Gaming for a Resilient Future: **Net-Zero Energy Campus**

presenting today

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overview of today

1 - Background

2 - Case Studies

3 - The Game

4 - Discussion

5 - Conclusion

Net Zero Energy **and Campuses**

Why?

- Mission Alignment
- American College and University President's Climate Commitment
- Long-Term Capital and Operations Planning

Opportunities

- Utility Providers
- Diverse Building Types
- Life-Cycle Mindset

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Current **requirements**

- ✓ Green building certification
- ✓ Life-cycle cost analysis
- ✓ Benchmarking
- ✓ Climate action plan goal
- ✓ Other

Defining **Net Zero Energy**

Zero Energy Building (ZEB)

an energy-efficient building where, on a source energy basis, the actual annual delivered energy is less than or equal to the on-site renewable exported energy.

Zero Energy Campus

an energy-efficient campus where, on a source energy basis, the actual annual delivered energy is less than or equal to the on-site renewable exported energy.

Zero Energy Portfolio

same as above, but with a portfolio instead of campus.

Zero Energy Community

same as above, but with a community instead of campus.

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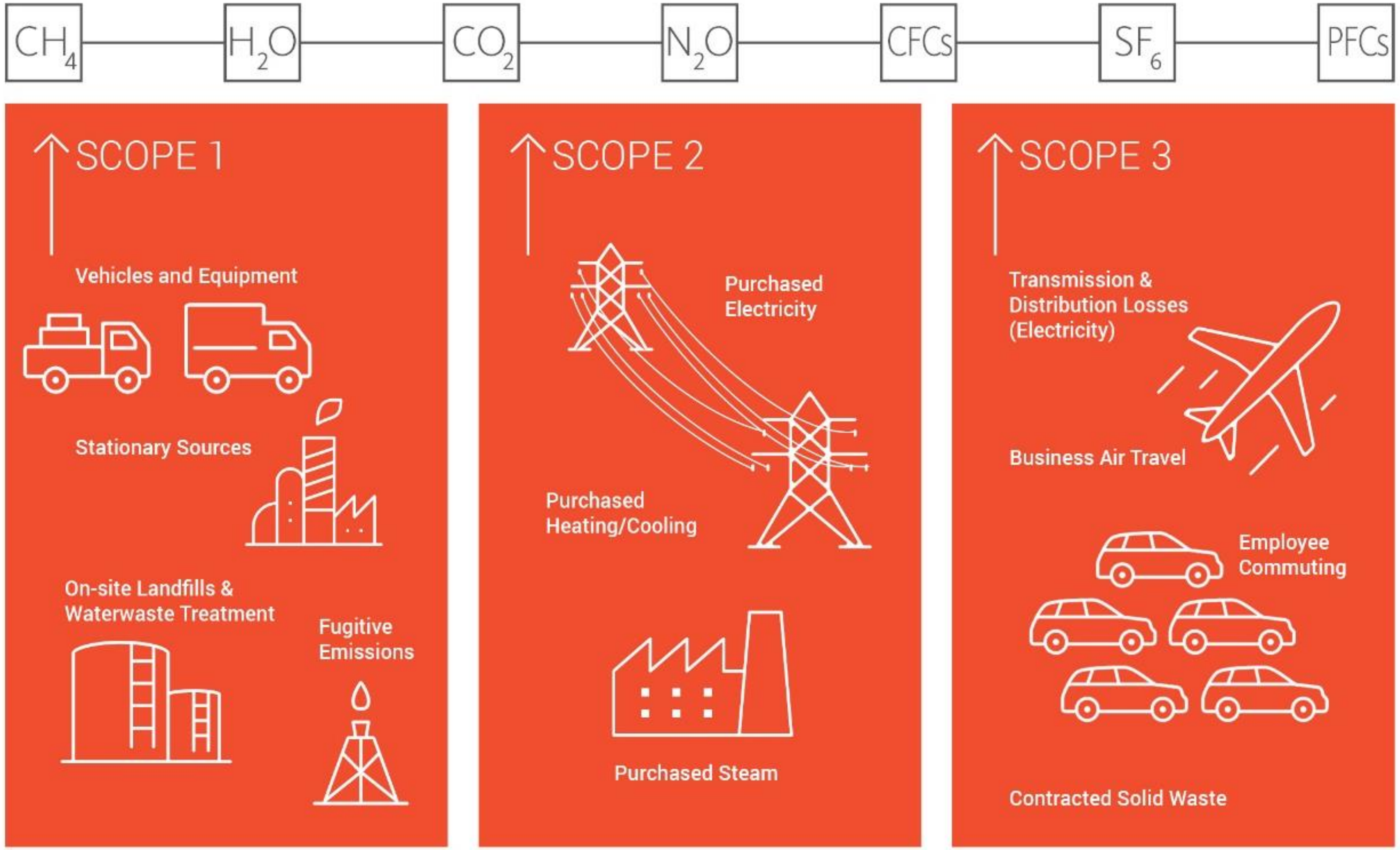
Defining **Net Zero Carbon**

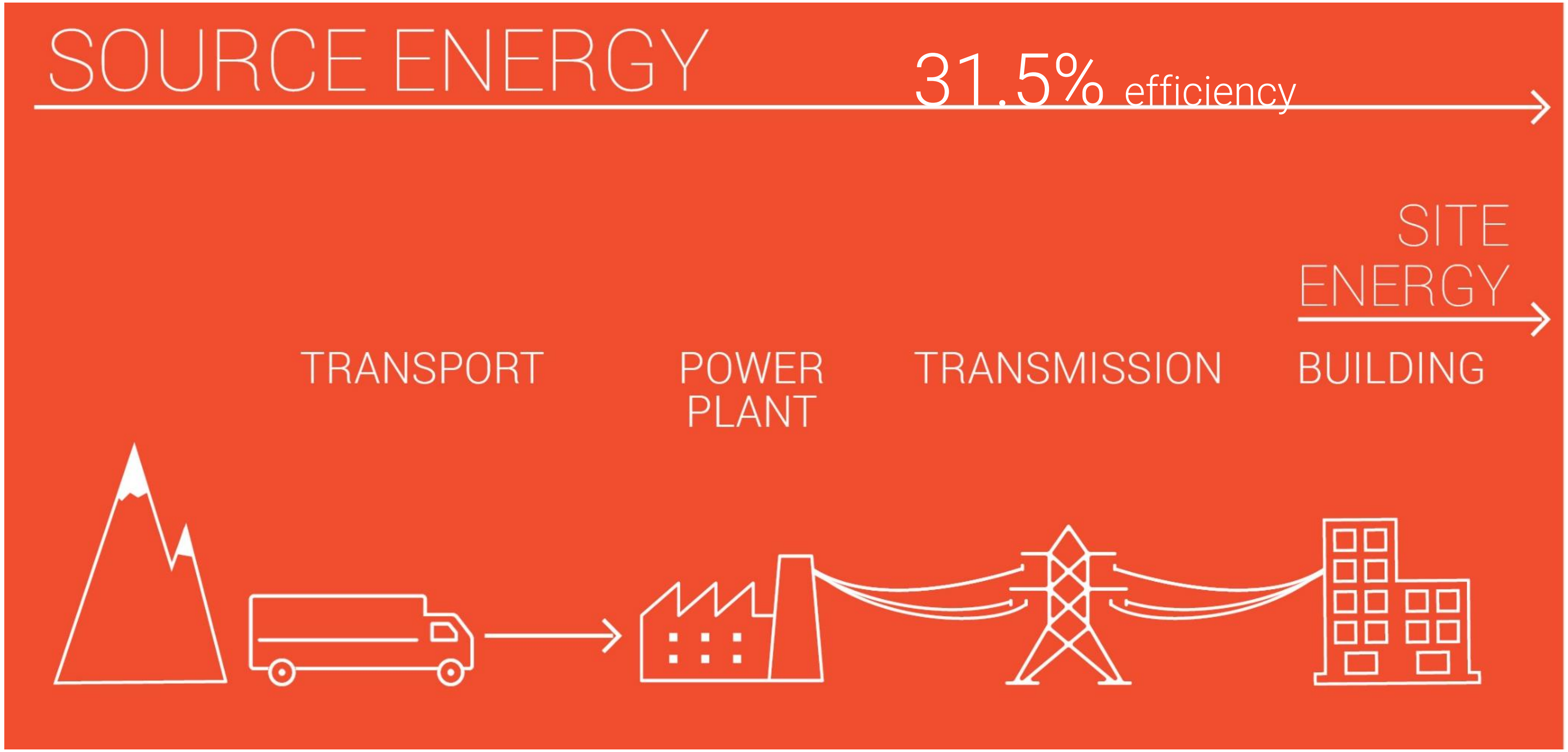


GREENHOUSE GAS EMISSIONS
from sources that are owned or controlled by a federal agency.

GREENHOUSE GAS EMISSIONS
resulting from the generation of electricity, heat, or steam purchased by a federal agency.

