7950
	23:30	3.6257

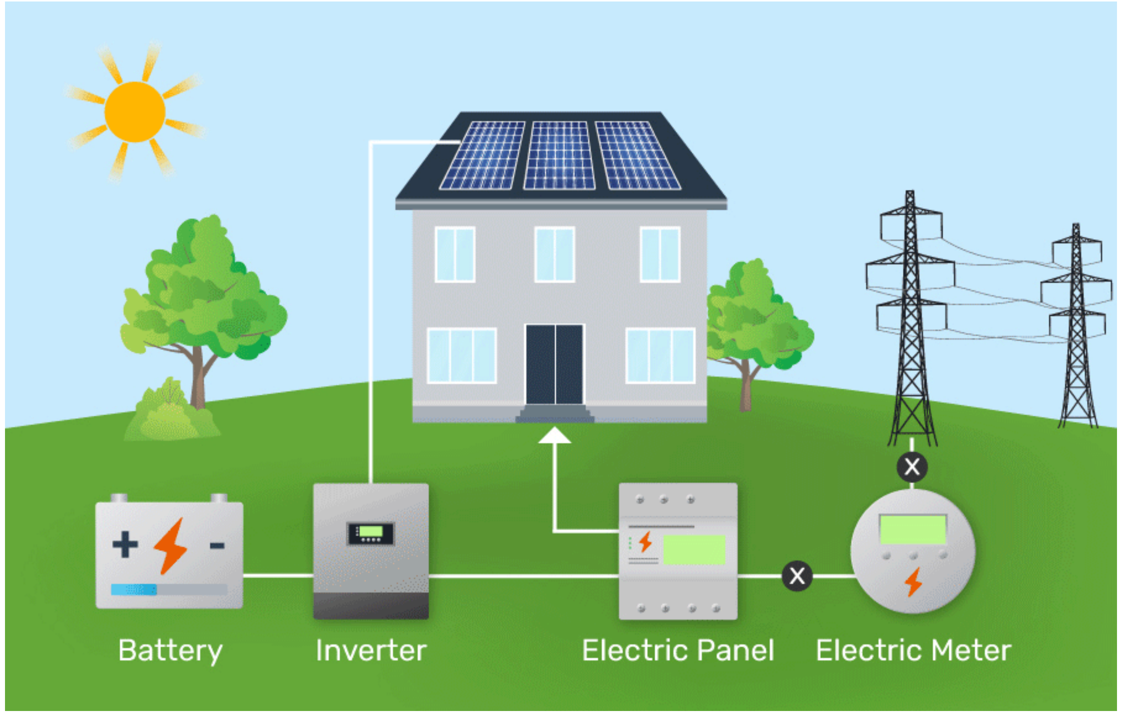
Critical Load



	No	Name	CO2 Emission Factor (kgCO2/kWh)	Source/Primary Factor (kWh
☐	0	Natural Gas	0.180100	1.090000
☐	1	LPG	0.214000	1.150000
☐	2	Biogas	0.025000	1.100000
☐	3	Oil	0.247100	1.190000
☐	4	Coal	0.315800	1.050000
☐	5	Biomass	0.317100	1.100000
☑	6	Electricity	0.617500	3.150000
☐	7	Waste Heat	0.018000	1.100000
☐	8	Anthracite	0.350100	1.050000
☐	9	Smokeless Fuel (inc Coke)	0.345000	1.100000
☐	10	Dual Fuel Appliances (Minera...	0.187000	1.100000
☐	11	Grid Displaced Electricity	0.617500	3.150000
☐	12	Grid Displaced Electricity PV	0.617500	3.150000
☐	13	House Meter - Elevator	0.617500	1.100000

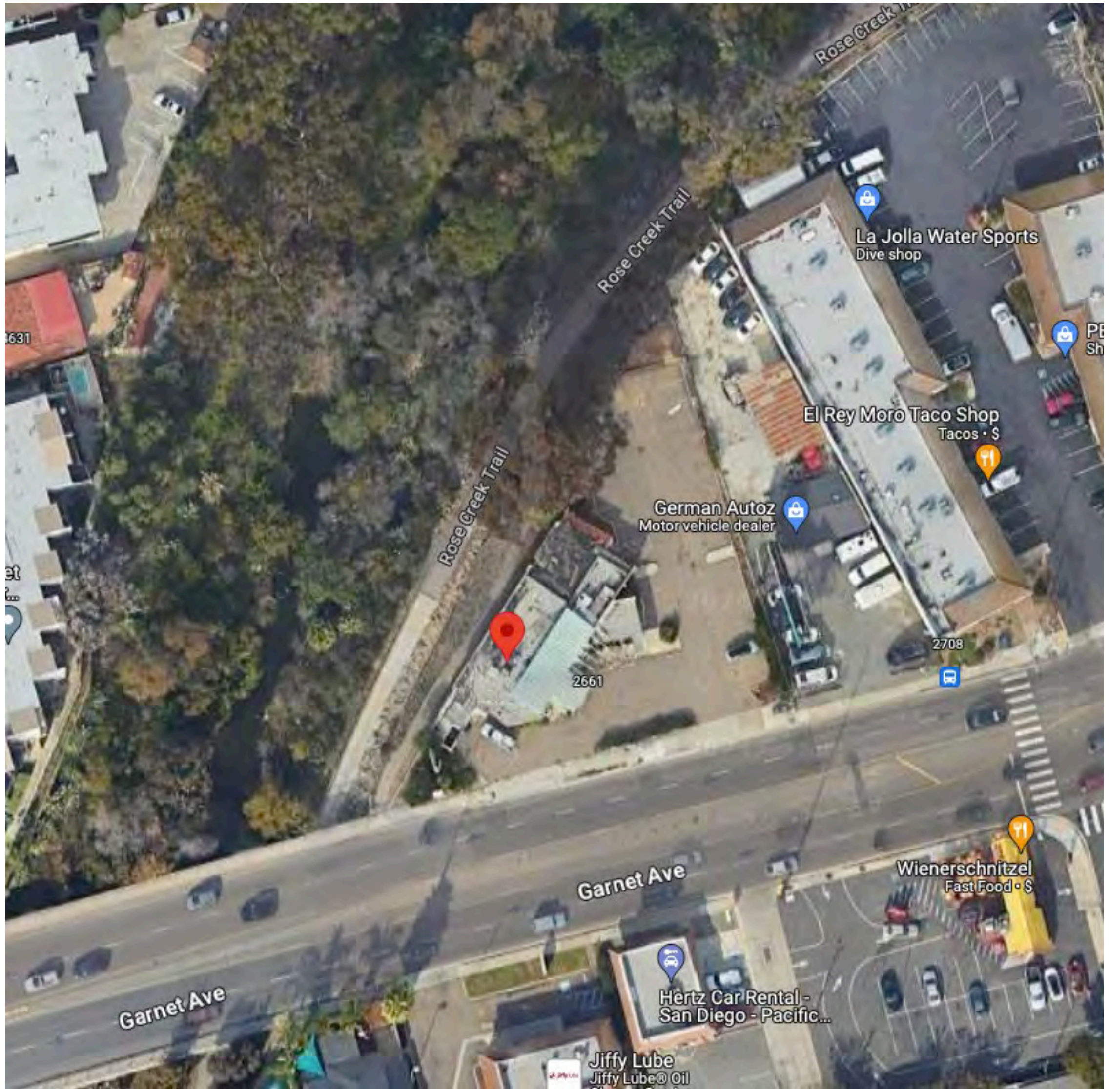


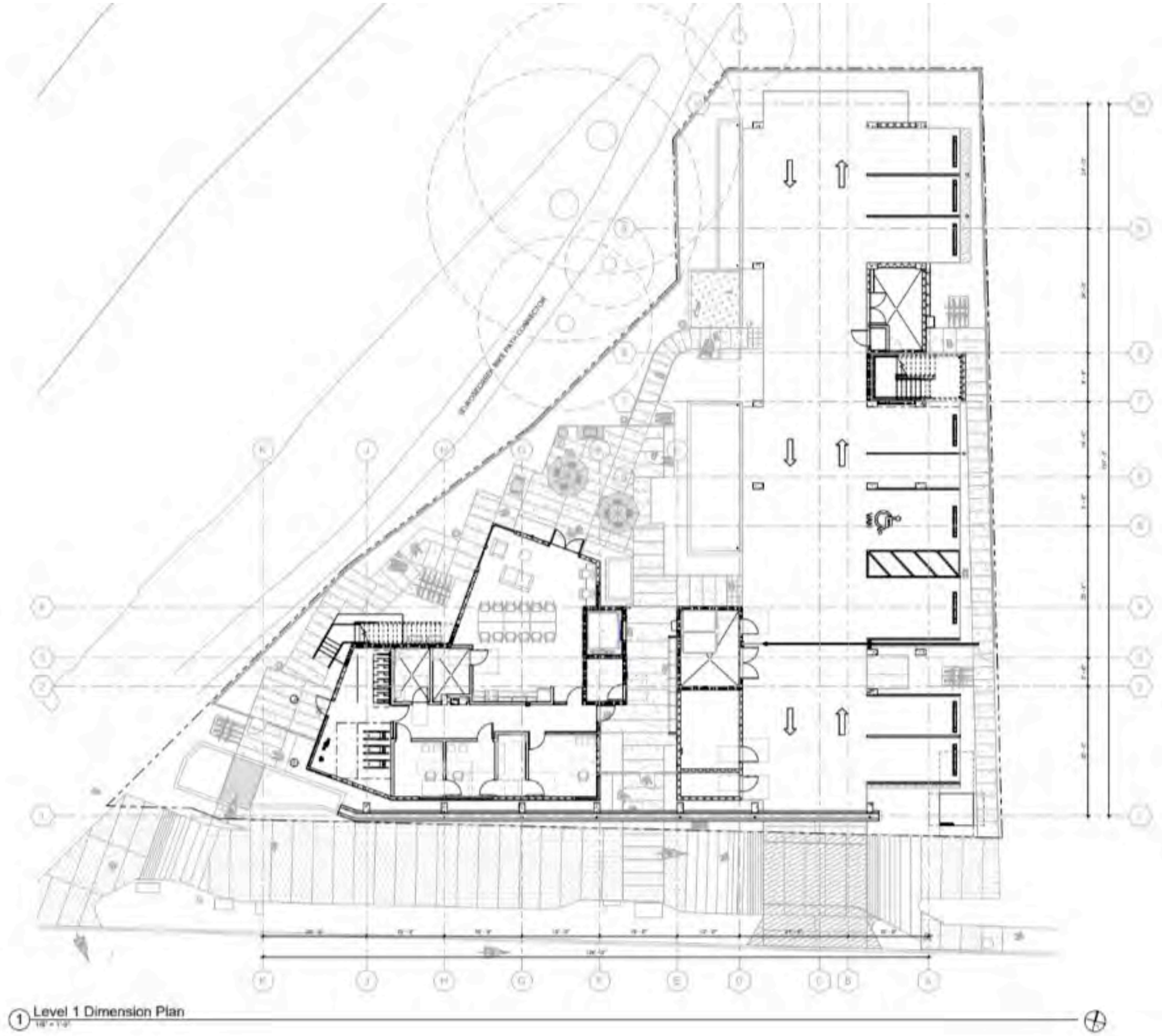

Chart(1): Peak Day - Grid import with battery peaks on Tue 01/Sep for Model
Output Analysis Help
Power (kW)
20
15
10
5
0
-5
-10
-15
-20
-25
-30
00:00
02:00
04:00
06:00
08:00
10:00
12:00
14:00
16:00
18:00
20:00
22:00
00:00
Grid import with battery peaks (+) on Tue 01/Sep for Model
Total electricity: (44kWDC-PV-30kW-60kWhBESS_battery.app)
PV Wind generated elec: (44kWDC-PV-30kW-60kWhBESS_battery.app)
Energy deposited or withdrawn: (44kWDC-PV-30kW-60kWhBESS_battery.app)
Grid import with battery: (44kWDC-PV-30kW-60kWhBESS_battery.app)

