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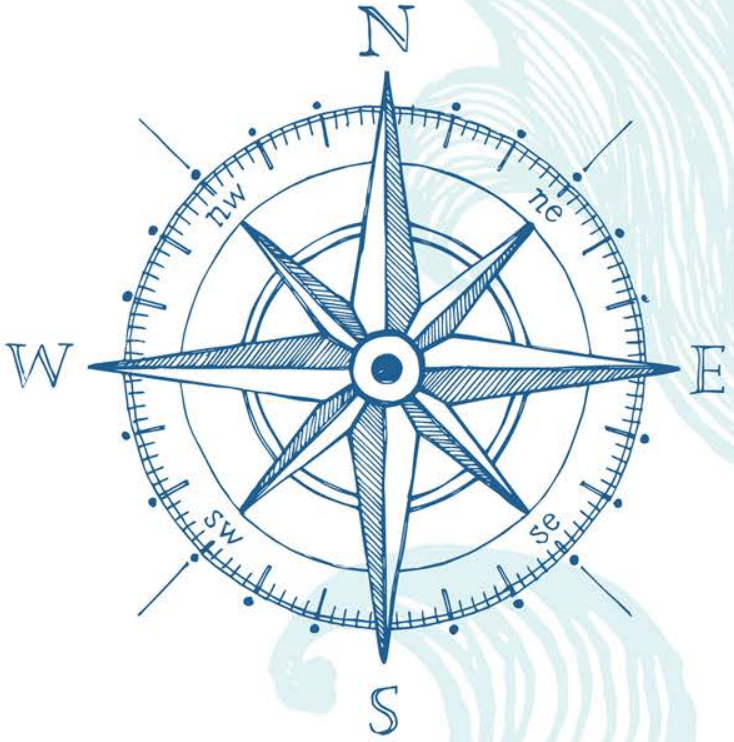

BUILDING COLLABORATIVE COMMUNITIES

NAVIGATING CHALLENGES, CHARTING INNOVATIONS

2018 CSU FACILITIES MANAGEMENT CONFERENCE

Net Zero Energy – The Ultimate Goal, at what cost?

Moderator:

- **Mark Zakhour** - Director of Design & Construction Services, CSU Long Beach

Net Zero Energy – The Ultimate Goal, at what cost?

Presenters:

- **Michael Clemson** – CSU Office of the Chancellor
- **Susan O'Connell** – Principal, AC Martin Architects
- **Albert Valdivia** – Project Executive, Clark Construction

Learning Outcomes

Agenda

- Defining Net Zero Energy
- CSU Policy Overview
- EUI Targeting
- Impacts of NZE on your projects
  - Schedule
  - Cost
  - Infrastructure
  - Unique Barriers
- Case Studies

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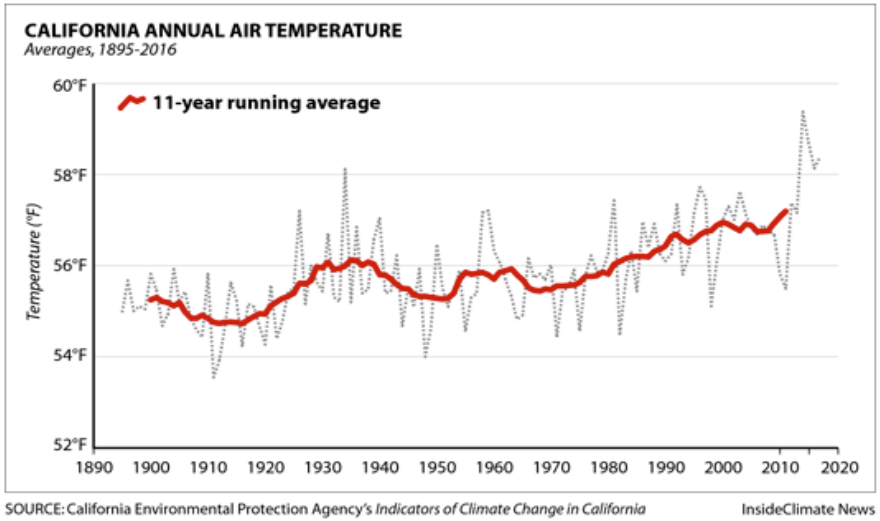
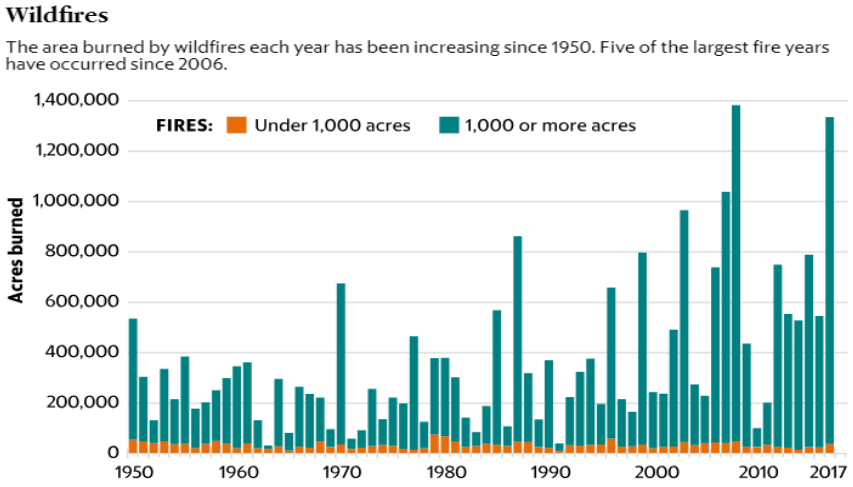
Why net Zero Energy?



SOURCE: California Environmental Protection Agency's *Indicators of Climate Change in California* InsideClimate News



Source: CalFire, 2018

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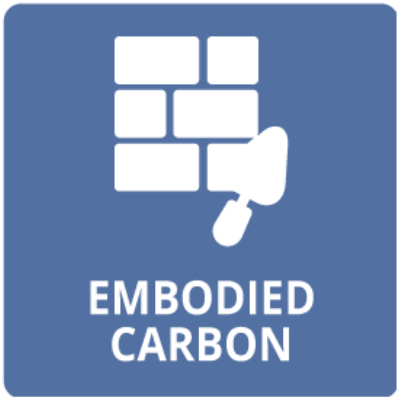
Why Net Zero Energy?

THE ACTIONS NEEDED TO ACHIEVE A CARBON-NEUTRAL BUILT ENVIRONMENT

ZERO CARBON EMISSIONS FROM:

New Buildings: Operational Emissions

By 2060, the world is projected to add 230 billion m^2 (2.5 trillion ft^2) of buildings, or an area equal to the entire current global building stock. This is the equivalent of adding an entire New York City to the planet every 34 days for the next 40 years.



New Buildings: Embodied Carbon

Annually, embodied carbon is responsible 11% of global GHG emissions and 28% of global building sector emissions.

Existing Buildings: Operational Emissions

Cities are responsible for over 70 percent of global energy consumption and CO2 emissions, mostly from buildings, marking a significant opportunity to focus climate change mitigation and adaptation efforts on dense urban environments.