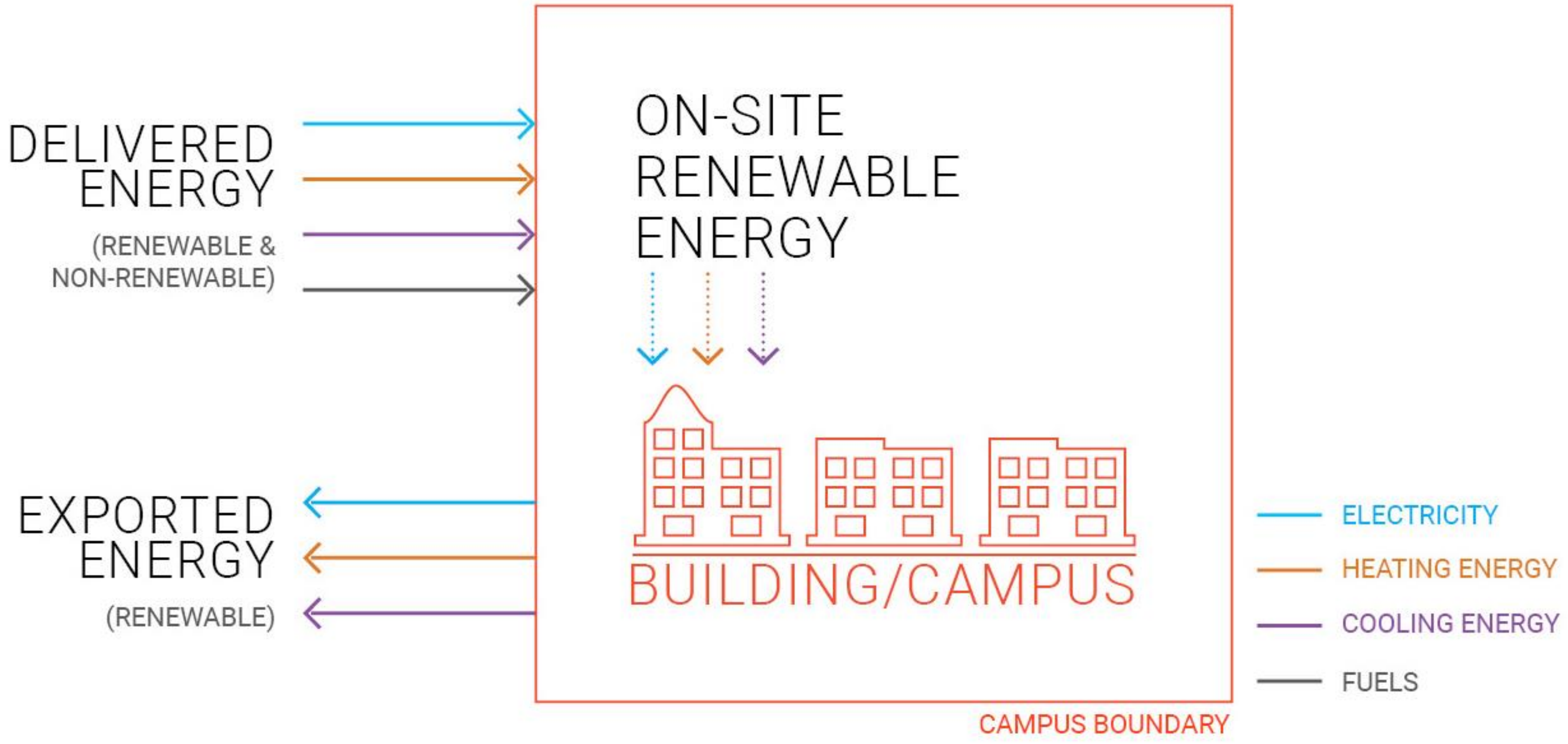
GREENHOUSE GAS EMISSIONS
from sources not owned or directly controlled by a federal agency but related to agency activities.

Not all metrics **are created equal**



Zero energy = Zero carbon = Zero cost
Definitions are key: Boundary driven

boundaries



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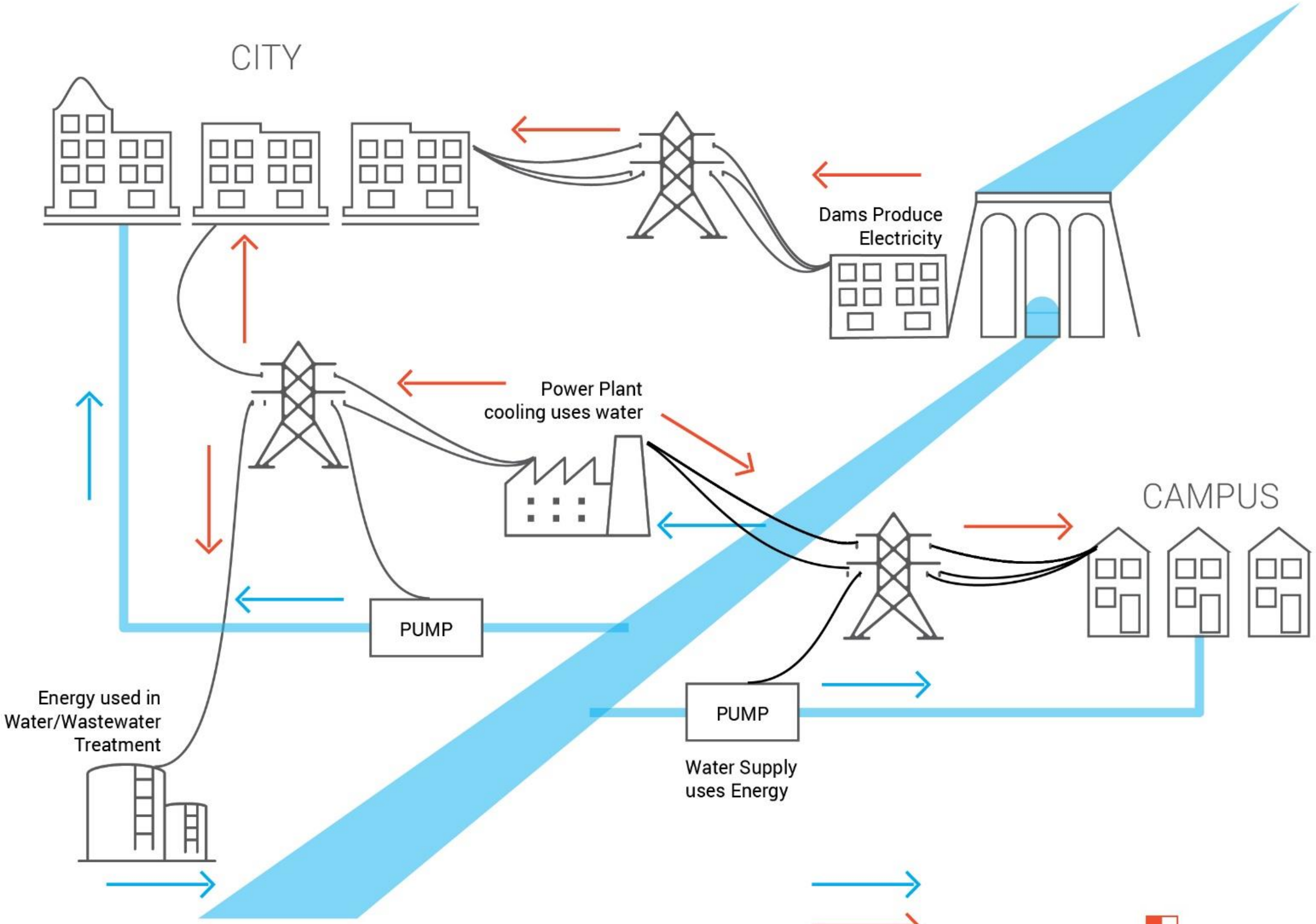
types of **energy**

- Non-renewable vs. Renewable
- Embodied Energy
- Water-Energy Nexus



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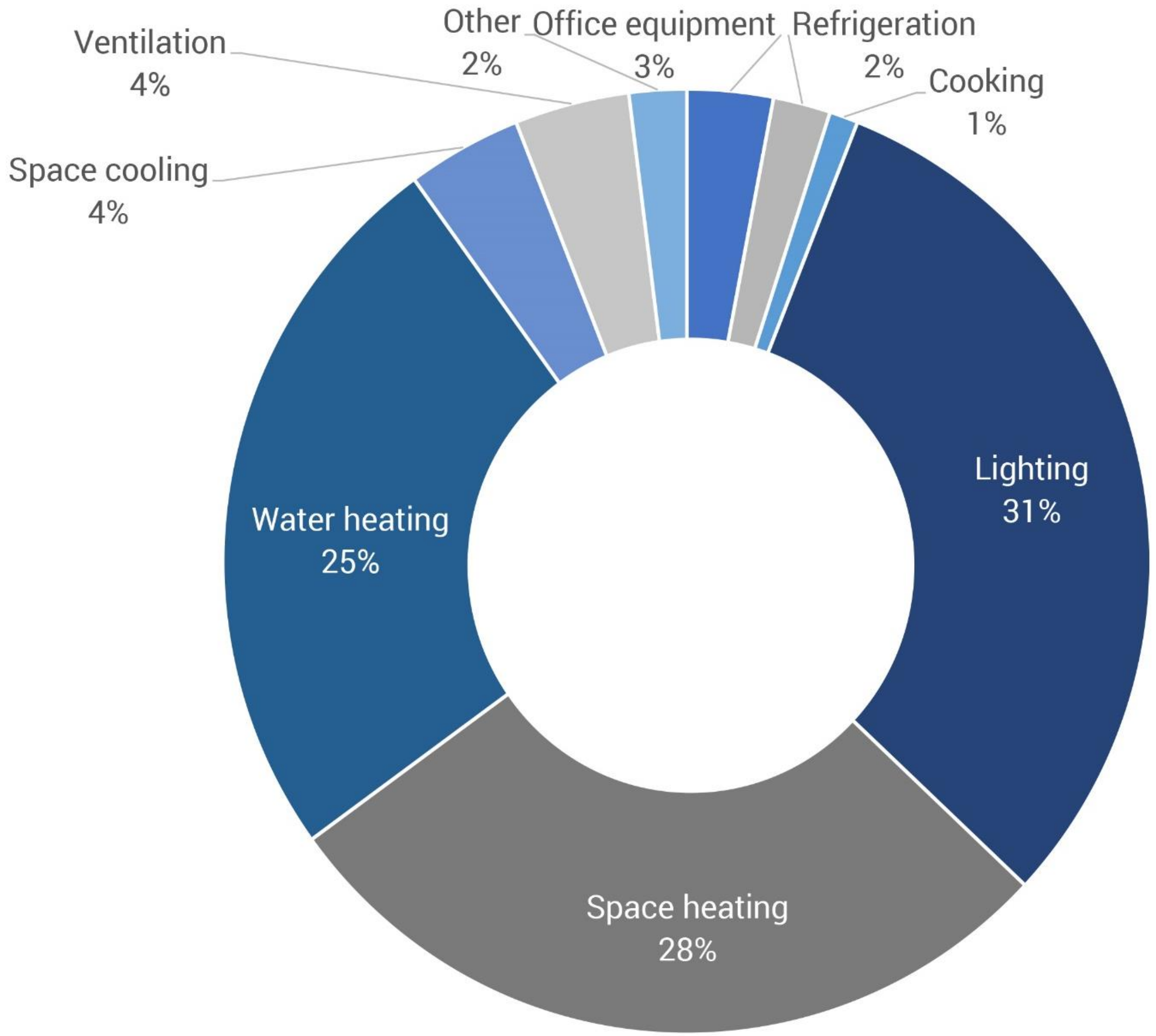
campus **energy**

energy by end use



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campus **energy**

- Benchmarking (ENERGY STAR)
  Median Site EUI: 130.7 kBTU/yr-gsf
  Median Source EUI: 262.6 kBTU/yr-gsf