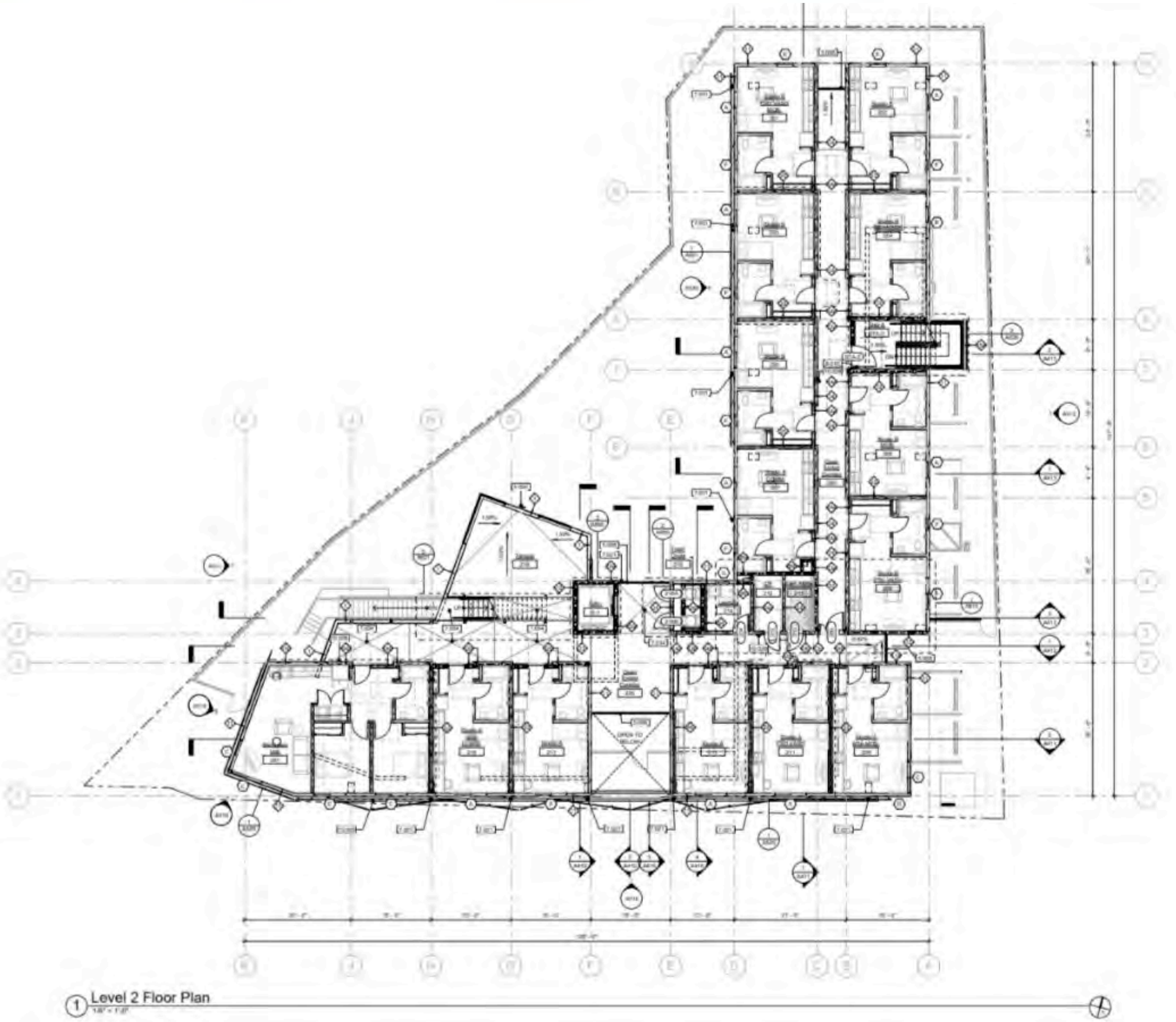

Battery
Inverter
Electric Panel
Electric Meter

When energy and economics converge – next steps…

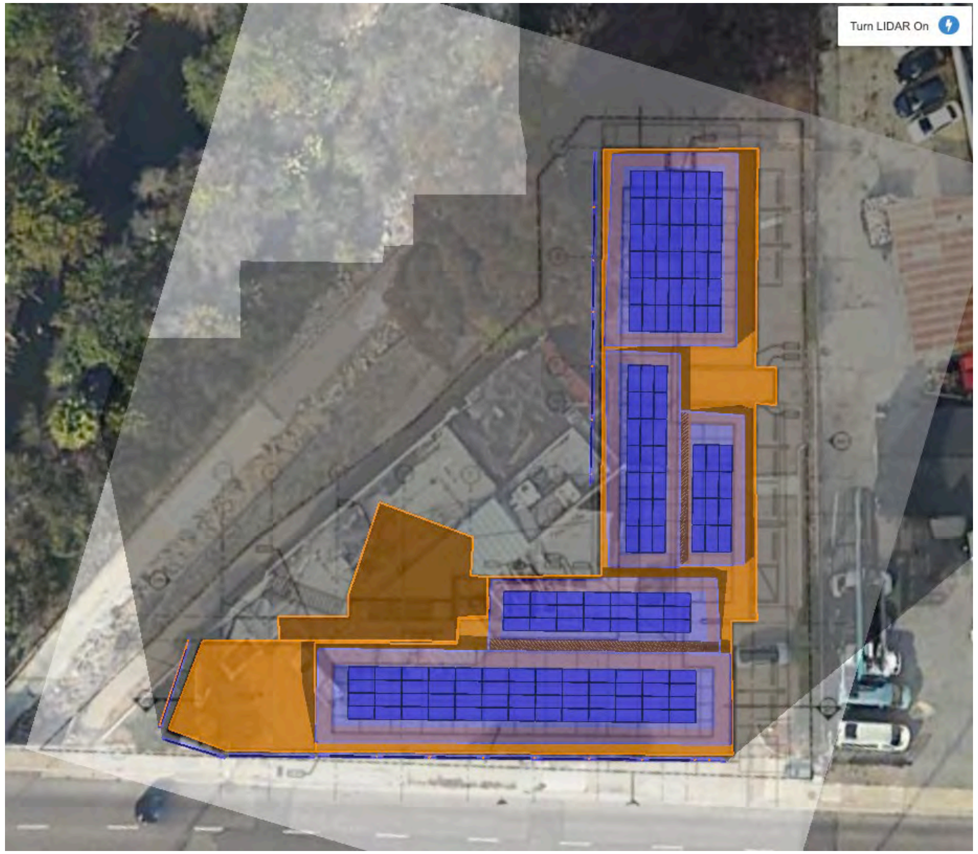
Rose Creek Village, San Diego, CA

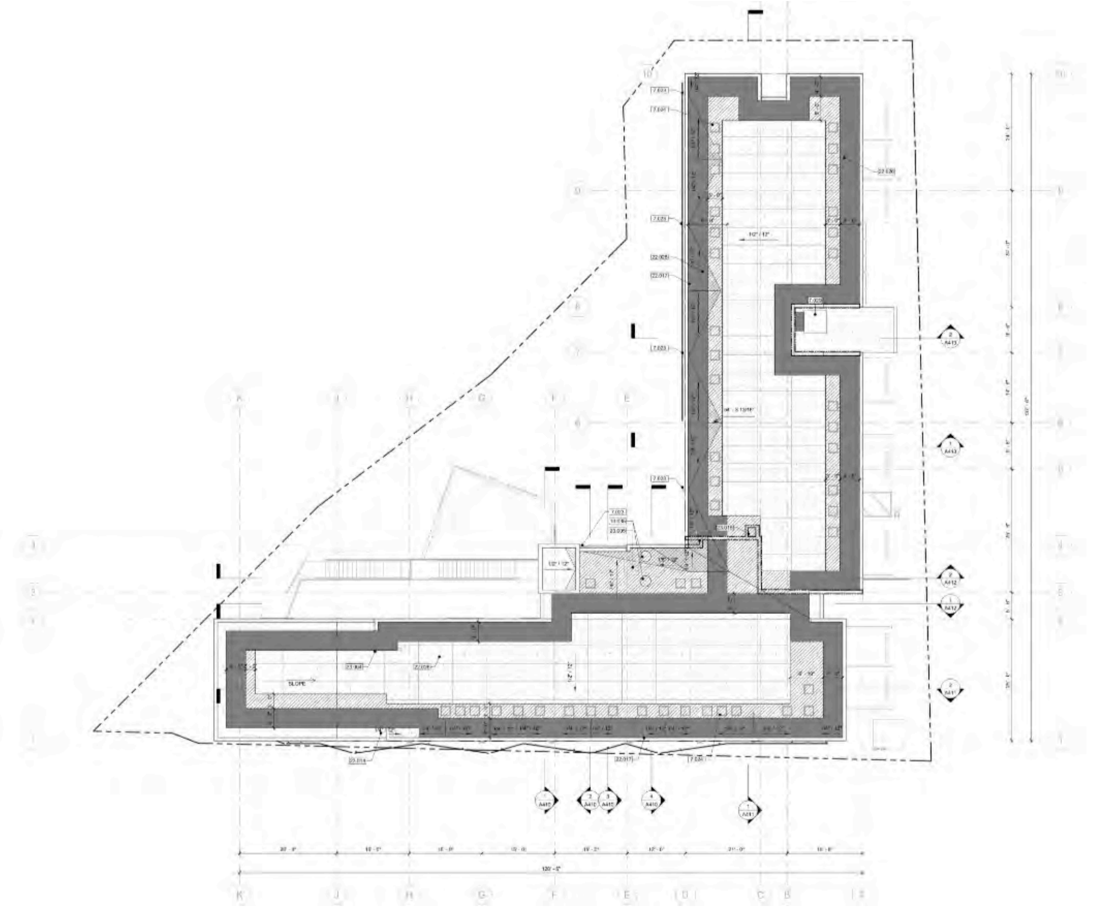




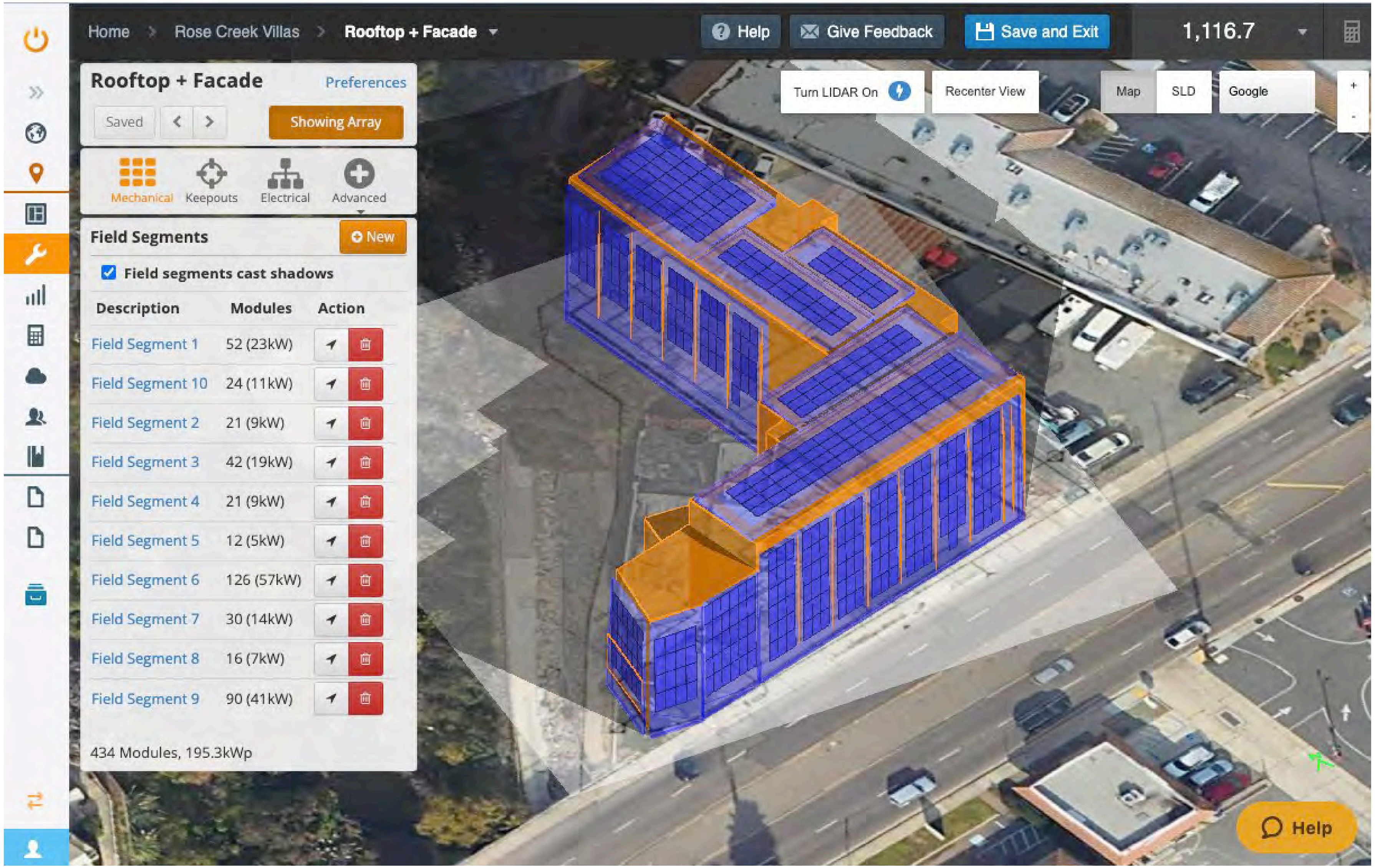

1 Level 2 Floor Plan


1 Level 4 Floor Plan


Turn LIDAR On



Rose Creek Village, San Diego, CA



CØREvolution

Rose Creek Village, San Diego, CA

2 Solar Elevation - Southwest A
1/8" = 1'-0"

1 Solar Elevation - South
1/8" = 1'-0"

4 Solar Elevation - West
1/8" = 1'-0"

3 Solar Elevation - Southwest B
1/8" = 1'-0"

2.1.1 PV System Details

General Information

Facility: Whole Building
Address: 2662 Garnet Ave San Diego CA 92109

Solar PV Equipment Description

Solar Panels: (434) Phono Solar PS450M4H-24/TH (1500V)
Inverters: (7) SMA Sunny Tripower 24000TL-US

Solar PV Equipment Typical Lifespan

Solar Panels: Greater than 30 Years
Inverters: 15 Years

Solar PV System Cost and Incentives	
Solar PV System Cost	$781,200
Net Solar PV System Cost	**$781,200**

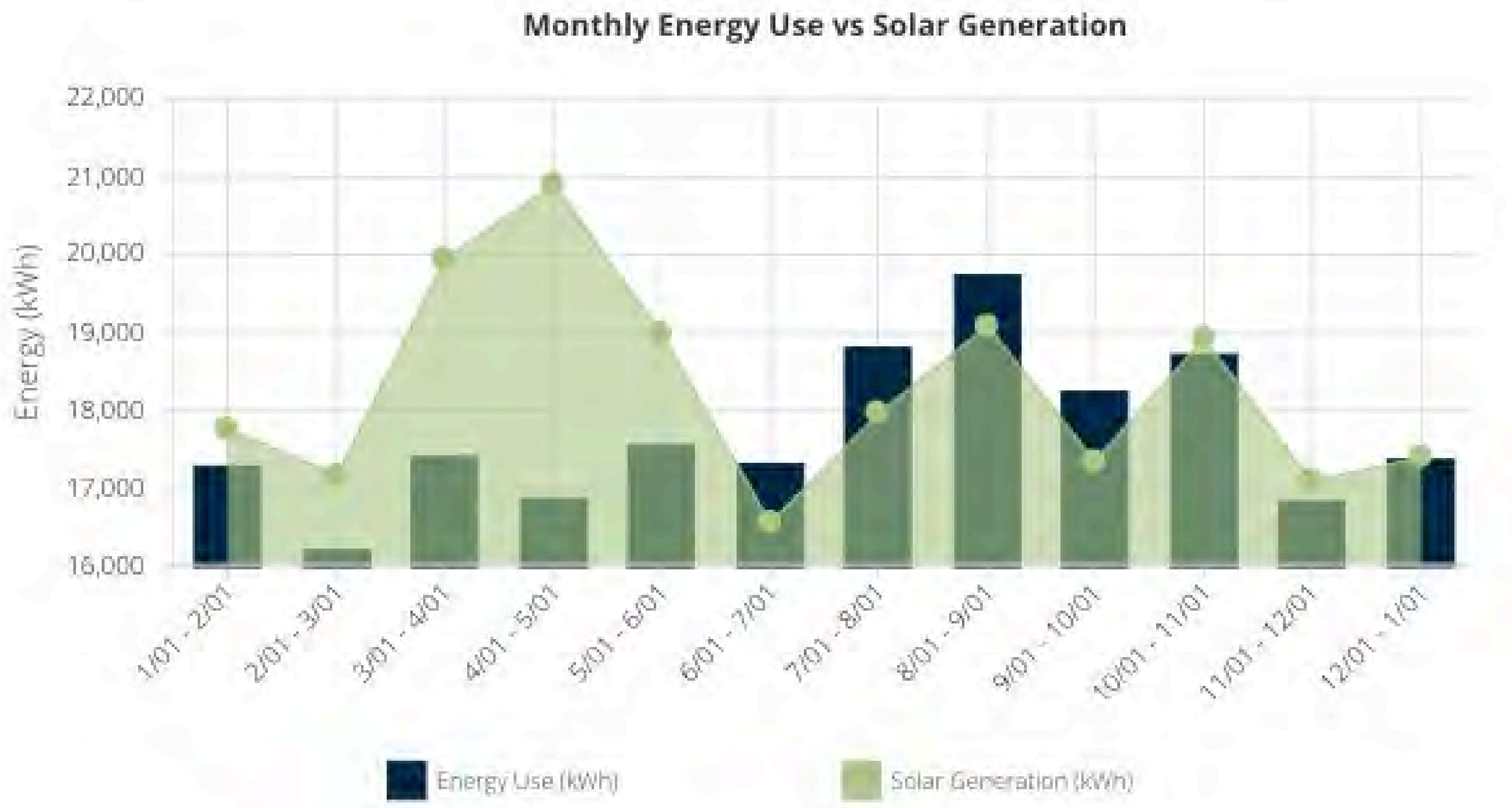
Solar PV System Rating

Power Rating: 195,300 W-DC
Power Rating: 170,118 W-AC-CEC

Energy Consumption Mix

Annual Energy Use: 212,316 kWh

Utility 6,838 kWh (0.00%)
Solar PV 219,154 kWh (100.00%)


Monthly Energy Use vs Solar Generation
Energy (kWh)
22,000
21,000
20,000
19,000
18,000
17,000
16,000
1/01 - 2/01
2/01 - 3/01
3/01 - 4/01