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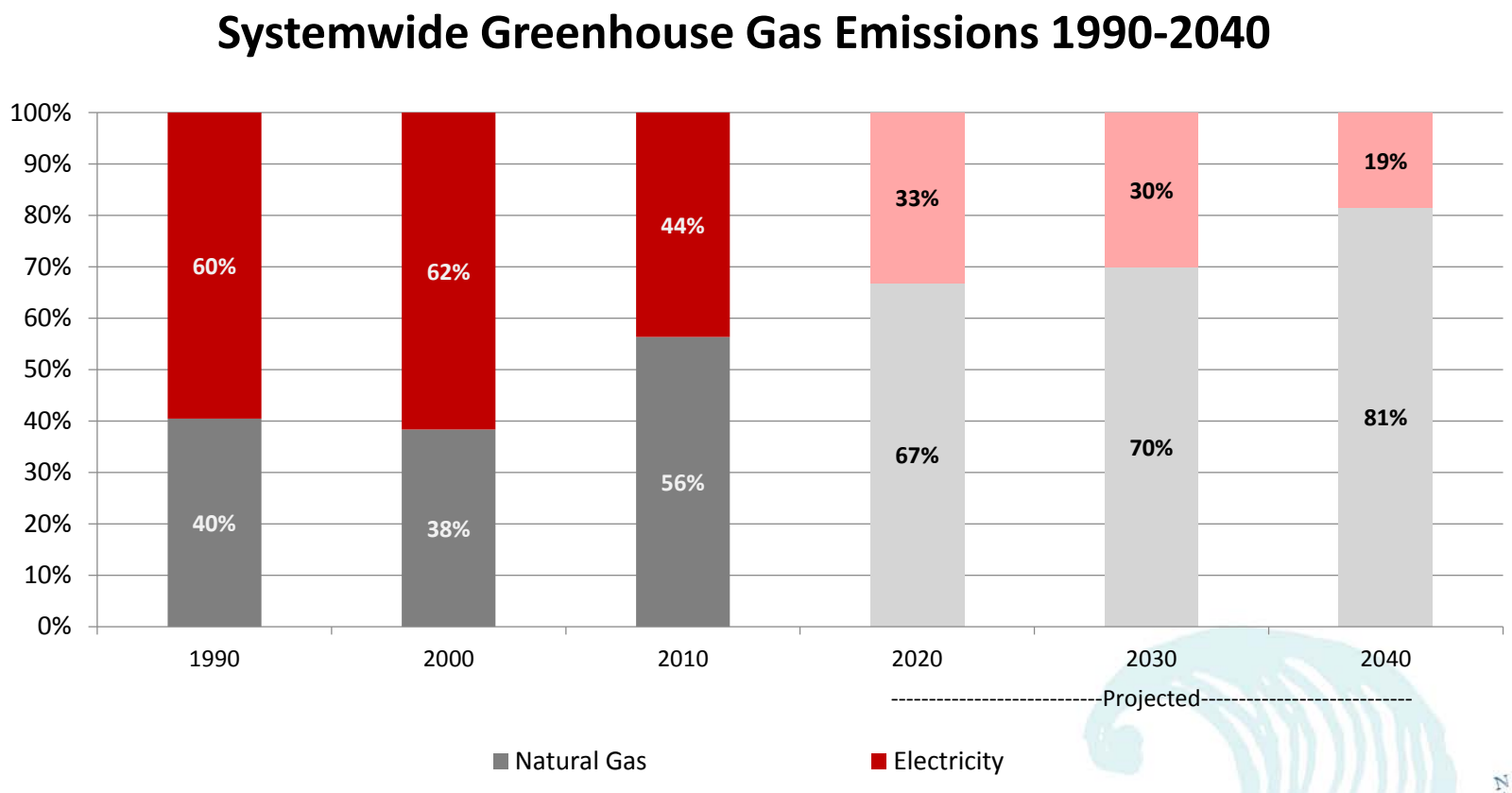
CSU Emissions



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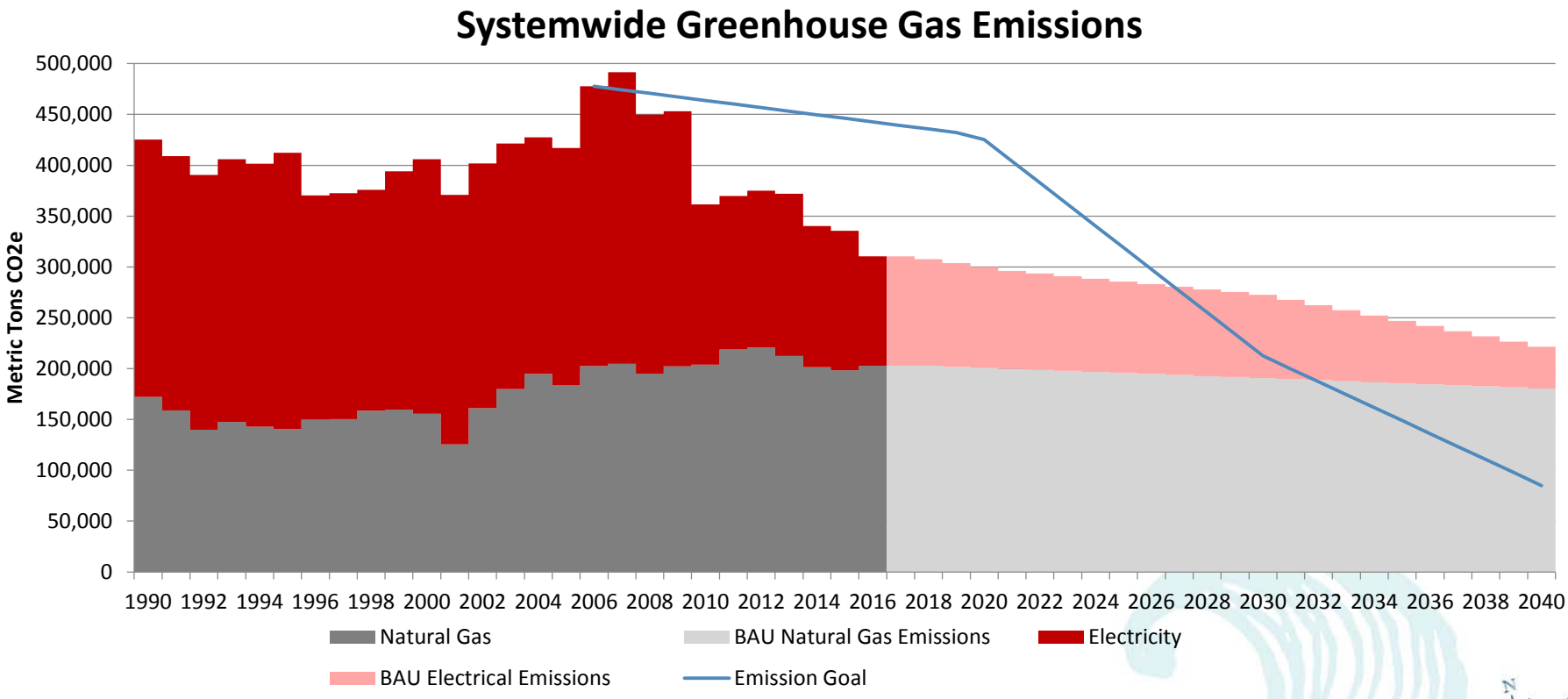
Systemwide Emission Projection



