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Updating Historical Behind-the-Meter PV Information

CEDU 2020

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California Energy Commission
August 26, 2020

Overview

- **What's different**
  - Historical PV capacity and capacity factors
    - Revisions to historical PV installation data
    - Revisions to PV capacity factors
    - Both changes to be discussed in later slides
  - Updates to electricity rates and fuel price forecasts, PV costs, building stock forecasts…

- **What's the same**
  - Methodology for forecasting PV adoption
    - No major methodological changes for forecasting PV adoption for the 2020 California Energy Demand Forecast Update (CEDU20)
    - NOTE: New capacity factors will affect forecasted PV generation

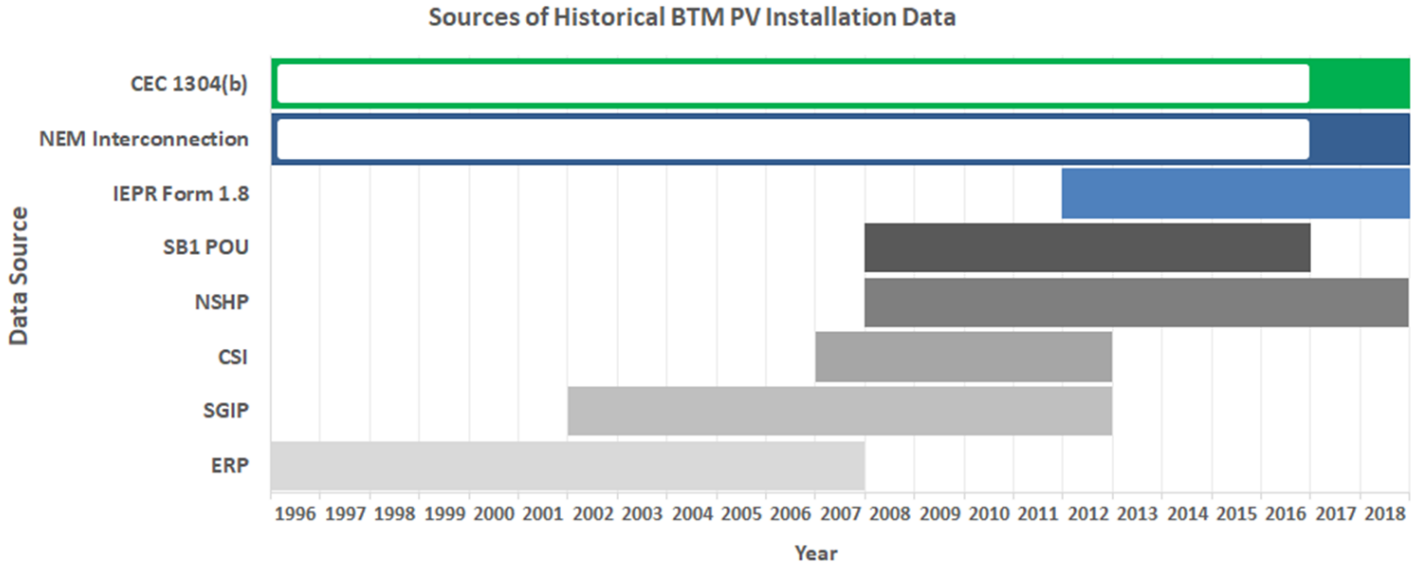
Compiling Historical DG Data

- The first step of forecasting involves processing historical data on BTM DG systems.
- The goal is to have a final dataset which maps every DG system in California with the following information:
  - Technology type
  - System Size (kW_{AC})
  - Installed cost and rebate data if available
  - Sector and subsector (when available)
  - Electric Utility
  - Utility planning area and forecast zone*
  - County
  - Date installed

*The Energy Commission's Demand Analysis Office divides the state into 20 demand forecast zones.

Historical BTM PV Installation Data

- We used a combination of interconnection and incentive program datasets in the past.



