

How to Approach Zero Net Energy for Existing Municipal Buildings

August 27, 2019



Center for
Sustainable
Energy™

Today's Presenters

Marissa Van Sant

Senior Manager

Distributed Energy Resources
Center for Sustainable Energy

Marissa.VanSant@energycenter.org



Center for
Sustainable
Energy™

Bryan Olson

Senior Civil Engineer

Sustainability Department
City of San Diego

OlsonB@sandiego.gov

The City of

SAN DIEGO



Agenda

11:05 – 11:20 a.m.

Overview of SD ZN3 Zero Net Energy (ZNE) project and the steps followed

- Presented by Marissa Van Sant

11:20 – 11:50 a.m.

Overview of municipal procedures followed to align with ZNE project

- Presented by Bryan Olson

11:50 – 12:00 p.m.

Question and answer session

SD ZN3 Project Overview

—

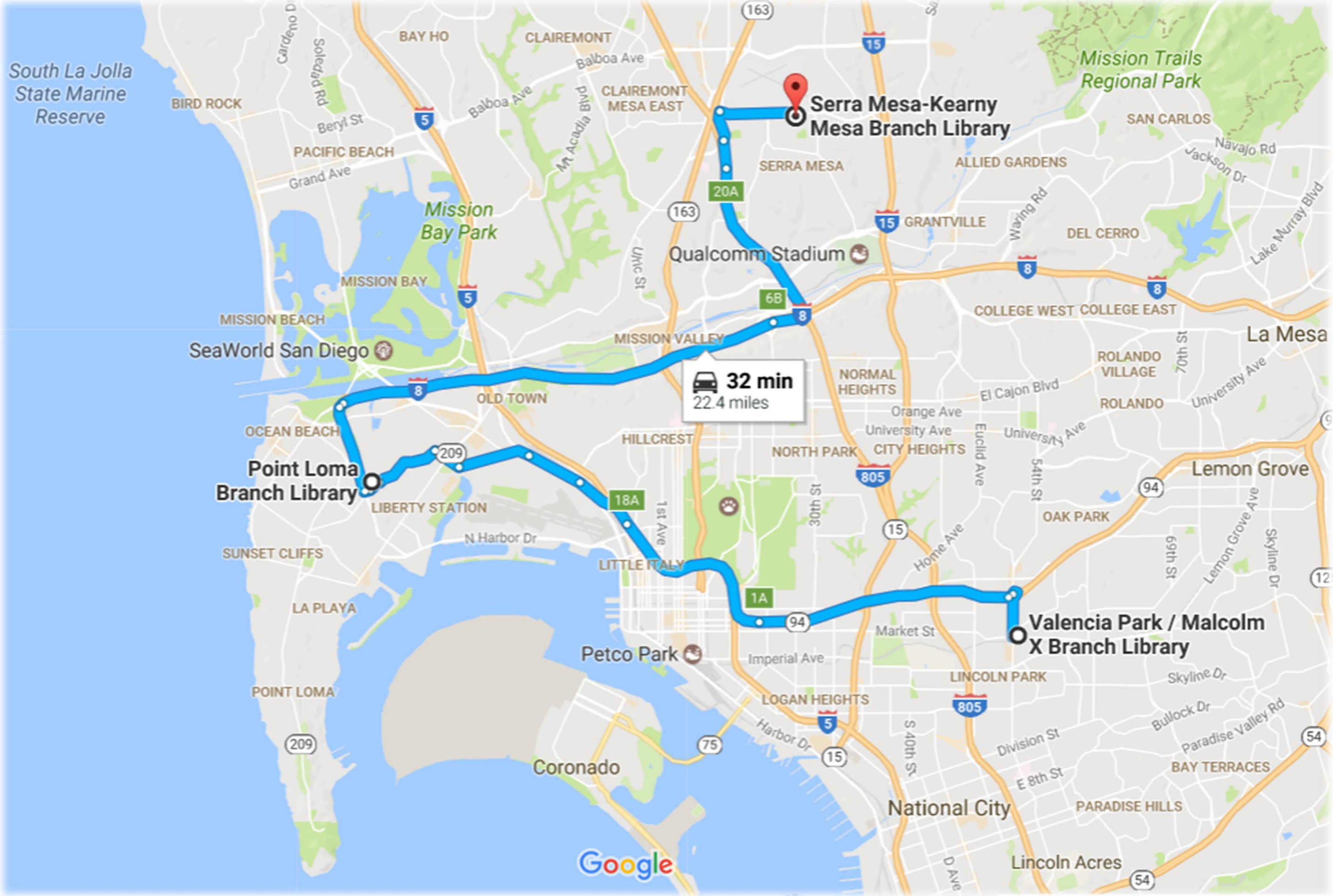
“San Diego ZN3”

Three City of San Diego public libraries are undergoing an integrated demand-side management demonstration to achieve ZNE through cost-effective energy efficiency upgrades, on-site renewable generation, enhanced building automation, pre- & post-installation monitoring, and occupant behavior analysis in order to provide a blueprint that shows ZNE is possible in existing municipal buildings.

Project Summary

Project Sites

- Malcolm X/Valencia Park Public Library*
- Serra Mesa/Kearny Mesa Public Library
- Point Loma Public Library



*Disadvantaged community

ZNE Goals

California (CPUC Energy Efficiency Strategic Plan)

- 50% of new major renovations to state buildings will be ZNE by 2025.
- 50% of commercial buildings will be retrofit to ZNE by 2030.

City of San Diego

- Reduce energy consumption at municipal facilities by 15% by 2020 and by 25% by 2035.

SDZN3 Project

- Achieve ZNE or near-ZNE at three existing libraries.
- Achieve maximum energy efficiency savings through cost-effective demand-side management technology testing and building monitoring.
- Demonstrate the City's ability to deploy this initiative outside of traditional capital improvement processes.
- Create a replicable blueprint for other municipalities.

