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

presenting today

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Facilitator Principal, Global Sustainability Leader

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overview of today

1 - Background

2 - Case Studies

3 - The Game

4 - Discussion

5 - Conclusion

Who **are you?**

Why **are you here?**

- **Expand technical knowledge**
- **To teach others**
- **Climate action plan goal**
- **Only presentation option at this time**
- **Other**

What's your institution type?

University
State College
K-12
Hybrid








Current **requirements**

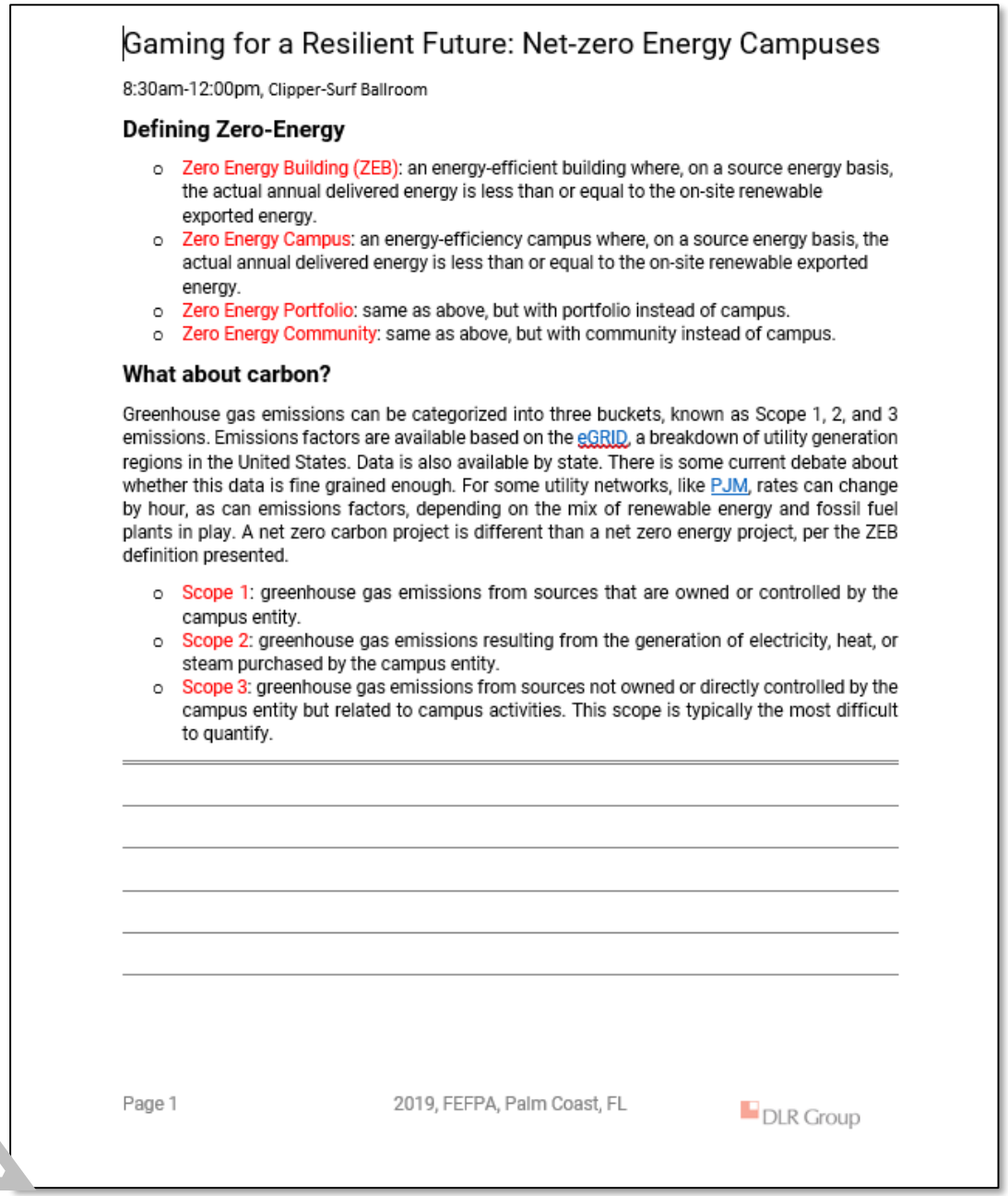
- ✓ Green building certification
- ✓ Life-cycle cost analysis
- ✓ Benchmarking
- ✓ Climate action plan goal
- ✓ Other

Setting the **Stage**

Your Workbook Includes:

Defining Net Zero Energy
Greenhouse Gas Emissions Inventory
Reference Data
- Typical Energy Use
- Emissions Factors
- Building Type Data

Data Collection Worksheet
Resources



Gaming for a Resilient Future: Net-zero Energy Campuses

8:30am-12:00pm, Clipper-Surf Ballroom

Defining 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-efficiency 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 portfolio instead of campus.
- Zero Energy Community: same as above, but with community instead of campus.

What about carbon?

Greenhouse gas emissions can be categorized into three buckets, known as Scope 1, 2, and 3 emissions. Emissions factors are available based on the eGRID, a breakdown of utility generation regions in the United States. Data is also available by state. There is some current debate about whether this data is fine grained enough. For some utility networks, like PJM, rates can change by hour, as can emissions factors, depending on the mix of renewable energy and fossil fuel plants in play. A net zero carbon project is different than a net zero energy project, per the ZEB definition presented.

- Scope 1: greenhouse gas emissions from sources that are owned or controlled by the campus entity.
- Scope 2: greenhouse gas emissions resulting from the generation of electricity, heat, or steam purchased by the campus entity.
- Scope 3: greenhouse gas emissions from sources not owned or directly controlled by the campus entity but related to campus activities. This scope is typically the most difficult to quantify.

Page 1 2019, FEFPA, Palm Coast, FL DLR Group

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

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

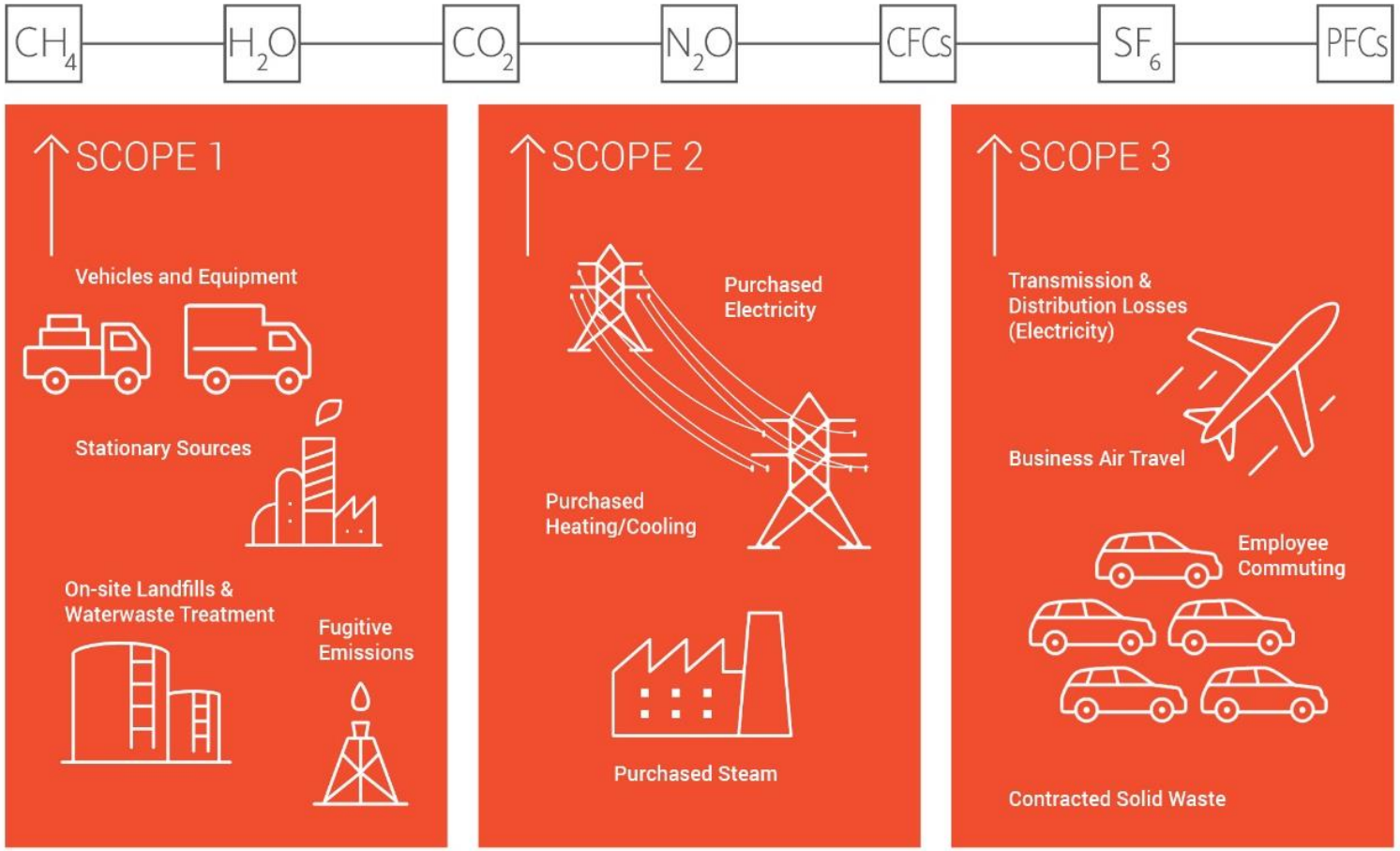
Zero Energy Portfolio

same as above, but with portfolio instead of campus.

Zero Energy Community:

same as above, but with community instead of campus.

Defining **Net Zero Carbon**



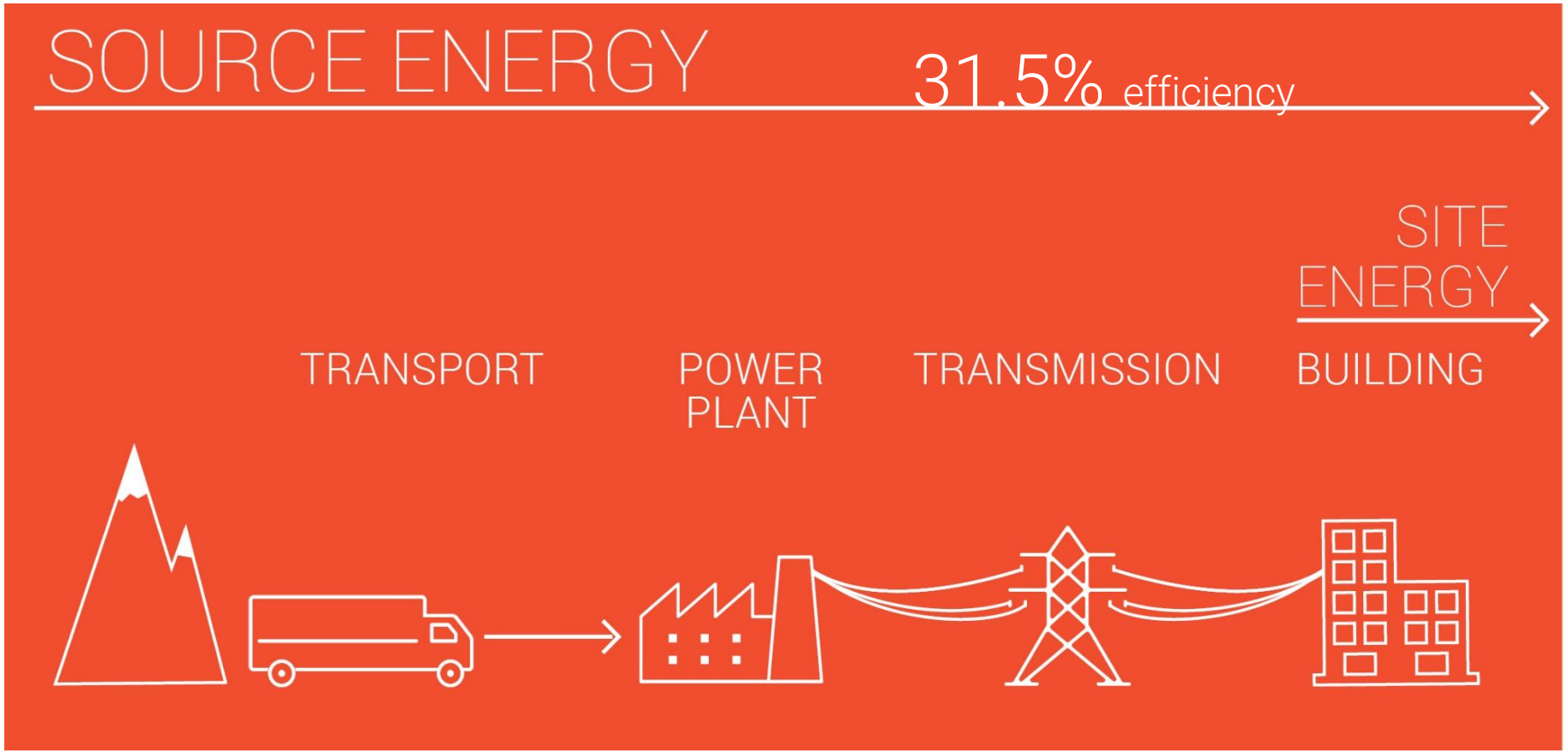
GREENHOUSE GAS EMISSIONS
from sources that are owned or controlled by a federal agency.

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.

WB Pg. 1 + 2

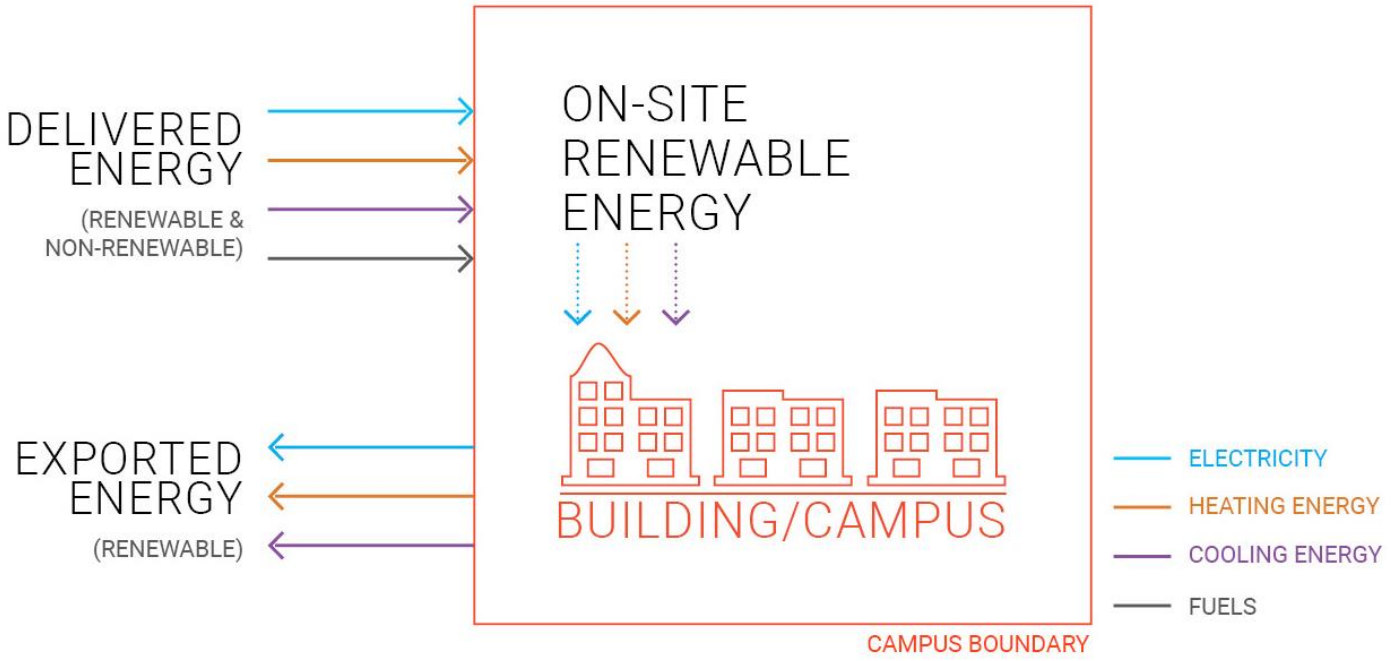
Not all metrics **are created equal**



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

WB Pg. 3 + 10

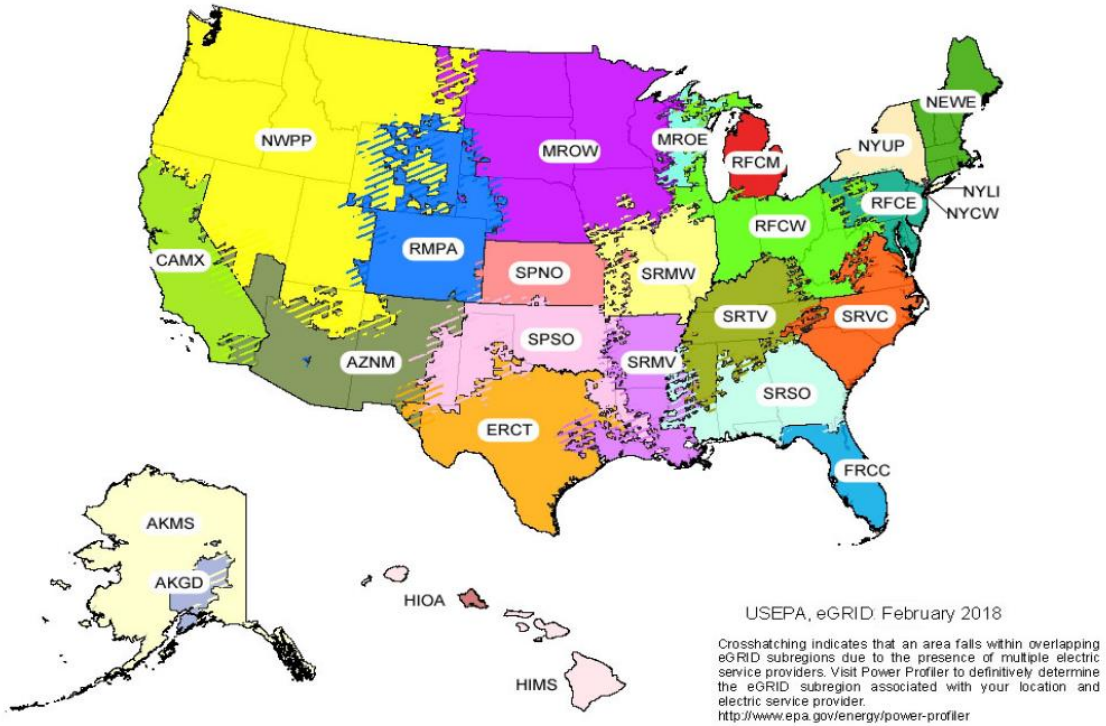
boundaries

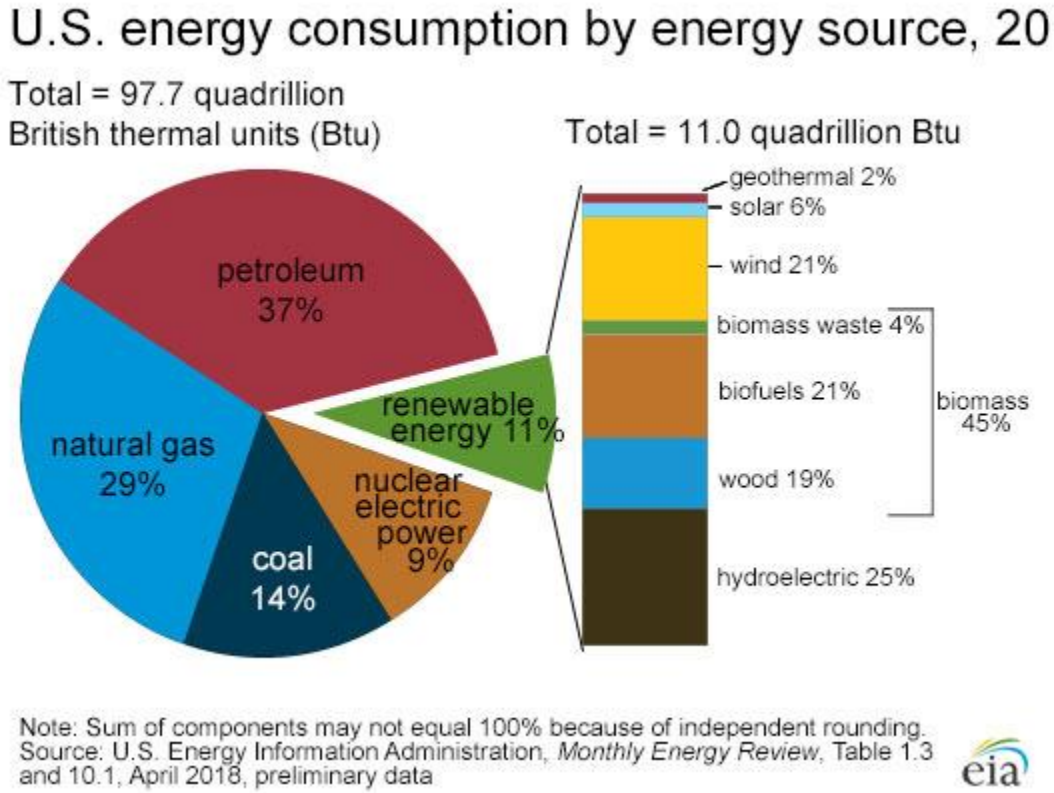


Notes
1. The dotted lines represent energy transfer with the boundary
2. The solid lines represent energy transfer entering/leaving the boundary used for zero energy accounting

