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Staff Workshop
Update on 2022 Standards Life Cycle Costing, Metrics, & Weather Files

Building Standards Office

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Workshop Agenda

1. Mazi Shirakh - Purpose of this workshop and recap of the October 2019 Metrics/LCC workshop
2. E3 - Update on natural gas TDV and CH4 Leakage impacts; update on electricity TDV and the shape of the retail adder
3. Bruce Wilcox – Impacts of new TDV changes on efficiency, PV, and DR measures in residential buildings
4. NORESCO - Impacts of new TDV changes on efficiency, PV, and DR measures in nonresidential buildings
5. Public comments
6. Adjourn

Background

- The recently adopted 2019 Standards is the last code cycle focused primarily on the ZNE goal, the 2022 and subsequent Standards cycles will have building decarbonization as the primary goal
- Therefore, a new metric or metrics needed to align buildings with the decarbonization goals without adverse consequences
- The new approach must support building decarbonization, resilient building envelope, and strong demand response signals all at the same time
- Also, new weather files, reflecting the planet's warming trends, will be introduced into the 2022 performance software programs; the new weather files will have an impact on measure tradeoffs

Recap of October 17, 2019 Lead Commissioner LCC/Metrics Workshop

1. Introduced the new weather files reflecting warming climate zones – These weather files are now incorporated in the research versions of CBECC-Res and CBECC-Com. Today's workshop will not revisit these files
2. Introduced the updated life cycle cost (LCC) methodology, including the updated natural gas and electricity TDVs – The Commission received extensive comments on the NG and electric TDV; these updates will be presented today
3. Introduced the new source energy metric designed to align buildings with decarbonization policies – Today's workshop will not revisit the source energy metric since there are no new updates since the October workshop
4. Introduced the new "2-EDR" approach designed to achieve building decarbonization while maintaining resilient building envelope and strong demand response signals - Today's workshop will not revisit the 2-EDR approach since there are no new updates since the October workshop
5. Presented simulation results to demonstrate the implications of the updated TDVs, the new source energy metric, and the new 2-EDR approach – Today's workshop will present updated measure impact analysis

TDV Updates

1. The natural gas TDV has been updated to include the impacts of CH4 leakage associated with the building
2. The electric TDV now includes two choices: A flat retail added and a non-flat retail adder

The impacts of these changes on efficiency, PV, and storage measures will be demonstrated today

Today's workshop will not present results for impacts of Global Warming Potential (GWP) impacts of refrigerants on electric TDV; these results will be presented at a later date. The GWP impact are important for fuel switching measures

ZNE and CO2 Emissions

CO_2 emissions reduced by 700,000 metric tons over three years, equivalent to taking 115,000 18-mpg gas cars off the road. California has one of the cleanest grids in the nation, CO_2 savings will be greater in other states with less green grids.

2700 sf prototype, CZ12		
CO2 Impact of Housing Choices		**Metric Tons of CO2 Generated/Year - Including Exports**
Mixed Fuel	2000 Compliant Building, No PV	**6.5**
Mixed Fuel	2016 Compliant Building, No PV	**3.3**
Mixed Fuel	2019 Standard Design, with 3.1 kW PV	**2.3**
Mixed Fuel	2019 Standard Design, with 3.1 kW PV With Batt	**2.1**
All-Elect	2019, 3.1 kW PV, No Batt	**1.1**
All-Elect	2019, 3.1 kW PV, With Batt	**1.0**
All-Elect	2019, 6 kW PV, With Batt	**0.2**

Question

Lead Commissioner Workshop
2022 Standards - The 2-EDR Approach

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The Primary Goals for New Metrics

The purpose of establishing new metrics for the 2022 Standards and beyond is to align the Building Standards with the state's climate change goals; the 2022 Standards approach must:

1. Encourage decarbonization by removing barriers to building electrification
2. Maintain <u>and</u> encourage thermal-resilient building envelope features that perform well in both heating and cooling climate zones, even as the planet warms up
3. Encourage self-utilization of onsite PV generation and demand response measures
4. Not increase the stringency of the residential standards for one code cycle
5. Avoid preemption

