



CALIFORNIA
ENERGY
CODES & STANDARDS

A STATEWIDE UTILITY PROGRAM






2020 Vision: Reach Codes Best Practices v2.0

Welcome and Introduction

June 5, 2019

Chris Kuch, P.E.

Agenda

-  Introduction and Welcome
-  Reach Codes 101
-  Residential Analysis Results
-  Nonresidential Analysis Results
-  Where Do We Go From Here?

IOU Codes and Standards Reach Codes Program

Helping cities meet their climate action goals

- Technical analysis:
Cost-effectiveness reports
- Coordination and collaboration
- Model ordinance language
- Ad-hoc support

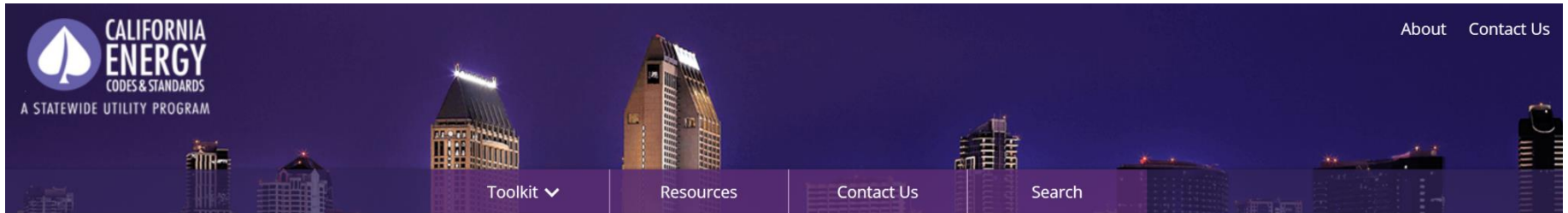
Visit www.localenergycodes.com
for more information



The California Codes and Standards (C&S) Reach Codes program provides technical support to local governments considering adopting a local ordinance (reach code) intended to support meeting local and/or statewide energy and greenhouse gas reduction goals. The program facilitates adoption and implementation of the code, by providing resources such as cost-effectiveness studies, model language, sample findings, and other supporting documentation.

Local Government – Local Energy Ordinance
Resources and Toolkit

LocalEnergyCodes.com – 2019 Resources



2019 Local Energy Ordinances

In preparation for the January 1, 2020 effective date of the 2019 Building Energy Efficiency Standards, the California Codes and Standards Reach Codes Program provides technical support to jurisdictions that wish to adopt a local energy ordinance (reach code). The program facilitates adoption and implementation of the code by providing resources such as cost-effectiveness studies, model language, sample findings, and other supporting documentation.

When you download a file, be sure to select "Yes, email me local codes news." to receive notifications when new versions of the studies are released or new resources become available.

[2019 Cost-effectiveness Studies](#) ▼

[Additional 2019 Resources](#) ▼

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2020 Vision: Reach Codes Best Practices v2.0

Reach Codes 101

June 5, 2019

Misti Bruceri

Green Building and Energy Reach Codes



2019 Reach Codes Options and Opportunities

Building Efficiency and Renewables

- Whole Building, Measure-specific

Energy Plus Water

- Hot Water Distribution, Indoor, Outdoor Water

Process Loads

- Commercial Kitchens, Elevators, Indoor Ag.

Retrofit-ready

- EV-Ready, Panel Upgrade, Pre-wiring

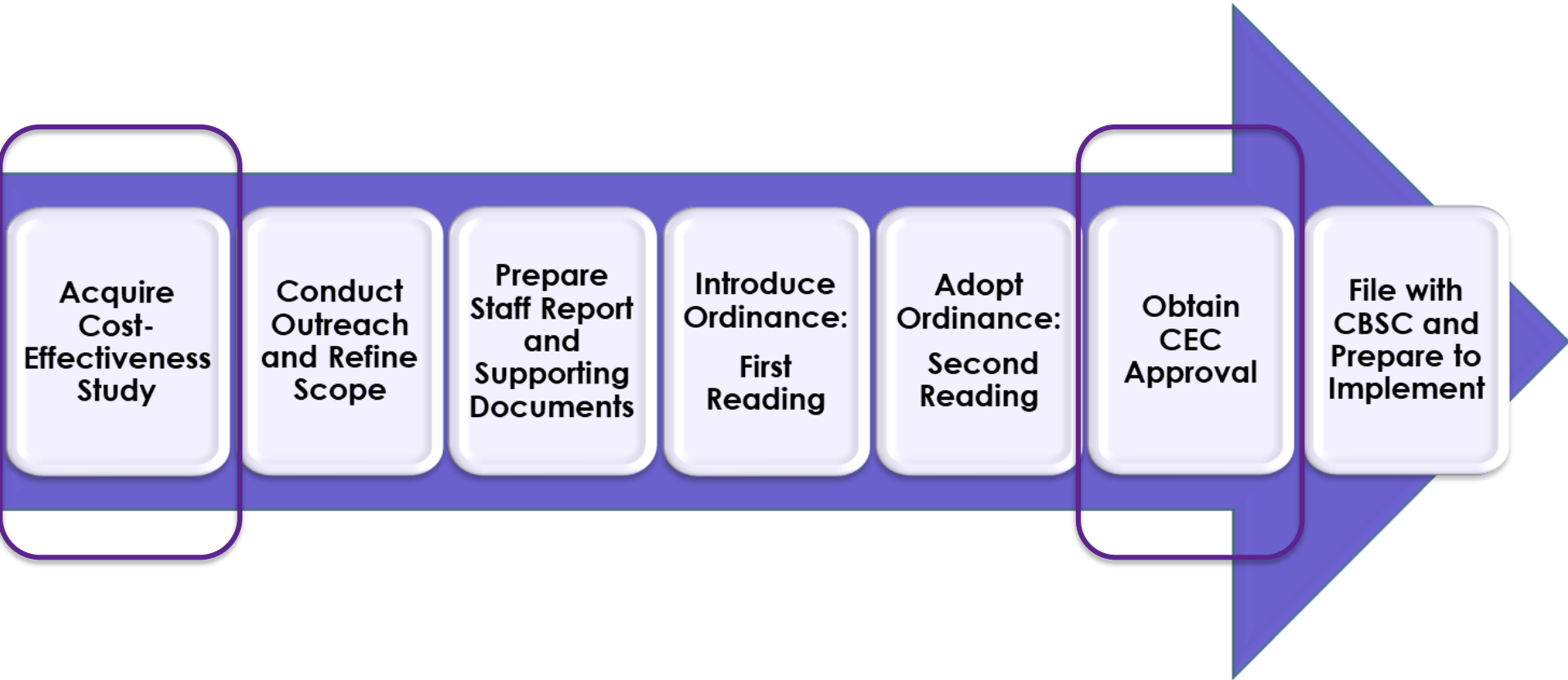
Information Disclosure

- Audits, Benchmarking

Additional Cost-effectiveness Studies

- Multifamily New Construction
- Residential Alterations and Additions
- Nonresidential Alterations and Additions
- 2019 Energy Plus Water Options
- Electric-Vehicle Readiness

Local Reach Code Adoption Process



California Building Standards Code (Title 24)

Title 24 is composed of 12 “Parts”:

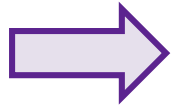
Part 1: California Building Standards Administrative Code

Part 2 – California Building Code – Vol I & II

Part 3 – California Electrical Code

Part 4 – California Mechanical Code

Part 5– California Plumbing Code



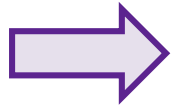
Part 6 – California Energy Code

Part 7 – No longer published in Title 24; see Title 8 CCR

Part 8 – California Historical Building Code

Part 9 – California Fire Code

Part 10 – California Existing Building Code



Part 11 – California Green Building Standards Code

Part 12 – California Reference Standards Code

2019 Standards Analysis: First, Some Important Terms and Definitions

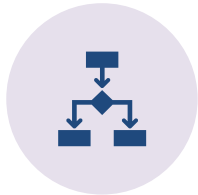


CEC Compliance
Software (CBECC-Res,
CBECC-Com)



Climate Zones

6-Torrance, 8-Fullerton,
9-Burbank, CZ 10-Riverside,
14-Palmdale, 15-Palm Springs



Performance and
Prescriptive Methods



High-rise residential
(Part 6): Four or more
habitable stories

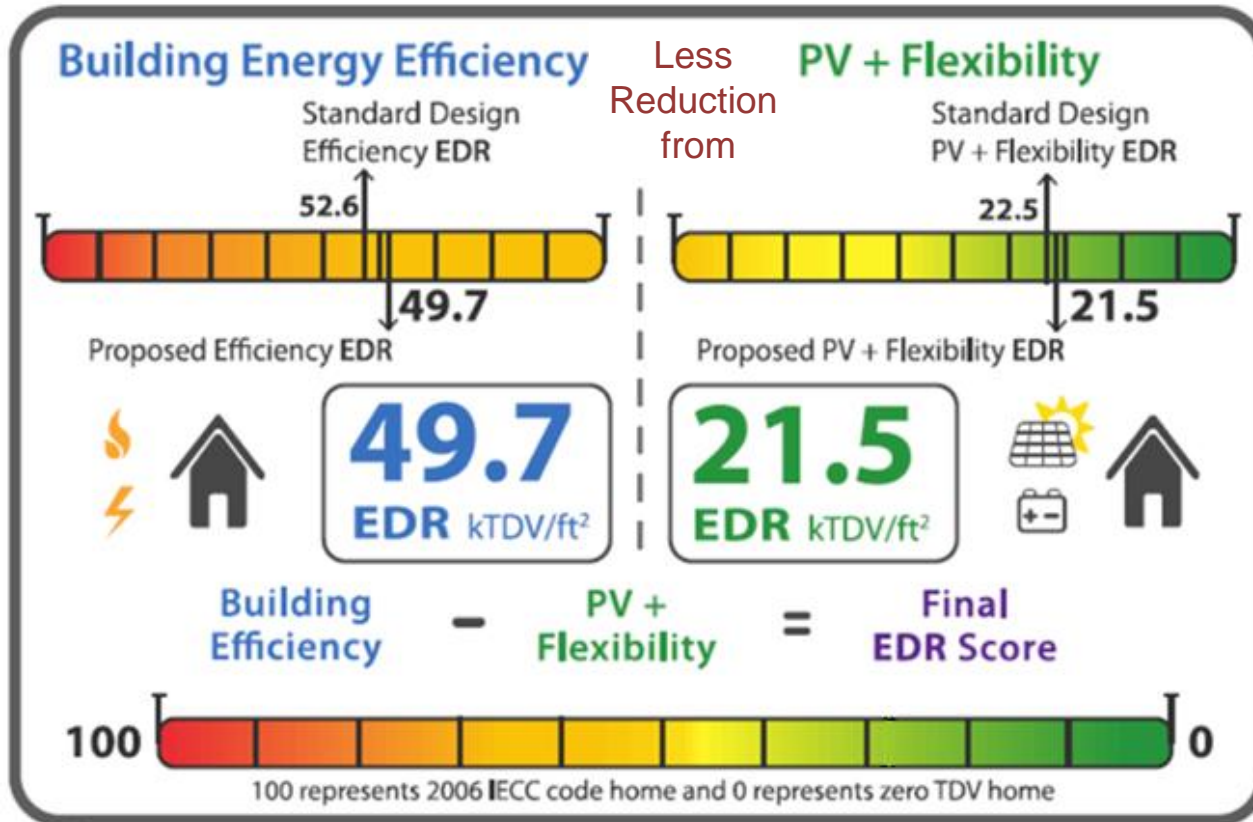


Time Dependent
Valuation (TDV)



