

Impacts of Renewables on Resource Adequacy in California and WECC

September 28, 2015
EPRI-IEA Workshop



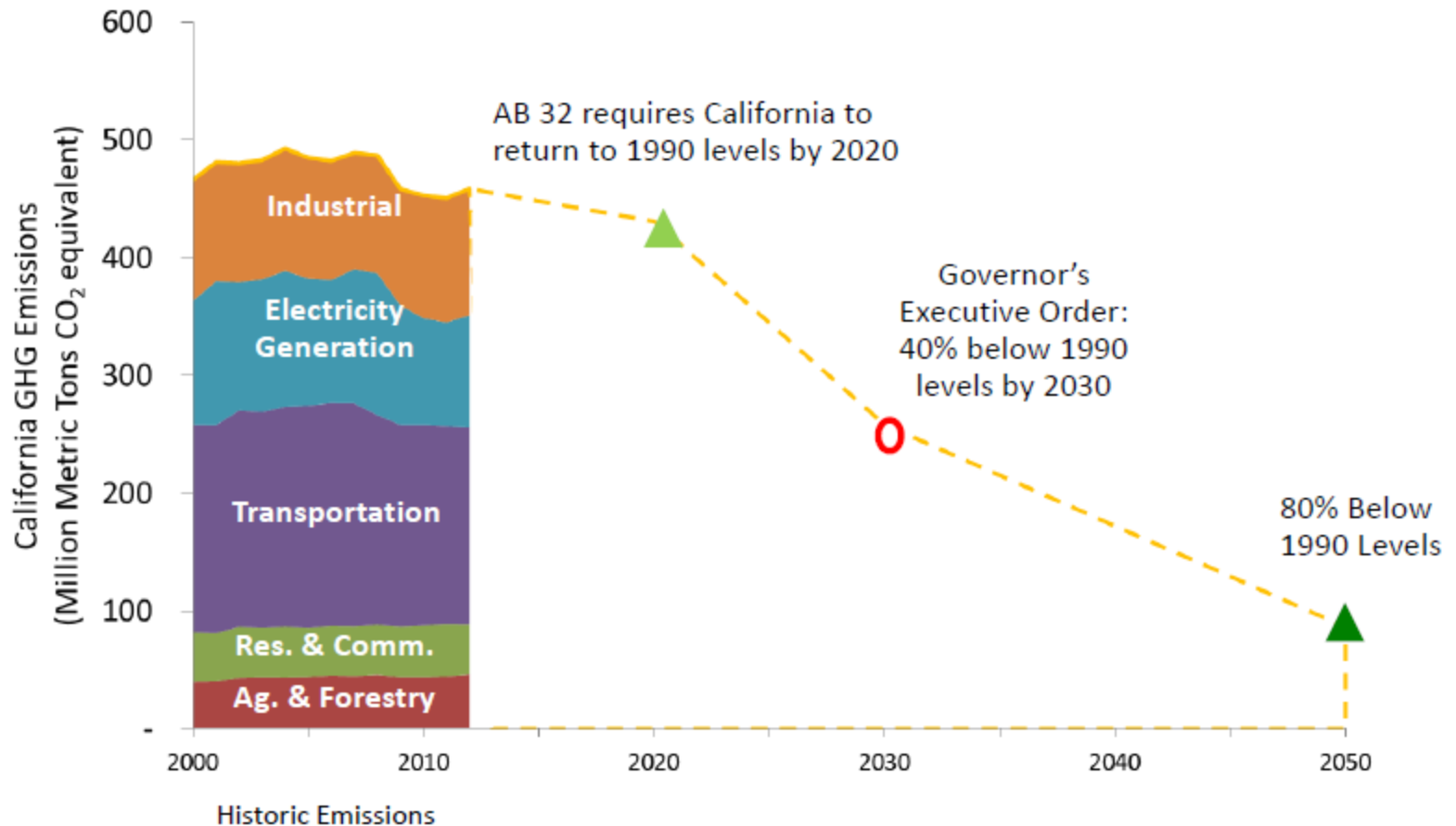


Agenda

- **California GHG Reduction and Renewables Goals**
- **2002-2020-2030**
 - Electricity Resource Mix
 - Changing Load Shape and Grid Operations Challenges
 - Mitigating Actions to Maintain System Reliability



