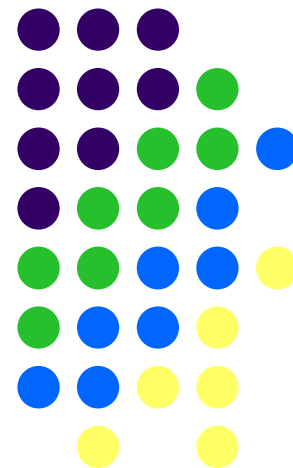


Market Transformation: Will Renewable Hydrogen Be Next?

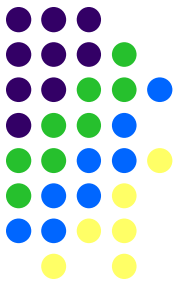
VIRTUAL ICEPAG 2020
16 September 2020
University of California - Irvine

Lori Smith Schell, Ph.D., ERP
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(970) 247-8181
LSchell@EmpoweredEnergy.com

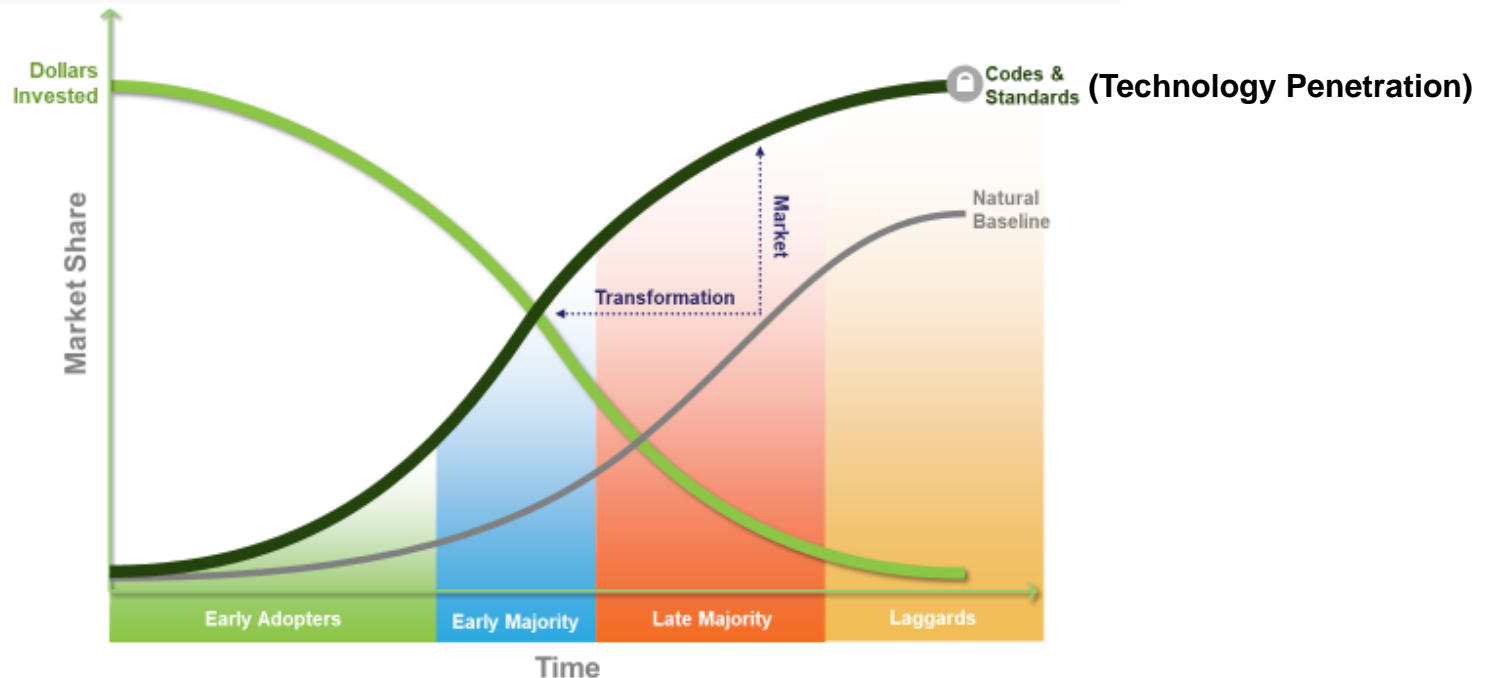


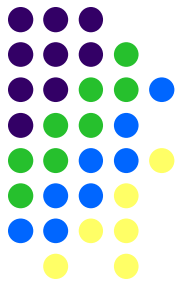
Market Transformation: An Abbreviated Definition



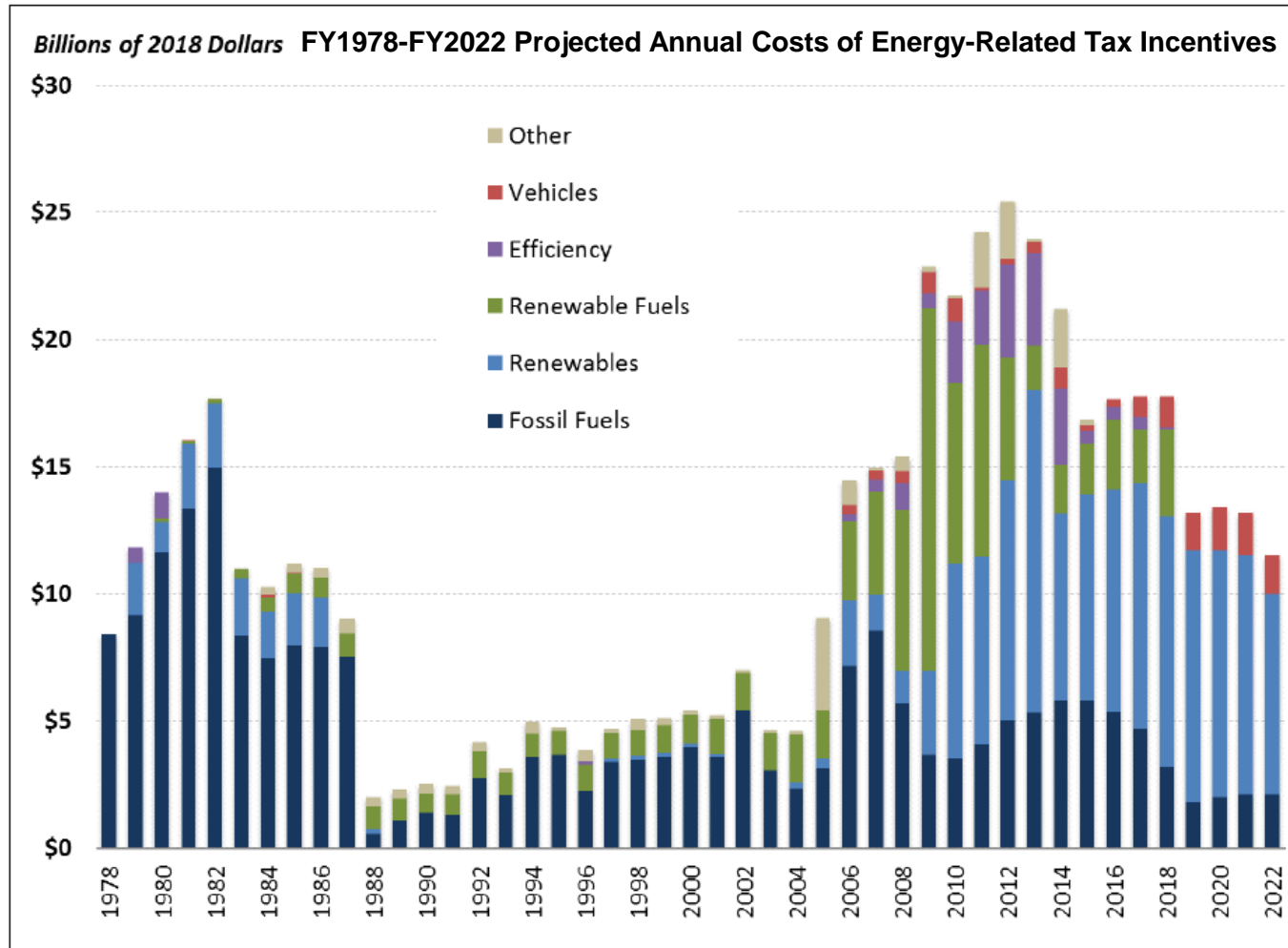
- “The strategic process of intervening in a market to create lasting change.”

Market Adoption Curve





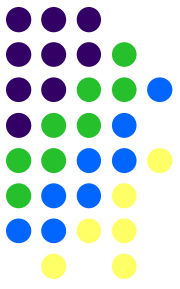
U.S. Energy Tax Incentives Reflect Policy Objectives



Source: CRS, using data from the Joint Committee on Taxation and Office of Management and Budget.