4/01 - 5/01
5/01 - 6/01
6/01 - 7/01
7/01 - 8/01
8/01 - 9/01
9/01 - 10/01
10/01 - 11/01
11/01 - 12/01
12/01 - 1/01
Energy Use (kWh)
Solar Generation (kWh)

2.1.4 Current Electric Bill

The table below shows your annual electricity costs based on the most current utility rates and your previous 12 months of electrical usage.

Rate Schedule: SDG&E - TOU-DR1

Time Periods	Energy Use (kWh)			Charges		
Bill Ranges & Seasons	On Peak	Off Peak	Super Off Peak	NBC	Energy	Total
1/1/2021 - 2/1/2021 W1	4,319	8,583	4,367	$592	$9,718	$10,310
2/1/2021 - 3/1/2021 W1	4,050	8,274	3,880	$556	$9,126	$9,681
3/1/2021 - 4/1/2021 W2	4,701	6,609	6,089	$597	$9,779	$10,376
4/1/2021 - 5/1/2021 W2	4,564	6,393	5,903	$578	$9,477	$10,055
5/1/2021 - 6/1/2021 W3	4,804	8,857	3,894	$602	$9,931	$10,533
6/1/2021 - 7/1/2021 S1	4,793	9,137	3,373	$593	$9,880	$10,473
7/1/2021 - 8/1/2021 S1	5,242	9,841	3,736	$645	$10,746	$11,391
8/1/2021 - 9/1/2021 S1	5,494	10,337	3,909	$677	$11,274	$11,951
9/1/2021 - 10/1/2021 S1	5,036	9,651	3,564	$626	$10,416	$11,042
10/1/2021 - 11/1/2021 S1	5,121	9,506	4,074	$641	$10,586	$11,227
11/1/2021 - 12/1/2021 W1	4,412	8,938	3,485	$577	$9,512	$10,089
12/1/2021 - 1/1/2022 W1	4,379	9,146	3,856	$596	$9,798	$10,394
Total	56,915	105,272	50,130	$7,280	$120,242	$127,522

2.1.4 Current Electric Bill

The table below shows your annual electricity costs based on the most current utility rates and your previous 12 months of electrical usage.