Energy Design Rating
(Residential only)

2019 Residential Compliance: Energy Design Rating



- Must meet Efficiency **AND** Final EDR scores
- May increase efficiency to reduce PV requirement
- May NOT reduce efficiency and make up with additional PV
- Study results presented as “EDR Margin” (a reduction in the EDR score)

EFFICIENCY EDR Margin $52.6 - 49.7 = 2.9$

TOTAL EDR Margin $30.1 - 28.2 = 1.9$

Standard: $52.6 - 22.5 = 30.1$

Proposed: $49.7 - 21.5 = 28.2$

Legal Requirements for Reach Codes

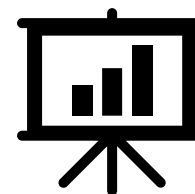
- Compliant with local requirements for ordinances
- Compliant with all state laws
- Updated for each new Building Code cycle
- Filed with the State
- Accessible to the public
- **More stringent than state requirements**
- **Cost effective**
- **May not preempt federal regulations (effectively, may not specifically require high efficiency HVAC and DHW equipment or any other appliances for which there is a federal standard)**

Avoiding Preemption: High Efficiency Appliances and Equipment

- State and local governments may not “preempt” federal appliance standards (includes HVAC and water heaters)
- State and local building codes must meet seven conditions to avoid preemption (US Code 42, Section 6297)
- If the code includes one or more options to meet the objective:
 - for every option that includes a high-efficiency appliance or equipment, at least one option shall include the same equipment which meets but does not exceed the minimum requirement.

2019 Cost-effectiveness Studies: DRAFT Analysis

- Objective: Identify cost-effective, non-preempted measure packages
- The study is NOT:
 - An example of best design practices,
 - A list of measures required to meet the ordinance.
- Analyzed two cost-effectiveness metrics:
TDV and On-Bill
- Mixed-fuel and all-electric designs and baselines
- All climate zones
- Consulted with utilities regarding rates and infrastructure costs
- Assumptions and methodologies consistent with Title 24, Part 6



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Local Energy Efficiency Ordinance 2019 Residential New Construction Cost-effectiveness Study DRAFT Results

June 5, 2019

Alea German – Frontier Energy

SoCal Reach Codes Best Practices Workshop Irvine, CA



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Residential Assumptions and Methodology

- Single family & low-rise multifamily new construction
 - Mixed-fuel and all-electric cases
 - All-electric vs. mixed fuel comparison
- All 16 Climate Zones
- CBECC-Res 2019.0.11 Alpha (1242)
 - To be updated with certified version (June 2019)
- Energy Design Rating (EDR)
 - EDR margin/reduction used instead of absolute values
- GHG impacts per CBECC-Res

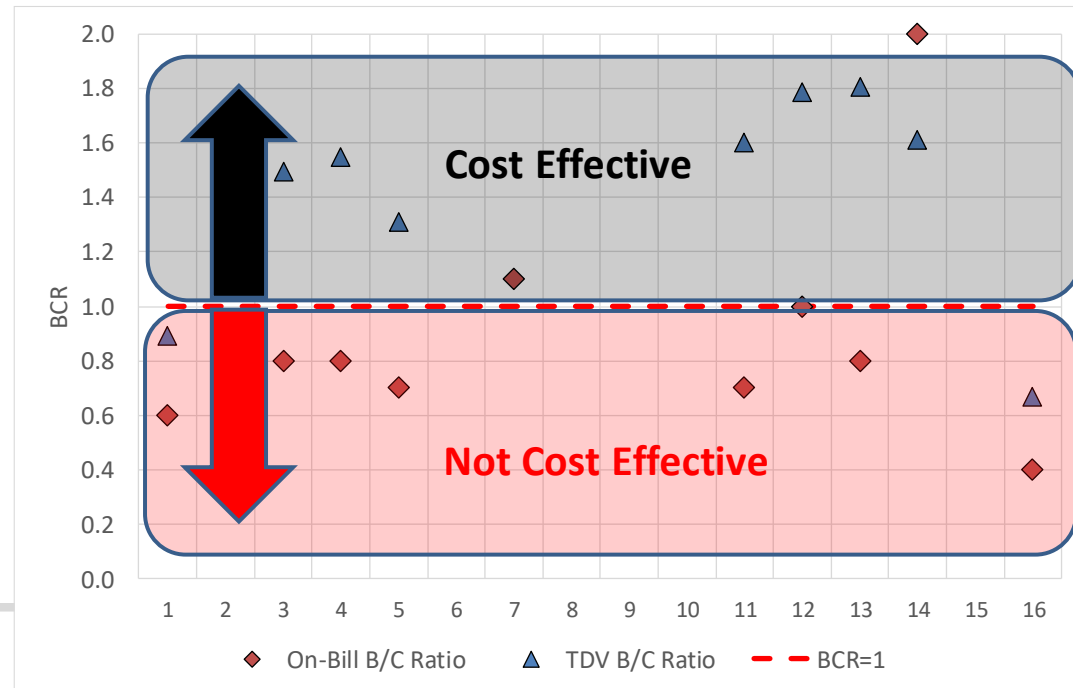
Cost Effectiveness

- 2 methodologies
 - Time Dependent Valuation (TDV) per CEC methodology
 - On-bill customer based
 - SCE TOU utility rates, 4-9 peak period
 - SoCalGas rates

- 30 year evaluation period

- Benefit-to-Cost Ratio (BCR)

$$BCR = \frac{NPV \text{ of benefit}}{NPV \text{ of cost}}$$

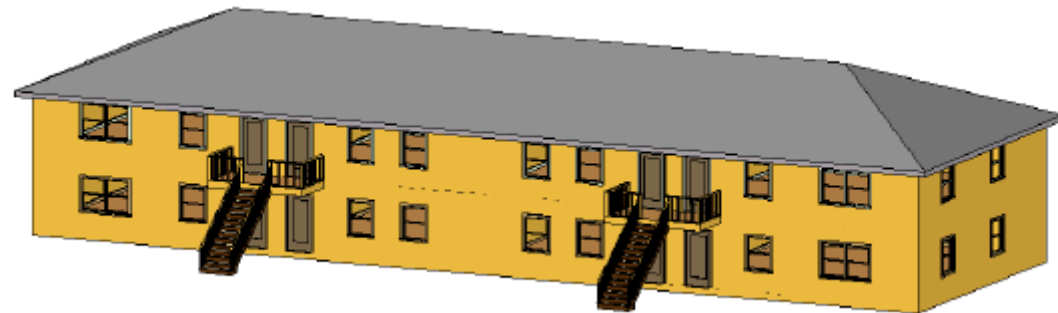


Residential Building Prototypes

- **Single Family (SF)**: Blended 2,430 ft²,
 - 45% 1-story / 2100 ft²,
 - 55% 2-story / 2700 ft²



- **Low-rise Multifamily (MF)**: 3 habitable stories or less
 - 6,960, 2-story, 8-unit, exterior loaded



Residential Building Prototypes

- 2019 Prescriptive requirements as starting point
 - Slab on grade
 - Vented attic
 - Minimum efficiency equipment
 - Ducted HVAC systems
 - SF = ducts in attic
 - MF = ducts in conditioned space
 - Individual water heaters
 - Heat pumps for all-electric
 - PV standard
 - Sized to offset electric loads in mixed fuel home,
 - excluding space heating, water heating, clothes drying, cooking

Four Measure Packages

1. **Efficiency – Non-Preempted**: Efficiency measures that don't trigger federal preemption including envelope, and water heating and duct distribution efficiency measures.
2. **Efficiency – Equipment, Preempted**: HVAC and water heating equipment that are more efficient than federal standards.
3. **Efficiency & PV**: (All-Electric case only)
 - Using the Efficiency – Non-Preempted package as a starting point, add PV to offset most of the estimated electricity use.
4. **Efficiency & PV/Battery** : Using the Efficiency – Non-Preempted package as a starting point, add PV and a battery system.

PV System Sizing Options in CBECC-Res

Package	Mixed Fuel	All-Electric
Efficiency (Envelope & Equipment)	PV Scaled @ 100%	Std Design PV
Efficiency & PV	n/a	PV Scaled @ 90%
Efficiency & PV/Battery	PV Scaled @ 100% 5 kWh battery / SF 2.75kWh battery / MF apt TOU battery control	

Self-Utilization Credit taken with batteries

- **Standard Design PV:** Same PV capacity as is required for the Standard Design case.
- **PV System Scaling:** PV system sized to offset a specified percentage of the estimated electricity use of the Proposed Case

All-Electric Compared to Mixed Fuel Home

- **Cost Assumptions:**
 - Include site and building infrastructure costs
 - Site gas infrastructure, venting
 - Electric service upgrades within the home
 - Lifetime costs (includes equipment replacement)
- **Cases:**
 - **2019 Code Compliant:** Code compliant mixed fuel vs code compliant all-electric
 - **Efficiency & PV:** Code compliant mixed fuel vs. all-electric package w/ efficiency and PV to offset 90% estimated electricity use.