List of Metrics Evaluated Overall

		Metric Category			
I.D.	Metric Name	Cost Effectiveness	Energy	GHG	Combined
0	TDV 2019 baseline	✓			
1	TDV 2022 with kBTu metrics	✓			
2	TDV 2022, high GHG, kBTu metrics	✓			
3	Source energy; RE = 0 Btu/kWh		✓		
4	Source energy; RE = 3412 Btu/kWh		✓		
5	Long-run source energy; RE = 0 Btu/kWh		✓		
6	Long-run source energy; RE = 3412 Btu/kWh		✓		
7	Short-run marginal emissions			✓	
8	Long-run marginal emissions using (1-RPS%) approach			✓	
9	Hourly Average emissions			✓	
10	TDV 2022 using PV$ metrics, same as 2019	✓			
11	TDV 2022, high GHG, using PV$ metrics	✓			
12	TRC 2022, which is the TDV units without the retail adder	✓			
13	TRC 2022, with higher marginal cost of GHG reduction	✓			
14	'Delivered' marginal source energy that includes capacity constraint				✓
15	'Delivered' marginal source energy with scaled capacity constraint				✓
16	Two Step (1/2) – Annual Average Emissions (long-run marginal)			✓	
17	Two Step (2a/2) – TRC with net marginal emissions @ GHG shadow price	✓			
18	Two Step (2b/2) – TDV with net marginal emissions @ GHG Shadow Price	✓			
19	'Delivered' average source energy with scaled capacity constraint				✓

Criteria to Guide Selection Of Metrics

	Criterion	Requirement
1	Facilitates fuel switching and building electrification	These are evaluated using the simulation results from the residential and non-residential simulation.
2	Supports demand flexibility and grid harmonization strategies	
3	Protects envelope efficiency measures, such as high performance attics and walls, and high efficiency windows	
4	Does not allow or encourage resistance space and water heating, or other inefficient use of appliances	
5	Does not increase the energy costs of the building for the occupants	Requires lifecycle cost-effectiveness evaluation
6	Results in long-term and sustainable GHG reduction in buildings, by supporting 1-5 above	
7	Avoid federal preemption issues	Use source energy as a proxy for GHG and avoid preemption issues
8	Does all of the above without the need for limiting prescriptive and performance path tradeoff rules	

Example of metric Comparison – Fuel Switching

Percent Savings ((Case1-Case2)/Case1) for 2700ft2 Single-Family Two Story (Metric Total)

Case 1 = 2019 package

Case 2 = 2019 electric package

Climate Zone	0 2019_TDV (kTDV/ft2)	1 2022_TDV (kTDV/ft2)	2 2022_TDV_LR_Emissions (kTDV/ft2)	9 Avg_Emissions (tCO2/ft2*10^5)	14 Combined_Metric (kTDV/ft2)	15 Combined_Metric_2 (kTDV/ft2)	16 Two_Step_GHG (tCO2/ft2*10^5)	18 Two_Step_TDV ($/ft2)	19 Combined_Metric_3 (kTDV/ft2)
CZ01	-47%	-53%	-25%	59%	17%	37%	83%	-22%	65%
CZ02	-28%	-33%	-10%	60%	26%	41%	84%	-8%	67%
CZ03	-40%	-43%	-19%	57%	16%	35%	83%	-17%	63%
CZ04	-35%	-38%	-16%	56%	17%	34%	83%	-14%	62%
CZ05	-47%	-50%	-25%	54%	14%	31%	81%	-22%	61%
CZ06	-27%	-29%	-10%	56%	16%	32%	83%	-8%	61%
CZ07	-33%	-34%	-14%	55%	12%	28%	82%	-11%	58%
CZ08	-22%	-23%	-8%	55%	10%	27%	83%	-6%	55%
CZ09	-18%	-19%	-7%	56%	7%	25%	83%	-6%	53%
CZ10	-19%	-20%	-8%	55%	6%	24%	83%	-7%	52%
CZ11	-22%	-23%	-9%	57%	13%	31%	83%	-7%	58%
CZ12	-21%	-24%	-8%	60%	15%	35%	84%	-6%	62%
CZ13	-20%	-22%	-9%	57%	9%	29%	84%	-7%	56%
CZ14	-22%	-25%	-10%	54%	12%	29%	82%	-8%	57%
CZ15	-17%	-16%	-10%	39%	-3%	7%	79%	-9%	30%
CZ16	-57%	-62%	-32%	59%	1%	34%	82%	-29%	64%
Statewide	**-26%**	**-28%**	**-11%**	**56%**	**11%**	**30%**	**83%**	**-9%**	**57%**
Average	-30%	-32%	-14%	56%	12%	30%	83%	-12%	58%

