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After 2020: prospects for + Higher RPS Levels in California

Northwest Power and Conservation Council
California Power Markets Symposium
September 5, 2013

Arne Olson, Partner, E3

California Policymakers are Starting to Look Beyond 2020

+ **CPUC is interested in evaluating electricity sector GHG reduction options and costs in 2030**

+ **CARB 2013 Update to AB 32 Scoping Plan**
  - Progress on 2020 GHG goals
  - Lay groundwork for a post-2020 plan

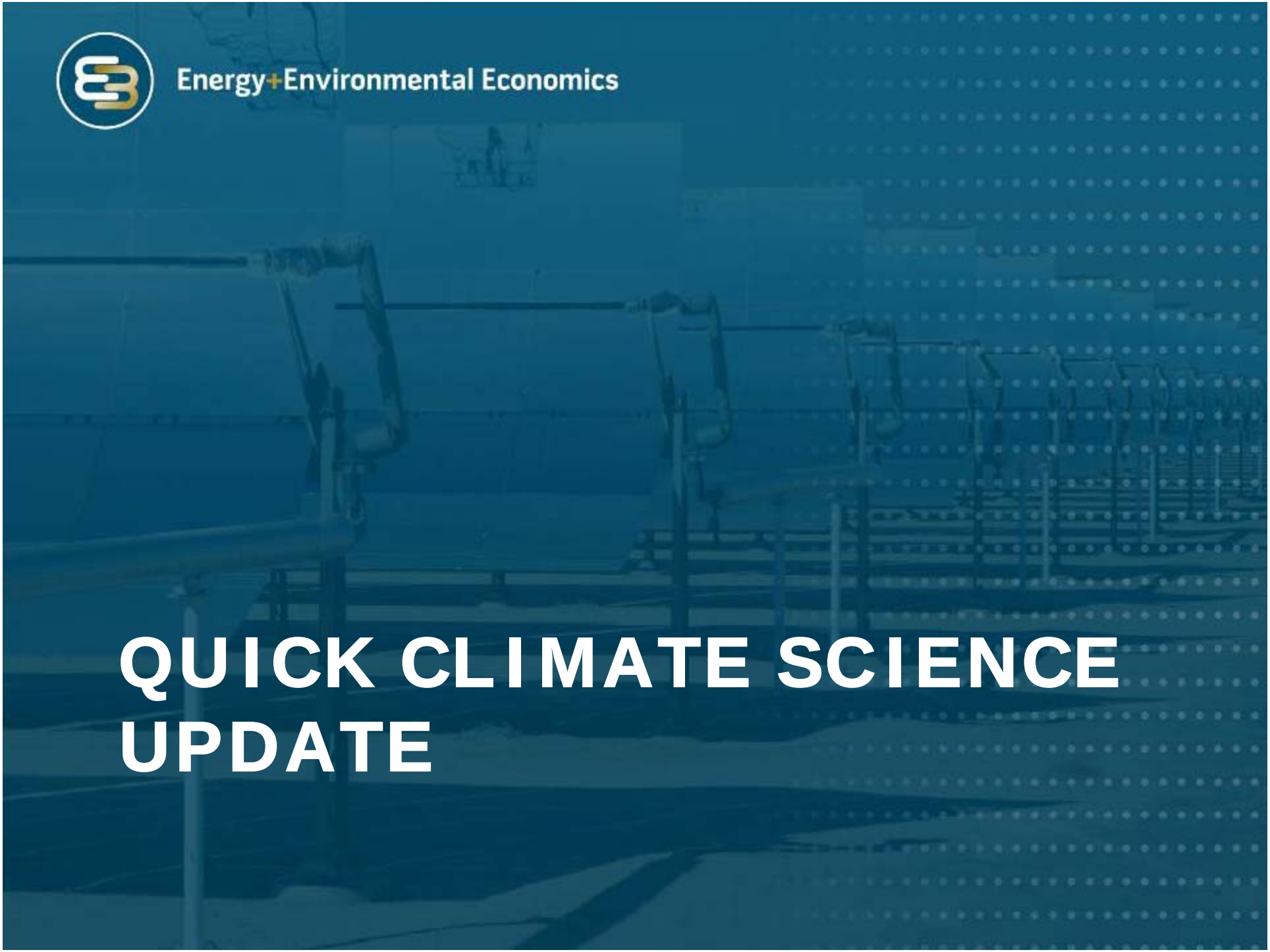
+ **CEC's 2013 Integrated Energy Policy Report (IEPR)**
  - "Evaluation of electricity system needs in 2030" workshop & modeling

+ **California legislators:**
  - Proposed bill for 51% RPS by 2030 did not make it out of committee; additional proposals are likely in next session

Why Renewable Energy?

1. California leadership & market transformation for emerging technologies
2. Fuel diversity, security, and reduction of fossil fuel dependence
3. Jobs & local economic development
4. Public health and local environmental quality
5. Greenhouse gas reductions

Renewables now being assessed as a GHG reduction measure to meet potential 2030 target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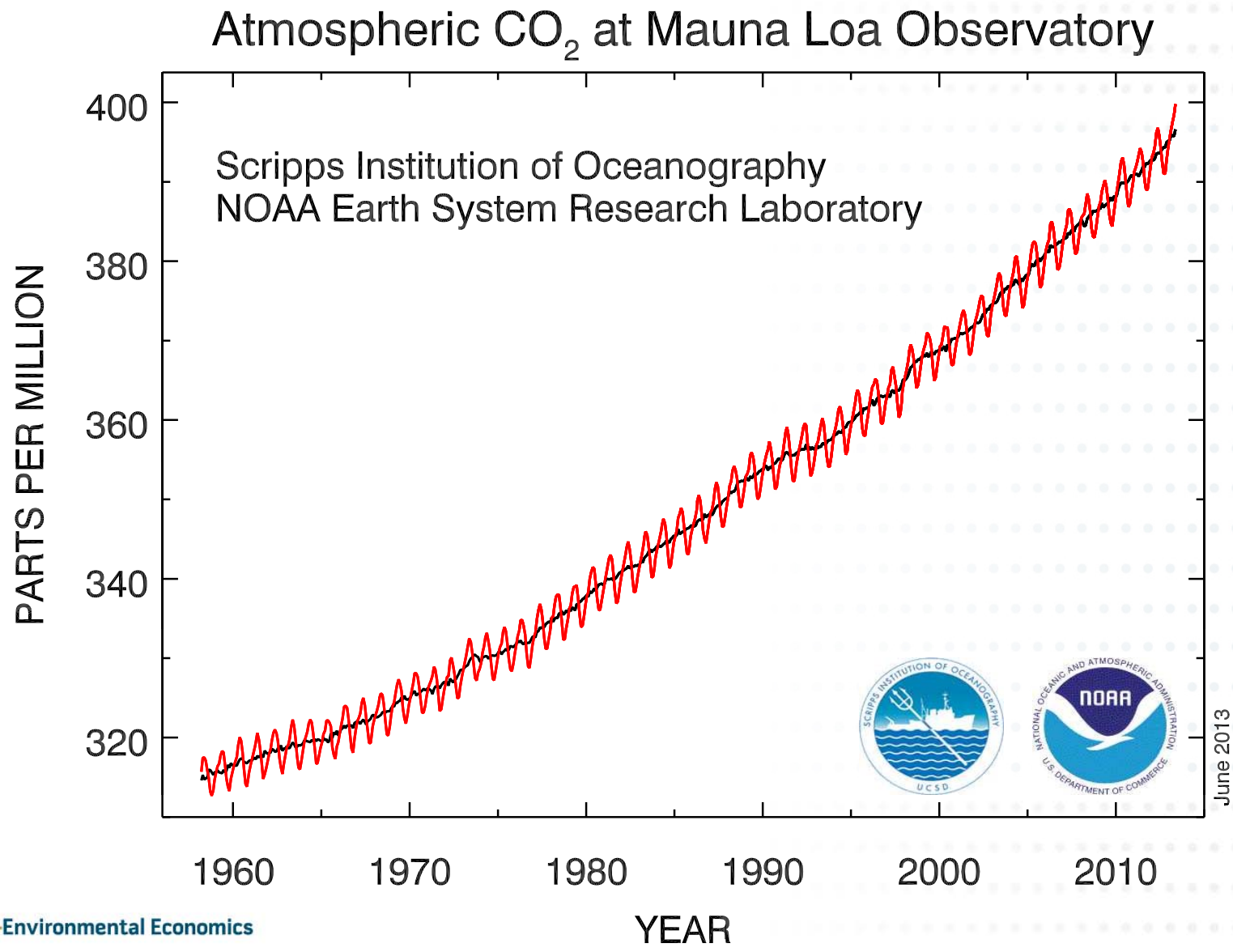
QUICK CLIMATE SCIENCE UPDATE