Rate Schedule: SDG&E - TOU-DR1

Time Periods
Bill Ranges & Seasons
1/1/2021 - 2/1/2021 W1
2/1/2021 - 3/1/2021 W1
3/1/2021 - 4/1/2021 W2
4/1/2021 - 5/1/2021 W2
5/1/2021 - 6/1/2021 W3
6/1/2021 - 7/1/2021 S1
7/1/2021 - 8/1/2021 S1
8/1/2021 - 9/1/2021 S1
9/1/2021 - 10/1/2021 S1
10/1/2021 - 11/1/2021 S1
11/1/2021 - 12/1/2021 W1
12/1/2021 - 1/1/2022 W1
Total

$677	$11,274	$11,951
$626	$10,416	$11,042
$641	$10,586	$11,227
$577	$9,512	$10,089
$596	$9,798	$10,394
$7,280	$120,242	$127,522

2.1.5 New Electric Bill

Rate Schedule: SDG&E - TOU-DR1

Time Periods	Energy Use (kWh)			Charges		
Bill Ranges & Seasons	On Peak	Off Peak	Super Off Peak	NBC	Energy	Total
1/1/2021 - 2/1/2021 W1	3,577	-3,769	-308	$306	$99	$405
2/1/2021 - 3/1/2021 W1	3,030	-4,001	4	$278	$219	$60
3/1/2021 - 4/1/2021 W2	1,891	-258	-4,171	$269	$1,071	$803
4/1/2021 - 5/1/2021 W2	725	-473	-4,295	$235	$2,001	$1,766
5/1/2021 - 6/1/2021 W3	935	-2,589	217	$248	$666	$418
6/1/2021 - 7/1/2021 S1	1,218	-1,236	758	$253	$609	$862
7/1/2021 - 8/1/2021 S1	1,201	-1,104	765	$268	$664	$932
8/1/2021 - 9/1/2021 S1	1,668	-1,826	811	$294	$703	$997
9/1/2021 - 10/1/2021 S1	2,221	-1,518	191	$285	$1,121	$1,405
10/1/2021 - 11/1/2021 S1	3,004	-3,773	548	$307	$814	$1,121
11/1/2021 - 12/1/2021 W1	3,743	-3,910	-94	$287	$226	$513
12/1/2021 - 1/1/2022 W1	3,945	-3,794	-171	$308	$349	$657
Total	27,158	-28,251	-5,745	$3,338	$628	$3,966

Annual Electricity Savings: $123,557

2.1.5 New Electric Bill

Rate Schedule: SDG&E - TOU-DR1

Time Periods	Energy Use (kWh)			Charges		
Bill Ranges & Seasons	On Peak	Off Peak	Super Off Peak	NBC	Energy	Total
1/1/2021 - 2/1/2021 W1	3,577	-3,769	-308	$306	$99	$405
2/1/2021 - 3/1/2021 W1	3,030	-4,001	4	$278	$219	$60
3/1/2021 - 4/1/2021 W2	1,891	-258	-4,171	$269	$1,071	$803
4/1/2021 - 5/1/2021 W2	725	-473	-4,295	$235	$2,001	$1,766
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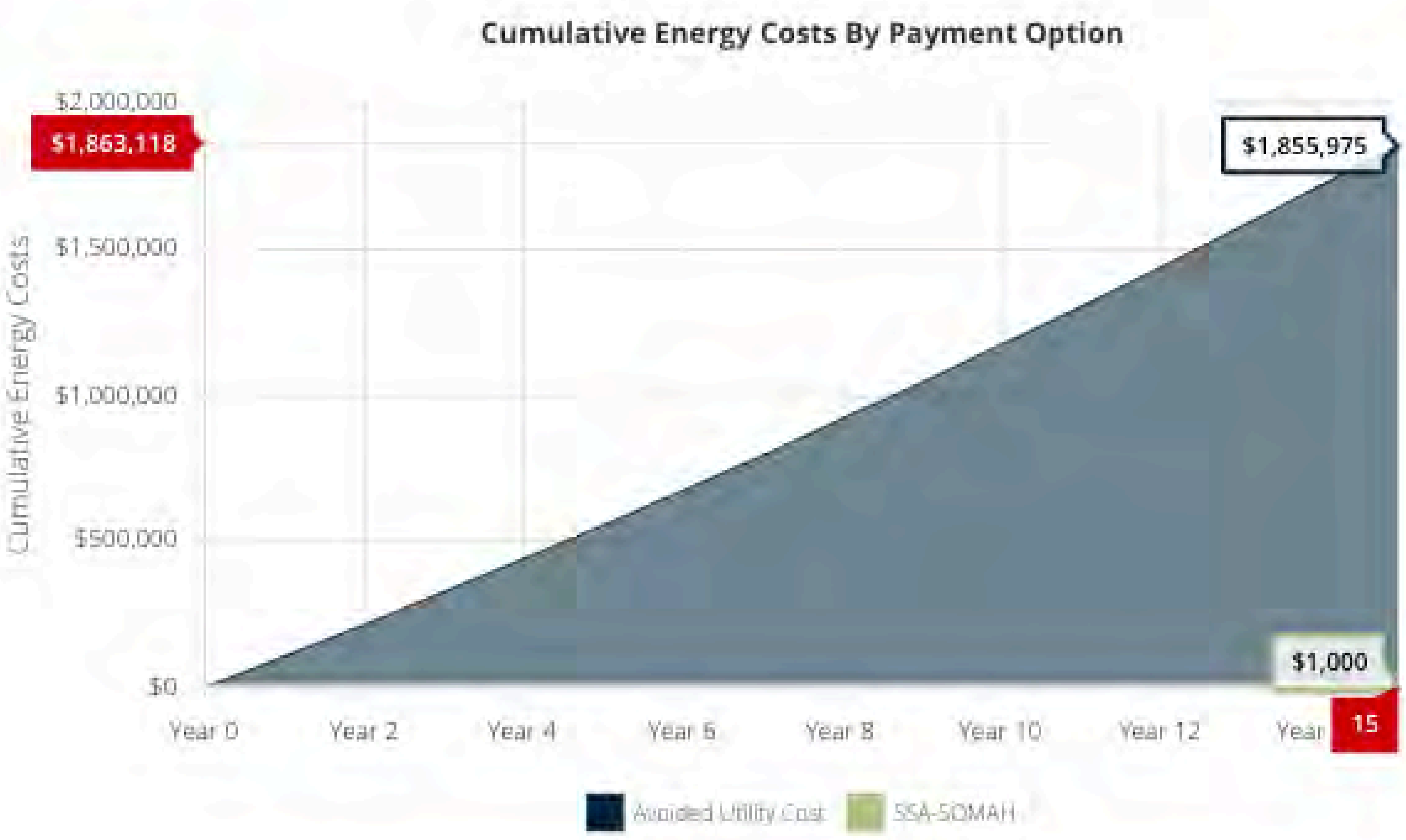
7/1/2021 - 8/1/2021 S1	1,201	-1,104	765	$268	$664	$932
8/1/2021 - 9/1/2021 S1	1,668	-1,826	811	$294	$703	$997
9/1/2021 - 10/1/2021 S1	2,221	-1,518	191	$285	$1,121	$1,405
						$1,121
						$513
						$657
						$3,966

Annual Electricity Savings: $123,557

Rose Creek Village, San Diego, CA



Rose Creek Village, San Diego, CA

HARC

HARC’s Headquarters

Certified LEED Platinum … and much more!

18,500 SF office building

$7.3 million overall project cost

13 Months from construction to move-in

High efficiency building envelope

11.52 kW rooftop solar plant

Geothermal field, high-efficiency heating and cooling

Life cycle assessment (LCA) on building materials

Ecological survey at 3.5 acre site, restorative landscaping

Sustainability Goals

- A/C - Geothermal wells
- Smaller mechanical systems; 25% of typical
- Daylight where possible; 75% of space
- Walls structured for future flexibility
- Rain screen wall/building envelope
- Low-flow, high efficiency water fixtures
- Natural habitat & bioswales hold and slowly divert rainwater
- Simple, stripped concrete floor
- Uncut carpet and ceiling tiles
- Recycled (new materials & construction waste)
- Regional materials

DAY LIGHT
FLEXIBILITY QUIET
FEWER DISTRACTIONS
COLLABORATION
SPACE NATURE
PRIVACY LIGHTING
OUTDOOR ACCESS

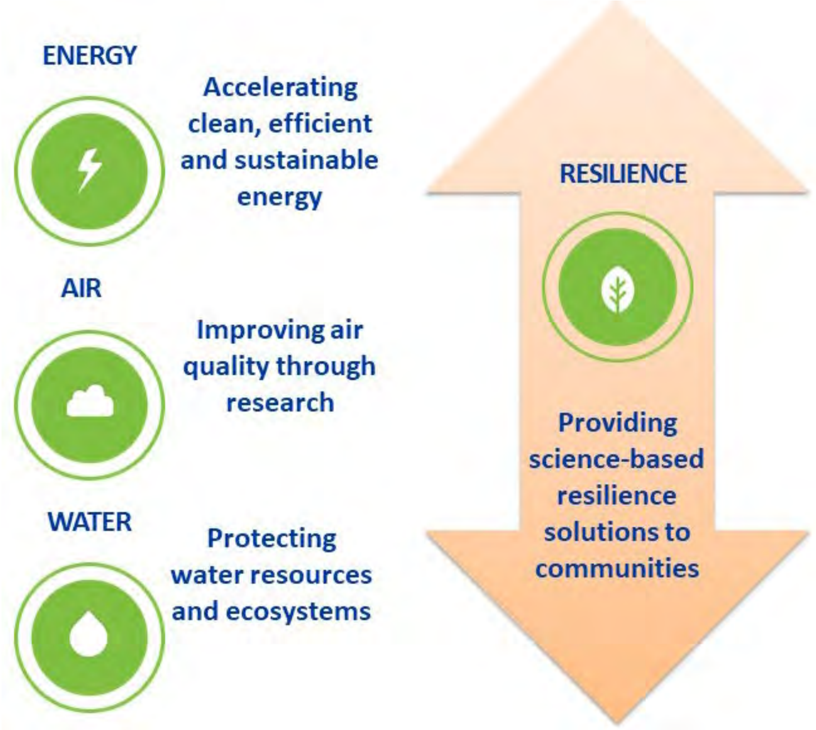

H A R C


THANK YOU,
HARC!

