California's 2020 Residential Solar Mandate; Could This Work In Your State?

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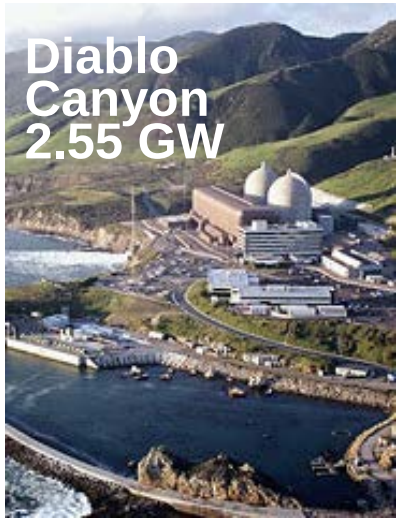
U.S. Solar Market Through Q1 2018

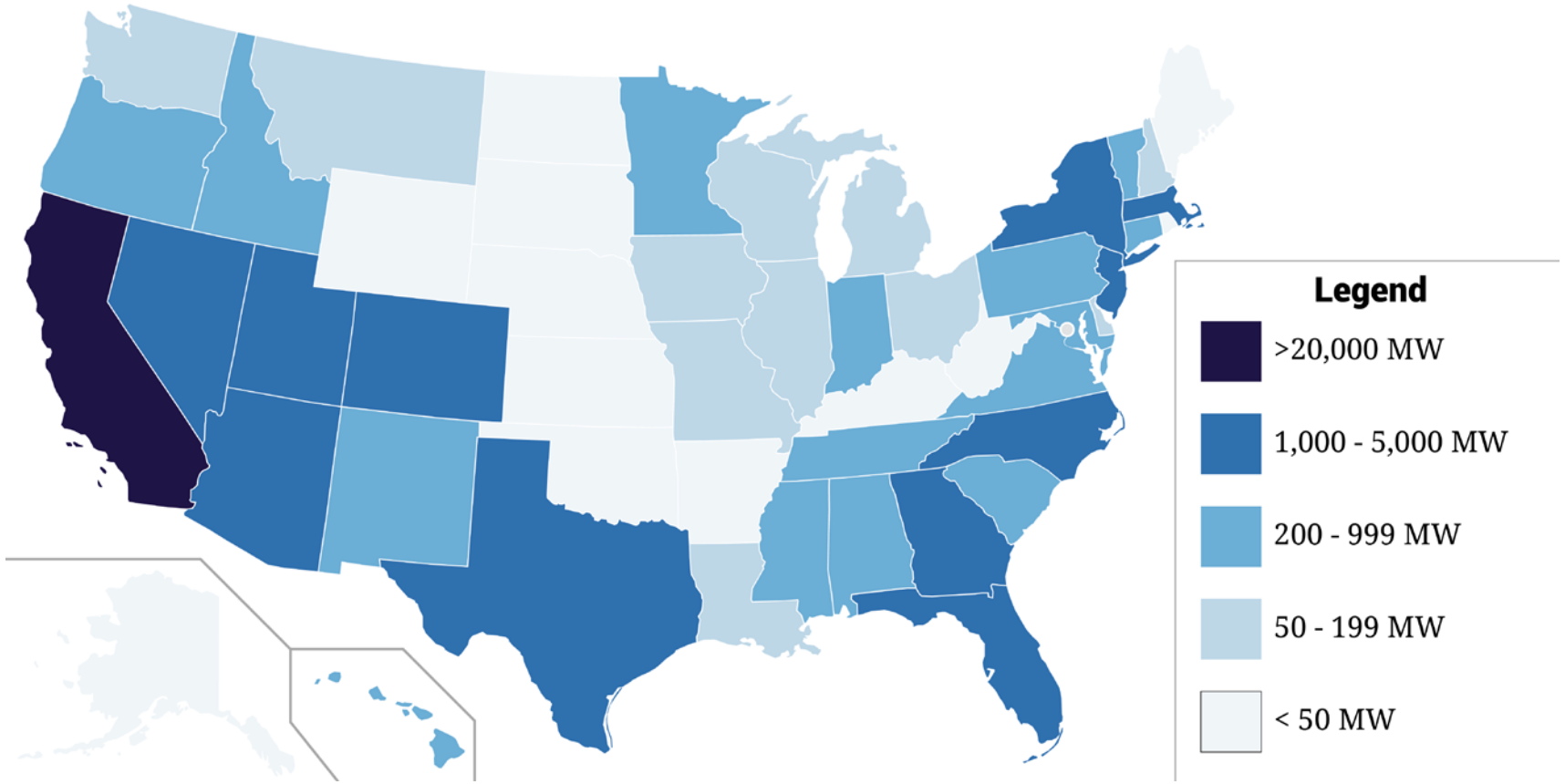
- **2.5 GW installed in Q1 2018**
  - Up 13% from Q1 2017 and down 37% from Q4 2017
  - Was the largest Q1 ever; benefitted from many utility-scale projects that slipped from late 2017 to early 2018 due to trade case uncertainty
- **Nearly 56 GW of total solar capacity now installed**
  - Average Annual Growth Rate of 59% over last 10 years
  - Generates enough electricity to power over 10.7 million homes
- **In Q1 2018, Solar accounted for 55% of all new electric capacity installed**
  - Solar has accounted for at least 30% of all new electric capacity for each of the last 3 years
  - Solar currently generates nearly 2% of all electricity nationally
- **While prices have dropped 52% over last 5 years, price declines slowed in 2017**
  - Total installed system price changes over last 12 months range from an increase of 1.9% in residential to a decrease of 1.6% in non-residential
  - System price increase primarily attributable to rising module costs caused by Section 201 case; other hardware and some soft costs have declined
  - Still, 27 states had reached grid parity for residential by end of 2017 (only 12 in 2014)
  - Utility-Scale PPAs now signed at $28 - $45 per MWh
- **There are now more than 1.7 million solar installations in the U.S.**
  - After reaching 1 million in 2016, 2 million should be hit in late 2018 and 4 million by 2023