- Variables
  Campus Utility System
  Building Types
  Academic Calendar
  Building Stock Vintage
  Submetering

2030 **challenge**

U.S. Medians for Site Energy Use and 2030 Challenge Energy Reduction Targets by Space/Building Type[1] From the Environmental Protection Agency (EPA): Use this chart to find the site fossil-fuel energy targets									
Building Use Description[2]	Available in Target Finder[3]	Median Source EUI[4] (kBtu/Sq.Ft./Yr)	Average Percent Electric	Median Site EUI[4] (kBtu/Sq.Ft./Yr)	2030 Challenge Site EUI Targets (kBtu/Sq.Ft./Yr)				
					50% Target	60% Target	70% Target	80% Target	90% Target
Education		144	63%	58	**29.0**	23.2	17.4	11.6	5.8
K-12 School	X								
College / University (campus-level)		244	63%	104	**52.0**	41.6	31.2	20.8	10.4

www.architecture2030.org

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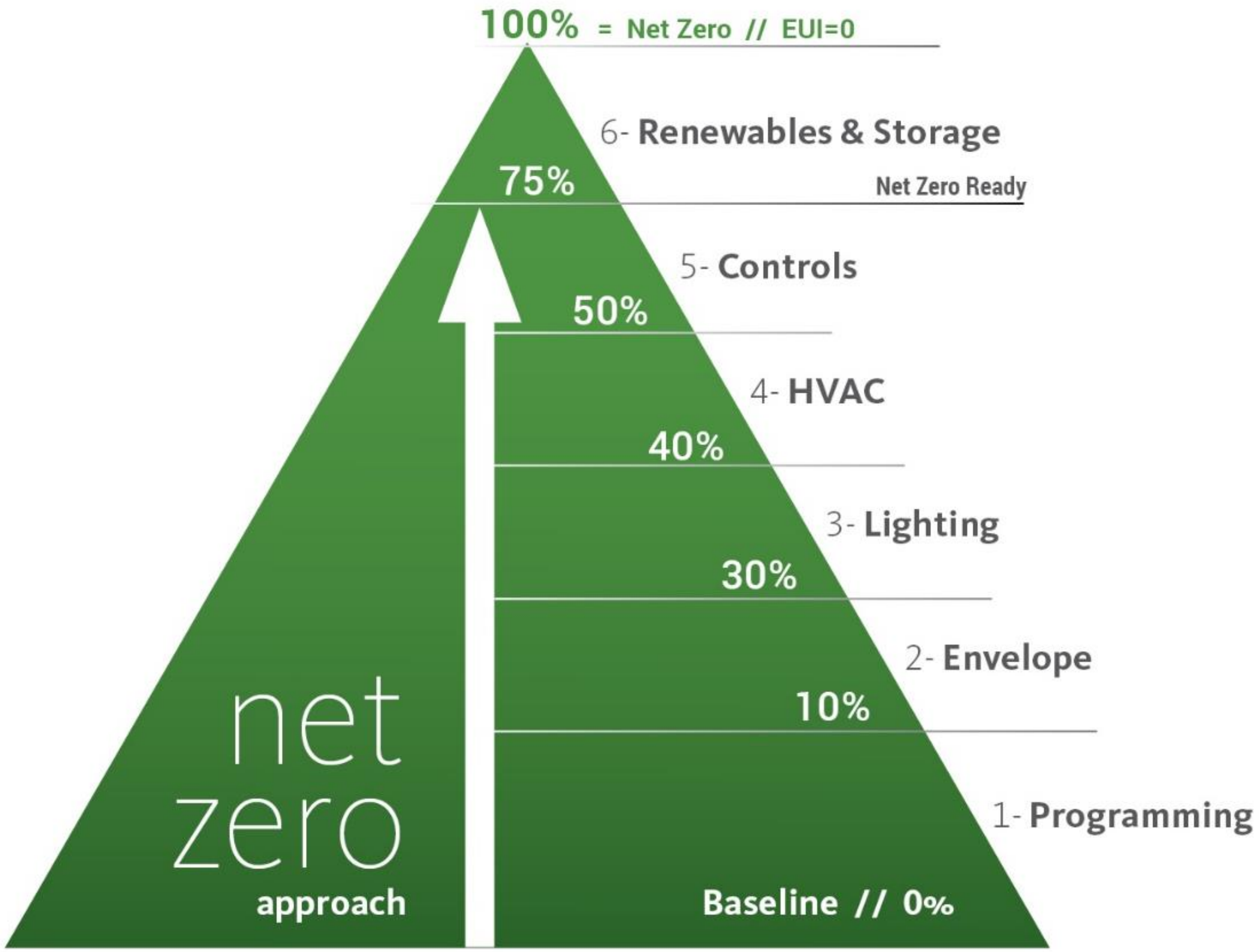
design for **net zero**

net zero approach



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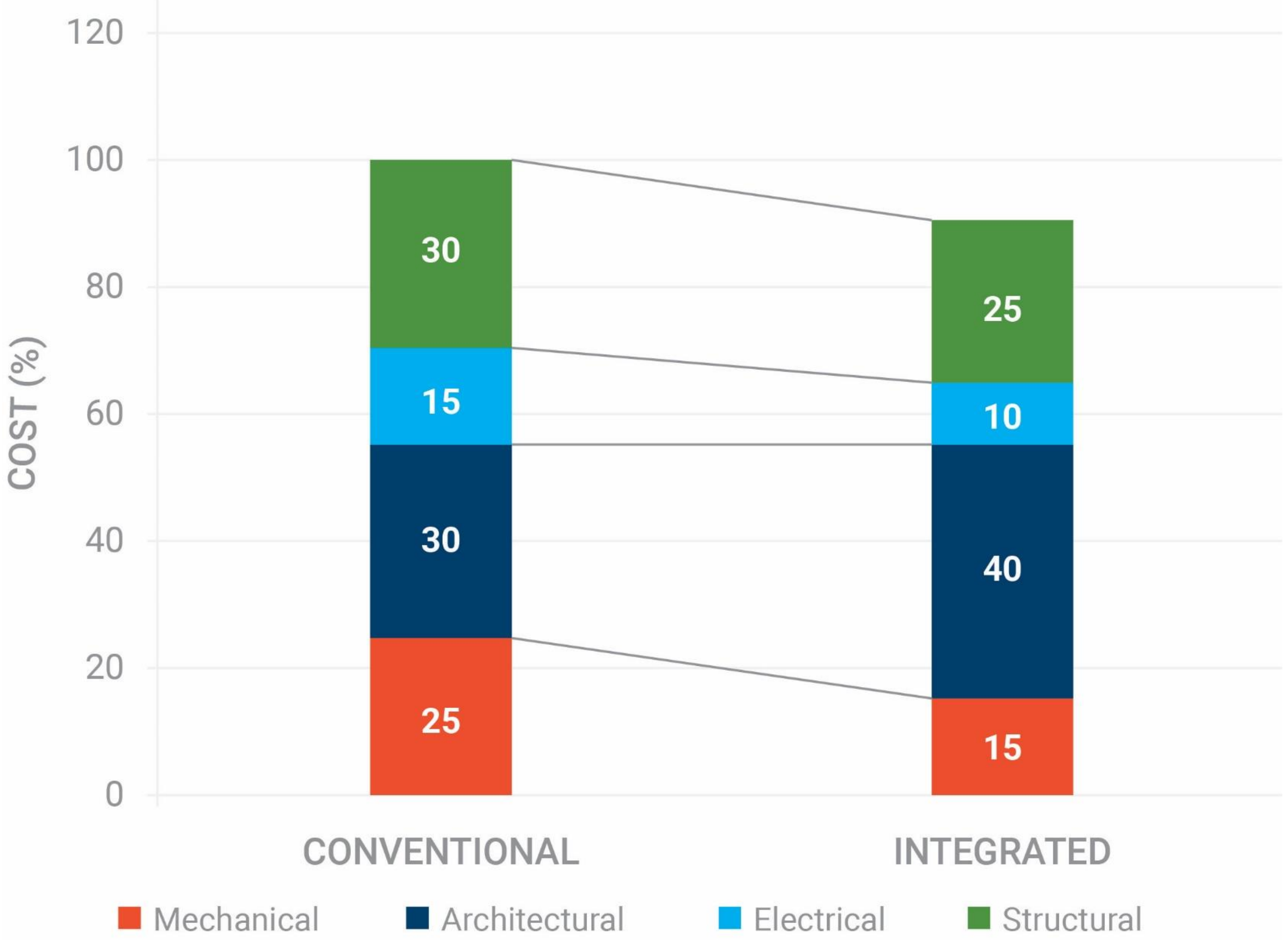
integrated design **matters**