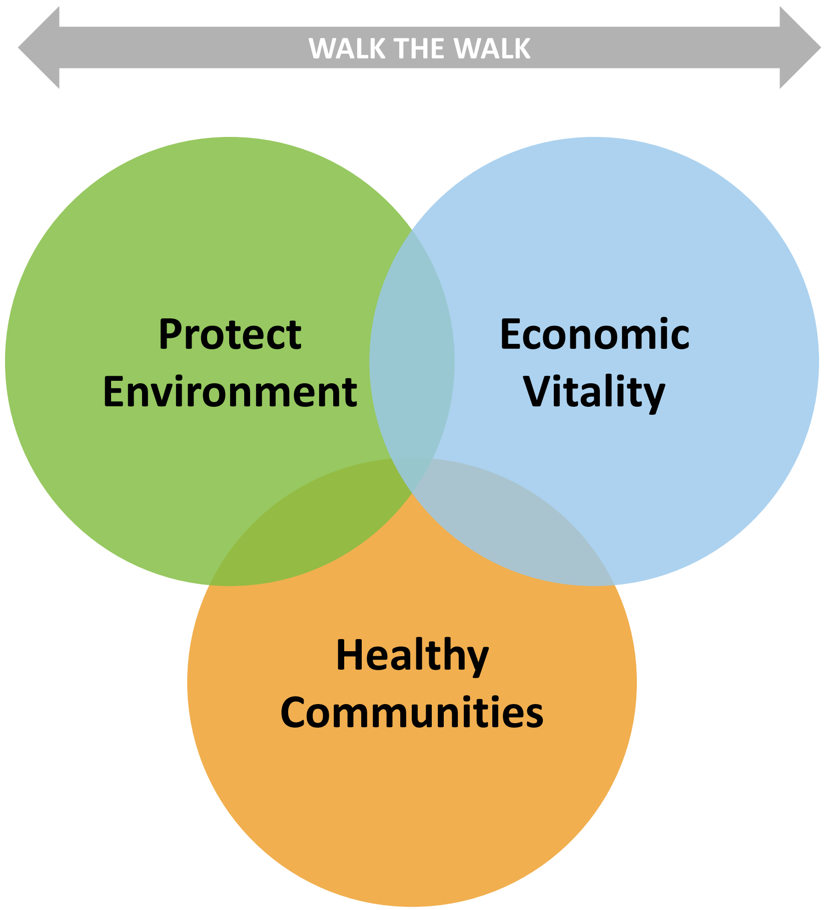
HARC Mission & Programs

Mission:

To provide independent analysis on **energy, air, and water** issues to people seeking scientific answers and to operate as a research hub finding **solutions for a sustainable future.**



Why a Green Building?

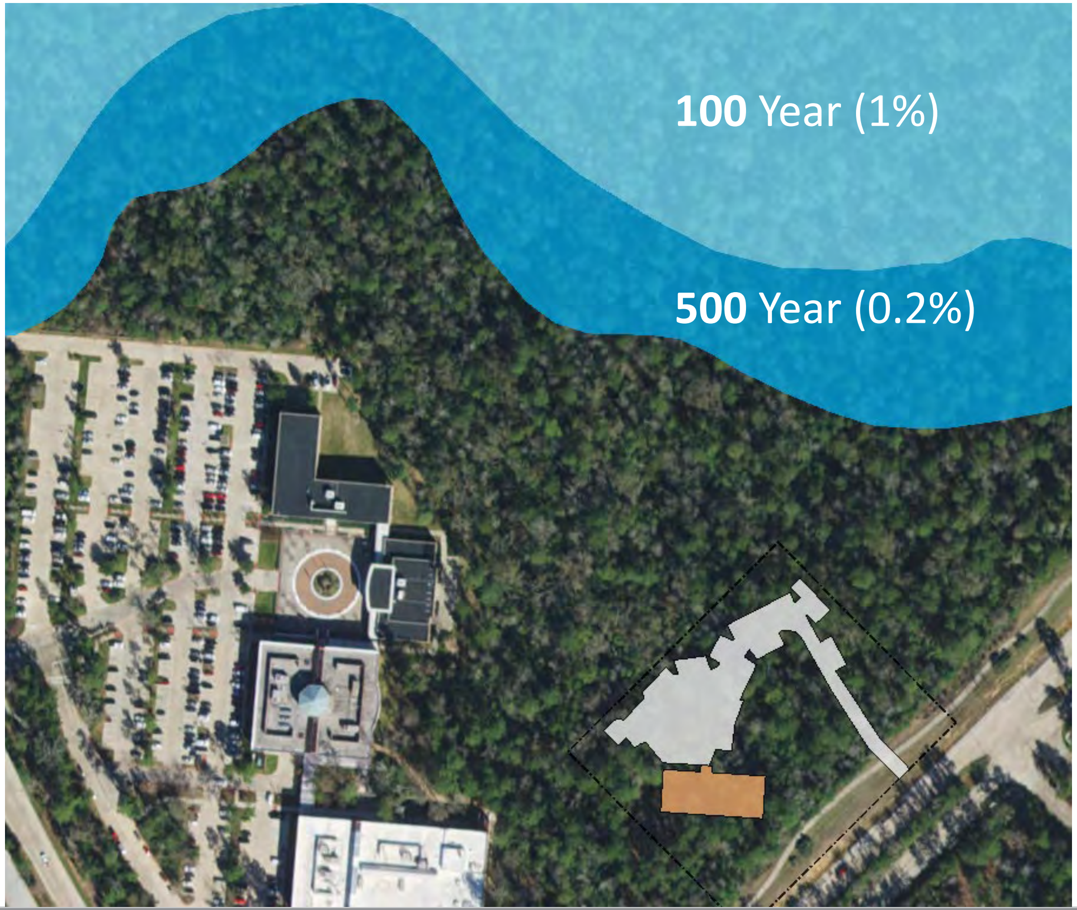


- HARC's sustainability mission
- Research collaboration
- Community meeting space
- Regional model
- Biodiversity & water management
- Energy & water efficiency
- Employee health & well-being
- Enhance partnerships
- Simplicity & cost of operation

Coordination as a Key Objective

Teams understood & supported HARC's mission and vision

Planning for an Event Like Harvey



- Outside of 500 year floodplain
- Elements of Low Impact Development (LID)
  a. Bioswales capture and slow the flow of rooftop & pavement rainfall runoff
  b. Permeable paving in many areas
  c. Habitat conservation

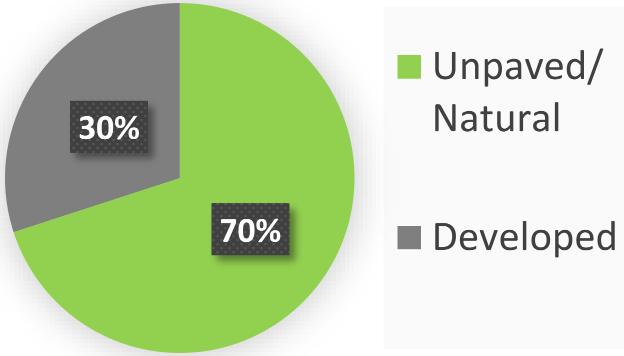
3.5 Acre Site

2014 habitat assessment completed

Minimize impacts to forest composition and structure, and other ecological features

- 54 plant species including:
  - Trumpet Creeper (*Campsis radicans*)
  - St. Andrews Cross (*Hypericum hypericoides*)
  - Farkleberry (*Vaccinium arboreum*)
  - American holly (*Ilex opaca*)
- 3.5 acres mixed pine hardwood forest
  - Unpaved/Natural = 2.5 acres
  - Developed = 1 acre

HARC Property Development



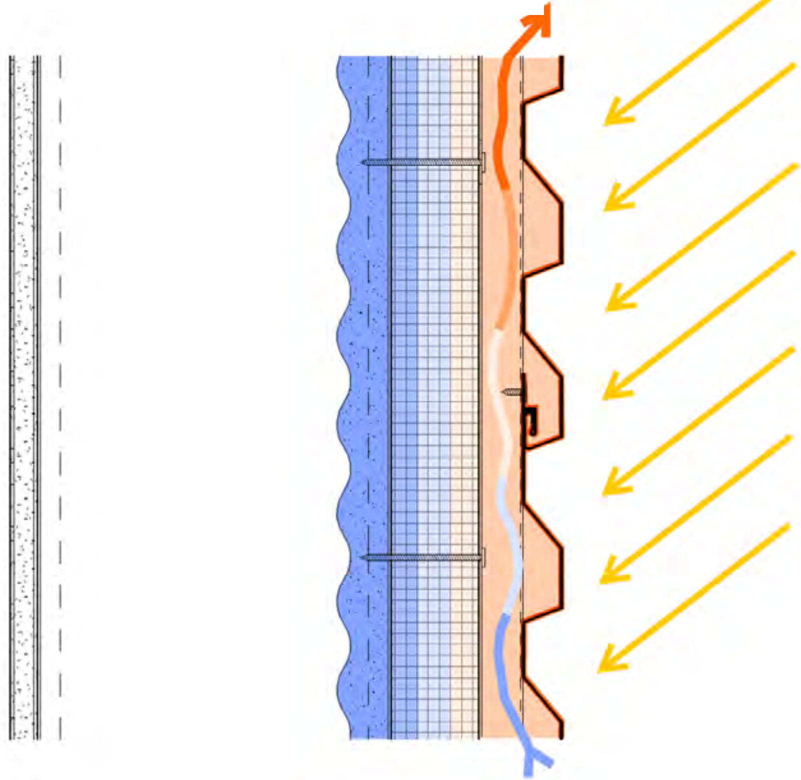
High performance building envelope

- Uses Dow Thermax insulation system and thermal venting
- Heat from exterior metal panels transfers to air (rather than enclosure) and vents upwards
- Reduces amount of heat hitting the insulation
- Effectively brings enclosure to R50 value
- Cladding protects the slab from direct sunlight and eliminating the slab as an external heat sink

Interior Wall

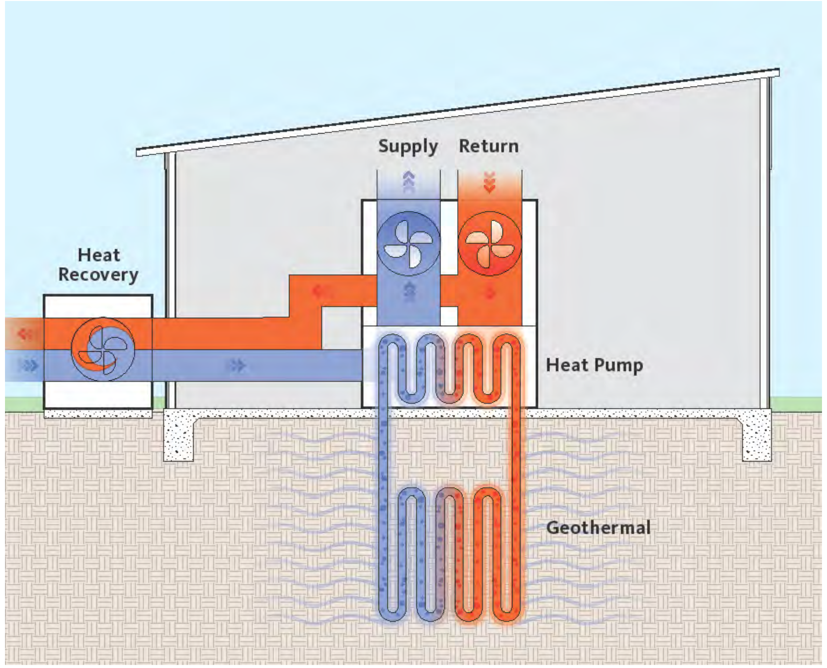
Dow Thermax Insulation

1” air gap & metal panels



Energy Modeling Goals & HVAC Design

- Net 22 kBTUs/sqft/yr
- > 70% of a baseline project of this size
- > $21k per year in energy costs (confirming)