400 ppm CO_2 Concentration Landmark Reached May 2013



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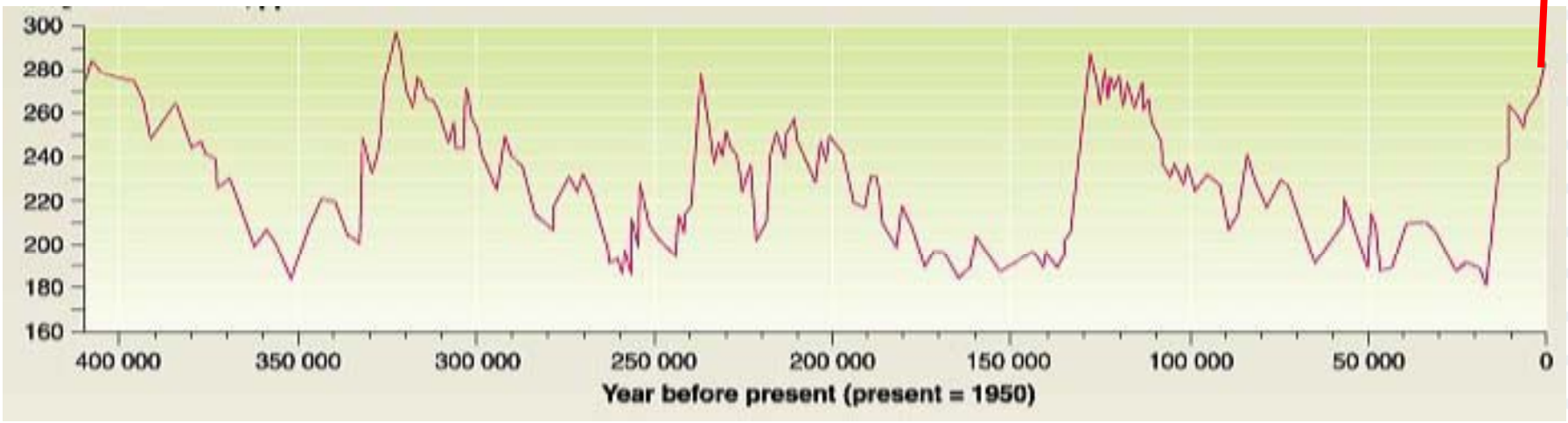
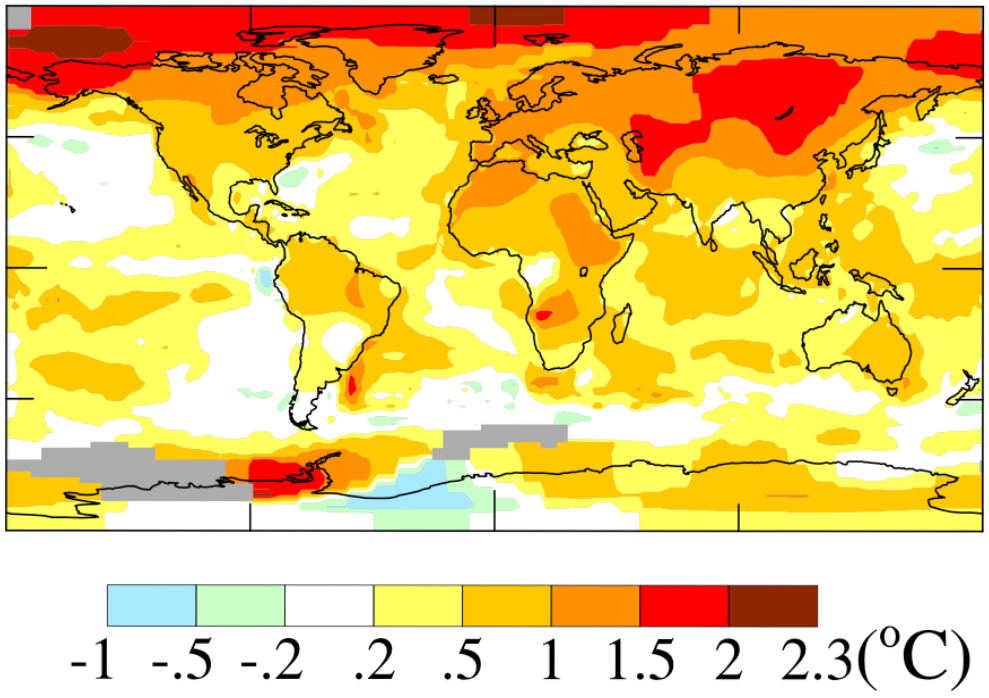
Atmospheric CO_2 Record

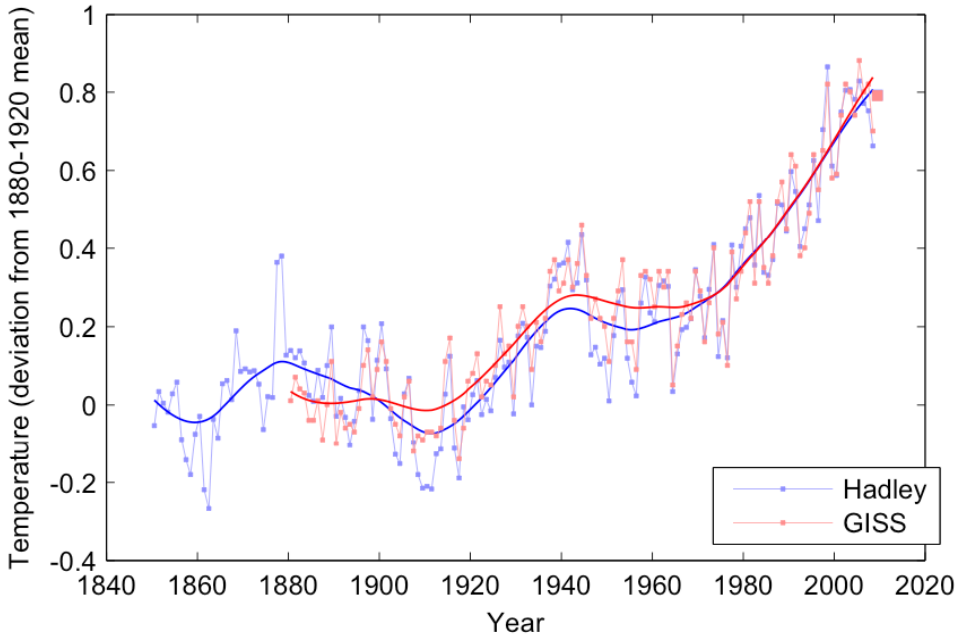
Atmospheric CO_2 record over last 420,000 years from Antarctic ice core data. Current concentration is higher by 100 ppm than at any time in last 420,000 years.