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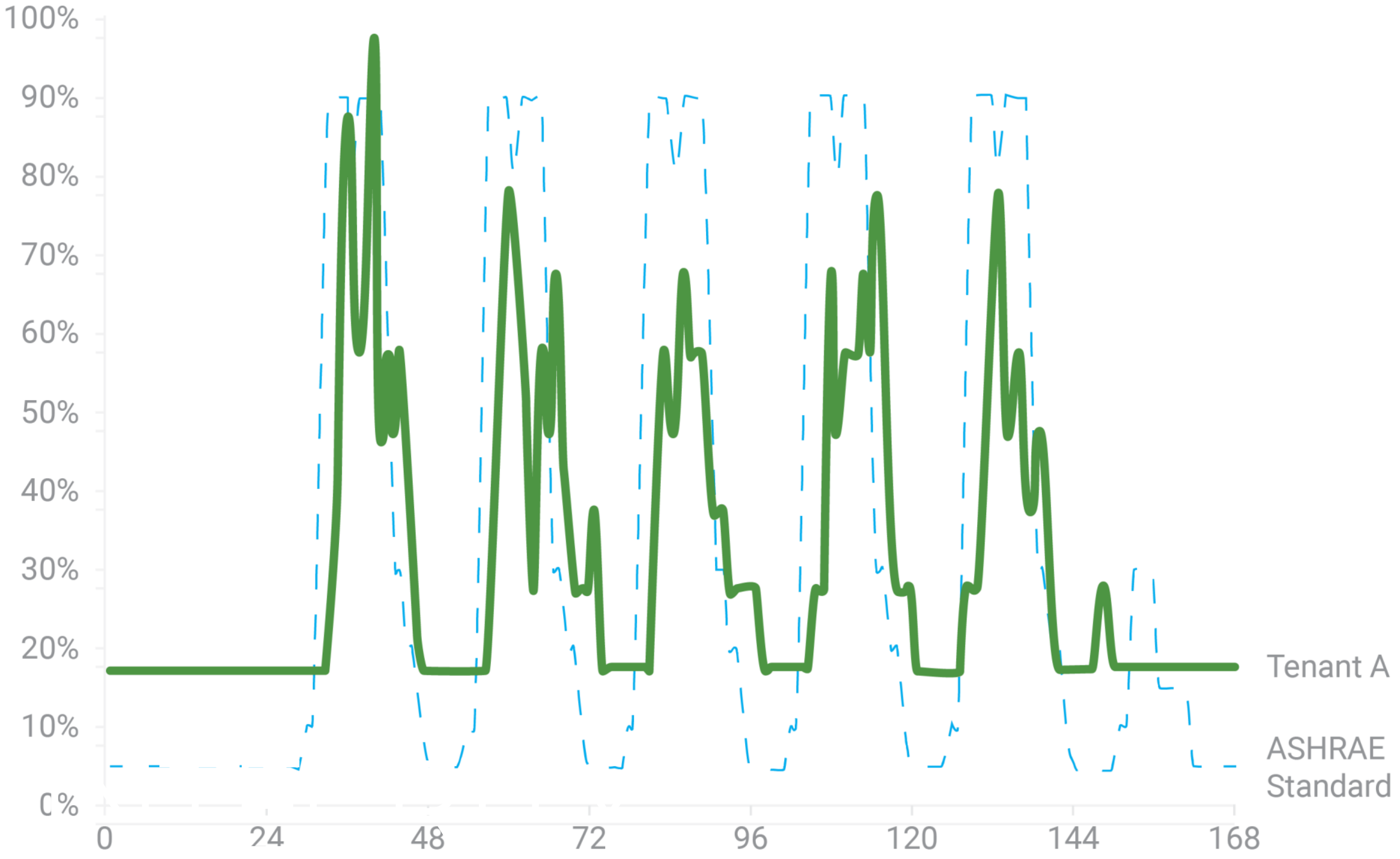
operations **matter**



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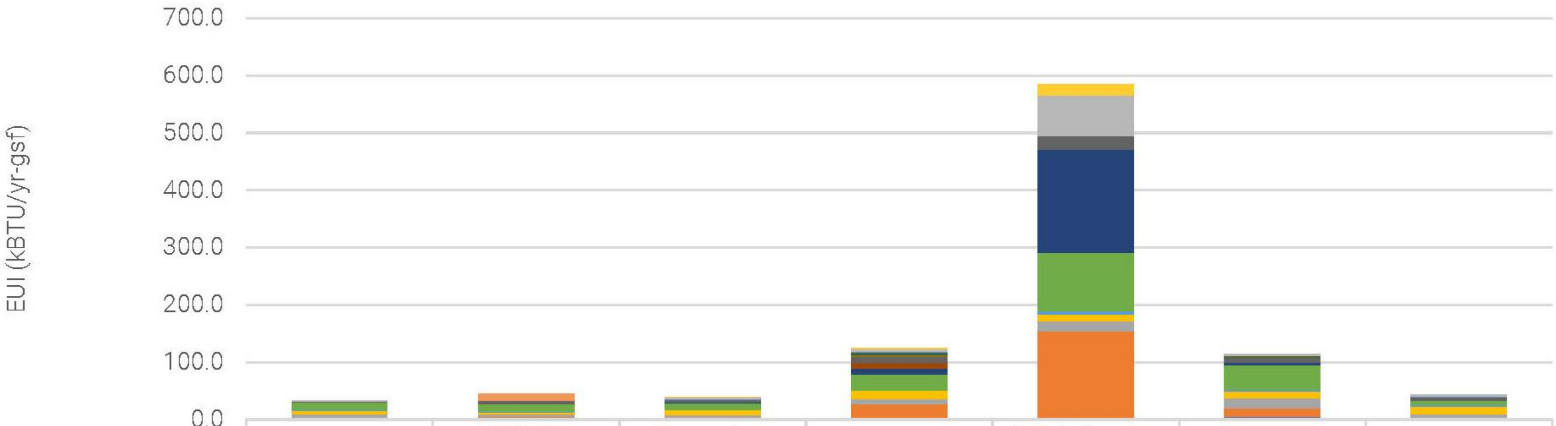
prototype **data**

Energy Use Intensity Breakdown by Building Type (ASHRAE 90.1-2013)



	Medium Office	Mid-Rise Apartment	Secondary School	Hospital	Quick-Service Restaurant	Outpatient	Retail
Refrigeration - E	0.0	0.0	0.6	0.6	19.8	0.0	0.0
Water Systems - G	1.3	0.0	2.2	4.7	70.9	2.9	3.6
Water Systems - E	0.0	11.1	0.7	0.1	0.0	0.0	0.0
Heat Recovery -E	0.0	0.0	1.3	1.0	0.0	0.5	0.8
Humidficiation - E	0.0	0.0	0.0	3.3	0.0	2.9	0.0
Heat Rejection - E	0.0	0.0	0.0	1.9	0.0	0.0	0.0
Pumps - E	0.0	0.0	0.2	2.1	0.0	0.4	0.0
Fans - E	1.4	5.7	3.8	11.3	22.6	8.8	6.6
Ext Equipment - E	0.0	0.0	0.0	9.8	0.0	0.0	0.0
Int Equipment - G	0.0	0.0	2.4	11.0	180.9	4.4	0.0
Int Equipment - E	13.3	14.4	10.8	27.2	100.8	42.4	7.5
Ext Light - E	1.9	1.1	0.5	0.8	5.8	2.6	2.4
Int Light - E	5.8	3.1	8.3	13.8	12.2	11.7	14.2
Cooling - E	5.0	3.6	6.8	9.4	17.8	18.1	5.2
Heating - G	2.5	5.8	2.1	24.9	154.6	14.4	4.0
Heating - E	2.1	0.0	0.0	2.5	0.0	5.8	0.0

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case **study**

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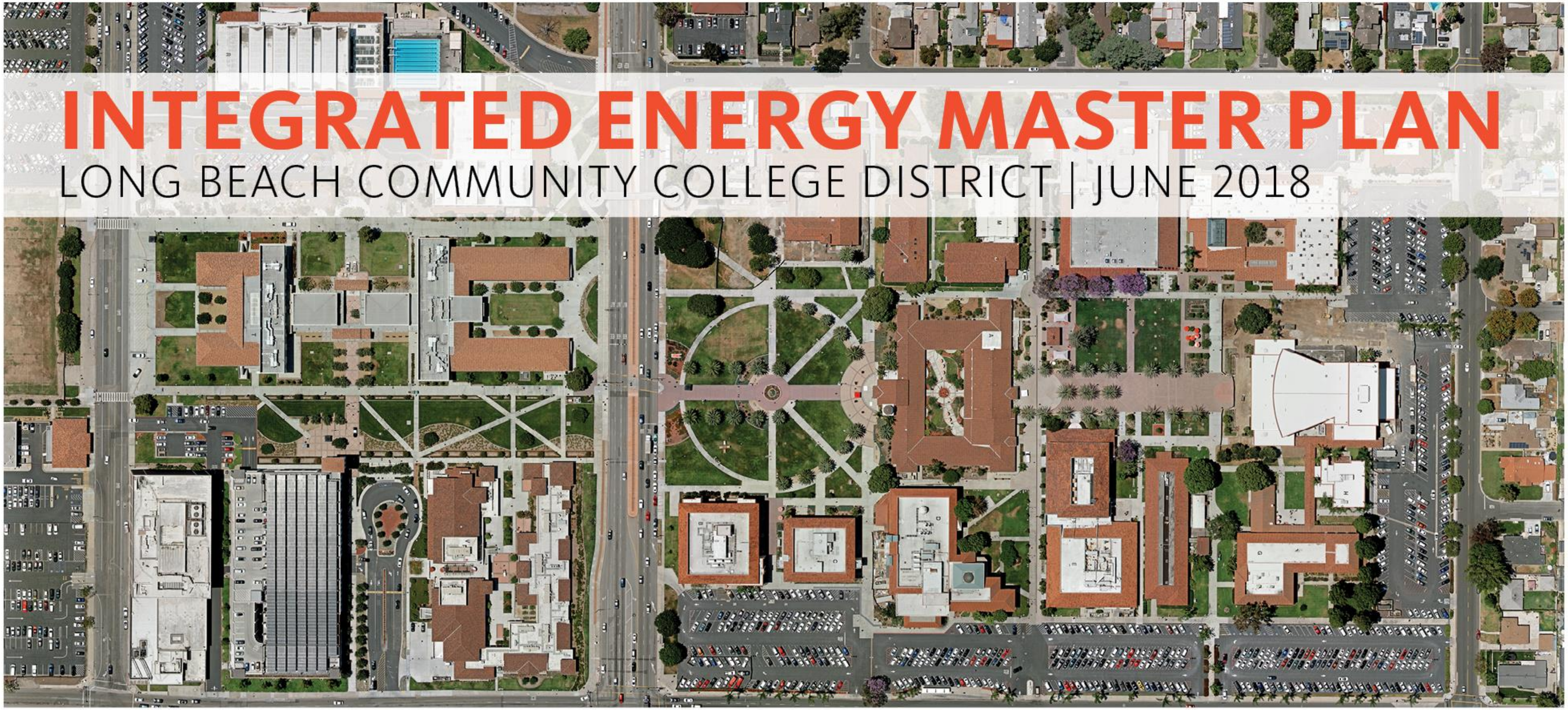
INTEGRATED ENERGY MASTER PLAN

LONG BEACH COMMUNITY COLLEGE DISTRICT | JUNE 2018



LONG BEACH CITY COLLEGE

CORDOBA CORPORATION
SACRAMENTO • SAN FRANCISCO • CHATSWORTH
LOS ANGELES • SANTA ANA • SAN DIEGO

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Architecture Engineering Planning Interiors