Project Team



Funder



Center for Sustainable Energy™

Prime Recipient

Contract Term
August 2016 – March 2021
Total Budget
\$3,259,084



Site Host & Sponsor



Emerging Technologies



Design and Construction



Education and Outreach



Baseline Monitoring

Getting to Zero



Phase 1: Pre-retrofit

1. Perform building energy audits.
2. Identify & install end-use monitoring equipment needs.
3. Collect baseline end-use data.
4. Create energy models.
5. Perform pre-retrofit behavior analysis.
6. Identify, assess & design Energy Conservation Measures (ECMs), including pre-commercial technologies.



Phase 2: Construction

7. Select installation contractors.
8. Apply for permits.
9. Procure equipment.
10. Notify library occupants and patrons.
11. Install ECMs.
12. Perform Commissioning (Cx) & Retrocommissioning (RCx).
13. Integrate new & existing systems into building management system.



Phase 3: Post-retrofit

13. Collect 12 months of measurement and verification data.
14. Educate & train facility operators.
15. Complete post-retrofit occupant behavior analysis.
16. Evaluate project results and benefits.

Project ZNE Definition

*“A **Zero-Net-Energy Code Building** is one where the net amount of energy produced by on-site renewable energy resources is equal to the value of the energy consumed annually by the building, at the level of a single ‘project’ seeking development entitlements and building code permits, measured using the Energy Commission’s Time Dependent Valuation metric...*

...A zero-net-energy code building meets an energy use intensity value designated in the Building Energy Efficiency Standards by building type and climate zone that reflect best practices for highly efficient buildings,” ([2013 Energy Commission Integrated Energy Policy Report, CEC](#))

CEC equation: [Value of modeled energy consumed] – [net modeled energy produced] = ≤0

The project is also evaluating ZNE site and ZNE source results.

Path to ZNE

SDZN3 Energy Efficiency Upgrades

(estimated costs do not include energy auditing, design, RCx and other construction costs)

- Stick to your ZNE definition.
- Know your delta to ZNE.
- Perform pre-retrofit monitoring.
- Isolate energy reductions by end-use to achieve maximum savings.
- Perform additive modeling.
- Perform post-retrofit monitoring (don't just rely on "ZNE design.")

Energy Conservation Measure	Electricity Savings (kWh/yr)	Total Annual Energy Savings (kBtu)	Electricity Savings (\$)	Peak Demand Savings (kW)	Natural Gas Savings (Therms/yr)	Natural Gas Savings (\$)	Total Energy Cost Savings (\$/yr)	Est. Installation Costs
Lighting Retrofit	106,812	364,444	\$ 29,373	39	0	\$ -	\$ 29,412	\$ 580,927
Lighting Controls	14,320	48,860	\$ 3,938	7	0	\$ -	\$ 3,945	\$ 150,000
HVAC Controls Upgrade: Tridium + Schedule and SAT Reset	13,170	47,870	\$ 3,622	33	29	\$ 24	\$ 3,708	\$ 195,000
Plug Load Optimization: BertBrain Plug Load Manager**	1,737	5,928	\$ 478	4	0	\$ -	\$ 482	\$ 10,000
Building Envelope: Window Film and Weatherization	1,589	5,717	\$ 437	1	3	\$ 2	\$ 443	\$ 7,000
TOTAL	137,629	472,818	\$ 37,848	84	32	\$ 26	\$ 37,990	\$ 942,927

More details on ECMs can be found at

www.energycenter.org/sdzn3

Additional research value

- Showcases public, private and nonprofit partnership project management.
- An example of integrated project delivery and contracting.
- Retrofit existing buildings with unique building characteristics & approx. 10,000 visitors per month.
- Tests pre-commercial plug load management devices that are integrated into building management systems.
- Pre- and post-retrofit behavior surveys.
- Conduct knowledge transfer activities.
- All being done to create a blueprint for local governments!



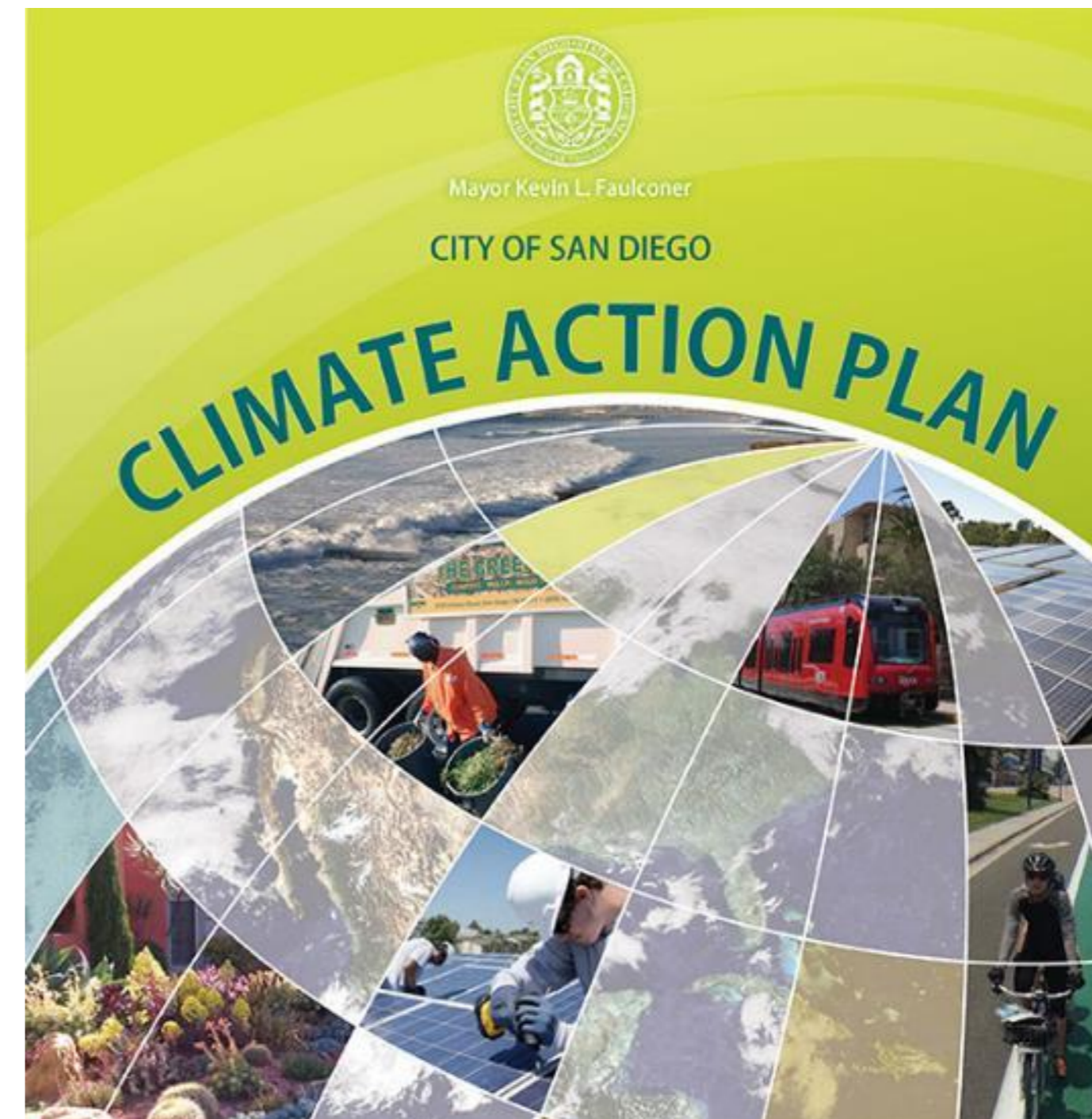
Municipal Procedures To Consider for ZNE