Source: Petit et al, Nature



Average change in surface temperature between 1950s and 2000s



Global average surface temperature change from 1850 to present = 0.8° C

The Copenhagen Diagnosis
Updating the World on the Latest Climate Science

http://www.copenhagendiagnosis.com/

Observed Arctic Sea Ice Loss More Extensive Than Predicted

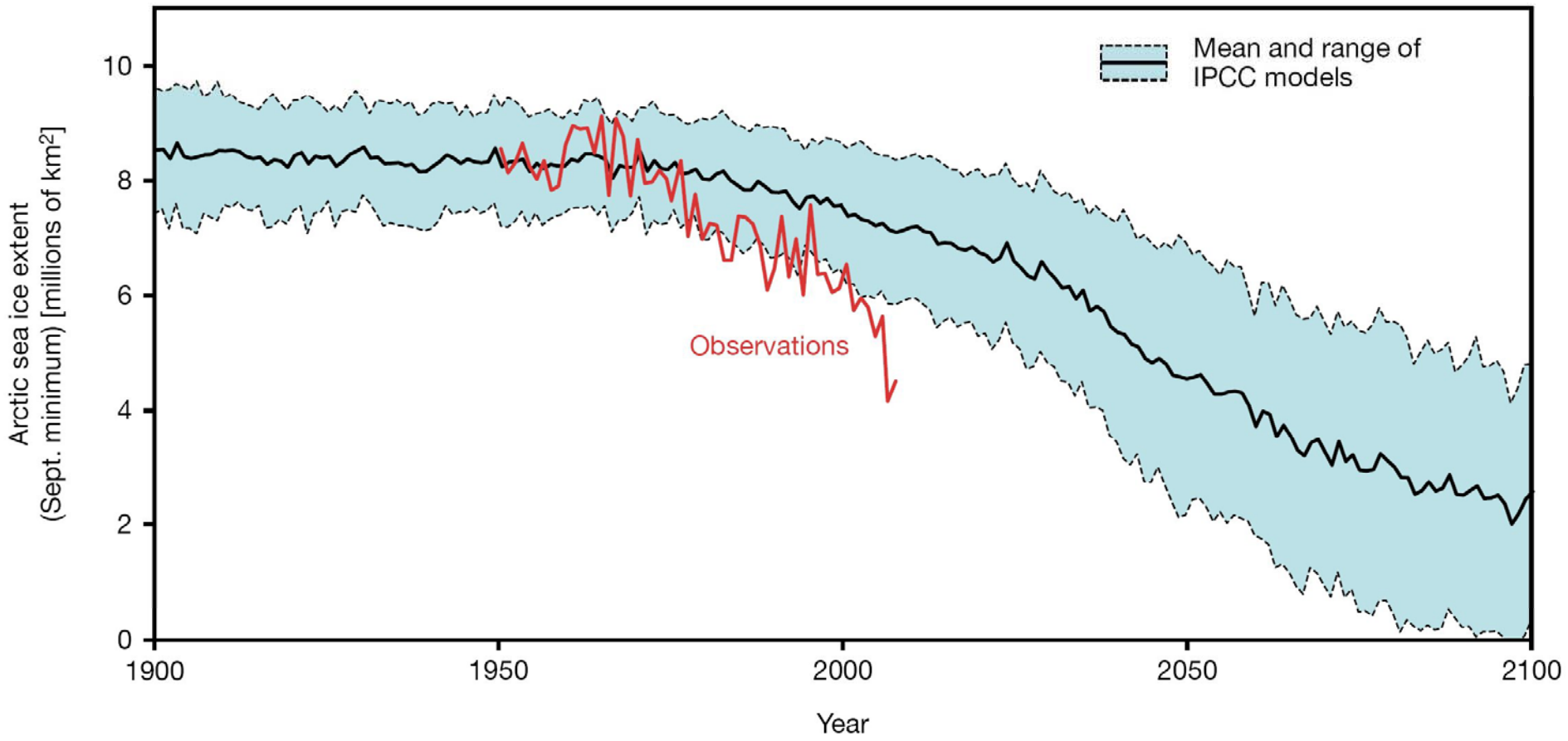
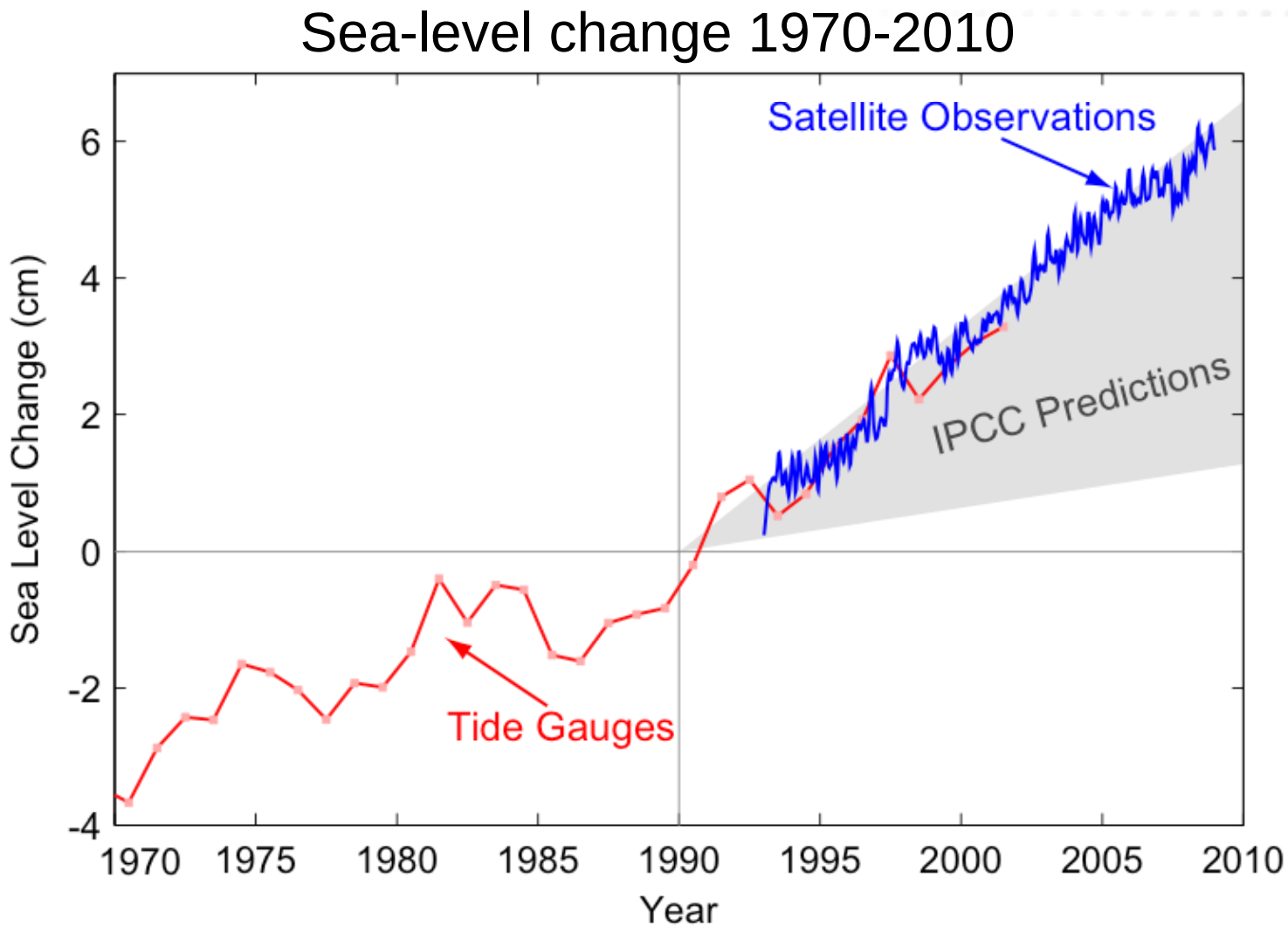