P2S ENG

LBCC IEMP

	District	LAC	PCC
No. of Buildings	48	30	18
Gross SF of Buildings	1,581,982	1,293,419	288,563
Staff	1282	1105	177
Students	25,811	20,642	5161
Electricity (kwh)	14,597,844	11,018,909	3,578,935
Natural Gas (therms)	369,315	307,085	62,230
Water (gallons)	21,120,452	14,246,408	6,874,044
Utility Costs	$2,592,418	$1,869,657	$722,761
Vehicles	127	/	/

steps in **energy master planning**

Step 1: Vision

- Identify drivers and set goals with timelines
- Convert goals into measurable KPIs (Key Performance Indicators)

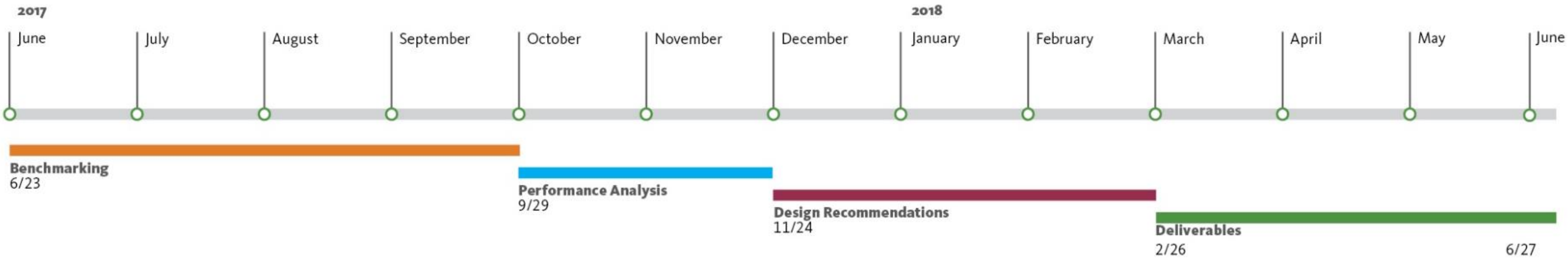
Step 2: Macro-scale Plan

- Implementable plan that identifies
  - Strategies to achieve set goals.
  - Projects that includes Strategies with acceptable ROI.
  - Timelines with funding opportunities.

Step 3: Micro-scale Initiatives

- Measurable and verifiable implementation projects
  - At campus level
  - At building level

scope and **schedule**



PLANNING PROCESS

Benchmark	Analyze	Design
DATA GATHERING + BENCHMARKING	PERFORMANCE ANALYSIS + TARGET SETTING	DEVELOPING DESIGN RECOMMENDATIONS

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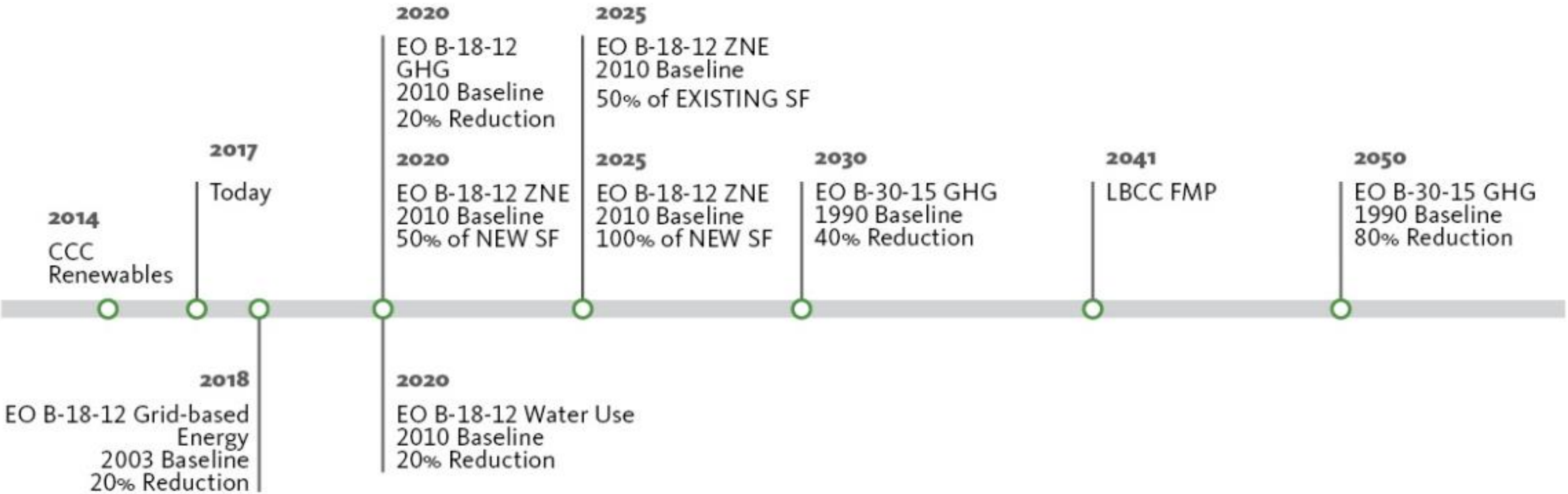
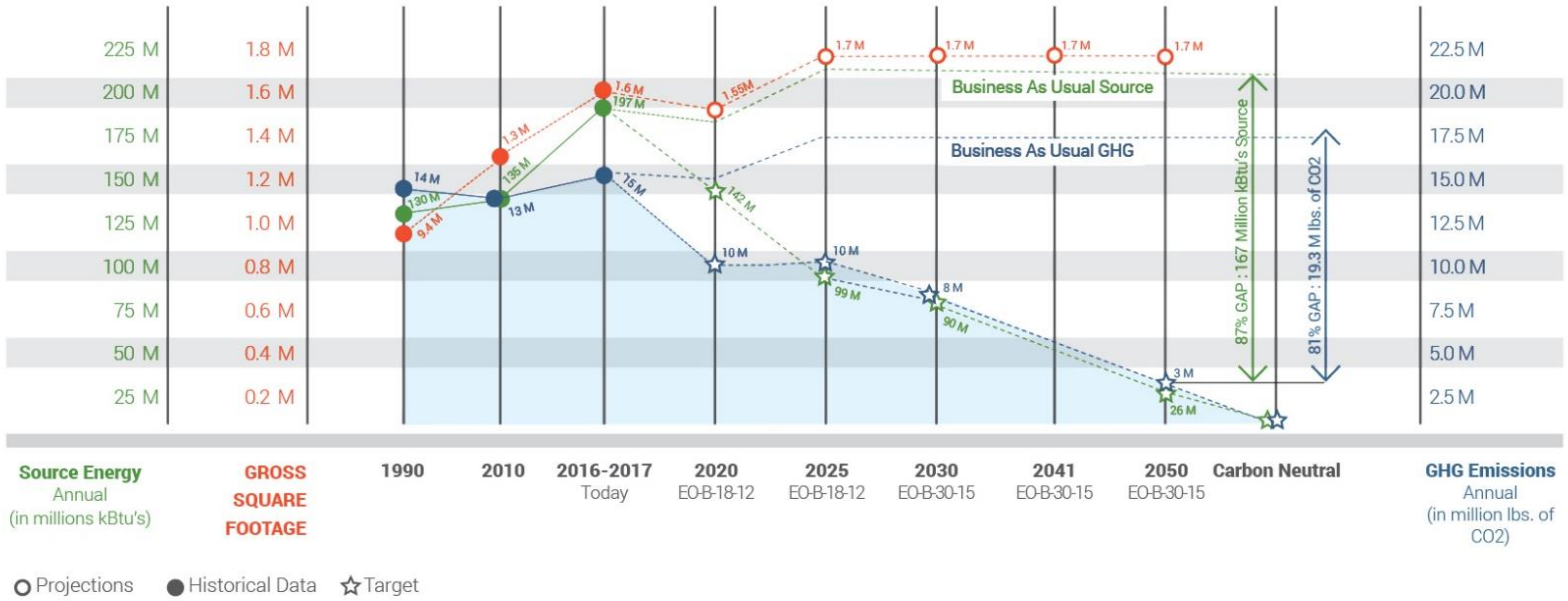
key metrics + **timelines**



setting **targets**



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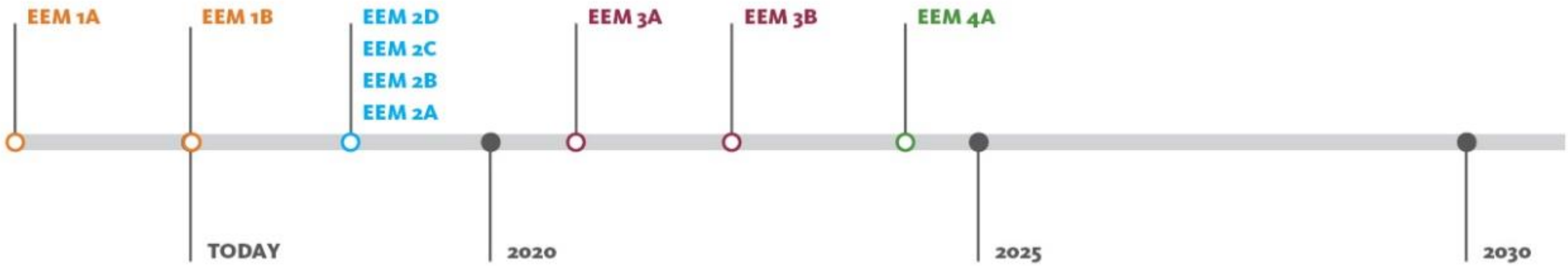
performance analysis – **lenses**

Use	Produce	Store	Share	Procure
REDUCE LOADS + BENCHMARKING	ACTIVE /PASSIVE RENEWABLES + CO-GENERATION	ACTIVE/PASSIVE THERMAL + ELECTRIC STORAGE	HEAT RECOVERY + SMART CONTROLS	ALTERNATIVE CLEANER POWER + RENEWABLE ENERGY OFFSETS

design **recommendations**



EEM 1 A

- Measures taken in the past.
- Measure E and Prop 39 Projects

EEM 1 B

- Measures currently pursuing to continue best practices in travel offsets, water efficiency and design standards.

EEM 2A

- Energy Use Reduction Strategies
- Implementing retro-commissioning and ASHRAE Level 1 & 2 recommendations including additional metering and reclaimed water conversion at LAC cooling tower.