California's GHG Reduction Goals

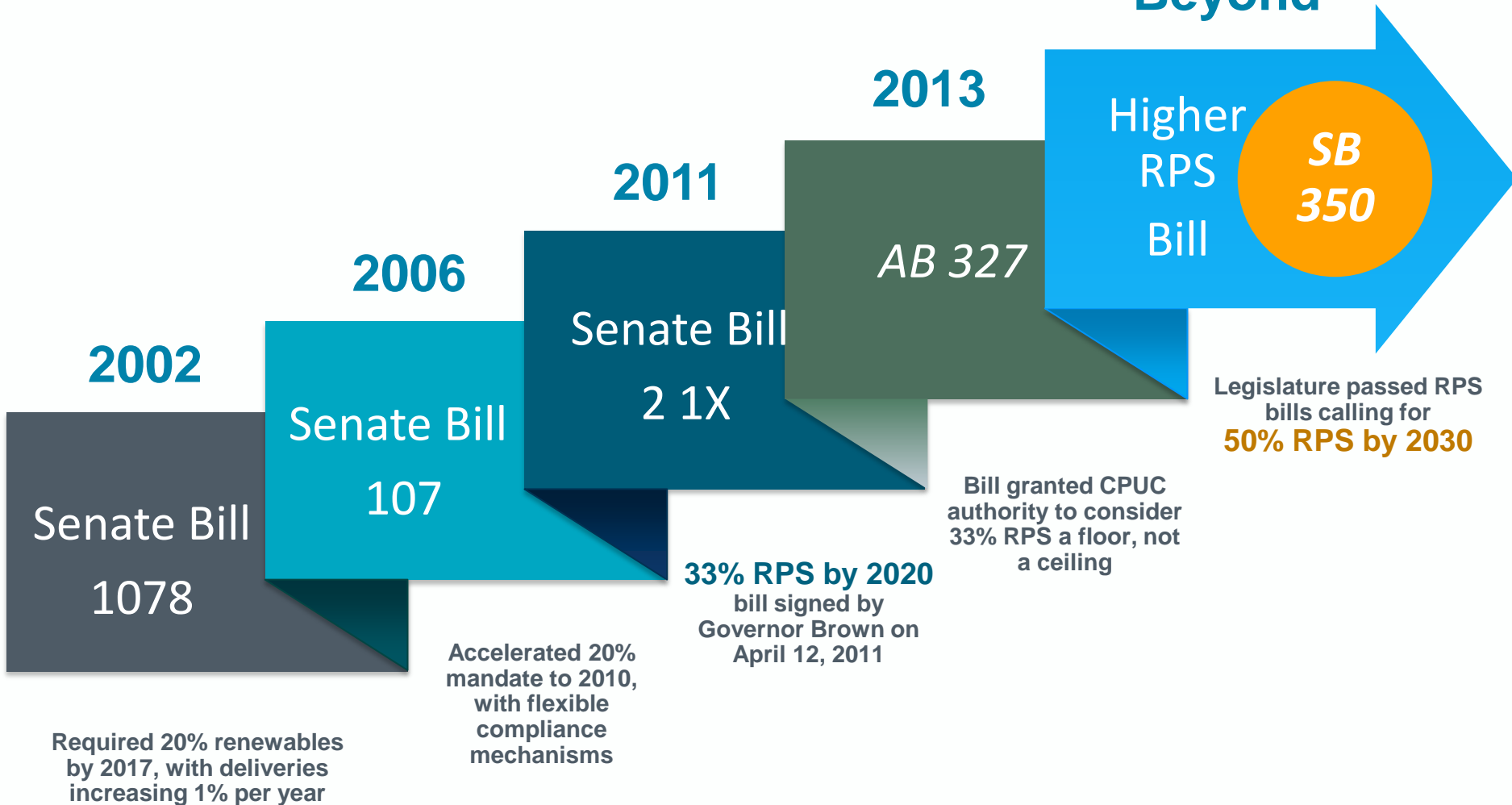


- The electricity sector has reduced emissions nearly 20% below 1990 levels, according to Air Resources Board's 2013 Emissions Inventory
- Utilities continues to be key players to achieve California's climate goals