Slide from 2019 DAWG Meeting

- CEDU20: Transitioned to using Interconnection data provided by utilities
  - Collected through the CEC's data collection rulemaking
    - California Code of Regulations, Title 20, Division 2, Chapter 3, Section 1304(b)
  - Collected data is kept confidential
    - Similar data is available publically
      - PG&E, SCE, & SDG&E: NEM Currently Interconnected data from California DG Stats website
      - POUs and small IOUs: "Net Metering dataset" from Form EIA-861 on the U.S. EIA website

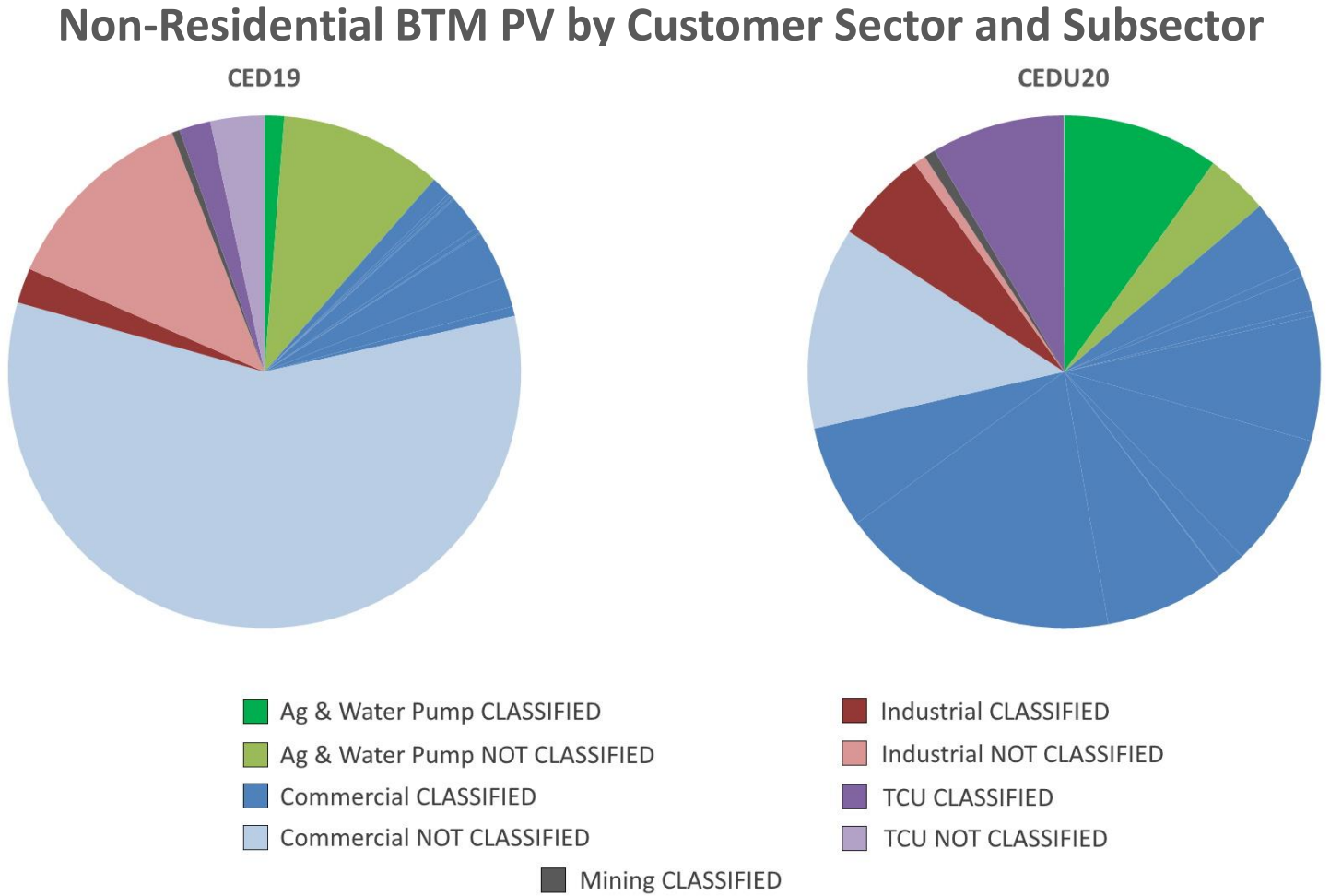
CEC's Interconnection Data

- Advantages
  - Staff can verify accuracy of some (but not all) information
  - Classify PV systems so they align with CEC customer sectors and subsectors
    - Previously relied on utilities (and others) for sector classification of PV systems
      - Which do not necessarily align with the CEC customer sectors
      - Did not provide subsector information sometimes needed by the Energy Commissions' sector modelers
  - Overall the historical PV data is more accurate than before