Results

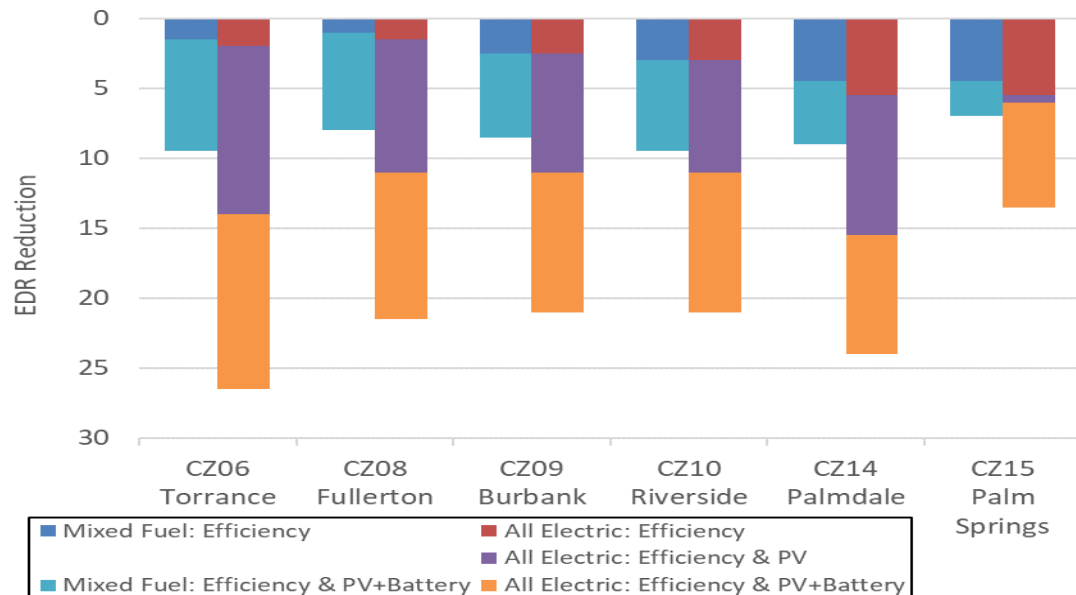
Efficiency Measures by Climate Zone – Single Family

Package	Measure	CZ 6	CZ 8	CZ 9	CZ 10	CZ 14	CZ 15
Non-preempted	ENVELOPE						
	Cool Roof (0.25 Solar Reflectance)				X	X	X
	R-10 Slab edge insulation				X	X	X
	Reduced Infiltration (3 ACH50)					X	
	High Performance Attic (R-38 + R-30 under deck)					E	X
	DHW/HVAC						
	Compact Hot Water Distribution	G	G	G	G	G	G
	Ducts in Conditioned Space		G				
	Verified Low Leakage Ducts in Conditioned Space	X	E	X	X	X	X
	Low Pressure Drop Duct Design	X	X	X	X	X	X
Equipment	High Efficiency HVAC Equipment – Preempted	X	G	X	X	X	X
	High Efficiency DHW Equipment – Preempted	X	X	X	X	X	X
	Low Leakage Air Handler				X	X	X
	Verified Low Leakage Ducts in Conditioned Space					G	
	Low Pressure Drop Duct Design	X	X	X	X	X	X
	Compact Hot Water Distribution	G	G	G	G	G	G

E = All-Electric package only, G = Mixed Fuel package only, X = Both packages
 Compact DHW is assumed in All-Electric baseline

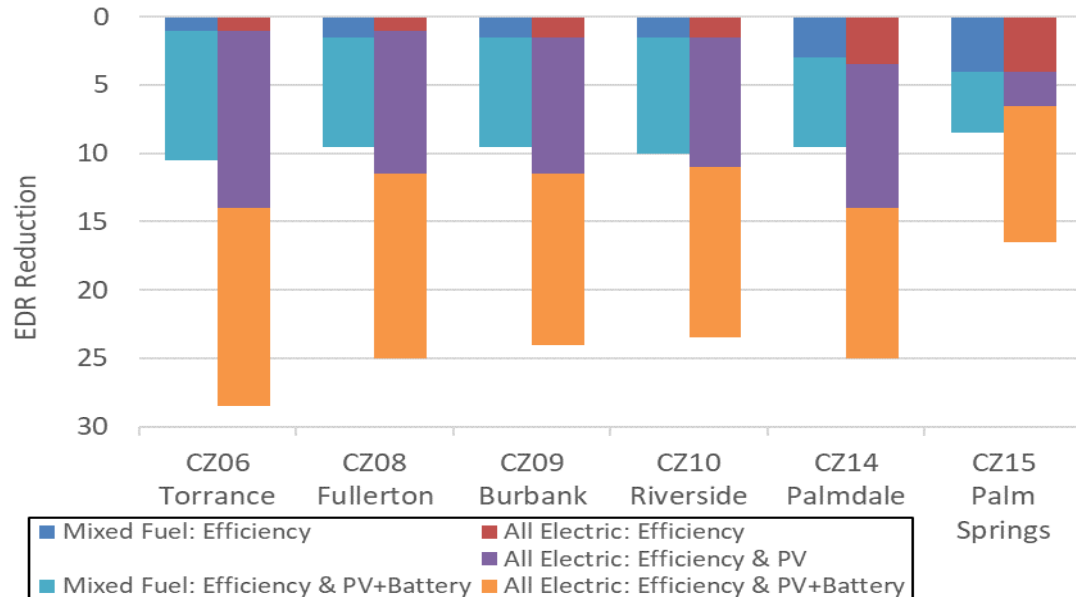
High Level Results – Single Family

- Cost-effective packages statewide
- Efficiency + PV package for all-electric case only
 - Additional EDR reduction possible with larger PV system to offset additional electricity loads (avg. +10 EDR Reduction)
- Efficiency+PV+Battery: Avg EDR reduction = 9 mixed fuel; 21 electric