EEM 2B

- Renewable Energy Production Strategies
- Solar system installations in phases.

EEM 2C

- Thermal Storage Strategies within buildings.
- Phase Change Material Technology implementation pilot at PCC followed by full implementation.

EEM 2D

- Clean energy use strategies for transportation.
- Install electric vehicle charging stations District wide.

EEM 3A

- Electric storage strategies at campus level.
- Install battery storage solutions.

EEM 3B

- Share and manage energy for resiliency
- Implement micro-grid solutions utilizing Siemens Controls.

EEM 4A

- Renewable Energy Production Strategies
- Install additional solar systems as needed to accommodate growth.

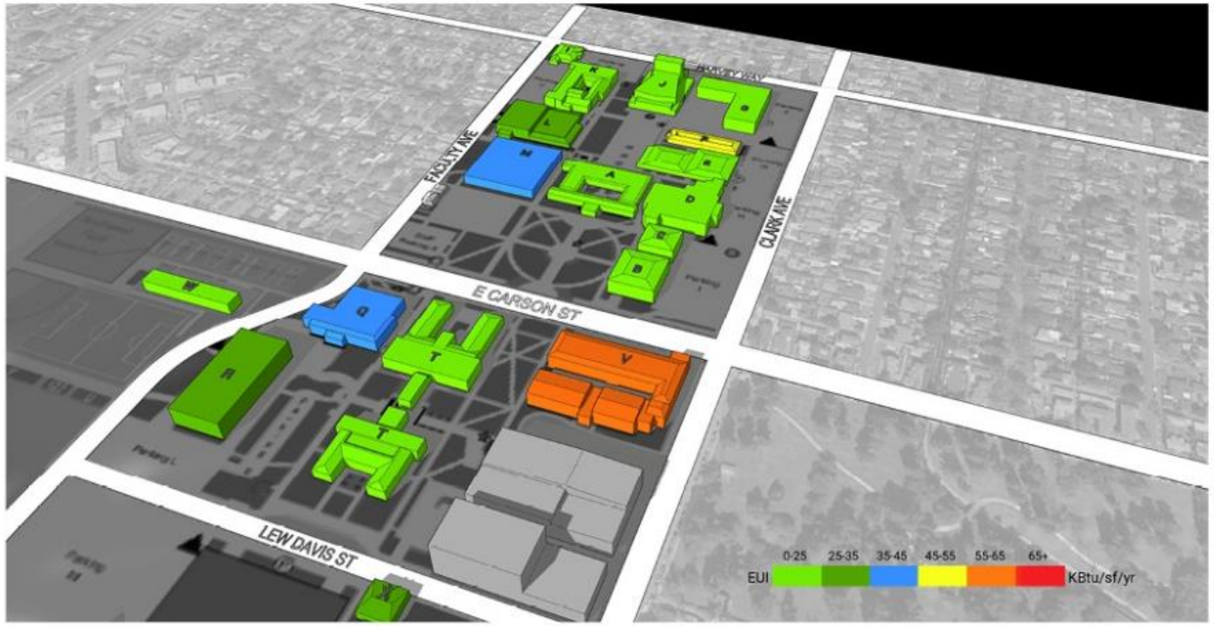
EEM 5-10

- Continue best practices periodic assessment of meeting targets every three years until 2050 and applying necessary best practices and technology to close the gap.

anticipated **results**

BEFORE:
Energy Use Intensity Graph for LAC

AFTER:
Energy Use Intensity Graph for LAC



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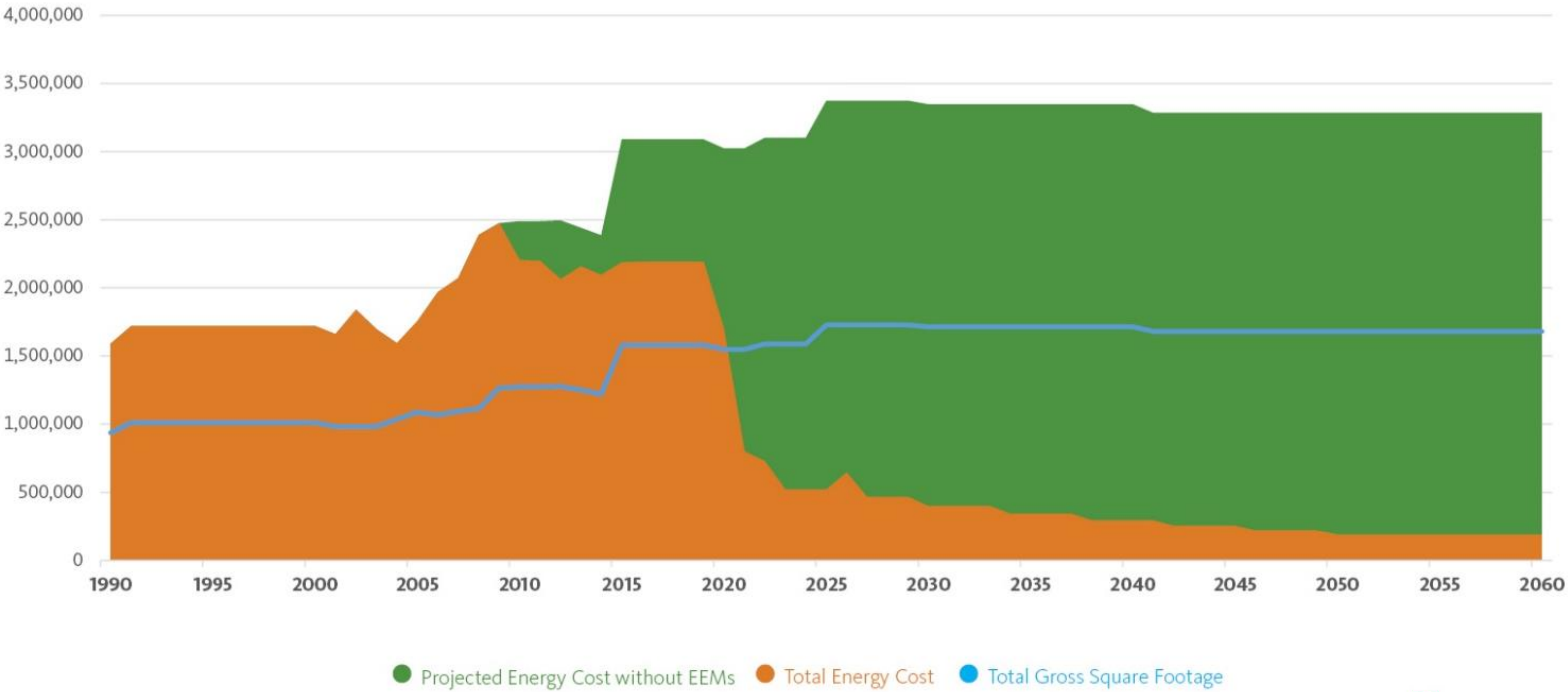
general fund **savings**



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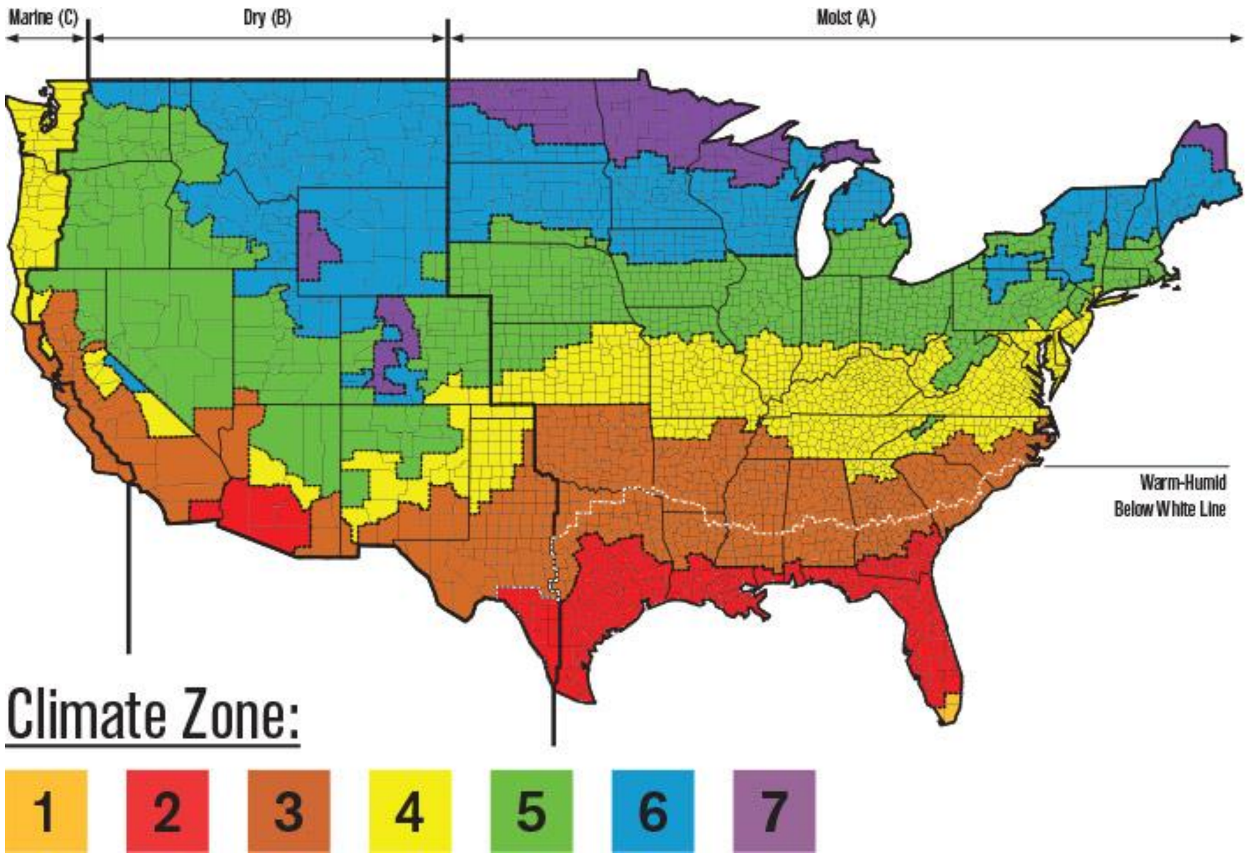
the **game**

the **game**

Hypothetical Hi-ED campus

- Total built area: 2,000,000 SF
- Climate zone: ASHRAE 4A
- Sustainability: LEED certified equivalent
- Energy performance: At least 5% better than code