the complexity of **energy**

USEPA eGrid
www.epa.gov/energy/power-profiler

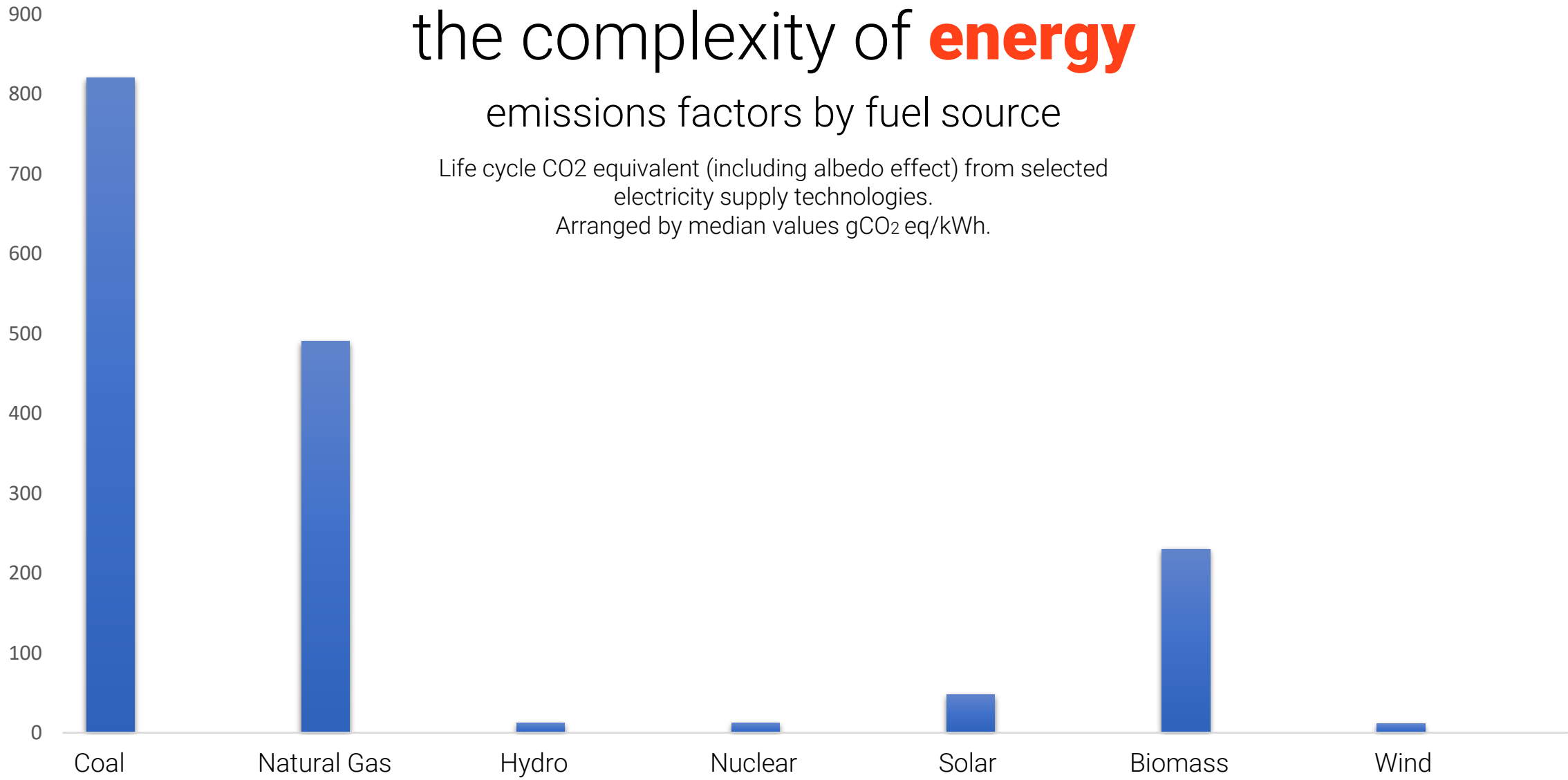




the complexity of **energy**

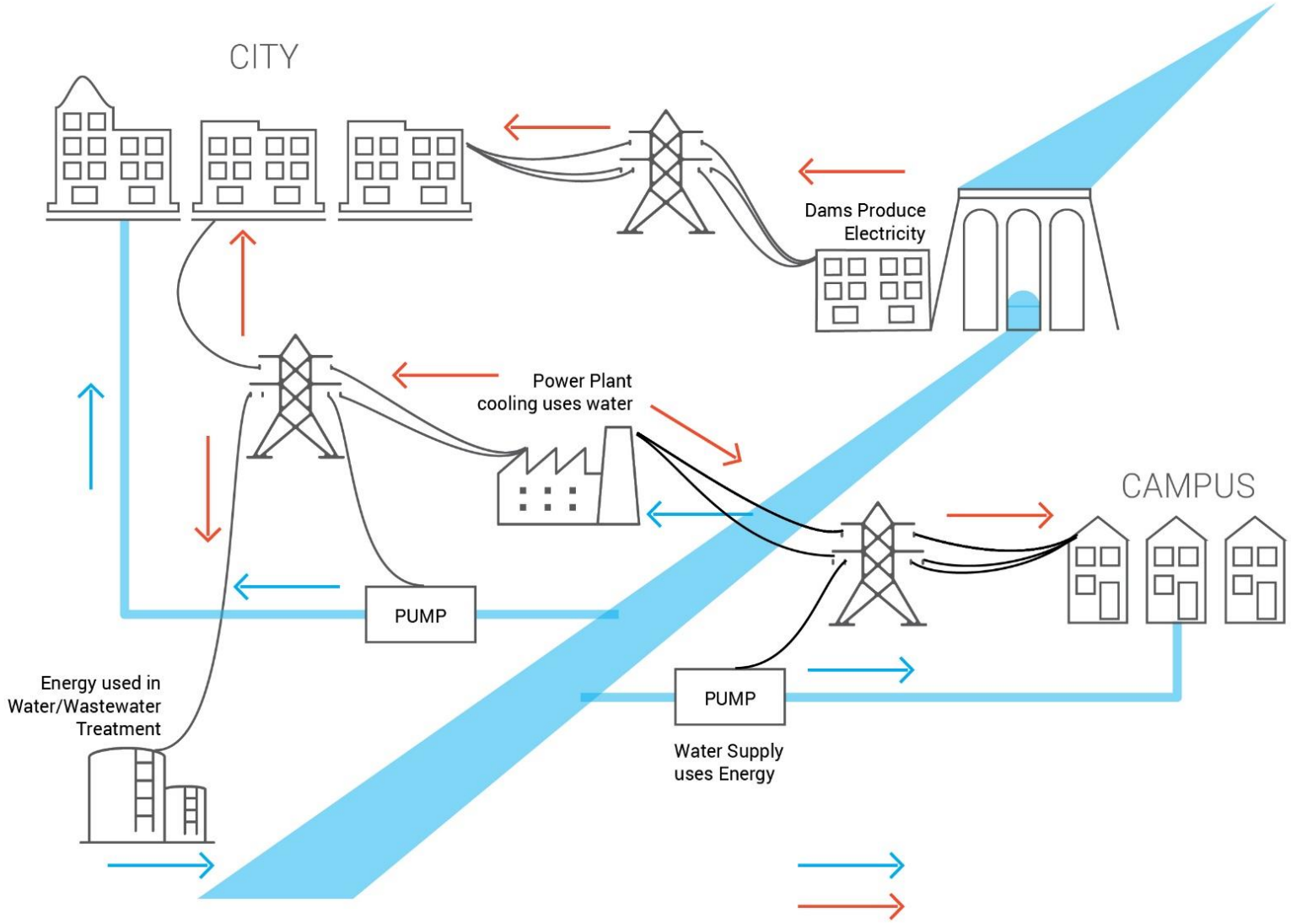
emissions factors by fuel source

Life cycle CO2 equivalent (including albedo effect) from selected electricity supply technologies.
Arranged by median values gCO_2 eq/kWh.



types of **energy**

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



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**

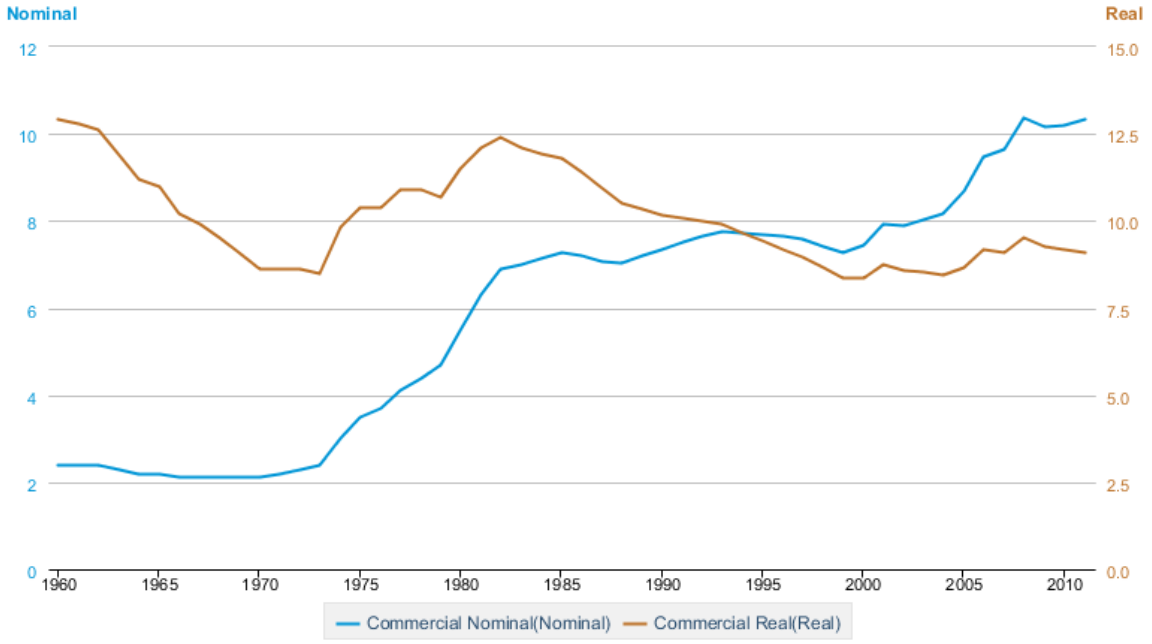
U.S. Medians for Site Energy Use and 2030 Challenge Energy Reduction Targets by Space/Building Type[1] From the Environmental Protection Agency (EPA): Use this chart to find the site fossil-fuel energy targets									
Building Use Description[2]	Available in Target Finder[3]	Median Source EUI[4] (kBtu/Sq.Ft./Yr)	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

campus **energy**

cost trends

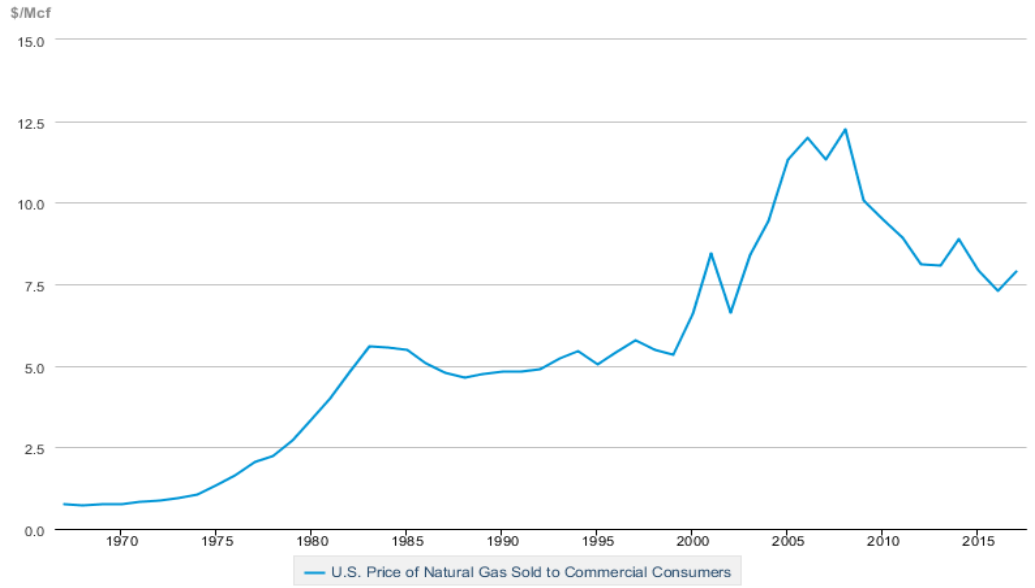
Electricity – average retail price



eia Source: U.S. Energy Information Administration

www.eia.gov/dnav

Natural Gas – average retail price



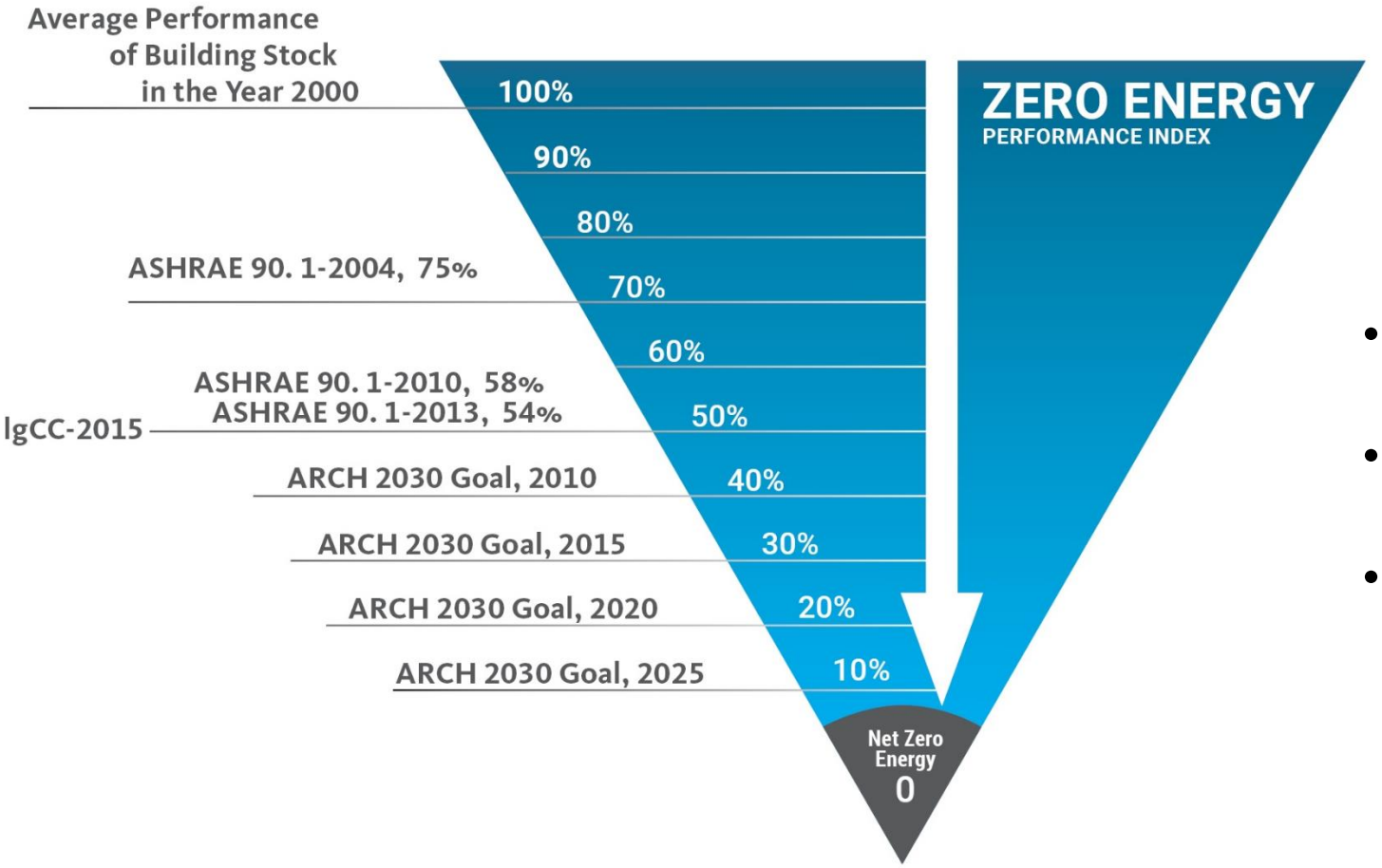
eia Source: U.S. Energy Information Administration

www.eia.gov/electricity

WB Pg. 8 + 9

standards **alignment**

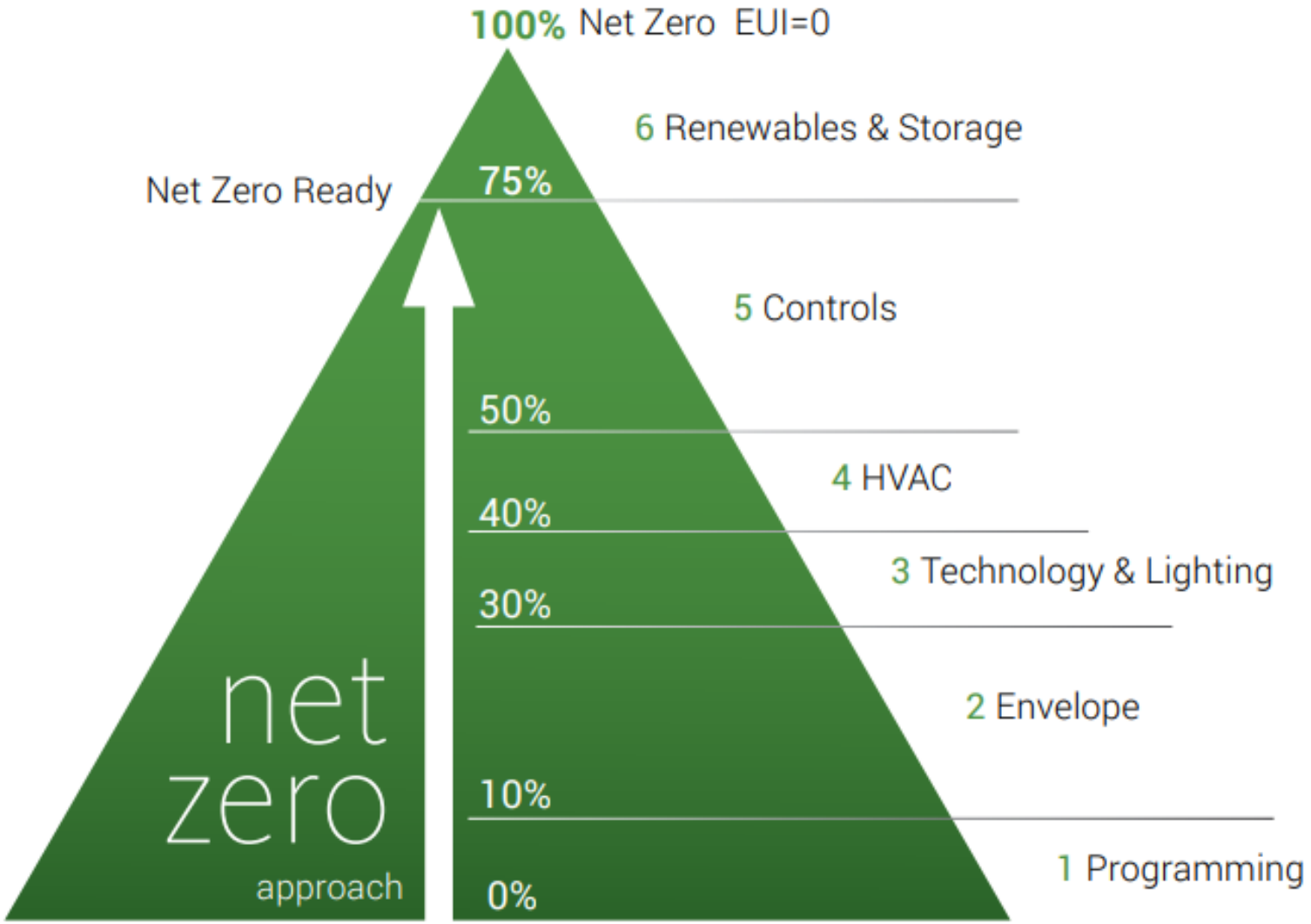
Zero Energy Performance Index – zEPI



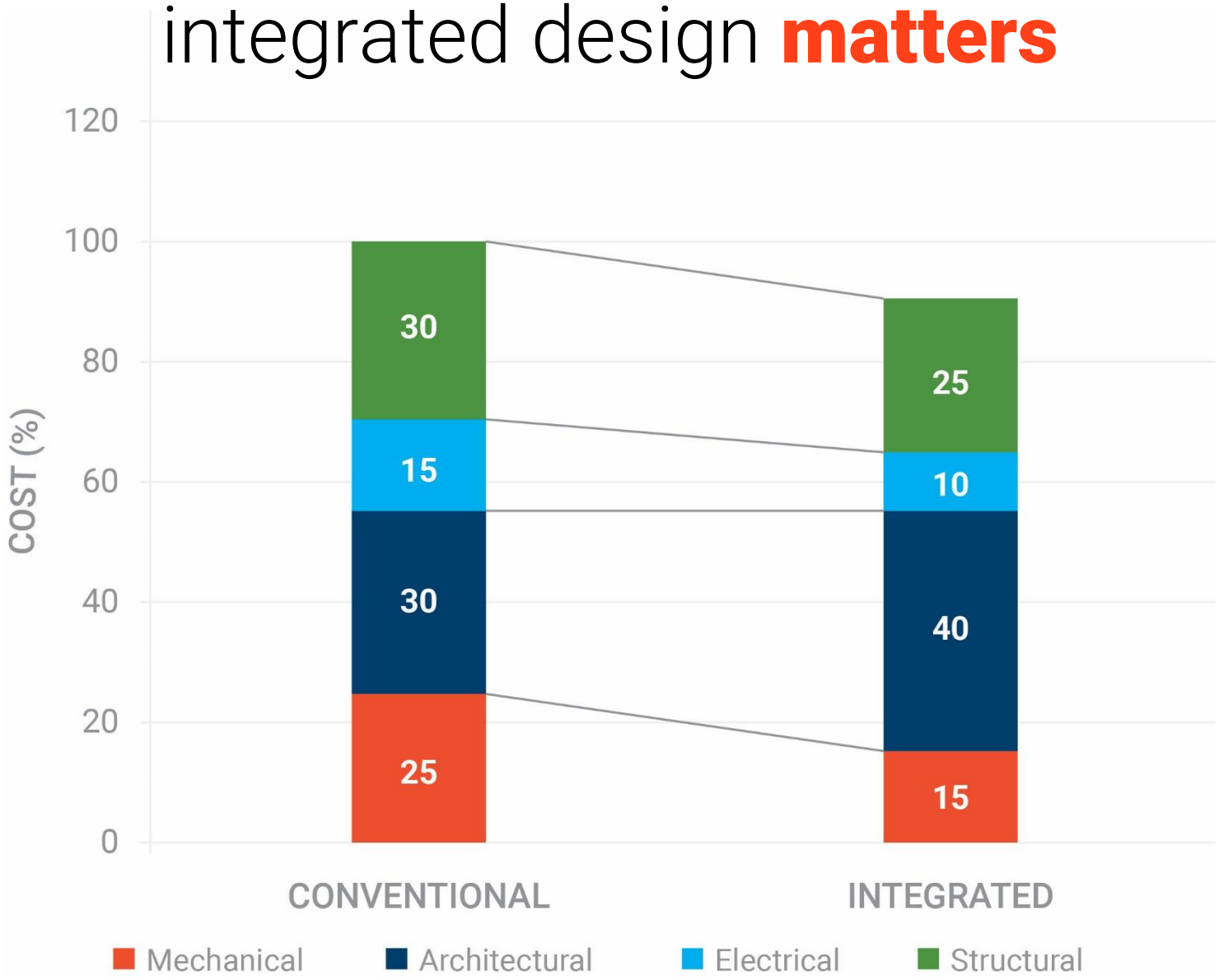
- Normalized Scale to 2003 CBECS = 100, Zero Energy = 0
- Goal was to index code/standard to scale to allow easier comparison
- Source energy basis