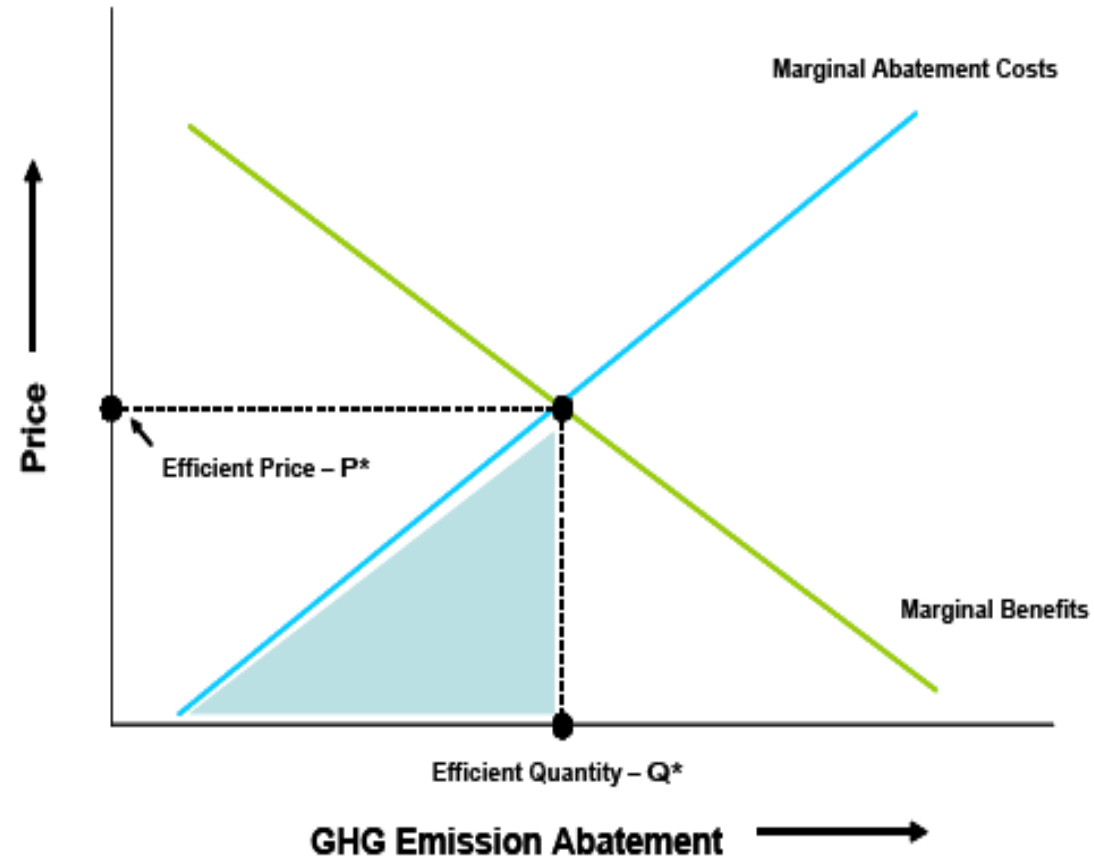
Source: Congressional Research Service, March 19, 2019, *The Value of Energy Tax Incentives for Different Types of Energy Resources*, R44852, p. 10. <https://crsreports.congress.gov/search/#/1?termsToSearch=energy%20subsidies&orderBy=Date>

Tax Incentives Less Efficient Than a Price on Carbon, but...



- Carbon Tax vs. Cap & Trade
- Efficient Carbon Tax:
Price at which
Cap & Trade
Marginal
Abatement Cost
= Cap & Trade
Marginal Benefit

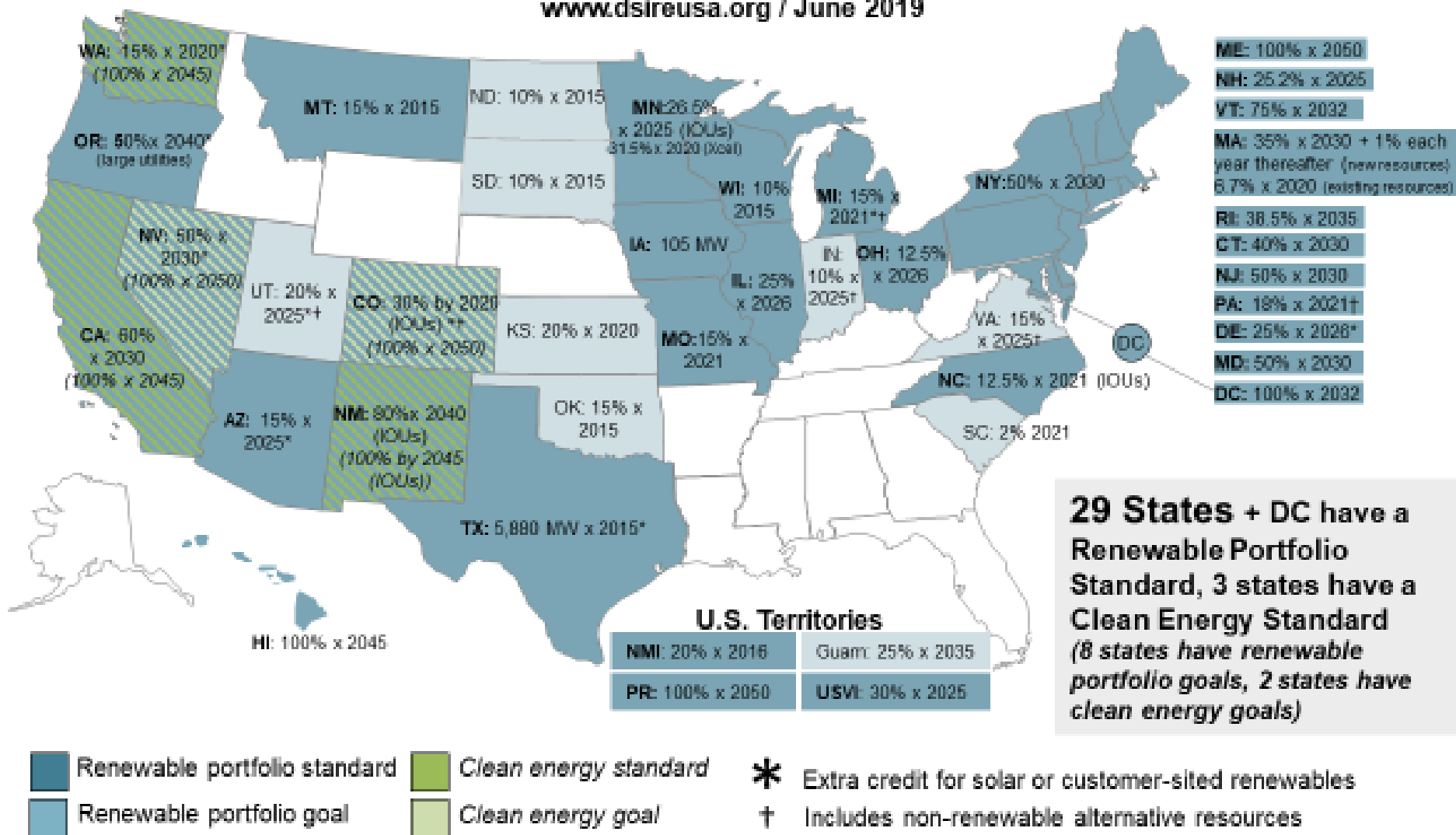
Figure 1. Illustration of Price Versus Quantity



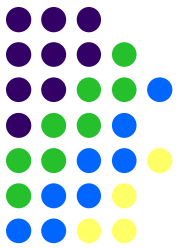
Source: Congressional Research Service, February 3, 2009, *Carbon Tax and Greenhouse Gas Control: Options and Considerations for Congress*, p. 4.
<https://www.hsdl.org/?abstract&did=736087>