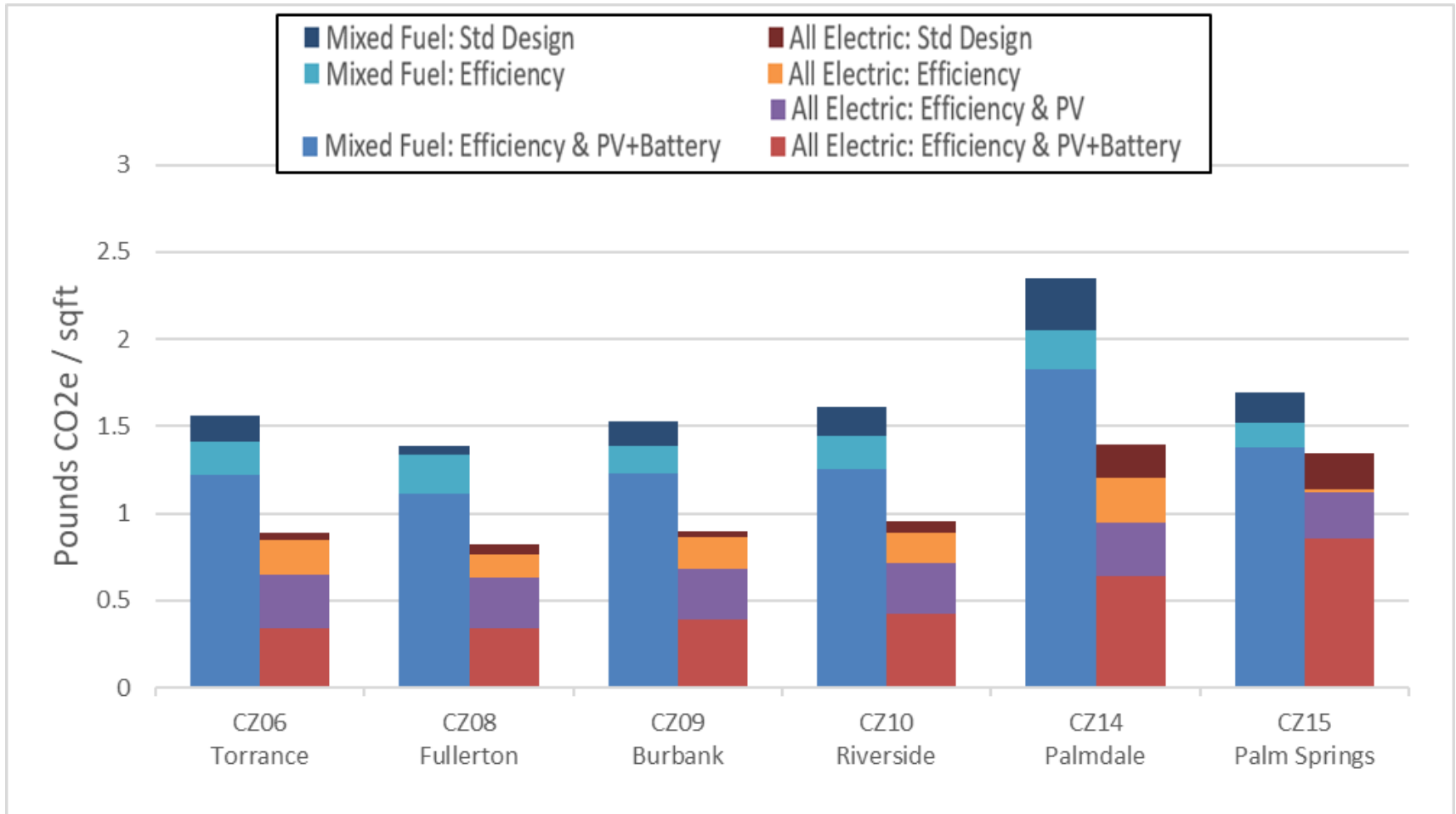


High Level Results – Multifamily

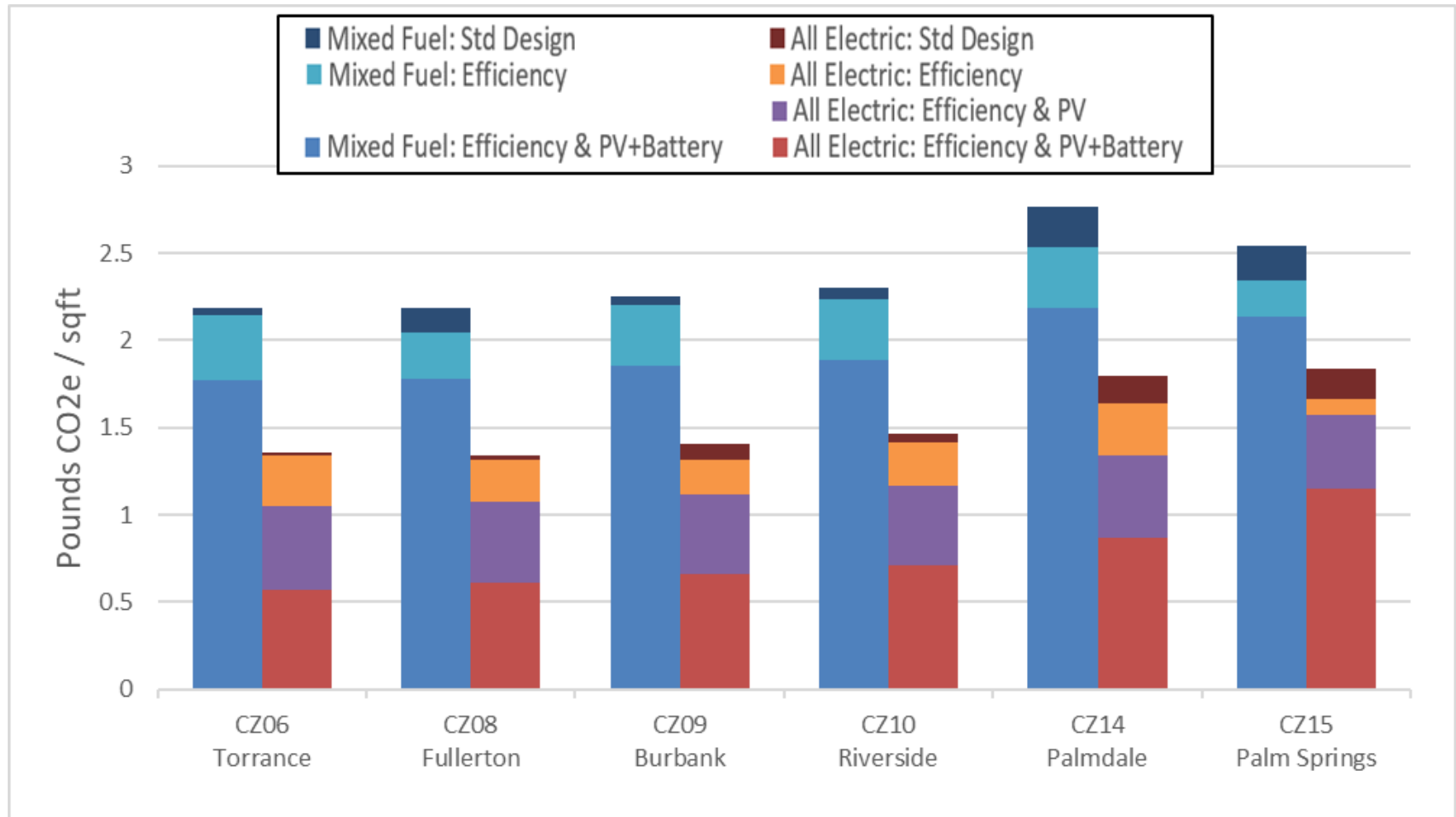
- Versus single family
 - Slightly lower efficiency EDR reductions
 - Slightly higher total EDR reductions
- Efficiency+PV+Battery: Avg EDR reduction = 10 mixed fuel; 24 electric



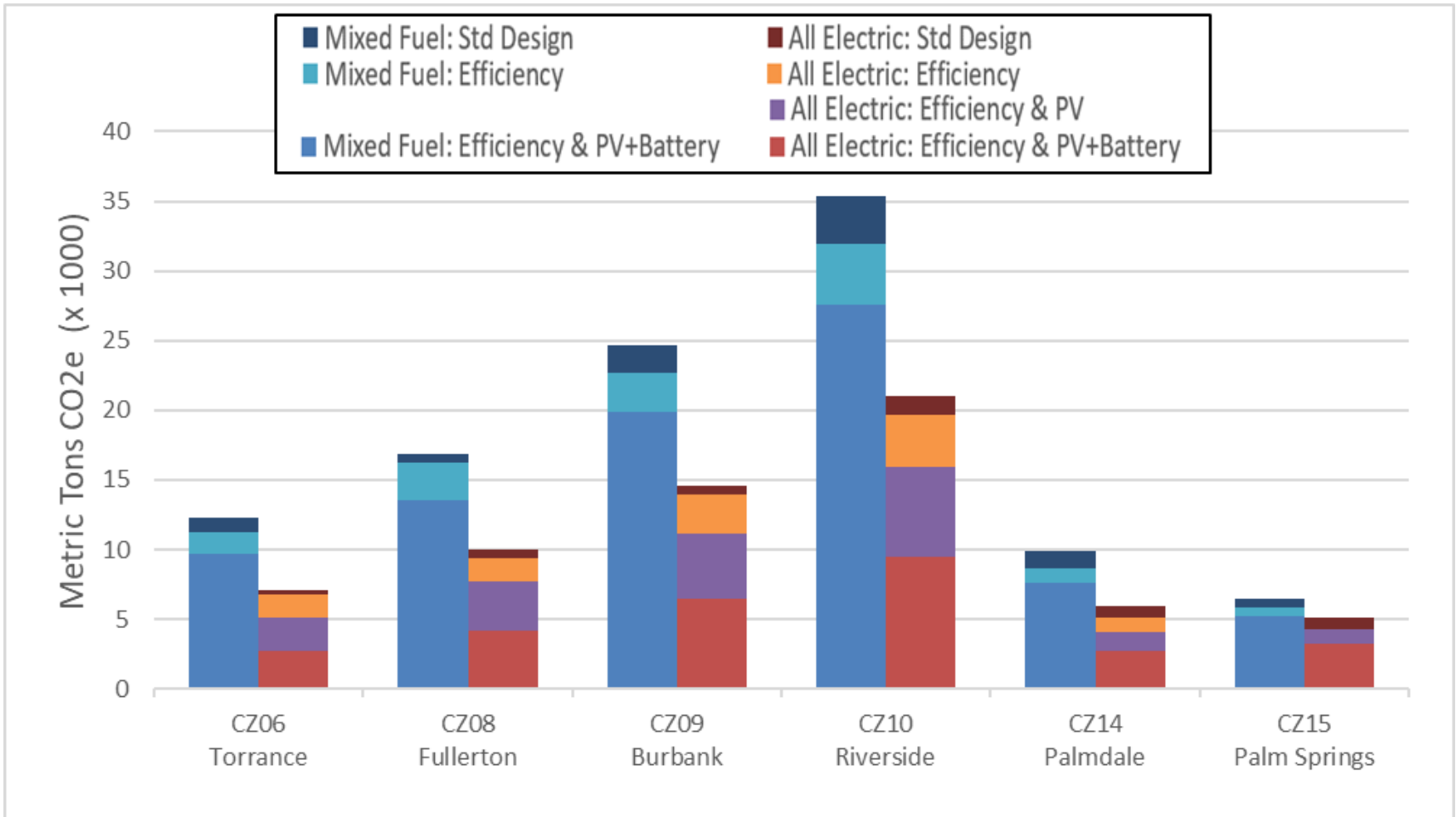
Single Family GHG Comparison



Multifamily GHG Comparison

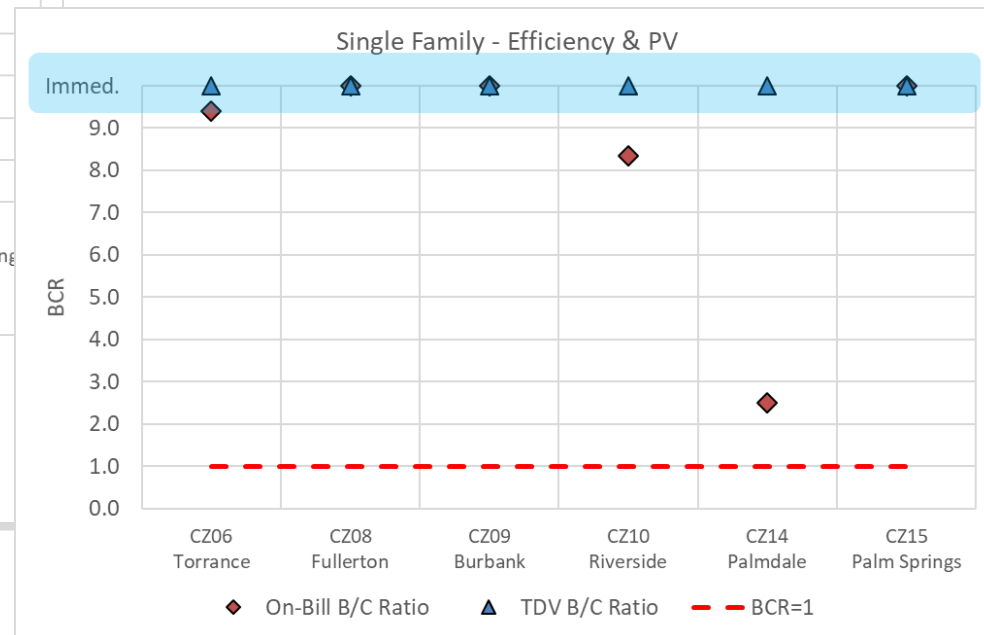
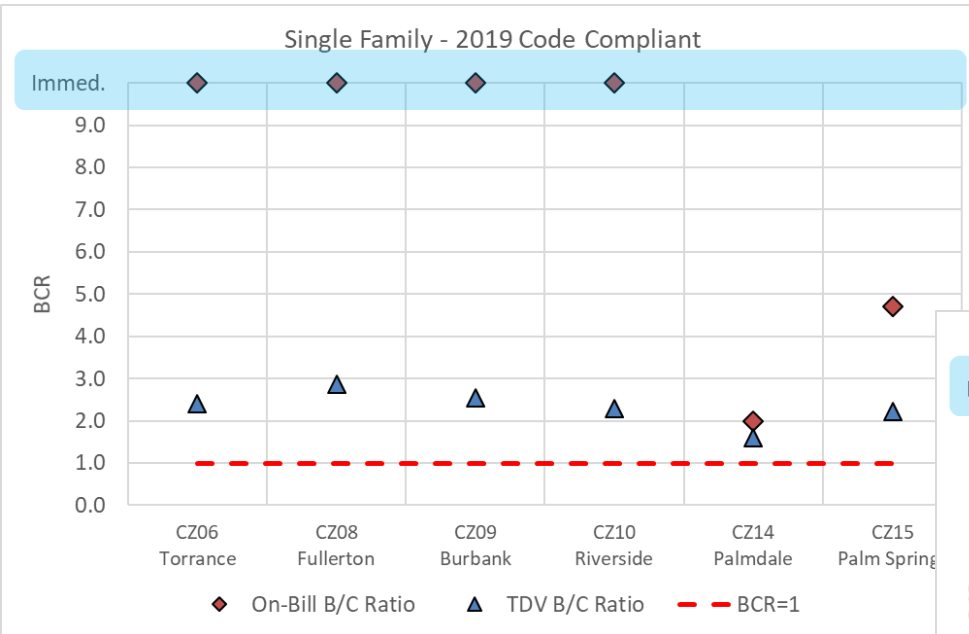