design for **net zero**

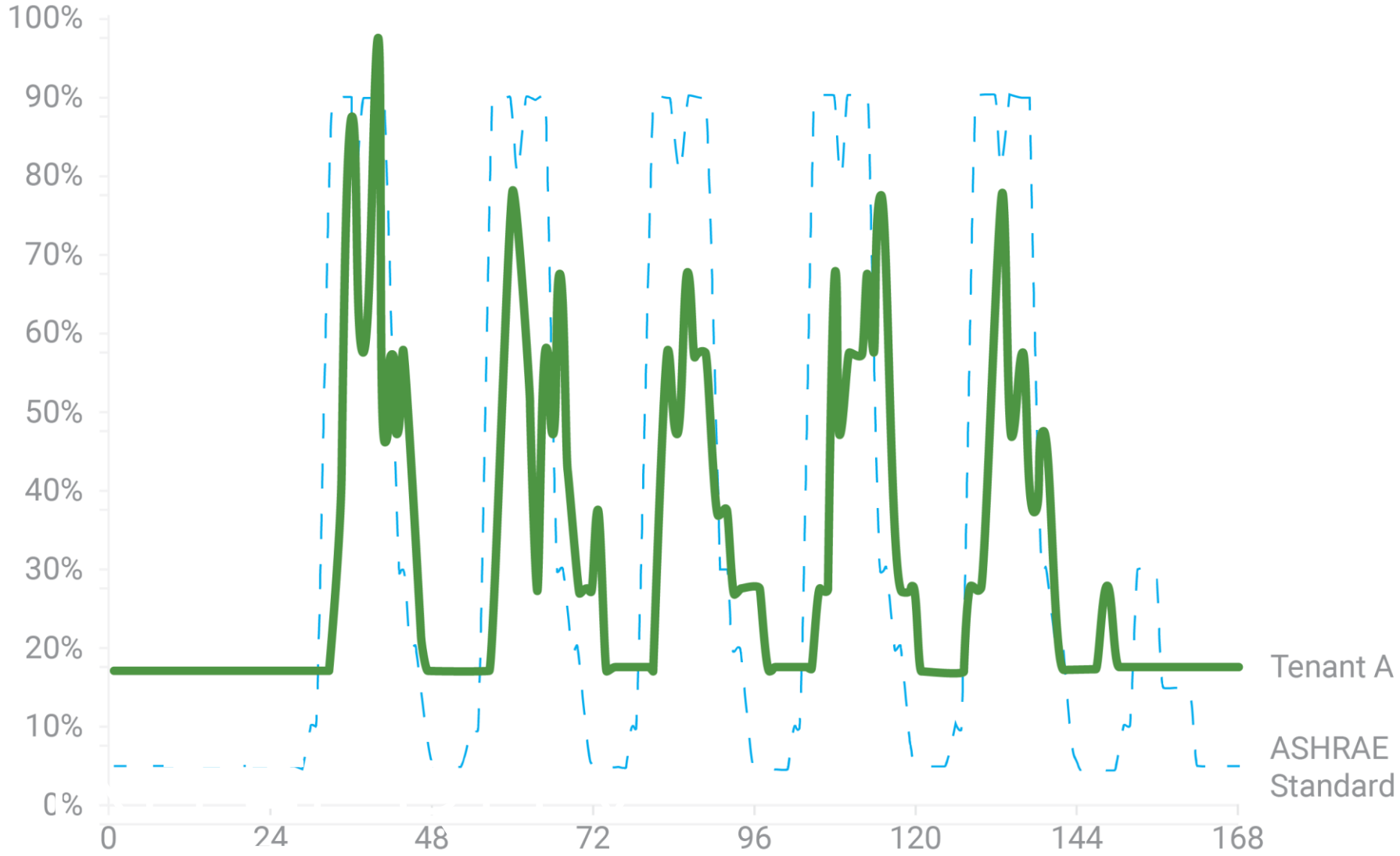
net zero approach



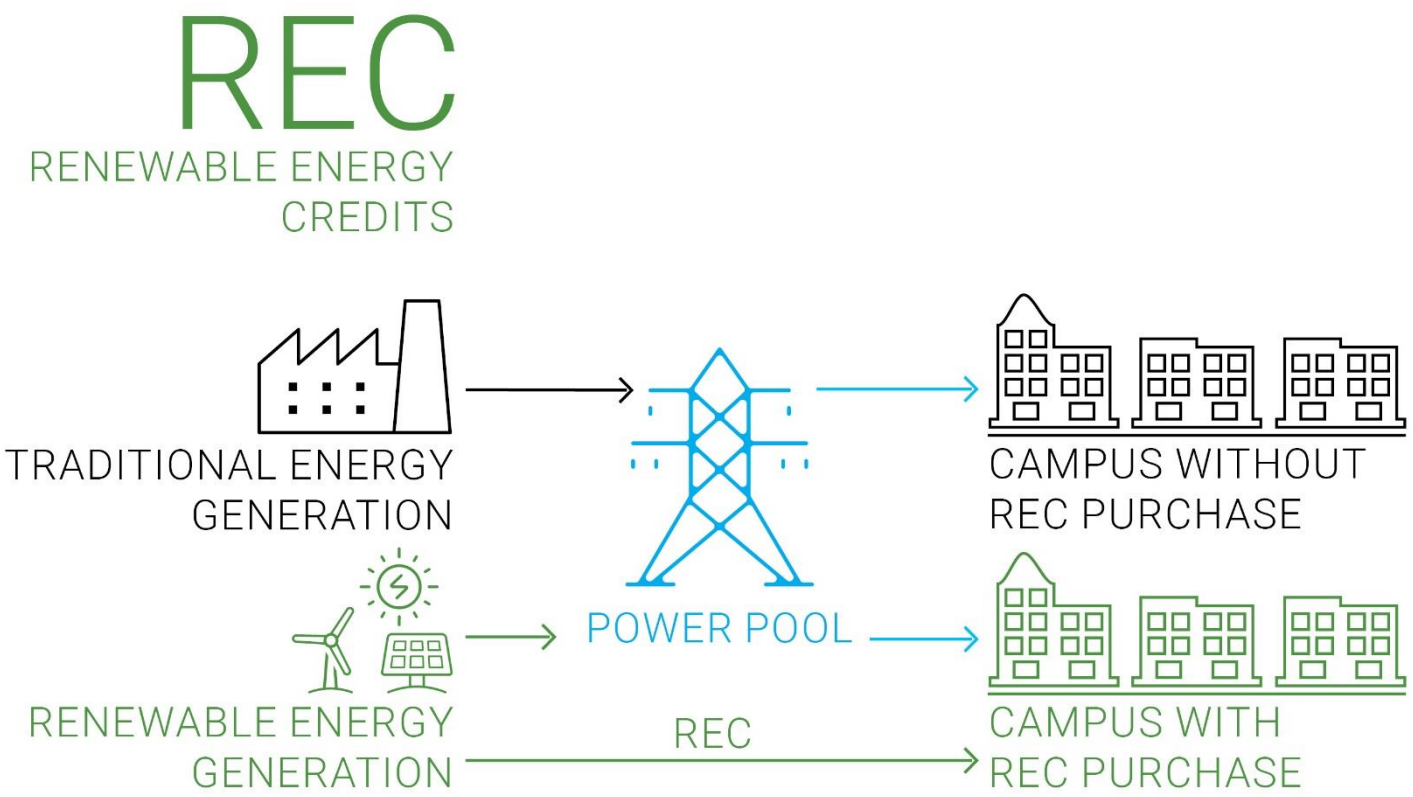
integrated design **matters**



operations **matter**



food for **thought**



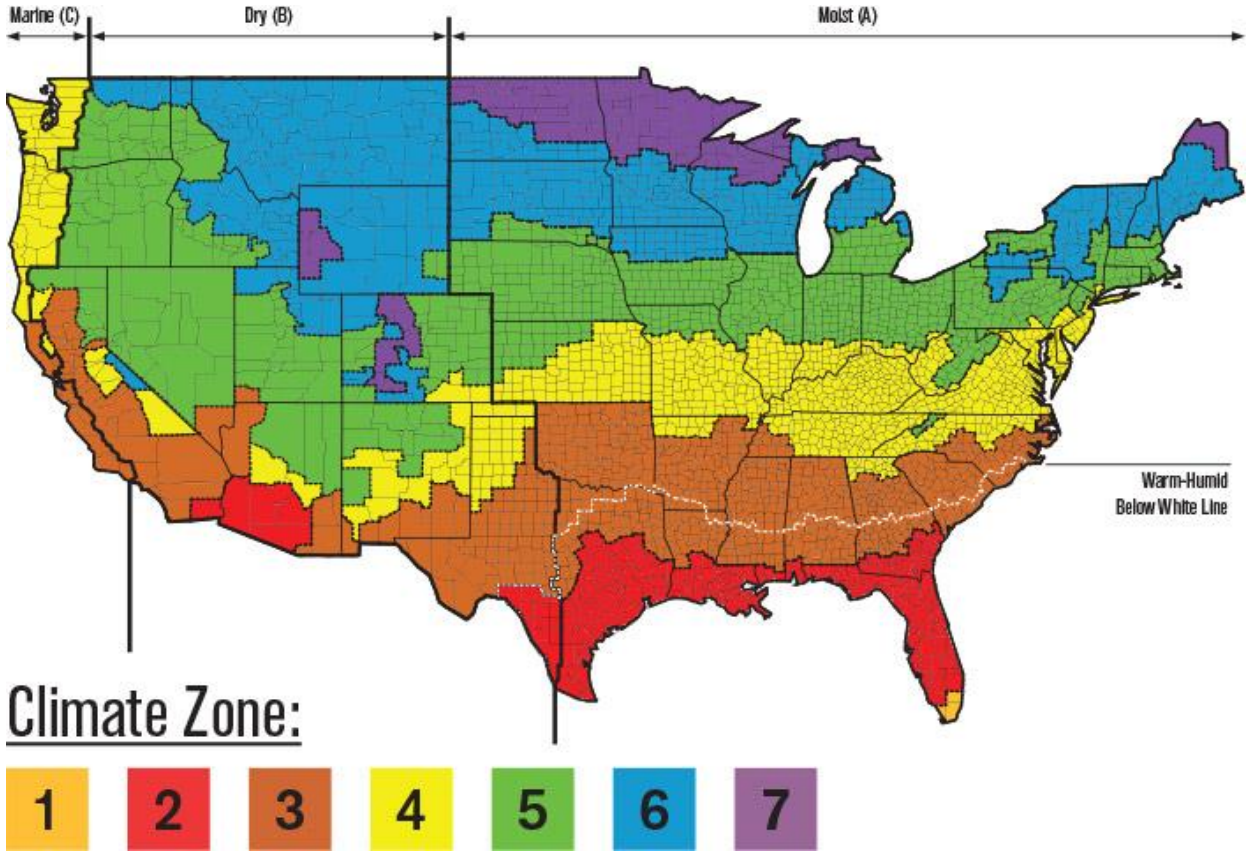
- Electrification
  District Utility + GSHP
  PV Cost
- Value of carbon for life-cycle cost analysis: $20/ton
- The role of renewable energy credits (RECs)

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



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%	

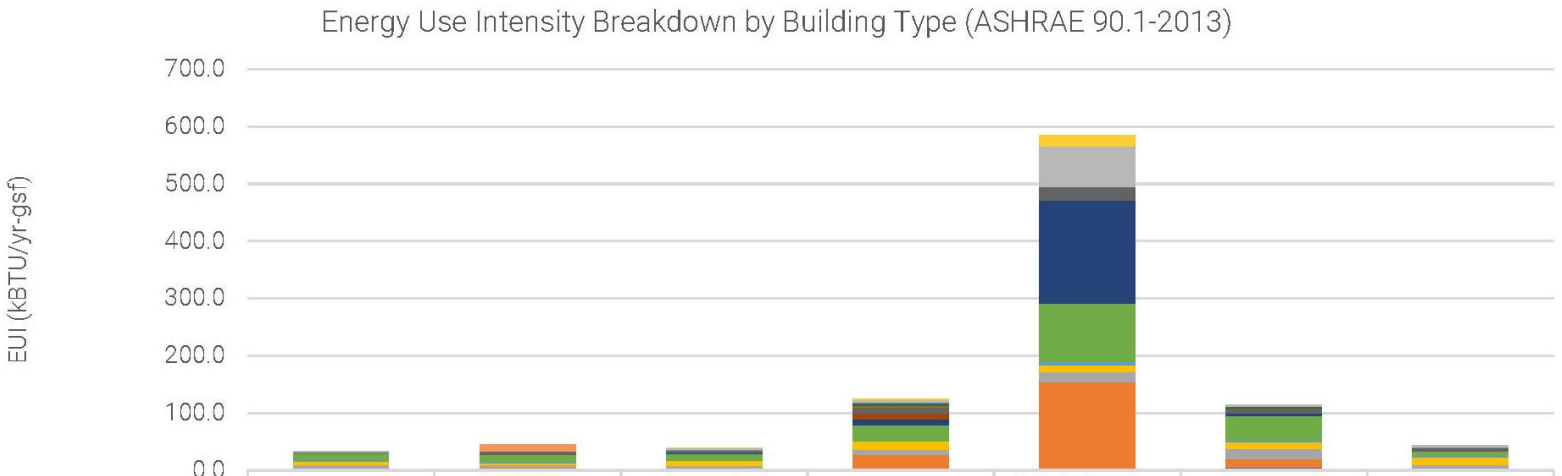
DLR Group WORKSHOP FLASHCARDS

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

prototype **data**

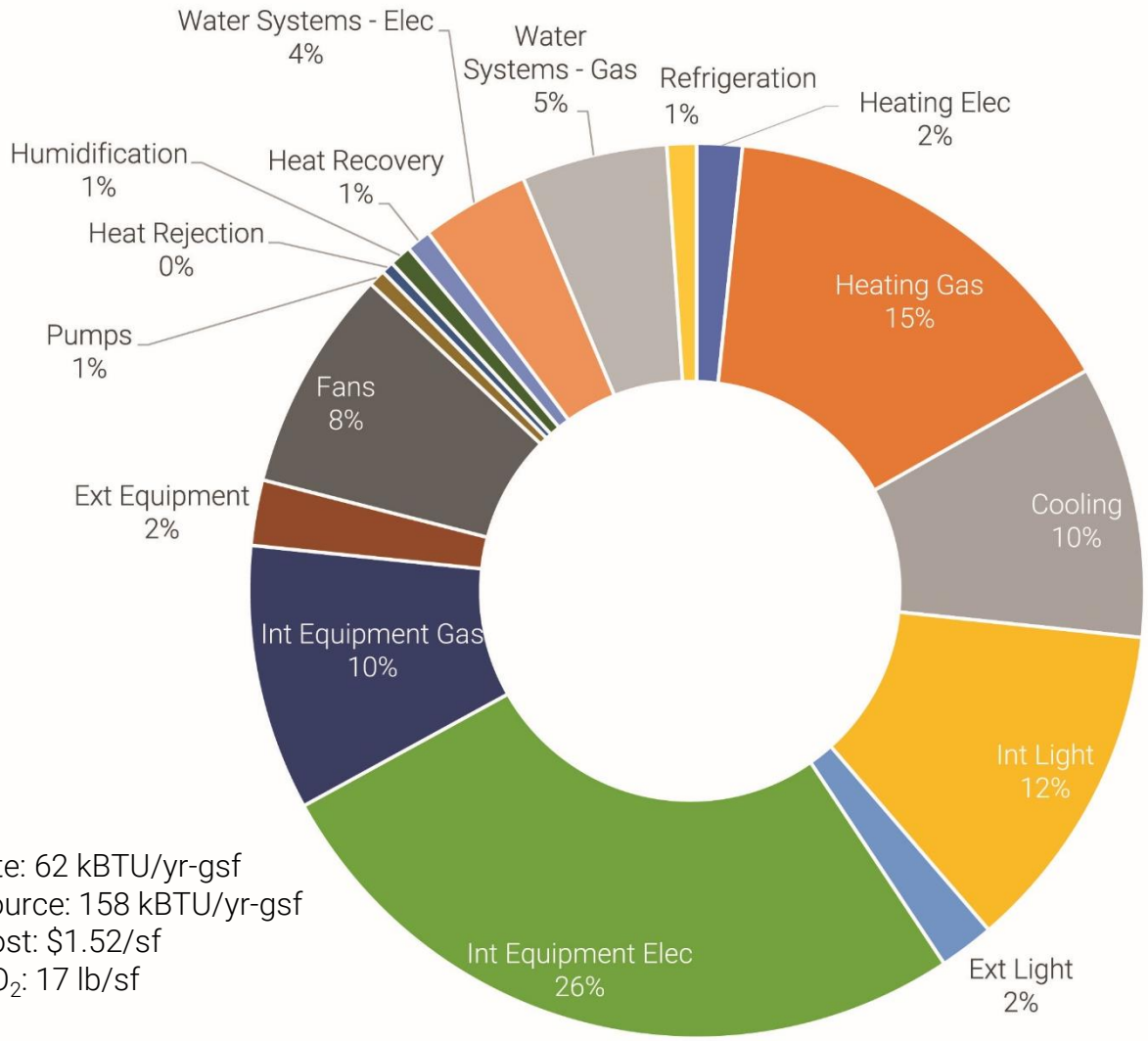


	Medium Office	Mid-Rise Apartment	Secondary School	Hospital	Quick-Service Restaurant	Outpatient	Retail
Refrigeration - E	0.0	0.0	0.6	0.6	19.8	0.0	0.0
Water Systems - G	1.3	0.0	2.2	4.7	70.9	2.9	3.6
Water Systems - E	0.0	11.1	0.7	0.1	0.0	0.0	0.0
Heat Recovery -E	0.0	0.0	1.3	1.0	0.0	0.5	0.8
Humidficiation - 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

WB Pg. 11

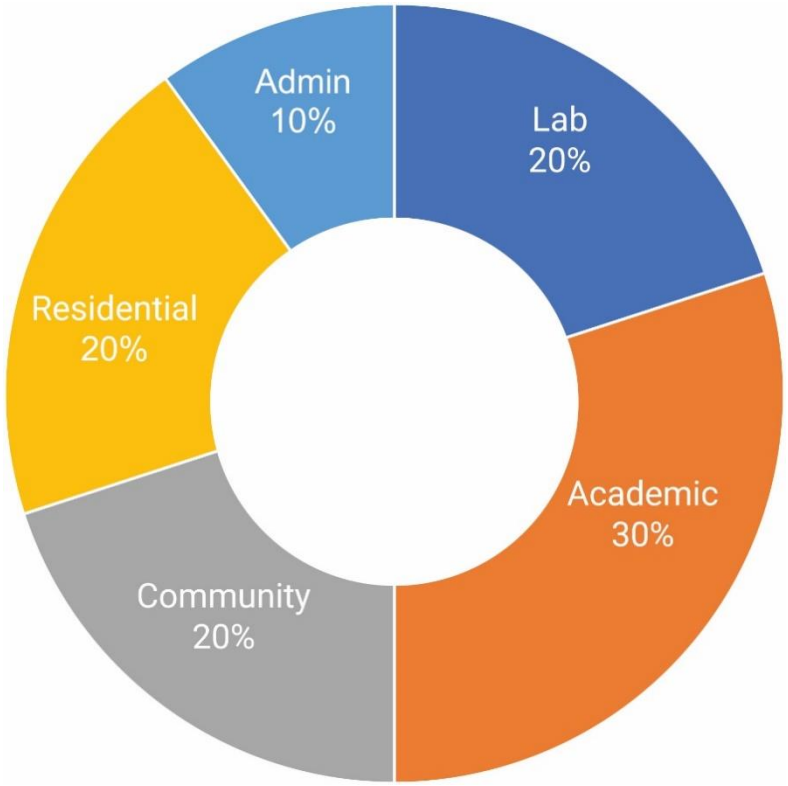
data by **metric** 90.1-2013

Usage by system type



Site: 62 kBTU/yr-gsf
Source: 158 kBTU/yr-gsf
Cost: $1.52/sf
CO_2: 17 lb/sf

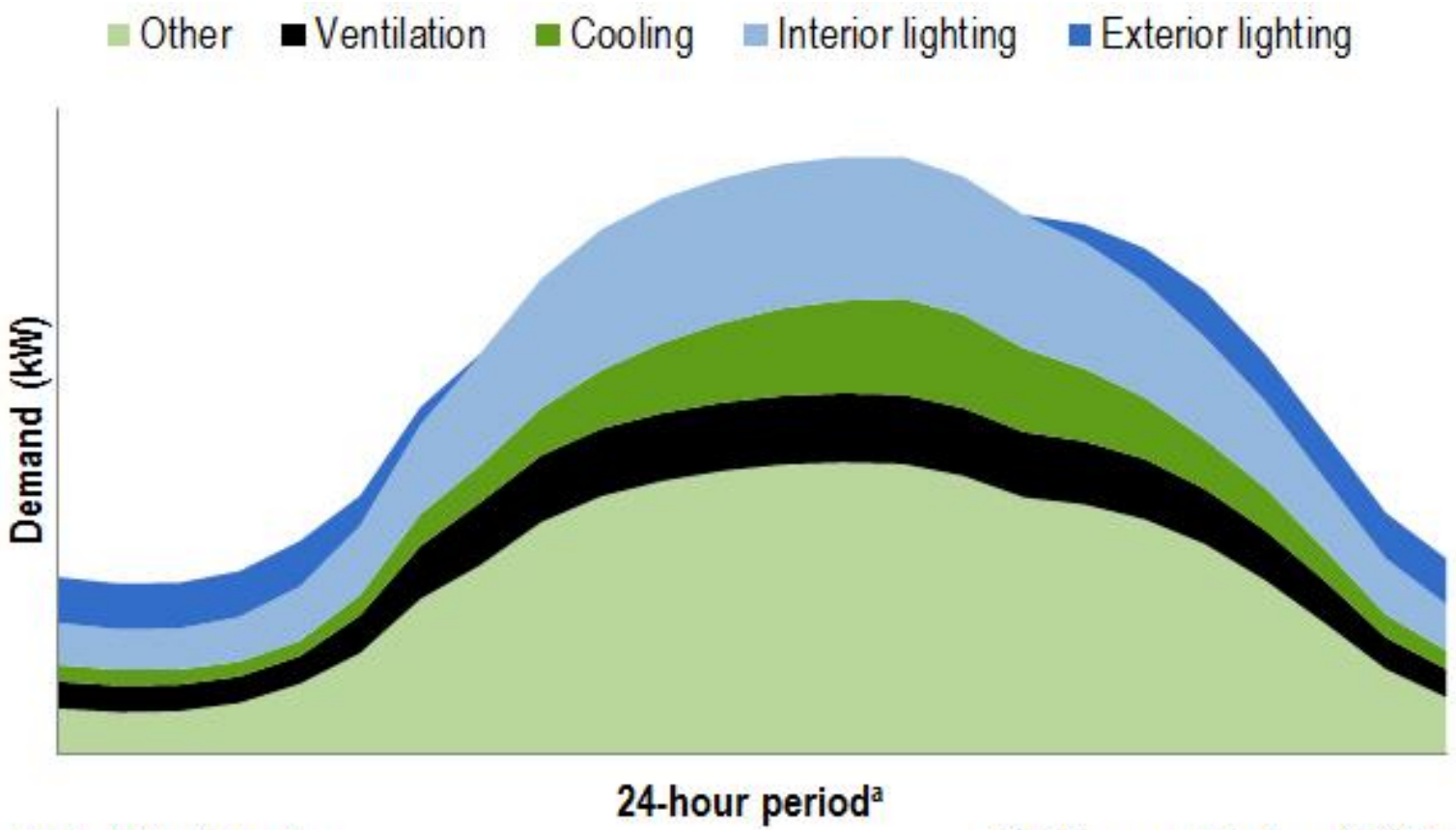
Usage by campus building type



three **activities**

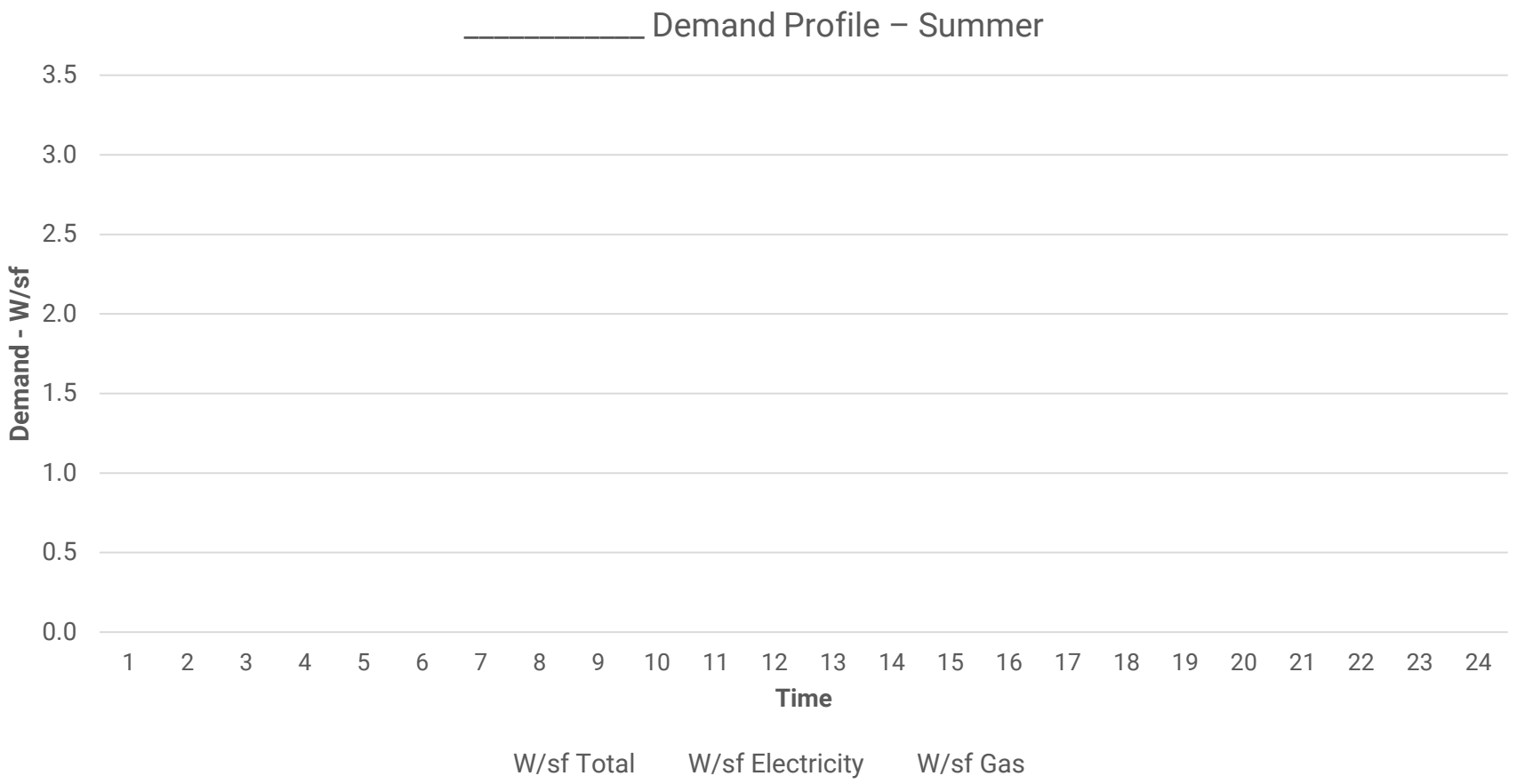
- Step 1: demand profiles
  - when is energy used?
- Step 2: energy use / cost
  - how is energy used?
- Step 3: net-zero strategy
  - what do you do to achieve the goal?