Figure 13: Observed and modeled Arctic sea-ice extent

Observed Sea Level Rise At Upper End of Range of Model Predictions



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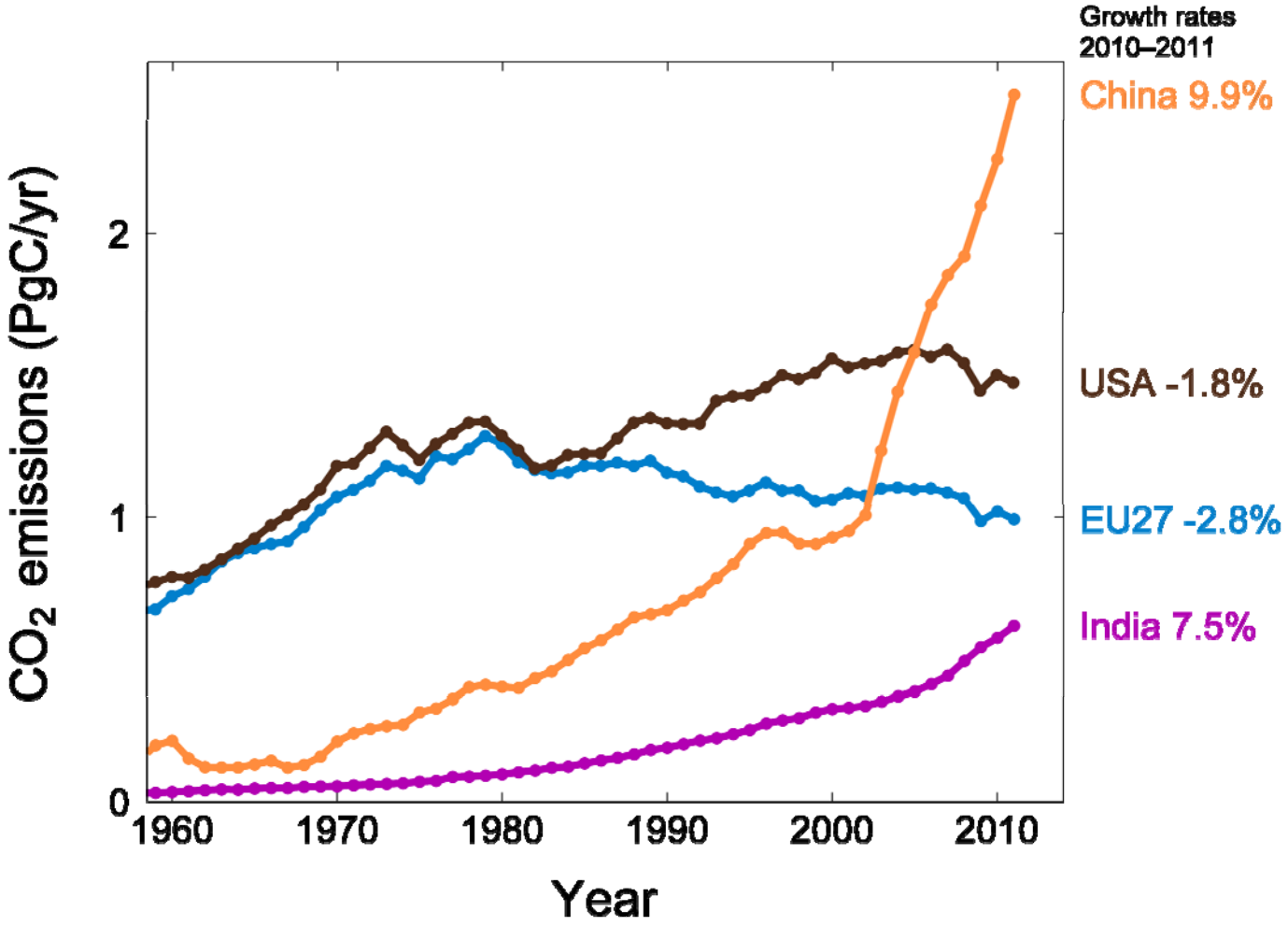
Source: Copenhagen Diagnosis

Top Fossil Fuel Emitters (Absolute)

Top four emitters in 2011 covered 62% of global emissions

China (28%), United States (16%), EU27 (11%), India (7%)



The growing gap between EU27 and USA is due to emission decreases in Germany (45% of the 1990-2011 cumulative difference), UK (19%), Romania (13%), Czech Republic (8%), and Poland (5%)

Source: CDIAC Data; Le Quéré et al. 2012; Global Carbon Project 2012

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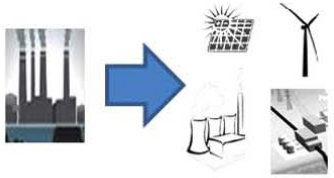
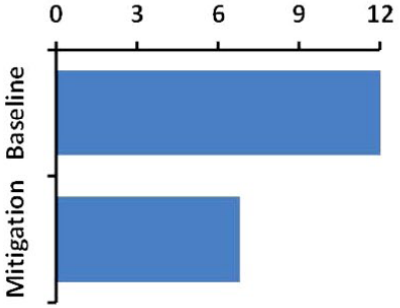
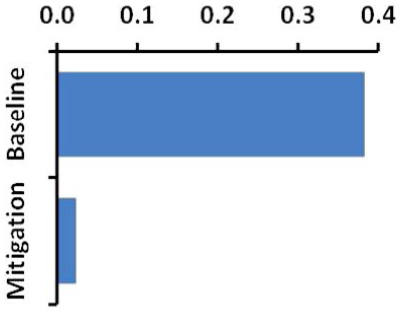
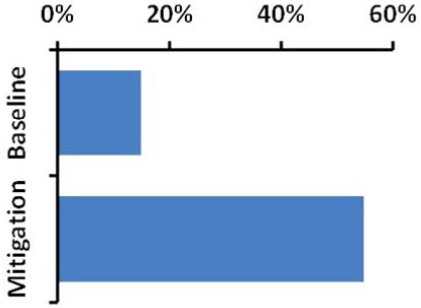
CALIFORNIA CONTEXT: LONG-TERM CLIMATE GOALS

California, Oregon & Washington GHG Legislation

- **California is not alone in seeking to reduce GHG emissions**
- **OR and WA have statutory targets**