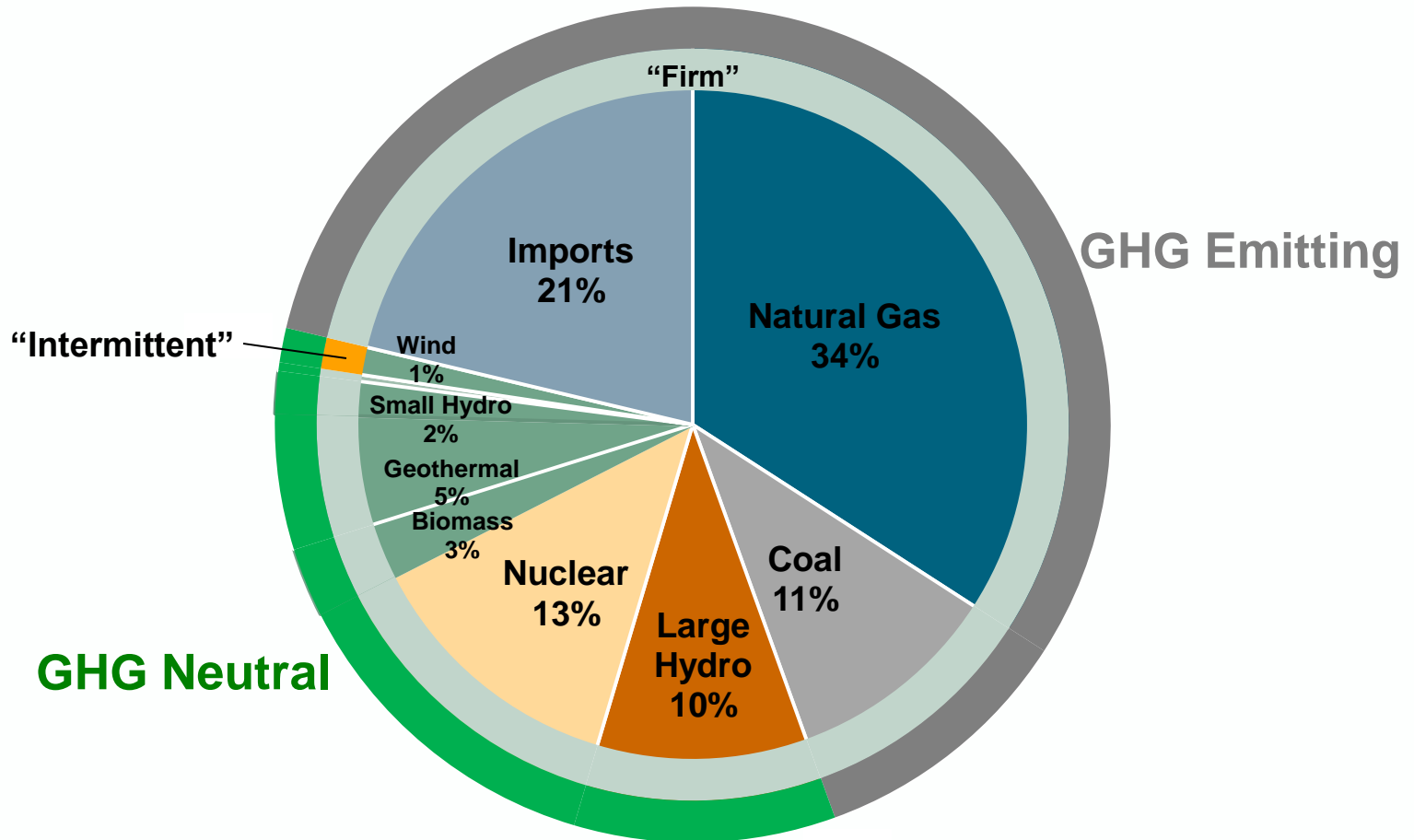
California's Renewable Energy Policy Landscape