Results of analysis

The following approaches were rejected as metrics for the Standards:

1. A Single Metric - No single metric emerged as a satisfactory option for simultaneously supporting building electrification, protecting the building envelope, preserving DR signals, and not increasing monthly energy costs. A metric that had strong "electrification" signal tend to have weak building envelope protection and grid harmonization signals and visa versa.
2. Combined Metrics Like 14 and 15 – Although an improvement over using a single metric, combined metrics were also unable to satisfactorily support building electrification, protecting the building envelope, preserving DR signals, and not increasing monthly energy costs at the same time. This approach suffered from a "sea-saw" effect", the more the metric favors one criterion (such as electrification), the weaker the signal gets for other criteria (such as preserving DR, protecting the envelope) and visa versa.

Recommended Approach

Two Independent Metrics – 2 EDRs Based on Source Energy and TDV

EDR1 Target – Hourly Source Energy: Based on hourly source energy establishes a "carbon-proxy budget" for the building in kBTU/sf-yr units to support decarbonization and electrification policy goals; the proposed building must have an EDR1 score that is equal or less than the EDR1 score of the reference building

EDR2 Target - TDV: A TDV based metric is used to protect building envelope and maintain strong grid harmonization signals; the proposed building must have an EDR2 score that is equal or less than the EDR2 score of the reference building

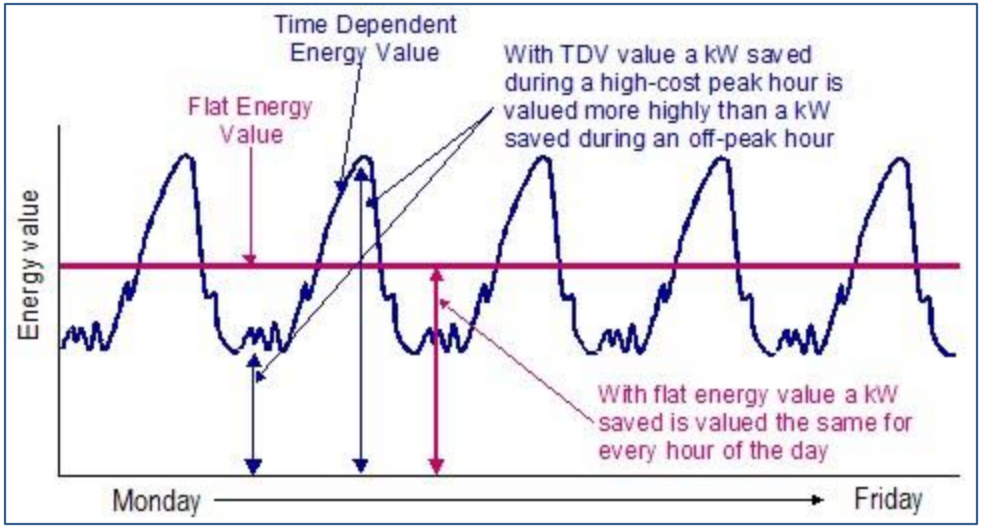
Tradeoff Rules: No tradeoffs are allowed between EDR1 and EDR2; for a building to comply, it must pass both EDR1 and EDR2 independently and simultaneously. This ensures that decarbonization, building envelope protection, and grid harmonization signals all remain uncompromised

Time Dependent Valuation (TDV)

TDV is an hourly energy cost metric for both electricity and natural gas, in place of a flat energy value throughout the day. TDV assumes that utilities meet their RPS and other obligations, and is projected over the 30-year life of the building.

TDV incorporates the hourly cost of:

- marginal generation
- transmission and distribution
- fuel
- capacity
- losses
- cap-and-trade-based CO2 emissions.



TDV values for electricity tend to favor designs that reduce cooling loads, when grid costs are highest. TDV values for natural gas tend to disfavor electrification because of the low cost of natural gas.

