

Experiencias en el Proceso de Transformación del Mercado de California

EnDimensions Background

- EnDimensions LLC is a Silicon Valley based Company, Providing Energy Settlements and Market Operation Platforms for Energy Market Operators and Energy Utilities Worldwide.
- Our EnSuite[®] Financials Package leads the industry in performance, scalability and reliability.
- EnDimensions LLC provides implementation services including Market Design, Data Modeling, Integration, and Business Process Design
- Our clients include Large Investor Owned Utilities (IOUs), ISO/RTO Operators, Generation Owners and Transmission Owners
- Our focus is to provide visionary expertise and advanced software tools that enable the transformation of energy markets and market operations worldwide to support

EnDimensions Executive Team



Dr. Jeffrey W. Chapman, CEO

Ph.D. Electrical Engineering, Massachusetts Institute of Technology
Expertise in Central Energy Market Design, Renewable Energy Policy & Design,
Strategic Development & Planning



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BS Mechanical Engineering, California Polytechnic University, San Luis Obispo
MBA San Francisco State University
Expertise in Marketing, Business Process and Business Management,
Project Finance and Contract Negotiation

EnDimensions Executive Team



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M.S. Electrical Engineering, McGill University, Montreal
Settlement System Design and Implementation,
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M.S. Power Systems, Minor in Economics, Iowa State University, Ames, IA
Power Market Structures, Data Modeling and Integration, Demand Response,
Market Design Market Settlements Systems and Architectures

Roadmap of a Transformation

- The Energy Imbalance Market: A Transformation of the California ISO (CAISO) Market System
 - What were the drivers
 - What were the challenges
 - What was the response
 - What were the results
 - What challenges remain

The Winding Road to Sustainability...

- How to respond to the challenges of the 21st century?
- How to create a market foundation for change and Innovation?
- How to do so in a democratic context with many stakeholders and competing interests?
- The path twists and turns, but the direction is toward continued progress



Drivers of Change

- 1, 2 and 3 – Global Warming and California State Policy
 - Created urgency to get renewable technologies out of the lab and into operation
 - Pushed system operators out of their comfort zone and forced a rethinking of both market and system design
 - Created a need for markets that foster innovation
- 4 – Technology
 - New production, grid control, and power electronic technologies enable more robust and efficient utilization of the grid
 - New market optimization and computing technologies enable more effective market designs
- 5 – Opportunity
 - Leveraging over 15 years of lessons learned to expand our horizons

The Challenges



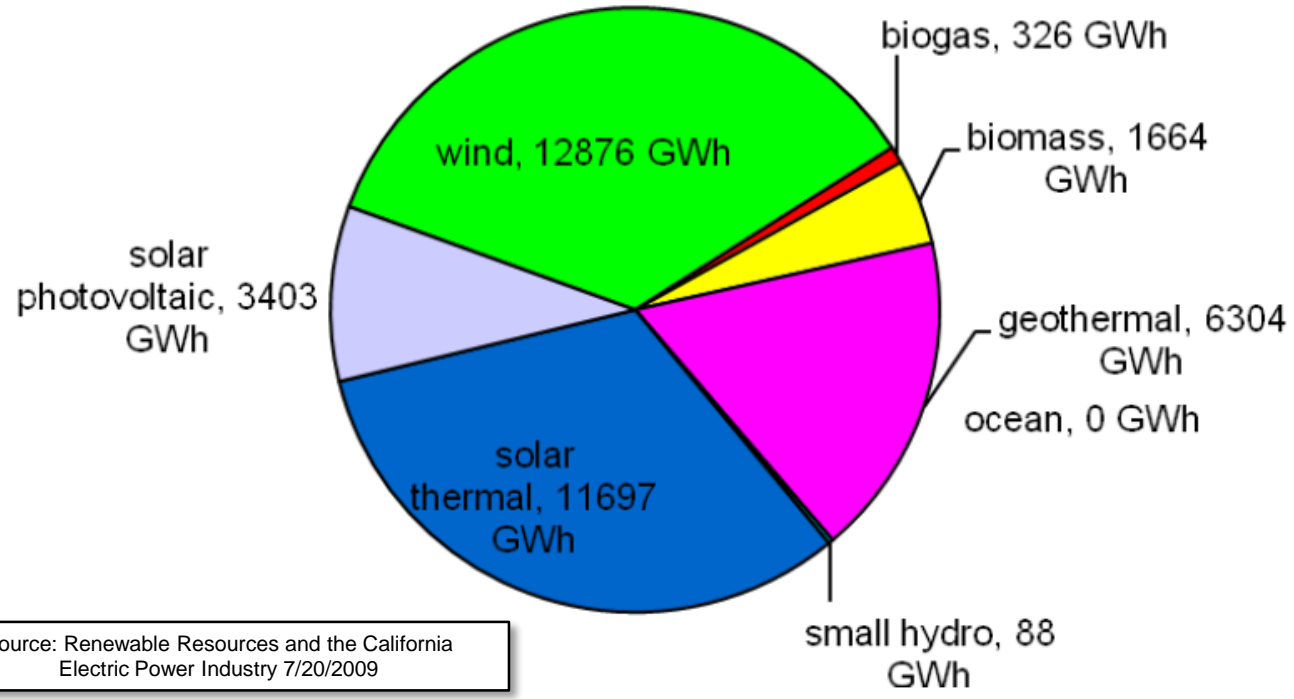
Recapping the Problem

- Warp back to 2007 – just over 10% of California energy was renewable.
- RFP deadlines, first proposed in 2002, begin to loom ahead.
- Several high-profile transmission projects approach completion
- In the end, wind doubles but solar explodes, from 402.6 MW in 2007 to 13,548 MW in 2018
- No one knows In whether the system will hold together
- Now what?