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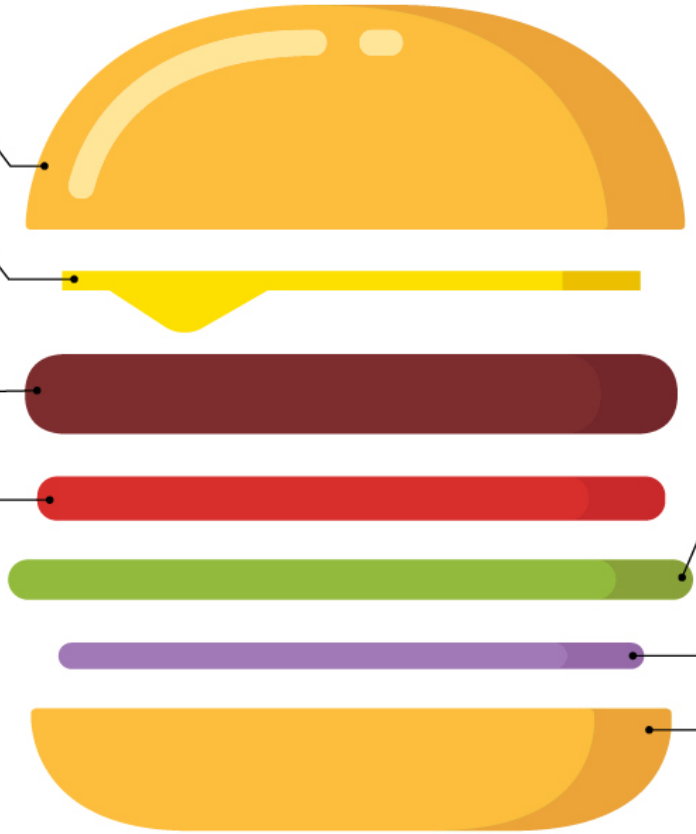
Layers of CSU Policy

Board of Trustees–Policy
High-level goals providing broad leadership for the system

Executive Orders
Directive delegating authority and responsibility to implement Board policy

State University Administrative Manual (SUAM)
Legal and procedural guidelines, principles and practices that provide campus audit standards

Compliance Guides, Tool Kits and Model Practices
Provide expert, detailed guidance to campus stakeholders on fulfilling the requirements of SUAM and Board policy



Request for Proposals
A description of the project, program goals, intents and requirements

Contracts
Established terms, conditions between campus partners for identified and specific projects & programs

Communicating CSU Norms and Values
Connect the Board policy goals to CSU core beliefs to build buy-in and achieve a successful program

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Board of Trustees/Executive Orders

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State University Administrative Manual

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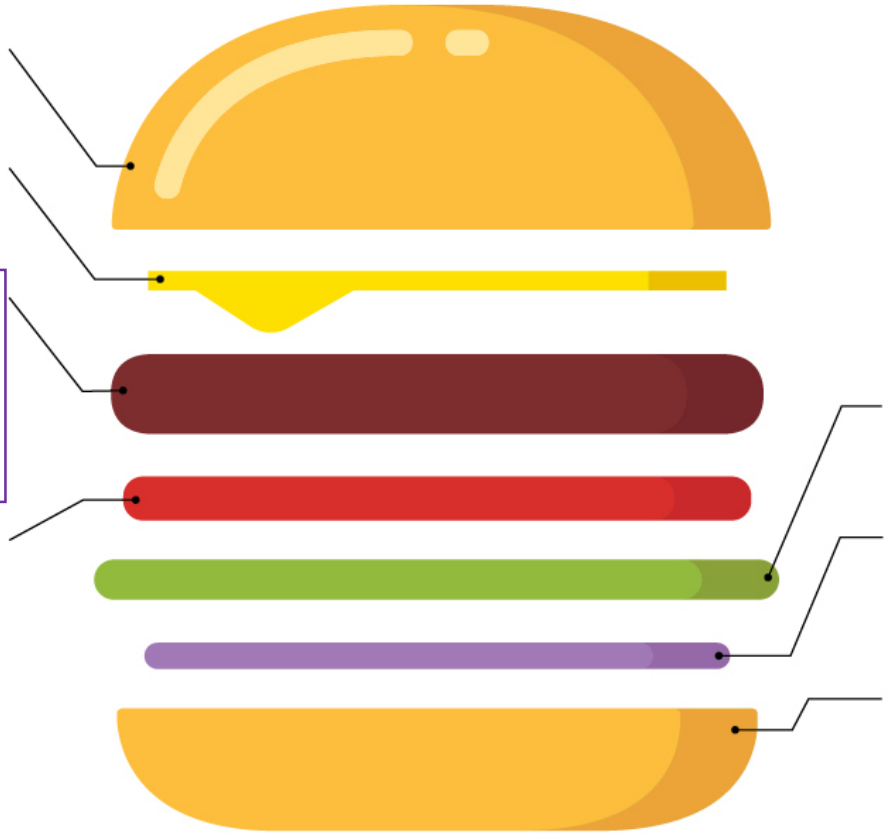
Legal and procedural guidelines, principles and practices that provide campus audit standards



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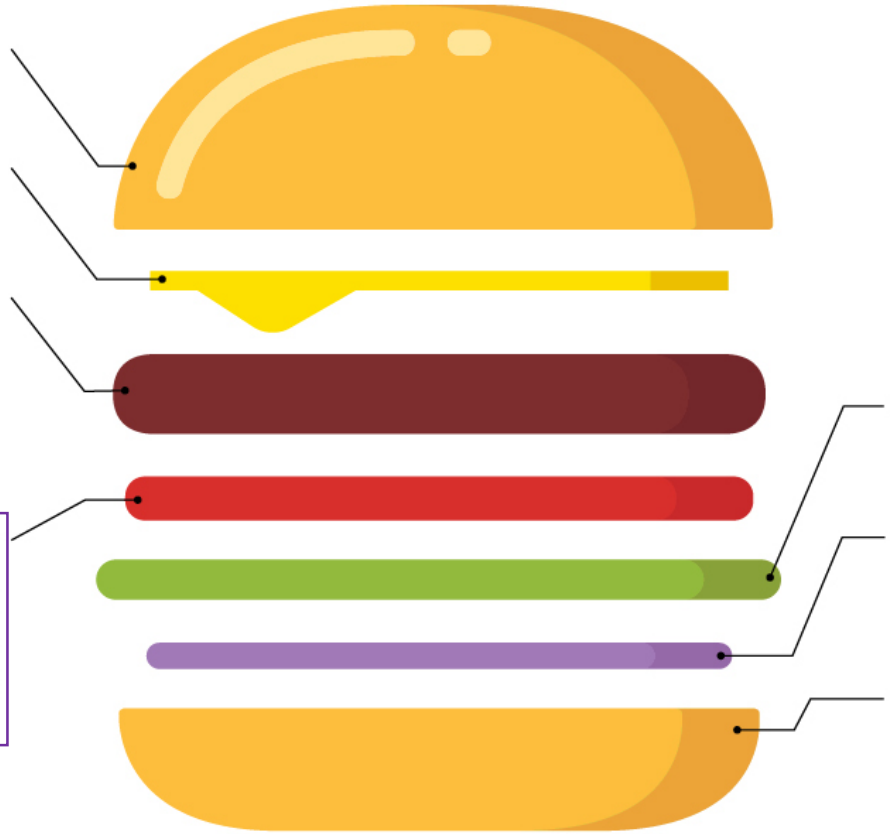
Compliance Guides