Renewable & Clean Energy Standards

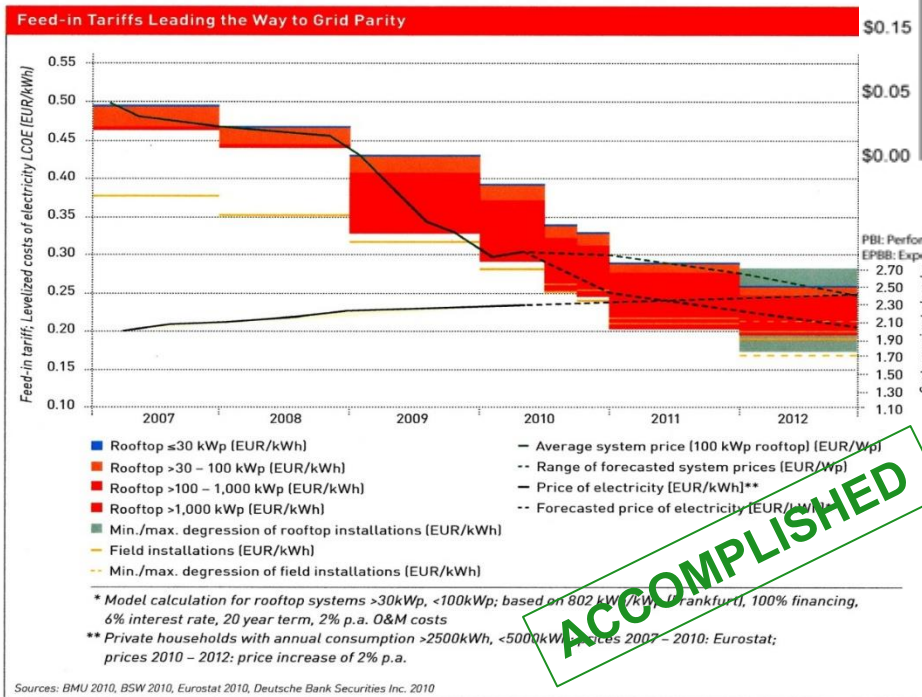
www.dsireusa.org / June 2019



Incentives Choose “Winners” for Market Transformation

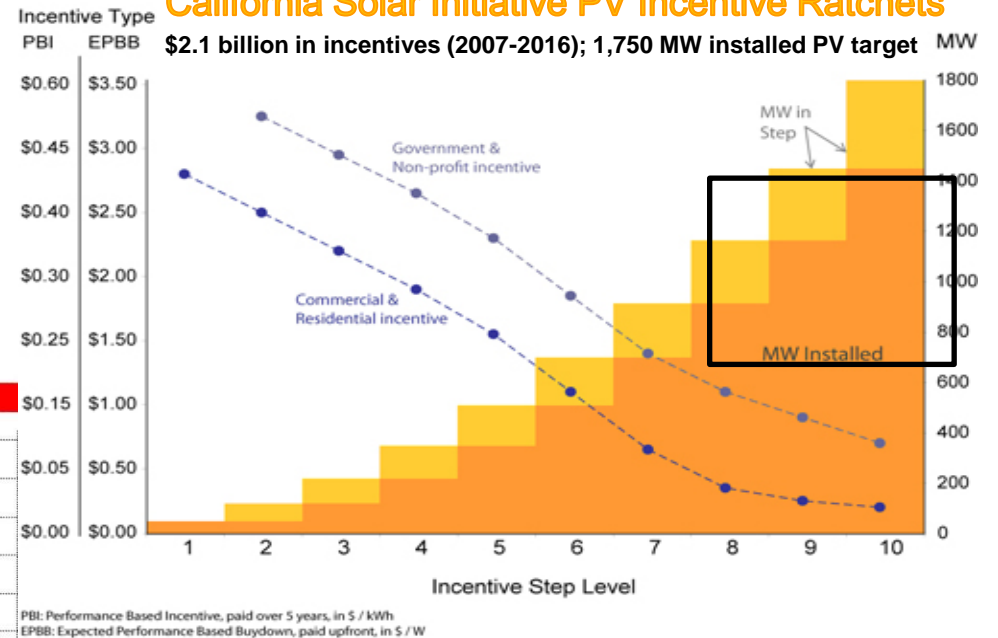


The German Solar PV Experience



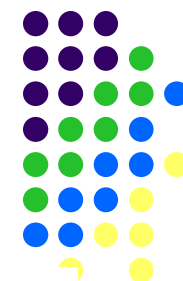
California Solar Initiative PV Incentive Ratchets

\$2.1 billion in incentives (2007-2016); 1,750 MW installed PV target



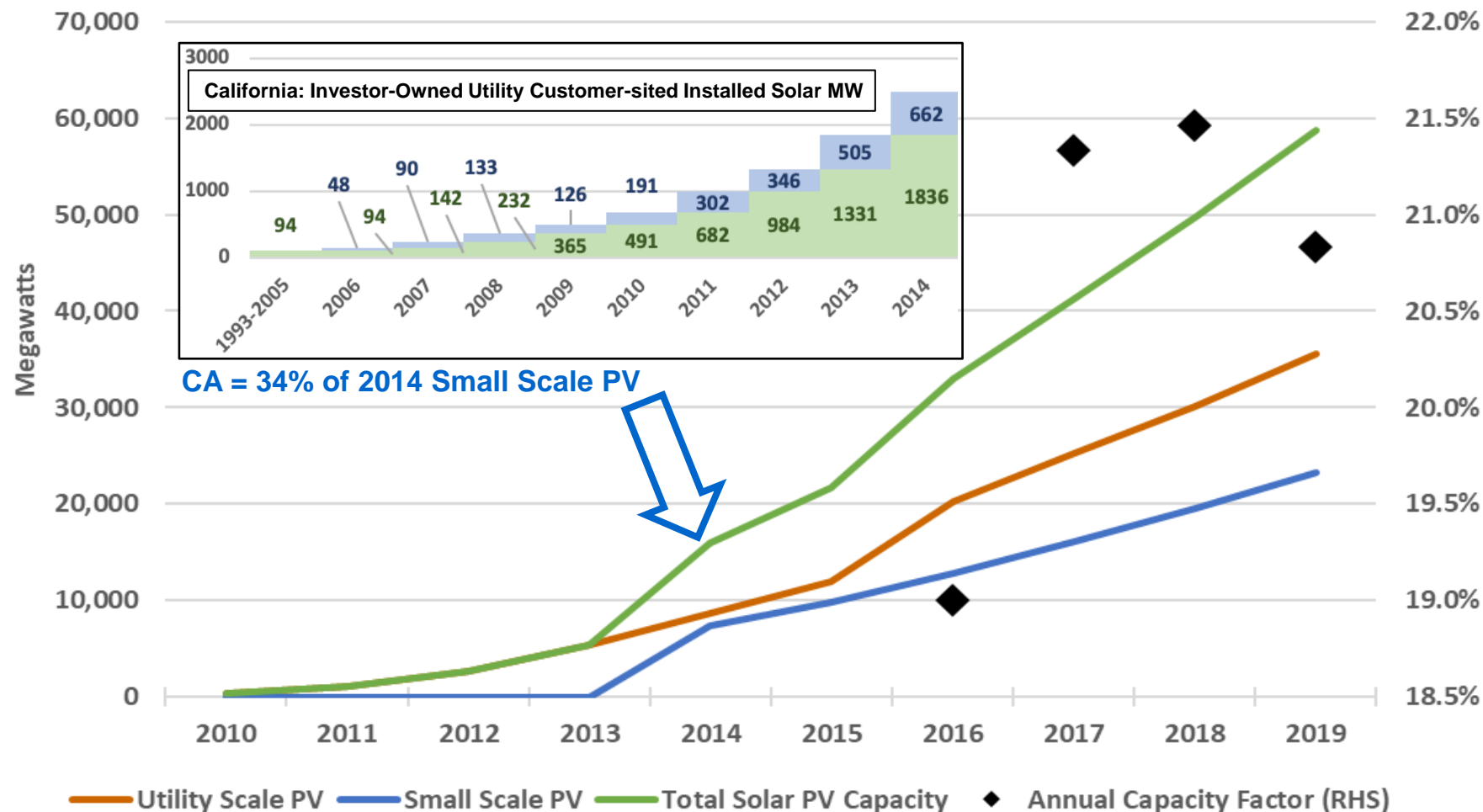
<http://www.cpuc.ca.gov/General.aspx?id=6058>

Source: Germany Trade & Invest, “The Photovoltaic Industry in Germany,” Issue 2010/2011, p. 4.

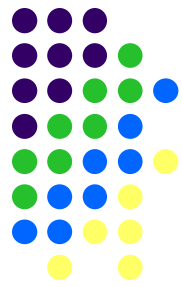


Incentives Have “Grown” Installed Solar PV Capacity...

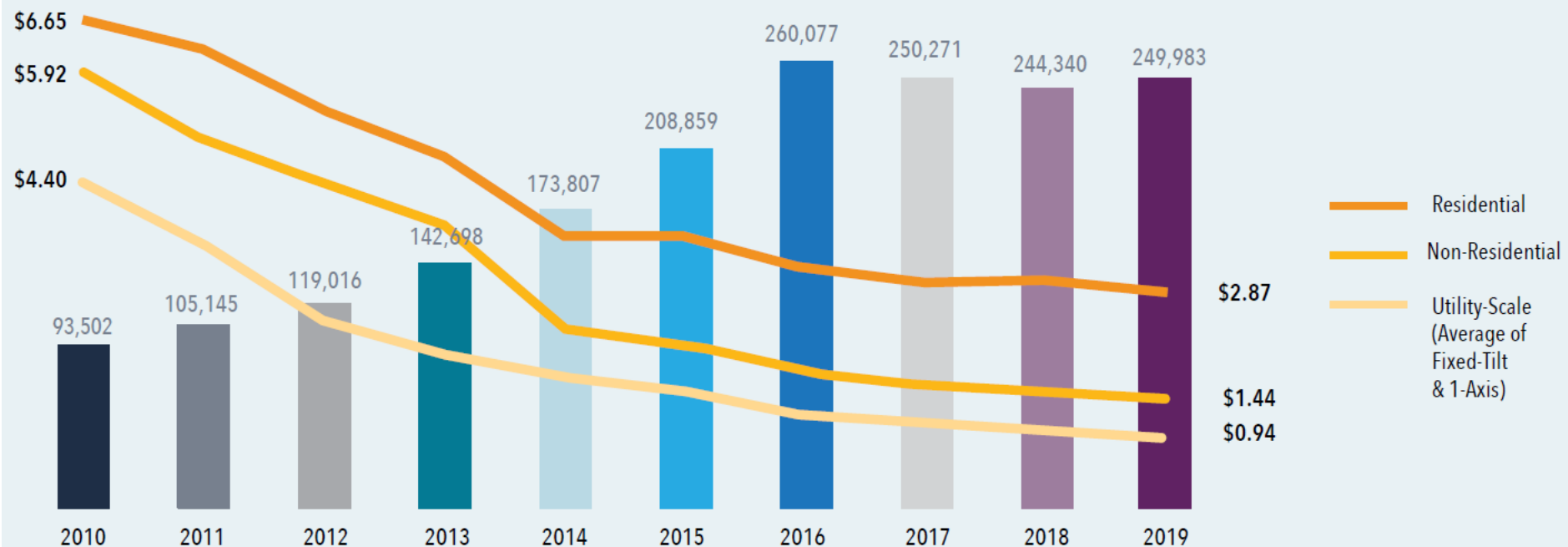
EIA: Estimated Net Summer Solar PV Capacity



Green Jobs Have Also Grown; Installed Costs Have Declined



INSTALLED SOLAR PV COSTS BY SEGMENT COMPARED TO SOLAR EMPLOYMENT GROWTH, 2010-2019

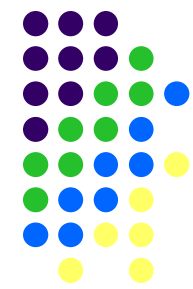


Note: Puerto Rico was not included in the solar jobs count prior to 2018.