Source: SEIA/GTM Research
U.S. Solar Market Insight

U.S. Solar Industry – a 50 State Market

Cumulative Solar Capacity by State through Q1 2018

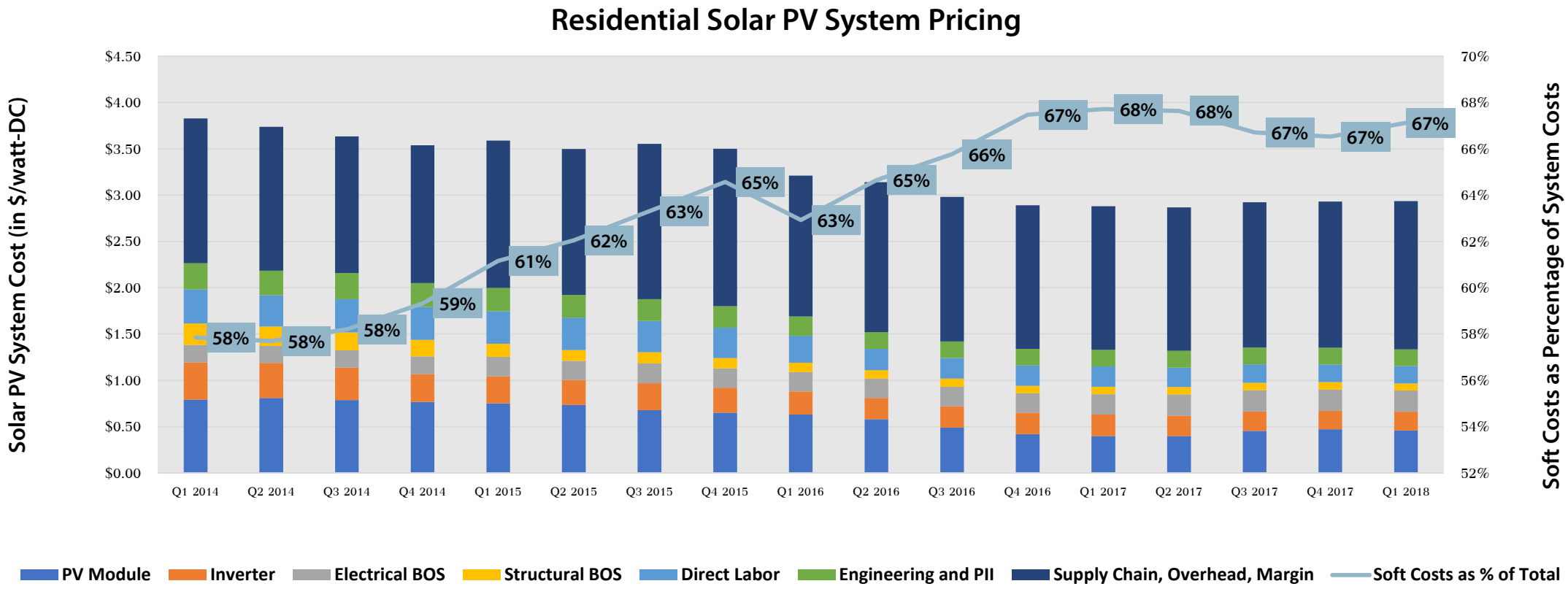


TOP 10 STATES (MW)