Hourly Source Energy (HSE)

Like TDV, HSE is an hourly energy metric for both electricity and natural gas. HSE assumes utilities meet all RPS and other obligations, and is projected out over the 30-year life of the building.

Whenever a renewable resource is on the margin, which increasingly occurs as RPS requirements increase, the source energy for that hour goes to zero. In hours where renewable resources are not available, the heat rate of the natural gas resource on the margin determines the source energy.

HSE represents the depletable energy content of the long-term, marginal generation resource required in each hour to meet incremental energy demand

The resulting HSE values are proportional to the GHG emissions of the long-run, marginal resource, and so HSE is a good proxy for GHG and a strong metric for encouraging fuel switching and decarbonization, and for reducing natural gas use.

HSE and TDV Comparison Summary

Metric:	What it is good at	What it is not good at
Hourly Source Energy (HSE)	Promoting electrification and efficient use of gas appliance	Protecting efficient building envelope features, such as HPA, HPW, high efficiency windows, low leakage envelope. HSE has weak grid harmonization signals
TDV	Protecting efficient building envelope features and maintaining strong grid harmonization signals	Encouraging electrification
HSE and TDV	Simultaneously promoting electrification, protecting efficient building envelopes, and maintaining strong grid harmonization signals	

2022 Standards Recommendation: Separate Gas and Electric Baselines

1. **Separate Baselines for Lowrise Residential Buildings:** Maintain separate baselines for mixed fuel buildings and all-electric buildings (same as 2019). This approach avoids performance path compliance barriers for building electrification.

2022 Standards Recommendation: 2-EDR Approach

2. EDR1 (“Carbon Proxy” metric) and EDR 2 (updated TDV)

EDR 1
Hourly Source Energy

→

EDR 2
Time Dependent Valuation

No tradeoffs between EDR1 and EDR2

- EDR 1 sends strong decarbonization signals
- EDR 2 maintains envelope resiliency, incentivizes demand flexibility and grid harmonization
- Similar to 2019 Standards, some tradeoffs within EDR2 for demand flexibility and energy efficiency are allowed

Beyond 2022 Standards: Single Baseline for All Buildings Coupled with 2-EDR Approach

A single baseline together with the 2-EDR approach:

1. Establish a carbon budget by switching natural gas end uses (such as space, water heating, and clothes drying) to heat pump technology, as well as induction cooking
   - Allows for gradual or sudden steps
2. EDR1 ensures no backsliding on carbon limits
3. EDR2 protects building envelope resiliency and maintains strong demand response signals

2022 CBECC Updates

The CBECC compliance software will be updated to include the new weather files, gas and electric TDVs, and the 2-EDR approach

These changes require modest modifications to CBECC compliance software output interface; the followings are some examples of these changes.

2-EDR Approach in CBECC-Res

- Under the EDR tab, there area additional windows for EDR1
- EDR2 is similar to the 2019 version (Efficiency, PV/Flexibility, and Total EDRs); to comply, the building must pass both EDR1 and EDR2 independently (no tradeoffs allowed)

2019_CZ12_2700ft2_Std_NGAS-NoERV - CZ12 STD2700 EGLASS20 NGAS ?

Compliance Summary | CO2 Emissions | Energy Design Rating | Energy Use Details | CO2 Details

EDR1 of Standard Design: 33.8

EDR1 of Proposed Design: 33.5

EDR2 of Standard Efficiency: 45.9 - EDR2 of Standard Design PV: 15.1 = Total Std Design EDR2: 30.8

Std Design PV: 3.71 kW

EDR2 of Proposed Efficiency: 45.3 - EDR2 of Prop PV + Flexibility: 15.1 = Total Proposed EDR2: 30.2