“Plans are Useless, but Planning is Everything”

-- Dwight D. Eisenhower

Total Expected Renewable Deliveries from Contracts Signed Since 2002, by Technology (minimum GWh)



Source: Renewable Resources and the California Electric Power Industry 7/20/2009

Problematic Production

Today's Outlook

Demand

Supply

Emissions

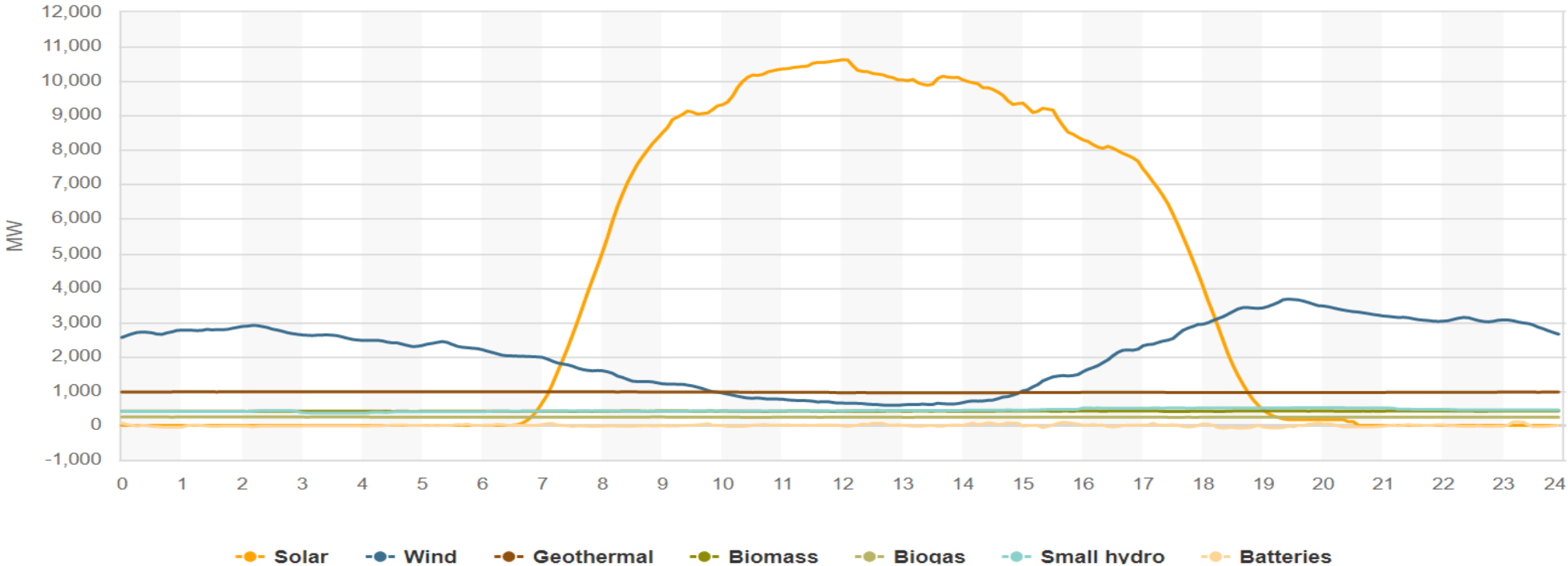
Prices

AS OF 18:15 09/04/2019

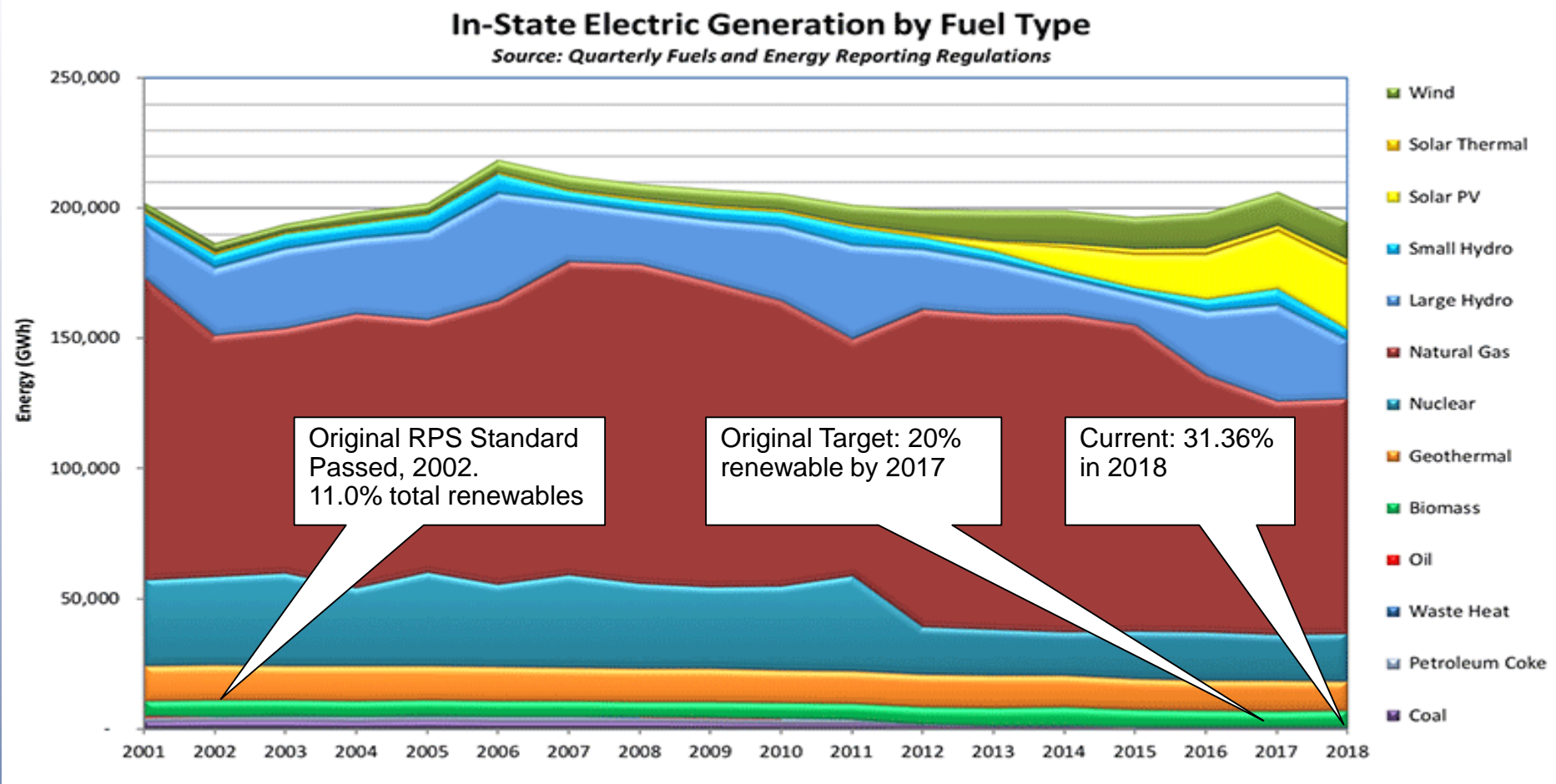
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Renewables trend