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Provide expert, detailed guidance to campus stakeholders on fulfilling the requirements of SUAM and Board policy

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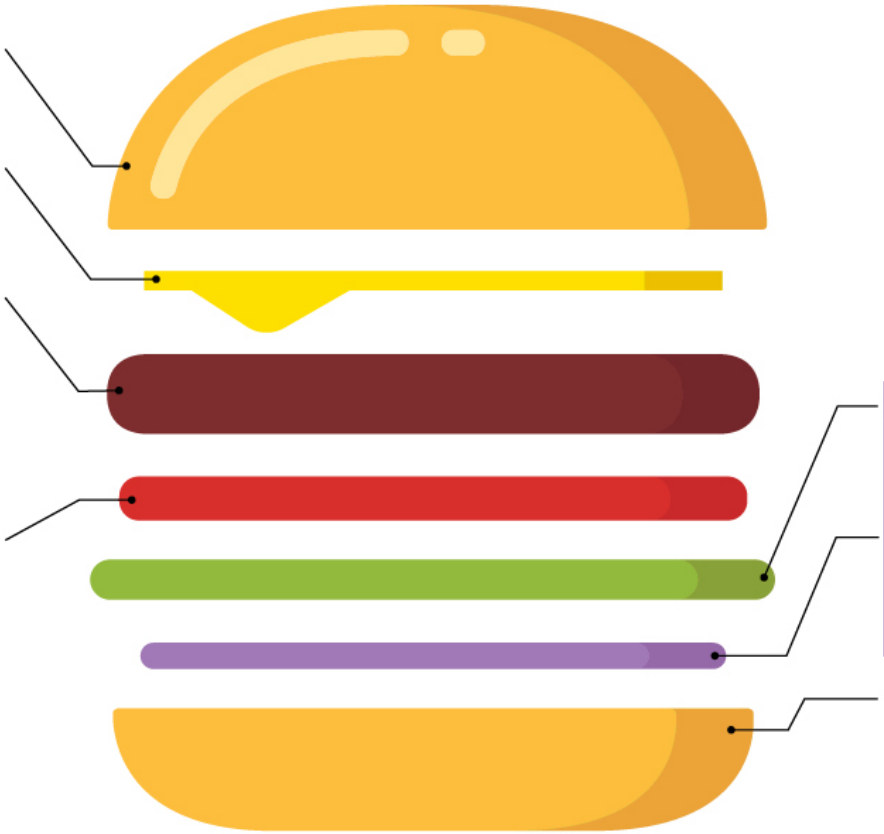
RFPs/Contracts



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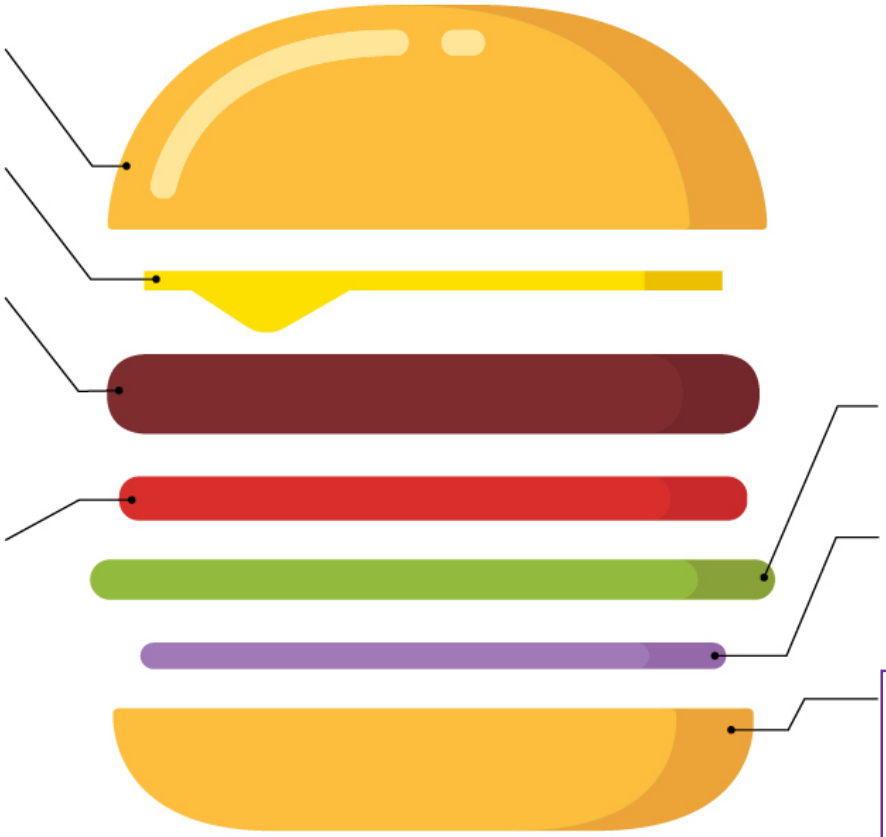
Communicating Values and Norms



Communicating CSU Norms and Values

Connect the Board policy goals to CSU core beliefs to build buy-in and achieve a successful program