Key Goal

- Achieve 100% renewable electricity city-wide by 2035.
- Clean and Renewable Energy Strategy

Actions

- Integrate projects (and pilots) and outcomes into City's Roadmap to 100% renewable electricity.
- Incorporate those outcomes to the Municipal Energy Strategy and long range planning energy reduction goals.

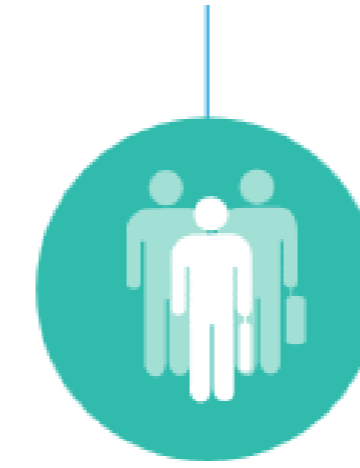


By 2020

- Reduce energy consumption at municipal facilities by 15%
- Reduce daily per capita water consumption by 4 gallons

By 2035

- Reduce energy consumption at municipal facilities by 25%
- Reduce daily per capita water consumption by 9 gallons



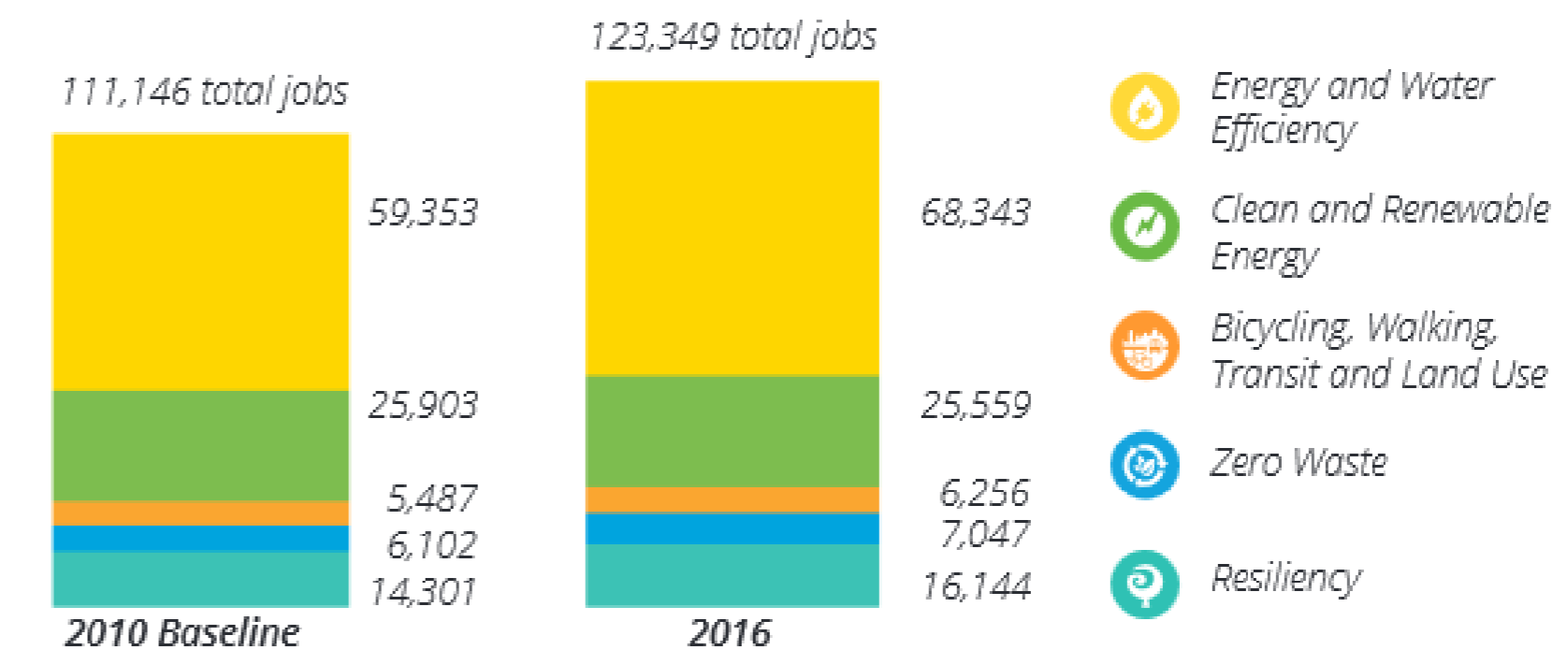
Supporting job creation

+10.9%
Growth in sustainability-related jobs
2010-2016

The City's commitment to sustainability creates jobs in clean technology and climate-related fields for San Diegans.