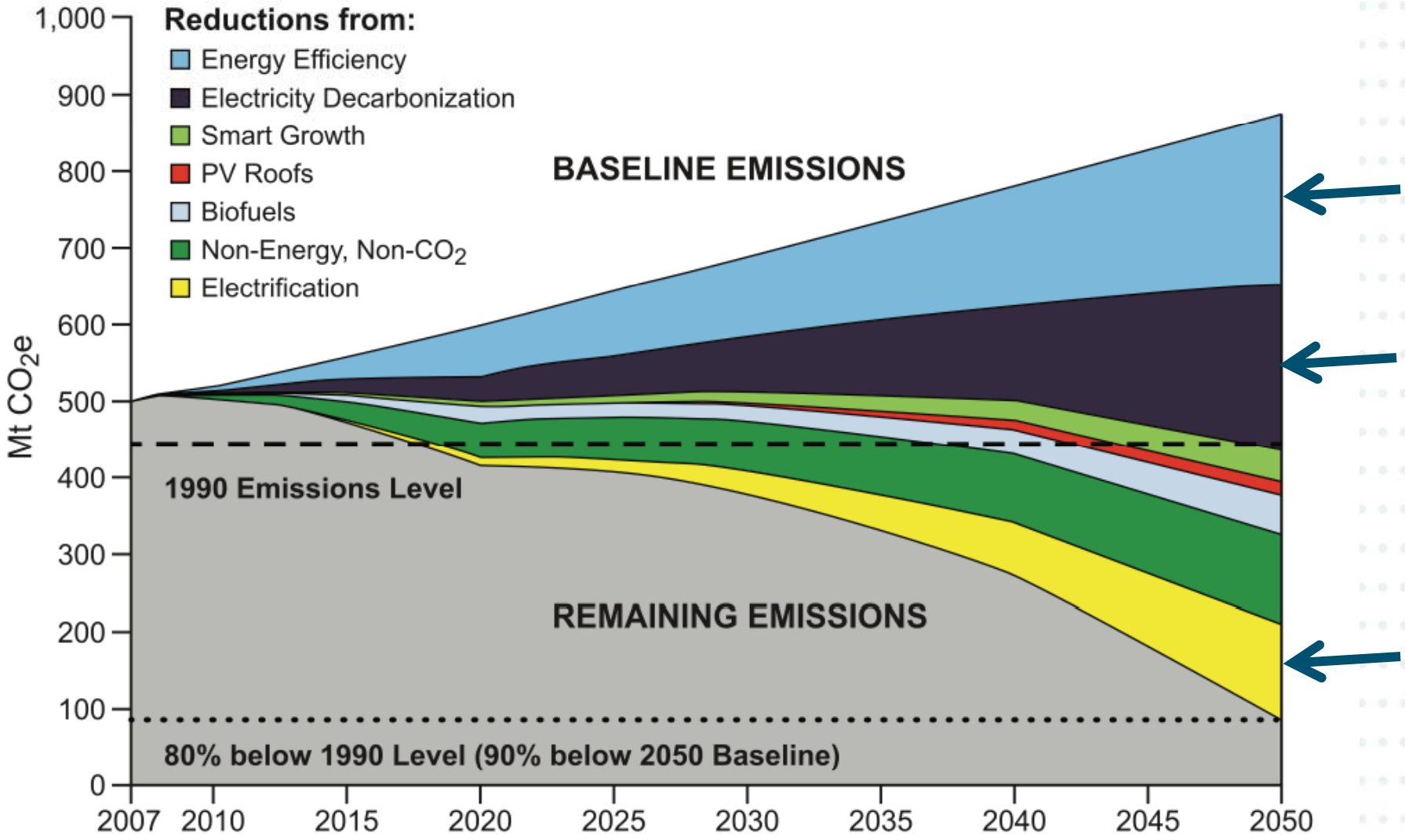
State GHG Targets	2020	2050
California (AB 32)	1990 levels	*80% below 1990 (non-binding executive order)*
Oregon (HB 3543)	10% below 1990	75% below 1990
Washington (SB 6001)	1990 levels	50% below 1990

Three Key Energy System Transformations Needed by 2050

Wedge	ENERGY EFFICIENCY	GENERATION DECARBONIZATION	ELECTRIFICATION
			
Key Metric in 2050	End Use Energy Consumption (Quads)	Electric Generation GHG Intensity (Mt CO2e/GWh)	Electricity Share of Total End Use Energy (%)
			
Constraints	• Max feasible rate of improvement: 1.3% y^{-1} • Fundamental changes in the built environment • Limitations on changes in human behavior	• Grid operability requires some natural gas usage • Large infrastructure investment required • Facility and transmission siting challenges	• Smart charging • Battery technology and cost • Low-carbon source of electricity

Source: "The Technology Path to Deep Greenhouse Gas Emissions Cuts by 2050: The Pivotal Role of Electricity," Williams et al, *Science* (2012)

Low Carbon Path Beyond 2020



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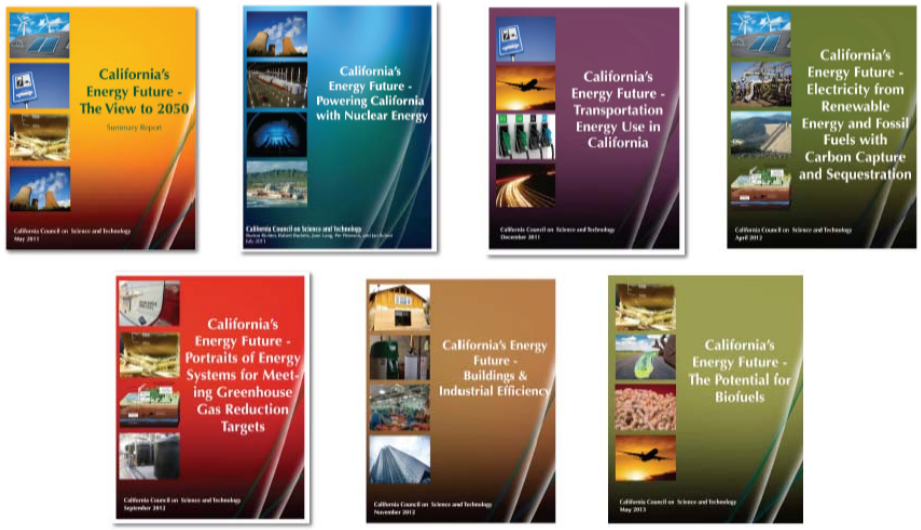
Source: "The Technology Path to Deep Greenhouse Gas Emissions Cuts by 2050: The Pivotal Role of Electricity," Williams et al, *Science* (2012)