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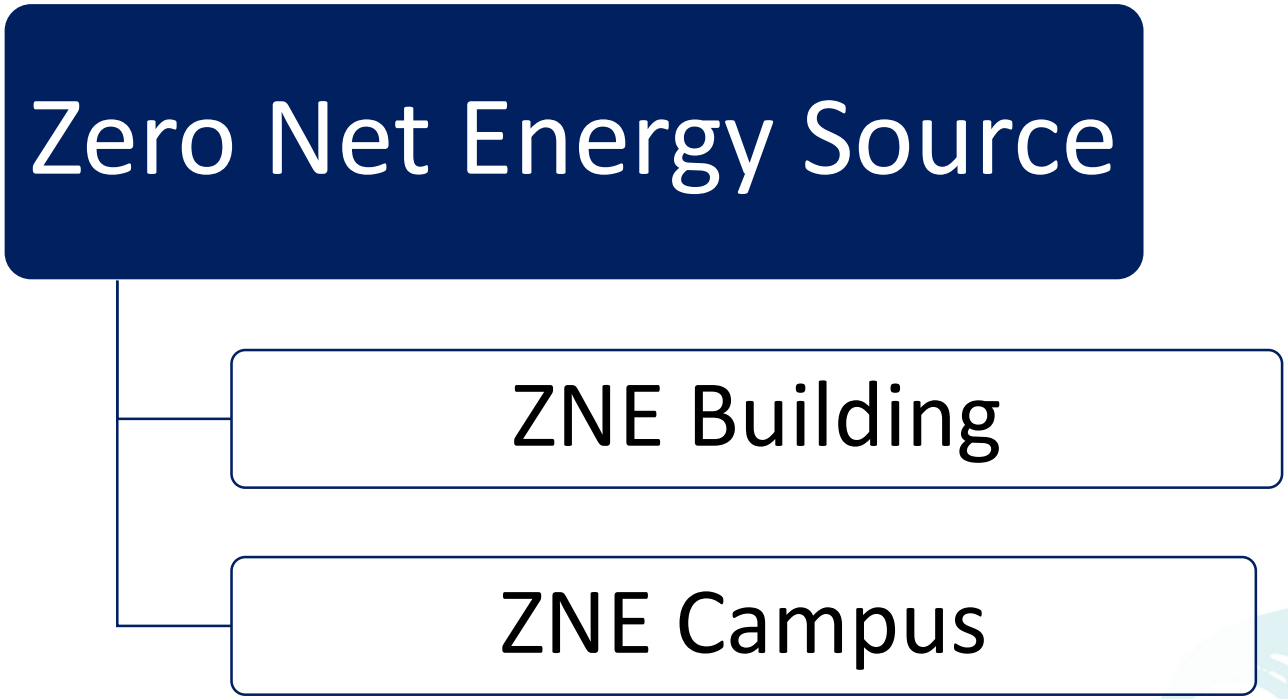
Zero Net Energy Definitions



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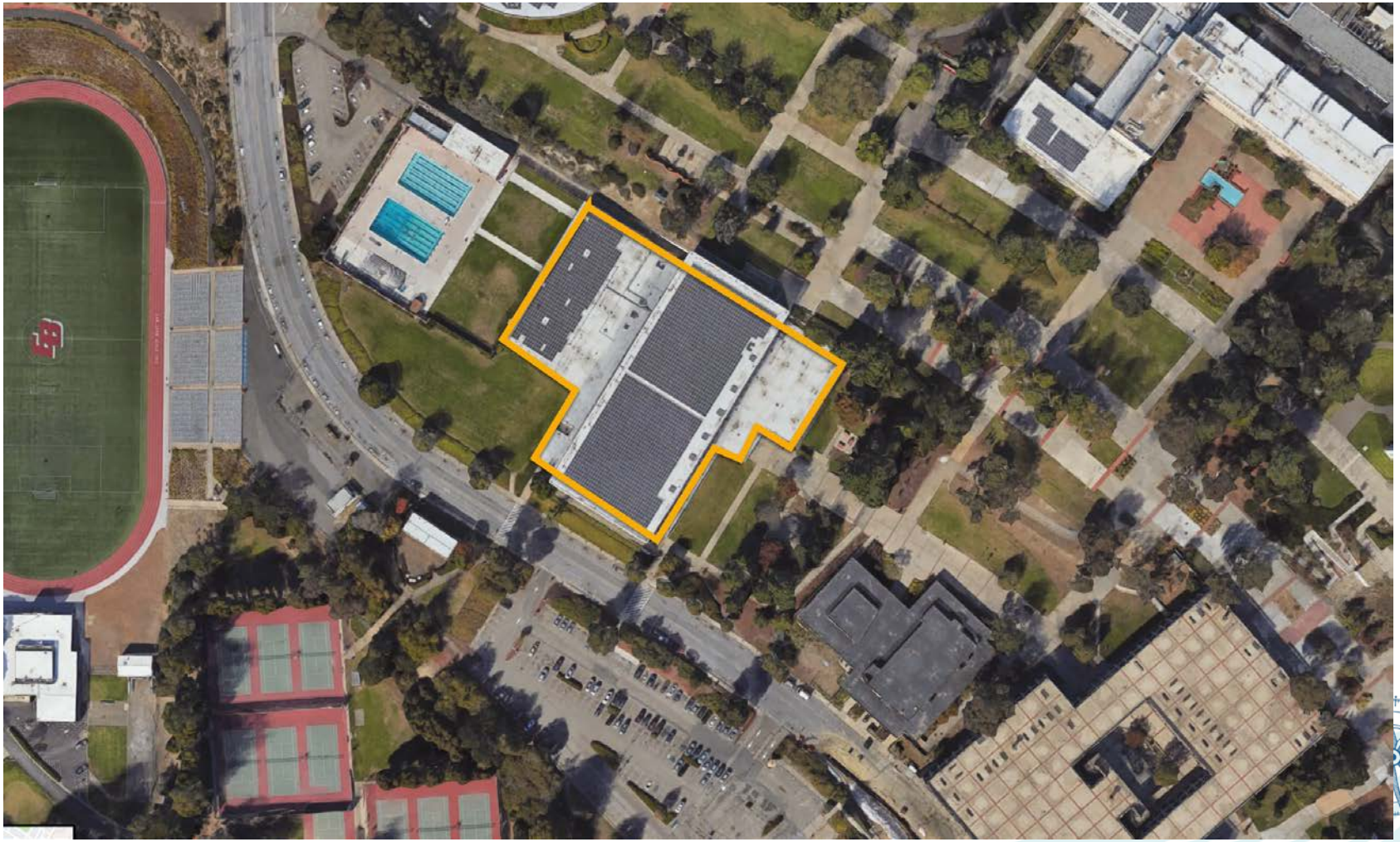
ZNE Building



