DOCKETED	
Docket Number:	19-SB-100
Project Title:	SB 100 Joint Agency Report: Charting a path to a 100% Clean Energy Future
TN #:	230802
Document Title:	Johnny Casana - Onshore wind
Description:	Presentation by Johnny Casana, Pattern Energy
Filer:	Harinder Kaur
Organization:	California Energy Commission
Submitter Role:	Commission Staff
Submission Date:	11/20/2019 8:53:17 AM
Docketed Date:	11/20/2019

Pattern

Western Wind for California

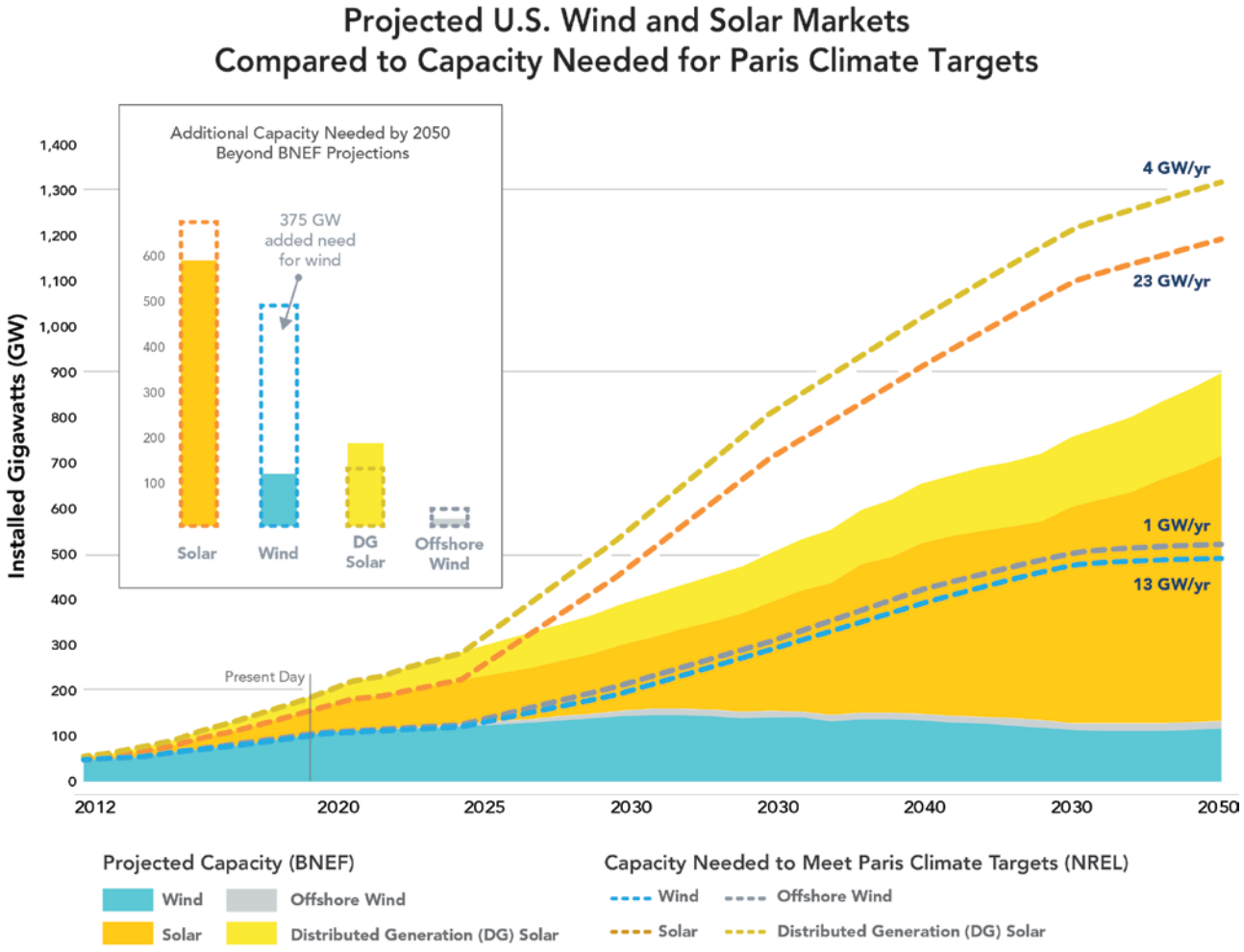
November 2019






The Scale of the Need for Wind and Solar

- Large U.S. market of **25 - 40 GW per year** for wind and solar
- Projected total need to meet climate goals:
  - 650+ GW solar
  - 450+ GW wind
- Solar is mostly on track, but wind is far behind
- New policies needed to achieve enough combined wind and solar

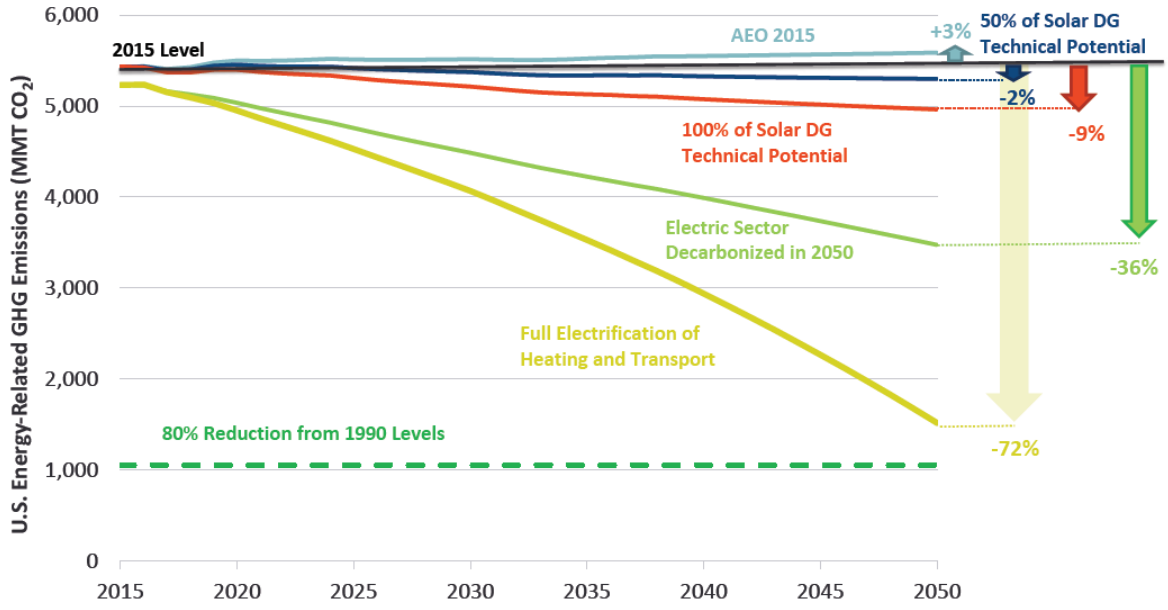


Sources: (1) "New Energy Outlook 2019" (BNEF) https://about.bnef.com/new-energy-outlook and (2) "Standard Scenarios Report" (NREL) https://www.nrel.gov/docs/fy19osti/71913.pdf