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building **types**

BUILDING TYPE PROGRAM: CLASSROOMS

AREA RATIO	30%	50% existing, 50% new
SITE FUEL RATIO - GAS	17%	
SITE FUEL RATIO - ELECTRIC	83%	

DLR Group WORKSHOP FLASHCARDS

BUILDING TYPE PROGRAM: LABORATORIES

AREA RATIO	20%	50% existing, 50% new
SITE FUEL RATIO - GAS	33%	
SITE FUEL RATIO - ELECTRIC	67%	

DLR Group WORKSHOP FLASHCARDS

BUILDING TYPE PROGRAM: RESIDENTIAL

AREA RATIO	20%	All existing
SITE FUEL RATIO - GAS	13%	
SITE FUEL RATIO - ELECTRIC	87%	

DLR Group WORKSHOP FLASHCARDS

building **types**

BUILDING TYPE PROGRAM: COMMUNITY

AREA RATIO	20%	All existing
SITE FUEL RATIO - GAS	50%	
SITE FUEL RATIO - ELECTRIC	50%	

DLR Group WORKSHOP FLASHCARDS

BUILDING TYPE PROGRAM: ADMINISTRATION

AREA RATIO	10%	All existing
SITE FUEL RATIO - GAS	12%	
SITE FUEL RATIO - ELECTRIC	88%	

DLR Group WORKSHOP FLASHCARDS

CAMPUS PROGRAM: TOTAL CAMPUS

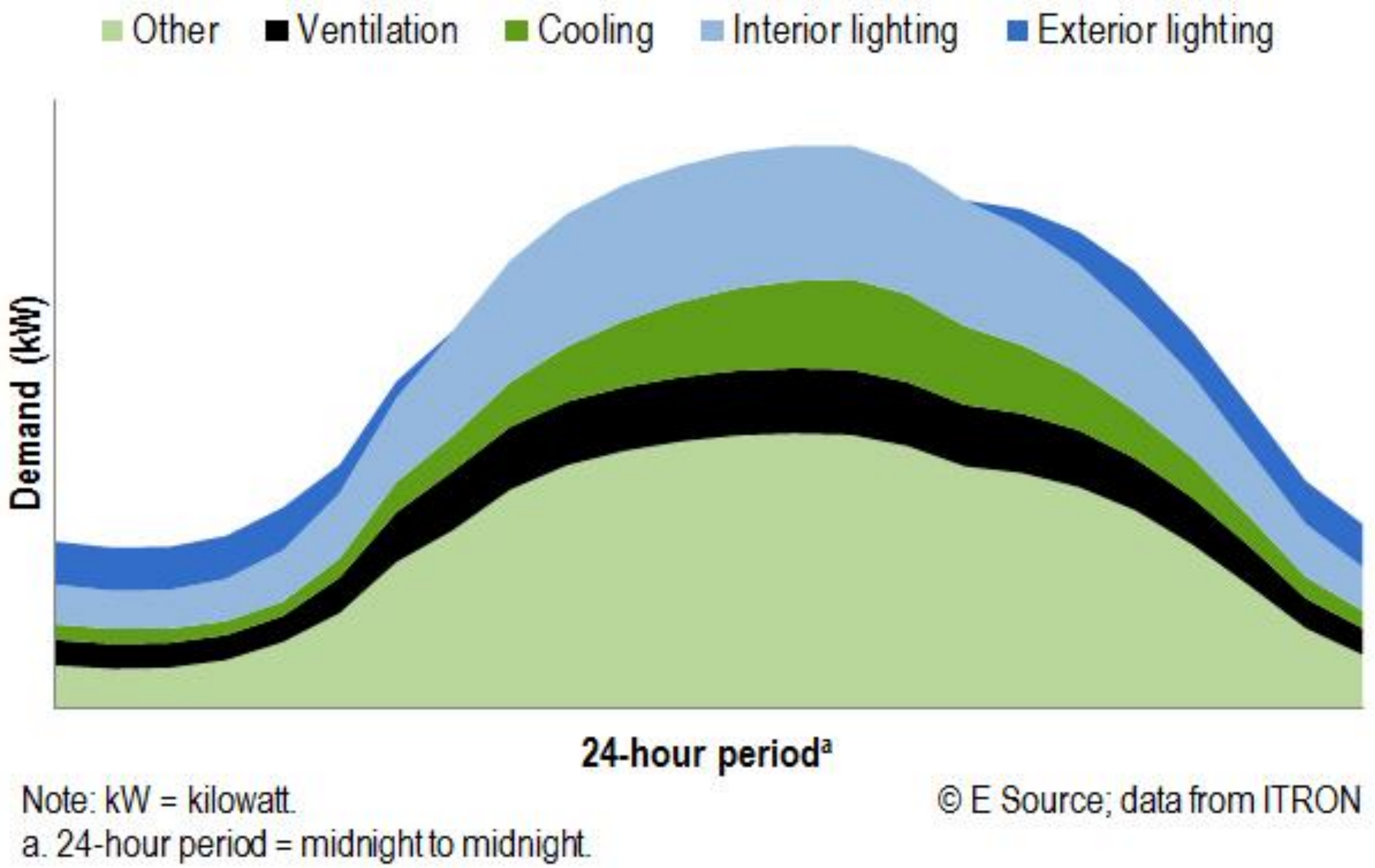
AREA RATIO	100%	65% existing, 35% new
SITE FUEL RATIO - GAS	31%	
SITE FUEL RATIO - ELECTRIC	69%	

DLR Group WORKSHOP FLASHCARDS

three **activities**

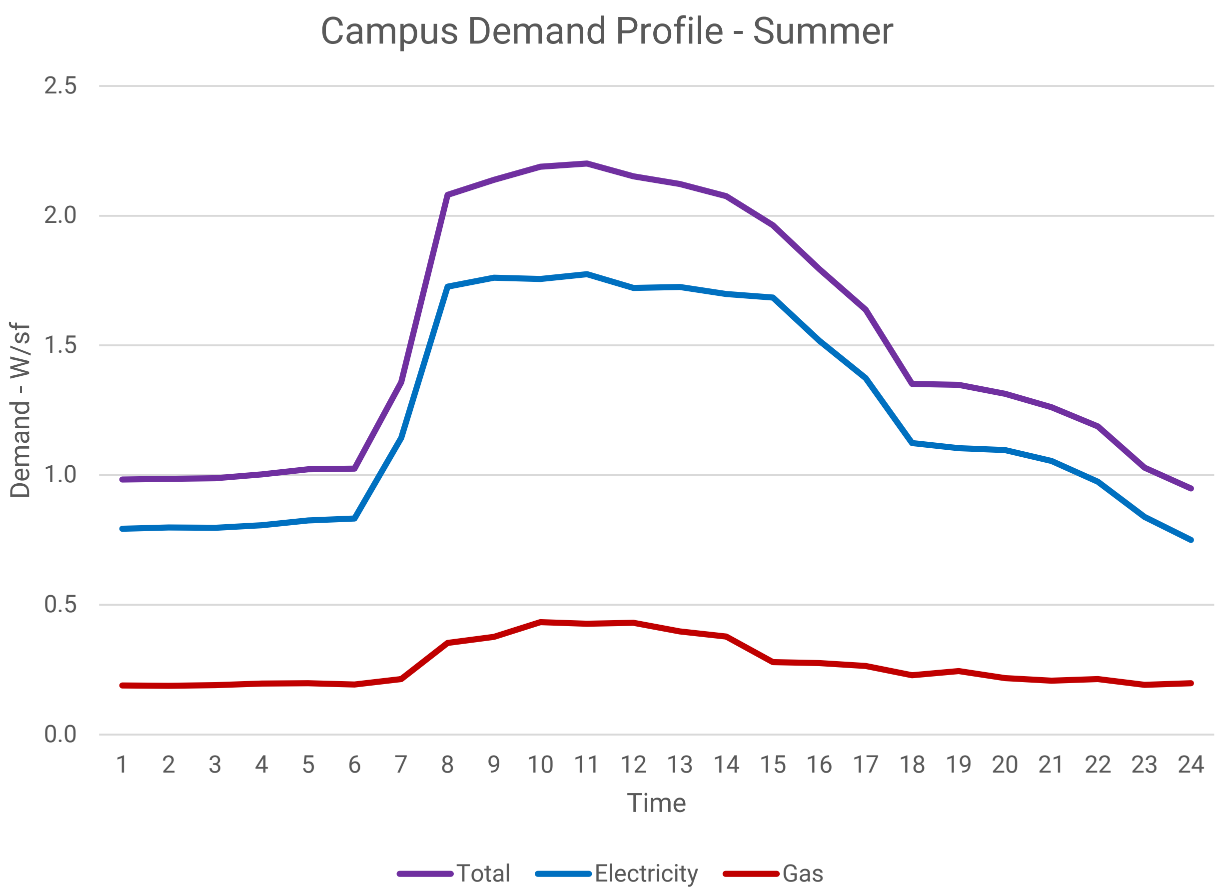
- Step 1: demand profiles
  - when is energy used?
- Step 2: energy use / cost
  - how is energy used?
- Step 3: net-zero strategy
  - what do you do to achieve the goal?
  - (20 minutes)