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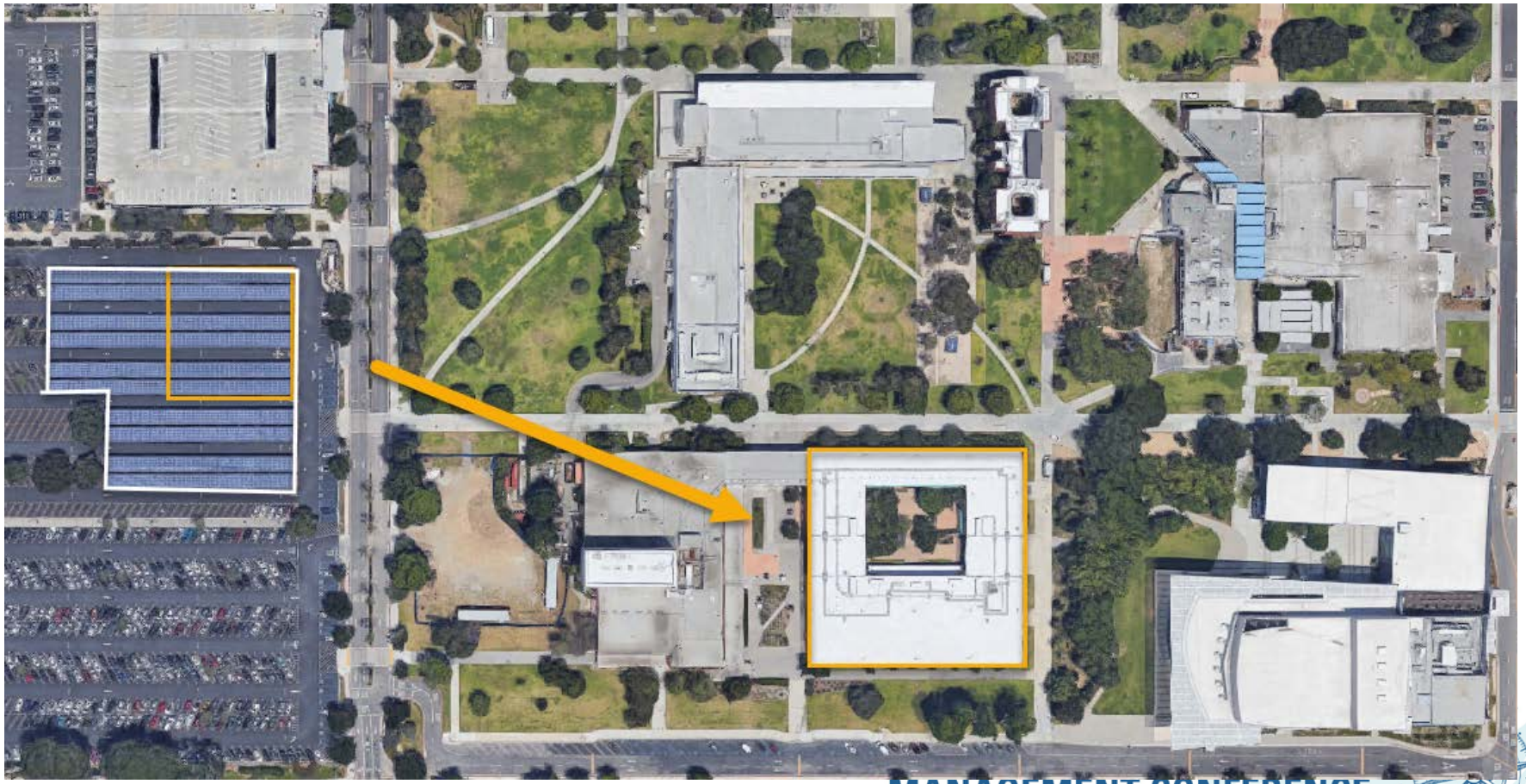
ZNE Campus



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EUI Targeting

Data Sources

- CSU Campus Energy Use Data (Monthly Energy Reports)
- California Commercial End-Use Survey (CEUS)
- US DOE/CA CEC Energy Code Performance

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EUI Estimates

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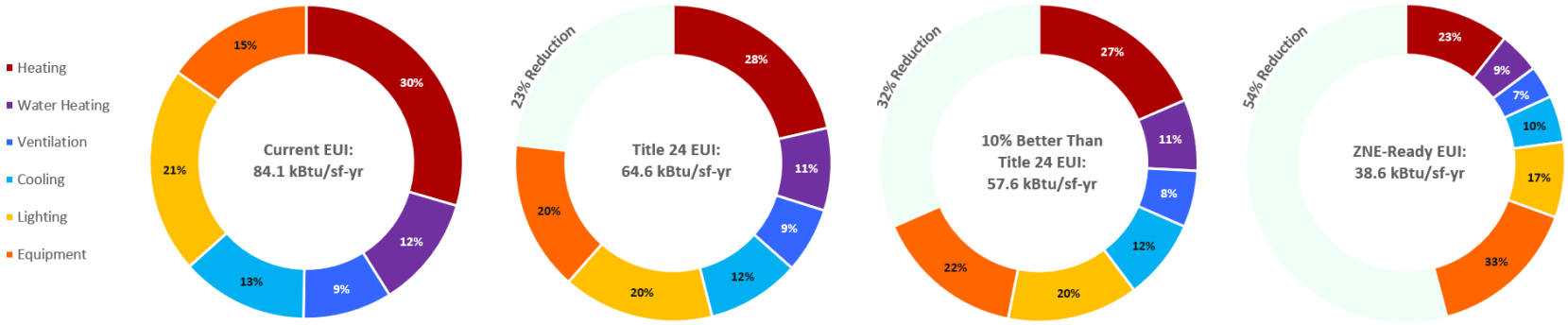
engineers for a sustainable future

Estimated End-Use Breakdown for a Classroom Building in CSU Monterey Bay



Current Usage

2016 Title 24
23% Reduction

10% Better than Title 24
32% Reduction

Zero-Net Energy
54% Reduction

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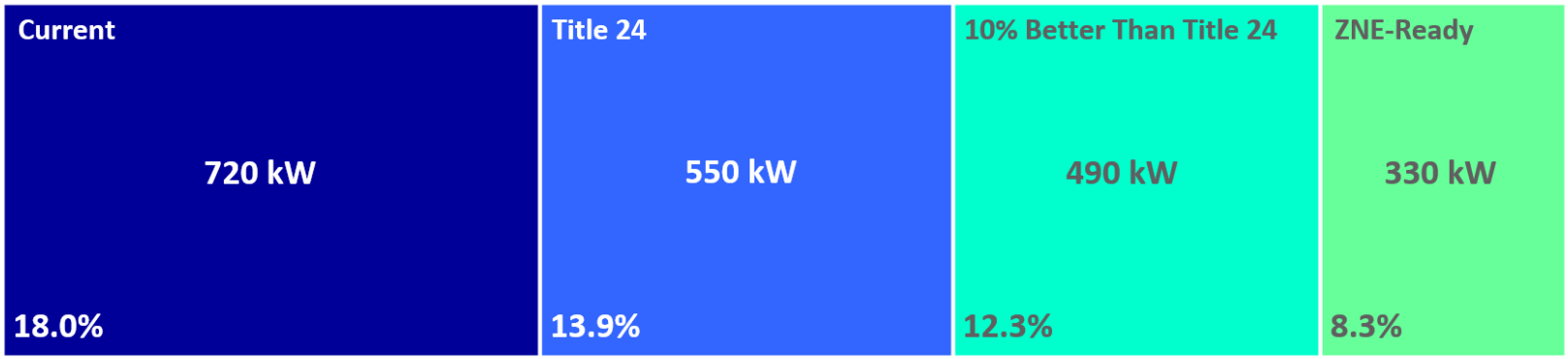
Required Investment in Solar PV to Achieve Zero Net Energy

[Percentage of Construction Costs for a 40,000 ft^2 Classroom Building in CSU Monterey Bay]