Utility-Scale Wind and Solar are at the Core of Climate Policy

- Two Step Process to Managing Climate:
  1) Clean the Grid
  2) Electrify Everything
- Utility-scale electric grid does majority of the work
- Rooftop solar contributes only marginally to climate

FIGURE 8 U.S. Energy-Related GHG Emissions with Full Electrification in 2050

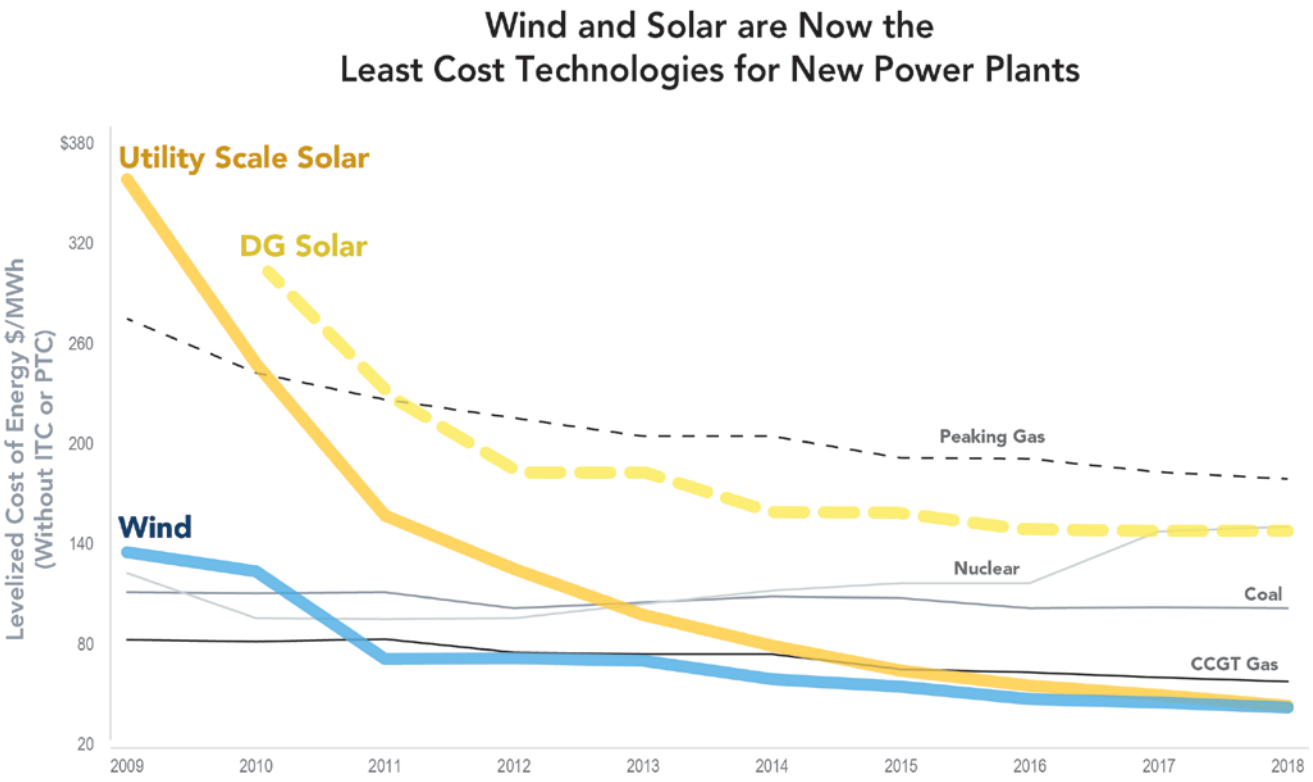


Source: AEO 2015, NREL 2016, The Brattle Group analysis

Brattle Electrification White Paper Brattle, 2017

Economics are Driving Wind and Solar

- Wind and solar are now cheaper than new gas and new coal, even without the ITC and PTC
- Wind and solar will be a large part of new energy markets based solely on competitive cost
- **Crossover in early 2030s**: new wind & solar will be cheaper than existing gas