Residential Statewide GHG Emissions




All Electric vs. Mixed Fuel: Single Family – 2019 Code Compliant

- All-electric design reduces GHG emissions ~40% in most cases relative to a comparable mixed fuel design
 - Cost effective across the state based on On-Bill & TDV



Single Family Climate Zone 8 Results



Climate Zone 8 SCE/SoCalGas Single Family		EDR Red.	PV Size Change (kW)	CO2-Equivalent Emissions (lbs/sf)		Incremental Cost (\$)	Benefit to Cost Ratio (B/C)	
				Total	Red.		On-Bill	TDV
Mixed Fuel	Efficiency-Non-Preempted	1.0	(0.0)	1.3	0.1	\$582	0.6	1.4
	Efficiency-Equipment	1.5	(0.0)	1.3	0.1	\$587	1.3	1.8
	Efficiency & PV/Battery	8.0	0.1	1.1	0.3	\$3,945	1.0	1.5
All-Electric	Efficiency-Non-Preempted	1.5	0.0	0.8	0.0	\$926	0.4	1.2
	Efficiency-Equipment	1.5	0.0	0.8	0.1	\$412	2.5	2.7
	Efficiency & PV	11.0	1.1	0.6	0.2	\$5,408	1.0	1.5
	Efficiency & PV/Battery	21.5	1.7	0.3	0.5	\$10,534	1.2	1.5
Mixed Fuel to All-Electric	Code Compliant	0.0	0.0	0.8	0.6	(\$5,349)	>1	2.9
	Efficiency & PV	11.0	1.1	0.6	0.9	\$60	128.7	>1

Multifamily Climate Zone 8 Results

Climate Zone 8 SCE/SoCalGas Multifamily		EDR Red.	PV Size Change (kW)	CO2-Equivalent Emissions (lbs/sf)		Incremental Cost (\$)	Benefit to Cost Ratio (B/C)	
				Total	Red.		On-Bill	TDV
Mixed Fuel	Efficiency-Non-Preempted	1.5	(0.2)	2.1	0.0	\$248	0.7	1.4
	Efficiency-Equipment	1.5	(0.1)	2.0	0.1	\$189	1.8	2.4
	Efficiency & PV/Battery	9.5	0.3	1.8	0.4	\$2,065	0.8	1.5
All- Electric	Efficiency-Non-Preempted	1.0	0.0	1.3	0.0	\$231	0.9	1.8
	Efficiency-Equipment	1.5	0.0	1.3	0.1	\$361	1.7	1.6
	Efficiency & PV	11.5	4.7	1.1	0.3	\$2,218	1.3	1.8
	Efficiency & PV/Battery	25.0	7.3	0.6	0.7	\$4,937	1.5	1.7
Mixed Fuel to All- Electric	Code Compliant	0.0	0.0	1.3	0.8	(\$2,337)	>1	2.6
	Efficiency & PV	11.5	4.7	1.1	1.2	(\$119)	>1	>1

Summary and Conclusions

1. Cost effective efficiency and PV + battery packages for both mixed-fuel and all-electric buildings.
2. All packages cost effective based on TDV
 - TDV cost-effectiveness typically more favorable than on-bill.
3. On-bill cost-effective packages found with higher efficiency equipment packages but federally preempted.
4. All-electric achieve higher GHG savings reductions. ~40% in most cases relative to a comparable mixed fuel design.
5. All-electric lower first cost but slightly higher operating utility costs.
 - Offset by adding efficiency & PV to reduce utility costs = cost effective everywhere

Thank you.

Alea German – Frontier Energy

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Los Angeles
Department of
Water & Power



Background Slides

Efficiency Measures by Climate Zone – Multifamily

Package	Measure	CZ 6	CZ 8	CZ 9	CZ 10	CZ 14	CZ 15
EE	ENVELOPE						
	Cool Roof (0.25 Solar Reflectance)	X	X	X	X	X	X
	R-10 Slab edge insulation				X	X	X
	Better Windows 0.24 U-factor, 0.23 SHGC					X	X
	High Performance Attic (R-38 + R-30 under deck)			E		E	X
	DHW/HVAC						
	Compact Hot Water Distribution	G	G	G	G	G	G
	Ducts in Conditioned Space		E				
	Verified Low Leakage Ducts in Conditioned Space	X	X	X	X	X	X
	Low Pressure Drop Duct Design	X	X	X	X	X	X
Equipment	High Efficiency HVAC Equipment – Preempted	X	E	G	G	X	X
	High Efficiency DHW Equipment – Preempted	X	X	X	X	X	X
	Low Leakage Air Handler				X	X	X
	Verified Low Leakage Ducts in Conditioned Space					E	
	Low Pressure Drop Duct Design	E	E	X	X	X	X
	Compact Hot Water Distribution	G	G	G	G	G	G

Single Family Climate Zone 6 Results

Climate Zone 6 SCE/SoCalGas Single Family		EDR Red.	PV Size Change (kW)	CO2-Equivalent Emissions (lbs/sf)		Incremental Cost (\$)	Benefit to Cost Ratio (B/C)	
				Total	Red.		On-Bill	TDV
Mixed Fuel	Efficiency-Non-Preempted	2.0	(0.0)	1.5	0.1	\$1,004	0.7	1.2
	Efficiency-Equipment	1.5	(0.0)	1.4	0.1	\$583	1.6	2.0
	Efficiency & PV/Battery	9.5	0.1	1.2	0.3	\$4,367	0.9	1.4
All- Electric	Efficiency-Non-Preempted	2.0	0.0	0.8	0.0	\$926	0.7	1.5
	Efficiency-Equipment	2.5	0.0	0.8	0.1	\$846	1.7	2.0
	Efficiency & PV	14.0	1.4	0.6	0.2	\$6,300	1.1	1.5
	Efficiency & PV/Battery	26.5	1.9	0.3	0.5	\$11,468	1.2	1.5
Mixed Fuel to All- Electric	Code Compliant	0.0	0.0	0.9	0.7	(\$5,349)	>1	2.4
	Efficiency & PV	14.0	1.4	0.6	0.7	\$952	9.4	>1

Multifamily Climate Zone 6 Results

Climate Zone 6 SCE/SoCalGas Multifamily		EDR Red.	PV Size Change (kW)	CO2-Equivalent Emissions (lbs/sf)		Incremental Cost (\$)	Benefit to Cost Ratio (B/C)	
				Total	Red.		On-Bill	TDV
				Mixed Fuel	Efficiency-Non-Preempted		1.0	(0.1)
Efficiency-Equipment	1.5	(0.0)	2.0		0.1	\$203	1.6	2.1
Efficiency & PV/Battery	10.5	0.3	1.8		0.4	\$2,006	0.6	1.6
All- Electric	Efficiency-Non-Preempted	1.0	0.0	1.3	0.0	\$231	0.6	1.3
	Efficiency-Equipment	2.0	0.0	1.3	0.1	\$361	1.7	1.9
	Efficiency & PV	14.0	5.5	1.1	0.3	\$2,561	1.2	1.7
	Efficiency & PV/Battery	28.5	8.1	0.6	0.8	\$5,283	1.5	1.7
Mixed Fuel to All- Electric	Code Compliant	0.0	0.0	1.4	0.8	(\$2,337)	>1	2.1
	Efficiency & PV	14.0	5.5	1.1	1.1	\$224	22.3	>1

Single Family Climate Zone 9 Results

Climate Zone 9 SCE/SoCalGas Single Family		EDR Red.	PV Size Change (kW)	CO2-Equivalent Emissions (lbs/sf)		Incremental Cost (\$)	Benefit to Cost Ratio (B/C)	
				Total	Red.		On-Bill	TDV
				Mixed Fuel	Efficiency-Non-Preempted		2.5	(0.0)
Efficiency-Equipment	2.5	(0.0)	1.4		0.1	\$574	1.8	3.6
Efficiency & PV/Battery	8.5	0.1	1.2		0.3	\$4,258	1.0	1.7
All- Electric	Efficiency-Non-Preempted	2.5	0.0	0.9	0.0	\$926	0.8	2.3
	Efficiency-Equipment	3.0	0.0	0.8	0.1	\$846	1.7	3.1
	Efficiency & PV	11.0	1.2	0.7	0.2	\$5,513	1.1	1.7
	Efficiency & PV/Battery	21.0	1.7	0.4	0.5	\$10,667	1.3	1.6
Mixed Fuel to All- Electric	Code Compliant	0.0	0.0	0.9	0.6	(\$5,349)	>1	2.6
	Efficiency & PV	11.0	1.2	0.7	0.9	\$165	50.9	>1

Multifamily Climate Zone 9 Results

Climate Zone 9 SCE/SoCalGas Multifamily		EDR Red.	PV Size Change (kW)	CO2-Equivalent Emissions (lbs/sf)		Incremental Cost (\$)	Benefit to Cost Ratio (B/C)	
				Total	Red.		On-Bill	TDV
				Mixed Fuel	Efficiency-Non-Preempted		1.5	(0.2)
Efficiency-Equipment	2.5	(0.3)	2.1		0.2	\$273	1.7	2.9
Efficiency & PV/Battery	9.5	0.2	1.9		0.4	\$1,947	1.0	1.7
All- Electric	Efficiency-Non-Preempted	1.5	0.0	1.4	0.0	\$721	0.5	1.0
	Efficiency-Equipment	1.5	0.0	1.3	0.1	\$361	1.7	2.0
	Efficiency & PV	11.5	4.7	1.1	0.3	\$2,691	1.1	1.6
	Efficiency & PV/Battery	24.0	7.3	0.7	0.7	\$5,404	1.4	1.6
Mixed Fuel to All- Electric	Code Compliant	0.0	0.0	1.4	0.8	(\$2,337)	>1	2.2
	Efficiency & PV	11.5	4.7	1.1	1.2	\$354	13.9	>1