1. California – 22,071
2. North Carolina – 4,412
3. Arizona – 3,463
4. Nevada – 2,607
5. New Jersey – 2,447
6. Massachusetts – 2,138
7. Texas – 1,973
8. Florida – 1,893
9. Utah – 1,616
10. Georgia – 1,553

Source: SEIA/GTM Research
U.S. Solar Market Insight

Soft Costs – Major Opportunity for Residential Price Declines



Note: Further cost reduction is attainable with efficiencies inherent in PV installations in new construction – especially repetitive use of PV design & installation methods in residential subdivisions

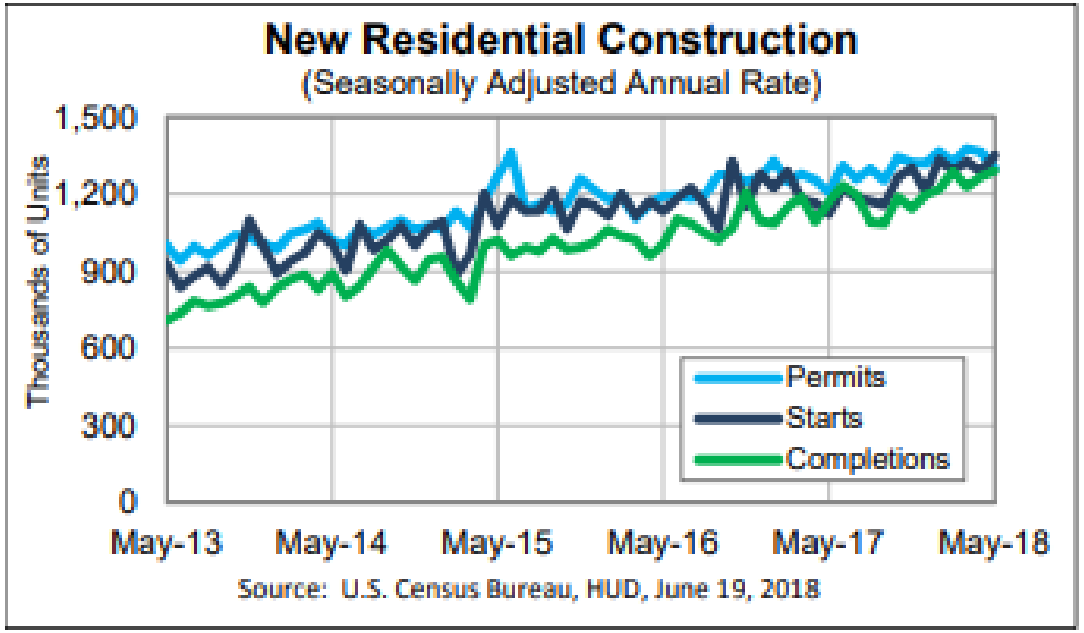
Source: SEIA/GTM Research
U.S. Solar Market Insight

New Home Completions in the United States

NEW RESIDENTIAL CONSTRUCTION MAY 2018

Building Permits:	**1,301,000**
Housing Starts:	**1,350,000**
Housing Completions:	**1,291,000**
Next Release:	**July 18, 2018**

Seasonally Adjusted Annual Rate
Source: U.S. Census Bureau, HUD, June 19, 2018



https://www.census.gov/construction/nrc/index.html

- Nationwide, over 1.3 million new residential units per year
- In California, 114,780 new privately owned housing units in 2017

CEC's 2019 Standards Goals and Path to the Future

- Increase building energy efficiency cost effectively
- Contribute to California's GHG reduction goals
- Substantially reduce the home's impact on the grid through efficiency and PV
- Promote grid harmonization and self-utilization of PV generation (through battery storage)
- Provide independent compliance paths for both mixed-fuel and all-electric homes
- Provide tools for Part 11 (CalGreen) Reach Codes and other beyond-code practices

Solar PV is Cost-Effective in All California Climate Zones

- In California (by the Warren-Alquist Act), all Standards measures, including efficiency or renewables, must be cost effective using life cycle costing (LCC)
- PV must comply with Net Energy Metering (NEM) sizing rules

PVs sized to displace annual kWhs are found to be cost effective in all 16 California Climate Zones

Minimum Sizing of PV Systems in Section 150.1(c)14

14. **Photovoltaic Requirements.** All low-rise residential buildings shall have a photovoltaic (PV) system meeting the minimum qualification requirements as specified in Joint Appendix JA11, with annual electrical output equal to or greater than the dwelling's annual electrical usage as determined by Equation 150.1-C:

EQUATION 150.1-C ANNUAL PHOTOVOLTAIC ELECTRICAL OUTPUT

$$kW_{PV} = (CFA \times A)/1000 + (NDwell \times B)$$

WHERE:

kW_{PV} = kWdc size of the PV system

CFA = Conditioned floor area

NDwell = Number of dwelling units

A = Adjustment factor from Table 150.1-C

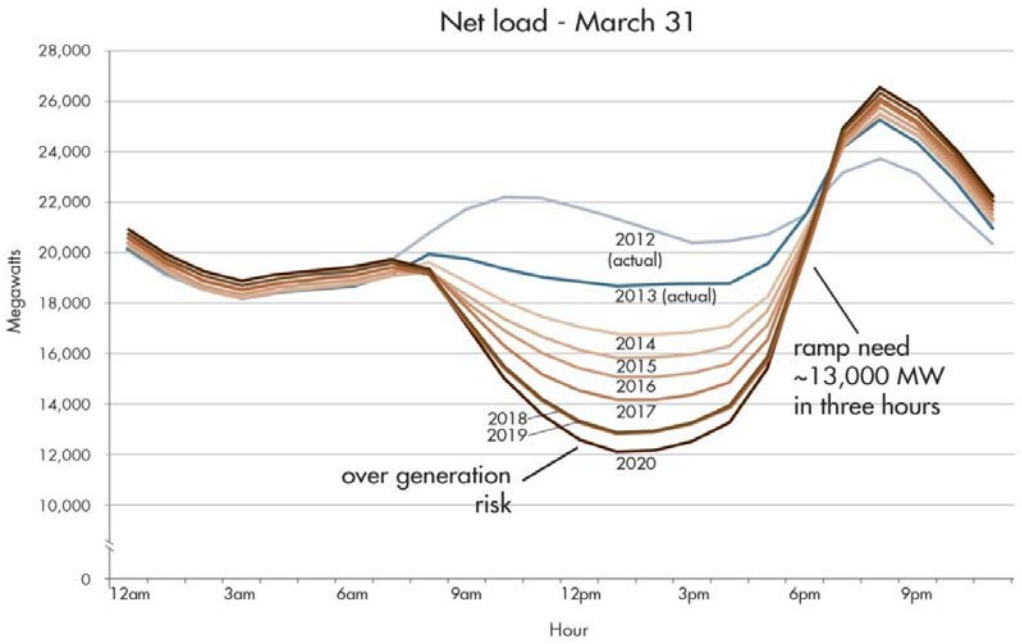
B = Dwelling adjustment factor from Table 150.1-C

Table 150.1-C – CFA and Dwelling adjustment Factors

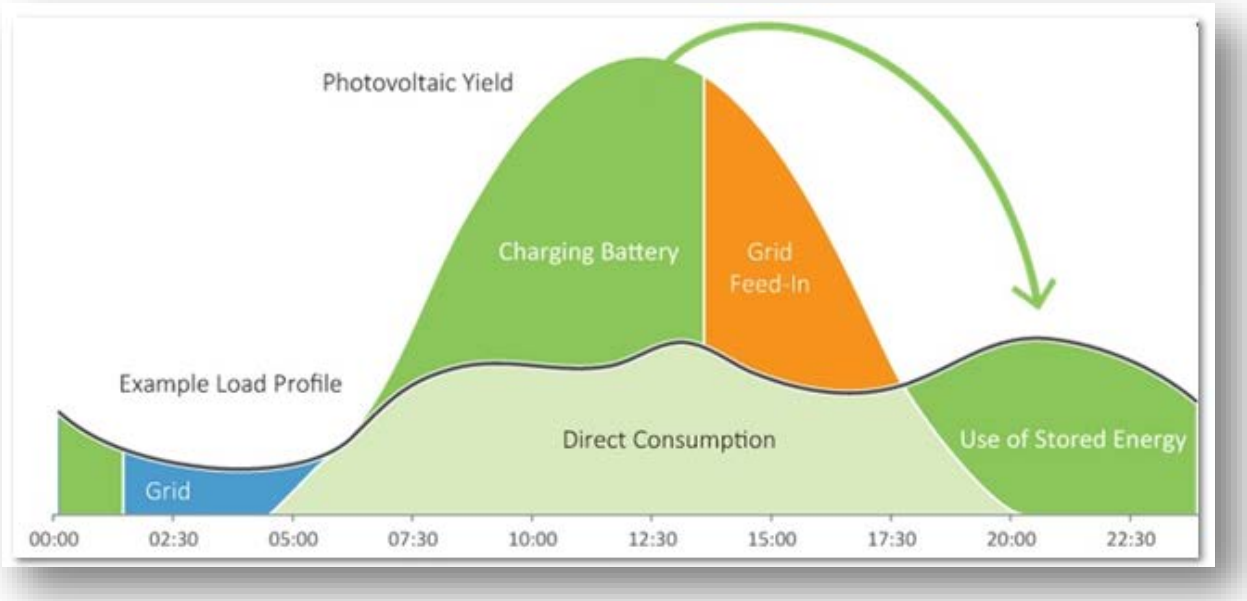
Climate Zone	A - CFA	B - Dwelling Units
1	0.793	1.27
2	0.621	1.22
3	0.628	1.12
4	0.586	1.21
5	0.585	1.06
6	0.594	1.23
7	0.572	1.15
8	0.586	1.37
9	0.613	1.36
10	0.627	1.41
11	0.836	1.44
12	0.613	1.40
13	0.894	1.51
14	0.741	1.26
15	1.56	1.47
16	0.59	1.22