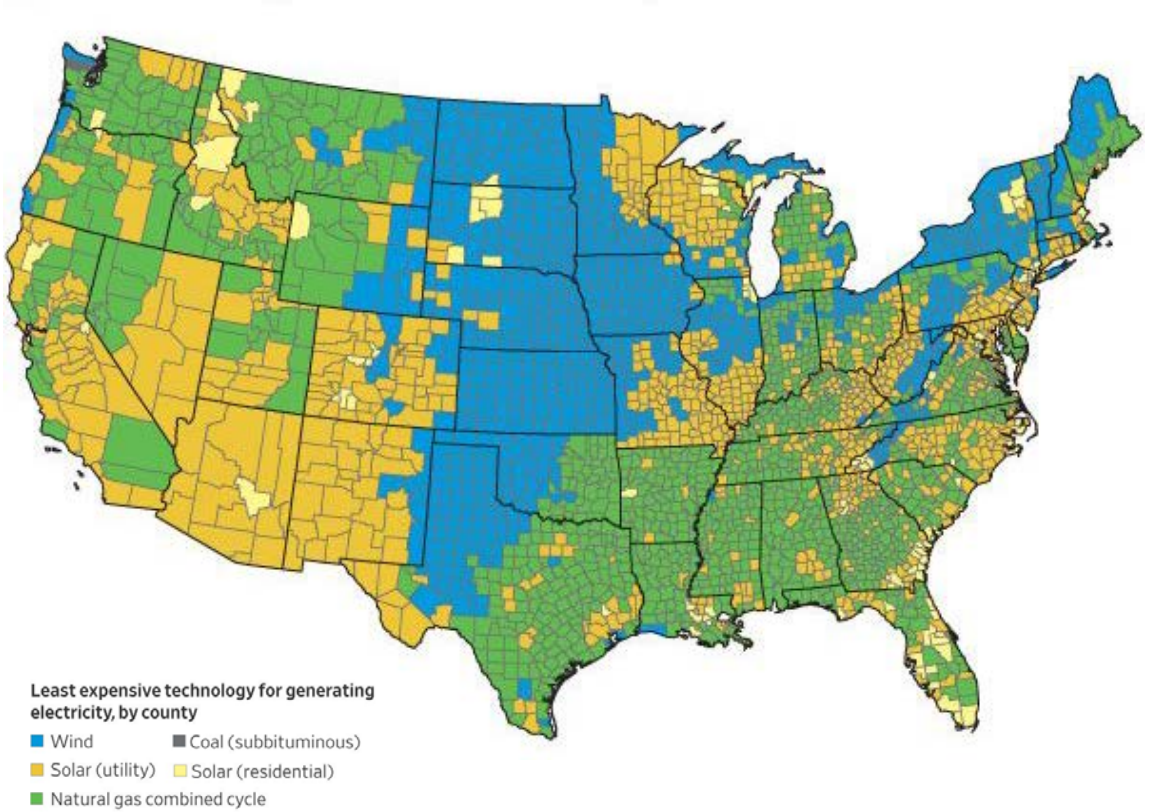


Sources: Lazard, "Lazard's Levelized Cost of Energy Analysis" (2018)

Newer Technologies are Winning on Price

- Coal retirement and other changes to the market are being driven by price
- But need access to the full market in order to fill the need left by coal and created by energy policy

Weather Dependent
Renewable energy sources now provide the cheapest power in windy and sunny parts of the country



Sources: (1) University of Texas at Austin Energy (2018)

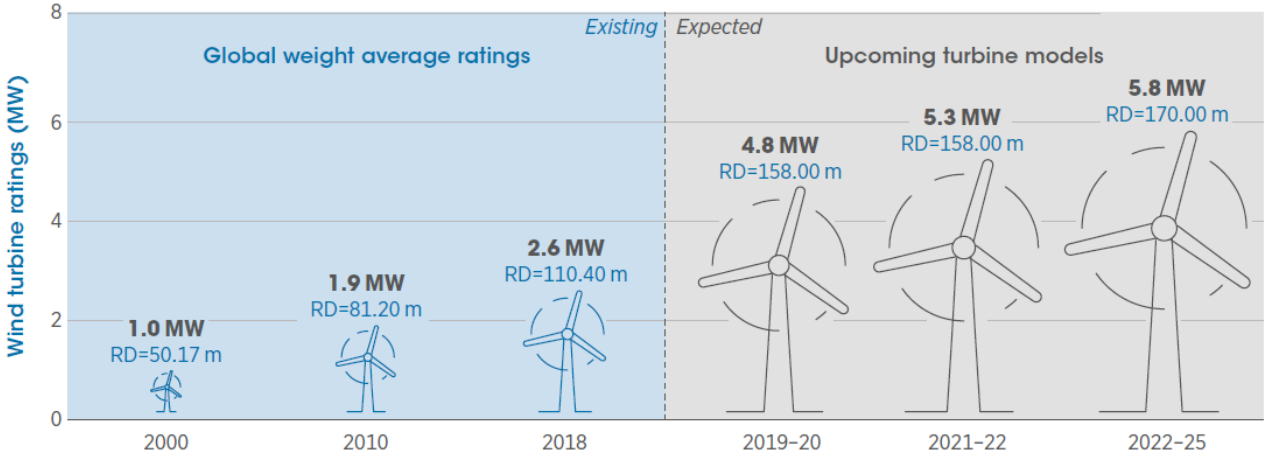
Technology Advances have Driven Costs Down

Three main cost reduction drivers have emerged for renewable power:

1) Technology improvements;
2) Competitive procurement;
3) A large base of experienced, international developers

Ongoing enhancements towards taller hub heights and larger rotor diameters will improve energy yields

Wind Turbine Technical Advances

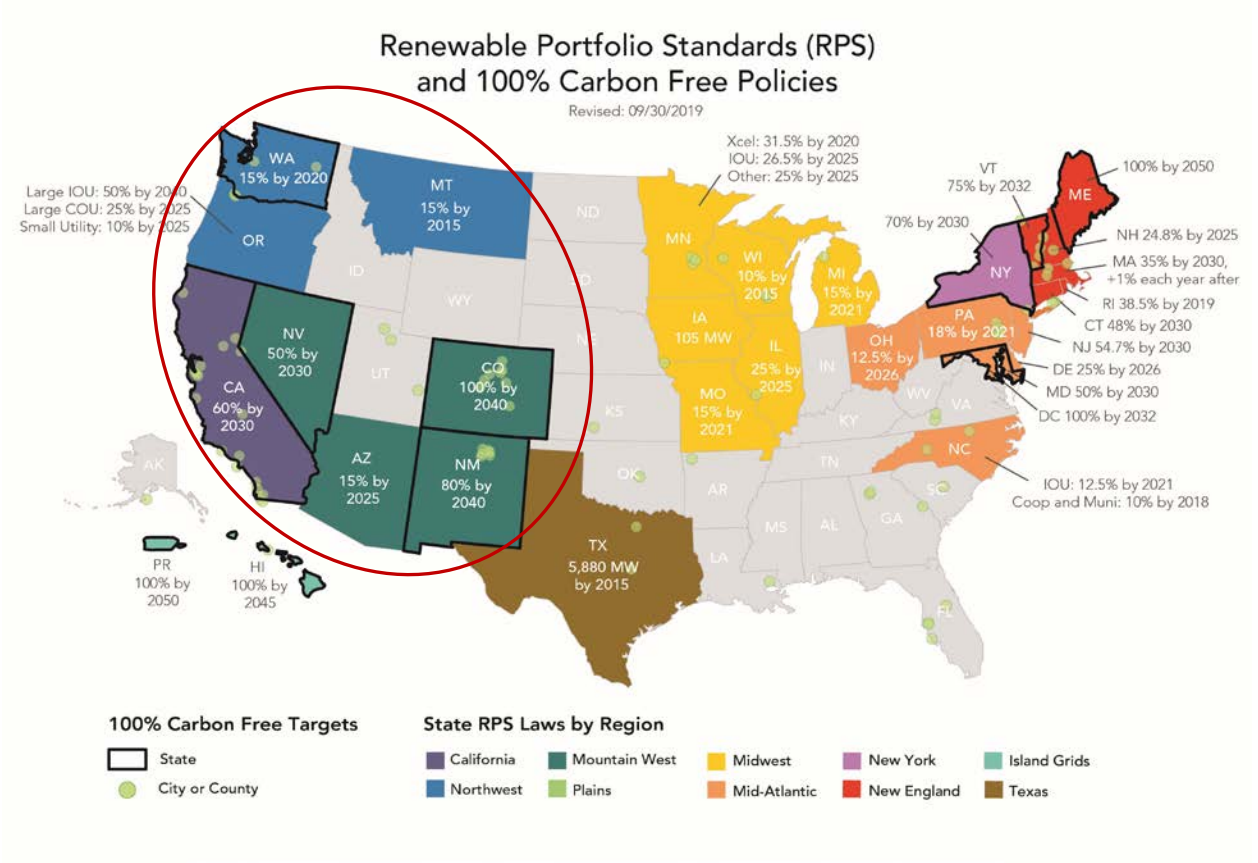


Drivers of Cost Improvement:

Sources: IRENA Future of Wind (2019)

Energy Policies Have Changed Rapidly in the Past Year

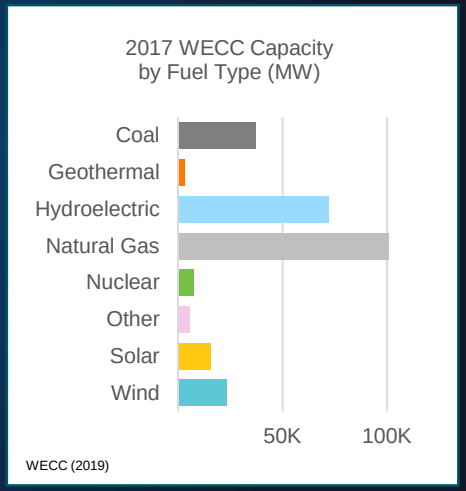
- **~80% of energy use** in the west is now aligned on decarbonization
- Five western states set 100% Clean Grid policies in the past twelve months
- Three of the largest western utilities set deep decarbonization targets
- The largest markets each have high Renewable Portfolio Standards

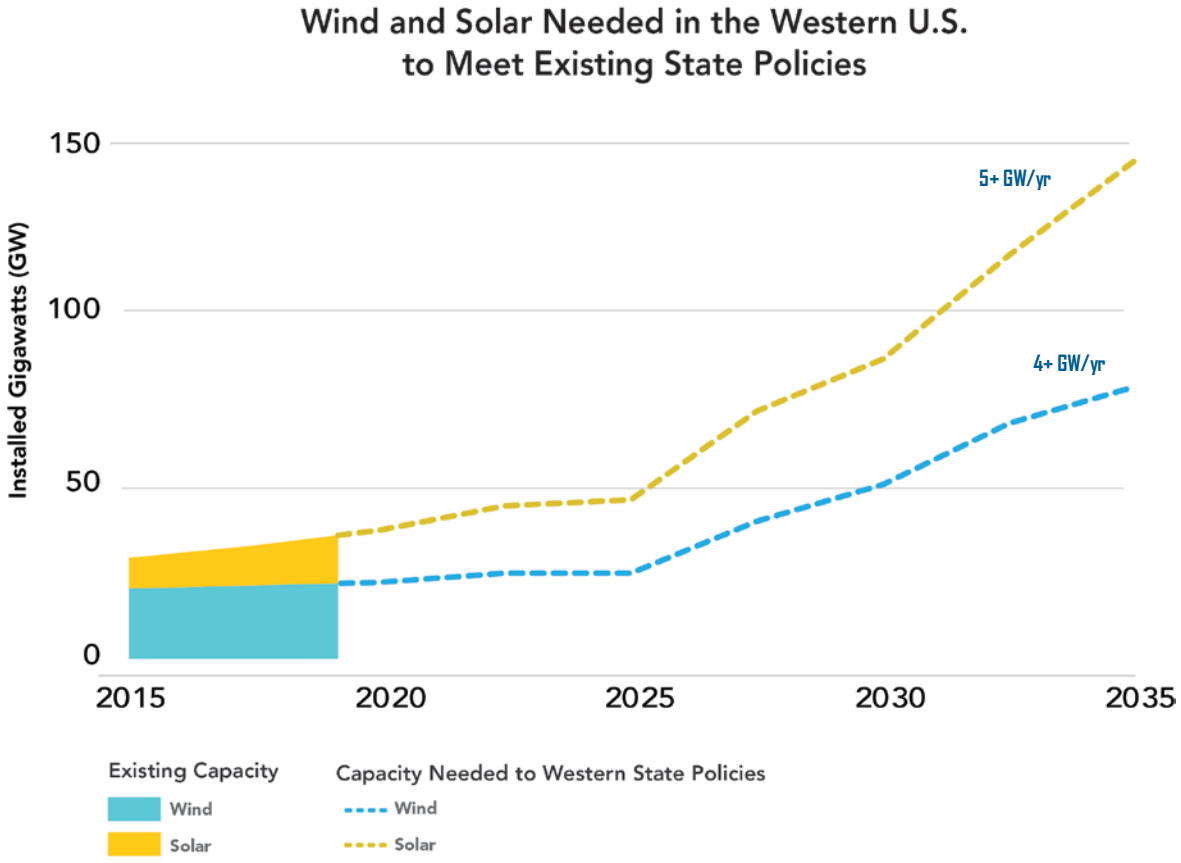


Sources: AWEA 2019 Q2 Market Report

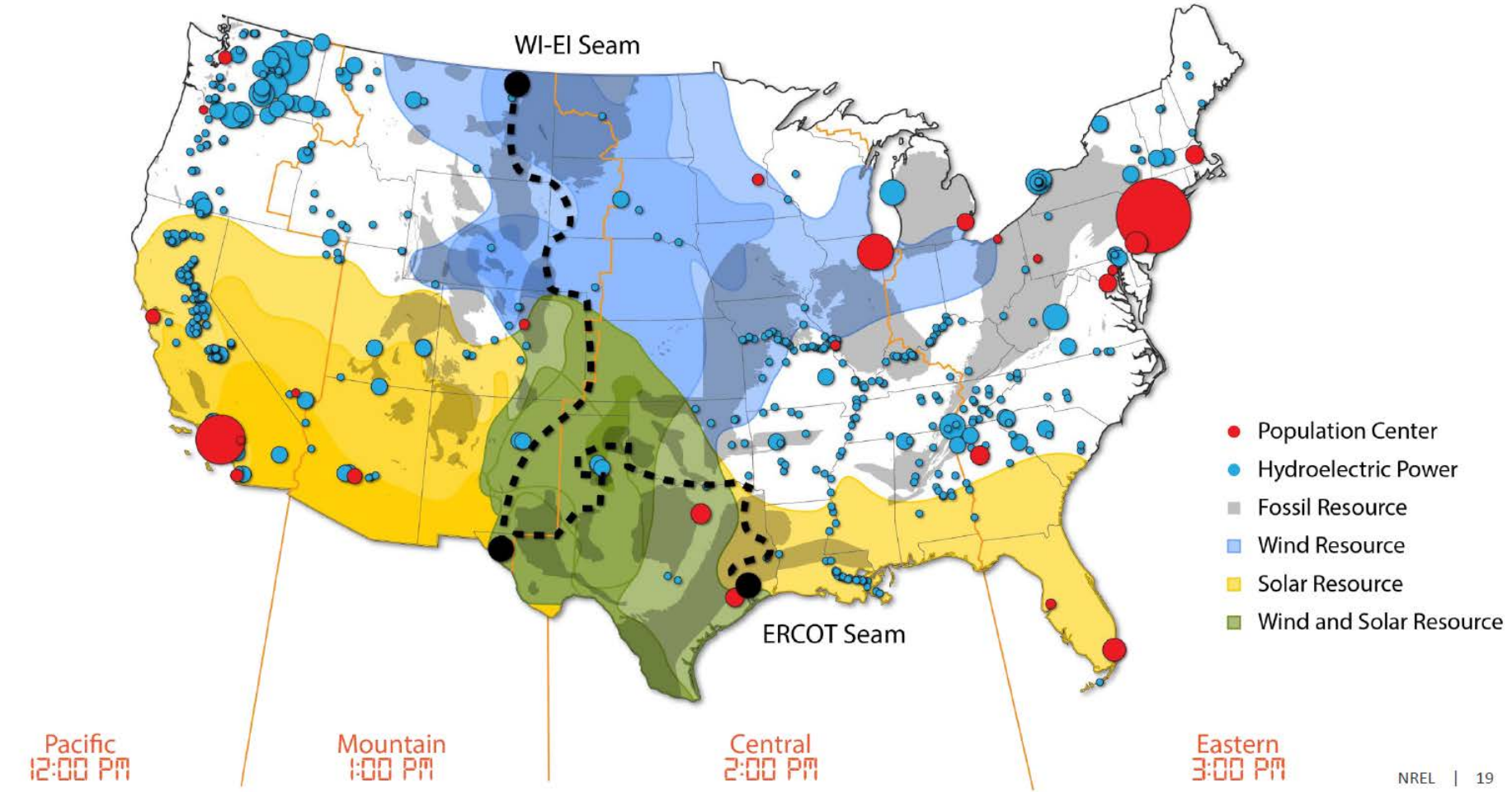
Western Market Demand: Total