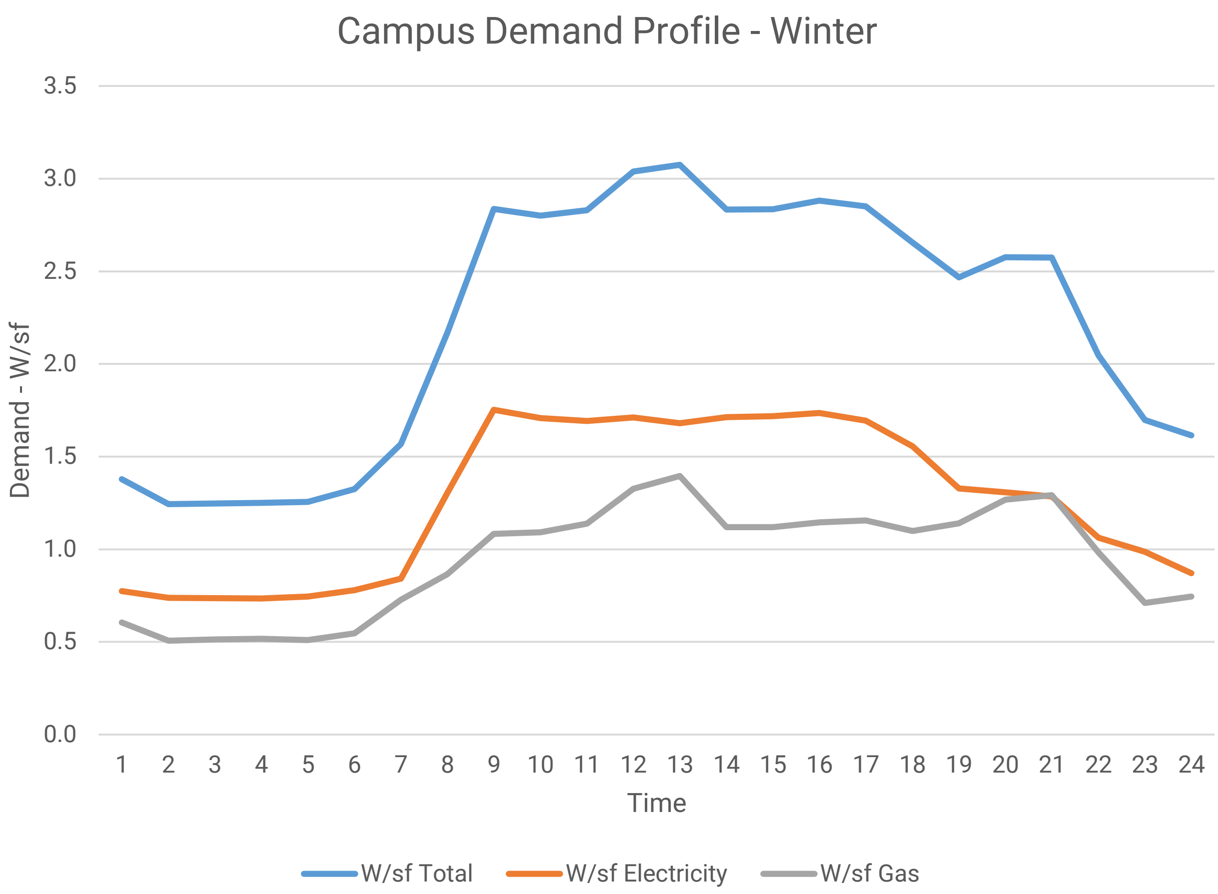
step 1: demand **profiles**



- Load profile for a typical college building in California

step 1 : demand **profiles**





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step 2: energy **use/cost**

- this exercise is to establish an energy budget per building type
- 100 blocks for electricity
- 100 blocks for gas
- 5 building type cards

- goal: how much source energy does each building consume in gas and electricity?

- total campus source energy use / site energy cost budget should equal to 100.

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step 2 : energy **use/cost**

BUILDING TYPE PROGRAM: CLASSROOMS	
AREA RATIO	30% 50% existing, 50% new
SITE FUEL RATIO - GAS	17%
SITE FUEL RATIO - ELECTRIC	83%

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source energy units: 18 (E – 17, G – 1)

energy cost units: 19 (E – 18, G – 1)

BUILDING TYPE PROGRAM: LABORATORIES	
AREA RATIO	20% 50% existing, 50% new
SITE FUEL RATIO - GAS	33%
SITE FUEL RATIO - ELECTRIC	67%

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source energy units: 34 (E – 29, G – 5)

energy cost units: 33 (E – 29, G – 4)

BUILDING TYPE PROGRAM: RESIDENTIAL	
AREA RATIO	20% All existing
SITE FUEL RATIO - GAS	13%
SITE FUEL RATIO - ELECTRIC	87%

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source energy units: 17 (E – 16, G – 1)

energy cost units: 17 (E – 16, G – 1)

step 2 : energy **use/cost**

BUILDING TYPE PROGRAM: COMMUNITY

AREA RATIO	20% All existing
SITE FUEL RATIO - GAS	50%
SITE FUEL RATIO - ELECTRIC	50%

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source energy units: 25 (E – 18, G – 7)

energy cost units: 24 (E – 19, G – 5)

BUILDING TYPE PROGRAM: ADMINISTRATION

AREA RATIO	10% All existing
SITE FUEL RATIO - GAS	12%
SITE FUEL RATIO - ELECTRIC	88%

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source energy units: 6 (E – 6, G – 0)

energy cost units: 7 (E – 7, G – 0)

CAMPUS PROGRAM: TOTAL CAMPUS

AREA RATIO	100% 65% existing, 35% new
SITE FUEL RATIO - GAS	31%
SITE FUEL RATIO - ELECTRIC	69%

DLR Group WORKSHOP FLASHCARDS

source energy units: 100 (E – 87, G – 13)

energy cost units: 100 (E – 89, G – 11)

step 3: net-zero **strategy**

- this exercise is to apply appropriate strategies to achieve net-zero energy at a campus level
- 87 blocks for electricity
- 13 blocks for gas

- goal: eliminate 100 source energy use units via strategies that have the least capital cost with the most savings on operational costs

- total campus energy use blocks left should equal to 0.

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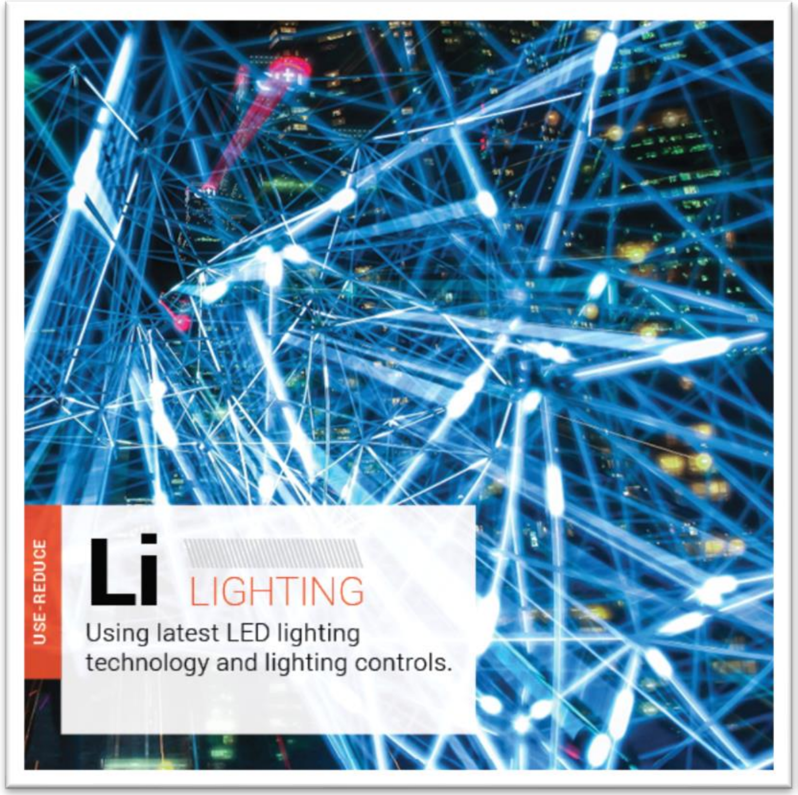
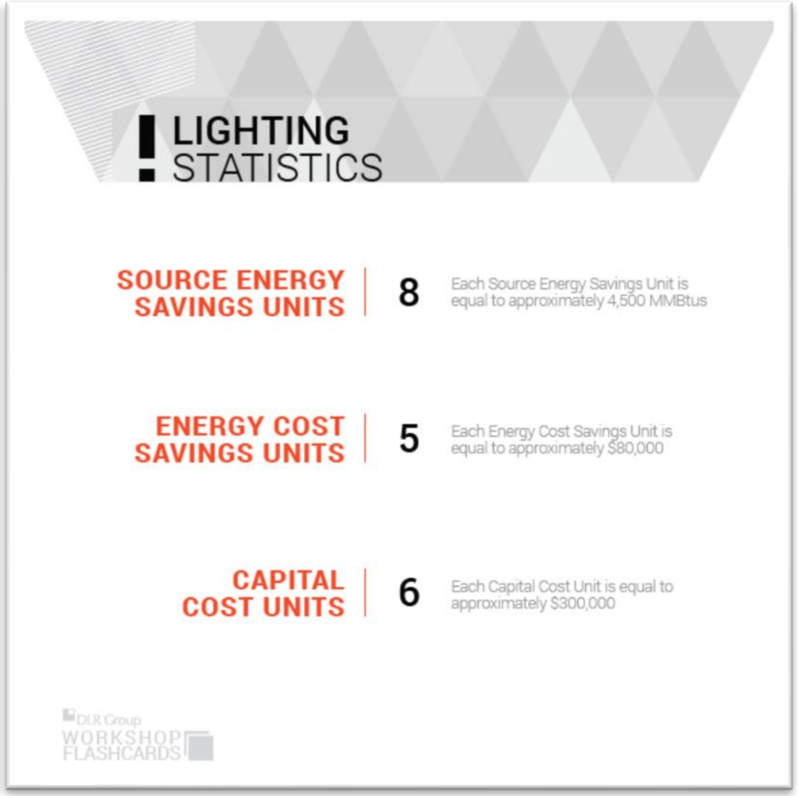
step 3: net-zero **strategy**





- 16 independent strategy cards
- 2 strategies are cumulative
  - solar – 15%, 30%, 45%
  - battery – 15%, 30%, 45%

- with each card, you can eliminate certain number of source energy units
- you will have to gauge how much of that is electricity and gas

- an estimate on actual numbers provided based on our simulation

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discussion

step 3 results: net-zero **strategy**

source energy units savings: 100 (E – 87, G – 13)

energy cost units: 114

capital cost units: 89

strategies:

- solar thermal
- lighting
- retro-commissioning
- low-cost HVAC
- medium-cost HVAC
- phase change materials
- plug-load control
- PV – 30%
- Cogen

- strategies eliminate both gas and electricity
- energy cost units are higher than 100 as synergies between strategies not taken into account

conclusion

Elevate the

human

experience through **design**