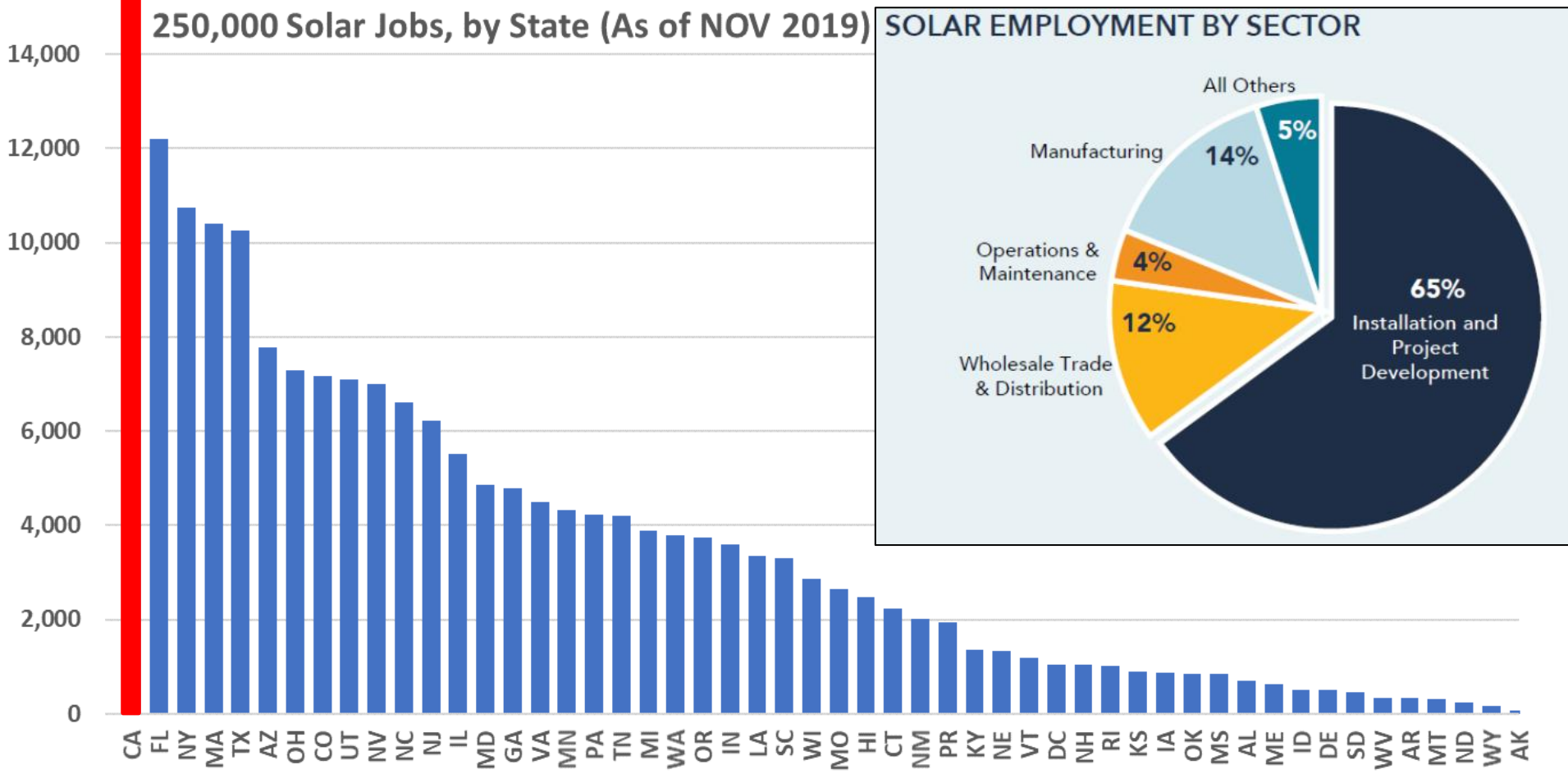
Sources: The Solar Foundation, National Solar Jobs Census; Wood Mackenzie, Limited, and the Solar Energy Industries Association, U.S. Solar Market Insight.

Source: The Solar Foundation, February 2020, 10th Annual National Solar Jobs Census 2019, p. 14.

<https://www.thesolarfoundation.org/national/>

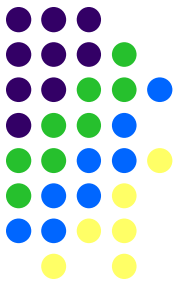


CA Solar Jobs Reflect 10 Years of Incentive Availability

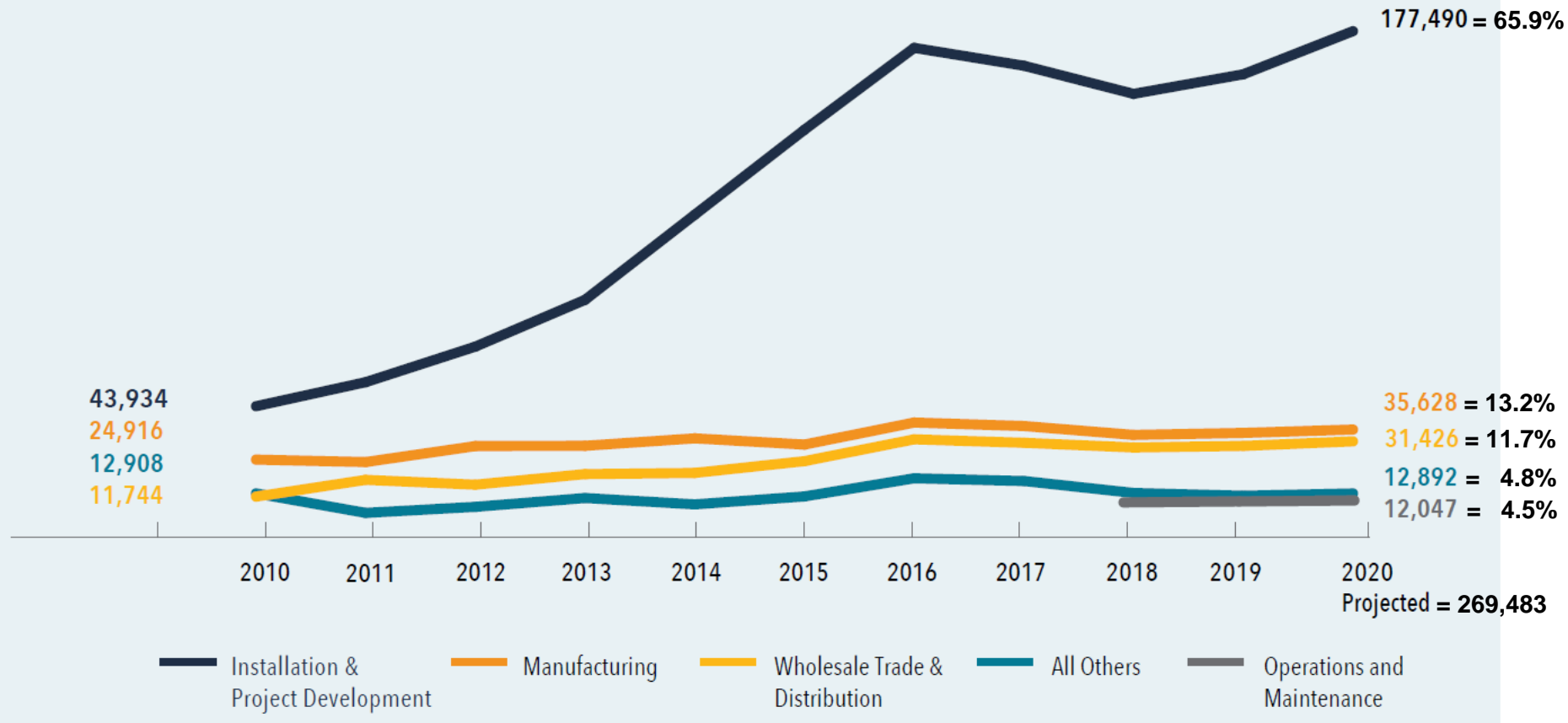


Source: The Solar Foundation, February 2020, 10th Annual National Solar Jobs Census 2019, p. 22 (graph), p. 46 (jobs data).
<https://www.thesolarfoundation.org/national/>