step 1: demand **profiles**



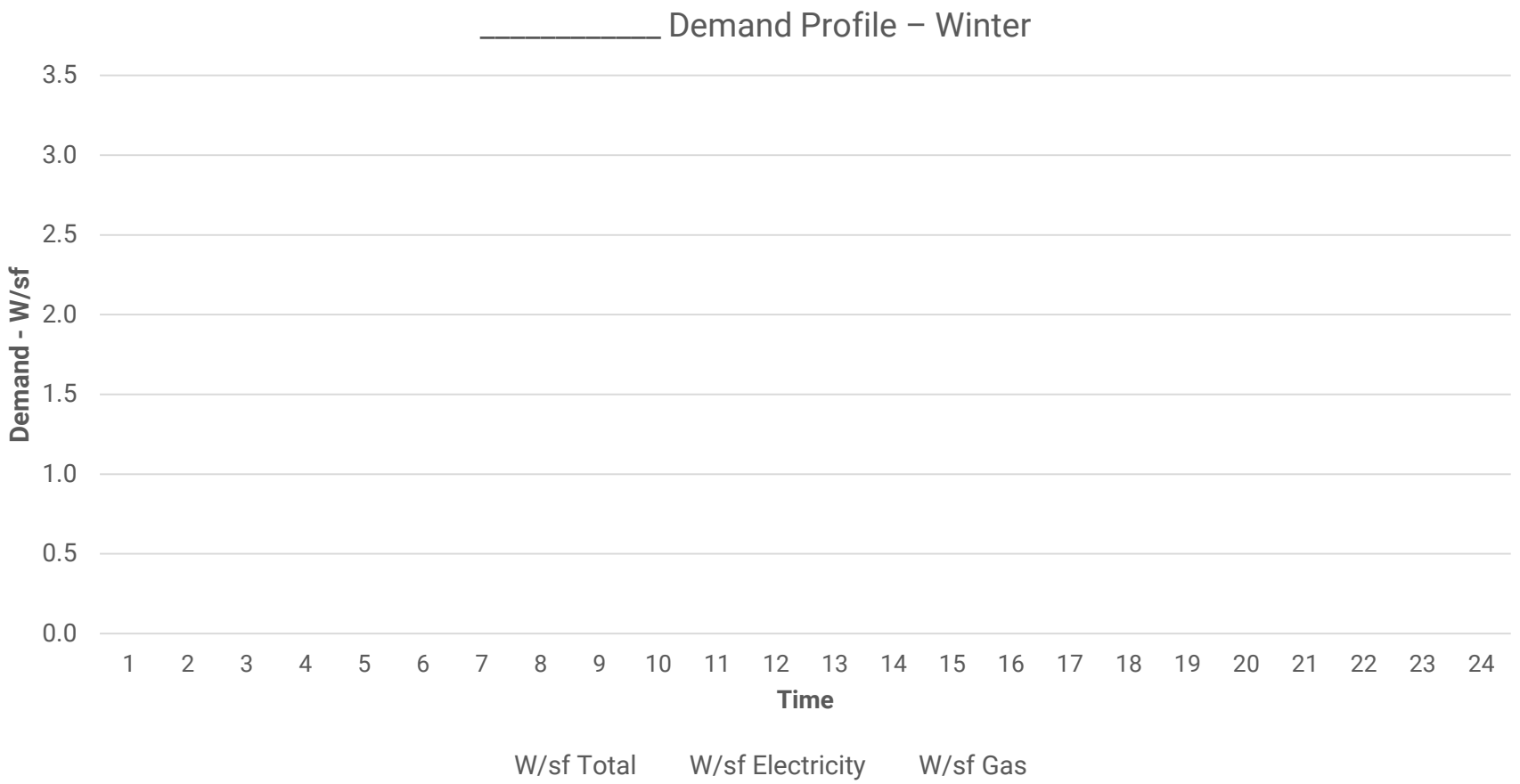
- Load profile for a typical college building in California

step 1: demand **profiles**



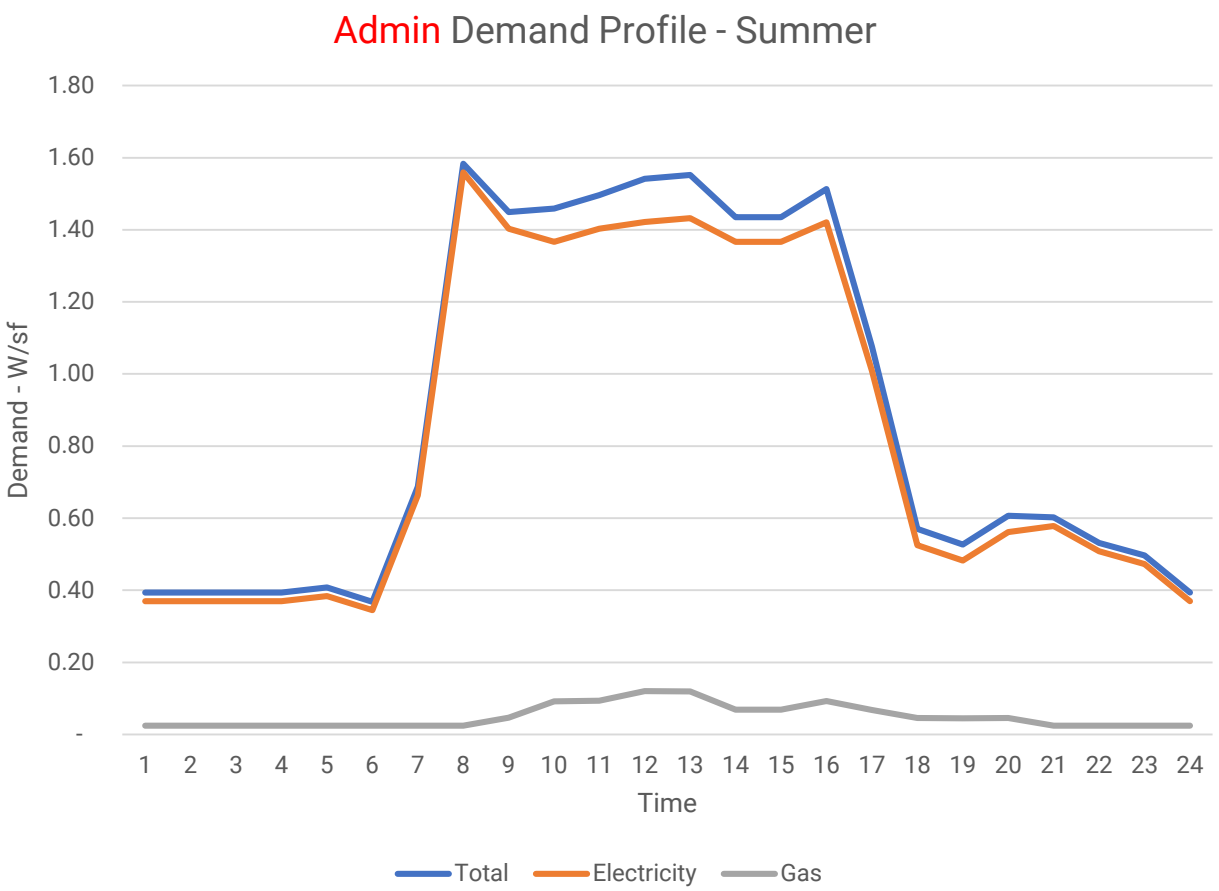
- Develop a load profile per building and accumulate for the whole campus.

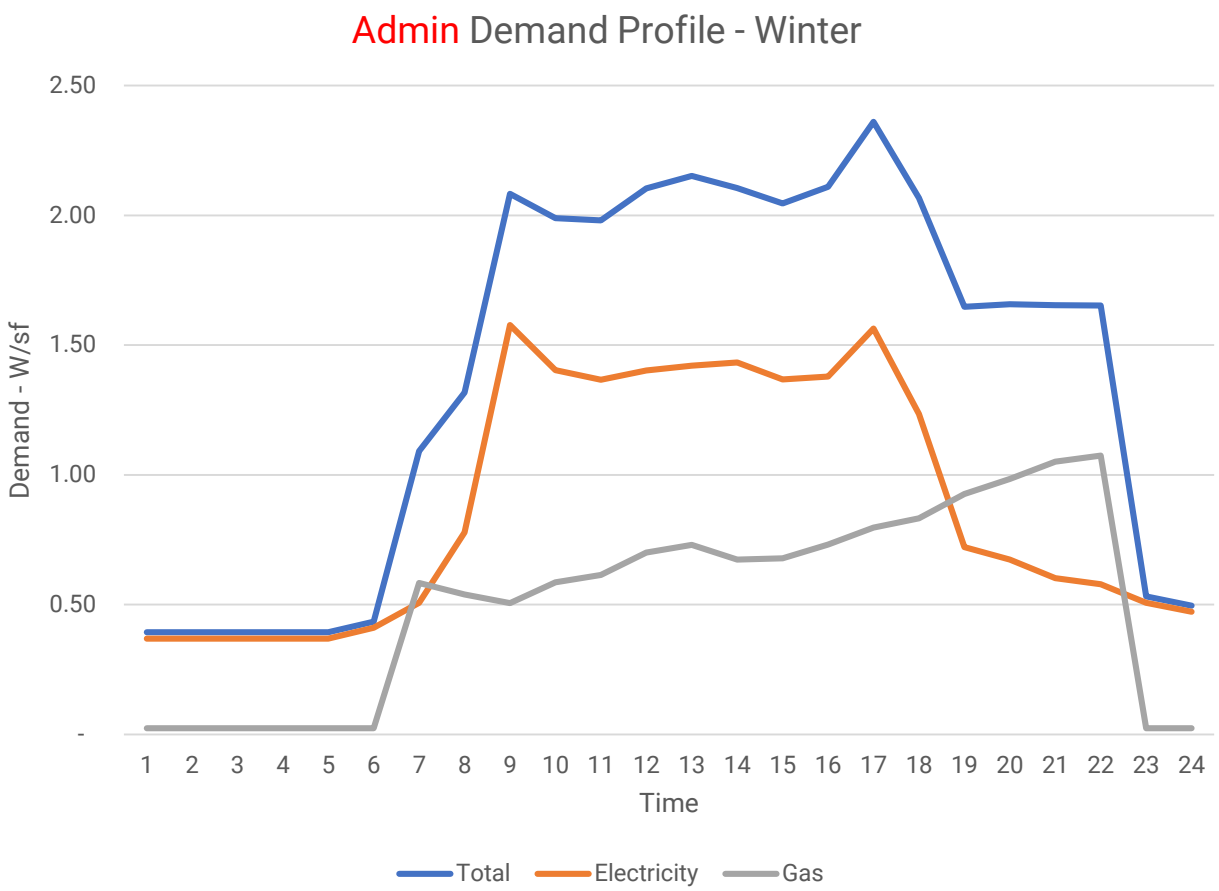
step 1: demand **profiles**



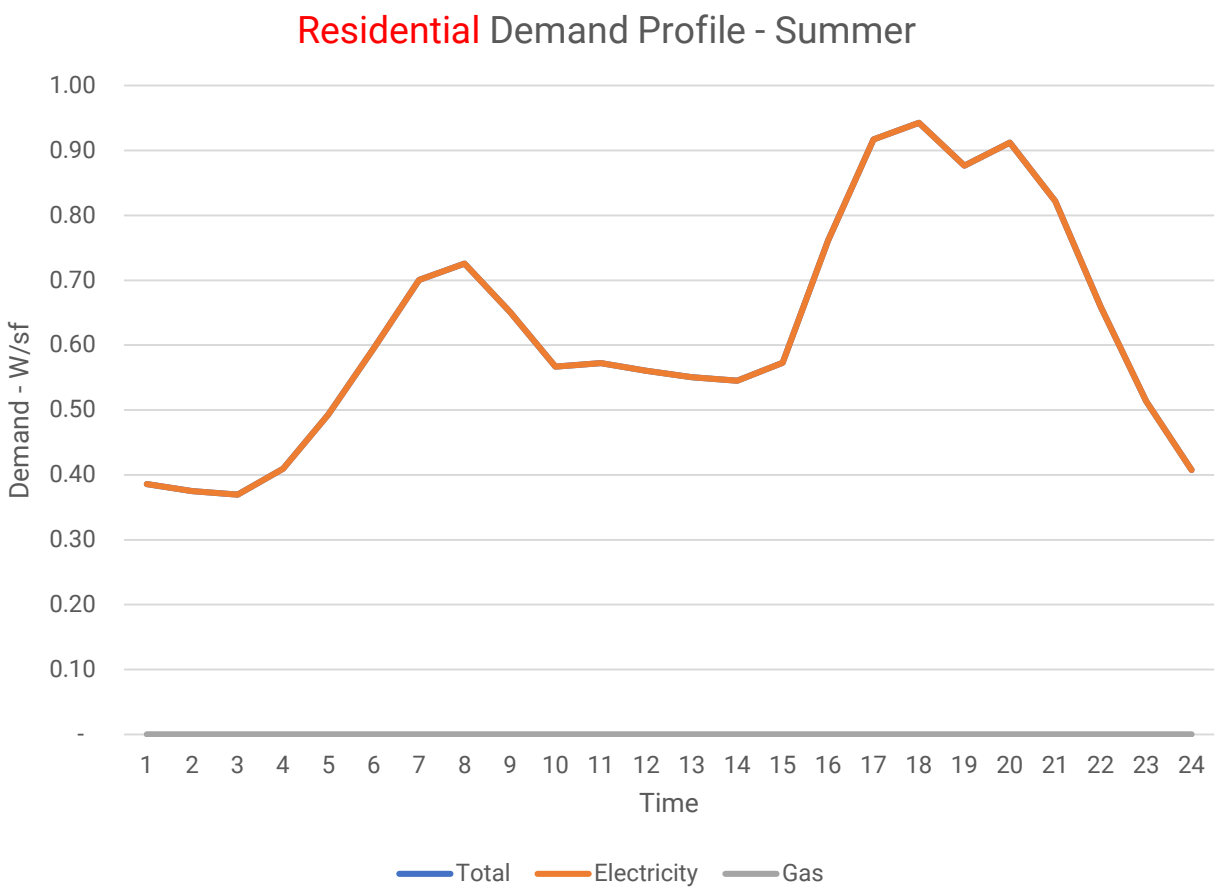
- Develop a load profile per building and accumulate for the whole campus.