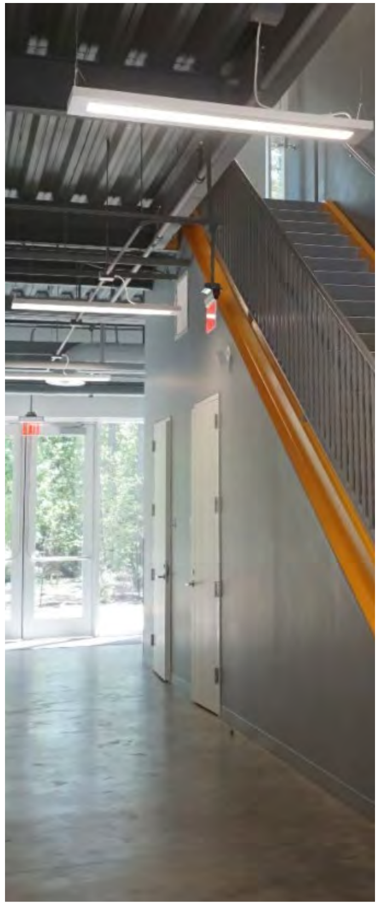
Solar Photovoltaics (PV)

- N-S building orientation
- Roof constructed to accommodate future solar
- 11.52 kW solar array
- 36 panels on NW corner of roof
- Kyocera Model: KU320-8BCA
- Entergy rebate program CLEAResult

KYOCERA
KYOCERA SOLAR SOLUTIONS

Lighting Design

A quality lit space with low energy usage

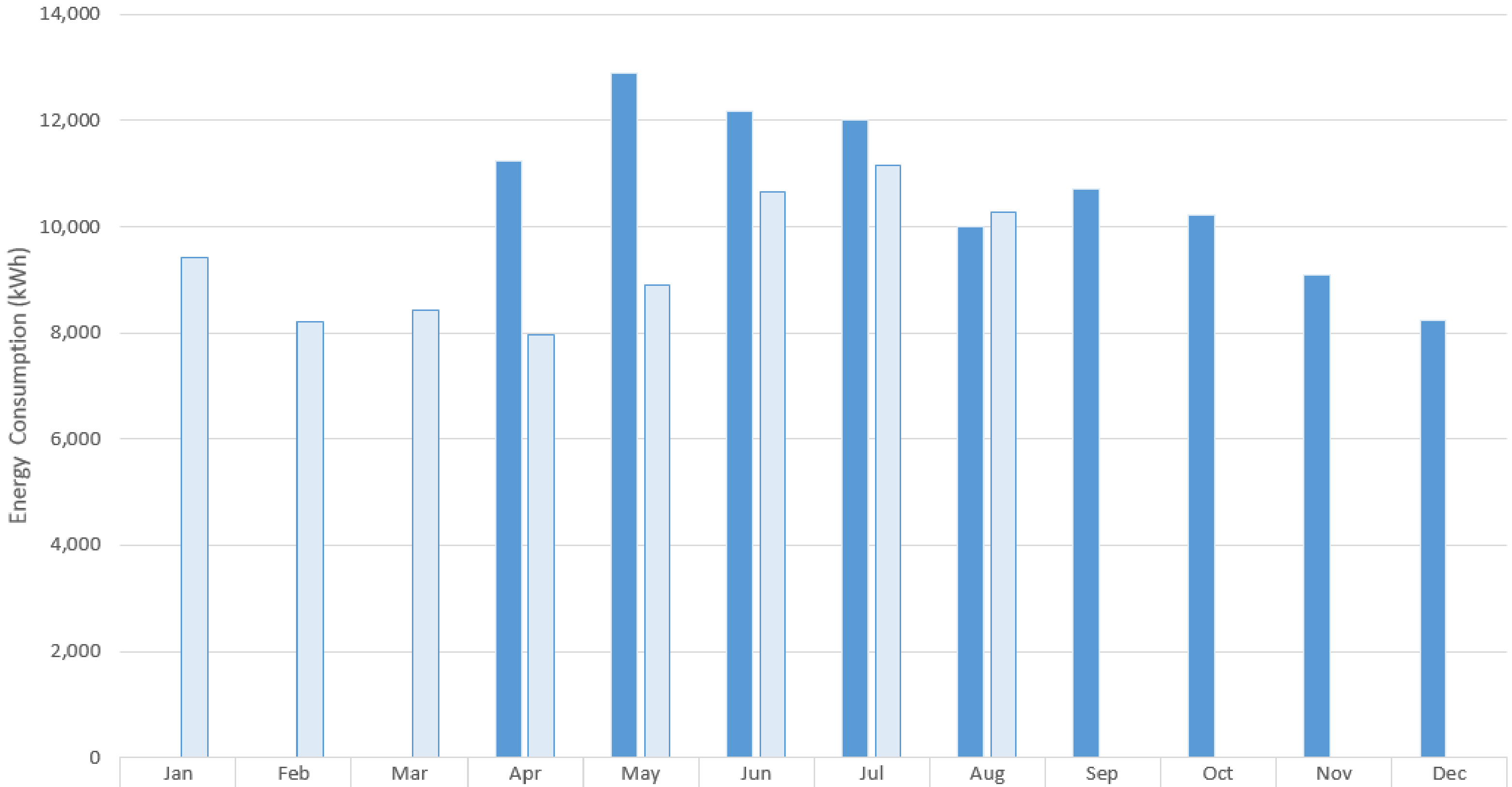


- Modeled lighting power budget, 0.25-0.34 w/sf
- Every office has daylighting and view of outside
- Daylight reaches 75% of space; use natural light when possible
- LED lights throughout; no incandescent or CFL bulbs please!



Energy Consumption

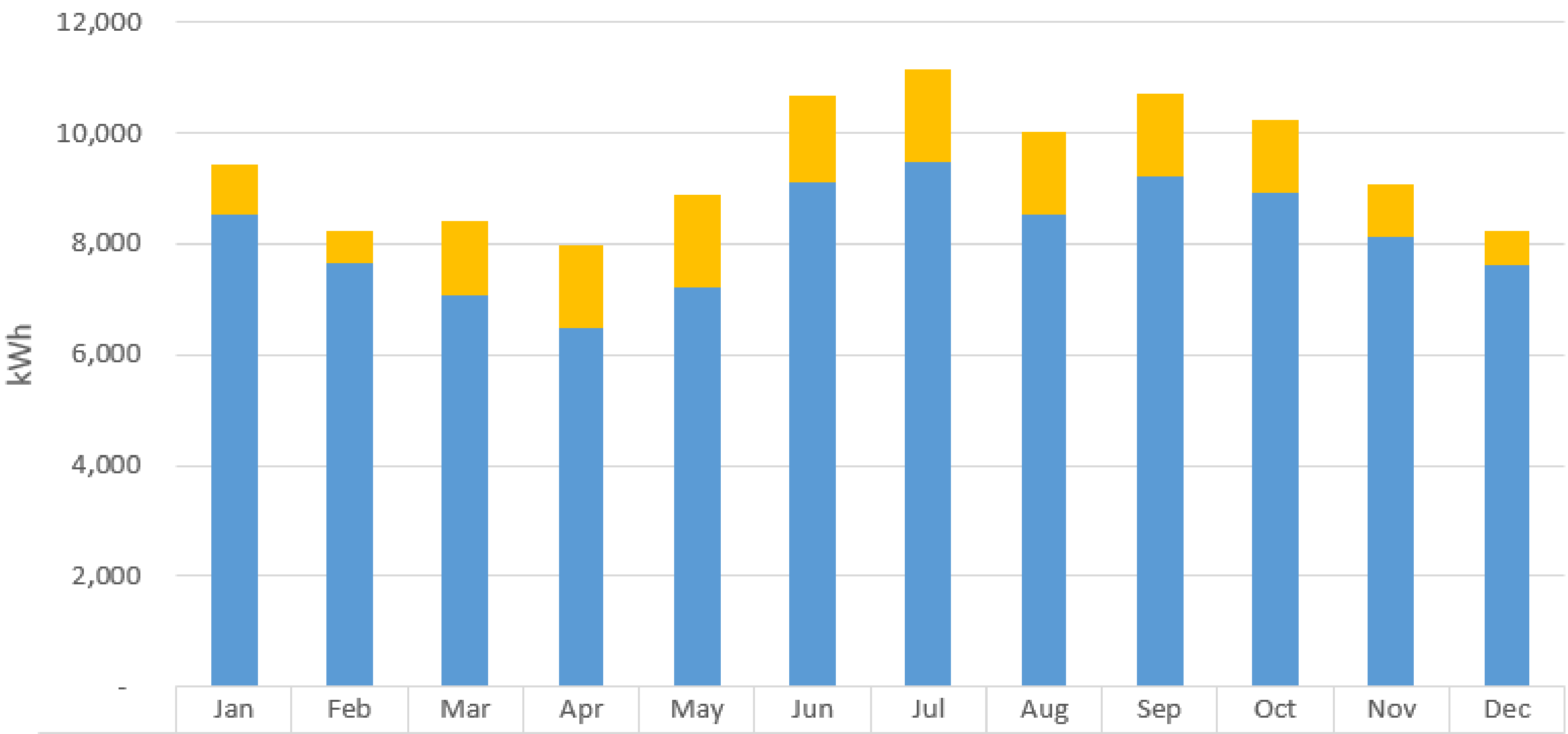
- 113,297 kWh last 12 months
- 6.1 kWh per sq. ft.
- 310.4 kWh per day



	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
2017				11,238	12,891	12,170	12,025	10,009	10,729	10,232	9,083	8,252
2018	9,422	8,226	8,432	7,972	8,895	10,669	11,147	10,275				