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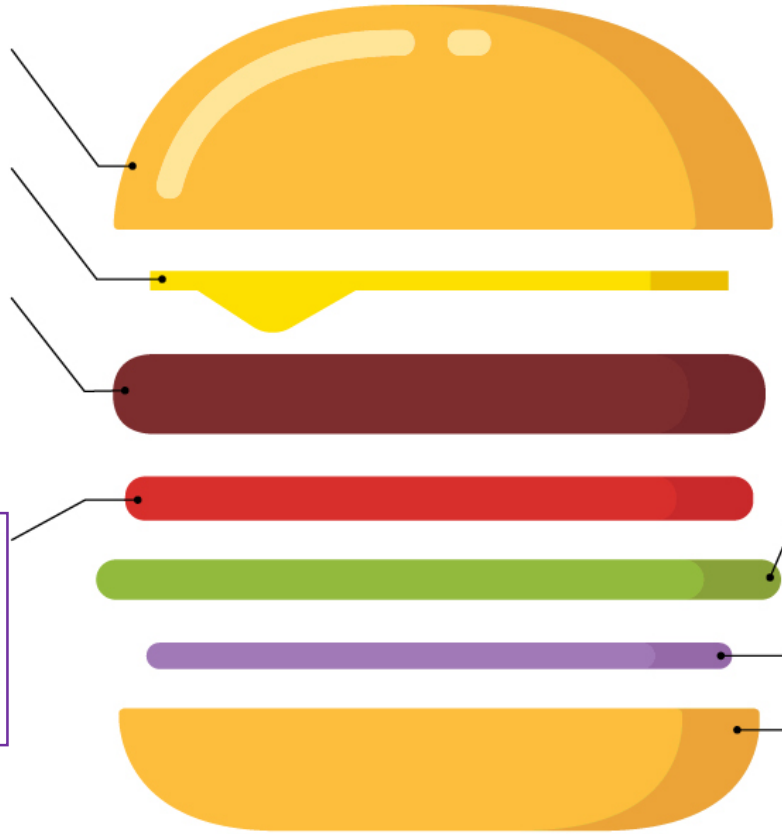
ZNE Sandwich



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Impacts of NZE on projects

- Schedule/Process
- Cost
- Campus Infrastructure
- Unique Barriers
- Case Study UCSD Torrey Pines Live Learn
- Case Study SDSU New Student Resident Hall

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Schedule/Process

- Requires more up front coordination/decisions between D/B team members and the University
- Requires more iterative calculations up front
- CSU Procedure guide requires SD drawings and a fixed cost by 75% SD
- Will require greater owner and design team contingencies

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Campus Infrastructure for NZE

- NZE Utilities Master Plan
- Phasing out natural gas
- CoGen
- Central Plant Thermal Storage
- PV solar storage

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Unique barriers to NZE

- Project Funding/Budgets and priorities
- Project Goals – what is the TOP priority?
- Facilities involvement in the NZE strategy
- O&M of unfamiliar technologies
- User education

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Case Study:
SDSU New Student Residence Hall

$125 million Project Costs
1242 beds
103,000 ASF
188,000 GSF
Completion Aug 17, 2019
Program:
- Residence hall
- Coffee shop & market
- Community room
- Amenity spaces

Case Study: SDSU New Student Residence Hall

1. Food truck court

2. Amphitheatre

3. West courtyard

4. East courtyard

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Case Study: SDSU New Student Residence Hall

Covered outdoor living room

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Case Study:
SDSU New Student Residence Hall

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Case Study:
SDSU New Student Residence Hall

To achieve NZE what would we change on this project?

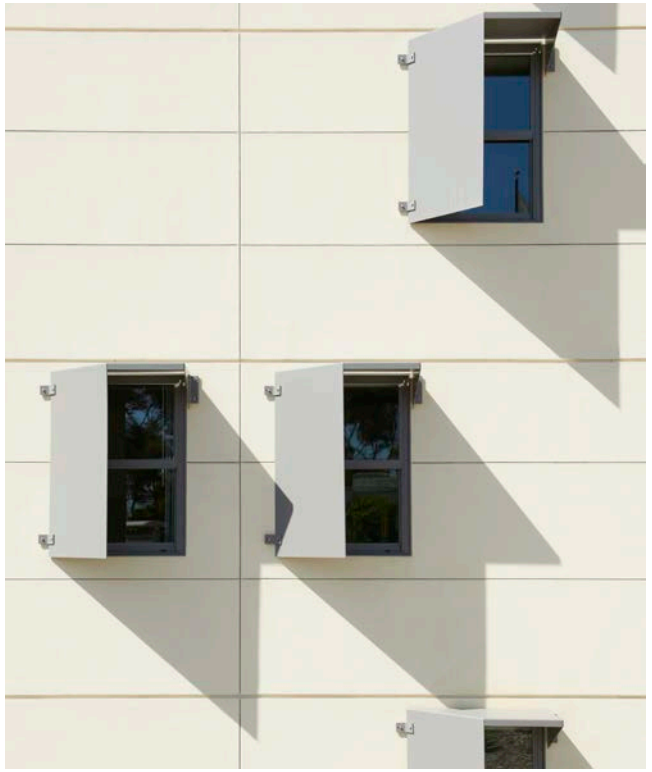
1. Alternative Skin
    1. Upgrade glazing
    2. Exterior shading
2. Controlled receptacles
3. Window interlocks
4. Domestic Hot Water reduction
5. Energy dashboard

Case Study:
SDSU New Student Residence Hall

Heavy precast slows temperature changes inside

Case Study:
SDSU New Student Residence Hall

Shades cut solar heat and scoop air into operable windows



Case Study:
SDSU New Student Residence Hall

Controlled outlets cut plug load

Case Study:
SDSU New Student Residence Hall

Open or closed, who decides?

SHARED DOUBLE ROOM

Case Study:
SDSU New Student Residence Hall

Timers on showers?

Valves: MTP Series

MASTER-TROL® PLUS WATER MANAGEMENT SYSTEM

MASTER-TROL® PLUS SYSTEM

Case Study:
SDSU New Student Residence Hall

How do we engage students in NZE?

Case Study:
SDSU New Student Residence Hall

Energy outcomes

NSRH CURRENT DESIGN	DESCRIPTION	ANNUAL ENERGY COST	ANNUAL ELECTRICITY USAGE (kWh)	ANNUAL NATURAL GAS USAGE (therms)	ANNUAL DESIGN EUI kBtu per sf	
	STEEL-FRAMED SKIN, 4-PIPE FAN COIL UNITS, LED LIGHTING	$189,145	1,384,616	5,185	31.5	
EEM#	**INDIVIDUAL ENERGY EFFICIENCY MEASURE**	**LOCATION**	**ANNUAL ELECTRICITY SAVINGS (kWh/yr)**	**ANNUAL NATURAL GAS SAVINGS (therms/yr)**	**ANNUAL EUI REDUCTION (kBtu/sf-yr)**	**%**
ENERGY EFFICIENCY MEASURES FOR CONSIDERATION						
1	Mass-Heavy Construction	Envelope	12,748	277	0.4	1.3%
2	Upgraded Glazing: Solarban 90 on clear	Envelope	3,660	-211	-0.1	-0.2%
3	Exterior Shading on East, West & South Facades	Envelope	17,289	0	0.4	1.1%
4	Receptacle Controls Utilizing Occupancy Sensors	Plug Loads	32,483	0	2.7	2.1%
5	Mixed-Mode Ventilation	HVAC	73,849	227	1.7	5.2%
6	Low-Flow Plumbing Fixtures	DHW	34,646	61	0.7	2.4%
ZNE PROPOSED						
	TOTAL SAVINGS	ALL	174,675	304	3.8	11.9%
NSRH NZE DESIGN	**DESCRIPTION**	**ANNUAL ENERGY COST**	**ANNUAL ELECTRICITY USAGE (kWh)**	**ANNUAL NATURAL GAS USAGE (therms)**	**ANNUAL DESIGN EUI kBtu per sf**	
	EEMs #1-6 COMBINED	$165,447* *BEFORE PV	1,209,941*	4,881*	27.7*	