In 2016, clean technology job levels continued to grow, with the Clean and Renewable Energy sector experiencing the largest annual increase. San Diego's cleantech job concentration is 2.6 times the national average.

Job Growth by Strategy



Source: 2017 Climate Action Plan Annual Report, City of San Diego

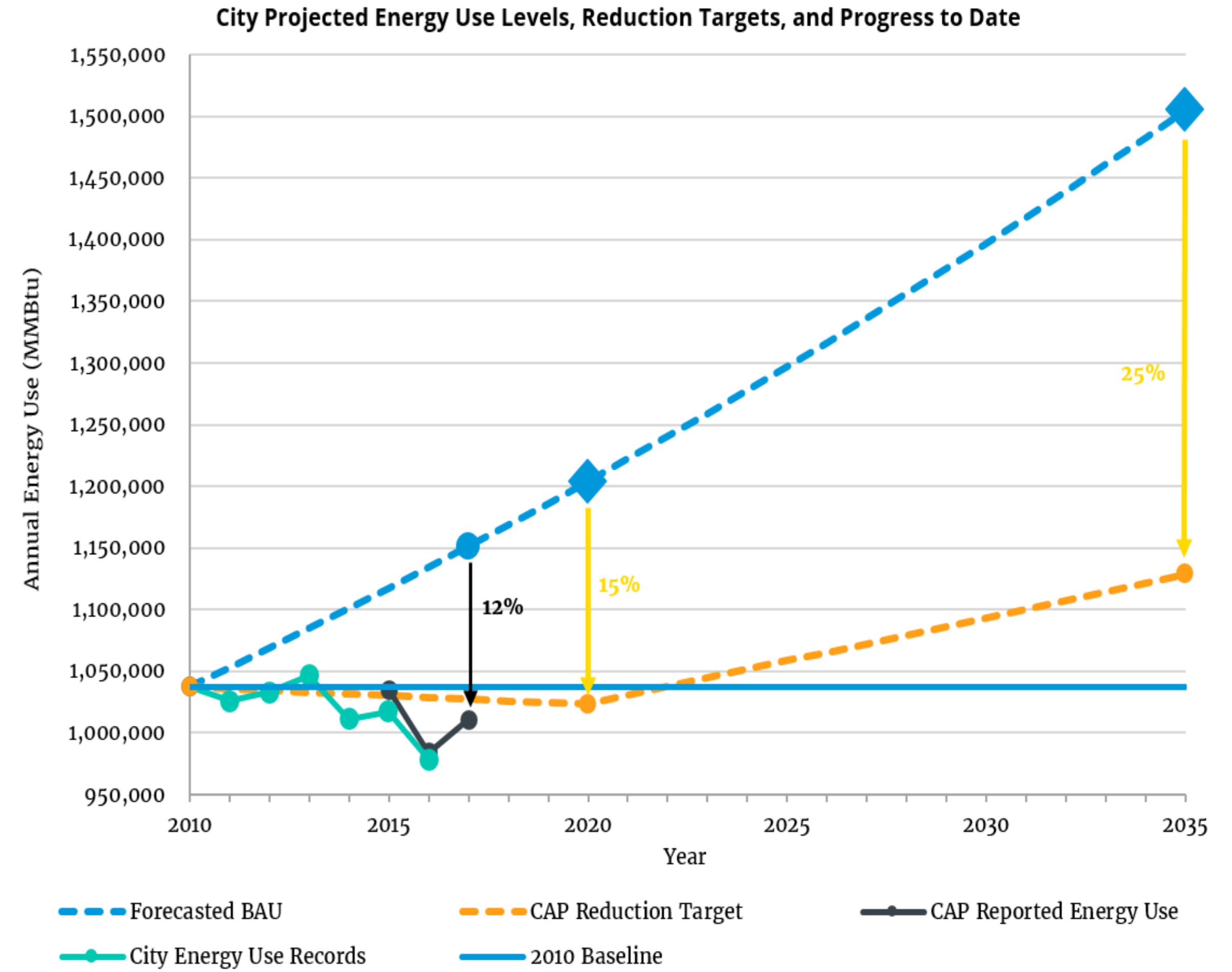


Current MES Draft – Clarifies Goals

Translates CAP GHG reduction goals to MMBtus, GWhs and MM Therms

STRATEGY 1: ENERGY & WATER EFFICIENT BUILDINGS							
LEAD DEPARTMENTS:	Environmental Services, Planning, Public Utilities and Development Services Departments						
GENERAL PLAN POLICIES:	CE-I.7, CE-I.5b, CE-I.13, CE-A.11e, CE-A.11h, CE-A.11i, CE-D.1h, CE-D.1i, CE-D.1j, CE-D.1k, CE-D.1l, CE-D.1m, CE-I.4						
GOAL:	Reduce municipal energy consumption.						
ACTION 1.2:	PHASE 1						
Present to City Council for consideration a Municipal Energy Strategy and Implementation Plan.							
TARGET:	<table border="1"> <thead> <tr> <th colspan="2">GHG REDUCTIONS:</th> </tr> <tr> <th>2020</th> <th>2035</th> </tr> </thead> <tbody> <tr> <td>11,580 MT/CO₂e</td> <td>9,011 MT/CO₂e</td> </tr> </tbody> </table>	GHG REDUCTIONS:		2020	2035	11,580 MT/CO ₂ e	9,011 MT/CO ₂ e
GHG REDUCTIONS:							
2020	2035						
11,580 MT/CO ₂ e	9,011 MT/CO ₂ e						
Reduce energy consumption at municipal facilities by 15% by 2020 and an additional 25% by 2035.							