2015 & Beyond





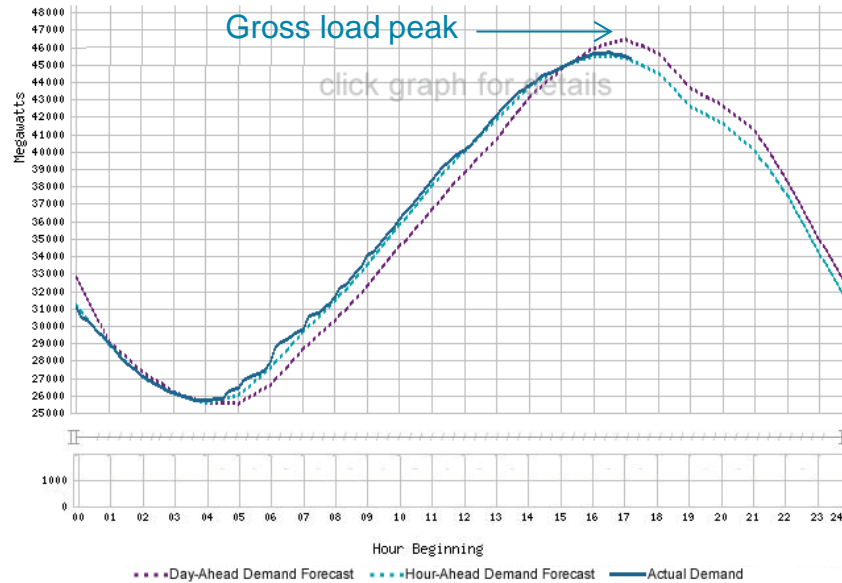
California Electricity Resource Mix (2002)



- Carbon Intensity – Medium; some GHG neutral resources
- Majority of the resources operating in dispatchable or baseload mode