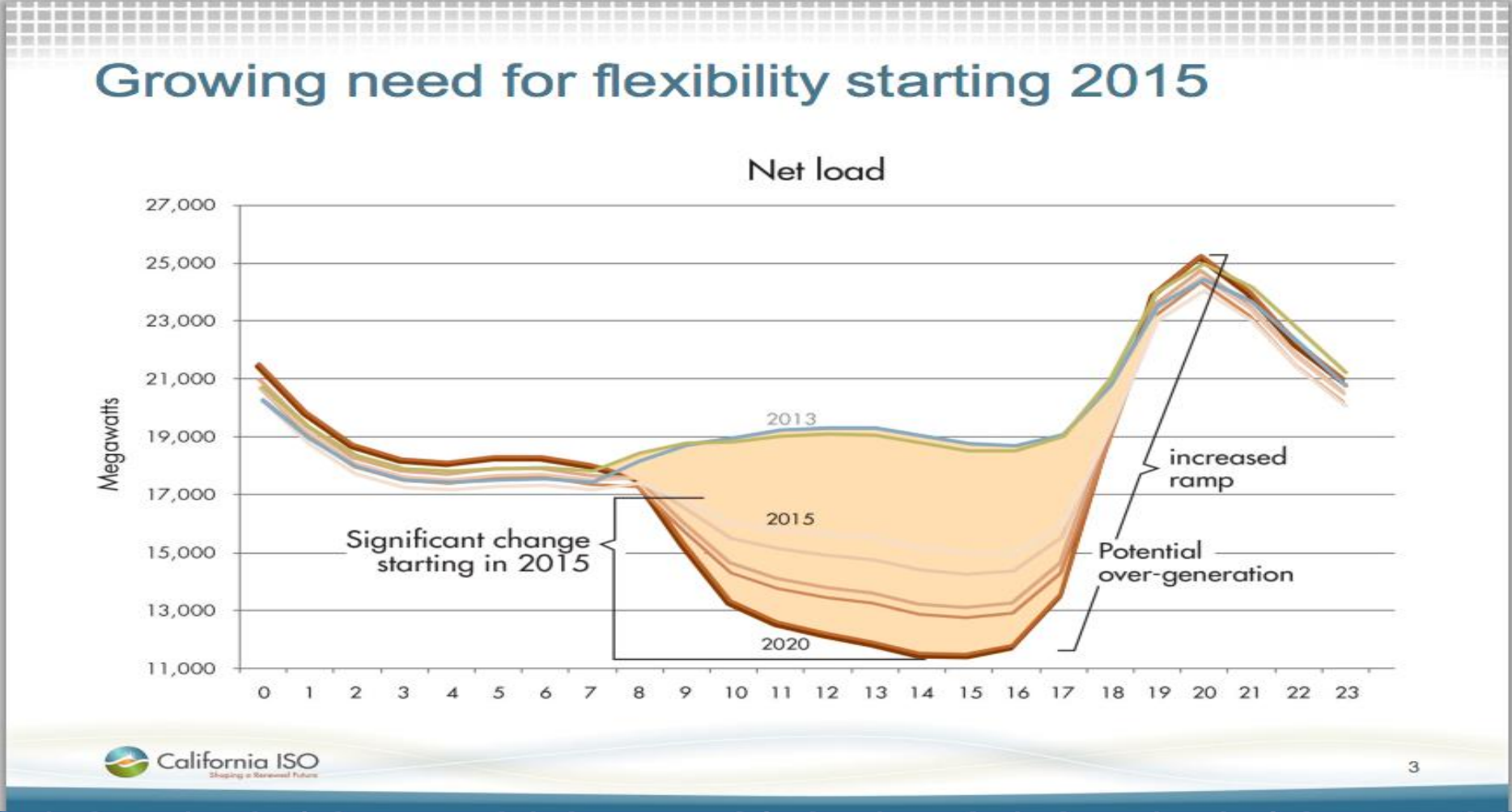
Data



Growth of Renewable Energy in California



The Duck We Didn't See Coming



What Were (Are) the Challenges?