GLUMAC
A TETRA TECH COMPANY

Case Study:
SDSU New Student Residence Hall

DESCRIPTION	U/M	QTY	UNIT $	EXTENDED
Mass-Heavy Construction: Precast	SF	110,000.00	$ 35.00	$ 3,850,000
Structural Upgrades to support Precast	GSF	190,000.00	$ 10.00	$ 1,900,000
Upgraded Glazing: Solarban 90 on clear	LS	1.00	$ 350,000.00	$ 350,000
Exterior Shading: Fins and overhangs on East, West and South facades	EA	292.00	$ 2,500.00	$ 730,000
Receptacle Control: Utilize occupancy sensors for controlled receptacles	EA	407.00	$ 395.00	$ 160,765
Mixed-mode ventilation: window contacts to shut off FCUs when windows open	EA	407.00	$ 442.50	$ 180,098
Double Hung Windows to Support Mixed-Mode Ventialation	EA	290.00	$ 1,200.00	$ 348,000
Low Flow Pumbing Fixtures reduce DHW by 30%	LS	1.00	$ 60,000.00	$ 60,000
Photovoltaic's - PV System	Watt	800,000.00	$ 3.75	$ 3,000,000
Photovoltaic's, roof upgrades, structure	SF	60,000.00	$ 25.00	$ 1,500,000

$ 12,078,863

*Costs are direct construction costs only, and do not include contractor, designer or campus markup fees

12 - 15% Cost of Work Increase

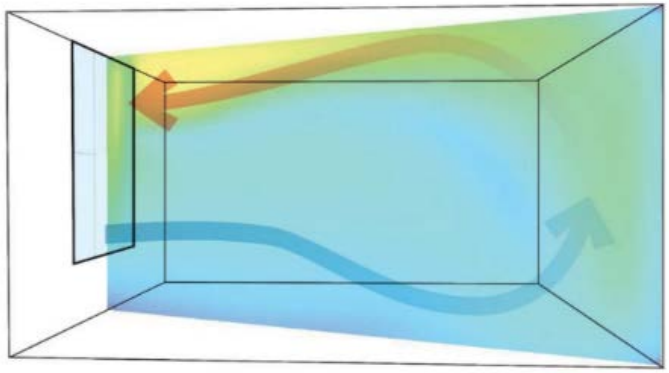
Structural and Skin Changes would delay opening by 1 semester

Case Study:
UCSD North Torrey Pines Live/learn

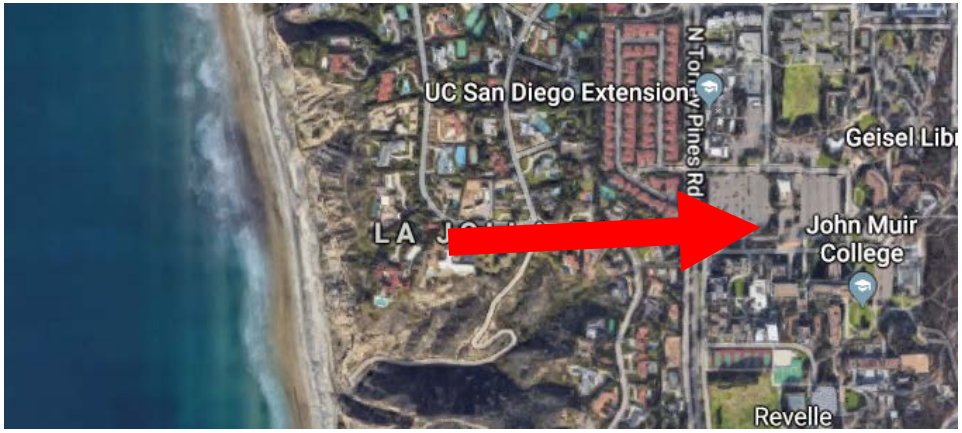
- $490 Million
- 1.5 M Square Feet
- pEUI – 31.5
- LEED Platinum
- NZE Ready

Case Study:
UCSD North Torrey Pines Live/learn

Natural Ventilation



- Natural Ventilation
- Single Sided Ventilation
- Augmented Natural Ventilation through exhaust fans



Case Study:
UCSD North Torrey Pines Live/learn

LCCA #	DESCRIPTION	MEASURE TYPE	PREDICTED ENERGY, FUEL, WATER AND WASTE SAVINGS					ESTIMATED PROJECT COST
			ELECTRIC CONSUMPTION (KWH)	NATURAL GAS CONSUMPTION (THERMS)	WATER CONSUMPTION (GALLONS)	WASTE (TONS)	ENERGY, FUEL, WATER & WASTE COST ($)	
1	180 ekW premium-efficiency polycrystalline photovoltaic array	Renewable Energy	299,000	0	0	0	$38,000	**$540,000**
2	AD 25 Series Portable and Modular Anaerobic Digester System	Renewable Energy and Waste	18,000	2,500	0	25	$5,000	**$80,000**
3	Natural ventilation for housing and academic offices	HVAC	1,390,000	0	0	0	$175,000	**$1,200,000**
4	High-performance envelope design	Envelope	560,000	20,000	0	0	$81,000	**$2,900,000**
5	Low power density lighting design	Lighting	1,100,000	-800	0	0	$138,000	**$1,500,000**
6	High-efficiency water fixtures	Water	0	0	20,630,000	0	$147,000	**$25,000**
7	Drought Resistive Plantings and Recycled Water Irrigation	Water	0	0	724,000	0	$5,000	**$50,000**
8	HVAC condensate recovery	Water	0	0	370,000	0	$3,000	**$108,000**
9	High-performance low-energy HVAC systems	HVAC	2,200,000	70,000	0	0	$314,000	**$3,600,000**
10	Clark Design Build Team - NTPLLN	ALL	5,567,000	91,700	21,727,000	25	$906,000	**$10,000,000**

- Less than 5% premium
- Payback in 11 Years

Case Study:
San Ysidro Land Port of Entry

- $750 Million
- LEED Platinum
- Solar Thermal
- PV
- Waste Water Treatment
- Rainwater Capture and Re-use
- Geothermal Heat Exchange System
- GSA Plans Net Zero Energy

Case Study:
San Ysidro Land Port of Entry

Case Study:
San Ysidro Land Port of Entry

- Geothermal Heat Exchange System
- 450 Wells 400’ deep = 70 Miles of Piping

10 Months of Drilling

Large Site Area prevented other construction from progressing

Redundant traditional systems Costs

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Please fill out session evaluation using Guidebook.

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END