- Existing State Policies in the West require **~9 GW** per year starting in 2026
- By 2050 the total demand is upwards of 150 GW





Source: Energy Strategies, "Western Flexibility Assessment" (2019)


WI-EI Seam
ERCOT Seam
Population Center
Hydroelectric Power
Fossil Resource
Wind Resource
Solar Resource
Wind and Solar Resource
Pacific
12:00 PM
Mountain
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Central
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Eastern
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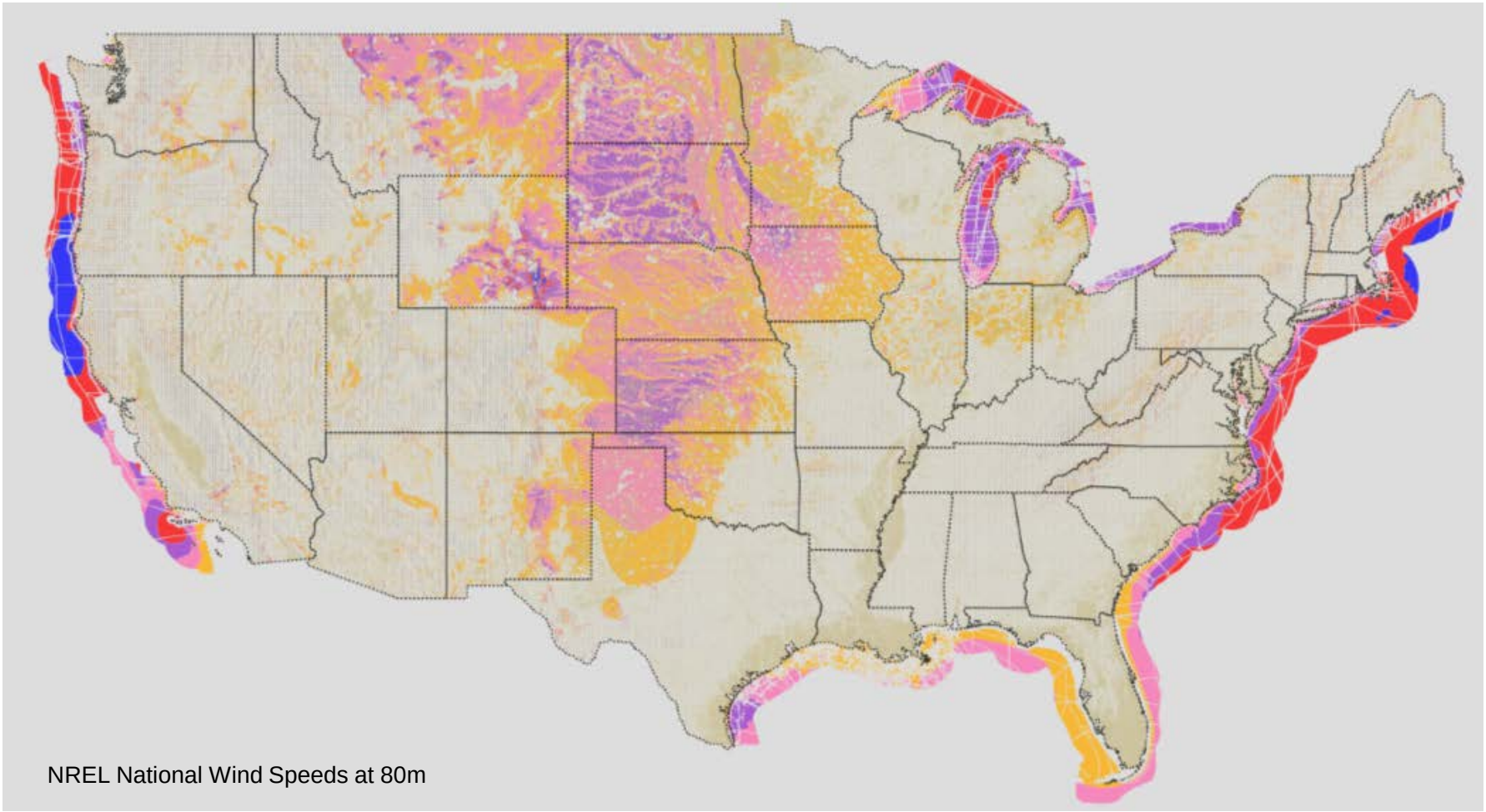
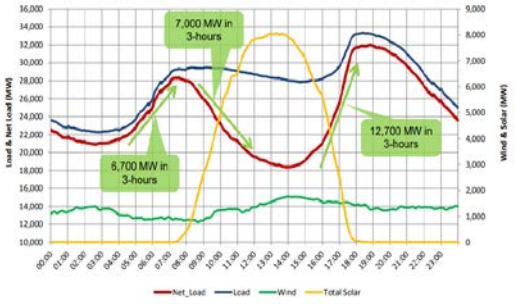