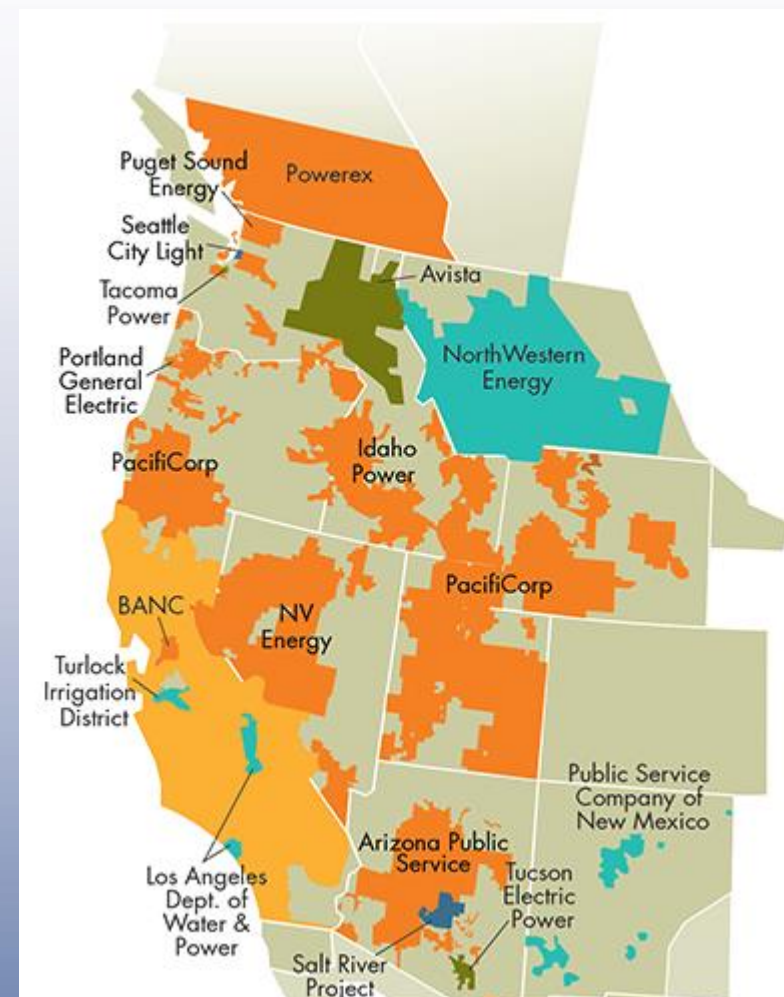
- Renewable energy is where you find it. Getting it to where you need it is hard.
 - Regulatory and operational difficulties transmitting energy across boundaries
 - New transmission is expensive and difficult to build
 - Infeasible to build new combined cycle generation
- Matching production and load is increasingly difficult
 - Remember the duck!
- More variation of energy vs. load, fewer conventional resources to manage it.
 - Need to make best use of every resource
 - Jurisdictional and regional barriers to market expansion create difficulties in moving and controlling renewable energy
- Existing modes of system operation and market design would not support the required increase in renewable energy

Grappling with Solutions



Taking a Wider View

- California ISO: The only fully-developed energy market in the Western United States
- CAISO was surrounded by areas that were linked via transmission but had minimal market structure
- The best option for continued renewable growth: Find a way to leverage the vast potential of the Western Interconnect in a new market structure