Single Family Climate Zone 10 Results

Climate Zone 10 SCE/SoCalGas Single Family		EDR Red.	PV Size Change (kW)	CO2-Equivalent Emissions (lbs/sf)		Incremental Cost (\$)	Benefit to Cost Ratio (B/C)	
				Total	Red.		On-Bill	TDV
				Mixed Fuel	Efficiency-Non-Preempted		3.0	(0.1)
Efficiency-Equipment	3.0	(0.1)	1.4		0.2	\$593	2.0	4.0
Efficiency & PV/Battery	9.5	0.0	1.3		0.4	\$4,999	1.0	1.7
All- Electric	Efficiency-Non-Preempted	3.0	0.0	0.9	0.1	\$1,773	0.7	1.5
	Efficiency-Equipment	3.5	0.0	0.9	0.1	\$949	1.9	3.2
	Efficiency & PV	11.0	1.2	0.7	0.2	\$6,390	1.0	1.5
	Efficiency & PV/Battery	21.0	1.7	0.4	0.5	\$11,591	1.2	1.6
Mixed Fuel to All- Electric	Code Compliant	0.0	0.0	1.0	0.7	(\$5,349)	>1	2.3
	Efficiency & PV	11.0	1.2	0.7	0.9	\$1,041	8.3	>1

Multifamily Climate Zone 10 Results

Climate Zone 10 SCE/SoCalGas Multifamily		EDR Red.	PV Size Change (kW)	CO2-Equivalent Emissions (lbs/sf)		Incremental Cost (\$)	Benefit to Cost Ratio (B/C)	
				Total	Red.		On-Bill	TDV
				Mixed Fuel	Efficiency-Non-Preempted		1.5	(0.2)
Efficiency-Equipment	2.5	(0.3)	2.1		0.2	\$250	1.9	3.2
Efficiency & PV/Battery	10.0	0.2	1.9		0.4	\$2,089	1.1	1.8
All- Electric	Efficiency-Non-Preempted	1.5	0.0	1.4	0.1	\$361	1.0	1.9
	Efficiency-Equipment	2.0	0.0	1.4	0.1	\$361	1.7	2.1
	Efficiency & PV	11.0	4.7	1.2	0.3	\$2,349	1.3	1.8
	Efficiency & PV/Battery	23.5	7.4	0.7	0.8	\$5,084	1.5	1.8
Mixed Fuel to All- Electric	Code Compliant	0.0	0.0	1.5	0.8	(\$2,337)	>1	2.1
	Efficiency & PV	11.0	4.7	1.2	1.1	\$13	390.9	>1

Single Family Climate Zone 14 Results

Climate Zone 14 SCE/SoCalGas Single Family		EDR Red.	PV Size Change (kW)	CO2-Equivalent Emissions (lbs/sf)		Incremental Cost (\$)	Benefit to Cost Ratio (B/C)	
				Total	Red.		On-Bill	TDV
Mixed Fuel	Efficiency-Non-Preempted	4.5	(0.2)	2.1	0.3	\$1,684	1.5	2.4
	Efficiency-Equipment	5.5	(0.2)	2.0	0.4	\$795	3.9	6.2
	Efficiency & PV/Battery	9.0	(0.1)	1.8	0.5	\$4,999	1.9	1.9
All- Electric	Efficiency-Non-Preempted	5.5	0.0	1.2	0.2	\$4,154	0.9	1.5
	Efficiency-Equipment	6.0	0.0	1.2	0.2	\$2,108	2.1	3.1
	Efficiency & PV	15.5	1.6	0.9	0.5	\$10,465	1.1	1.6
	Efficiency & PV/Battery	24.0	2.2	0.6	0.8	\$15,878	1.3	1.7
Mixed Fuel to All- Electric	Code Compliant	0.0	0.0	1.4	1.0	(\$5,349)	2.0	1.6
	Efficiency & PV	15.5	1.6	0.9	1.4	\$5,116	2.5	>1

Multifamily Climate Zone 14 Results

Climate Zone 14 SCE/SoCalGas Multifamily		EDR Red.	PV Size Change (kW)	CO2-Equivalent Emissions (lbs/sf)		Incremental Cost (\$)	Benefit to Cost Ratio (B/C)	
				Total	Red.		On-Bill	TDV
Mixed Fuel	Efficiency-Non-Preempted	3.0	(0.3)	2.5	0.2	\$874	0.7	1.2
	Efficiency-Equipment	3.0	(0.4)	2.5	0.2	\$347	1.9	3.0
	Efficiency & PV/Battery	9.5	0.1	2.2	0.6	\$2,669	1.1	1.5
All- Electric	Efficiency-Non-Preempted	3.5	0.0	1.7	0.1	\$1,011	1.0	1.6
	Efficiency-Equipment	3.5	0.0	1.6	0.2	\$795	1.5	2.1
	Efficiency & PV	14.0	5.5	1.3	0.5	\$3,312	1.3	1.9
	Efficiency & PV/Battery	25.0	8.1	0.9	0.9	\$6,045	1.6	1.9
Mixed Fuel to All- Electric	Code Compliant	0.0	0.0	1.8	1.0	(\$2,337)	>1	1.5
	Efficiency & PV	14.0	5.5	1.3	1.4	\$975	5.9	>1

Single Family Climate Zone 15 Results

Climate Zone 15 SCE/SoCalGas Single Family		EDR Red.	PV Size Change (kW)	CO2-Equivalent Emissions (lbs/sf)		Incremental Cost (\$)	Benefit to Cost Ratio (B/C)	
				Total	Red.		On-Bill	TDV
Mixed Fuel	Efficiency-Non-Preempted	4.5	(0.4)	1.6	0.1	\$2,151	0.9	1.6
	Efficiency-Equipment	4.5	(0.4)	1.5	0.2	(\$930)	>1	>1
	Efficiency & PV/Battery	7.0	(0.3)	1.4	0.3	\$5,493	2.5	1.7
All- Electric	Efficiency-Non-Preempted	5.5	0.0	1.1	0.2	\$4,612	1.0	1.6
	Efficiency-Equipment	7.0	0.0	1.1	0.3	\$2,108	3.1	4.5
	Efficiency & PV	6.0	0.1	1.1	0.2	\$5,101	1.1	1.6
	Efficiency & PV/Battery	13.5	0.8	0.9	0.5	\$10,879	1.3	1.6
Mixed Fuel to All- Electric	Code Compliant	0.0	0.0	1.3	0.4	(\$5,349)	4.7	2.2
	Efficiency & PV	6.0	0.1	1.1	2.2	(\$248)	>1	>1

Multifamily Climate Zone 15 Results

Climate Zone 15 SCE/SoCalGas Multifamily		EDR Red.	PV Size Change (kW)	CO2-Equivalent Emissions (lbs/sf)		Incremental Cost (\$)	Benefit to Cost Ratio (B/C)	
				Total	Red.		On-Bill	TDV
Mixed Fuel	Efficiency-Non-Preempted	4.0	(1.2)	2.4	0.1	\$510	1.2	2.3
	Efficiency-Equipment	4.0	(1.3)	2.3	0.2	(\$158)	>1	>1
	Efficiency & PV/Battery	8.5	(0.8)	2.1	0.4	\$2,316	1.3	1.9
All- Electric	Efficiency-Non-Preempted	4.0	0.0	1.7	0.2	\$1,011	1.4	2.1
	Efficiency-Equipment	6.0	0.0	1.6	0.3	\$1,954	1.2	1.6
	Efficiency & PV	6.5	1.9	1.6	0.3	\$1,798	1.4	2.0
	Efficiency & PV/Battery	16.5	4.9	1.1	0.7	\$4,702	1.6	1.9
Mixed Fuel to All- Electric	Code Compliant	0.0	0.0	1.8	0.7	(\$2,337)	>1	2.4
	Efficiency & PV	6.5	1.9	1.6	1.9	(\$539)	>1	>1



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2019 Nonresidential New Construction Cost Effectiveness Study DRAFT Results

June 5, 2019

Avani Goyal

TRC Advanced Energy



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SoCalGas

A Sempra Energy utility^{*}



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Overview

- Methodology
 - Measure packages
 - Prototype descriptions

(pause for questions)

- Results
 - Initial focus on Climate Zone 8
 - SCE territory
- More Questions

Nonresidential Methodology

- Measure definition and research
 - Efficiency packages
 - Solar PV + battery
 - All-electric space and water heating, including utility infrastructure
 - Contractors and designers for system configuration and costs
- Ran building simulations
 - EnergySoft collaboration, developers of EnergyPro
 - Engine based on CBECC-Com 2019 0.4 (January)
 - GHG emissions factors built-in
- Cost effectiveness metrics
 - Time Dependent Valuation (TDV) per Energy Commission methodology
 - On-bill with Time of Use Rates

Efficiency Measure Packages

Package		Fuel Type		Energy Efficiency Measures	Solar PV & Battery	High Efficiency Appliances
		Mixed Fuel	All-Electric			
Mixed-Fuel Code Minimum (Baseline for all other packages)		X				
Mixed-Fuel	+ EE	X		X		
	+ EE + PV	X		X	X	
	+ HE	X				X
All-Electric	Fed Code Min		X			
	+ EE		X	X		
	+ EE + PV		X	X	X	
	+ HE		X			X

EE = Energy Efficiency
 PV = Solar PV + Battery
 HE = High Efficiency / Preemptive

Nonresidential Building Prototypes

		Medium Office	Medium Retail	Small Hotel
Conditioned Floor Area (ft)		53,628	24,691	42,552
Num. of Stories		3	1	4
Num. of Guest Rooms		0	0	78
HVAC System	Baseline	Packaged DX + VAV with HW reheat. Central gas boilers.	Single zone packaged DX with gas furnaces	<u>NonRes:</u> Packaged DX + VAV with HW reheat. Central gas boilers. <u>Res:</u> Single zone DX AC unit with gas furnaces
	Proposed All-Electric	Packaged DX + VAV with electric resistance reheat.	Single zone packaged heat pumps	<u>NonRes:</u> Packaged DX + VAV with electric resistance reheat <u>Res:</u> Single zone heat pumps
DHW System	Baseline	Electric resistance with storage	Electric resistance with storage	<u>NonRes:</u> Electric resistance storage <u>Res:</u> Central gas storage with recirculation
	Proposed All-Electric	Electric resistance with storage	Electric resistance with storage	<u>NonRes:</u> Electric resistance storage <u>Res:</u> Individual heat pumps

Nonresidential Building Prototypes

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HVAC System	Baseline	Packaged DX + VAV with HW reheat. Central gas boilers.	Single zone packaged DX with gas furnaces	<u>NonRes</u> : Packaged DX + VAV with HW reheat. Central gas boilers. <u>Res</u> : Single zone DX AC unit with gas furnaces
	Proposed All-Electric	Packaged DX + VAV with electric resistance reheat.	Single zone packaged heat pumps	<u>NonRes</u> : Packaged DX + VAV with electric resistance reheat <u>Res</u> : Single zone heat pumps
DHW System	Baseline	Electric resistance with storage	Electric resistance with storage	<u>NonRes</u> : Electric resistance storage <u>Res</u> : Central gas storage with recirculation
	Proposed All-Electric	Electric resistance with storage	Electric resistance with storage	<u>NonRes</u> : Electric resistance storage <u>Res</u> : Individual heat pumps

Measure Descriptions and Applications to Each Prototype

Package	Measure	Office	Retail	Hotel
EE	ENVELOPE			
	Lower SHGC Fenestration	X	X	
	Fenestration as a Function of Orientation	X		
	DHW/HVAC			
	Drain Water Heat Recovery			X
	VAV Box Minimum Flow	X		X
	Economizers on Small Capacity Systems		X	
	LIGHTING			
	Interior Lighting Reduced LPD	X	X	X
	Institutional Tuning	X	X	X
	Daylight Dimming Plus Off	X		
	Occupant Sensing in Open Plan Offices	X		
PV	Solar PV	135 kW	80 kW	90 kW
	50 kWh Battery	X	X	X
HE	Preemptive efficiencies	X	X	X

Questions on Methodology?