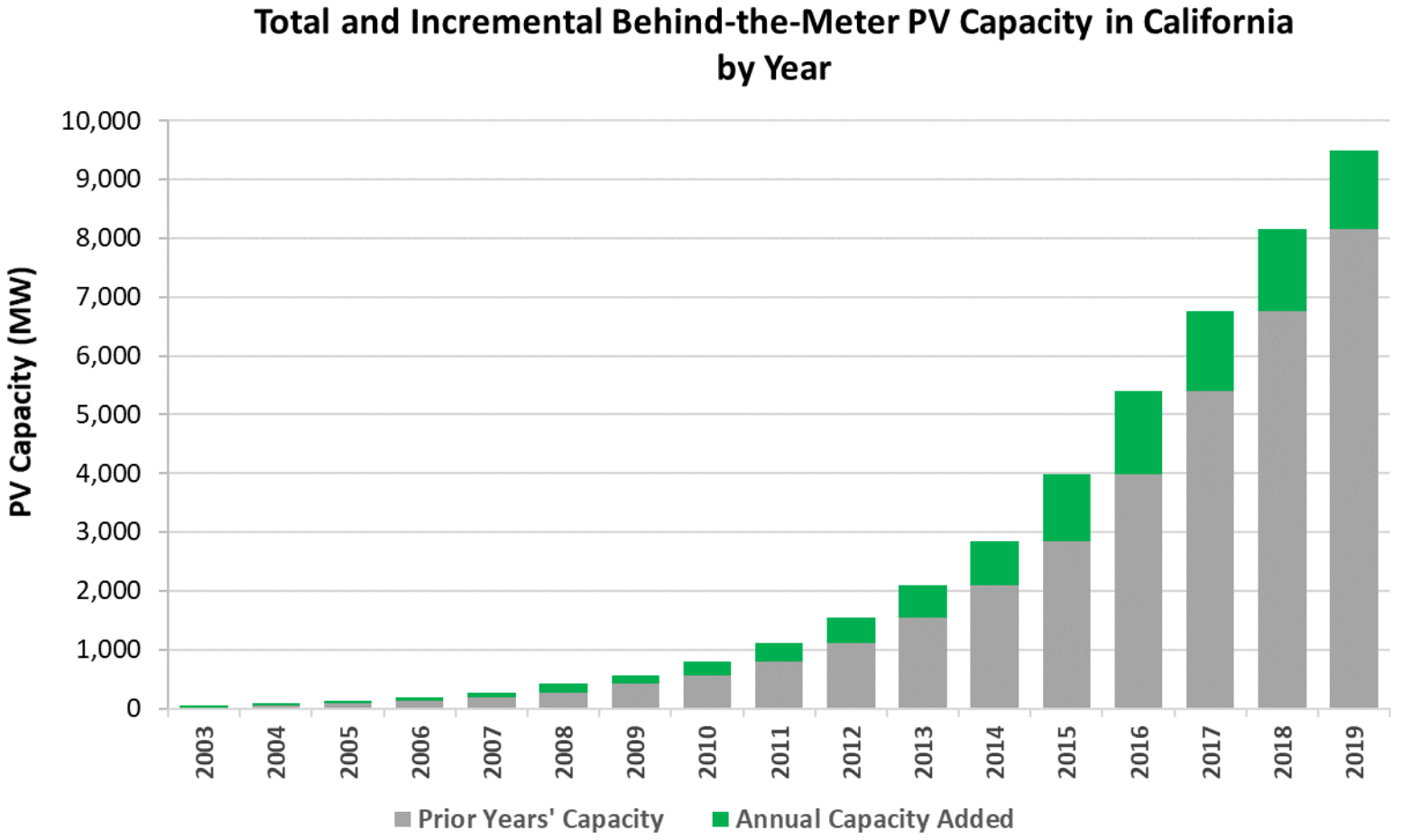
- Disadvantages
  - Requires staff to verify, clean, and curate interconnection data
    - California DG Stats team performs hundreds of data integrity checks on NEM Interconnection data
  - Classifying systems by sector and subsector takes significant amounts of time and effort
    - Unclear if this work can be done during full IEPR year vs. IEPR update
  - Does not provide system orientation, installed cost, or incentive data
    - Staff will continue to rely on NEM Interconnection and other Incentive datasets for this information
  - Some discontinuity from previous forecast → revisions to historical data