The Western Interconnection



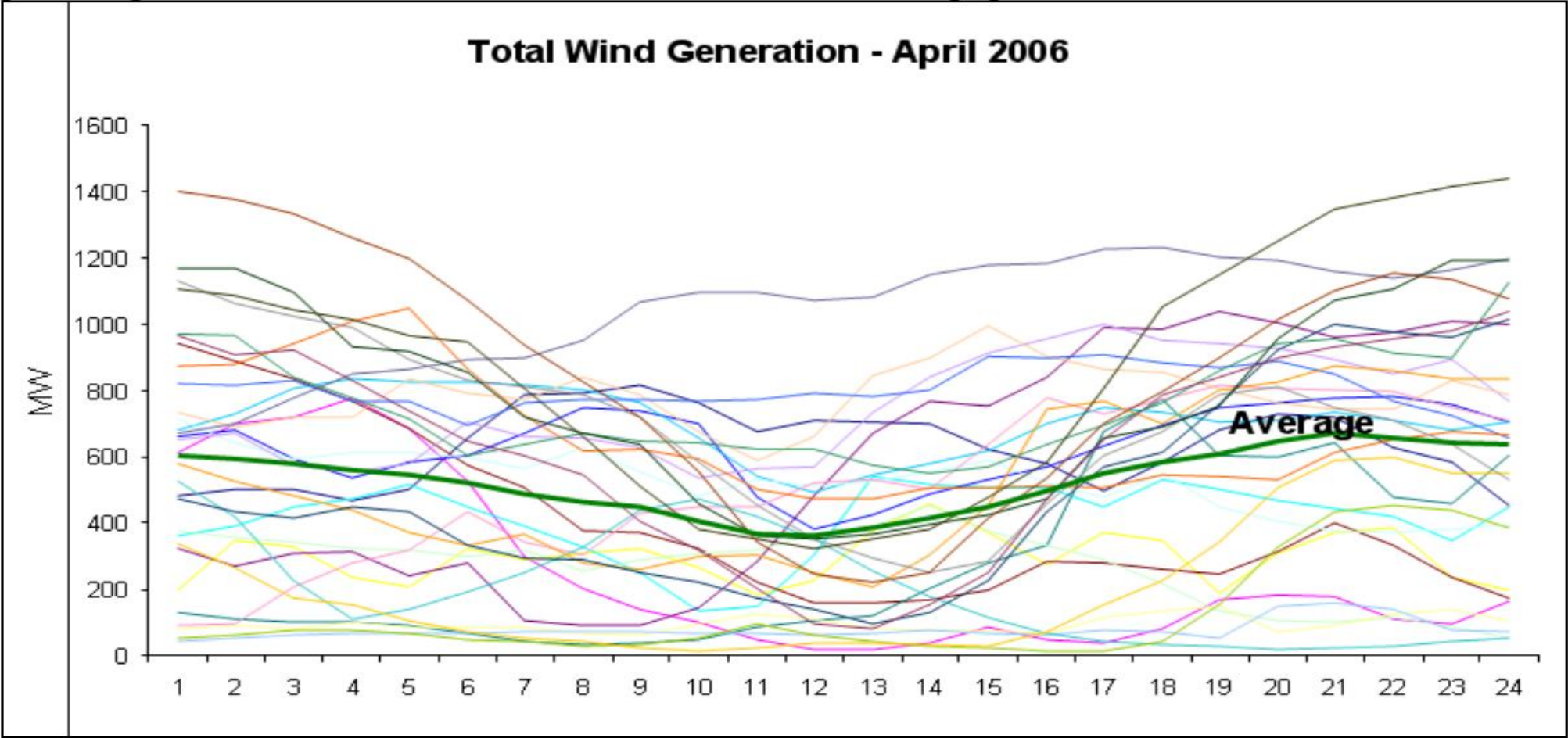
EIM Vision

- CAISO 2015 Peak Load: 50,116 MW
- WECC Peak Load: 151,000 MW
- Expand the geographic extent of the market to encompass most of the Western Interconnect.
- Expand access to flexible resources across the West
- Break down barriers to transmitting renewable energy and accessing flexible energy resources
- Preserve local autonomy in the areas that join the market
- Re-tool market structures to accommodate new modes of operation