Municipal Energy Consumption Projection and Targets (MMBtu)				
	2010	2017	2020	2035
Total Projected Energy Consumption	1,037,357 (actual)	1,151,305	1,203,895	1,505,148
City Target Energy Consumption Levels	-	1,027,525	1,023,311	1,128,861
Required Energy Reduction	-	123,781	180,584	376,287
Total Reduction from CAP	-	140,286 (actual)	40,298 (remaining)	236,001 (remaining)





Current MES Draft: Suggests Policy Revisions

- Suggests updates to existing policies and development of new policies to drive reductions
- Suggests programmatic actions to drive behavior changes

Required Actions		
Description	Responsible Party	Due Date
Update Policy 900-14 with the following substantial requirements <ul style="list-style-type: none"> • In Energy and Atmosphere category of the LEED Scorecard, require all new construction and major renovation projects to: <ol style="list-style-type: none"> 1. Achieve maximum points in Enhanced Commissioning Credit 2. Achieve maximum points in Measurement and Verification Credit • To successfully achieve ZNE goal: <ol style="list-style-type: none"> 1. Require new buildings provide a minimum 50% onsite renewable source 2. Require new projects provide a 100% of total building energy from onsite renewable sources beginning in 2025 • Require new buildings or major renovation projects to provide total building energy than the most energy efficient building as modeled following the Title 24, Part 01, Section 01050.2 • Require new buildings or major renovation projects to: <ol style="list-style-type: none"> 1. Installation of energy efficient sensors 2. Building management system (BMS) to be controlled remotely 3. Energy efficient HVAC systems 		
Ensure designs of new buildings and major renovation projects per the guidelines in the policy		
Update "New Construction Standards and Specification Guideline" as per the policy	Public Works	2020
Conduct surveys to ensure implementation of the policy	Sustainability Department	2020
Estimated Category Impact: 50% Reduction in Energy Use of Building Planned to Be Built By 2020 and 100% Reduction in Energy Use of Buildings Planned to Be Built After 2020~ 14,480 MMBtu <small>Reference: Estimated based on known new construction projects</small>		

ZNE in new City buildings:

1. Require new buildings or major renovation projects to provide a minimum of 50% of total building energy from onsite renewables starting in 2020
2. Require new projects or major renovation projects to provide a 100% of total building energy from onsite renewable sources beginning in 2025.

Required Actions:		
Description	Responsible Party	Due Date
Maintain thermostat temperature at a maximum of 69-degrees F in cold weather and at a minimum of 77-degree F during warmer weather. In cases where this is impractical, set thermostats to ensure optimum energy use.	Facilities Management Staff	2020
Where systems allow, lower chilled water temperatures several degrees below normal settings prior to peak periods, and allow temperatures to drift above the settings during peak periods.	Facilities Management Staff	2020
Prohibit use of personal electronic appliances such as space heaters, refrigerators, radios, coffee makers, etc. except in cases of extreme emergency.	Department Directors	2020
Turn off all lights and unplug all appliances except for the building lights necessary for security.	Facilities Management Staff	2020
Set water heaters at 110 degrees F.	Facilities Management Staff	2020
	Staff	2020
	Staff	2020
		2020
		2020
		2020
		2020
		2020
		2020
		2020
Communicate success of the MESP by sending out a quarterly newsletter to the City employees	Communications / Sustainability Department	2020
Leverage ENERGY STAR resources, and publish brochures on "Simple actions you can take" and share with City employees on a monthly basis	Communications / Sustainability Department	2020
Conduct surveys of energy behaviors among employees and post the results in common areas of City facilities and on City's website	Sustainably/ Communication Department	2020
Conduct surveys to ensure the implementation of the policy and to identify best practices	Sustainably/ Communication Department	2020
Estimated Category Impact: 5.0% Reduction in Energy Use of Municipal Buildings~ 11,500 MMBtu <small>http://www.lbpsa.org/proceedings/asim2012/0050.pdf</small>		



Current MES Draft: What's Missing?

- Ambitious goals above and beyond CAP GHG reduction targets
 - ZNE facilities – existing building policy
 - Pilot projects such as the EPC-15-085 are vital to the long-range planning efforts of the City of San Diego
 - Carbon Neutral facilities – existing and new
- Added electricity loads from EV charging
- Energy Storage Systems
- Demand response, CAISO bidding opportunities
- Equity
- Resiliency
- Funding sources



Components of ZNE Retrofit

Technology & Data Stack

End-use monitoring, BMS, and energy dashboard



Existing Equipment

Code Cycle, Inventories of Lighting, HVAC, Controls, etc.