NREL National Wind Speeds at 80m

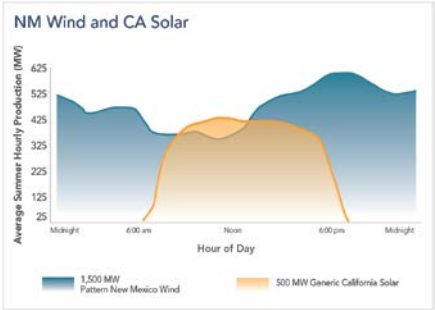
Benefits of Diversified Grids

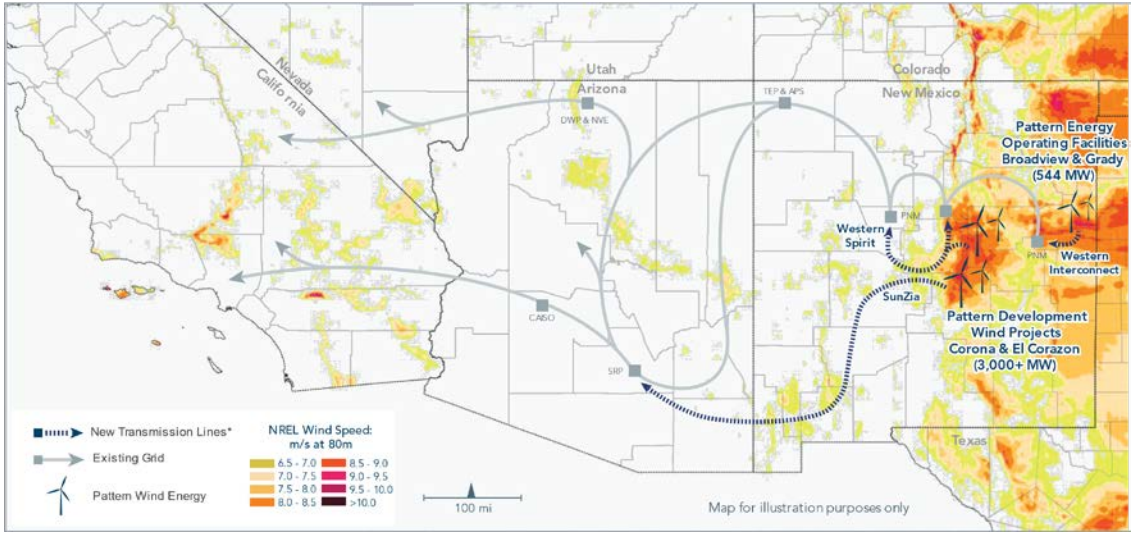
- Electricity markets are not designed for variable, zero-marginal-cost wind and solar so they need regional diversity
- "Duck Curve" challenges are affecting many markets with high renewable penetration
- Regional coordination enables least cost, highly efficient pairing of wind and solar resources