Note: Maximum PV system size is regulated only by interconnection requirements

Obstacles to ZNE: Hunting the Duck (Curve)



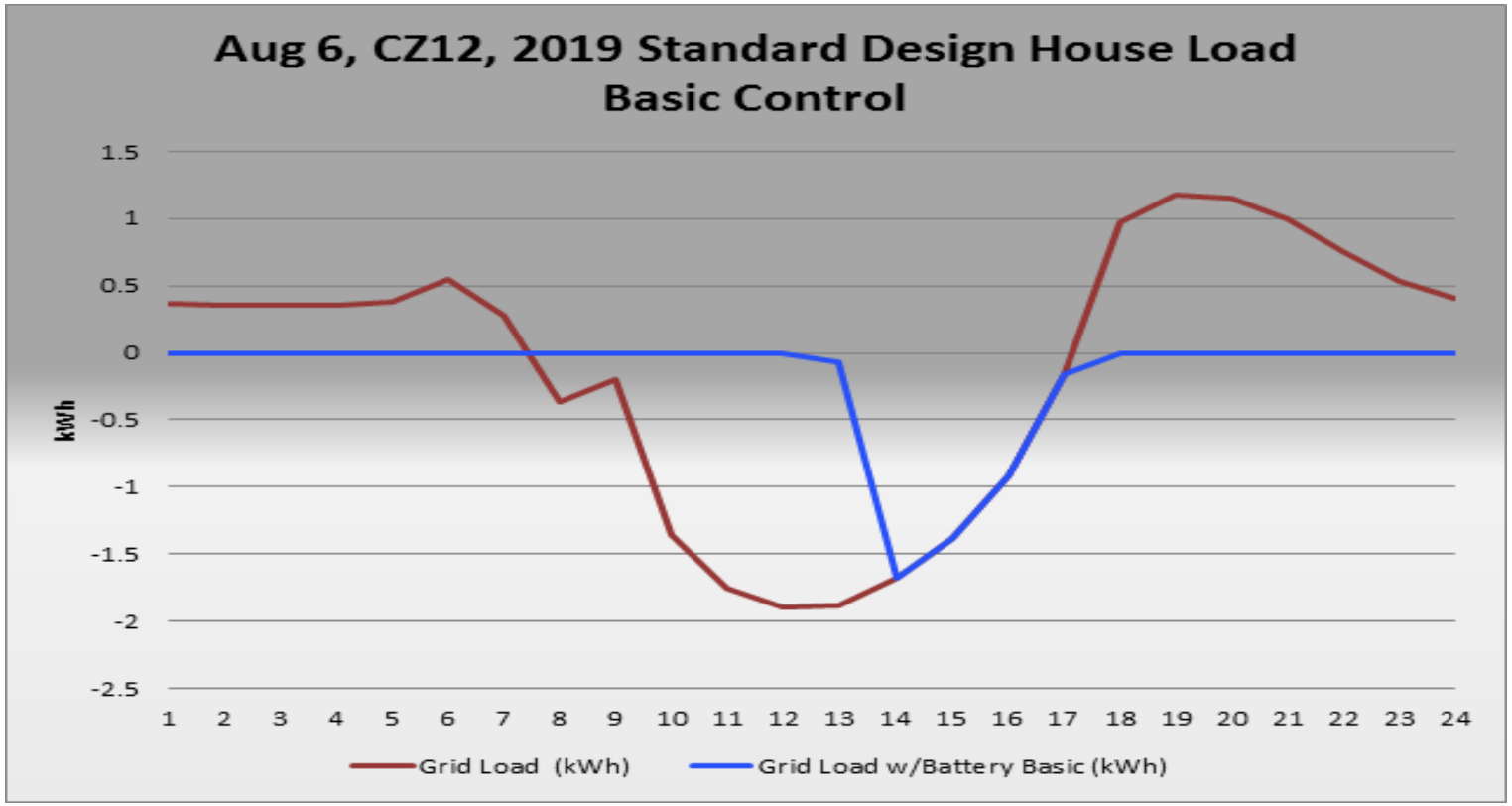
- The “Duck Curve” is quite often a point of discussion regarding grid impacts of high penetration of renewables
- Peak demand for electricity is out of phase with peak power production of solar
- Battery storage helps!