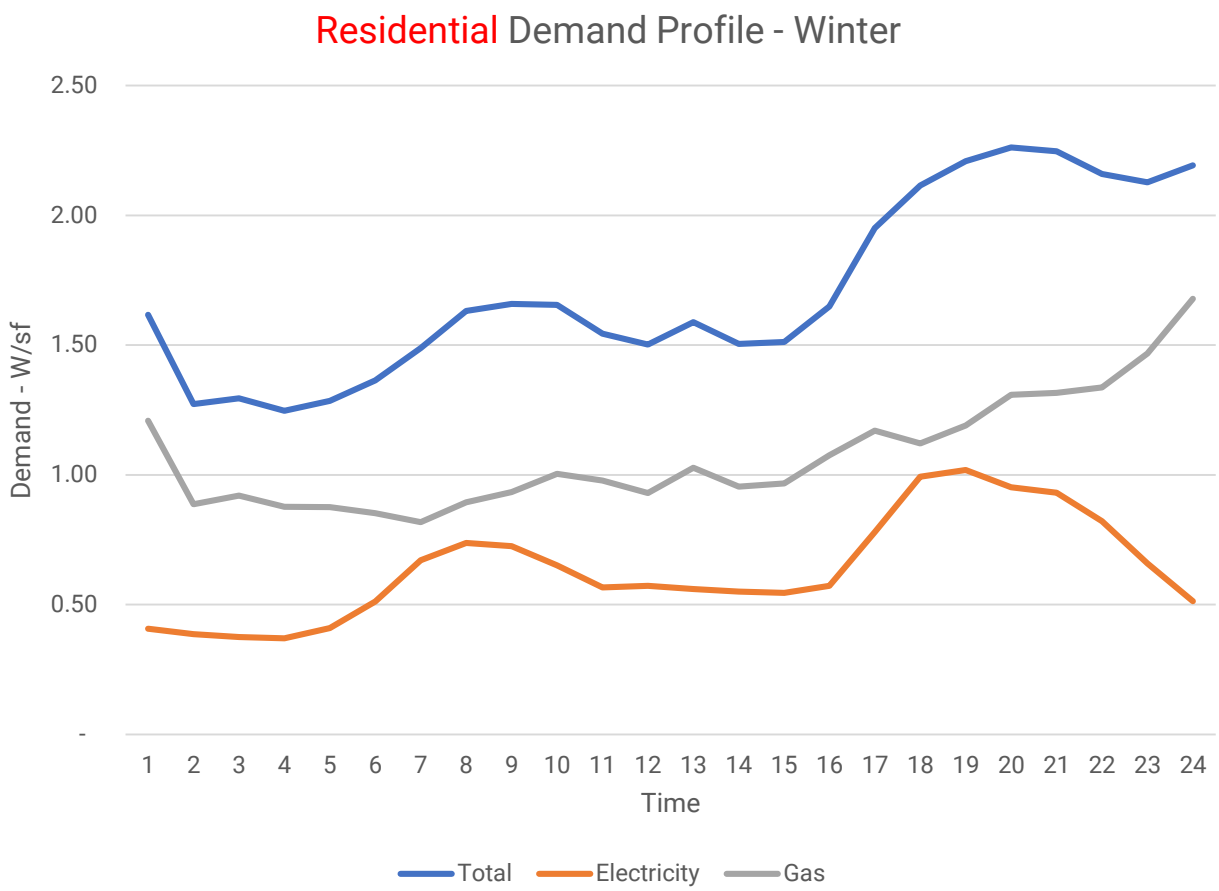
step 1 results: demand **profiles**



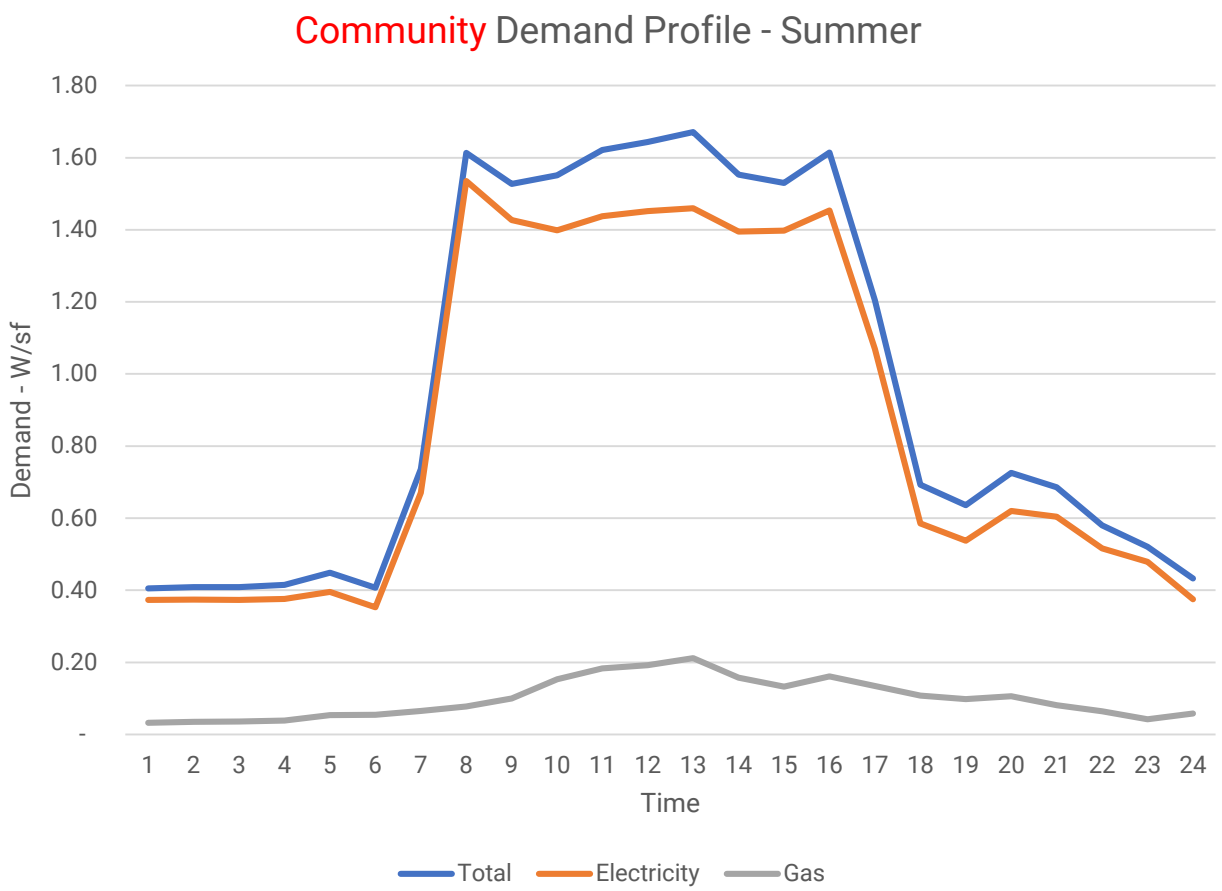


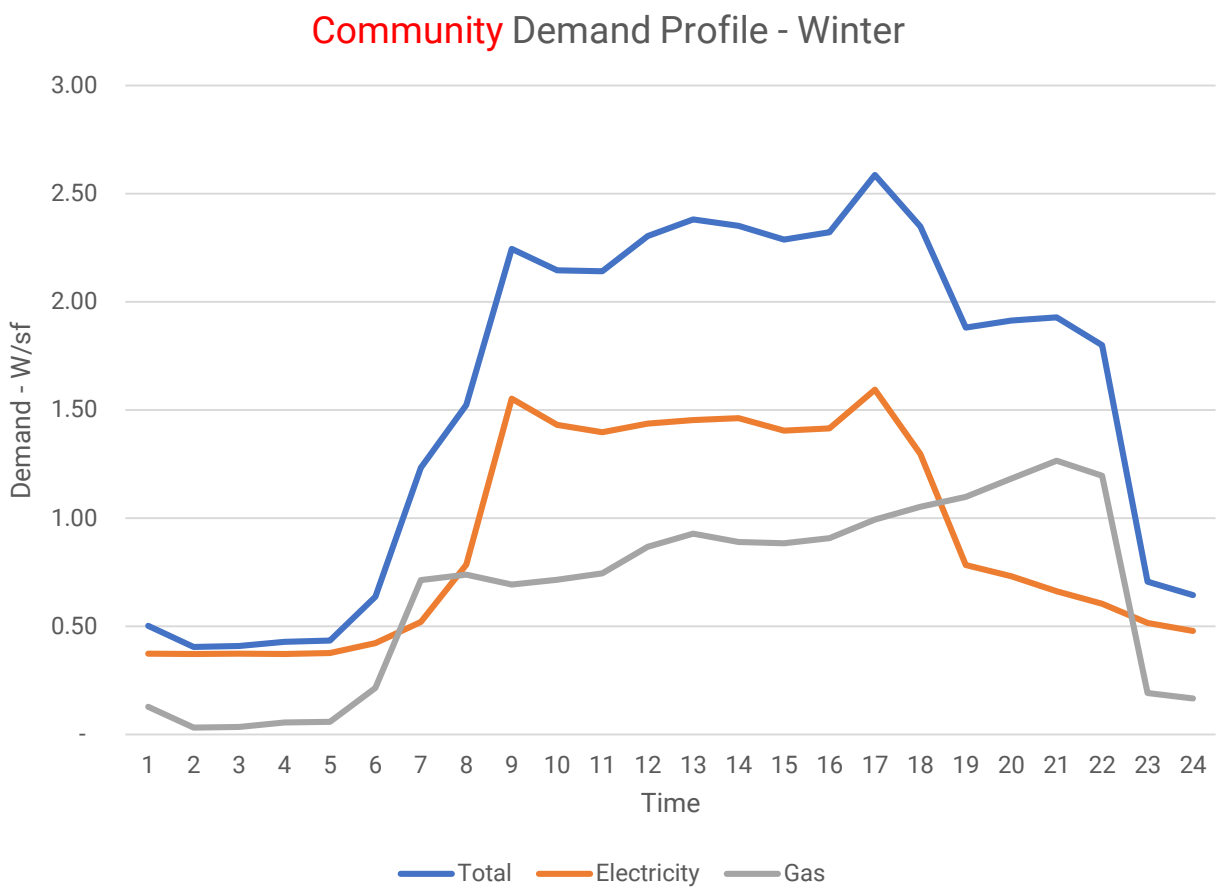
step 1 results: demand **profiles**



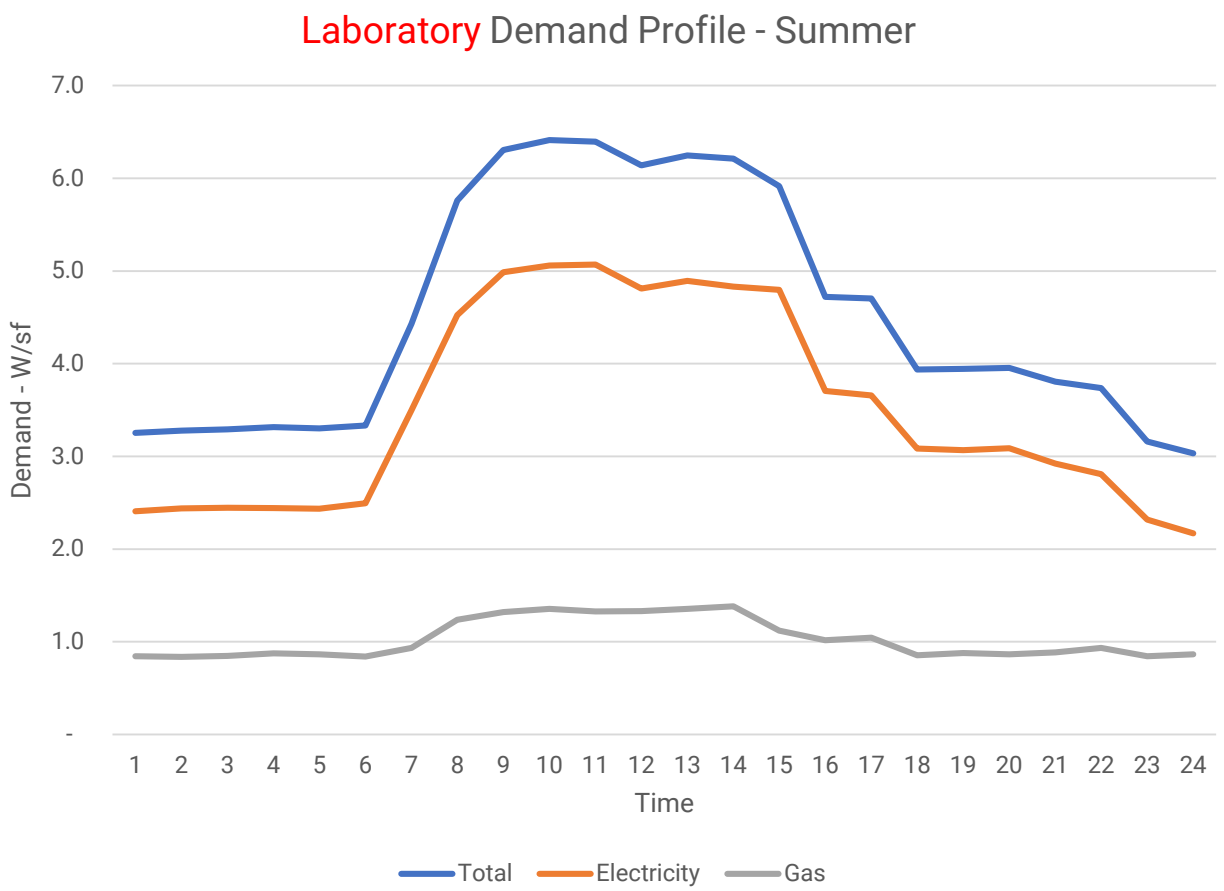


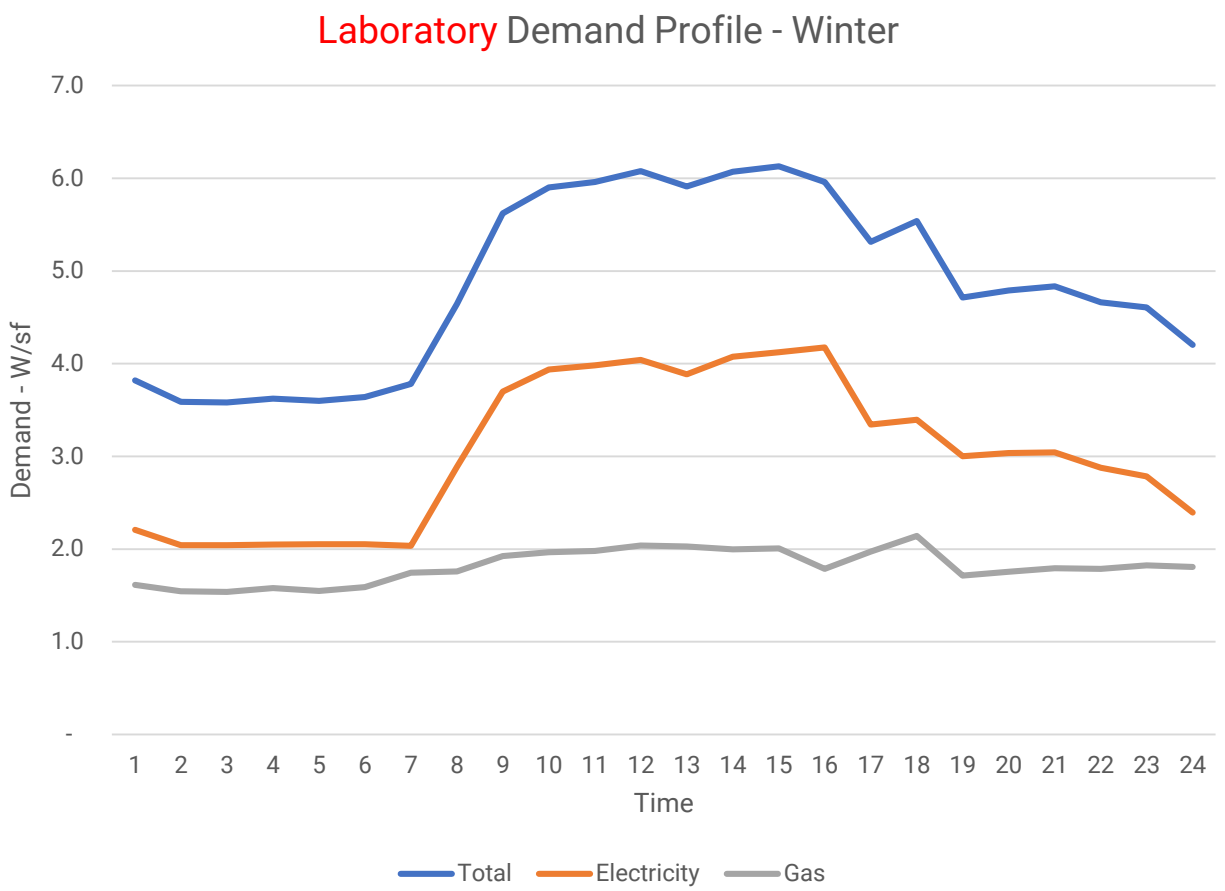
step 1 results: demand **profiles**



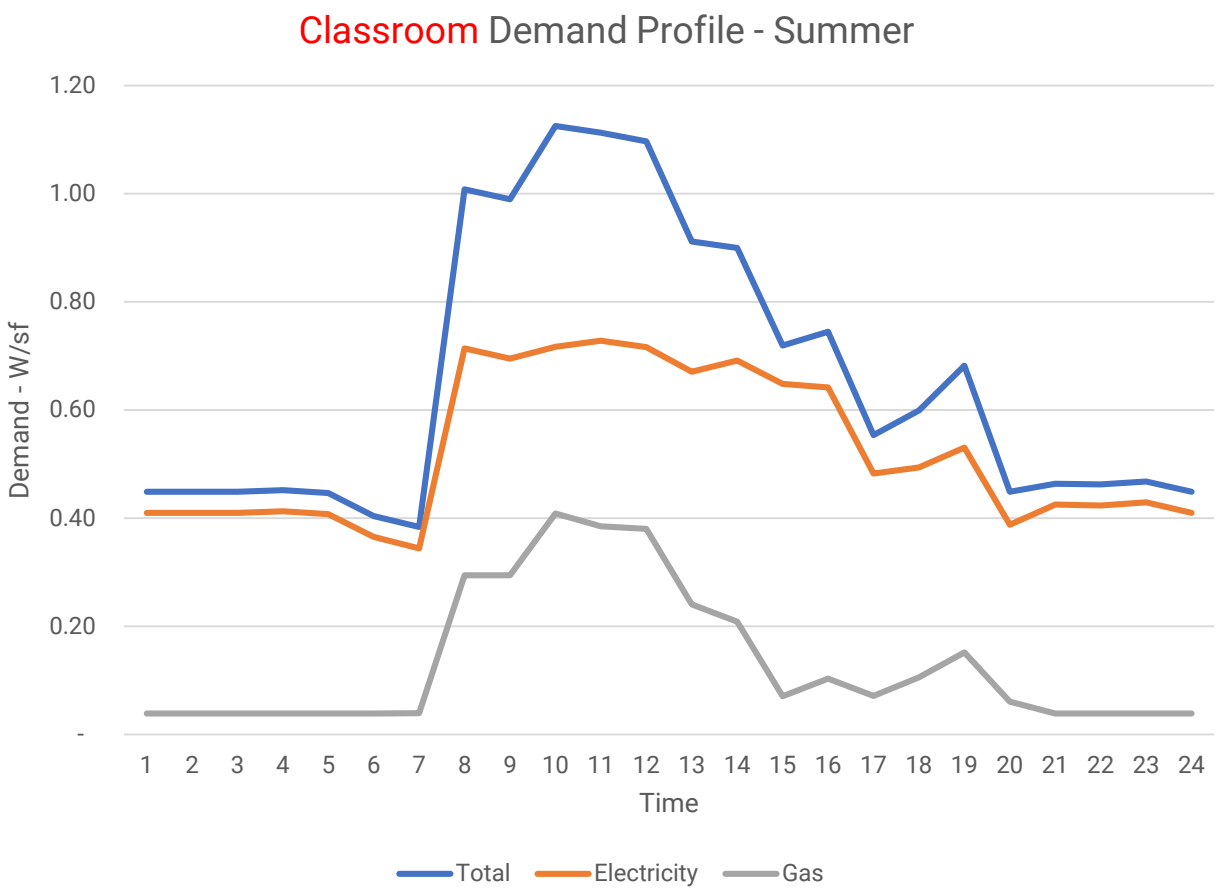


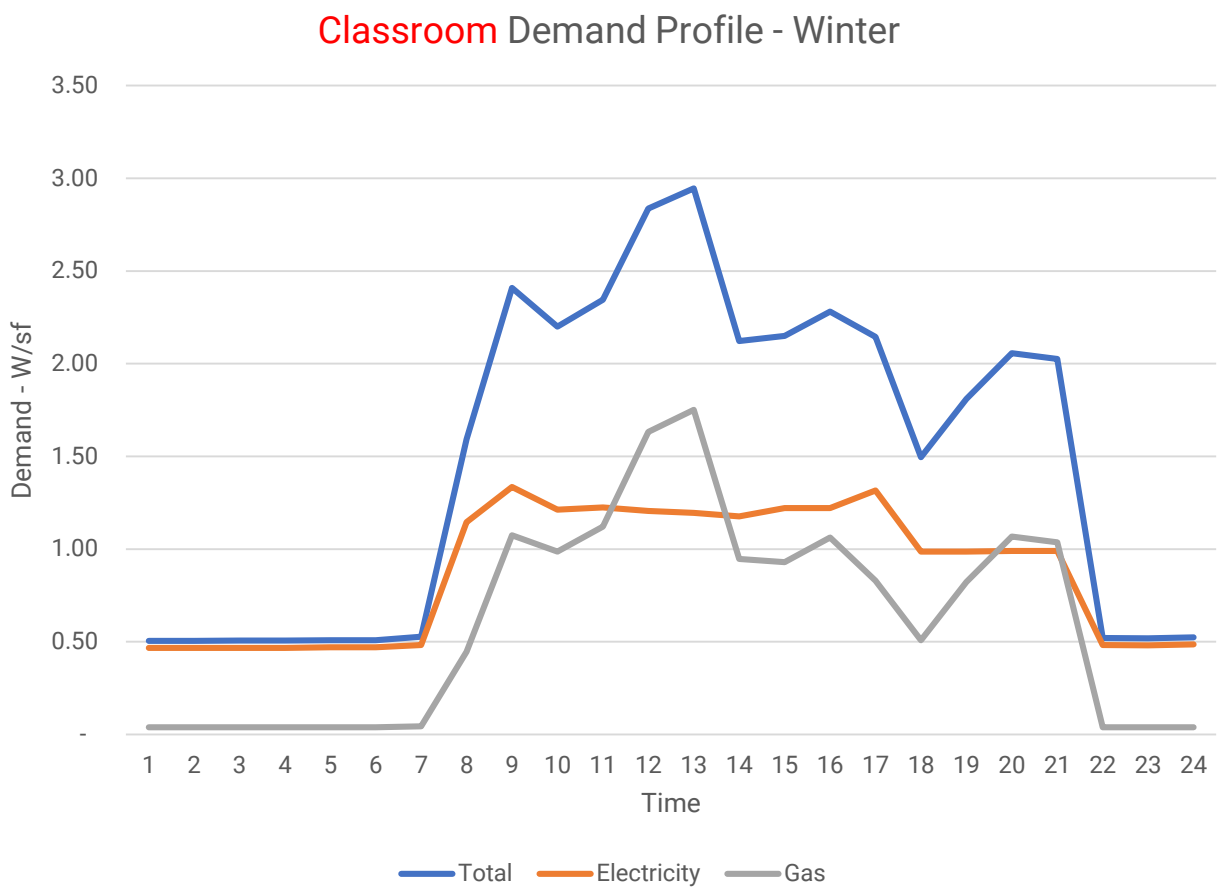
step 1 results: demand **profiles**



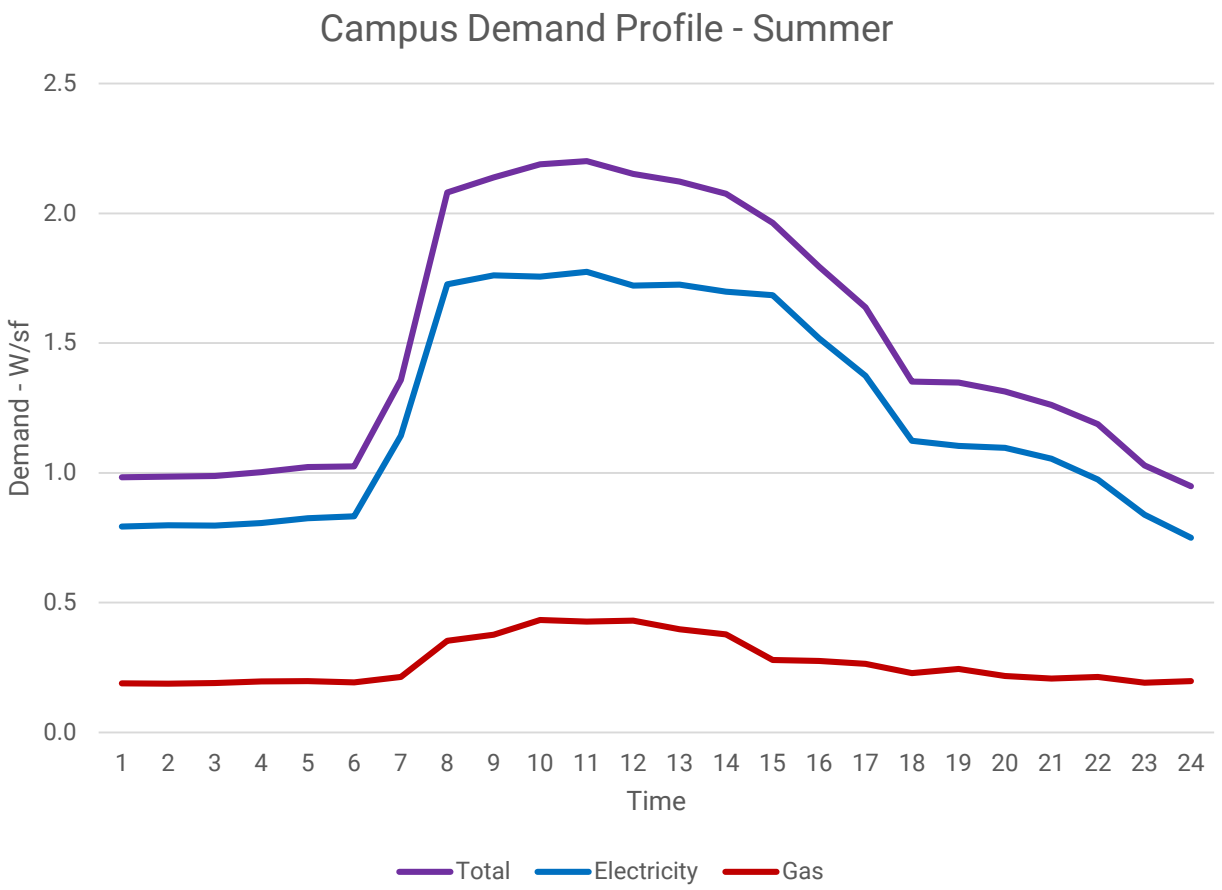


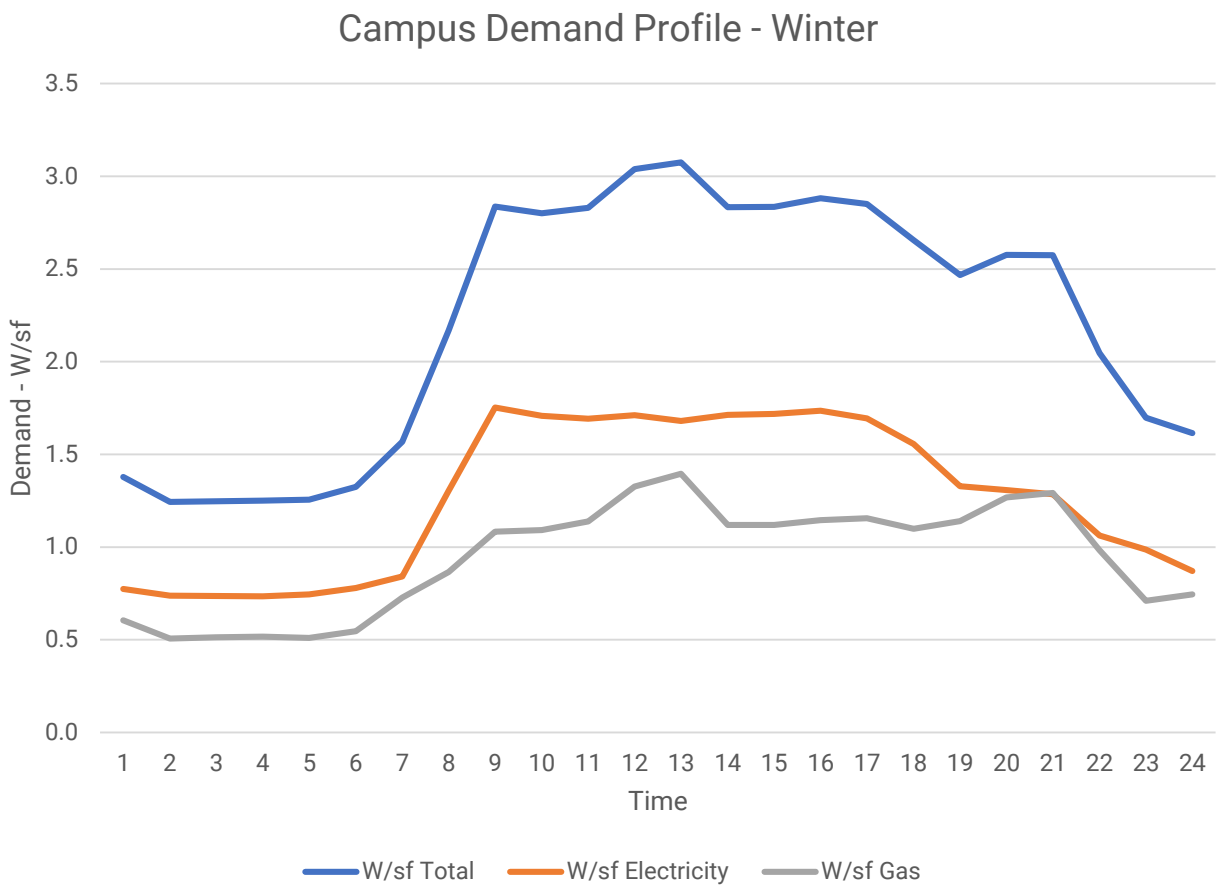
step 1 results: demand **profiles**





step 1 results: demand **profiles**





break

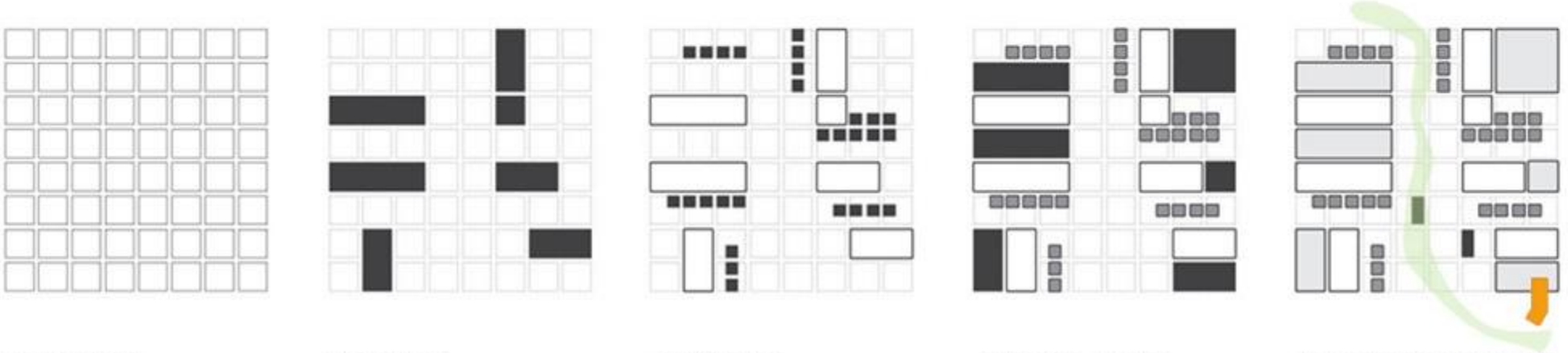
case **studies**

West-MEC SW Campus

master plan

The new Western Maricopa Education Center (West-MEC) Southwest Campus is a first-of-its-kind innovative partnership between a public utility; Arizona Public Service, a community college; Estrella Mountain Community College and a joint technical education high school district; West-MEC. The primary goal of this triumvirate of industry, higher education and secondary education is to encourage and provide a career pathway into the energy industry and augment an aging workforce. The West-MEC Southwest Campus is a unique Career and Technical Education campus with a specialized focus on sustainable energy; ranging from solar, water conservation, to geothermal strategies to minimize dependence on the nation's 'Energy Grid'

The 'National Energy Grid' is the inspiration for the campus physical plan and is symbolic of a didactic educational curriculum; the photovoltaic canopy becomes a tool to teach students about renewable energy systems.



master plan

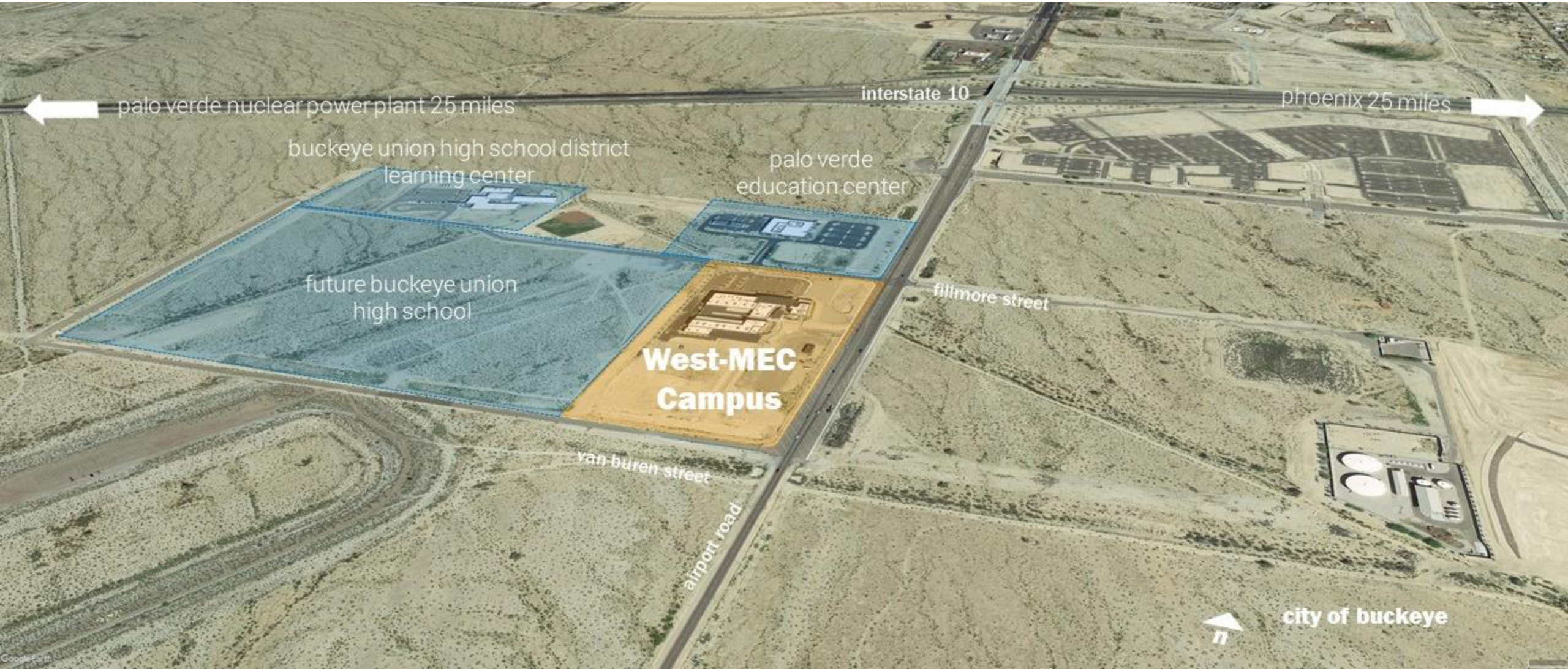
the BIG idea

... what if an education campus not only taught about the energy industry, but incorporated energy related concepts into every aspect of the curriculum and environment?

... what if it created the first off-the-grid high school building in the nation as a teaching tool?