Solar Causes Grid Challenges in California



NM Wind Helps CA as a High Value Resource



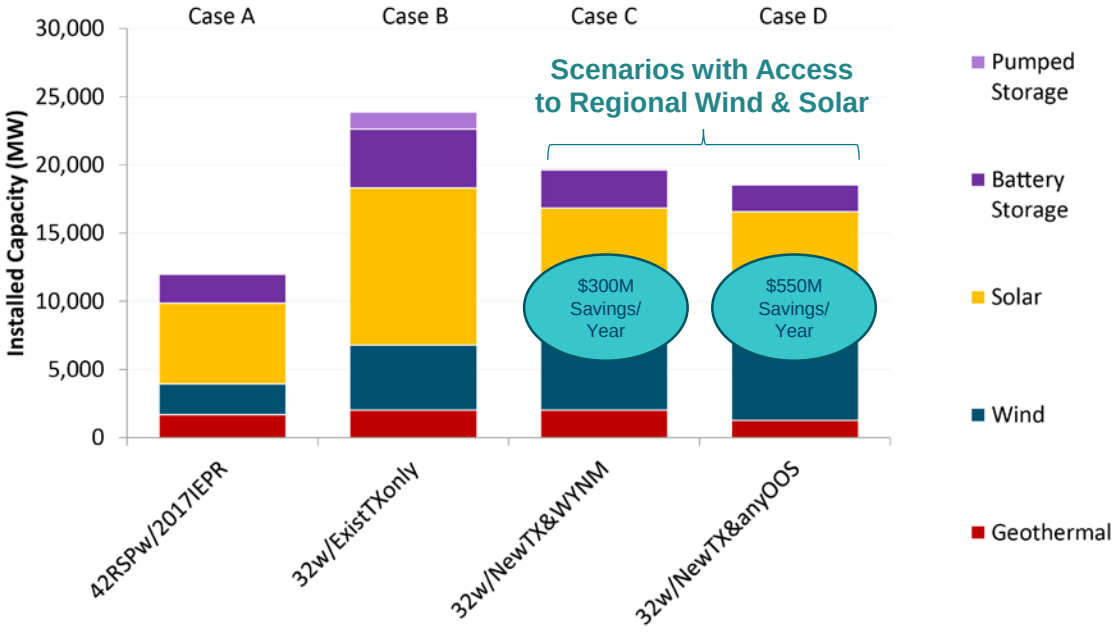


Sources: CAISO (2019); Pattern Development

Western Market Demand: California

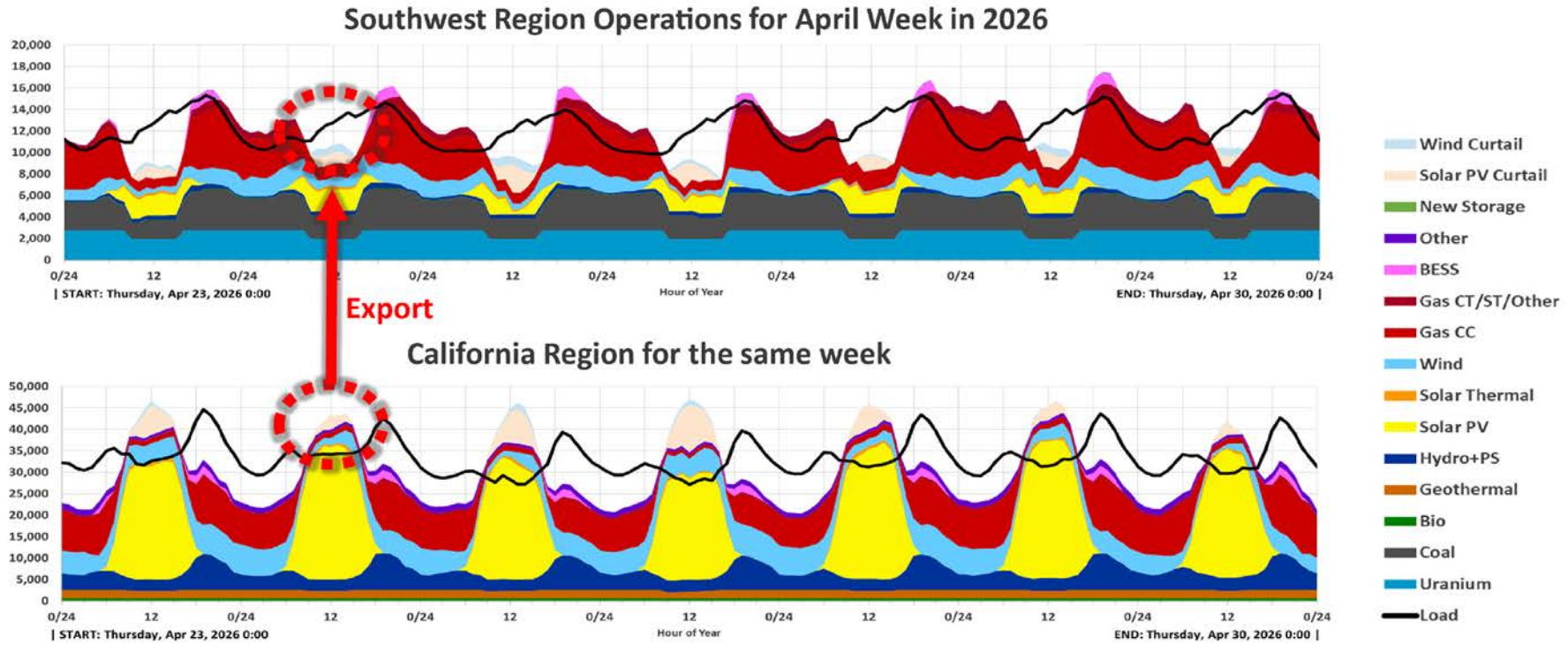
- The cost savings of an organized western grid measure in the billions by the 2030s
- Deep GHG reductions in the Western Grid require coordination

CPUC Identifies $300M – $550M Annual Savings With Access to Regional Wind and Solar



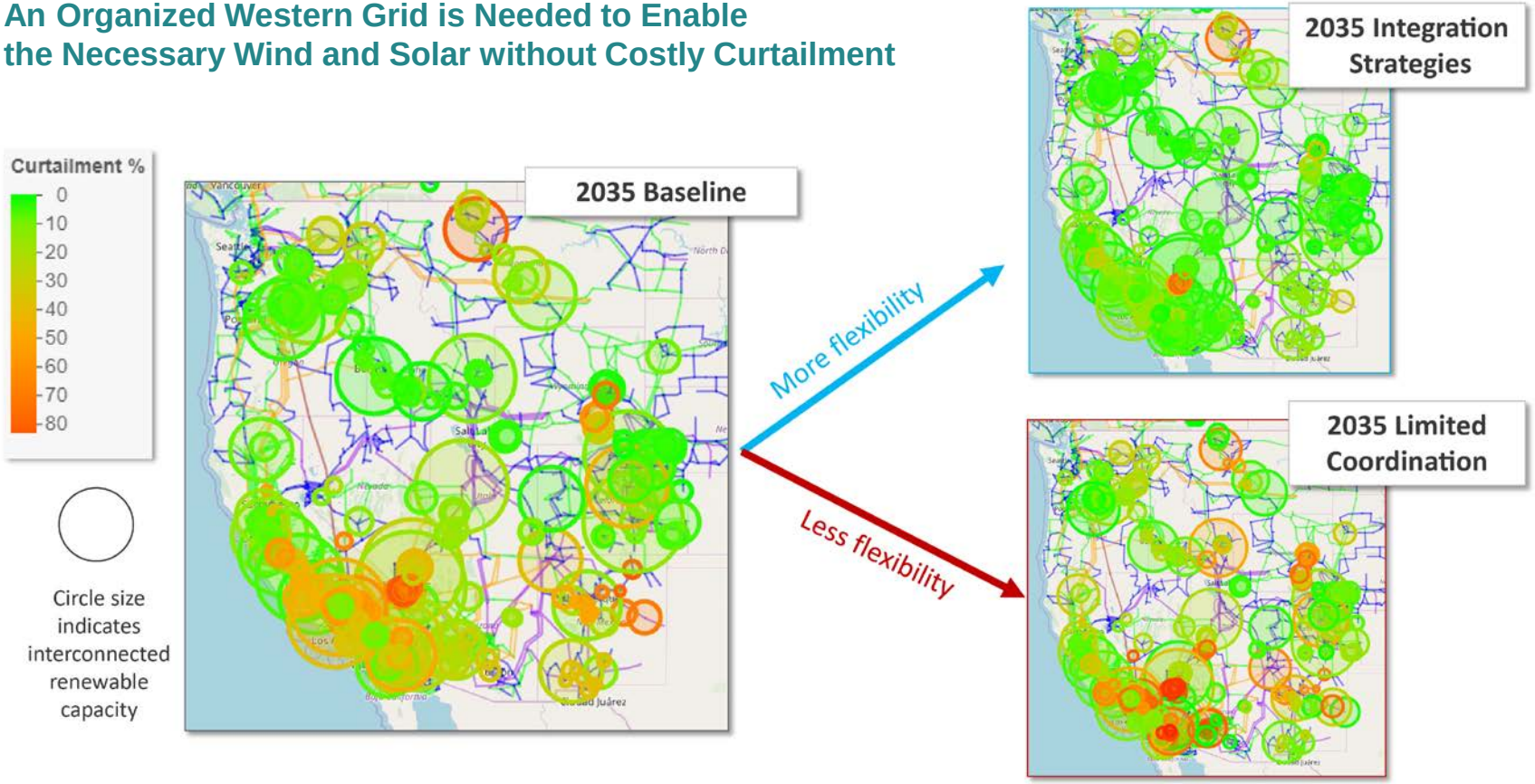
Sources: CPUC, "Proposed IRP Portfolios for the 2019-20 CAISO Transmission Planning Process" (2019)