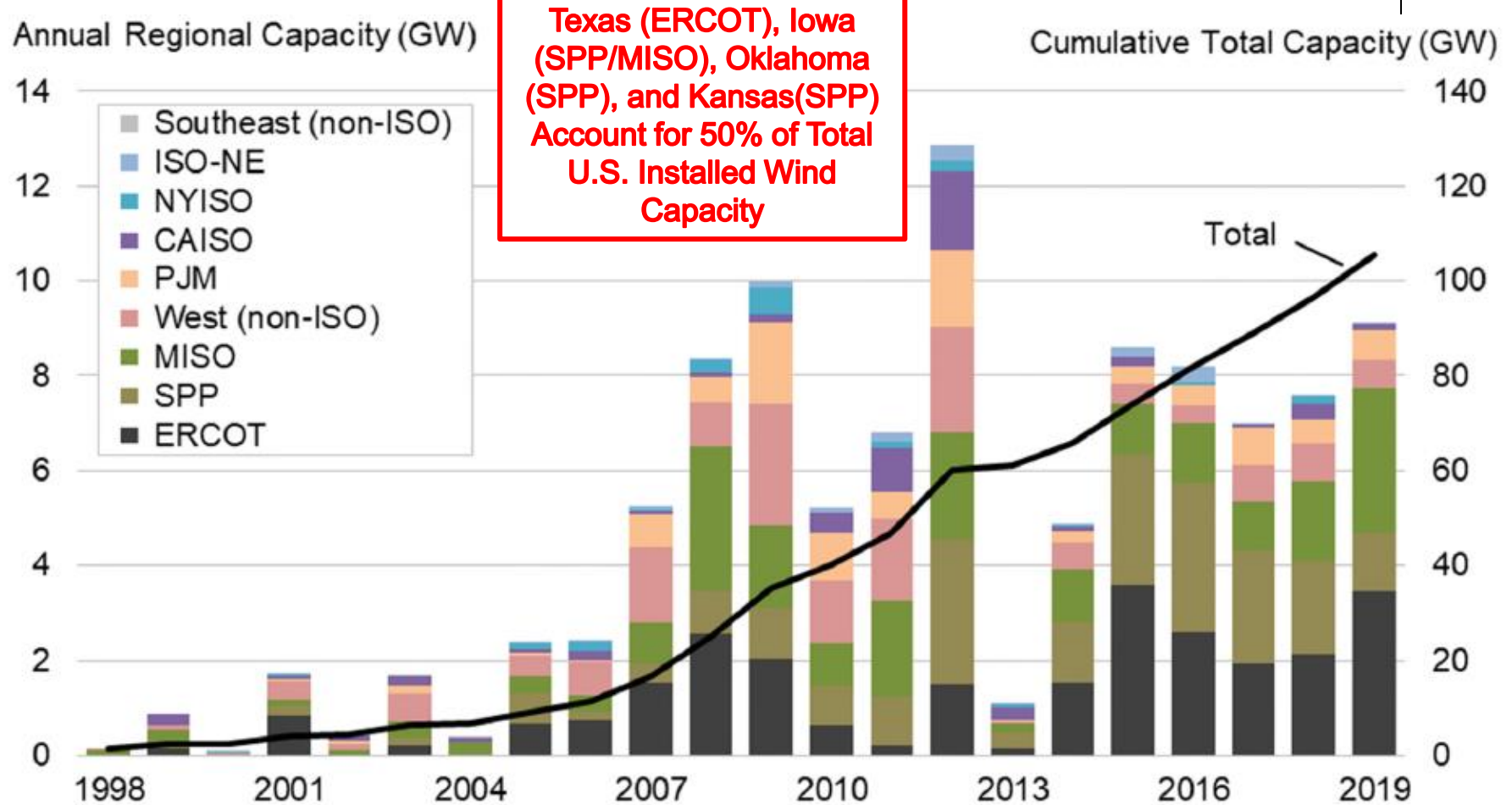
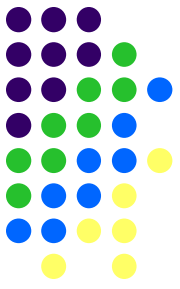
Longevity of Solar Jobs an Issue as Penetration Increases



SOLAR EMPLOYMENT GROWTH BY SECTOR, 2010-2019

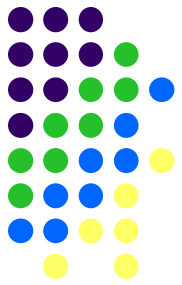


Installed Wind Capacity Has Responded to Tax Incentives



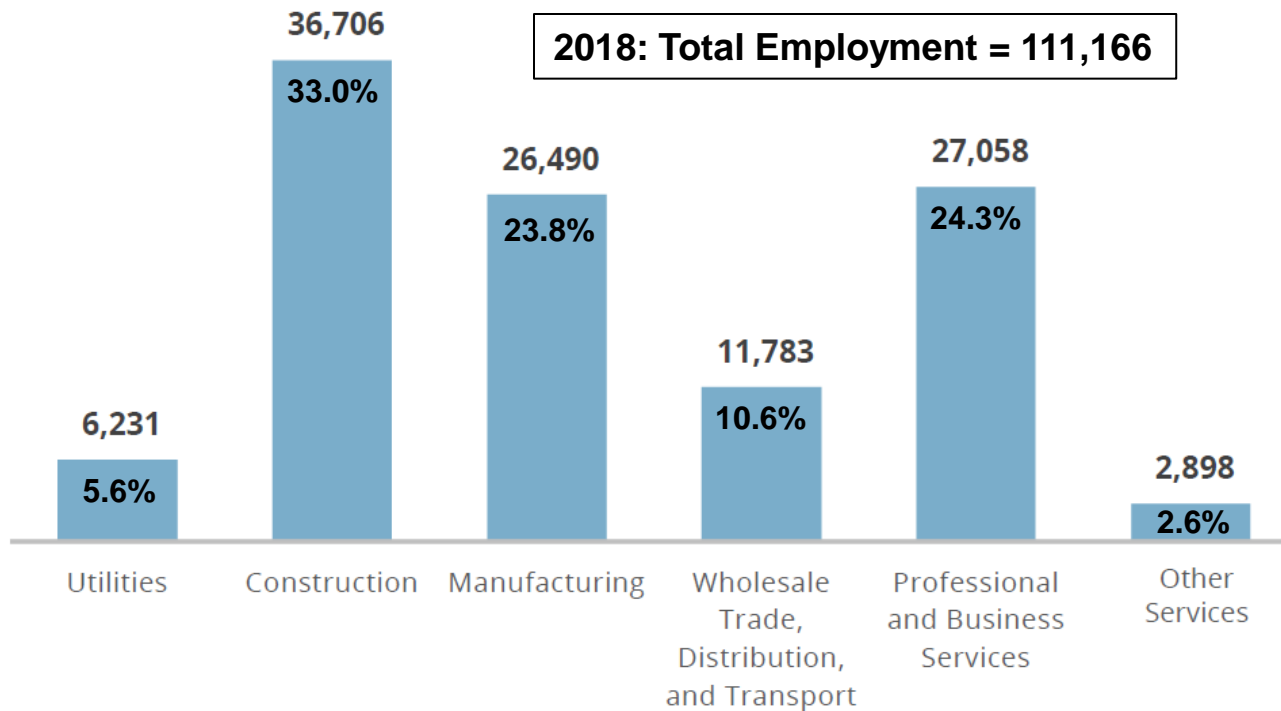
Source: AWEA WindIQ

Source: Berkeley Lab, August 2020, *Wind Energy Technology Data Update: 2020 Version*, p. 8. <https://emp.lbl.gov/wind-technologies-market-report/>