... what if it harvested the power of the sun while providing protective shade to the inhabitants below?

context


palo verde nuclear power plant 25 miles
interstate 10
phoenix 25 miles
buckeye union high school district learning center
palo verde education center
future buckeye union high school
West-MEC Campus
fillmore street
van buren street
airport road
city of buckeye


WESTNET

master plan

SITE PLAN

0 40 80 160 FT

FIRST LEVEL

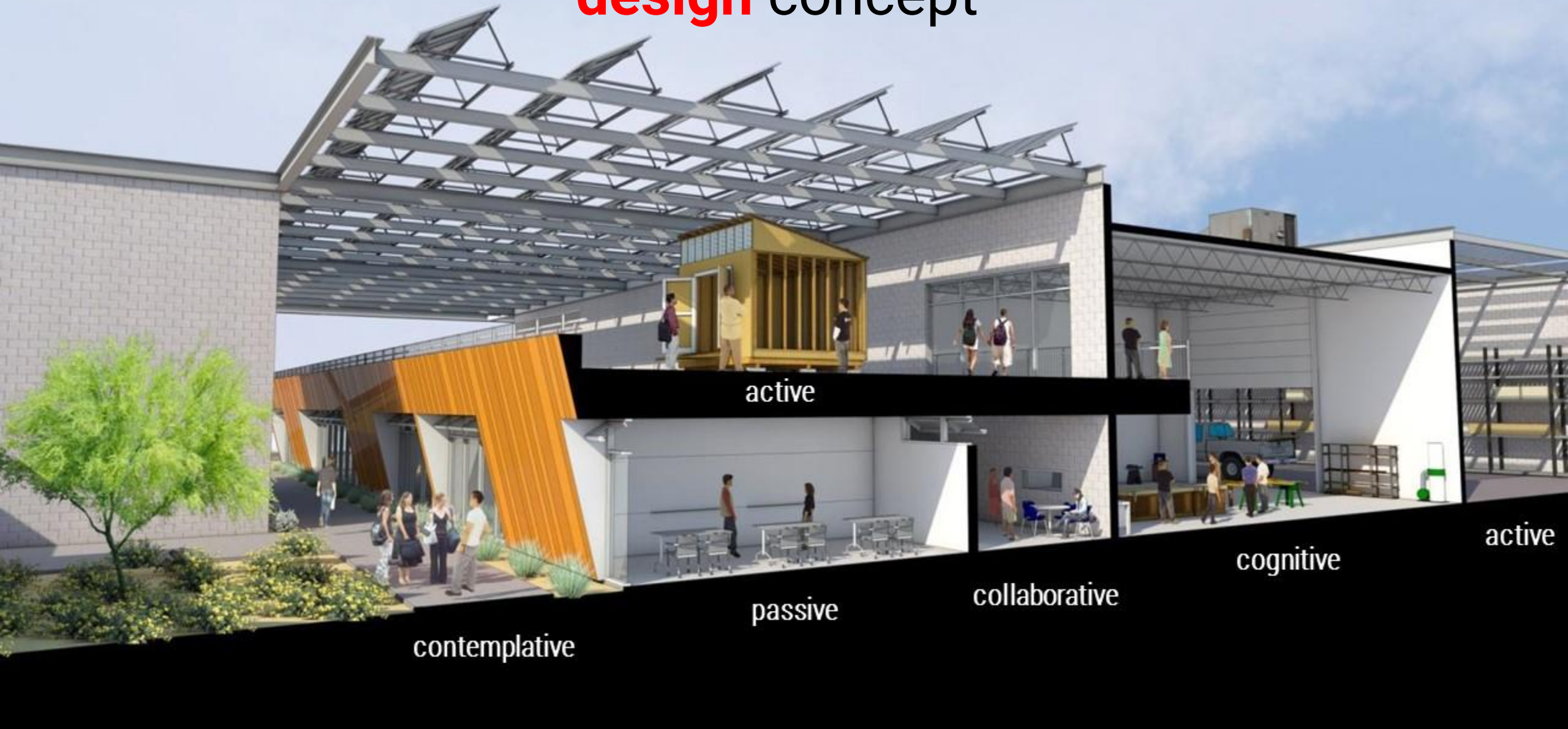
0 40 80 160 FT

1. Administration
2. Classrooms
3. High-Bay
4. Courtyard

SECOND LEVEL

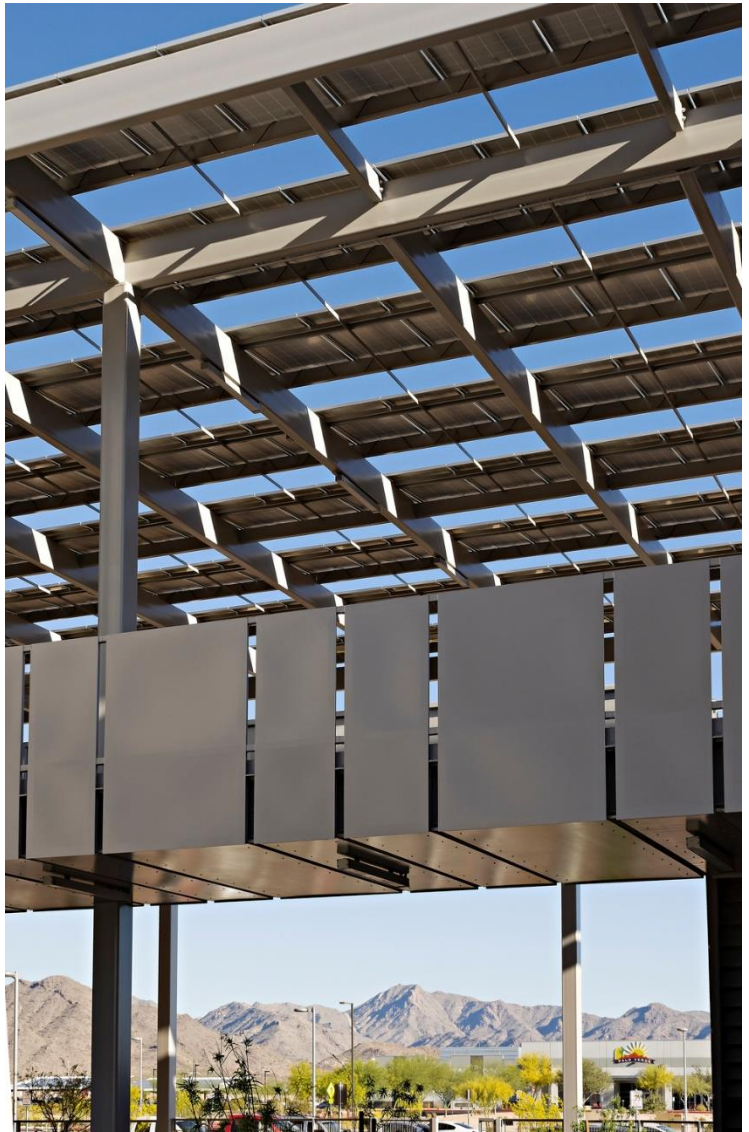
0 40 80 160 FT

design concept



design concept

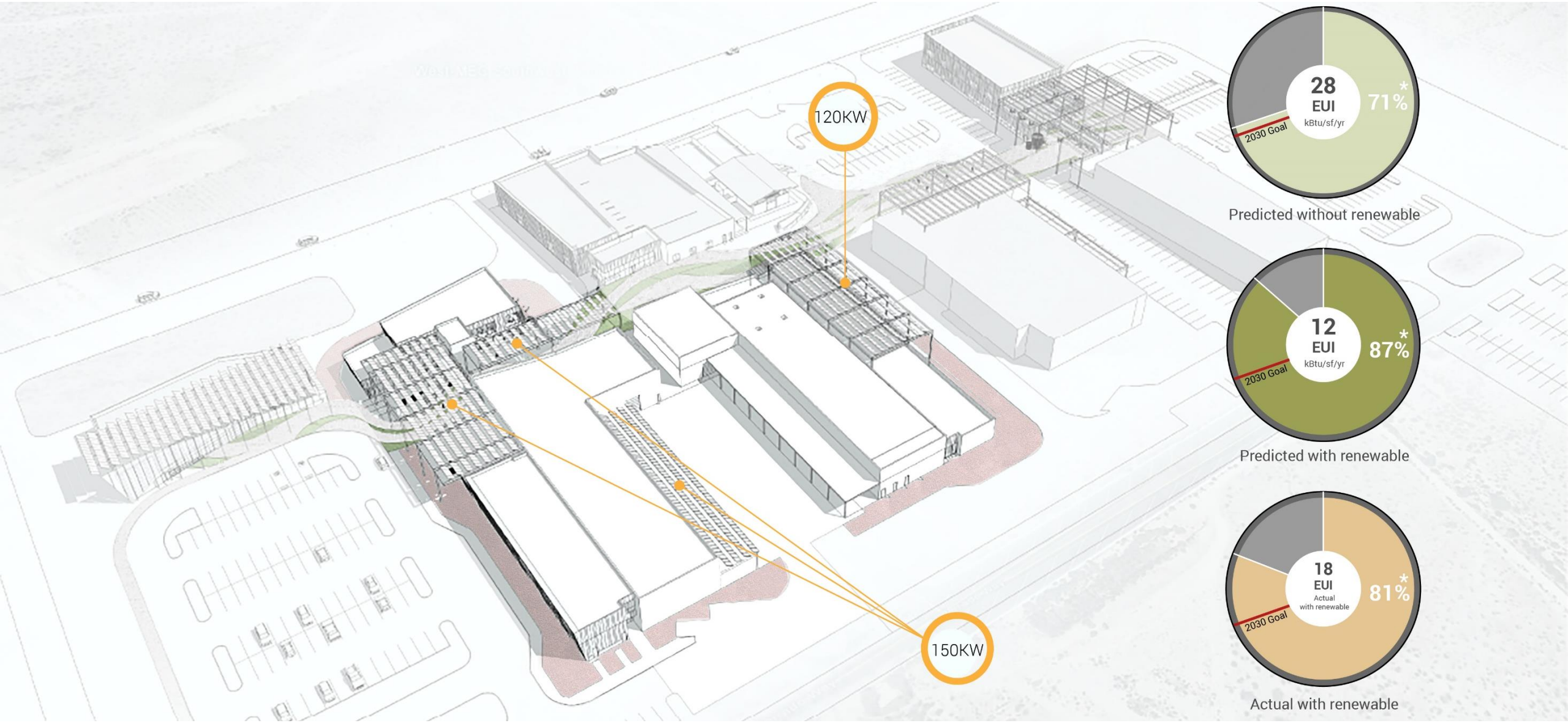
active learning



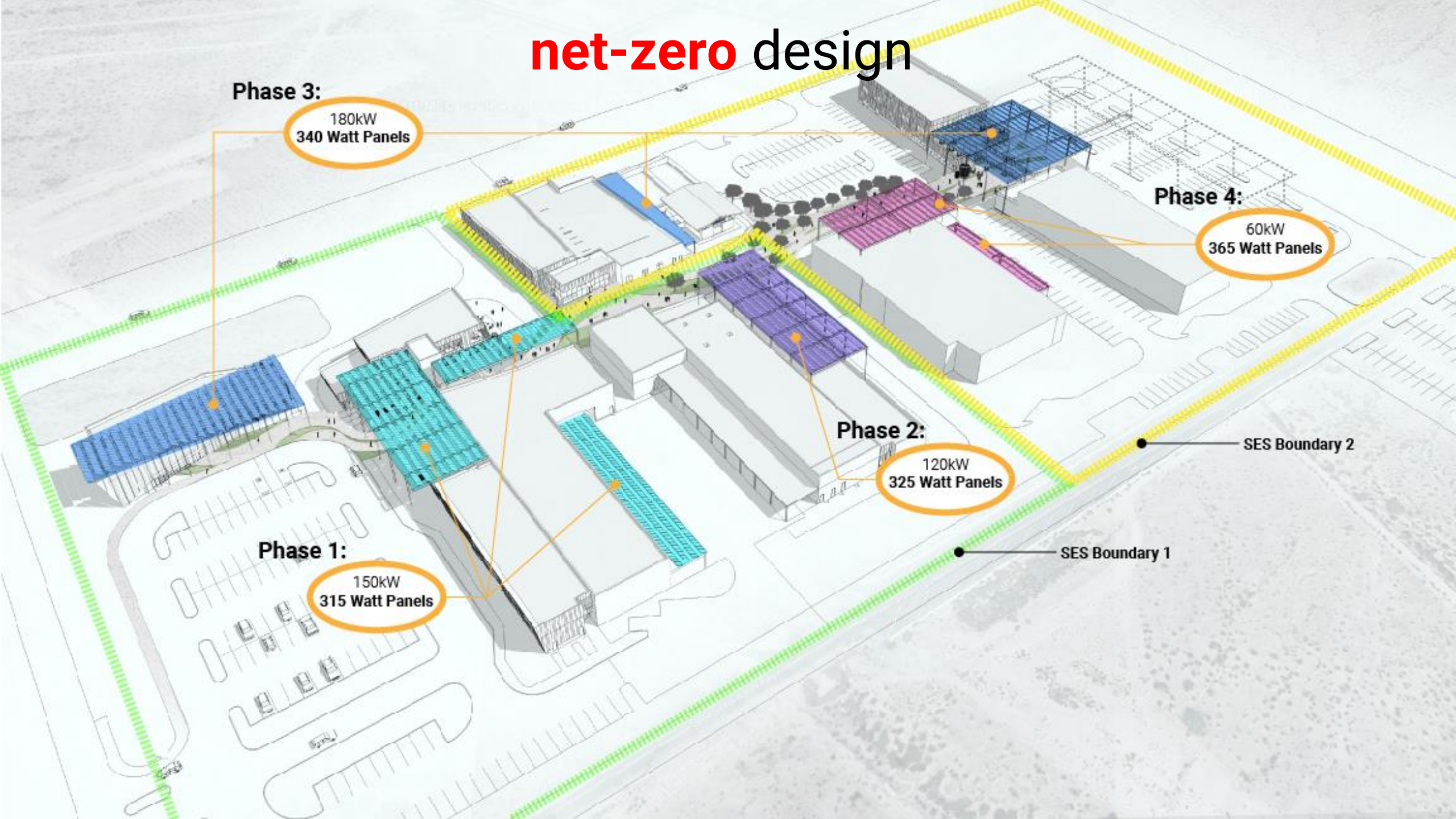
cognitive learning

collaborative learning

net-zero design



net-zero design



net-positive design

lessons learned

Creating a ‘microgrid’ – **scale down**

- **Establish the electrical load** and its upstream electrical utility impact
- **Recognize** the infrastructure limitations - medium voltage service in lieu of a series of 3000 Amp services as determined by utility company
- Solar technology **advancements are advantageous**

Building Usage Changes – good to do post-occupancy reviews to adjust master planning for future phases
We were able to balance the additional need in energy through a much more aggressive passive design and optimized solar design.

If micro-grid is the vision, explore a variety of strategies:
- Diversity in usage between buildings
- Ownership of individual buildings over the period of development if it is not under one management
- Development agreements to include load shedding, connected utilities and utility purchase and sale costs
- Energy recovery between various building usages
- Maintenance agreements on centralized energy sources

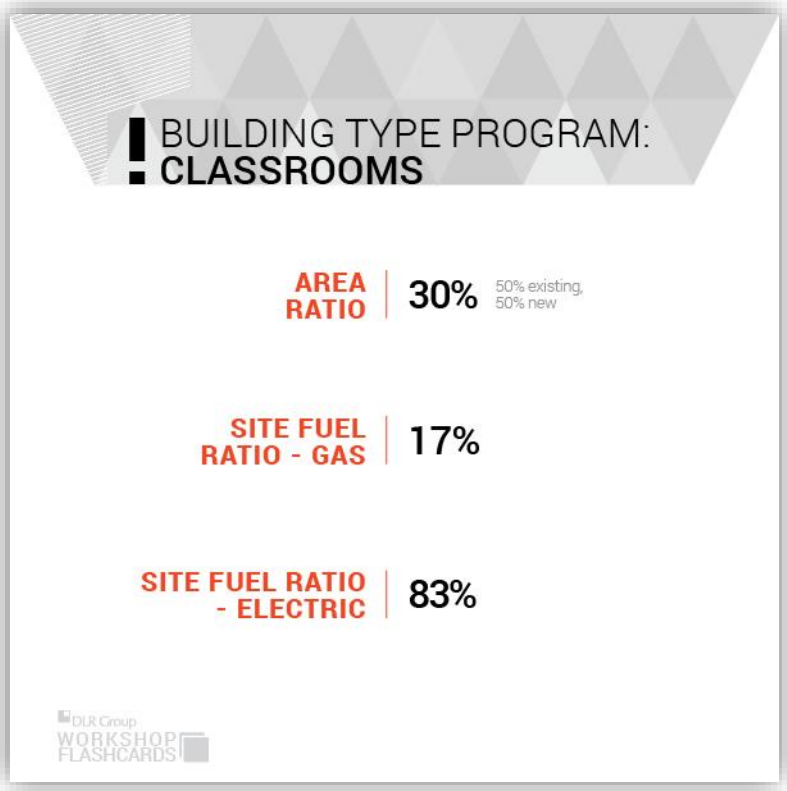
step 2: energy **use/cost**

- this exercise is to establish an energy budget per building type
- Bag of Legos at each table
- 5 building type cards

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

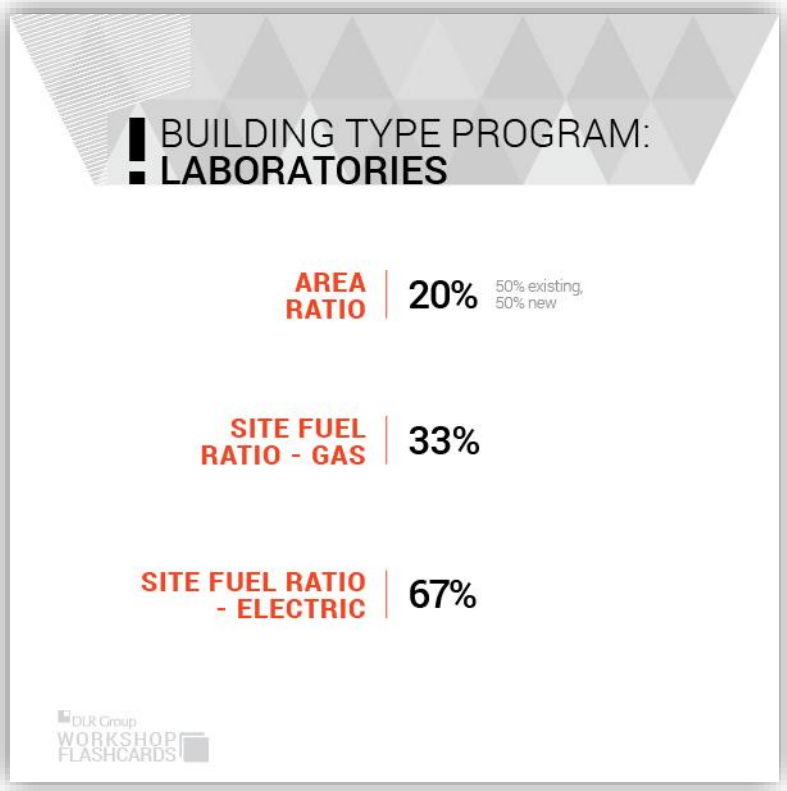
- total campus source energy use / site energy cost budget should equal to 100.

step 2 results: energy **use/cost**



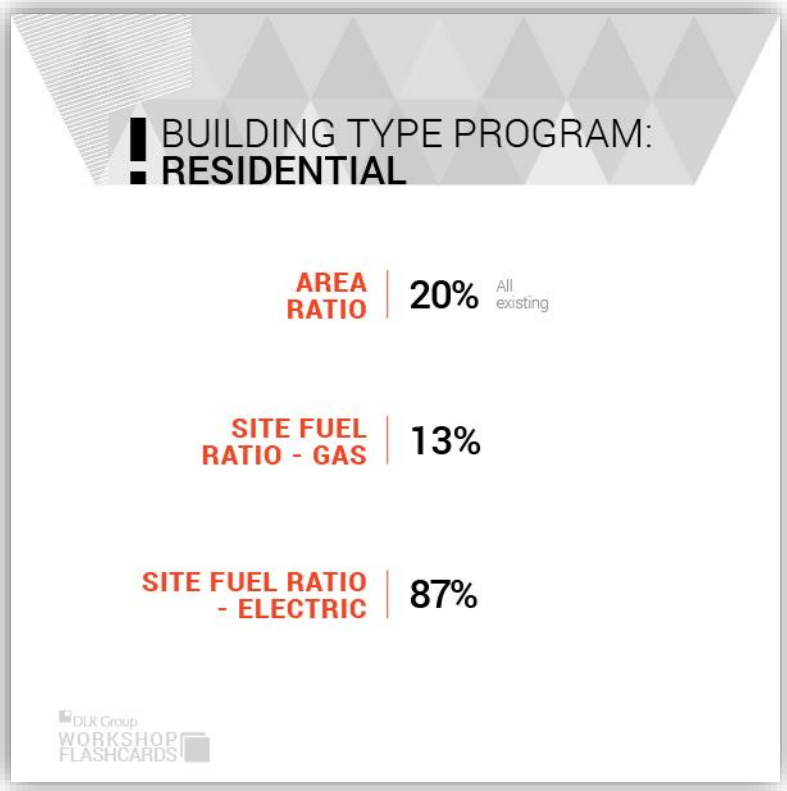
source energy units: 18 (E – 17, G – 1)

energy cost units: 19 (E – 18, G – 1)



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

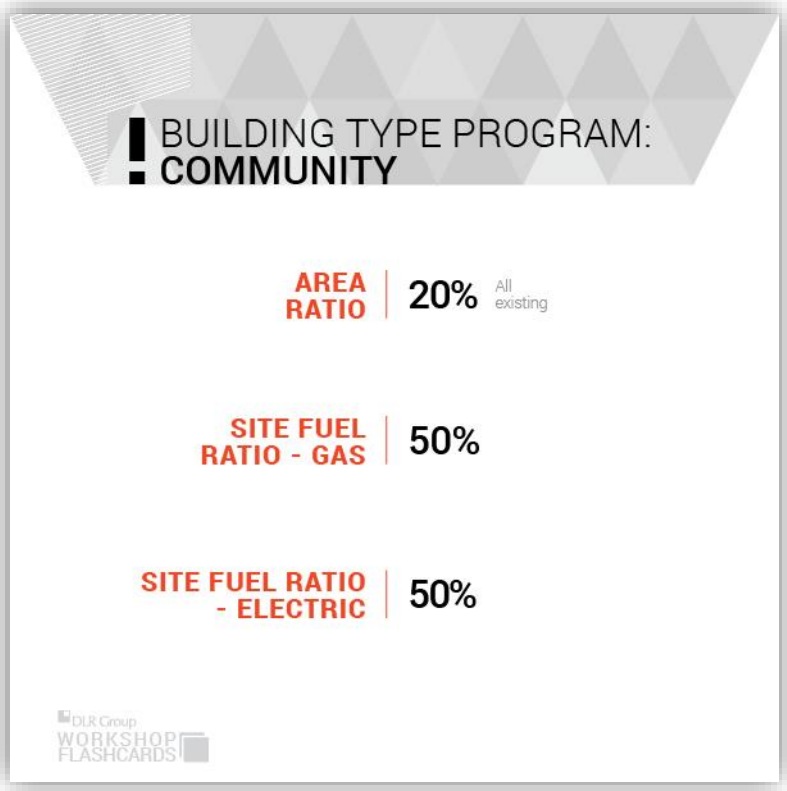
energy cost units: 33 (E – 29, G – 4)



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

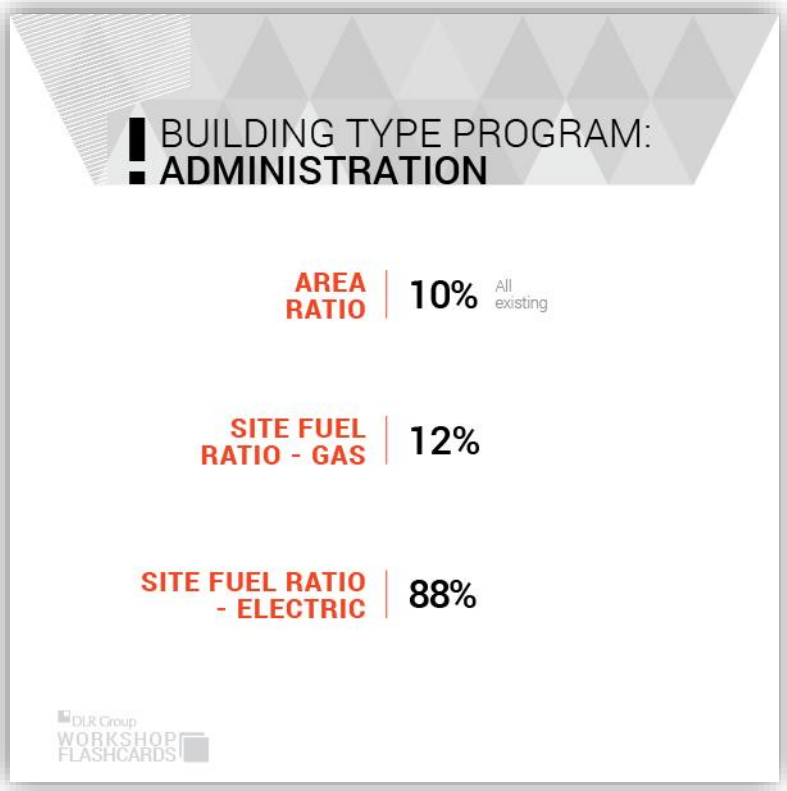
energy cost units: 17 (E – 16, G – 1)

step 2 results: energy **use/cost**



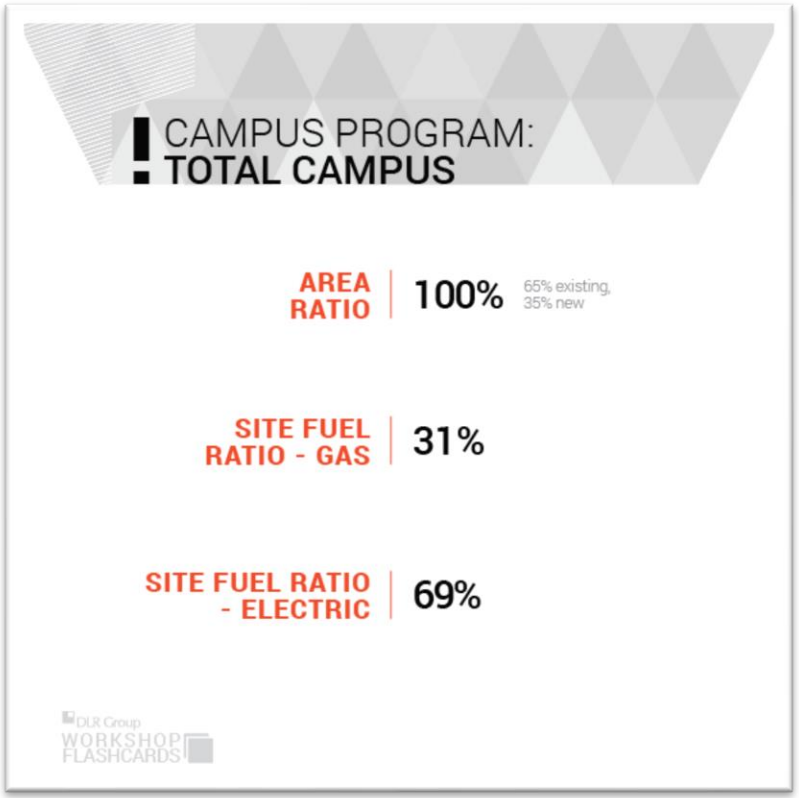
source energy units: 25 (E – 18, G – 7)

energy cost units: 24 (E – 19, G – 5)



source energy units: 6 (E – 6, G – 0)

energy cost units: 7 (E – 7, G – 0)

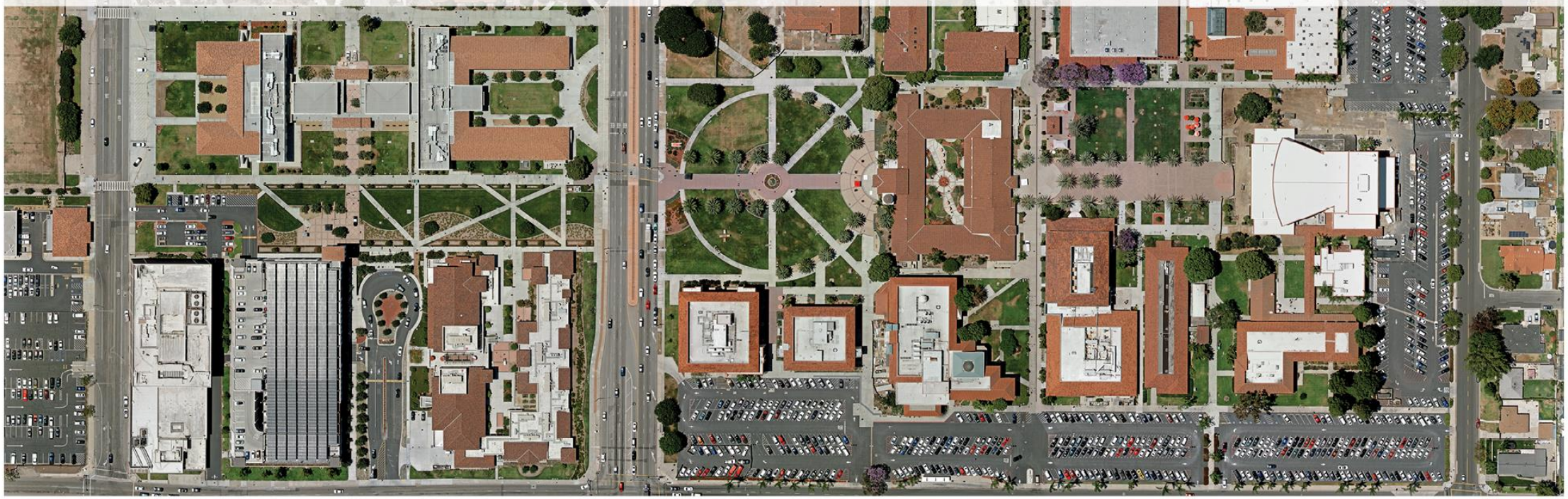


source energy units: 100 (E – 87, G – 13)

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

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

DLR Group
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

driving factors

- Energy codes getting more stringent – driving toward zero net energy.
- Student population expecting stewardship.
- Develop an integrated energy master plan (IEMP) to primarily meet the requirements of Executive Order (EO) B-18-12.
- Align the IEMP with other energy policies such as EO B-30-15, EO S-3-05, AB 32 etc.
- Include recommendations for larger sustainability goals as part of the IEMP as an additional scope.