Key Considerations While Viewing Results

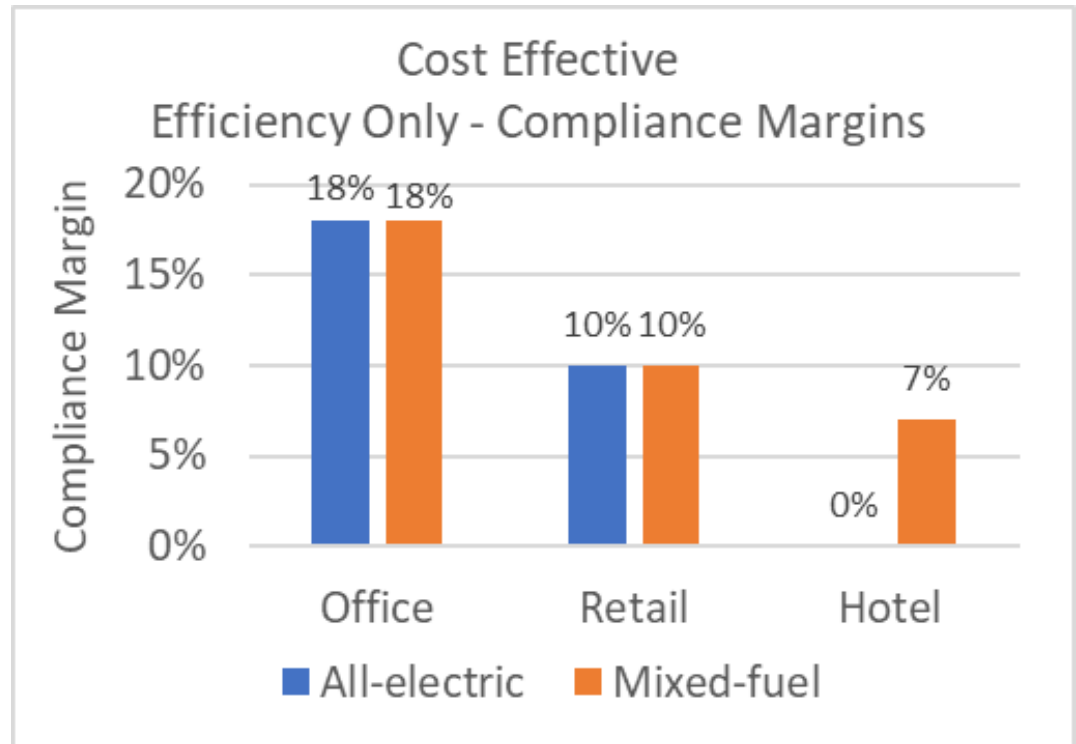
- Local reach codes must both
 - Have >0% compliance margin
 - Be cost effective
- Solar PV or batteries do not earn compliance credit
- Standard Design HVAC or DHW remain mixed-fuel when Proposed Design is electric
- Findings are specific to these scenarios, methodology, assumptions.

Climate Zone 8 - Construction Costs Breakdown for Medium Office

Prototype	Cost Component	Mixed Fuel Baseline	All Electric System	Incremental cost for All-Electric
Office	HVAC	\$1,250,564	\$1,172,937	(\$77,626)
	Electrical Infrastructure	\$0	\$27,802	\$27,802
	Natural Gas Infrastructure	\$18,949	\$0	(\$18,949)
	Efficiency Measures	\$66,649		\$0
	Solar PV + Battery	\$306,493		\$0
	Total	\$1,642,655	\$1,573,881	(\$68,773)

Climate Zone 8 - Cost Effective Compliance Margins

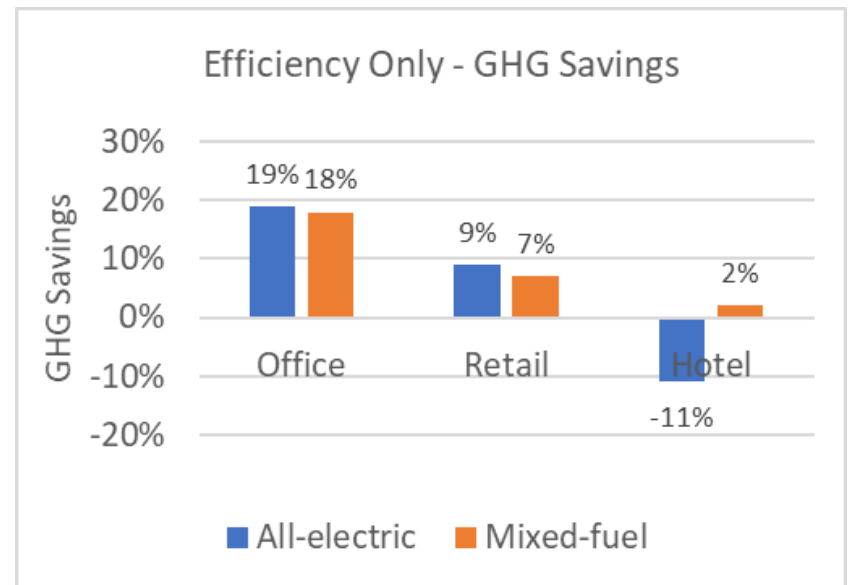
- **Office:** All-electric compliance on-par with mixed-fuel despite being electric resistance due to very little heating load
- **Retail:** Equivalent all-electric compliance due to low heating loads
- **Hotel:** No all-electric positive compliance margin due to heat pump water heater modeling



Climate Zone 8 – Solar PV + Battery, GHGs

- Solar PV + Batteries: Benefit-to-cost ratio lower than efficiency measures, but Net Present Value is higher.
- All-electric buildings generally save more GHG emissions
- Hotel results imprecise, and not indicative of RPS goals

Mixed Fuel Office in CZ 10	Benefit/Cost Ratio (On-bill)	Net Present Value (On-Bill)
Efficiency Only	1.5	\$32,829
Solar PV + Battery	1.4	\$161,652



MEDIUM OFFICE – Compliance Margins & Cost Effectiveness

CZ	Utility	Mixed Fuel Compliance Margin			All Electric Compliance Margin			
		EE	EE + PV	HE	Fed Code	EE	EE + PV	HE
CZ6	SCE/SCG	20%	20%	3%	-5%	18%	18%	-3%
CZ8	SCE/SCG	18%	18%	4%	-2%	18%	18%	1%
CZ9	SCE/SCG	16%	16%	4%	-2%	14%	14%	1%
CZ10	SCE/SCG	17%	17%	4%	-4%	13%	13%	-1%
CZ14	SCE/SCG	18%	18%	10%	0%	14%	14%	4%
CZ15	SCE/SCG	12%	12%	5%	-2%	11%	11%	3%
Avg GHG Savings								
		15%	44%	3%	2%	17%	47%	3%

LEGEND

>0% Compliance
and both

TDV Cost Effective
and
On-Bill Cost Effective

>0% Compliance
and either

TDV Cost Effective
or
On-Bill Cost Effective

<0% Compliance
or

not cost effective

MEDIUM RETAIL – Compliance Margins & Cost Effectiveness

CZ	Utility	Mixed Fuel Compliance Margin			All Electric Compliance Margin			
		EE	EE + PV	HE	Fed Code	EE	EE + PV	HE
CZ6	SCE/SCG	10%	10%	3%	0.5%	11%	11%	3%
CZ8	SCE/SCG	10%	10%	3%	0.4%	10%	10%	4%
CZ9	SCE/SCG	9%	9%	4%	0.4%	10%	10%	4%
CZ10	SCE/SCG	12%	12%	4%	0.1%	12%	12%	4%
CZ14	SCE/SCG	12%	12%	5%	0.5%	12%	12%	5%
CZ15	SCE/SCG	11%	11%	5%	0.9%	10%	10%	6%
Avg GHG Savings		11%	68%	2%	6%	14%	71%	8%

LEGEND

>0% Compliance and <u>both</u> TDV Cost Effective and On-Bill Cost Effective	>0% Compliance and <u>either</u> TDV Cost Effective or On-Bill Cost Effective	<0% Compliance or not cost effective
--	---	--

SMALL HOTEL – Compliance Margins & Cost Effectiveness

CZ	Utility	Mixed Fuel Compliance Margin			All Electric Compliance Margin			
		EE	EE + PV	HE	Fed Code	EE	EE + PV	HE
CZ6	SCE/SCG	8%	8%	1%	-50%	-37%	-37%	-22%
CZ8	SCE/SCG	7%	7%	2%	-49%	-41%	-41%	-20%
CZ9	SCE/SCG	6%	6%	2%	-44%	-37%	-37%	-17%
CZ10	SCE/SCG	5%	5%	3%	-40%	-34%	-34%	-16%
CZ14	SCE/SCG	4%	4%	3%	-41%	-34%	-34%	-18%
CZ15	SCE/SCG	3%	3%	5%	-27%	-24%	-24%	-8%
Avg GHG Savings								
		1%	20%	2%	-7%	-6%	13%	9%

LEGEND

>0% Compliance and <u>both</u> TDV Cost Effective and On-Bill Cost Effective	>0% Compliance and <u>either</u> TDV Cost Effective or On-Bill Cost Effective	<0% Compliance or not cost effective
--	---	--

Summary and Conclusions

1. Efficiency packages and solar PV + battery scenarios are cost effective for both mixed-fuel and all-electric buildings.
2. Medium Office and Retail mixed-fuel scenarios achieve higher compliance margins, but all-electric scenarios achieve higher GHG savings reductions.
3. All electric small hotel is challenging to show cost-effectively exceeding the state's budget, and uncertain precision given modeling limitations.
4. High efficiency appliances must be integrated into design, but are not as effective as efficiency packages.