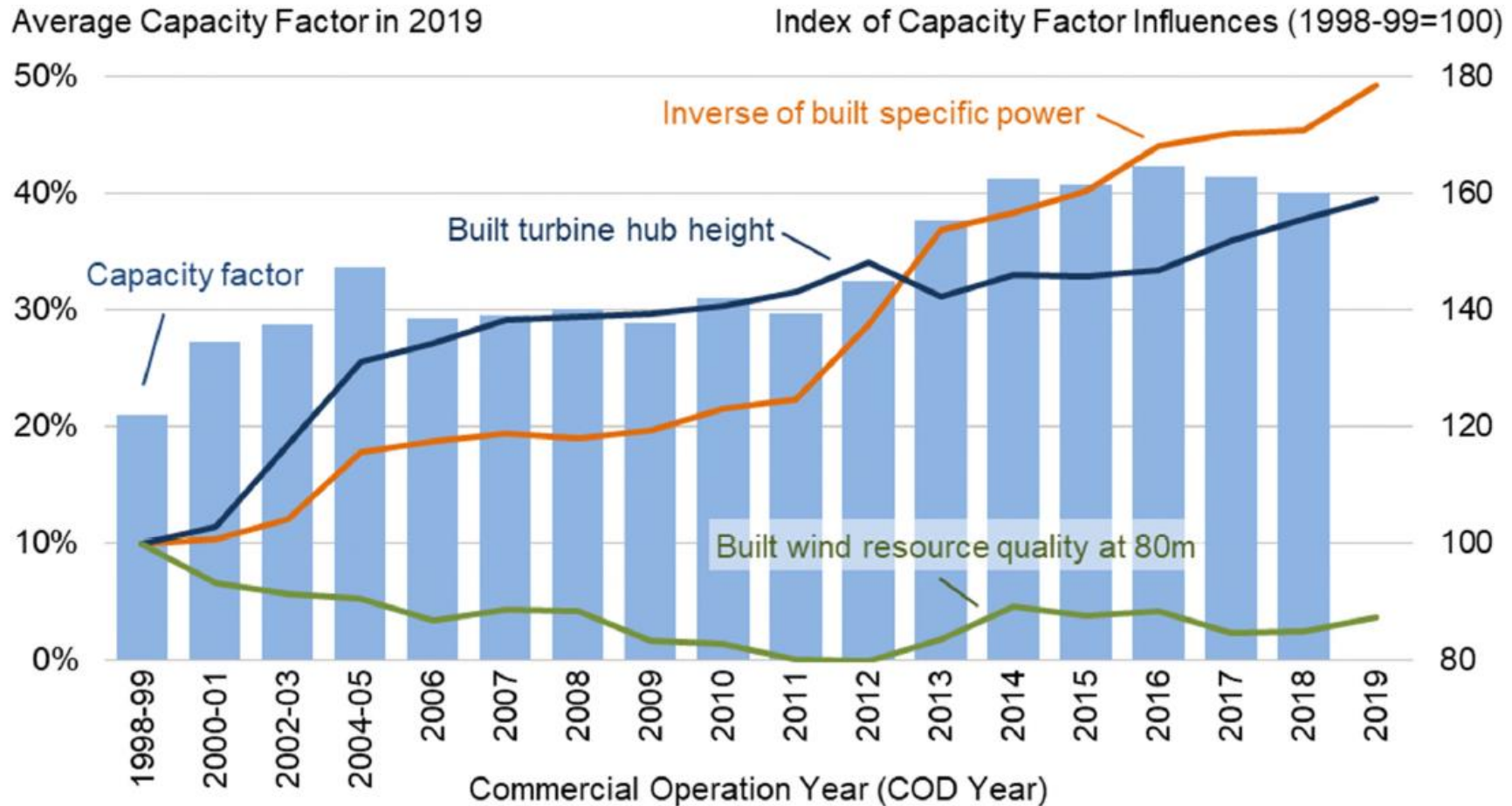
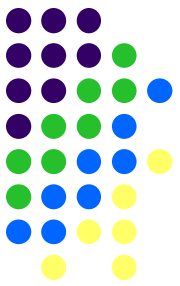
Wind Employment Less Dominated by Construction

Wind Electric Power Generation – Employment by Industry Sector



Source: NASEO & EFI, *The 2019 U.S. Energy and Employment Report*, p. 68. <https://www.usenergyjobs.org/2019-report>

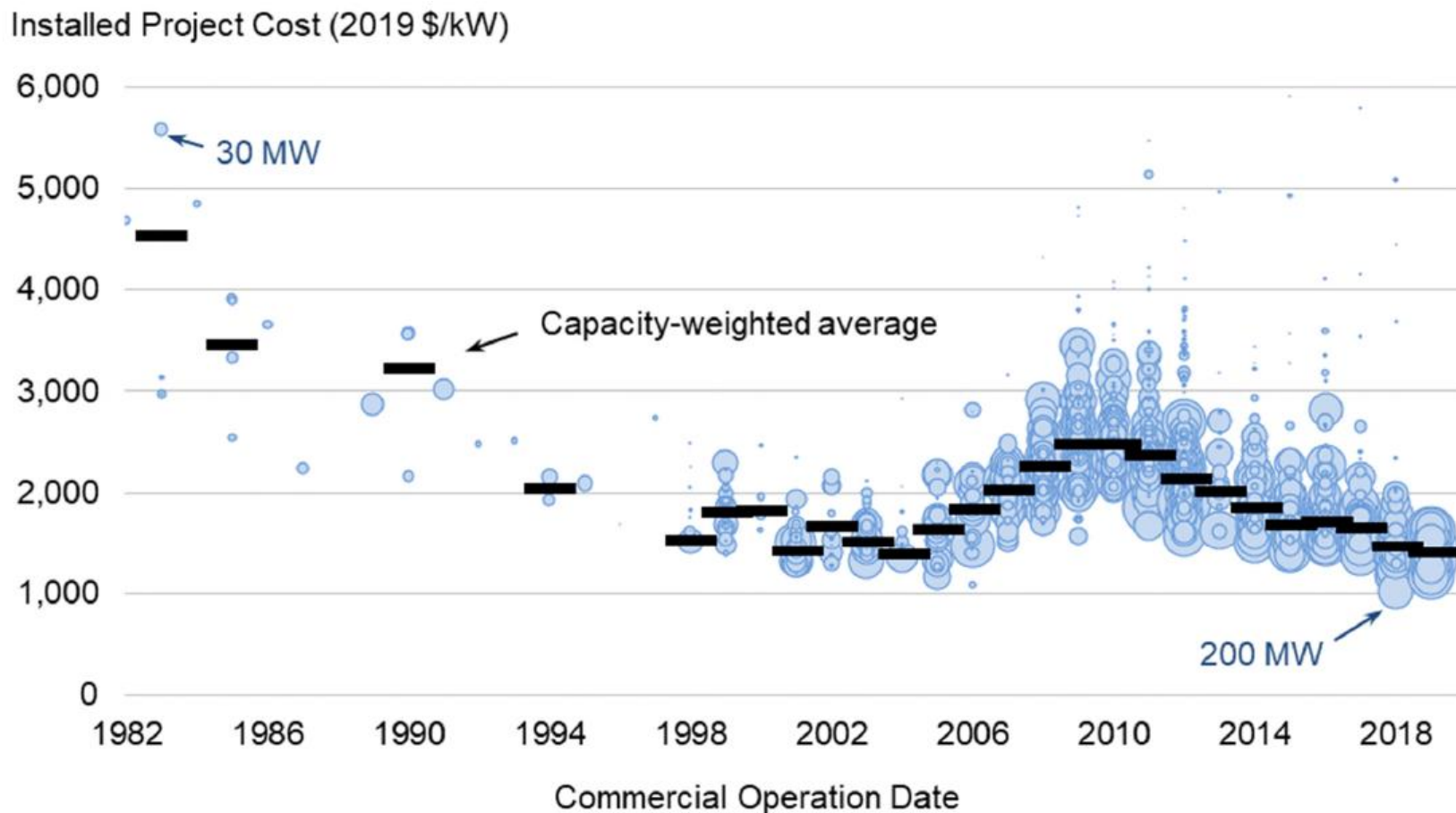
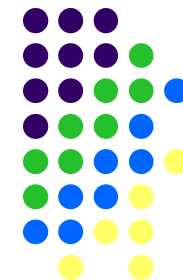
Wind Capacity Has More “Moving Parts” than Solar PV



Source: EIA, FERC, Berkeley Lab

Source: Berkeley Lab, August 2020, *Wind Energy Technology Data Update: 2020 Version*, p. 47.
<https://emp.lbl.gov/wind-technologies-market-report/>

Making Wind Capacity Cost Declines More Variable



Sources: Berkeley Lab (some data points suppressed to protect confidentiality), Energy Information Administration