Other long-term analyses of GHG reductions reach similar conclusions

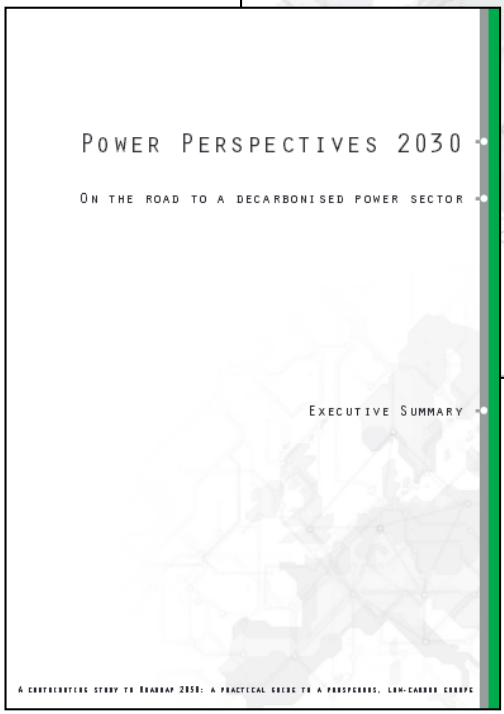
California's Energy Future reports



http://ccst.us/publications/2011/CEF%20index.php

European Roadmap 2050

European Power Sector 2030



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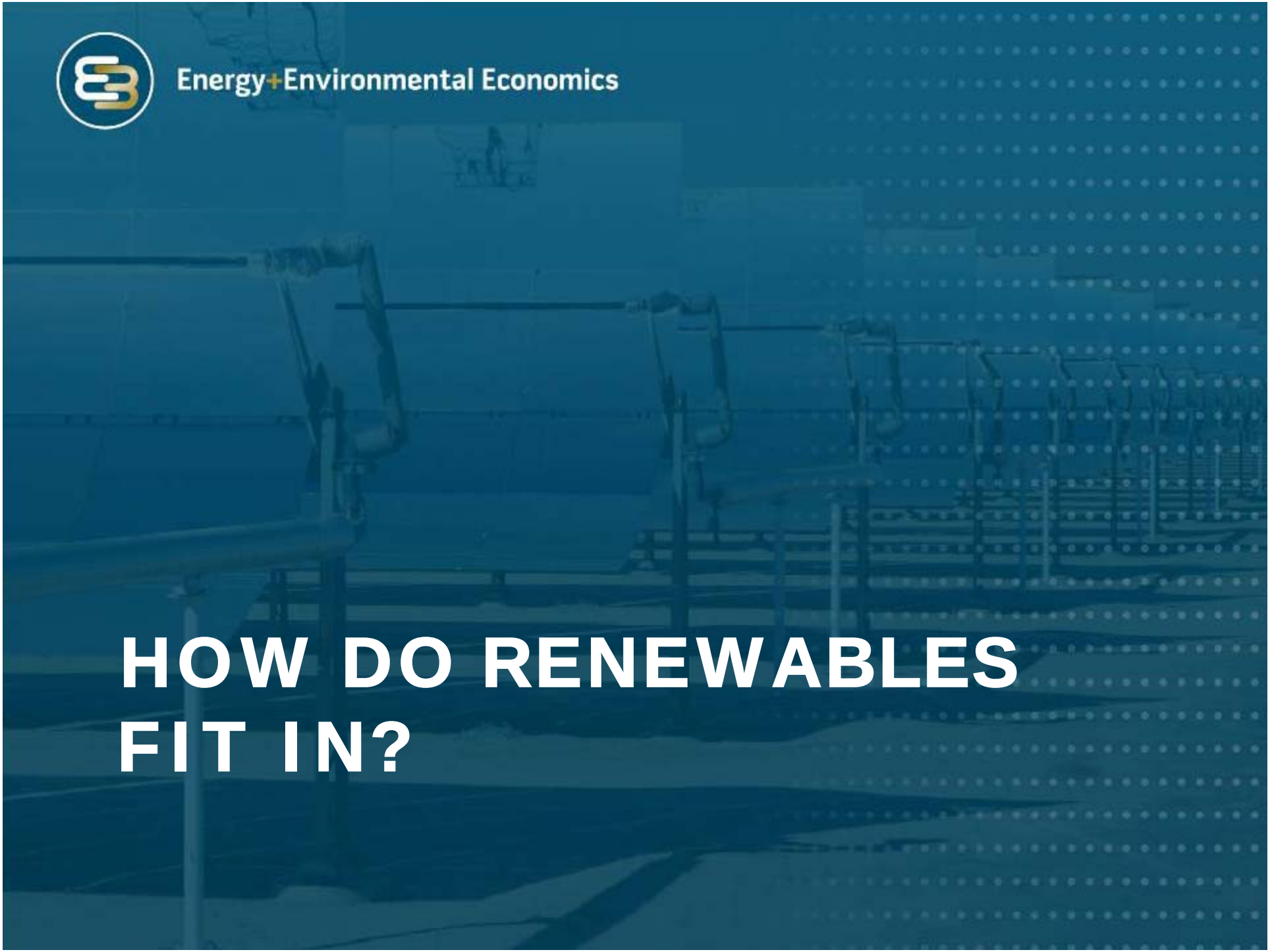
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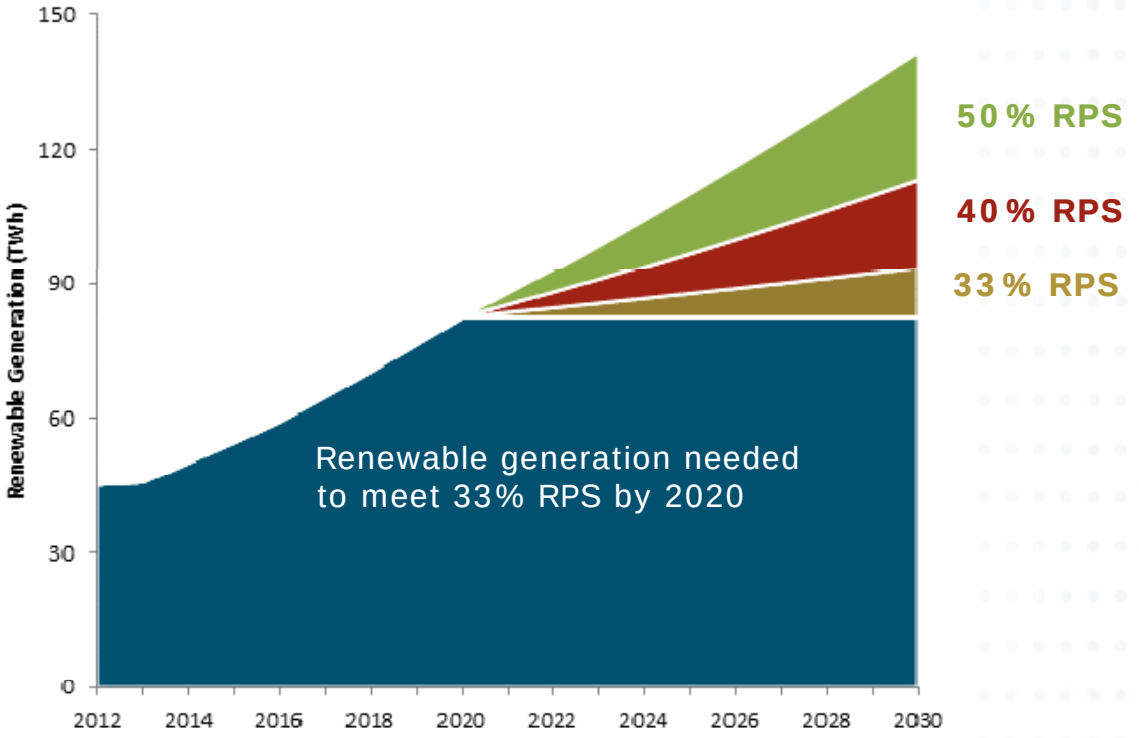
HOW DO RENEWABLES FIT IN?

Few Other Options for Electric Sector Decarbonization

- **State law prohibits construction of new nuclear facilities until the federal government has designated a permanent nuclear waste repository**
  - San Onofre Generating Station has closed permanently
- **Carbon capture and storage (CCS) has not developed as quickly as hoped**
  - No commercial projects in service
  - Proposed projects and are struggling to make it to the finish line due to cost overruns, political opposition, low gas prices

Higher RPS in CA post-2020?