Energy Supply

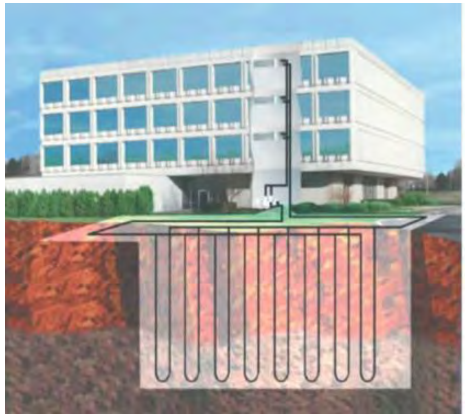
Energy Consumption per Month and Source

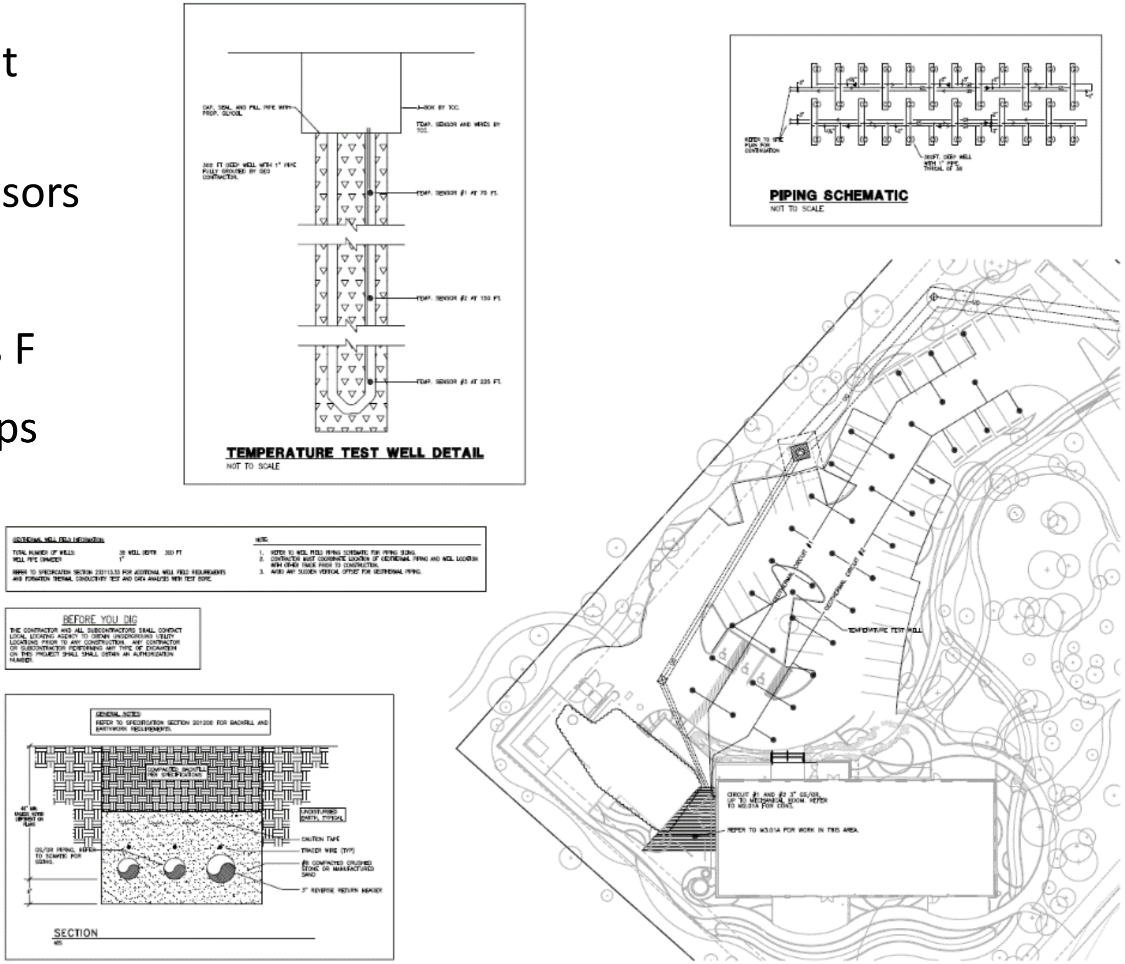


	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
PV	905	591	1,360	1,478	1,666	1,549	1,677	1,495	1,495	1,317	969	622
Entergy	8,517	7,635	7,072	6,494	7,229	9,120	9,470	8,514	9,234	8,915	8,114	7,630

Geothermal Heat Exchange

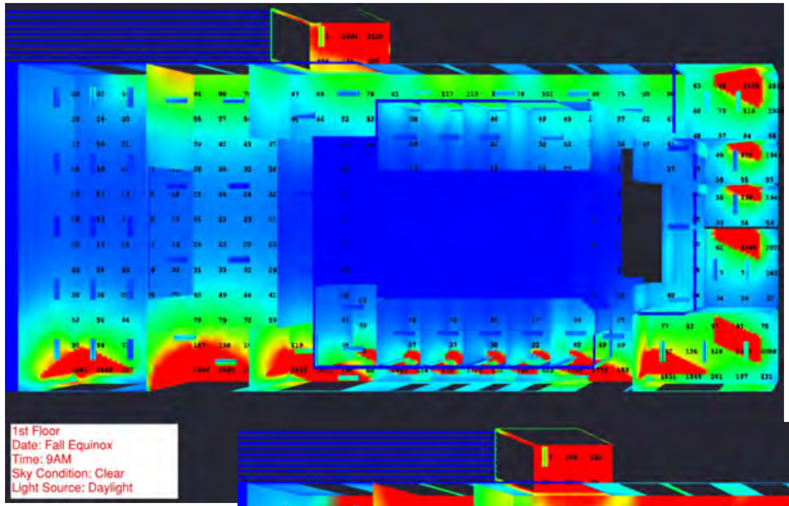
- Closed loop geothermal heat exchange system
- 36 wells + 1 test well w/ sensors
- Wells 300’ deep
- Constant temp ~70 degrees F
- 15 high efficiency heat pumps throughout building

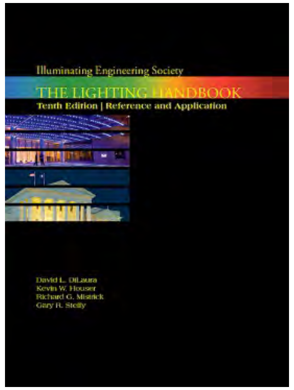


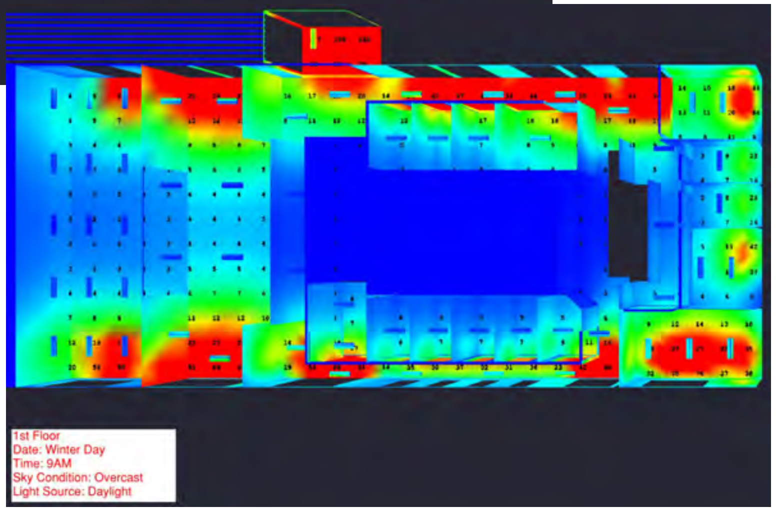


Active Owner Involvement

Lighting Levels – Reviewed IES range for recommend lighting levels. Worked with owner to understand impacts lighting & daylighting plays and targeted specific levels for various spaces.



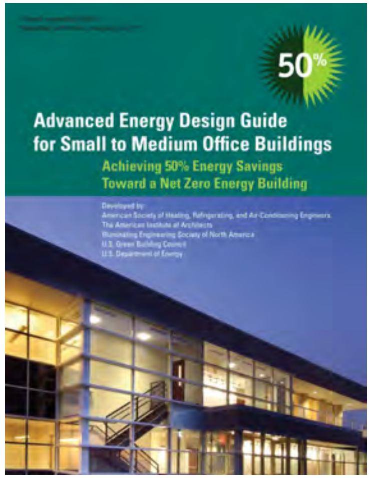




Active Owner Involvement

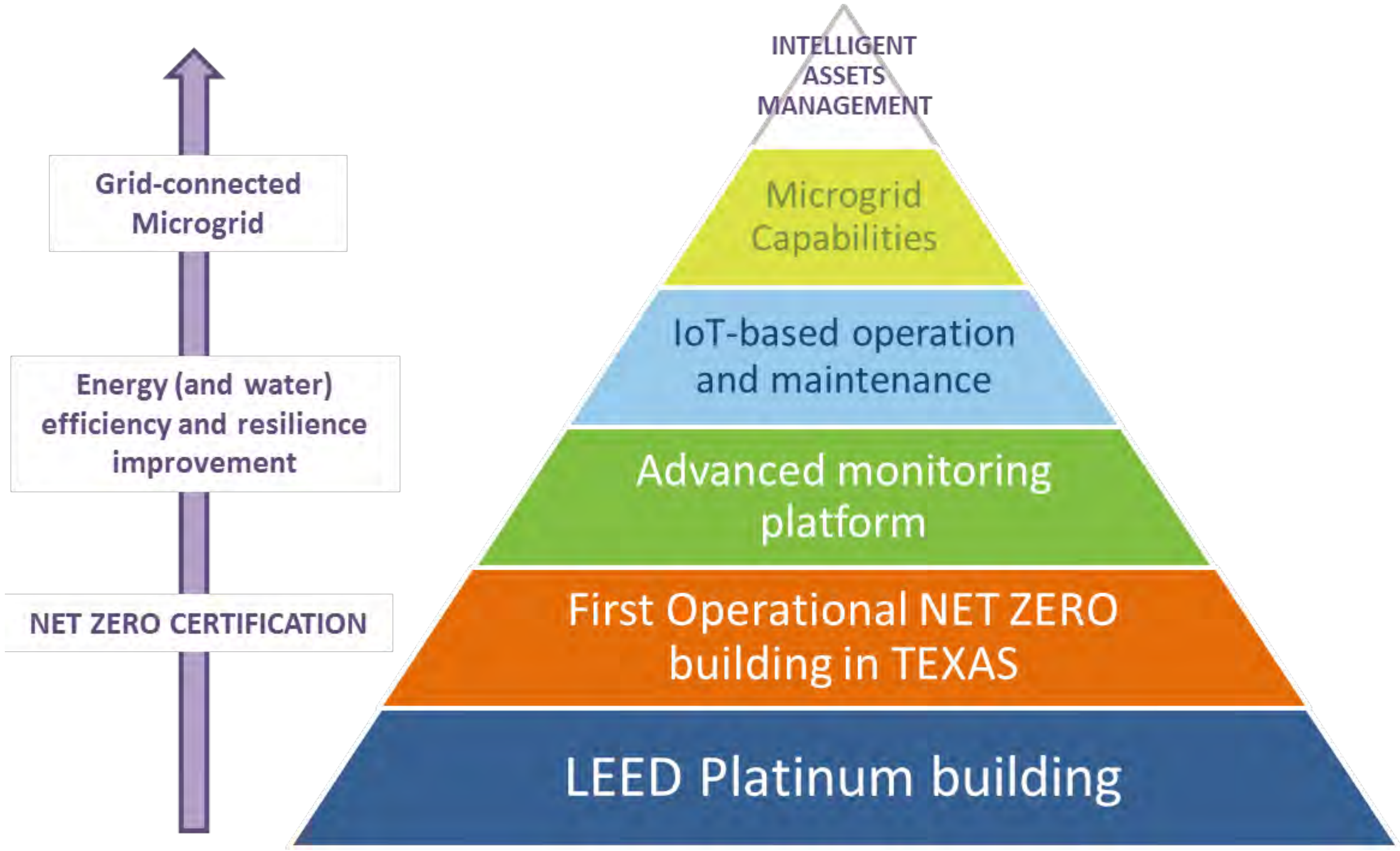
Building energy consumption – Assisted in setting energy targets. Provided information on various types of building and expected energy consumption.

HVAC selection - Priority ranking based on owner defined matrix.