Regional Diversity Balances Wind and Solar without Costly Curtailment



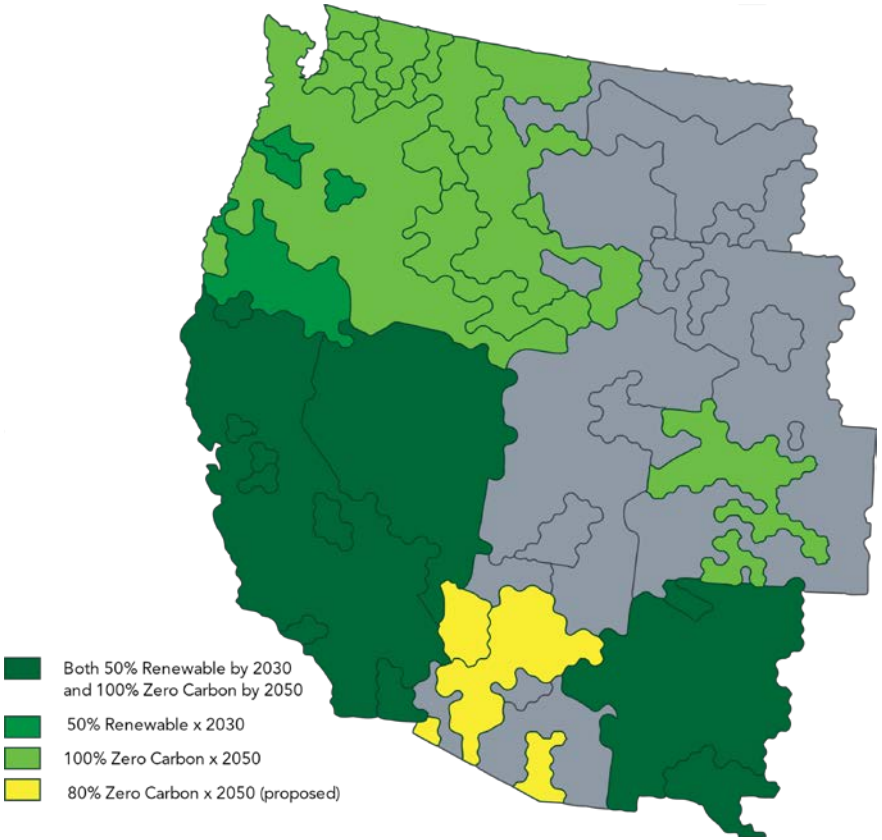
Sources: Energy Strategies, "Western Flexibility Assessment" (2019)

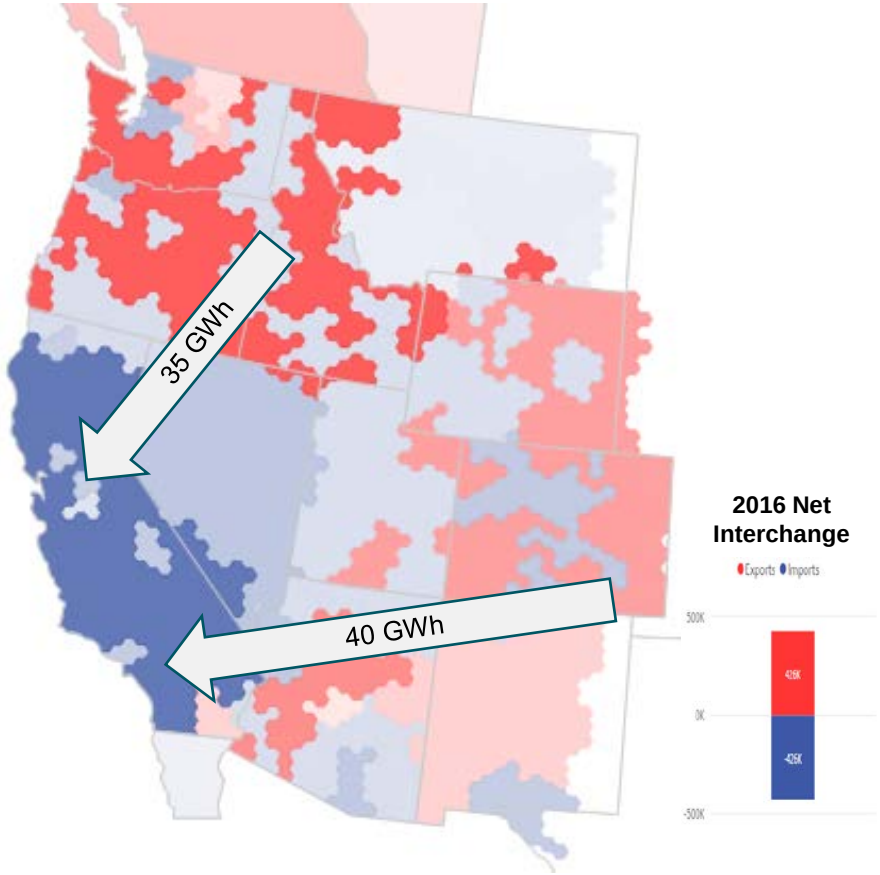
An Organized Western Grid is Needed to Enable the Necessary Wind and Solar without Costly Curtailment



Sources: Energy Strategies, "Western Flexibility Assessment" (2019)

The Current Western Grid Relies Heavily on Coal Imports from Mountain States to California





2050 Need for new Wind & Solar: ~140 GW
Current installed Wind & Solar: ~35 GW

WECC (2018)