Improved PV System Classification

- For CEDU20, the sector of many PV installations were reclassified.
- Significant increase in number of systems assigned to subsectors.

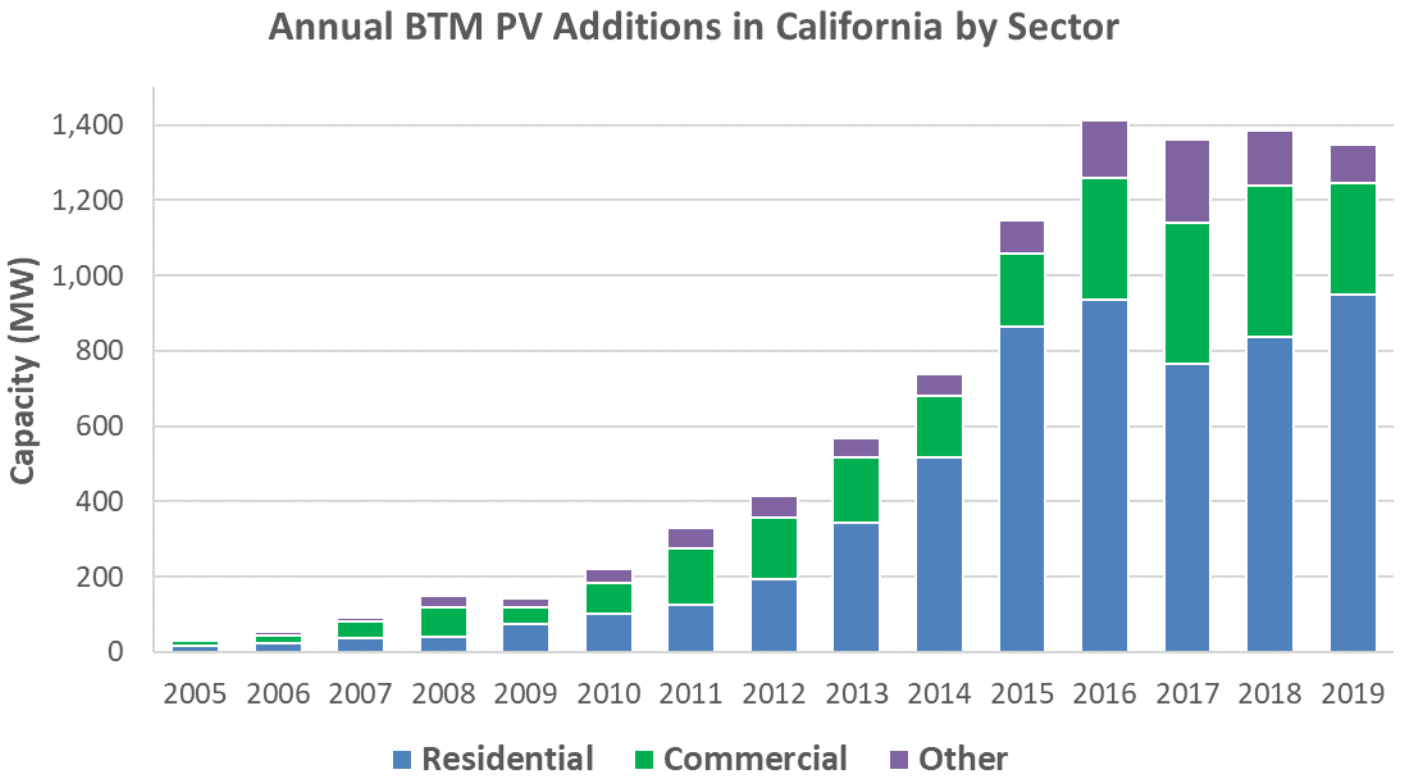


BTM PV Capacity Additions



- Statewide BTM PV Capacity at the end of 2019: > 9,400 MW

PV Capacity Additions by Sector



- Maturing PV market: about 1,300-1,400 MW installed annually 2016-19

PV Installation Data by Utility

PV Interconnection Data

Utility	Through…	Capacity (MW)
PG&E	Dec 2019	4,395
SCE	Dec 2019	2,891
SDG&E	Dec 2019	1,249
LADWP	Dec 2019	309
SMUD	Dec 2019	186
Imperial Irrigation District	Dec 2019	84.2
Modesto Irrigation District	Dec 2019	50.7
Turlock Irrigation District	Dec 2019	39.8
Riverside, City of	Dec 2019	35.0
Anaheim, City of	Dec 2019	33.2
Roseville Electric	Dec 2019	23.2
Glendale Water and Power	Dec 2019	22.0
Silicon Valley Power	Dec 2019	19.5
Redding, City of	Dec 2019	13.0
Palo Alto, City of	Dec 2019	12.8
Pasadena Water and Power	Dec 2019	11.7
Moreno Valley Electrical Utility	Dec 2019	10.0
Burbank Water and Power	Dec 2019	8.4
Lodi, City of	Dec 2019	7.7
Merced Irrigation District	Dec 2019	7.6
Colton, City of	Dec 2019	5.5
Bear Valley Electric	Dec 2019	3.6
Utilities (all other)	Dec 2019	31.4

95.5 %

99.5 %

Incorporating PV System Orientation and Updating PV Capacity Factors

Incorporating System Orientation

- Prior to CEDU 20:
  - Assumed all PV systems were oriented south and tilted.
  - Staff then selected the capacity factor for a tilted, south facing system.

- For CEDU 20:
  - Calculated capacity factors based on system orientation.
  - Capacity factors are “weighted” using orientation.
  - Let me explain on next few slides…

PV System Orientation Data

- IOU PV capacity and system orientation is publicly available through NEM Interconnection data:
  - www.californiadgstats.ca.gov/downloads/
  - IOUs started collecting orientation data in 2015 for majority of PV systems
  - Similar data not available for POUs
    - Staff assumed POU data similar to IOUs in nearby regions.

- For CEDU20, CEC incorporated PV system orientation data in its historical PV Generation estimates.

Share of PV Systems with Orientation Data

Year	PGE	SCE	SDGE
2000	0.0%	0.0%	0.0%
2001	0.0%	0.0%	0.0%
2002	0.0%	0.8%	0.0%
2003	1.4%	0.5%	0.0%
2004	0.2%	0.2%	0.0%
2005	0.6%	0.8%	0.0%
2006	0.3%	0.3%	0.0%
2007	0.6%	59.4%	0.0%
2008	0.0%	81.8%	0.0%
2009	0.0%	66.7%	0.0%
2010	0.9%	67.6%	3.0%
2011	0.5%	59.5%	2.5%
2012	0.0%	58.8%	0.0%
2013	0.2%	56.9%	0.0%
2014	49.7%	31.1%	0.0%
2015	76.3%	55.7%	71.0%
2016	92.8%	95.9%	99.9%
2017	96.8%	100.0%	99.9%
2018	99.8%	100.0%	100.0%
2019	99.8%	100.0%	100.0%
2020	100.0%	100.0%	100.0%
Total	70.3%	80.2%	70.1%

Source: Analysis of NEM Interconnection Applications Data, April 30, 2020.