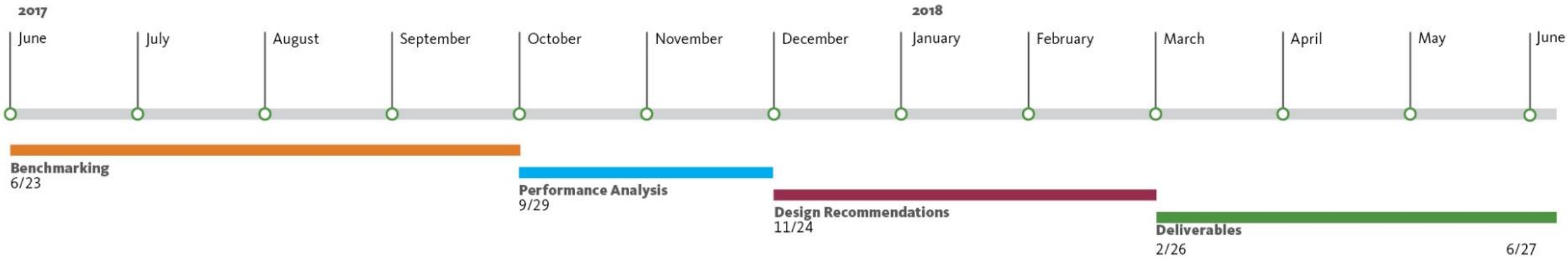
IEMP **goals**

→ Sustainability

- Education & Research
- Utilize Green Building Practices
- Climate Change Management
- Sustainable Food & Dining
- Renewable Energy
- Sustainable Land Use
- Purchase Sustainable Goods & Services
- Alternative Fuel
- Waste Management
- Manage Water Resources
- Improve Social & Economic Factors
- Energy Use Optimization

● Current Focus
● Future Focus

scope and **schedule**



PLANNING PROCESS

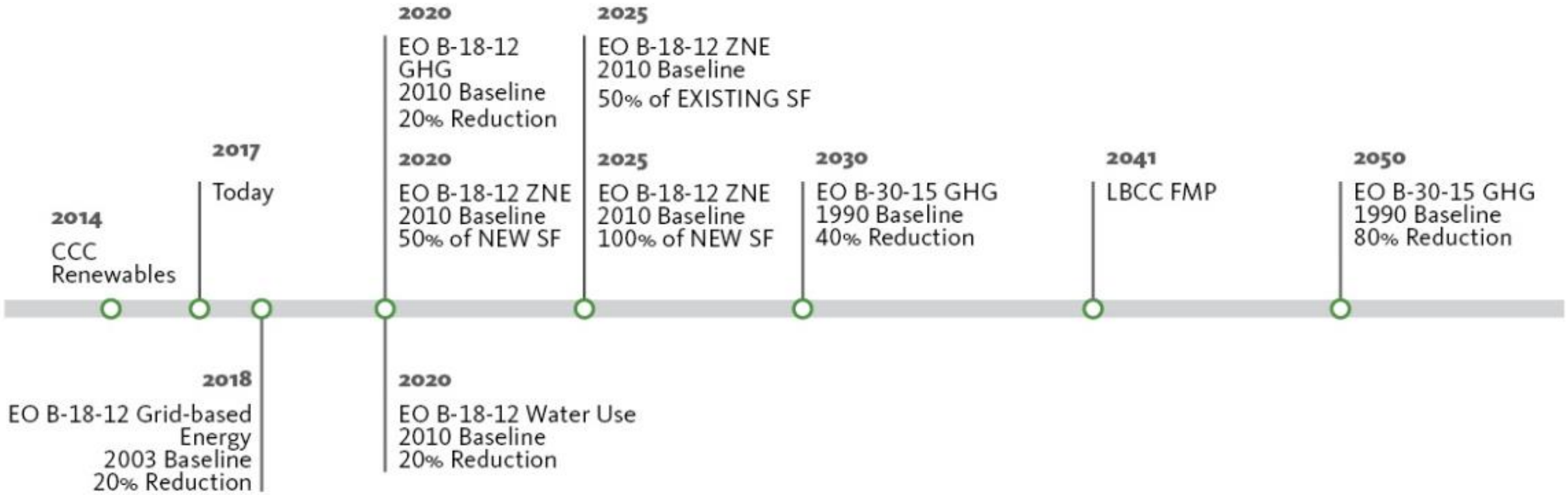
Benchmark	Analyze	Design
DATA GATHERING + BENCHMARKING	PERFORMANCE ANALYSIS + TARGET SETTING	DEVELOPING DESIGN RECOMMENDATIONS

key performance **indicators**

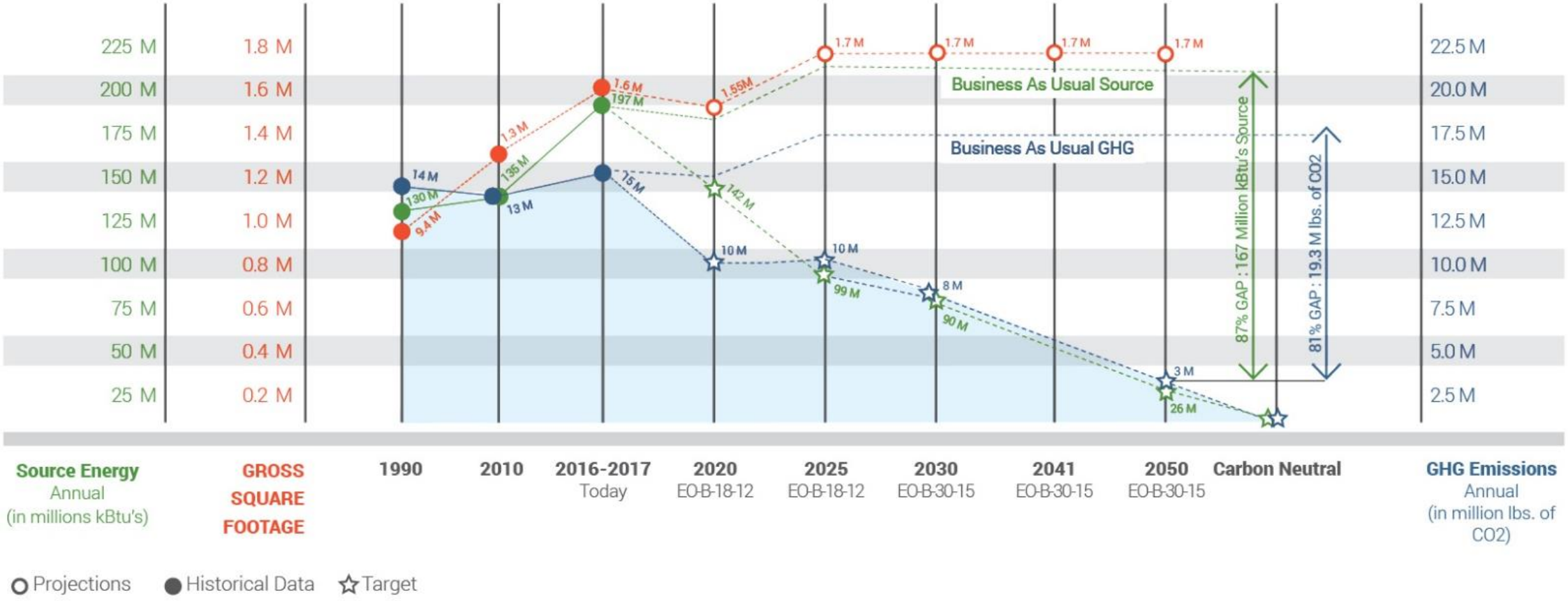
Focus Area	Topic	Driving Factors	Metric	Baseline	Timeline	Scale
1	Management of Climate Change					
	Entity-wide Greenhouse Gas reduction	EO B-18-12	10% Reduction	2010	2015	District Level
	EO B-18-12; AB 32	20% Reduction	2010	2020	District Level	
	EO B-30-15	40% Reduction	1990	2030	District Level	
	EO B-30-15; EO S-3-05	80% Reduction	1990	2050	District Level	
2	Optimization of Energy Use					
	2a ZNE for new buildings	EO B-18-12	50% of SF	Avg. Building EUI	2020 to 2025	District Level
	2b ZNE for new buildings and major renovation	EO B-18-12	100% of SF	Avg. Building EUI	2025 onwards	District Level
	2c ZNE for existing buildings	EO B-18-12	50% of SF	Avg. Building EUI	2025	District Level
	2d Reduce grid-based energy purchases for buildings	EO B-18-12	20% Reduction	2003	2018	District Level
	2e Reduce grid-based energy purchases for non-buildings	EO B-18-12	20% Reduction	2003	2018	District Level
	2f Participate in demand response programs	EO B-18-12			2012 onwards	Building Level
3	Renewable Energy					
	On-site energy generation for new or major renovation	EO B-18-12	> 10,000 SF		2012 onwards	District Level
	Purchase electricity from renewable energy sources	ACUPCC	15% of total electricity purchase			
4	Manage Water Resources					
	Water use reduction	EO B-18-12	10% reduction	2010	2015	District Level
		EO B-18-12	15% reduction	2010	2020	District Level
5	Use Green Building Practices					
	5a LEED Silver or higher on new and major renovation	EO B-18-12	> 10,000 SF	current version	2012 onwards	Building Level
	Comply with Cal Green Building Standards' Tier 1 measures	EO B-18-12	< 10,000 SF	current version	2012 onwards	Building Level
	LEED EBOM certification on existing buildings	EO B-18-12	> 50,000 SF, Energy Star >75	Avg. Building	2015	Building Level
	5b Building commissioning on new or major renovation	EO B-18-12	>5,000 SF		2012 onwards	Building Level
	Building commissioning on existing buildings	EO B-18-12	As needed	Avg. Building EUI	2012 onwards	Building Level
	Monitoring based commissioning on existing buildings	EO B-18-12	>5,000 SF as needed	Avg. Building EUI	2012 onwards	Building Level
	5c Develop operation and maintenance policies and guidelines	EO B-18-12		2013	Building Level	
6	Indoor Environmental Quality					
	Implement Division A5.5 of Cal Green Building Std code	EO B-18-12		current version	2012 onwards	Building Level
7	Use Alternative Transportation & Fuels					
	7a Electric vehicle charging station	EO B-18-12	Plan for future demand		2012 onwards	Campus Level
8	Sustainable Land Use					
	Develop sustainable land use planning principles		Address in the future			Campus Level
9	Purchase Sustainable Goods and Services					
	Purchasing policy EO B-18-12	Public Contract Code 12400		2012 onwards	District Level	
10	Waste Management					
	Participate in waste minimization measures	ACUPCC	Adopt 3 or more reduction measures			

EO - Executive Order; ACUPCC - American College & University Presidents Climate Commitment; AASHE - The Association for the Advancement of Sustainability in Higher Education

key metrics + **timelines**



setting **targets**



anticipate **results**

baseline
1990

2016-2017 school year

20% reduction
2020 baseline: 2010

40% reduction
2030

80% reduction
2050

carbon neutral

Scope 1

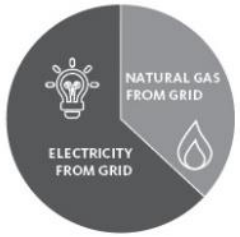
Direct GHG Emissions
Fleet, Combustion, Fossil Fuel

baseline 441,388 lbs of CO2

Scope 2

Indirect GHG Emissions From Purchase Energy

Buildings + Non-Buildings
Parking Lots, Sports Fields, etc.



baseline 8,919,061 lbs. of CO2

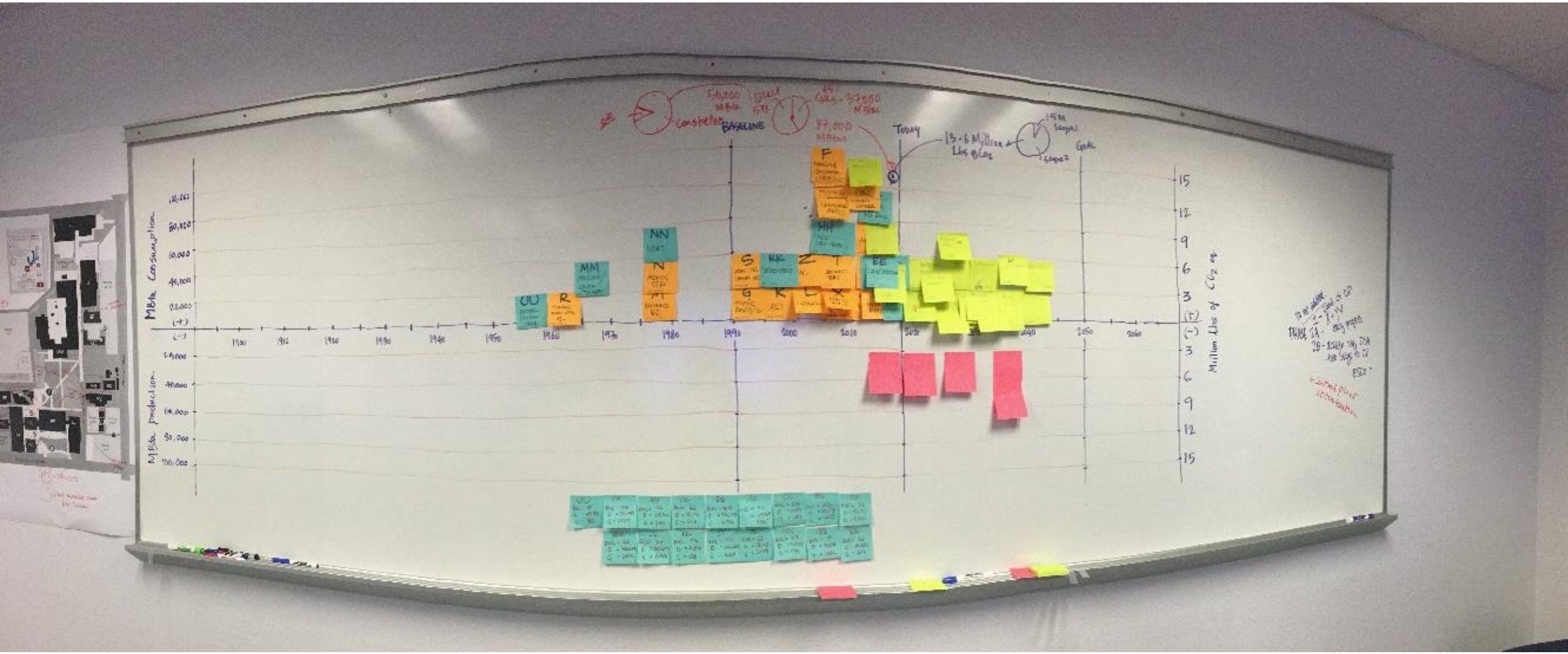
Scope 3

Other Indirect GHG Emissions
Employee Travel

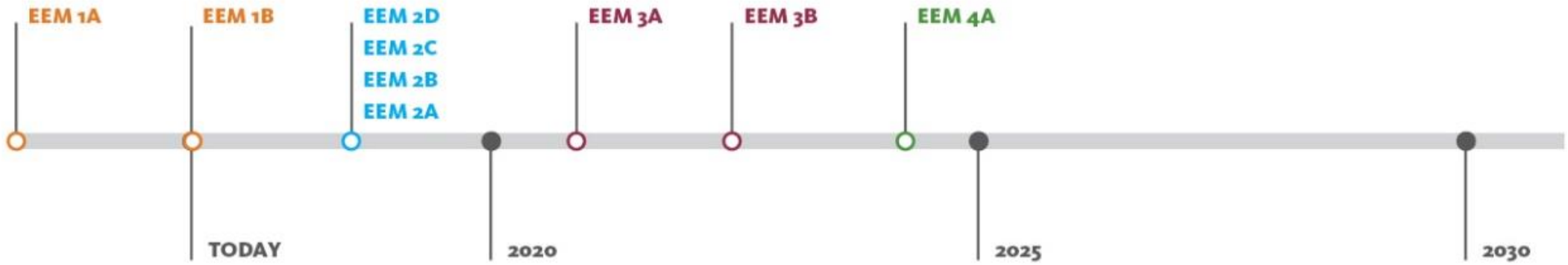
baseline 4,745,111 lbs. of CO2

performance analysis – **lenses**

performance analysis – **lenses**



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

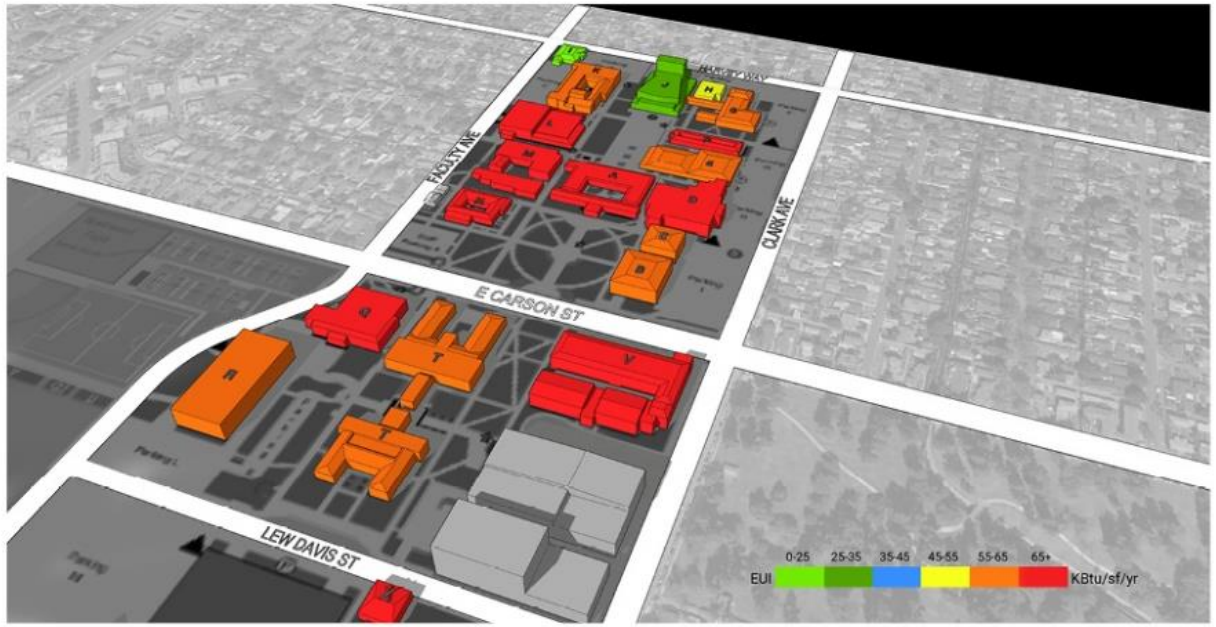
- Continue best practices periodic assessment of meeting targets every three years until 2050 and applying necessary best practices and technology to close the gap.

ex.: design **recommendations**

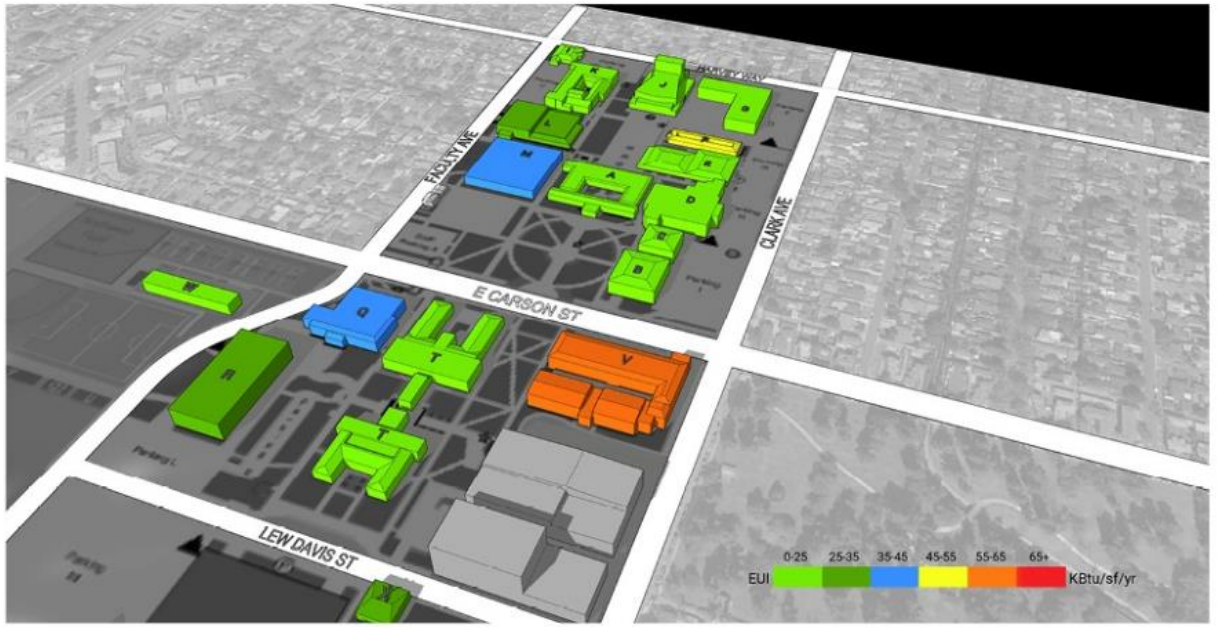
- ASHRAE LEVEL 1 & 2 STRATEGIES
- RECLAIMED WATER CONVERSION AT COOLING TOWER
- SITE LIGHTING IMPROVEMENT & WALKWAY/ROADWAY