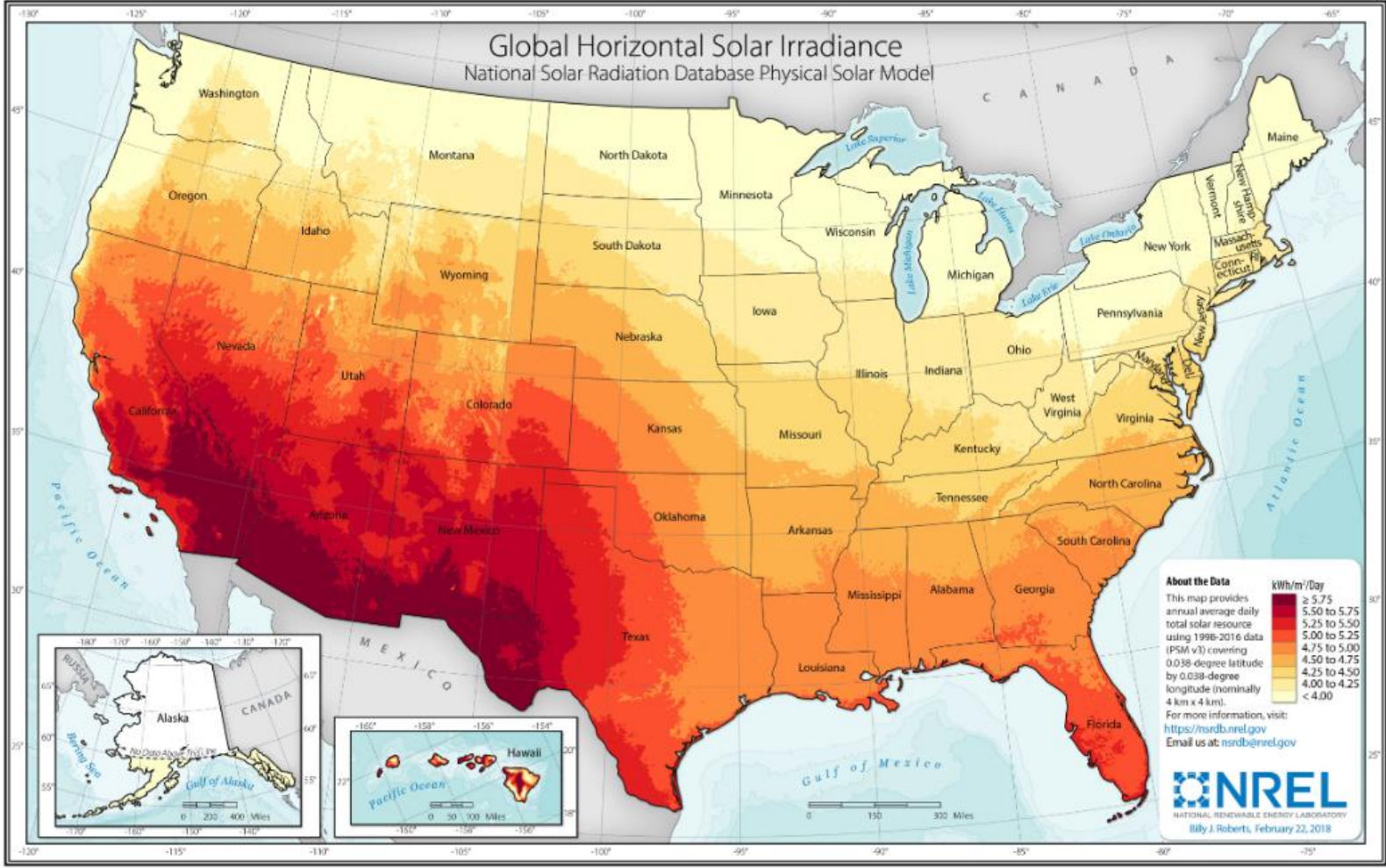
Addressing Supply Variability

- Problem: Deviations in renewable output can be additive across smaller geographic areas – this strains system resources
 - When there is a lack of diversity in supply, variation of renewable output is a much bigger problem
 - Solution: Expanding the geographical area over which resources are available also reduces the net average deviations, reducing the need for load following capacity to smooth out deviations

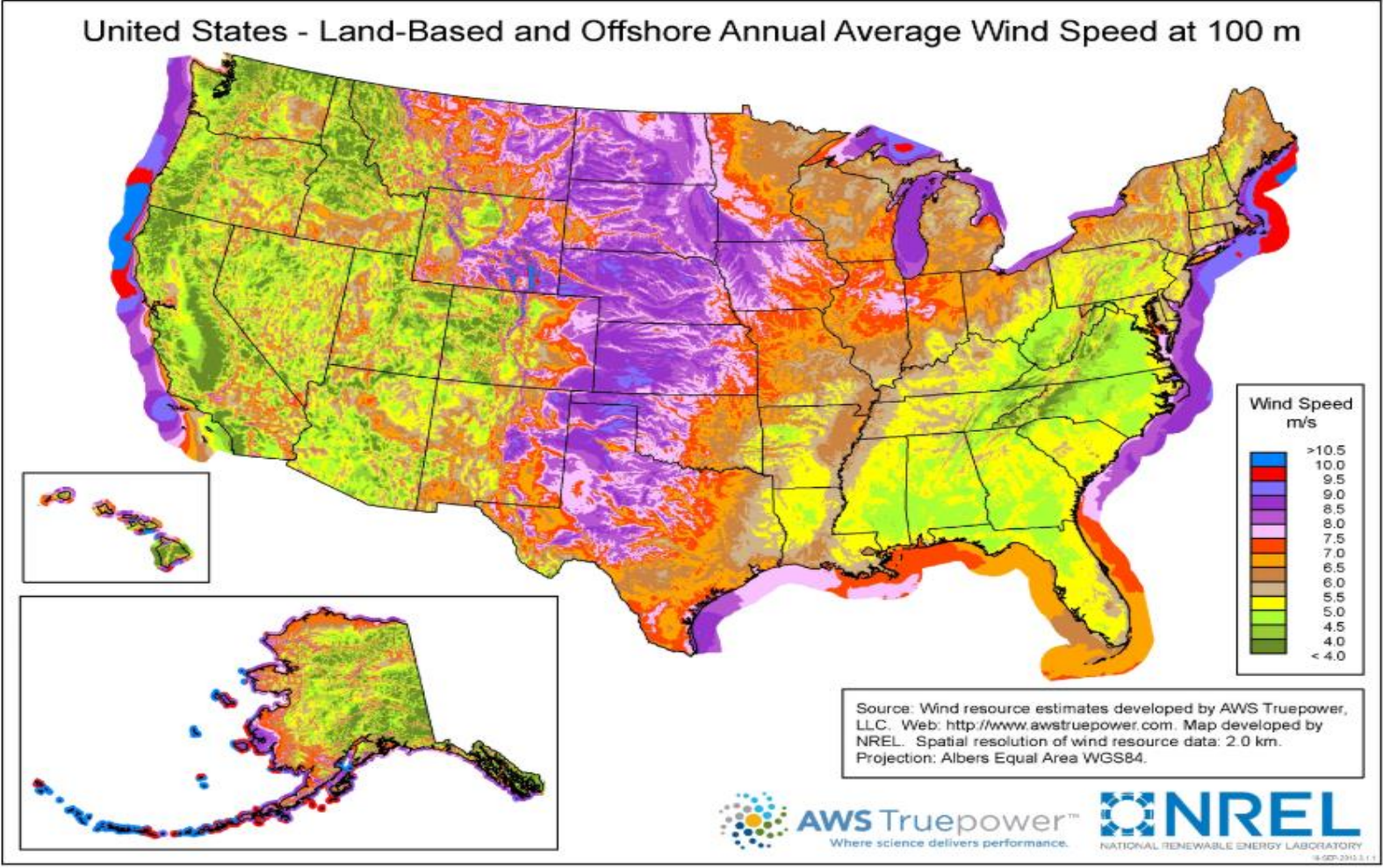
Variability when Sources are Few



Distribution of Solar Potential



Distribution of Wind Potential



Gaining Efficiencies

- Problem: Resources that do not have access to a wider market are under-utilized and inefficient
 - When energy cannot move, resources are not optimally utilized, causing inefficiencies and reducing revenues for resource owners
 - Solution: With a regional market, diverse resources have access to expanded markets, and the entire fleet benefits
- Problem: Renewable Energy won't fit into hourly blocks
 - High costs related to “smoothing” renewable energy for scheduling and dispatching in hourly blocks – purchasers and sellers of renewable energy have large exposure to the volatile spot market.
 - Solution: Reduce transmission scheduling between areas to 15-minute blocks
 - Layer on a regional 5-minute market across the area