Review of PV Orientation Data

Share of BTM PV Capacity by Orientation for California IOUs

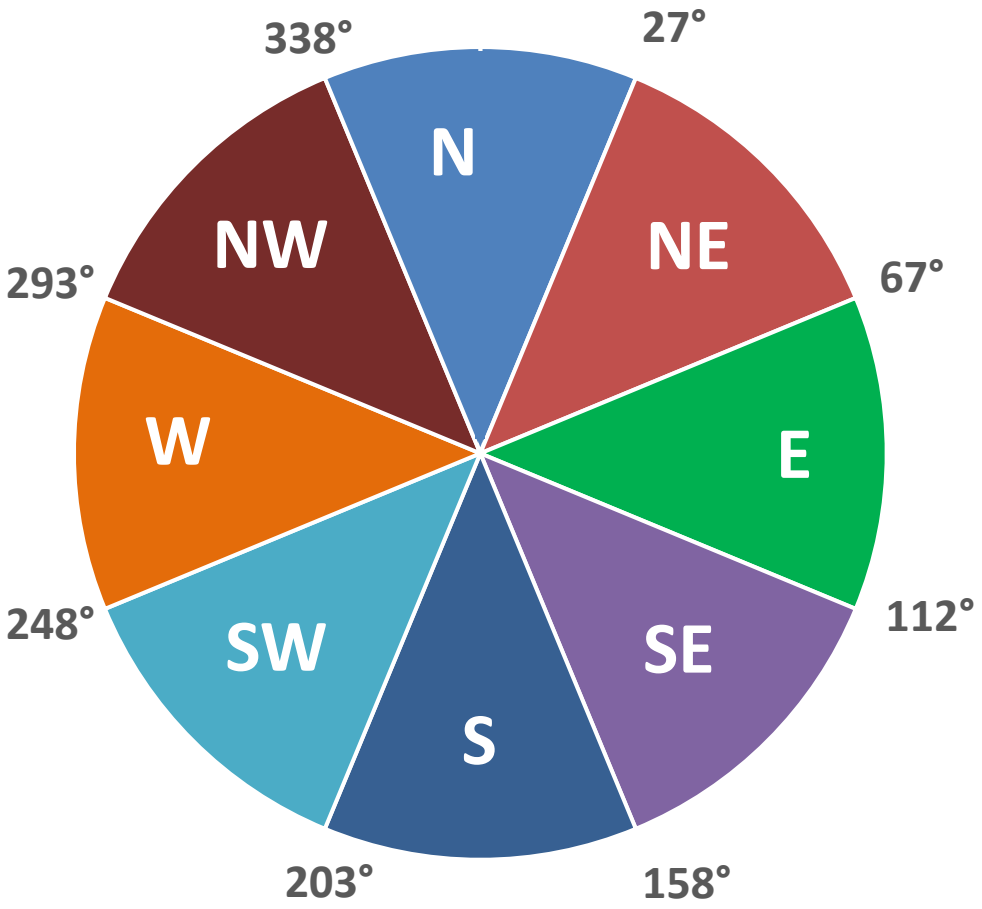
Year	TILTED						FLAT	OTHER	Orientation Data (kW)	
	E	N/NE/NW	S	SE	SW	W			Yes	No
2007	0.4%	1.3%	68.4%	0.9%	9.4%	1.7%	6.2%	3.7%	12,487	71,346
2008	0.2%	0.9%	60.9%	3.4%	5.2%	2.0%	4.9%	21.0%	28,786	101,766
2009	0.6%	0.4%	55.5%	4.2%	12.1%	6.1%	5.0%	13.7%	22,363	96,807
2010	1.0%	0.4%	56.4%	6.3%	9.9%	7.4%	5.3%	12.9%	37,033	146,251
2011	1.1%	0.1%	47.9%	6.1%	10.5%	6.0%	15.5%	12.4%	57,811	224,995
2012	2.3%	0.2%	39.8%	7.7%	9.9%	8.3%	14.6%	17.0%	75,601	265,061
2013	3.4%	0.3%	44.8%	8.7%	11.5%	9.3%	10.1%	11.1%	102,999	392,083
2014	0.7%	0.1%	15.4%	2.2%	3.0%	2.2%	74.4%	1.8%	231,042	420,481
2015	6.8%	3.3%	32.0%	8.1%	8.7%	11.4%	28.8%	0.4%	706,724	328,709
2016	8.0%	5.2%	42.2%	8.9%	10.3%	13.1%	6.7%	4.8%	1,195,237	64,009
2017	6.9%	4.4%	47.0%	7.6%	9.3%	12.9%	7.3%	4.5%	1,123,038	19,459
2018	6.1%	3.1%	45.0%	8.7%	10.6%	12.9%	8.9%	4.3%	1,165,496	1,008
2019	6.7%	3.2%	46.1%	8.6%	11.0%	13.6%	8.1%	2.5%	1,164,444	1,001
2020	5.8%	3.7%	47.4%	8.3%	10.5%	13.5%	7.9%	2.3%	381,780	0
Total	**6.3%**	**3.6%**	**42.8%**	**8.1%**	**9.9%**	**12.2%**	**12.7%**	**4.0%**	**6,305,333**	**2,264,754**