anticipated **results**

BEFORE:
Energy Use Intensity Graph for LAC

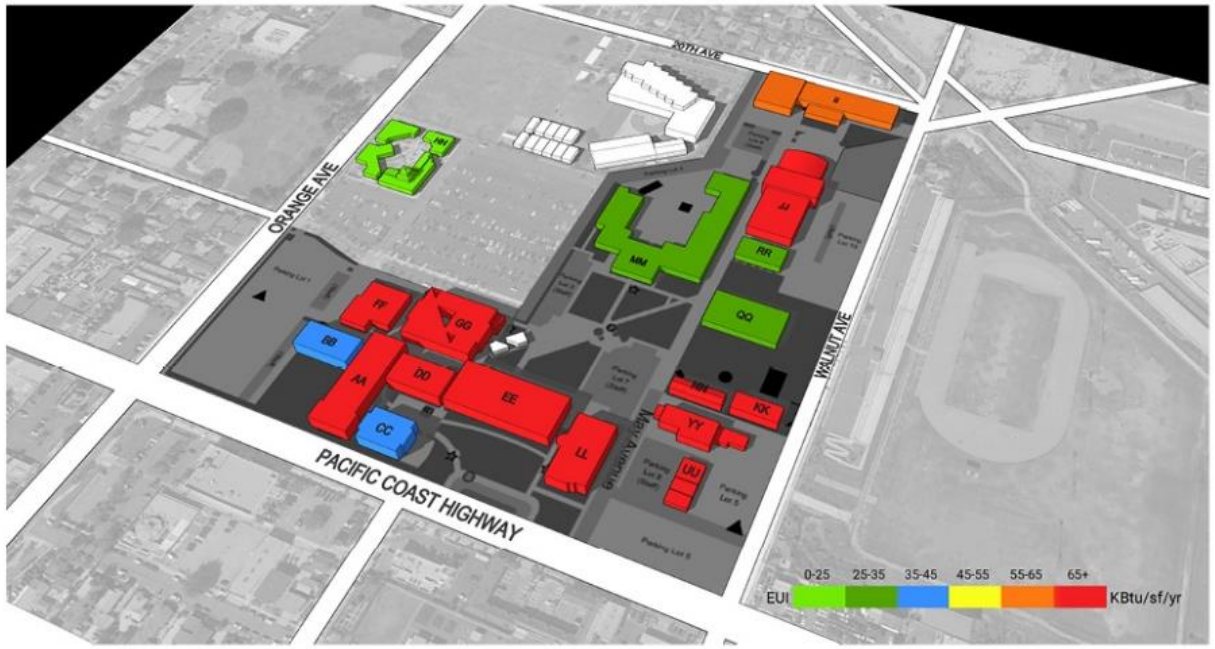


AFTER:
Energy Use Intensity Graph for LAC



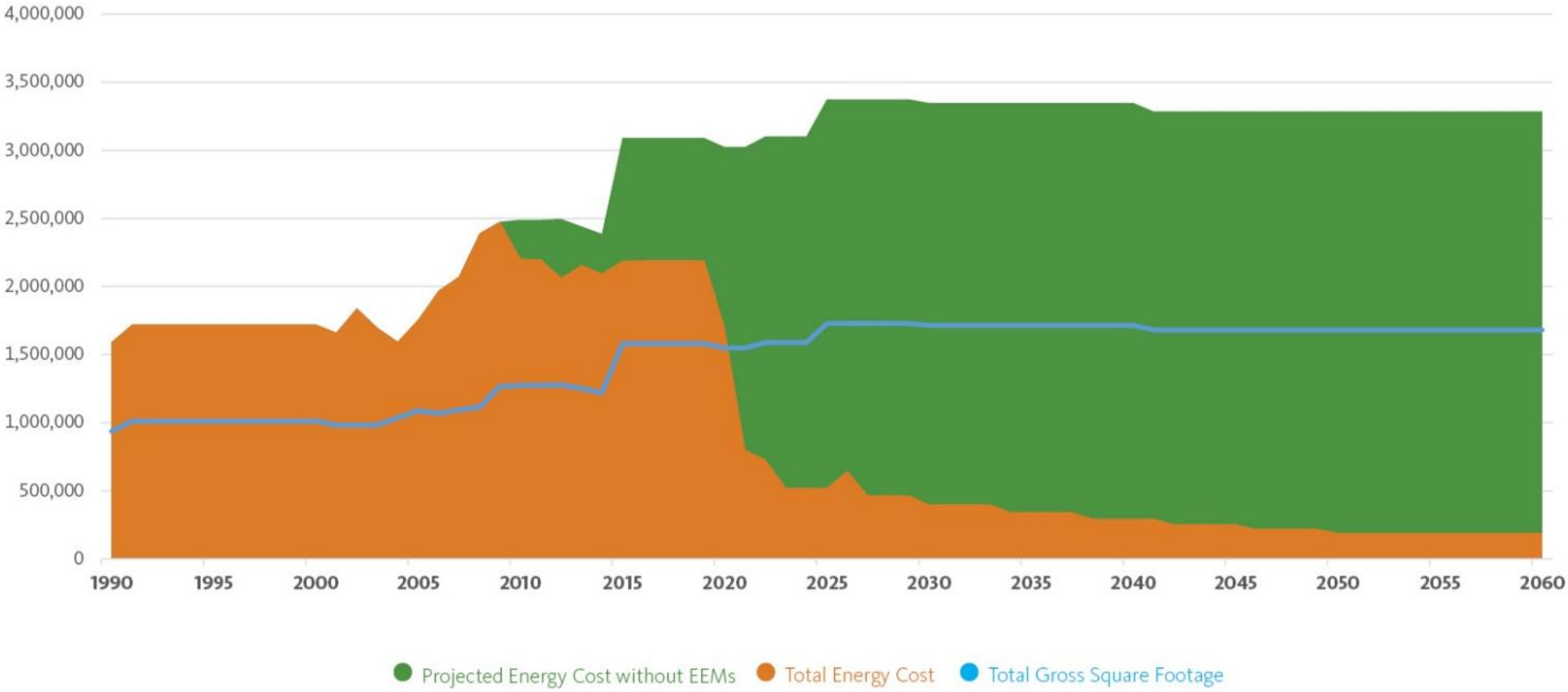
anticipated **results**

BEFORE:
Energy Use Intensity Graph for PCC

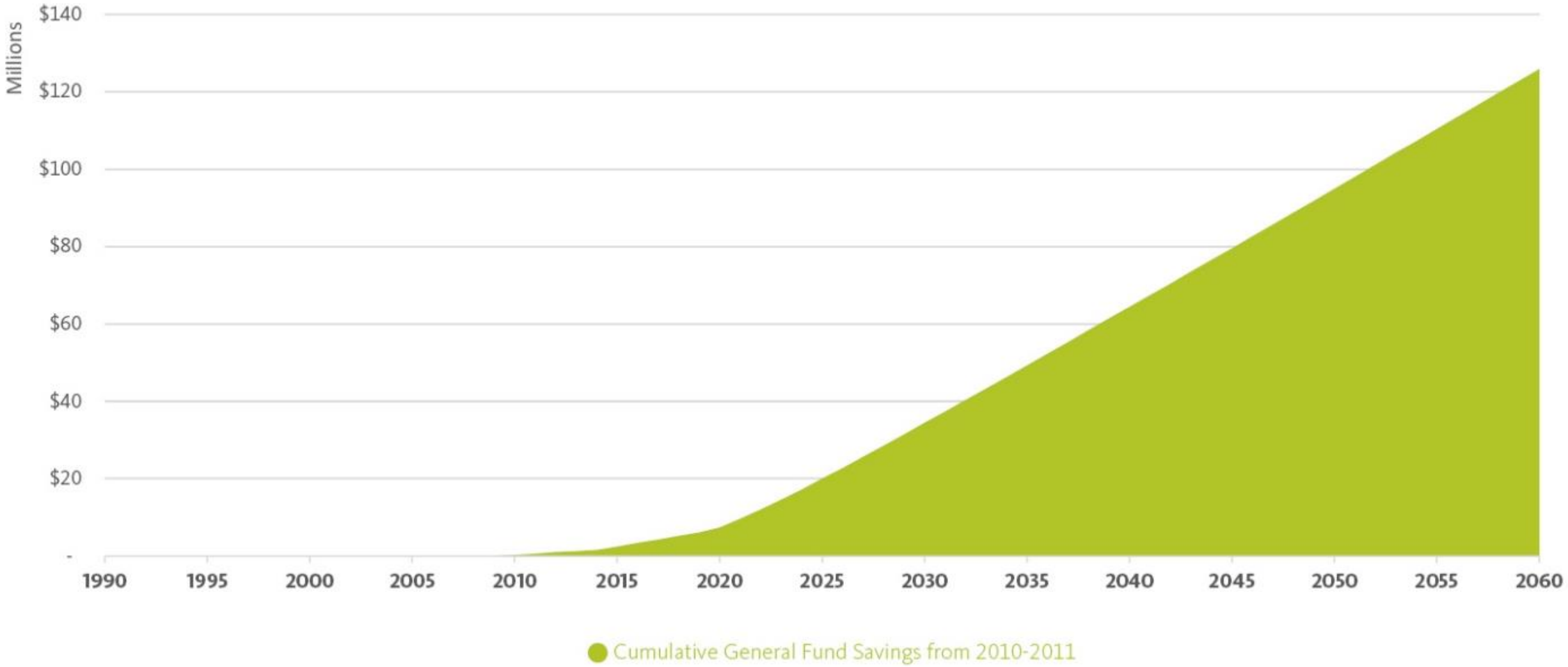


AFTER:
Energy Use Intensity Graph for PCC

general fund **savings**



general fund **savings**



break

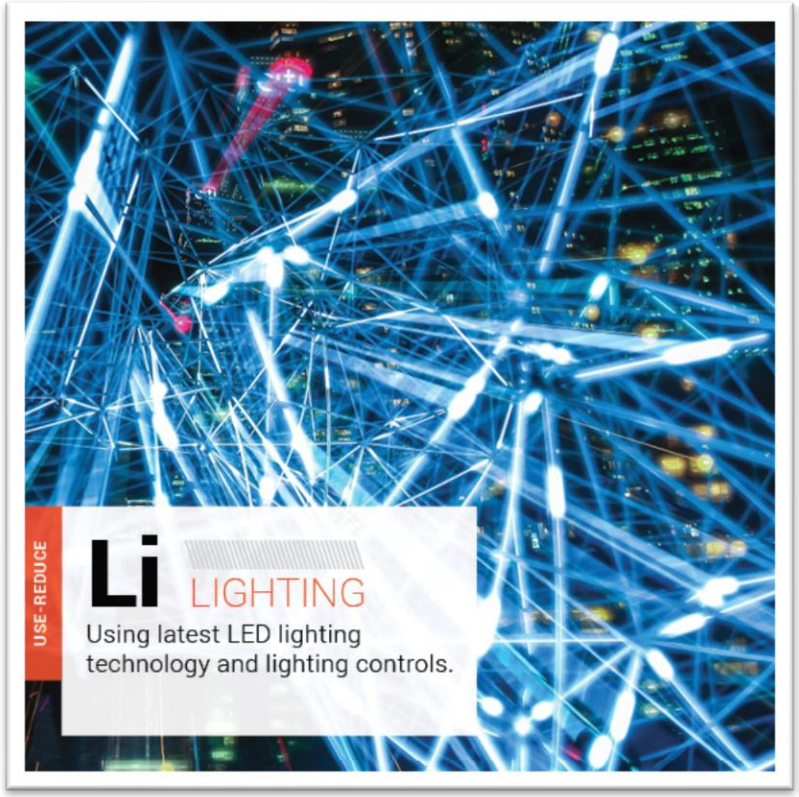
step 3: net-zero **strategy**

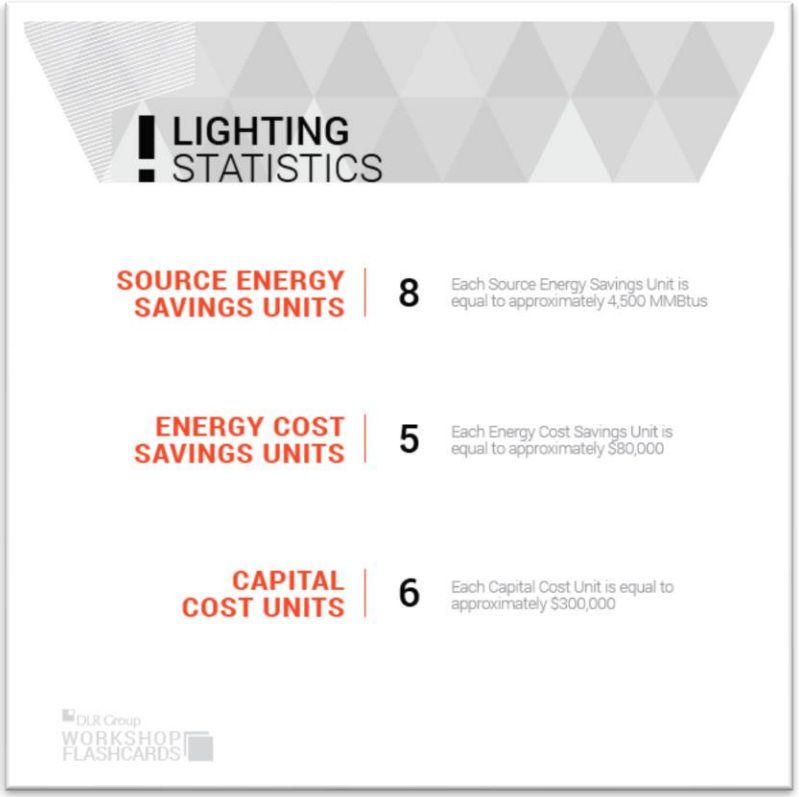
- this exercise is to apply appropriate strategies to achieve net-zero energy at a campus level
- 87 legos for electricity
- 13 legos for gas

- 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.

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

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

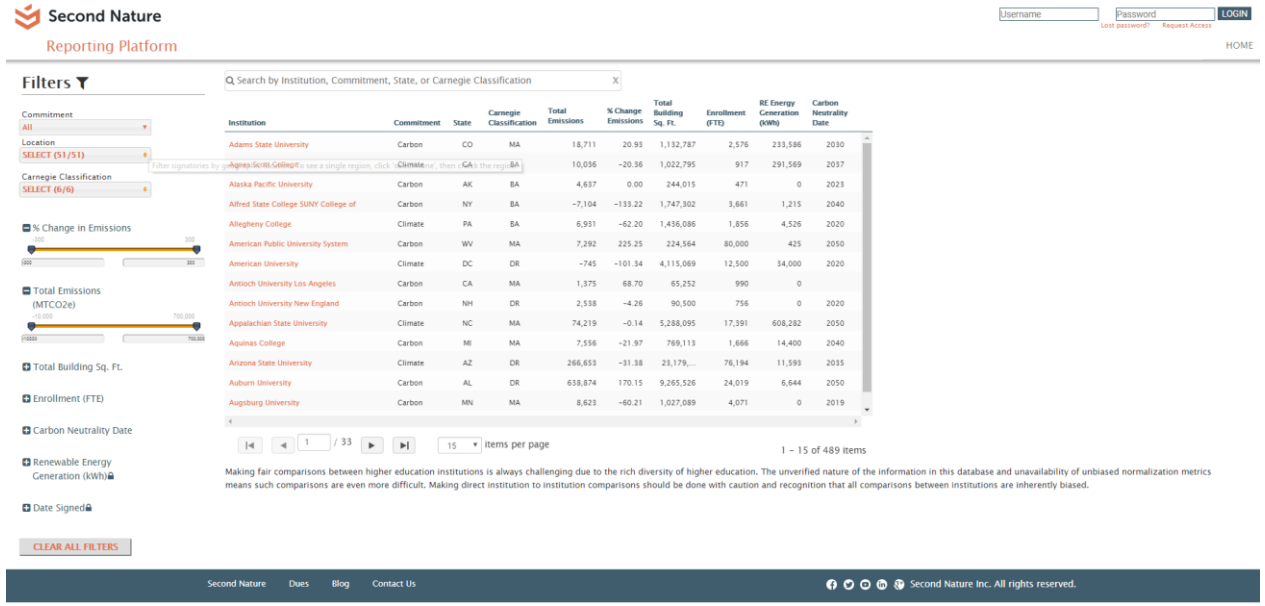
- strategies eliminate both gas and electricity
- energy cost units are higher than 100 as synergies between strategies not taken into account

discussion

climate **commitment**

American College and University Presidents Climate commitment.
The Climate Commitment integrates carbon neutrality with climate resilience and provides a systems approach to mitigating and adapting to a changing climate.

The **Second Nature** website is a resource to help innovative leaders build broader and deeper levels of climate action impact both on and off campuses.



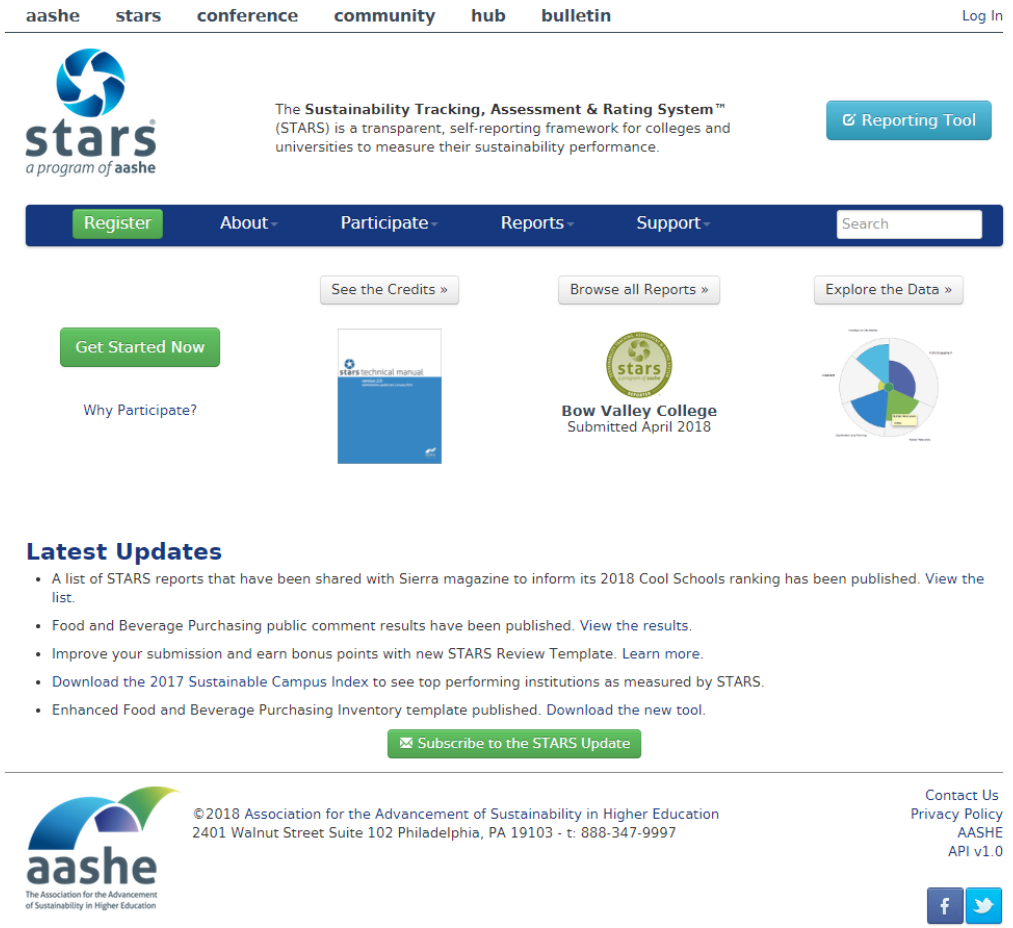
http://secondnature.org/climate-guidance/the-commitments/#Climate_Commitment
http://reporting.secondnature.org/home/

aashe **stars**

Association for the Advancement of Sustainability in Higher Education

Sustainability Tracking, Assessment and Rating System

OP1: Greenhouse Gas Emissions
OP3: Building Operations and Maintenance
OP4: Building Design and Construction
OP5: Building Energy Consumption
OP6: Clean and Renewable Energy

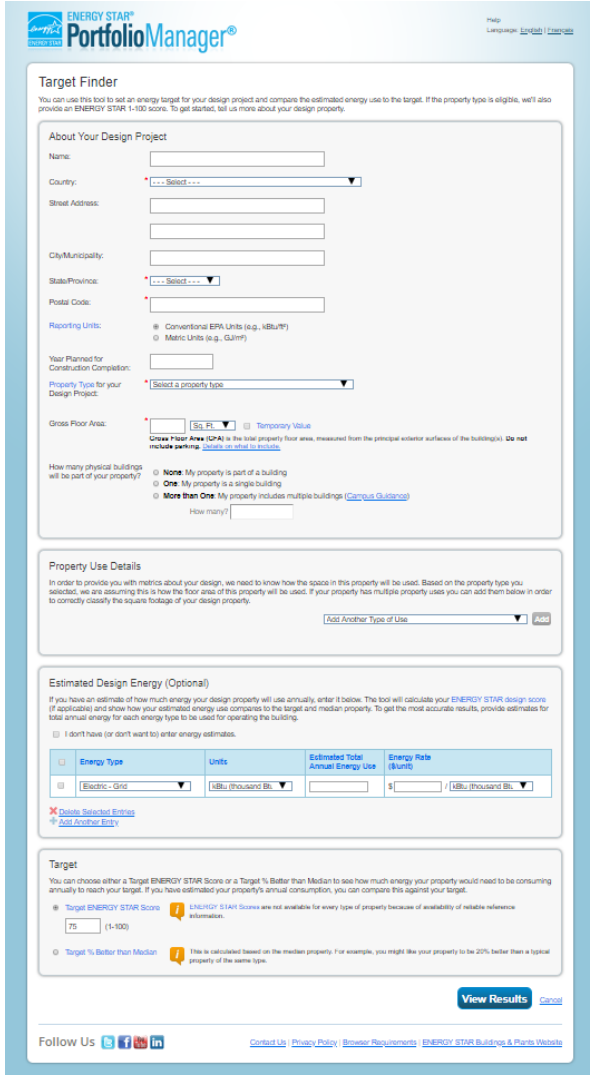


https://stars.aashe.org/

ENERGY STAR **Target Finder**

Energy Benchmarking

http://www.energystar.gov/buildings/tools-and-resources/target-finder-0

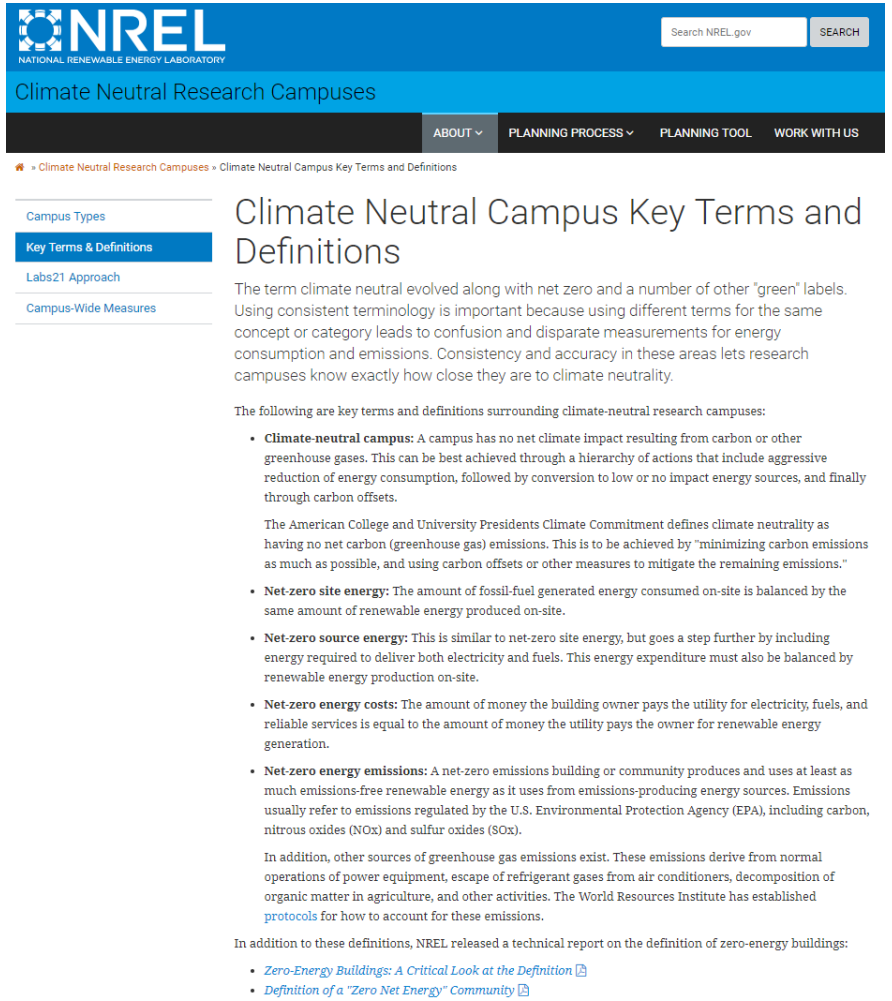


lab **benchmarking**

Labs 21 Benchmarking Tool is hosted by Lawrence Berkeley National Lab (LBNL)
http://www.labs21benchmarking.lbl.gov

carbon **neutral**

NREL Carbon Neutral Campus Key Terms and Definitions



NREL
NATIONAL RENEWABLE ENERGY LABORATORY

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Climate Neutral Research Campuses

ABOUT PLANNING PROCESS PLANNING TOOL WORK WITH US

» Climate Neutral Research Campuses » Climate Neutral Campus Key Terms and Definitions

- Campus Types
- Key Terms & Definitions
- Labs21 Approach
- Campus-Wide Measures

Climate Neutral Campus Key Terms and Definitions

The term climate neutral evolved along with net zero and a number of other "green" labels. Using consistent terminology is important because using different terms for the same concept or category leads to confusion and disparate measurements for energy consumption and emissions. Consistency and accuracy in these areas lets research campuses know exactly how close they are to climate neutrality.

The following are key terms and definitions surrounding climate-neutral research campuses:

- **Climate-neutral campus:** A campus has no net climate impact resulting from carbon or other greenhouse gases. This can be best achieved through a hierarchy of actions that include aggressive reduction of energy consumption, followed by conversion to low or no impact energy sources, and finally through carbon offsets.

  The American College and University Presidents Climate Commitment defines climate neutrality as having no net carbon (greenhouse gas) emissions. This is to be achieved by "minimizing carbon emissions as much as possible, and using carbon offsets or other measures to mitigate the remaining emissions."
- **Net-zero site energy:** The amount of fossil-fuel generated energy consumed on-site is balanced by the same amount of renewable energy produced on-site.
- **Net-zero source energy:** This is similar to net-zero site energy, but goes a step further by including energy required to deliver both electricity and fuels. This energy expenditure must also be balanced by renewable energy production on-site.
- **Net-zero energy costs:** The amount of money the building owner pays the utility for electricity, fuels, and reliable services is equal to the amount of money the utility pays the owner for renewable energy generation.
- **Net-zero energy emissions:** A net-zero emissions building or community produces and uses at least as much emissions-free renewable energy as it uses from emissions-producing energy sources. Emissions usually refer to emissions regulated by the U.S. Environmental Protection Agency (EPA), including carbon, nitrous oxides (NOx) and sulfur oxides (SOx).

  In addition, other sources of greenhouse gas emissions exist. These emissions derive from normal operations of power equipment, escape of refrigerant gases from air conditioners, decomposition of organic matter in agriculture, and other activities. The World Resources Institute has established protocols for how to account for these emissions.

In addition to these definitions, NREL released a technical report on the definition of zero-energy buildings:

- *Zero-Energy Buildings: A Critical Look at the Definition*
- *Definition of a "Zero Net Energy" Community*

https://www.nrel.gov/climate-neutral/terms-definitions.html

carbon **neutral**

NREL's Climate Action Planning Tool provides a quick, basic estimate of how various technology options can contribute to an overall climate action plan for your research campus.

https://nrel.gov/climate-neutral/planning-tool

conclusion

Elevate the

human design

experience through