Localizing Costs and Preventing Abuse

- Problem: Complex markets and regional differences in regulatory and operational procedures create the potential for cost shifting, market abuse and price distortions
 - Solution: Robust market monitoring, correct allocation of costs, and innovative market designs mitigate these issues.
 - New Charges and Credits to encourage accurate scheduling and market participation
 - Localize costs of congestion, regional reliability and CAISO-specific market costs
 - Expanded transmission and resource modeling

Respecting Local Autonomy

- Each area may have different resource and transmission scheduling practices
 - Incremental market design only covers spot and hourly energy, does not require a complete operational re-tooling.
 - Participation is voluntary and market costs are allocated pro-rata based on actual market volume
- Each area must have final control of its resources
 - Transparency and involvement of stakeholders is key
 - Regional governor's board composed of representatives from EIM Entities; Participating Transmission Owners; Publicly Owned Utilities; Suppliers and Marketers of Generation and Energy Service Providers; The Body of State Regulators.

The Results

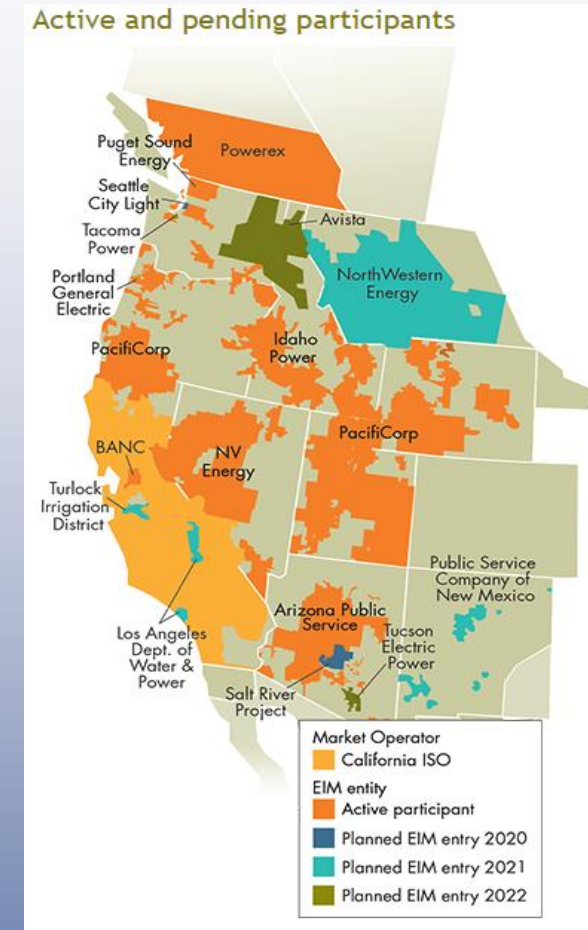


Launch of the First EIM Participant

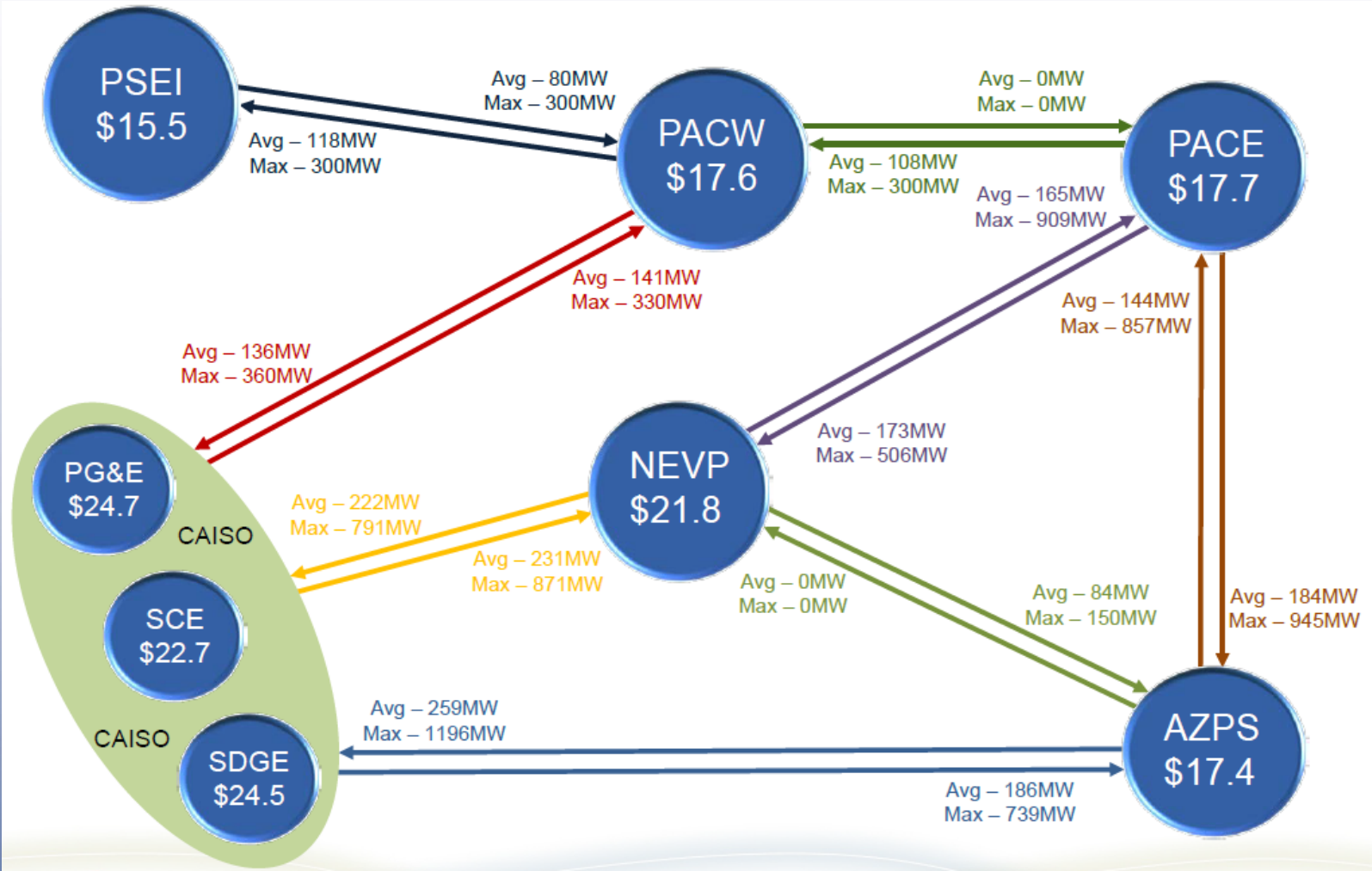
- PacifiCorp and CAISO turned on the switch to the first EIM market in late 2014 -- the entire western United States was watching
- First year of operation netted \$12.6 Million USD for CAISO and \$26.23 Million USD for PacifiCorp
- And there were problems, but nothing blew up!
- The benefits were too large to ignore, and other areas entered into participation agreements.