Resource Adequacy in 2002

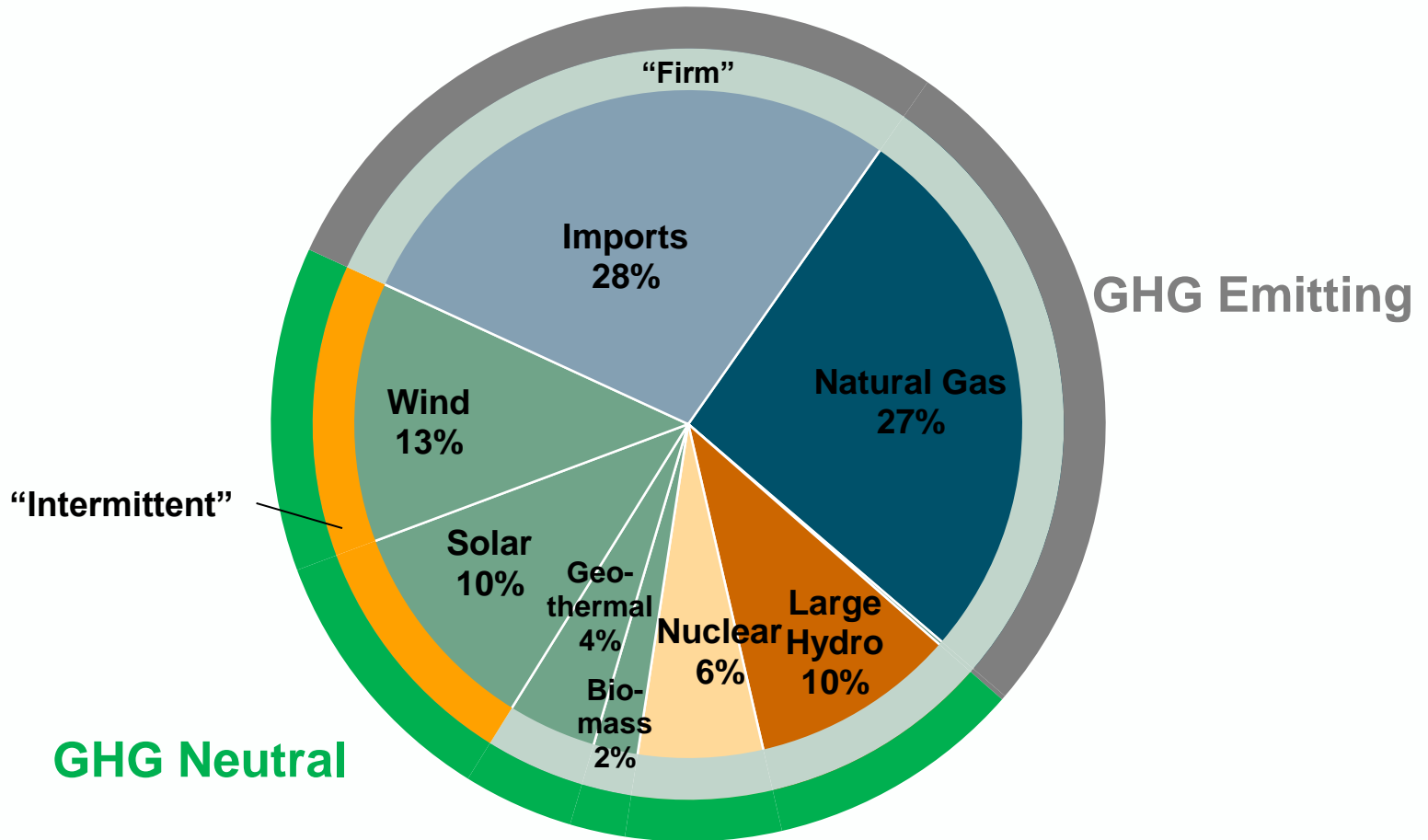


Source: CAISO Today's Outlook, Illustrative Load forecast

- Resource Adequacy focus on peak / summer days
- Intermittent resources had little impact on load shape
- Substantial dispatchable resources to manage load swings