	Reference Design:				Proposed Design:				Design Rating Margins:	
End Use	Site (kWh)	Site (therms)	EDR1 (kBtu/ft²-yr)	EDR2 (kTDV/ft²-yr)	Site (kWh)	Site (therms)	EDR1 (kBtu/ft²-yr)	EDR2 (kTDV/ft²-yr)	EDR1 (kBtu/ft²-yr)	EDR2 (kTDV/ft²-yr)
Space Heating	668	555.6	23.90	64.43	184	271.1	10.70	28.41	13.20	36.02
Space Cooling	1,610		3.78	67.58	423		1.01	23.61	2.77	43.97
IAQ Ventilation	961		1.76	9.98	961		1.76	9.98	0.00	0.00
Water Heating		180.5	16.80	39.76	88	126.6	4.99	12.38	11.81	27.38
Self Utilization Credit								0.00		0.00
Photovoltaics					-5,829 *		-6.37	-41.99	6.37	41.99

2-EDR Approach in CBECC-Res

Under the Energy Use Detail tab, additional columns under Standards and Proposed Designs to accommodate EDR1

2019_CZ12_2700ft2_Std_NGAS-NoERV - CZ12 STD2700 EGLASS20 NGAS

Compliance Summary | CO2 Emissions | Energy Design Rating | Energy Use Details | CO2 Details

	Standard Design:				Proposed Design:				Compliance Margins:	
End Use	Site (kWh)	Site (therms)	EDR1 (kBtu/ft²-yr)	EDR2 (kTDV/ft²-yr)	Site (kWh)	Site (therms)	EDR1 (kBtu/ft²-yr)	EDR2 (kTDV/ft²-yr)	EDR1 (kBtu/ft²-yr)	EDR2 (kTDV/ft²-yr)
Space Heating	188	276.8	10.93	28.97	184	271.1	10.70	28.41	0.23	0.56
Space Cooling	398		0.96	24.72	423		1.01	23.61	-0.05	1.11
IAQ Ventilation	961		1.76	9.98	961		1.76	9.98	0.00	0.00
Water Heating	88	126.6	4.99	12.38	88	126.6	4.99	12.38	0.00	0.00
Self Utilization Credit								0.00		0.00
Compliance Total			18.64	76.05			18.46	74.38	0.18	1.67
Photovoltaics	-5,829		-6.37	-41.98	-5,829 *		-6.37	-41.99		2.2 %
Battery							0.00	0.00		
Flexibility										
Inside Lighting	616		1.29	7.47	616		1.29	7.47		
Appl. & Cooking	1,057	48.2	3.76	16.09	1,059	48.2	3.76	16.11		

2-EDR Approach in CBECC-Res

Under the Compliance Summary tab, additional inputs for EDR1; to comply, the building must pass both EDR1 and EDR2 independently (no tradeoffs allowed)

2019_CZ12_2700ft2_Std_NGAS-NoERV - CZ12 STD2700 EGLASS20 NGAS

Compliance Summary | CO2 Emissions | Energy Design Rating | Energy Use Details | CO2 Details

	Energy Design Ratings:			Compliance Margins:		
	Source (EDR1)	Efficiency[1] (EDR2)	Total[2] (EDR2)	Source (EDR1)	Efficiency[1] (EDR2)	Total[2] (EDR2)
Standard Design	33.8	45.9	30.8			
Proposed Design	33.5	45.3	30.2	0.3	0.6	0.6

Result[3]: COMPLIES

(not current)

Sample Simulations – Avoiding Adverse Consequences

	EDR Comparison for 2700ft2 Single-Family Two Story in Climate Zone 12							
		Case 2 2022 Mid-IEPR Standard PV			Individual Pass/Fail			Overall Pass/Fail
	Case 2 Choices	Source (EDR1)	Efficiency (EDR2)	Total (EDR2)	Source (EDR1)	Efficiency (EDR2)	Total (EDR2)	Overall
	Mixed/2019Pkg (Standard Design)	51	51	34				
1	Mixed/-HPW/+96afue	50	51	34	Pass	Fail	Fail	Fail
2	Mixed/-HPA/+96afue	50	53	36	Pass	Fail	Fail	Fail
3	Mixed/-HPA/-HPW/+96afue	51	54	37	Pass	Fail	Fail	Fail
4	Mixed/-81Tankless/+63Storage/SuperInsulation	53	51	34	Fail	Pass	Pass	Fail

- Scenarios 1, 2, and 3 show how HSE by itself fails to protect envelope features
- Row 4 shows how TDV by itself fails to protect against poor gas appliances (decarbonization)
- HSE together with TDV will protect both decarbonization and resilient building envelope features

Questions?