EIM Market Growth Since 2014

- Currently there are nine active participants, and nine more in the pipeline
- All have signed up voluntarily
- New participants are activated as they can be accommodated



2017 Market Activity



Aggregate Benefit over 4.5 Years

WESTERN EIM BENEFITS REPORT

SECOND QUARTER 2019

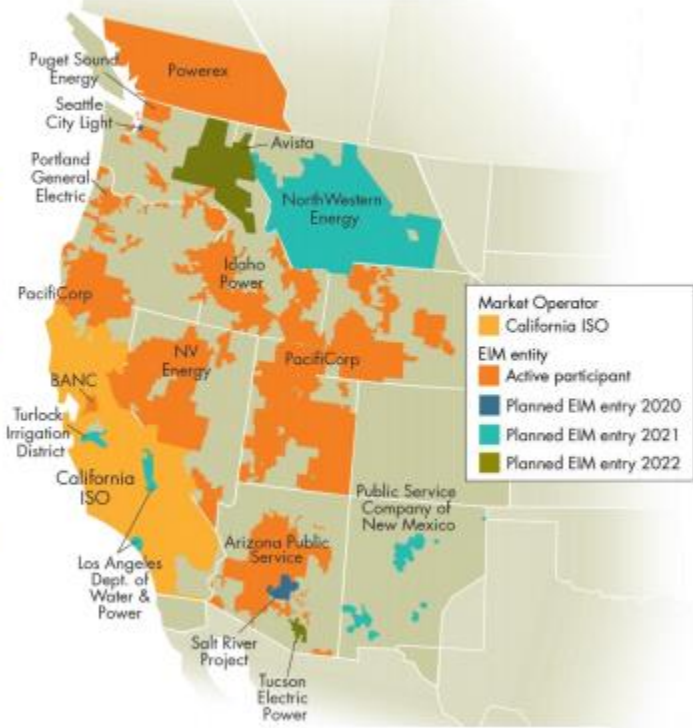
EXECUTIVE SUMMARY

Gross benefits from EIM since November 2014

\$736.26 million

This report presents the benefits associated with participation in the Western Energy Imbalance Market (EIM) for the second quarter of 2019. The benefits include cost savings and the use of surplus renewable energy.

The Western EIM is helping to displace less-clean energy supplies with surplus renewable energy that otherwise may have been curtailed.



2,535B COP

The Breakdown

Benefits

\$736.26 million in gross benefits since Nov 2014 (as of 07/31/2019)

(millions \$)

EIM PARTICIPANTS	2014	2015	2016	2017	2018	2019		TOTAL
						Q1	Q2	
Arizona Public Service Entered 10/2016			\$5.98	\$34.56	\$45.30	\$8.20	\$8.55	\$102.59
BANC Entered 04/2016							\$8.81	\$8.81
California ISO Entered 11/2014	\$1.24	\$12.66	\$28.34	\$36.96	\$67.94	\$13.08	\$23.53	\$183.75
Idaho Power Company Entered 04/2018					\$26.88	\$8.45	\$8.33	\$43.66
NV Energy Entered 12/2015		\$0.84	\$15.57	\$24.20	\$25.55	\$5.71	\$4.62	\$76.49
PacifiCorp Entered 11/2014	\$4.73	\$26.23	\$45.47	\$37.41	\$61.68	\$23.76	\$15.15	\$214.43
Portland General Electric Entered 10/2017				\$2.83	\$27.57	\$11.74	\$10.89	\$53.03
Powerex Entered 04/2018					\$7.84	\$7.23	\$3.06	\$18.13
Puget Sound Energy Entered 10/2016			\$1.56	\$9.86	\$13.68	\$7.21	\$3.06	\$35.37
TOTAL	\$5.97	\$39.73	\$96.92	\$145.82	\$276.44	\$85.38	\$86.00	\$736.26

To Summarize...

- The Major Areas That Were Addressed:
 - Political and Jurisdictional Issues
 - Technical and System Operations Issues
 - Market and Settlements Design
 - Cost Allocation and Cost Localization Issues
 - Planning and implementation
- It was a complex, multi-faceted and long-term effort, but the results speak for themselves
- And now, on to the next challenge

Thank You!