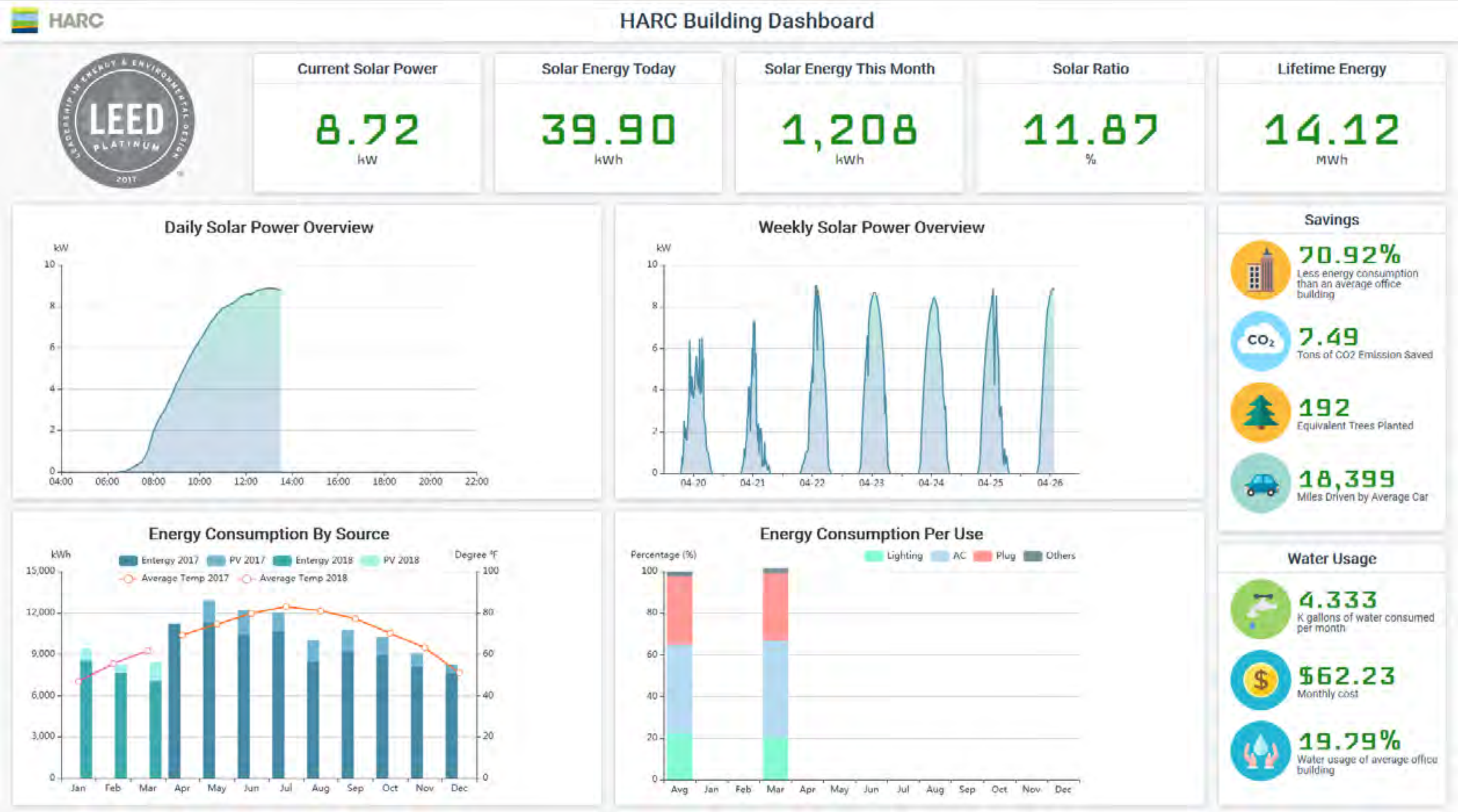


		WorkPlace					Cost					Sustainability					Score	
		Comfort	Layout Adaptability	Load Adaptability	Operational	Accoustics	1st Cost	Associated Building Cost	Maintenance Cost	Ease of Maintenance	Proven Technology	Energy Use	Water Consumption	CO2 Emmissions	Resilience	Simplicity	Total Score (Sys Rank x	Ranking
		Owner Priority Rankings on Scale of 1 to 10 (best)																
System #	System Ranking	9	7	8	8	9	7	7	9	8	7	9	9	9	8	9		
		HVAC System Rankings on Scale of 1 to 10 (best)																
1	Geotheramal, Closed Loop	6	5	5	8	6	3	5	5	4	7	9	8	6	6	6		
1a	Hybrid Geothermal	6	5	6	7	6	4	5	6	5	7	8	5	5	6	5		
1c	Water Cooled Heat Pump	6	5	6	6	6	5	5	6	5	8	7	3	4	6	5		
2	UAS	7	8	4	6	7	5	2	6	5	6	6	8	4	4	5		
3	Active Chilled Beam	5	4	3	4	7	3	3	5	3	3	6	8	4	4	3		
4	VAV w/air cooled chiller	6	6	7	6	4	5	5	6	5	8	6	8	4	7	5		
5	Water Cooled DX w VAV	6	5	6	6	5	5	5	6	5	8	7	3	4	6	5		
6	Air Cooled DX w VAV	5	6	6	6	4	7	5	5	5	8	5	8	3	5	4		
		HVAC Scoring (System Rank x Owner Priority)																
1	Geotheramal, Closed Loop	5.4	3.5	4	6.4	5.4	2.1	3.5	4.5	3.2	4.9	8.1	7.2	5.4	4.8	5.4	73.8	1
1a	Hybrid Geothermal	5.4	3.5	4.8	5.6	5.4	2.8	3.5	5.4	4	4.9	7.2	4.5	4.5	4.8	4.5	70.8	3
1c	Water Cooled Heat Pump	5.4	3.5	4.8	4.8	5.4	3.5	3.5	5.4	4	5.6	6.3	2.7	3.6	4.8	4.5	67.8	5
2	UAS	6.3	5.6	3.2	4.8	6.3	3.5	1.4	5.4	4	4.2	5.4	7.2	3.6	3.2	4.5	68.6	4
3	Active Chilled Beam	4.5	2.8	2.4	3.2	6.3	2.1	2.1	4.5	2.4	2.1	5.4	7.2	3.6	3.2	2.7	54.5	8
4	VAV w/air cooled chiller	5.4	4.2	5.6	4.8	3.6	3.5	3.5	5.4	4	5.6	5.4	7.2	3.6	5.6	4.5	71.9	2
5	Water Cooled DX w VAV	5.4	3.5	4.8	4.8	4.5	3.5	3.5	5.4	4	5.6	6.3	2.7	3.6	4.8	4.5	66.9	6
6	Air Cooled DX w VAV	4.5	4.2	4.8	4.8	3.6	4.9	3.5	4.5	4	5.6	4.5	7.2	2.7	4	3.6	66.4	7

Building Update – Beyond Platinum



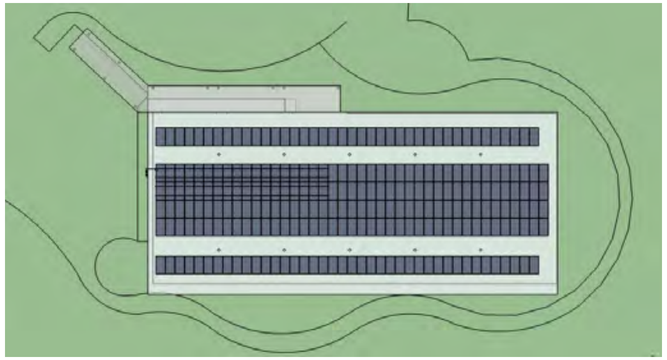
Building Dashboard:
Evaluating Building Performance



Certified Zero Energy

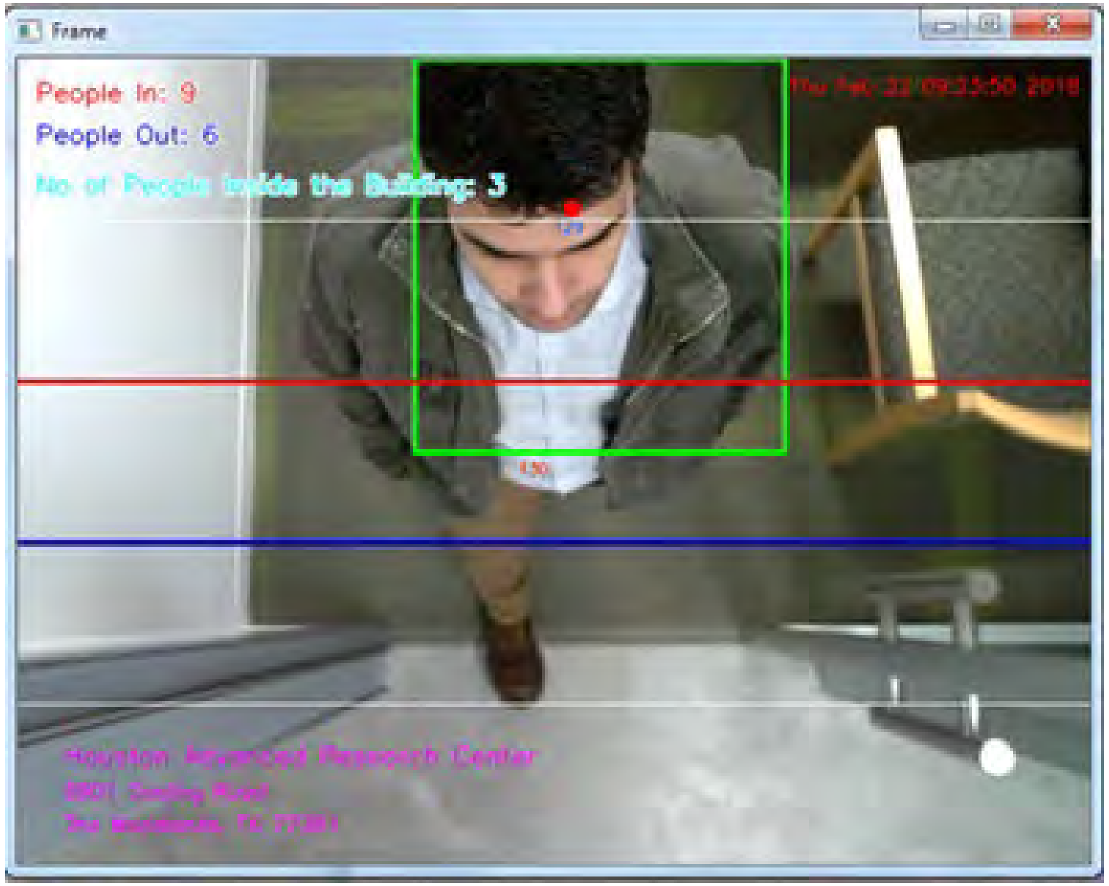
- Transition from intermittent net-zero events during the weekends to being one of the first certified commercial net-zero energy (NZE) buildings in Texas
- This is happening due to the generous financial support ($136,000) of the Green Mountain Energy Sun Club which will allow HARC to expand its existing solar array
- 208 additional solar panels (about 75 kW DC) with the requisite inverters
- Expected completion date: November 2018

Green Mountain Energy
SUN CLUB®



Certified Zero Energy

- Facility occupancy and use monitoring
- Additional power meters, light and occupancy sensors, water meters
- A weather station along with biowswale flow and Soil moisture sensors
- Internet of Things (IOT) approach
- Enhanced data and analysis and artificial intelligence
- … and more to come!



Q & A

Thank you!