Maintenance

Age of Equipment, Deferred Maintenance

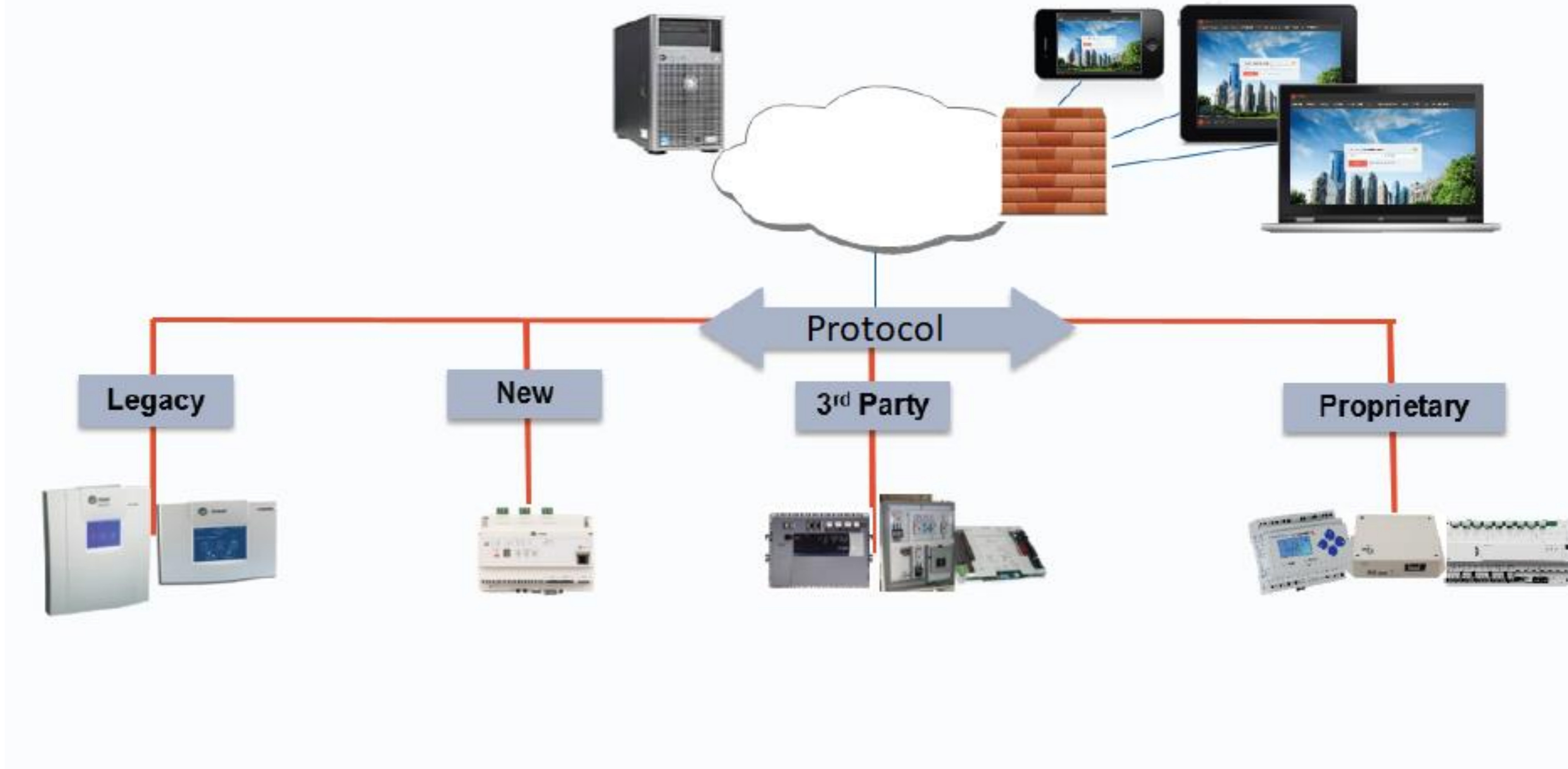


Renewable Generation

Solar Power Purchase Agreements



Technology & Data Stack

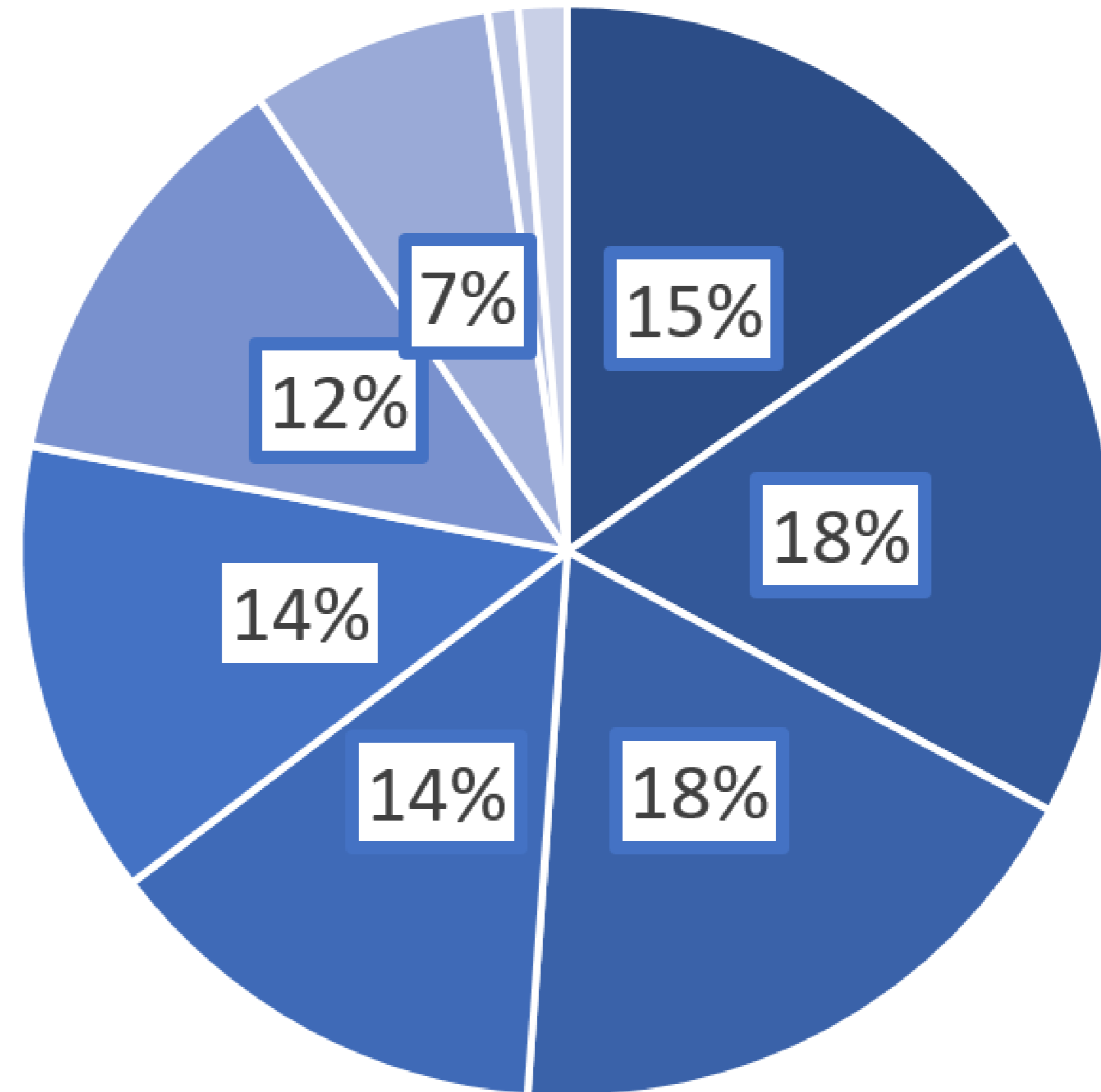




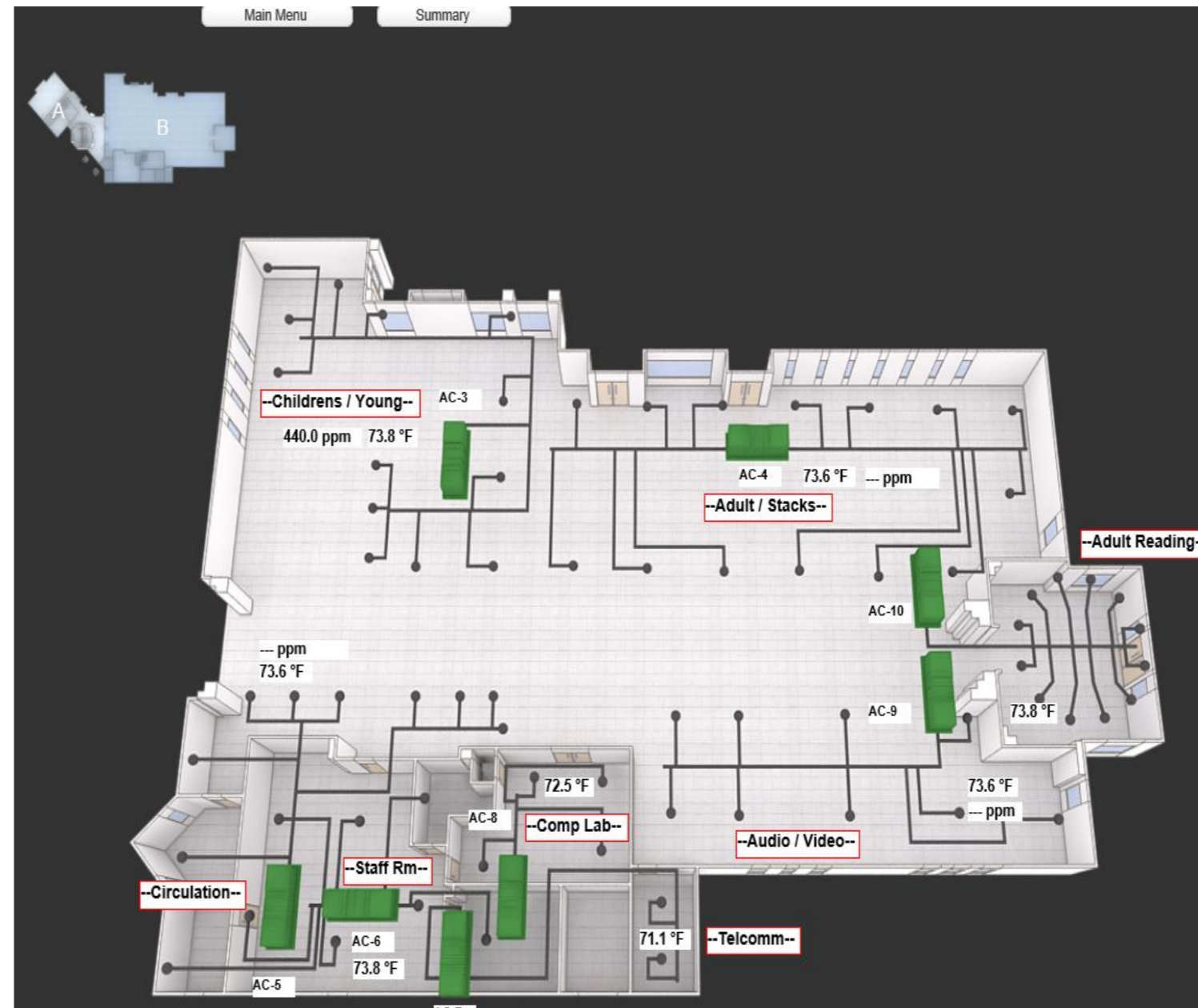
Existing Equipment

- Facilities built in different code cycles
 - 700+ Facilities
 - 3500 Electric Accounts
 - Diverse Portfolio
(Age, Size, Asset Type)
- Varying controls, equipment and operations

Building Stock By Decade



- ASHRAE Audits
 - Consider age and condition of existing equipment
 - (Facility Condition Assessment)
- Evaluate long-range planning efforts for equipment replacement
- Incorporate equipment maintenance and replacement into long-range ZNE planning



- Solar may exist on-site already
 - Consider system size
 - Contractual constraints
- 17 Completed Solar Systems 2017 & 2018
 - PPA – Cooperative Procurement
 - Approx. 3.5 MW_{dc}





- **Solar Energy Innovation Network (National Renewable Energy Laboratory)**
 - City of San Diego Tools Created (Target Release October 2019):
 - Solar PPA Case Study and Lessons Learned
 - PPA Cost Analysis
 - Calculate Costs Between PPA & Business-As-Usual