As Costs Decline, Tax Incentives Should Also Decline

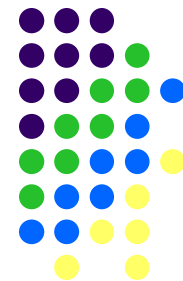
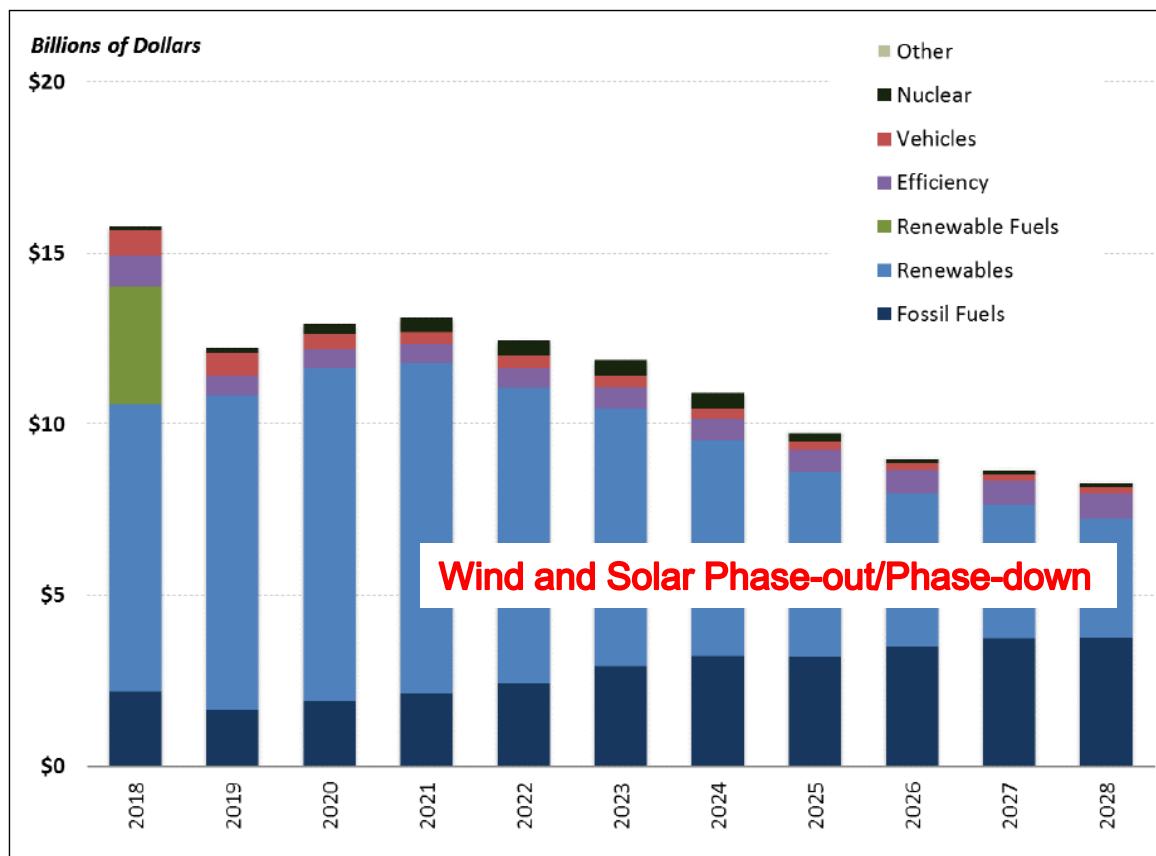


Figure 2. Projected Cost of Energy Tax Provisions: FY2018-FY2028

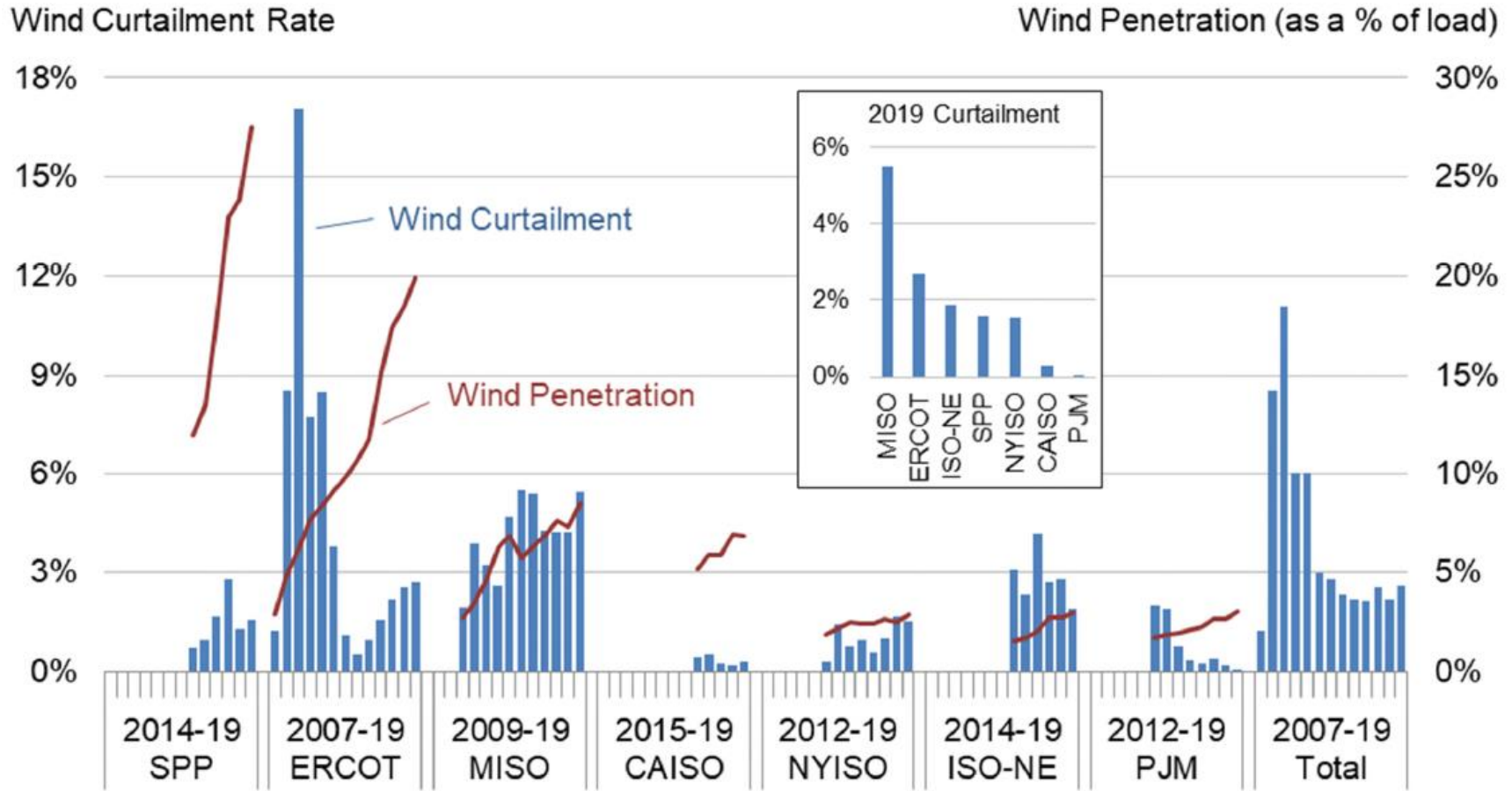
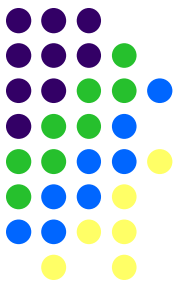


Source: CRS, using data from U.S. Department of the Treasury, <https://home.treasury.gov/policy-issues/tax-policy/tax-expenditures>.

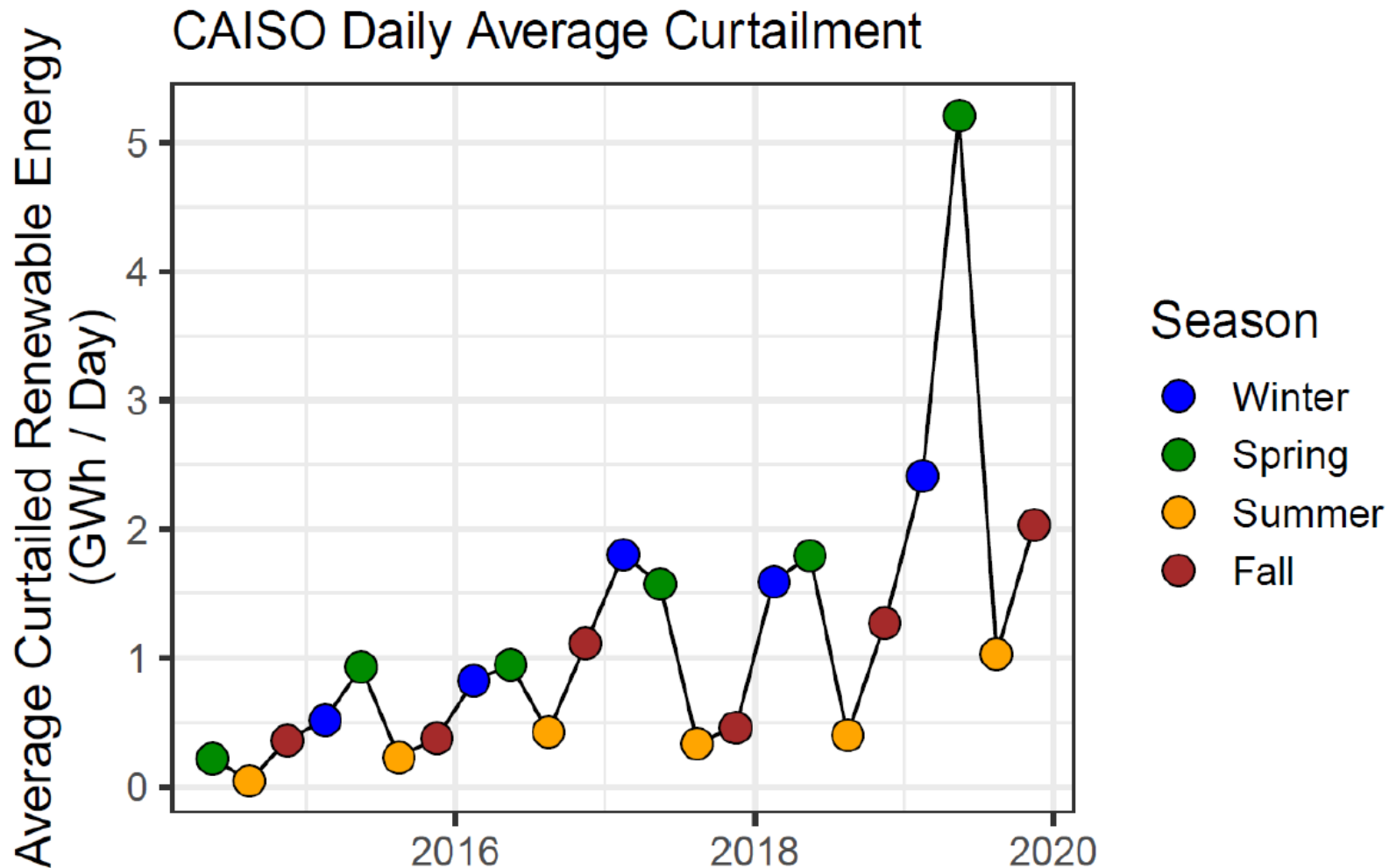
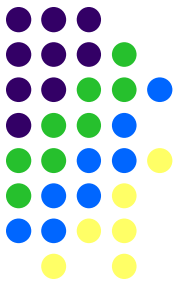
Notes: Treasury tax expenditure estimates are not directly comparable to JCT tax expenditure estimates. See the text for additional information.