Fun fact: Hawaii named their curve “The Nessie Curve”

California ISO

Taking the “Net” Out Of Zero Net…



- Temporal netting assumes all hours of the day have the same emission and energy cost values, not a correct assumption - Blue line smooths out the belly of the duck and achieves zero carbon and zero energy without resorting to netting

- The Invisible House - PV Plus Basic Battery – A “Mild” Summer Day

Battery Storage Systems: A Very Attractive Option

- In the performance compliance approach, optional battery storage systems can be combined with mandatory PV to improve compliance results; CBIA supported this flexibility
- Qualification requirements found in Joint Appendix JA12

JA12.2.2 Minimum Performance Requirements

The installed battery storage system should meet or exceed the following performance specification:

(a) Usable capacity of at least 5 kWh.

(b) Single Charge-discharge cycle AC to AC (round-trip) efficiency of at least 80 percent.

(c) Energy capacity retention of 70 percent of nameplate capacity after 4,000 cycles covered by a warranty, or 70 percent of nameplate capacity under a 10-year warranty.

Community Shared Solar PV and Battery Storage Systems

- In cases where there is inadequate on-site space available for PV systems (or on-site space for optional battery systems), Section 10-115 provides criteria for on-site or off-site Community Shared Solar and Battery Storage Systems such that these systems "may be approved by the Commission"

(a) Community Shared Solar Electric Generation System or Battery Storage System Offset. A community shared solar system, other community shared renewable system, community shared battery storage system, or combination of the aforementioned systems (hereinafter referred to as a community shared solar or battery storage system) may be approved by the Commission as a compliance option to partially or totally meet the onsite solar electric generation system and/or battery storage system that is otherwise required by Section 150.1(b)~~2~~1 of Title 24, California Code of Regulations, Part 6. To be approved the community shared solar electric generation or community shared battery storage system shall meet the following requirements.

- The CEC recognizes that in order to move toward ZNE/Zero Carbon goals for commercial occupancies in future development cycles, off-site renewable energy must be considered