The City of **SAN DIEGO** **Solar Photovoltaic Case Study: Lessons Learned**
Balboa Park, San Diego California

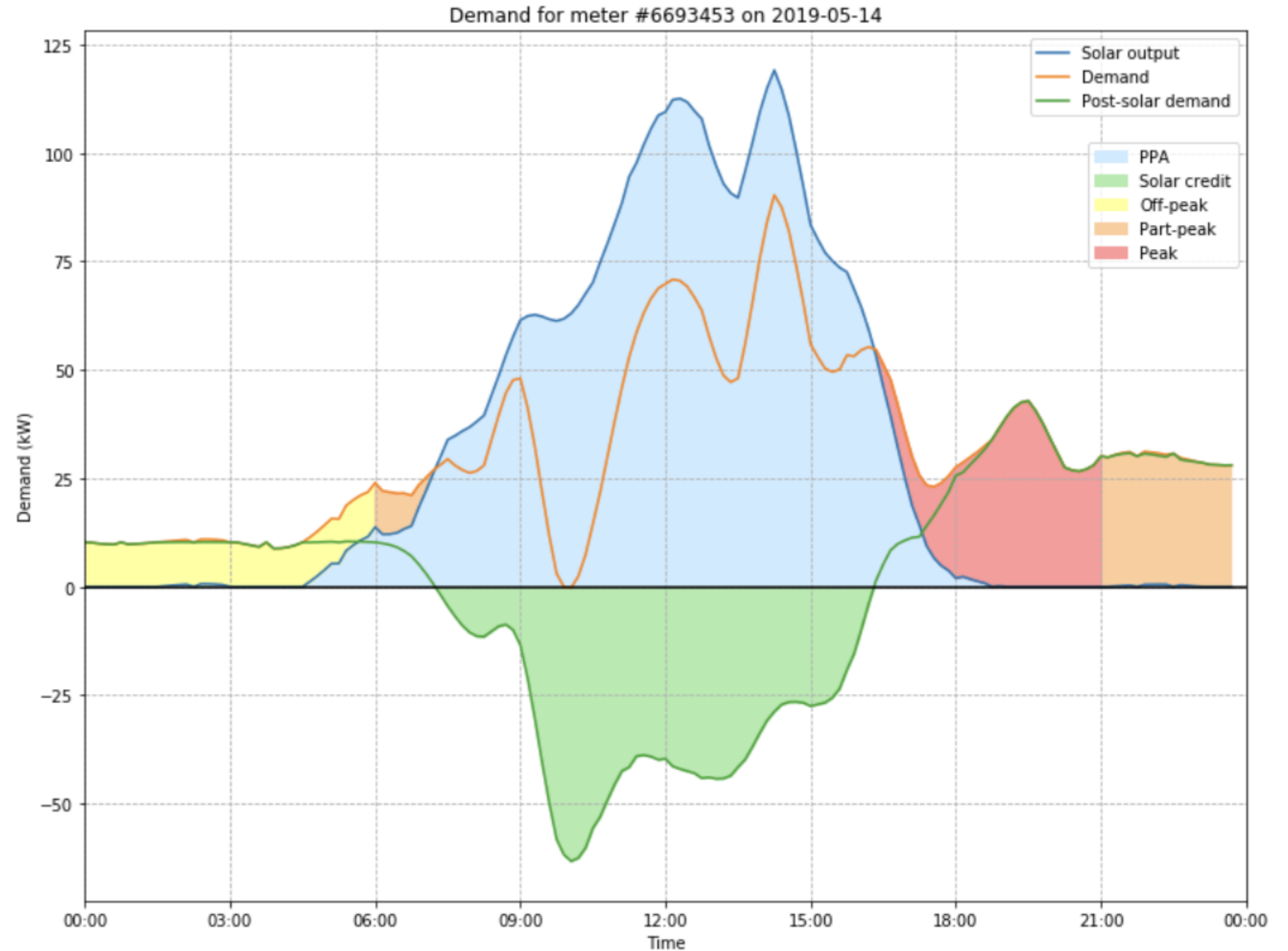
SD sustainability

- Outreach:** Standardize messaging for Community Group/Committee/Stakeholder Engagement meeting and host events at each future solar site.
- Risk and Responsibilities:** Ensure that the Contractor understands the risk and responsibilities for the project, including but not limited to existing infrastructure, geotechnical and environmental hazards.
- Terms:** Specify terms for future data access, O&M, PV panel recycling requirements and liquidated damages.
- Lighting:** Anticipate how the system will affect existing parking lot lighting, and ensure contractor is proposing to meet lighting standards.
- Irrigation:** Require irrigation system checks pre and post construction.
- Hardscape:** Define minimum pavement rehabilitation guidelines for asphalt patching, restriping and concrete removal and replaces.
- City Coordination:** Ensure that asset owners as well as the procurement department have a review and approval of the plans, shop drawings and materials before permitting.
- Define performance goals:** Consider maximum kWh production and demand charge reduction.
- Landscaping:** Address the potential impact of the solar canopies on landscaping and create a mitigation plan for plant removal and relocation.



PPA Avoided Cost Model

- Monthly & Yearly Energy Costs
- Visualize Daily Energy Consumption and Use
- Inputs:
 - 15-min utility consumption data (NEM)
 - Modeled or Actual Solar Production
 - 15-min weather file (NSRDB)



Final Thoughts

- Know your ZNE definition.
- Identify the right energy modeling tool for the project.
- Cyber security will need to be addressed with whole-buildings controllers.
- Lighting upgrades and building controls are cost-effective ECMs for existing buildings but many emerging technologies are still cost-prohibitive.
- Be adaptable and be prepared to learn new things.

Questions?

Follow the Project



About the Libraries



Get Project Updates



Upcoming Presentations

Visit

EnergyCenter.org/SDZN3