Source: CEC Staff analysis of CPUC NEM Interconnection Data, through April 30, 2020

- NOTE: Tilt vs. Flat and directions (such as E, W, N, S) are defined by CEC staff.
- For example, if Tilt >= 7°, then “Tilted”, otherwise “Flat”.

Classifying PV Systems by Orientation

PV System Azimuth (Φ) Classification by Direction



True North = 0°
True South = 180°

Source: California Energy Commission

Calculating New Capacity Factors

- For a given region (forecast zone), we know the following:
  - Tilt and azimuth (or orientation) from the NEM Interconnection data
  - Capacity factors by tilt and direction

- Example: Annual capacity factor by zone, tilt, and azimuth

Zone	Tilted						FLAT
	NE	E	SE	S	SW	W	
X	0.190	0.195	0.200	0.210	0.200	0.195	0.200
Y	0.180	0.185	0.195	0.200	0.195	0.190	0.190
Z	0.175	0.180	0.185	0.190	0.185	0.180	0.185

  - Calculate an "orientation-weighted" average capacity factor for each zone
  - $CF_z = (CF_{E,z})(\%\ PV_{E,z}) + (CF_{W,z})(\%\ PV_{W,z}) + \cdots + (CF_{Flat,z})(\%\ PV_{Flat,z})$