Examples of EDR Scores & PV Size for 2700 sf Prototype

PV Sizes for Mixed Fuel Homes. 2700 SF Prototype

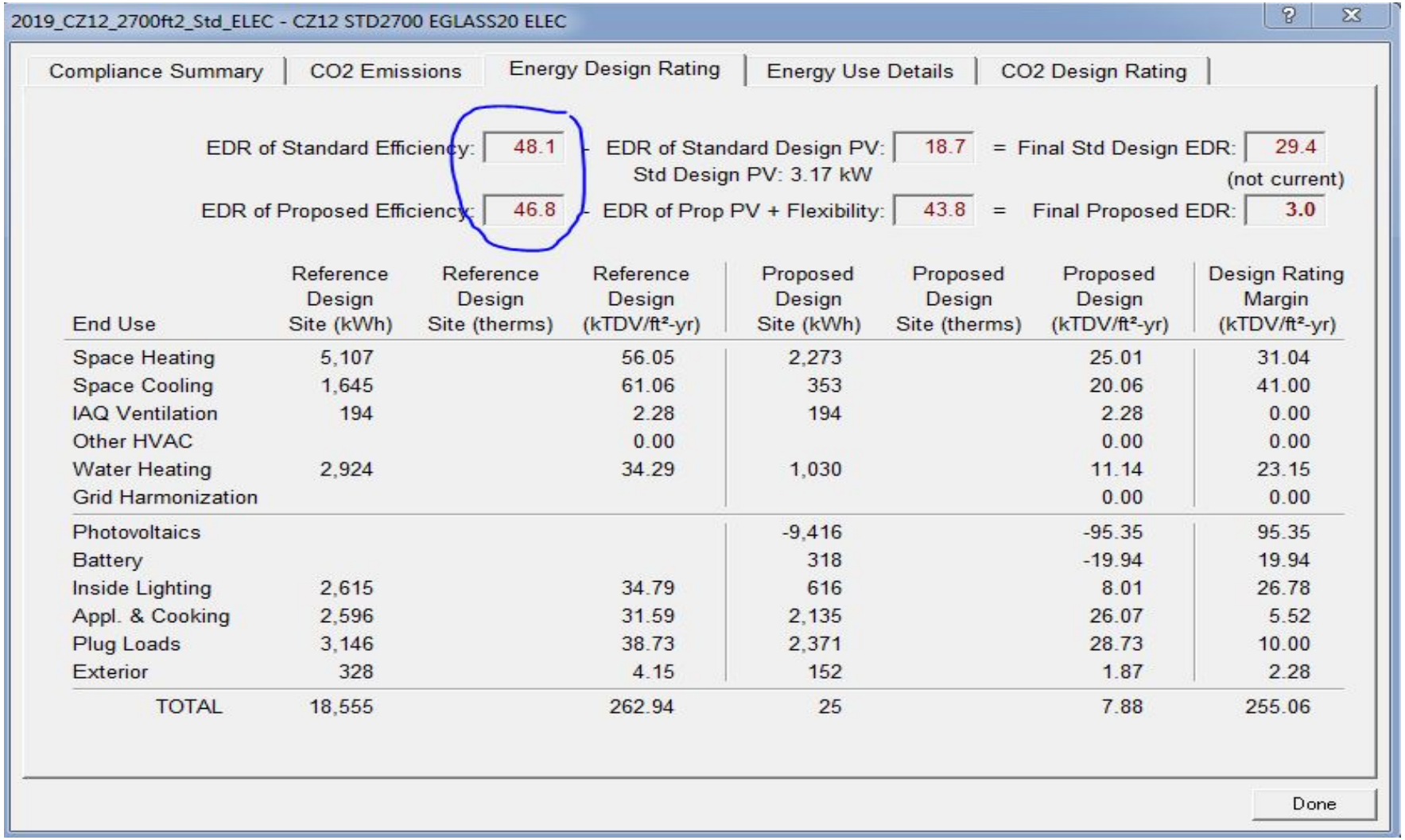
1	2	3	4
CZ	Efficiency EDR without PV, based on 2019 Efficiency Measures	Target Design Rating Score for Displacing kWh Elect with PV	kW PV Size for Displacing kWh Electric Only
1	48.0	26.5	3.4
2	41.2	18.0	2.9
3	46.9	22.7	2.8
6	48.0	20.9	2.9
7	48.0	14.9	2.7
8	43.0	14.6	2.9
11	43.3	23.4	3.8
12	43.1	24.5	3.1
13	44.8	22.1	4.0
14	44.6	21.3	3.4
15	48.0	17.9	5.7
16	46.3	27.5	3.0

These PV sizes are for the 2700 square feet prototype

PV size will vary based on square footage

Statewide average PV size is 2.8 kW

Target EDR and CBECC-Res Compliance Tool



End Use	Reference Design Site (kWh)	Reference Design Site (therms)	Reference Design (kTDV/ft²-yr)	Proposed Design Site (kWh)	Proposed Design Site (therms)	Proposed Design (kTDV/ft²-yr)	Design Rating Margin (kTDV/ft²-yr)
Space Heating	5,107		56.05	2,273		25.01	31.04
Space Cooling	1,645		61.06	353		20.06	41.00
IAQ Ventilation	194		2.28	194		2.28	0.00
Other HVAC			0.00			0.00	0.00
Water Heating	2,924		34.29	1,030		11.14	23.15
Grid Harmonization						0.00	0.00
Photovoltaics				-9,416		-95.35	95.35
Battery				318		-19.94	19.94
Inside Lighting	2,615		34.79	616		8.01	26.78
Appl. & Cooking	2,596		31.59	2,135		26.07	5.52
Plug Loads	3,146		38.73	2,371		28.73	10.00
Exterior	328		4.15	152		1.87	2.28
TOTAL	18,555		262.94	25		7.88	255.06

Example of how CBECC-Res calculates the Target EDR for both EE and PV in CZ12 for the 2,700 sf house

Note unregulated loads (appliance, lighting, plug loads) are much larger than regulated loads (space htg & clg, DHW)

CO_2 Reduction in Buildings: EE + PV + ESS!