Source: Congressional Research Service, March 19, 2019, *The Value of Energy Tax Incentives for Different Types of Energy Resources*, p. 12. <https://crsreports.congress.gov/search/#/1?termsToSearch=energy%20subsidies&orderBy=Date>

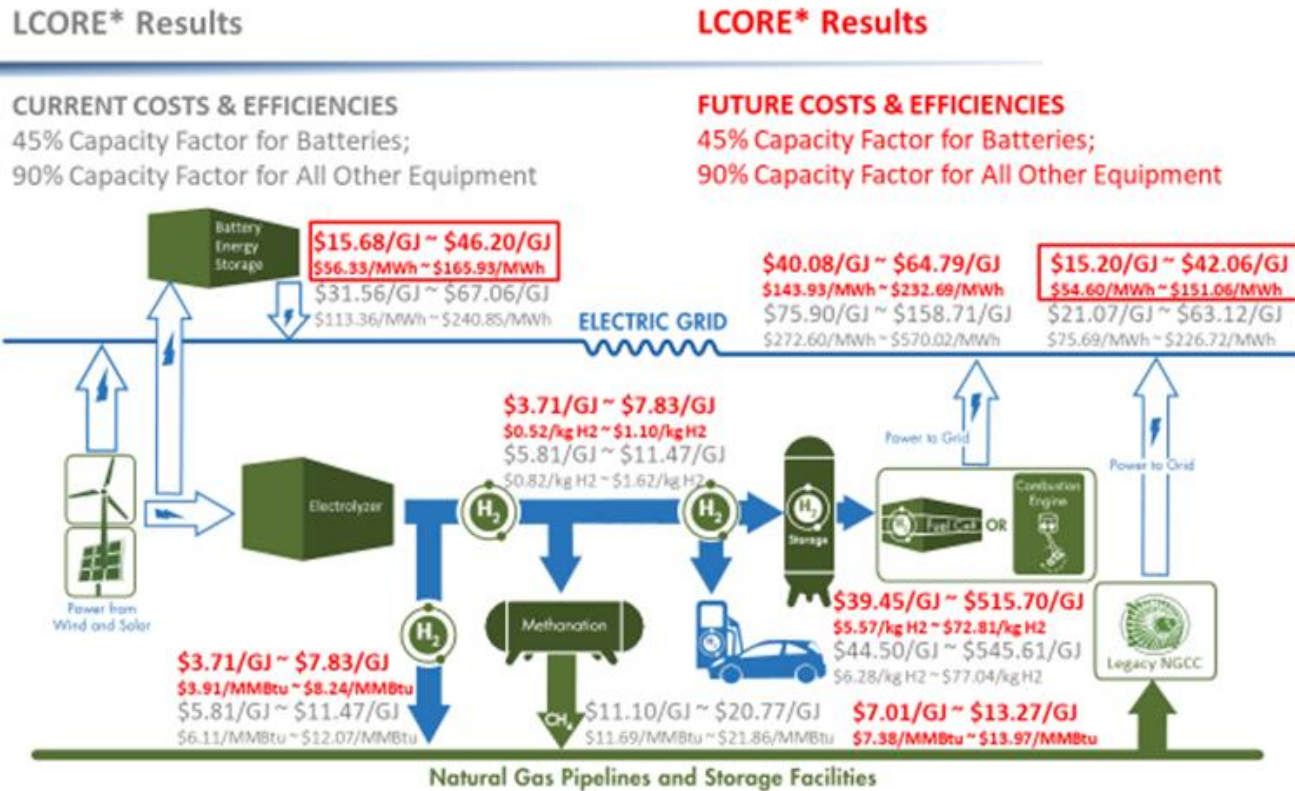
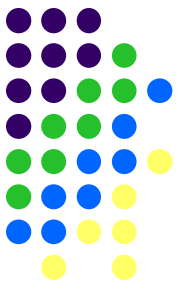
To Enable New Technologies To Solve to New Problems



Curtailment Differs By Region, Season, and Time of Day



Renewable H2 Markets: More Diverse than Wind and Solar



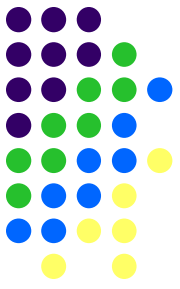
* LCore = Levelized Cost of Returned Energy = Levelized Cost of Energy with Zero-Cost Electricity Input

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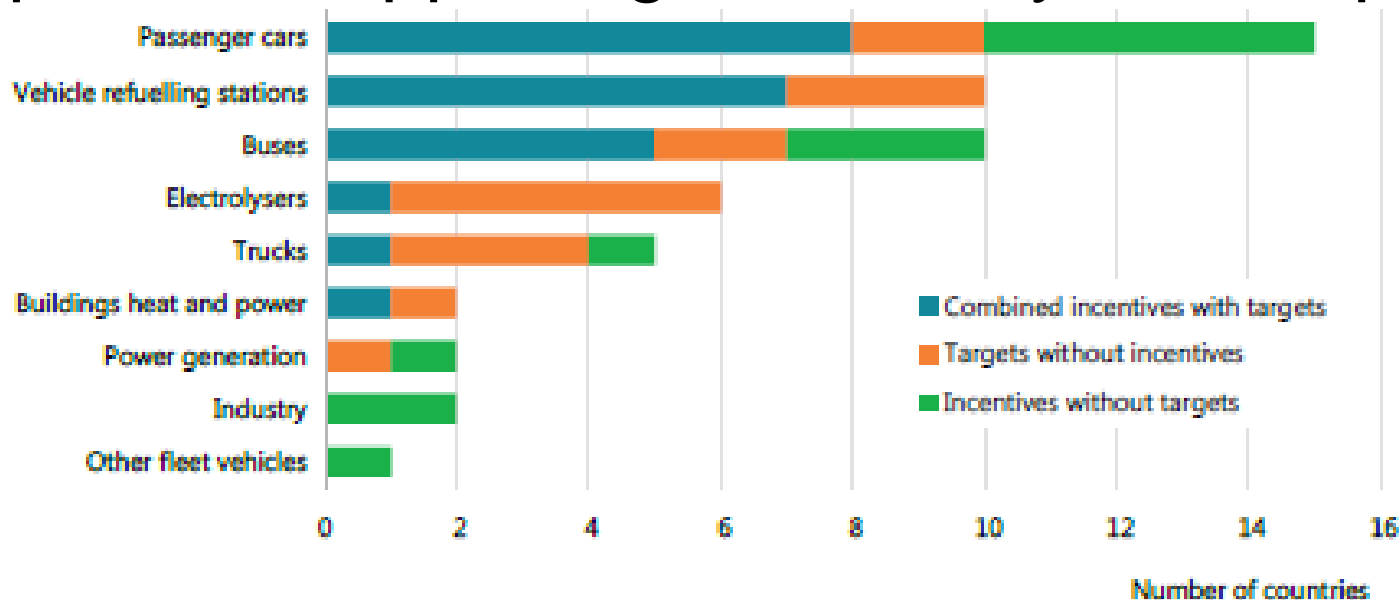


- Also: Maritime, shipping, heating, and manufacturing

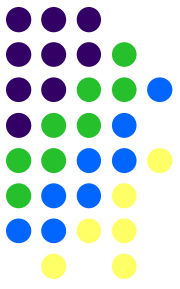
Requiring Market-Specific Incentives to Meet Objectives



- California: 33% renewable H2 requirement; Low Carbon Fuel Standard credits for H2
- International Energy Agency identified 50 policies supporting H2, mostly in transport:



Renewable Hydrogen Market Transformation “Guidelines”



- As with solar PV and wind, the renewable H2 market transformation will be enabled by policy commitment and incentive programs
- Renewable hydrogen’s multiple markets may require more targeted/nuanced incentives
 - Impact could be much broader than for solar and wind due to multiple market applications
 - U.S. can learn from experiences around the globe
- Uncertainty is the bane of any investment. Incentives must provide long-term certainty.

Market Transformation: Will Renewable Hydrogen Be Next?

THANK YOU!
QUESTIONS?

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