Weighted average capacity factor for zone

Capacity factor – west facing

% of PV Capacity – west facing

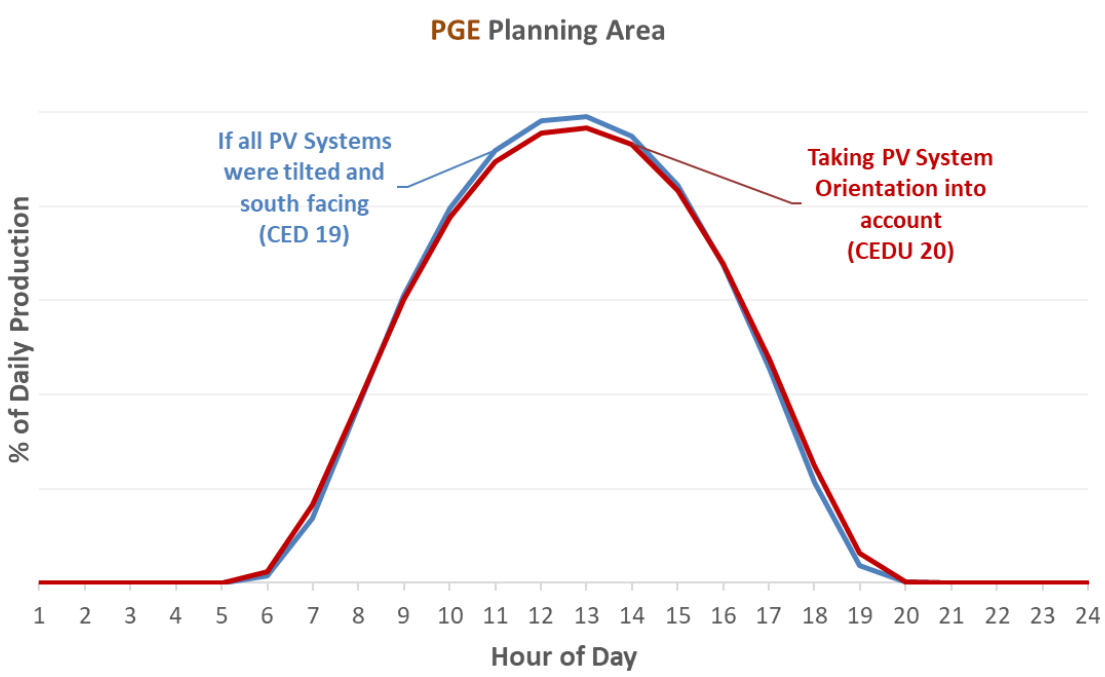
Results

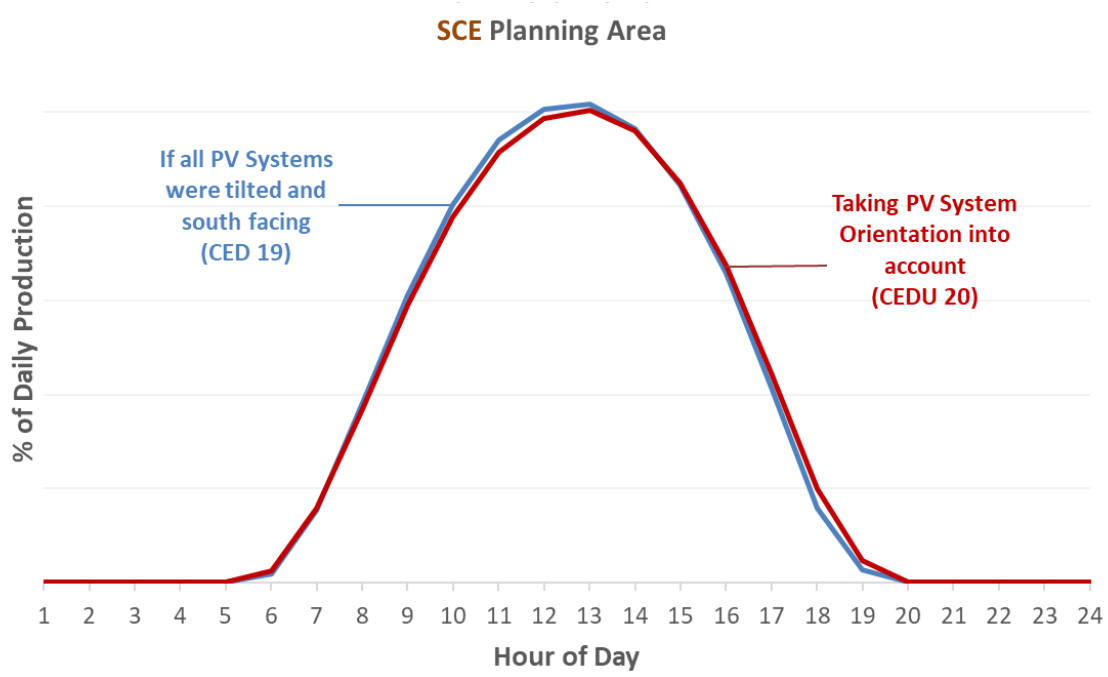
- Orientation-weighted average (annual) capacity factors are about 2-3% less that capacity factor (CF) if all PV systems were tilted and south facing.
  - So if tilted south facing CF was 0.200, weight average CF would be ~0.195 (0.200)(1-0.025) = 0.195
  - NOTE: 2.5% reduction of CF ≠ CF is 0.175. 0.175 CF would be 12.5% reduction (0.175 / 0.200).

- Factoring in panel orientation also affects hourly PV production estimates

Comparing Hourly PV Production

Hourly PV Production for a Day in Early July
CED 2019 vs. CEDU 2020





- Effects of incorporating system orientation on estimated hourly PV production
  - Slightly less production during mid day
  - Slightly higher production during morning and evening hours