2019 Standard Buildings That Are Electrified and Grid Harmonized (with Battery Storage) Have Lowest CO2 Emission Levels

2700 sf prototype, CZ12					
CO2 Impact of Housing Choices		Total CO2 Potential, Without PV	Metric Tons of CO2 Generated/Year - Including Exports	Metric Tons of CO2 Generated/Year - Excluding Exports	CUI Kg of $CO2/m^2$-yr
Mixed Fuel	2000 Compliant Building, No PV	6.5	6.5	6.5	25.91
Mixed Fuel	2016 Compliant Building, No PV	3.26	3.26	3.26	13.00
Mixed Fuel	2019 Standard Design, with 3.1 kW PV	3.05	2.29	2.76	9.13
Mixed Fuel	2019 Standard Design, with 3.1 kW PV & Batt	3.05	2.12	2.24	8.45
All-Elect	2019, 3.1 kW PV, No Batt	1.86	1.12	1.48	4.47
All-Elect	2019, 3.1 kW PV, With Batt	1.86	0.98	0.99	3.91
All-Elect	2019, 6 kW PV, With Batt	1.86	0.18	0.69	0.72

A Burning Question: Solar Providers in Deep Rural Areas?

A marijuana company that bought a California ghost town with plans to turn it into a pot-tourism destination has run out of money

- Will it be roofing companies that meet demand?
- Will roofers want to add electrical/solar contractor's licenses to their businesses?

CalGreen Code Tier 1 – Reduced EDR Target Scores

CalGreen (Part 11) Appendix A4
Residential Voluntary Measures

•Performance approach, no longer percent better than Part 6

•A4.203.1.3.1 Tier 1

•Modeled using:

- PV oversizing factors of 1.0 for mixed fuel and 1.1 for all-electric
- TOU battery controls

CZ	Mixed Fuel	All-Electric
1	23	36
2	12	16
3	10	14
4	8	12
5	10	16
6	10	12
7	5	7
8	10	10
9	13	13
10	10	11
11	11	12
12	12	13
13	11	13
14	15	16
15	11	8
16	22	39

CalGreen Code Tier 2 – Reduced EDR Target Scores

CalGreen (Part 11) Appendix A4
Residential Voluntary Measures

- **A4.203.1.3.2 Tier 2**

- Modeled using:
  - PV oversizing factors up to 1.4 for mixed fuel
  - PV sized to offset annual kWh for all-electric
  - TOU battery controls

CZ	Mixed Fuel	All-Electric
1	13	0
2	5	0
3	0	0
4	0	0
5	0	0
6	0	0
7	0	0
8	0	0
9	0	0
10	0	0
11	0	0
12	0	0
13	0	0
14	5	0
15	0	7
16	14	10

Model Solar Ordinance Language for Early Adopters

Resources for Local Jurisdictions

The following model ordinance is designed for local jurisdictions considering solar PV ordinances to reach beyond the mandatory requirements of the current 2016 Standards. It is complimented by a study showing cost effectiveness for various levels of load displacement depending on climate zone. The proposed ordinance language and supporting study are provided as a resource to local jurisdictions wishing to pursue a solar ordinance that satisfies Title 24, Part 1, Section 10-106 and is consistent with the statewide standards for solar photovoltaics currently being developed by the Building Standards Office.

Draft Model Local Solar Ordinance v5

Model Solar Ordinance Cost Effectiveness Study

http://energy.ca.gov/title24/2016standards/ordinances/

- Cities with solar ordinances include: Brisbane, Davis, Fremont, Lancaster, Palo Alto, San Francisco, San Mateo, Santa Monica
- County of Alameda has an application pending with the CEC

Poll By Morning Consult

Public Supports Solar Mandates in States

Majority of adults in poll also say they would consider installing solar

Morning Consult – A majority of American adults would consider installing solar on their homes, citing the opportunity to save money as the number one reason and the benefits to the environment also providing strong motivation, according to a June 14-18 Morning Consult poll.

Fully 58 percent of Americans would consider putting solar panels on their homes, while only 22 percent said they would not. 63 percent of respondents would be in favor of their state requiring solar installations on new homes, as was recently passed in California.

https://morningconsult.com/wp-content/uploads/2018/06/Solar-Crosstabs-2.pdf

Moving Forward Together – A Clean Energy Economy

- Stakeholders should acknowledge we have done a good job of reducing regulated loads, such that they are now a smaller percentage of overall energy use. Congratulations!
- To move forward together toward a clean energy economy – and reduced carbon footprint – we should agree on EE *plus* RE (not EE versus RE) to reduce/offset total load (regulated plus unregulated)
- Builders should have flexibility to choose the most cost-effective means of compliance, and should get credit for what they do
- Future codes should prioritize attractive options for builders to install:
  - PV Systems (and Solar Thermal DHW, especially for multi-family/high density)
  - Battery Storage systems
  - EV chargers
- 2021 IECC: Appendix chapter for Residential Solar Mandate?
  - Appendix chapter for Residential Solar Mandatory provisions?
  - Appendix chapter for Path to Zero Net Energy (or “near zero”)?

Thank you for attending!
Questions?

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