Reach Code Measure Considerations

- Develop policies accounting for various building types and/or building systems.
 - Groceries, labs, spas... have very different energy demands
- Lower GHG emissions by encouraging
 - All-electric design
 - Higher compliance margins for mixed-fuel buildings
 - Increased solar PV and battery penetration

Thank you!

Avani Goyal – TRC Advanced Energy

Appendix

Climate Zone 8 - Construction Costs Breakdown for Medium Retail

Prototype	Cost Component	Mixed Fuel Baseline	All Electric System	Incremental cost for All-Electric
Medium Retail	HVAC	\$368,687	\$369,792	\$1,104
	Electrical Infrastructure	\$0	\$0	\$0
	Natural Gas Infrastructure	\$28,027	\$0	(\$28,027)
	Efficiency Measures	\$5,569		\$0
	PV + Battery	\$183,993		\$0
	Total	\$566,276	\$559,354	(\$26,923)

Climate Zone 8 - Construction Costs Breakdown for Small Hotel

Prototype	Cost Component	Mixed Fuel Baseline	All Electric System	Incremental cost for All-Electric
Small Hotel	HVAC and DHW	\$2,333,662	\$1,053,717	(\$1,279,946)
	Electrical Infrastructure	\$0	\$26,800	\$26,800
	Natural Gas Infrastructure	\$56,020	\$0	(\$56,020)
	Efficiency Measures	\$20,971		\$0
	PV + Battery	\$190,650		\$0
	Total	\$2,601,303	\$1,292,138	(\$1,309,166)

High Efficiency Appliance Assumptions

	Federal Minimum Efficiency	Preempted Efficiency
Gas space heating and water heating	80-82%	90-95%
Packaged rooftop cooling	9.8-12 EER 11.4-12.9 IEER	10.5-13 EER 15-15.5 IEER
Heat pump space heating	7.7 HSPF 3.2 COP	10 HSPF 3.5 COP
Heat pump water heating	2.0 UEF	3.3 UEF

Natural Gas Cost Breakdown

Cost Type	Medium Office	Medium Retail	Small Hotel
Natural Gas Plan Review	\$2,316	\$2,316	\$2,316
Service Extension	\$13,000	\$13,000	\$13,000
Meter	\$3,000	\$3,000	\$3,000
Plumbing Distribution	\$633	\$9,711	\$37,704
Total Cost	\$18,949	\$28,027	\$56,020

Greenhouse Gas Multipliers

	Electric (lbs/kWh)	Natural Gas (lbs/therm)
PG&E	0.69	11.65
SDG&E	0.807	11.65
SCE	0.807	11.65



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2020 Vision: Reach Codes Best Practices v2.0

**Model Ordinances:
Where Do We Go From Here?**

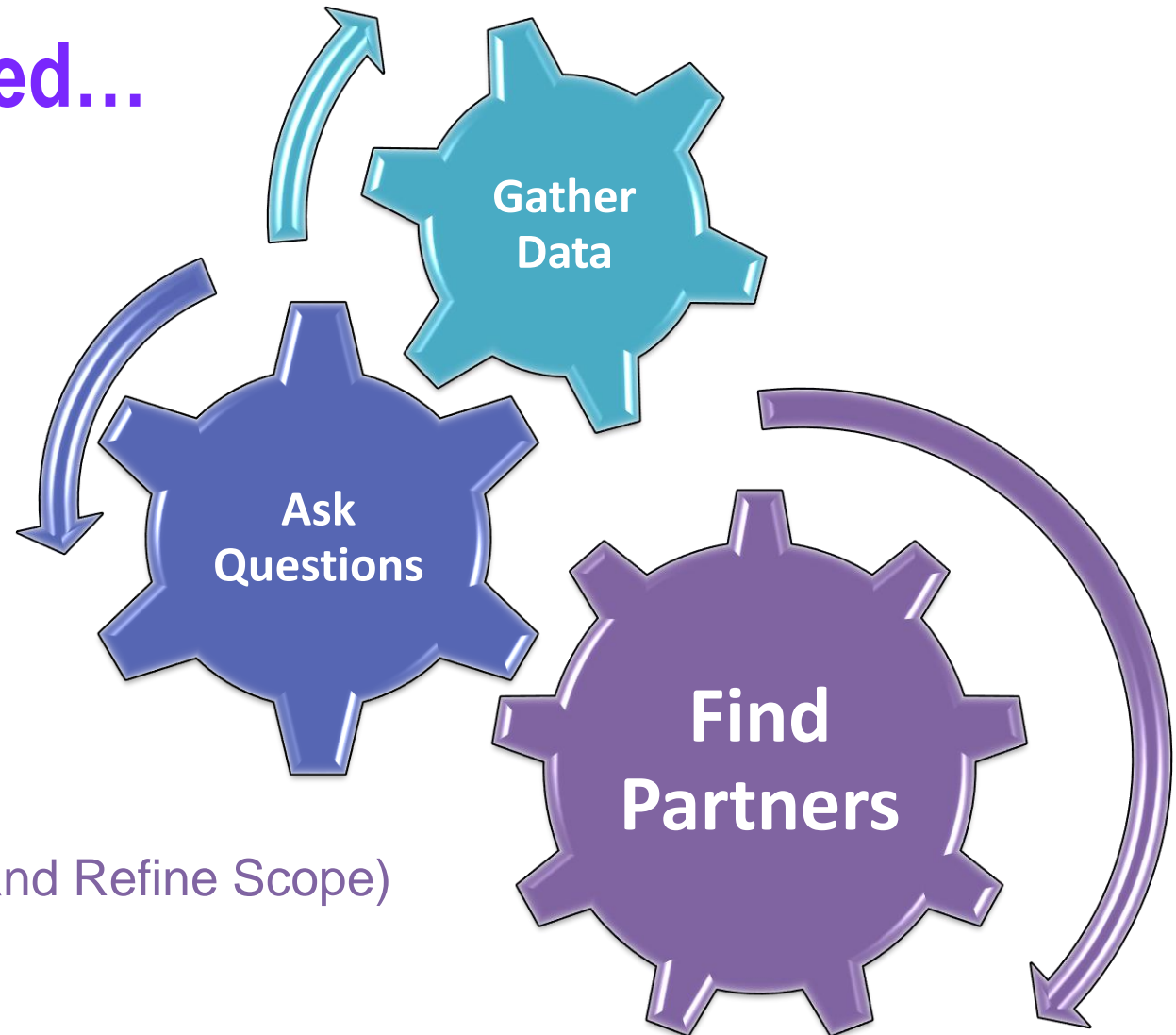
June 4-5, 2019

Misti Bruceri

Local Reach Code Adoption Process



Getting Started...



(Conduct Outreach and Refine Scope)

New Construction Model Ordinance Language

➤ Efficiency Focus

- Equivalent performance requirements for mixed-fuel and all-electric building designs
- Mixed-fuel designs retrofit-ready

➤ Emissions Focus

- All-electric building designs meet state code
- Mixed-fuel building designs meet advanced performance requirements
- Mixed-fuel designs retrofit-ready

Efficiency Focus – Residential New Construction

Efficiency Focus (RNC)			
Climate Zone	Walk		Run
	Single Family	Multi-family	All Low-rise Res
	EFFICIENCY EDR Margin		TOTAL EDR Margin
6	2	1	9
8	1	1	8
9	2	1	8
10	3	1	9
14	4	3	9
15	4	4	6

Walk - Design and/or efficiency

Run:

All-electric - Design and/or efficiency and/or PV

Mixed-fuel - Design and/or efficiency and/or PV and storage

Emissions Focus – Residential New Construction

Emissions Focus (RNC)			
Climate Zone	All-Electric	Walk	Run
		Mixed-fuel	
	Total EDR MARGIN		Total EDR SCORE
6	0	9	CALGreen Tier 1
8	0	8	
9	0	8	
10	0	9	
14	0	9	
15	0	6	

Walk - Design and/or efficiency

Run:

All-electric - Design and/or efficiency and/or PV

Mixed-fuel - Design and/or efficiency and/or PV and storage

Nonresidential New Construction

Nonresidential New Construction			
Occupancy Type	Compliance Margin (%)		
	Efficiency Focus	Emissions Focus	
	All Buildings	All-Electric	Mixed-fuel
Office / Retail	10	0	10
Hotel/motel and High-rise residential	5	0	5
All Others	5	0	5

Minimum PV System Capacity:

PV system must fill the entire solar zone (15% of roof area).

Reach Codes Sample Timeline

2019 Reach Codes: Sample Timeline																	
	2018				2019												2020
	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan
Develop idea for draft ordinance	█																
Compliance software completed	█	█	█	█	█	█	█	█	█	█	█	█	█	█	█	█	
Develop cost-effectiveness (c/e) study			█	█	█	█	█	█	█	█	█	█	█	█	█	█	
Work with stakeholders			█	█	█	█	█	█	█	█	█	█	█	█	█	█	
Develop and draft ordinance							█	█	█	█	█	█	█	█	█	█	
Review by local committees								█	█	█	█	█	█	█	█	█	
Public process and revisions									█	█	█	█	█	█	█	█	
First reading of ordinance (introduction)											█	█	█	█	█	█	
Second reading of ordinance (adoption)												█	█	█	█	█	
Application to CEC													█	█	█	█	
CEC public comment period														█	█	█	
Approval from CEC																█	
File with BSC																	█
Effective Date (1/1/2020)																	█

CA Reach Codes Resources

IOU Codes and Standards: LocalEnergyCodes
<https://www.localenergycodes.com>

- California Energy Commission
 - Reach Codes: Gabe Taylor
Gabriel.Taylor@energy.ca.gov
- Building Decarbonization Coalition
 - <http://www.buildingdecarb.org>
- BayREN Codes and Standards: Reach Codes
 - <https://www.bayrencodes.org/reachcodes/>

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