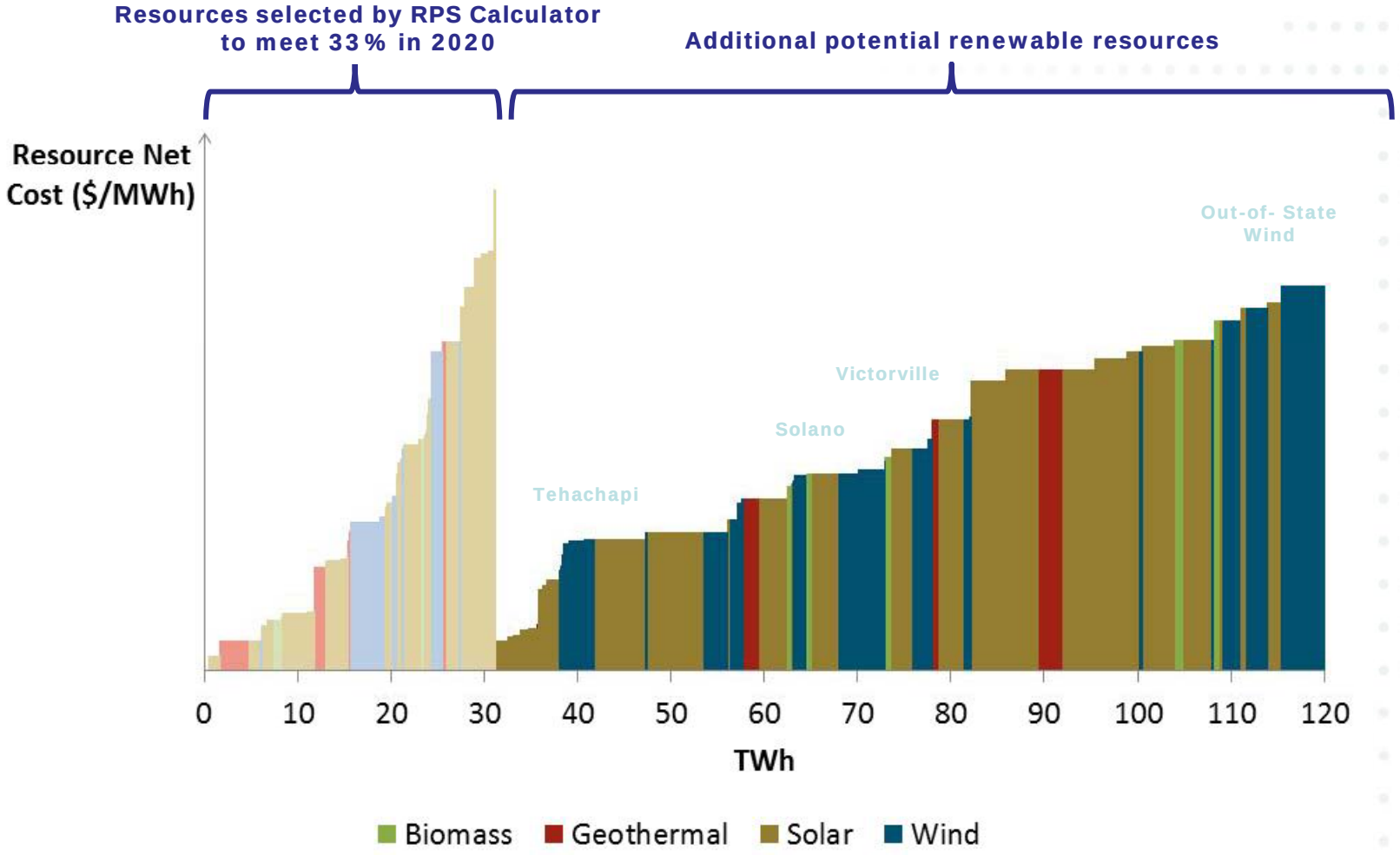
- **50% RPS in California would maintain current market size for renewable resources**



Source: E3 calculation of statewide renewable generation needs under different RPS scenarios

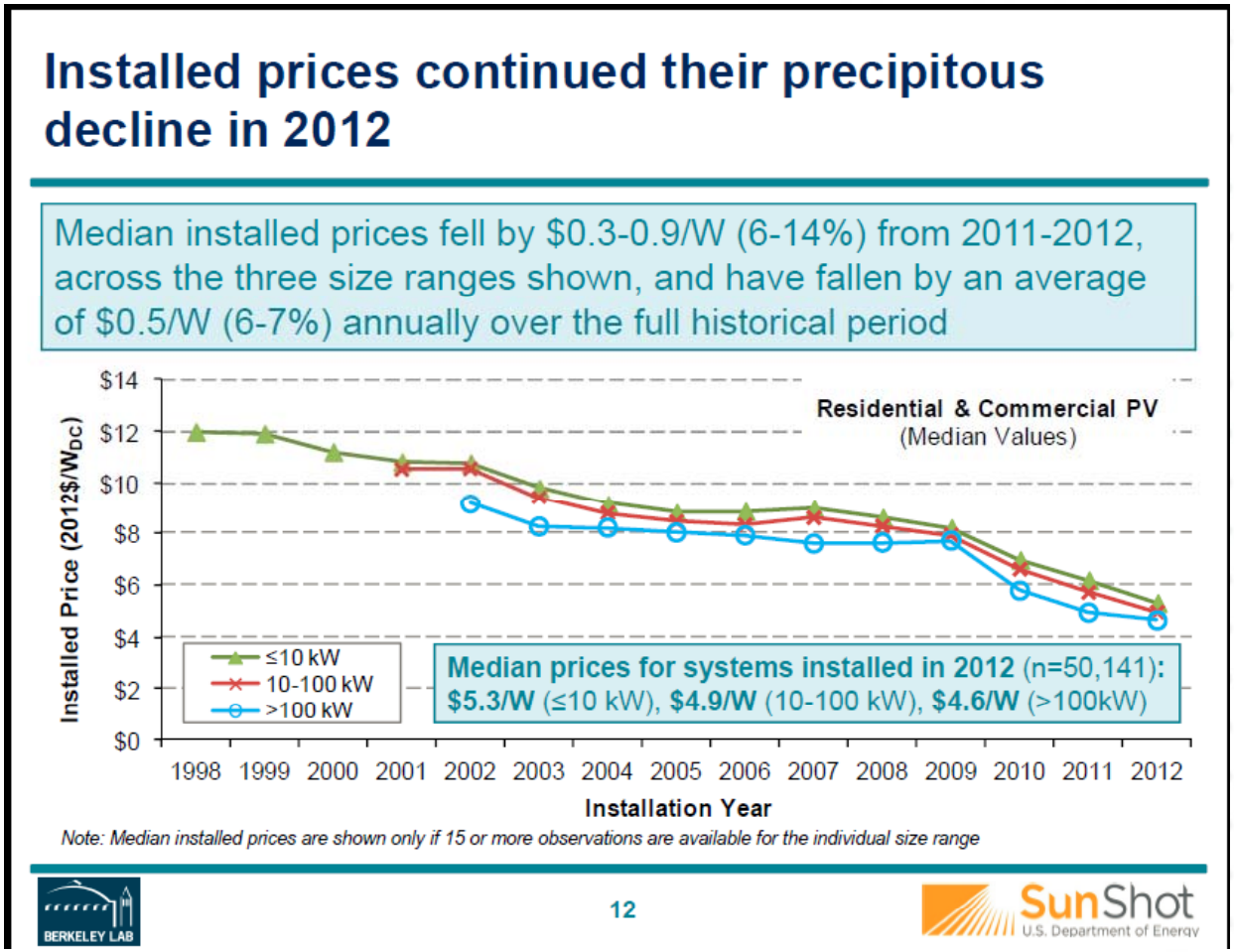
There is Plenty of Supply to Meet a Higher RPS

- Chart shows relative availability and location of renewable resources in WECC available to meet a CA RPS target above 33%. Relative cost rankings are based on historical gas prices, CO2 prices, energy, capacity values, etc. which will change over time.



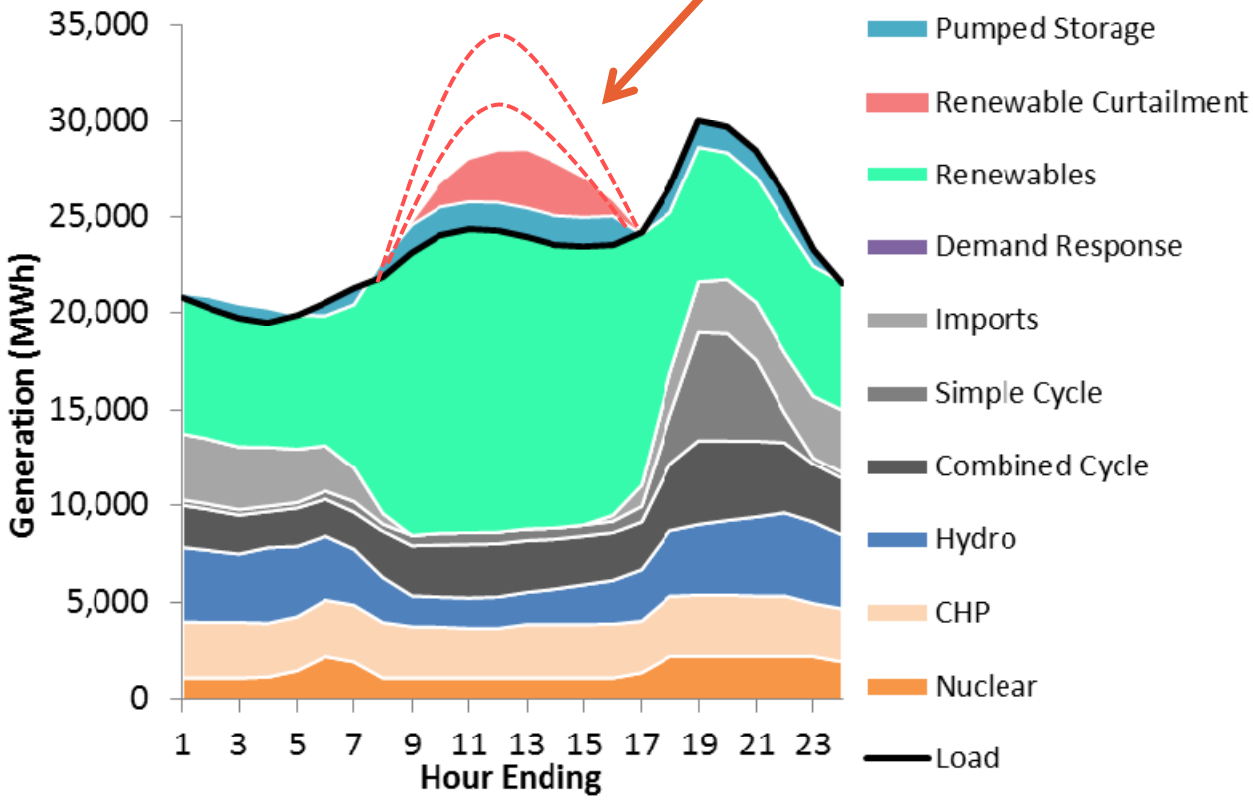
Renewable Resource Costs Continue to Decline

Source: "Tracking the Sun VI" Barbose et al, LBNL, 2013



Integration Challenges are Magnified Above 33%

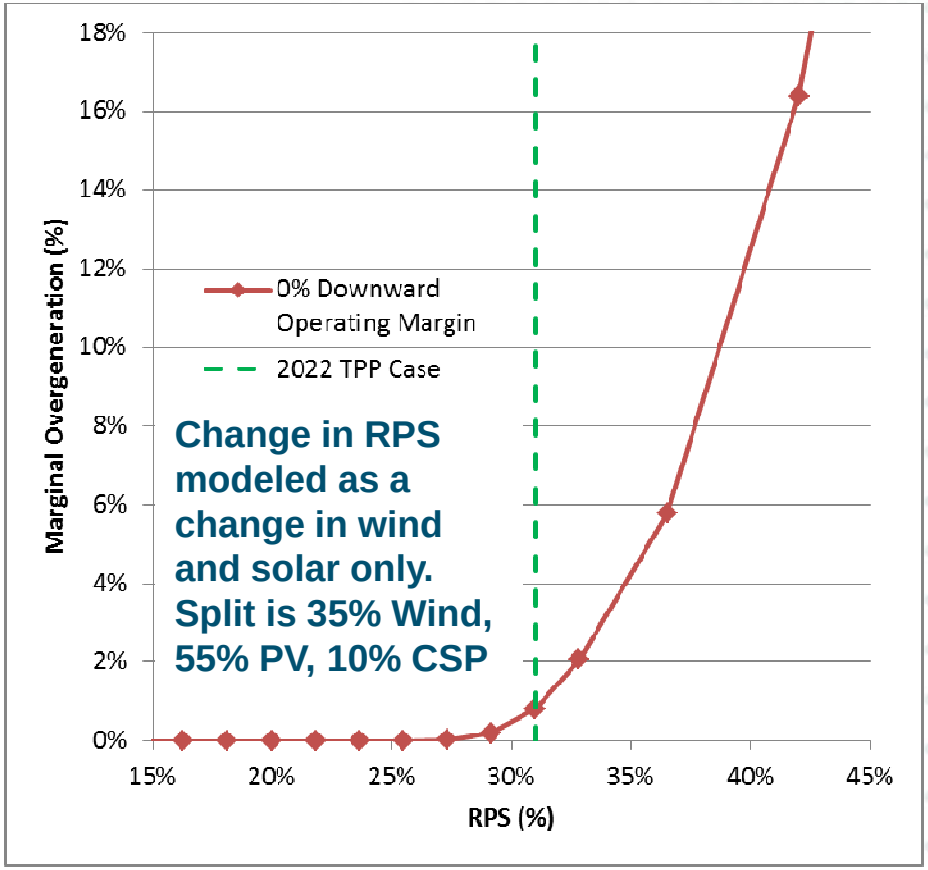
Higher amounts of solar leads to too much generation vs. too little demand in middle of day



Illustrative Result: 33% RPS in April, 2022

Overgeneration Increases Exponentially as RPS Increases

- **Curtailment looks starts to become a big issue starting at around 33% RPS**
- **Implementation of renewable integration solutions would be needed to mitigate overgeneration:**
  - Exports
  - Responsive load
  - Storage
  - Increasing conventional fleet flexibility
  - Increasing renewable portfolio diversity



Additional over-generation to provide system flexibility not shown, nor is the mitigating impact of storage or exports

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CONCLUSION

Renewable Outlook Post 2020

- **Legislation to increase renewable energy goals post-2020 appears to be likely**
  - Favorable politics, influential solar industry
  - Aggressive climate goal requires decarbonizing electricity
  - Lack of other realistic options
  - Mechanism might not be an RPS
- **Renewable integration challenges increase significantly above 33%**
  - Research is just beginning on challenges & potential solutions
  - Geographic and renewable technology diversity helps
  - Regional coordination will be essential

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Thank You!

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