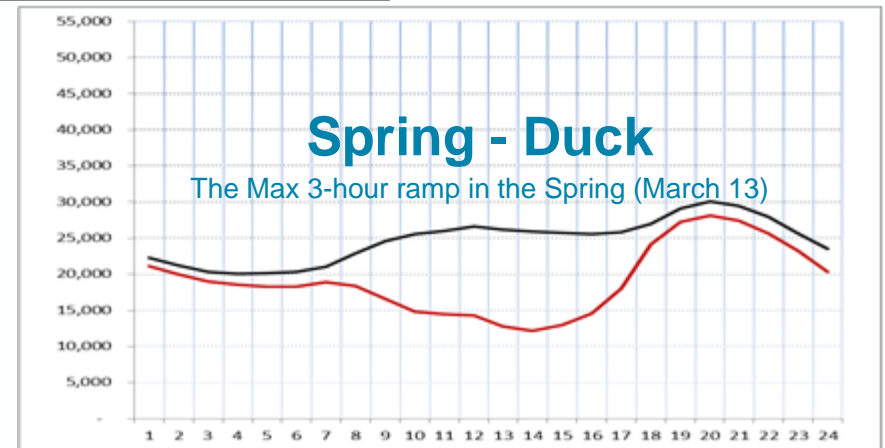
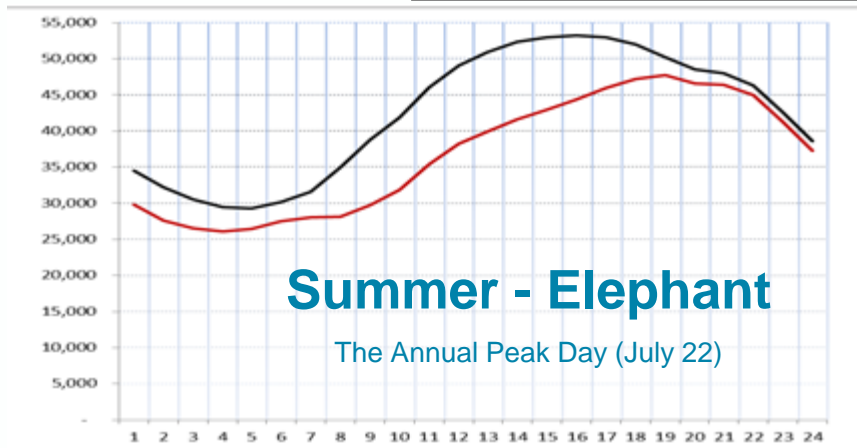
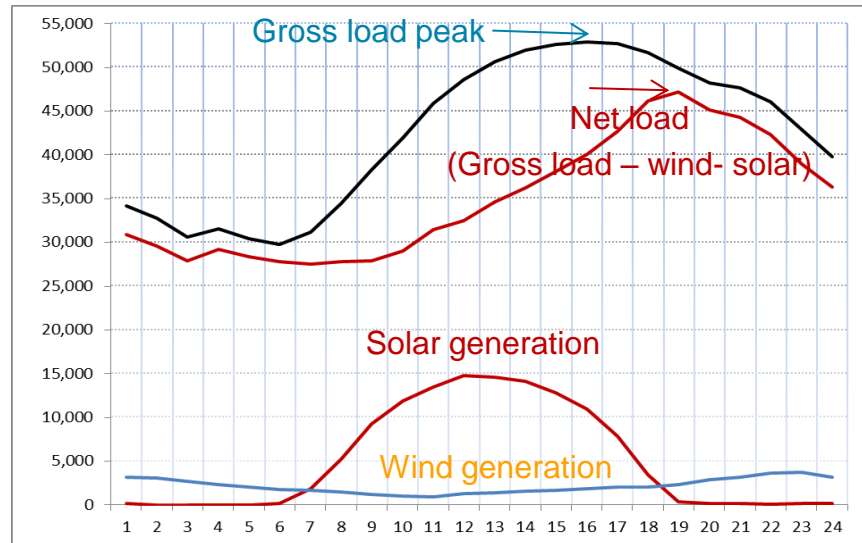
California Electricity Resource Mix (2020)



- Carbon Intensity – reduced; increased renewables, no coal
- Substantial increase in the intermittent renewables



Changing Net Load Shape by 2020

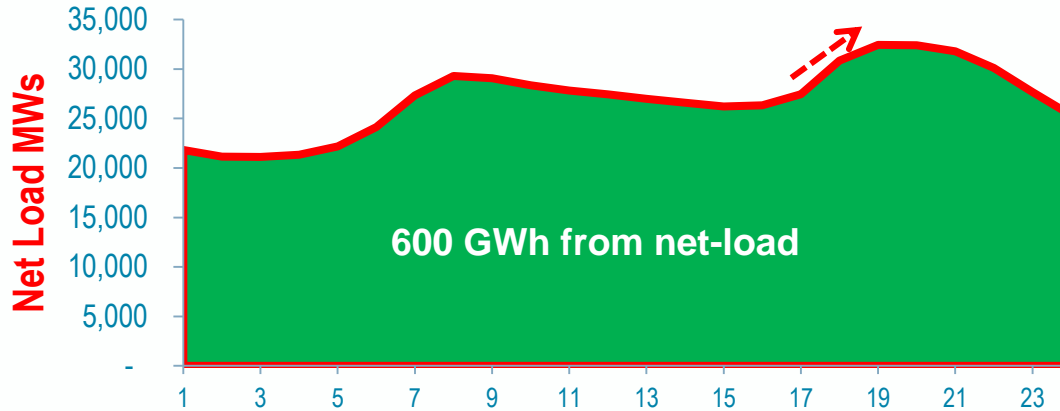


- Spring and winter days look like a duck
- Summer days require *more* capacity than “duck” days



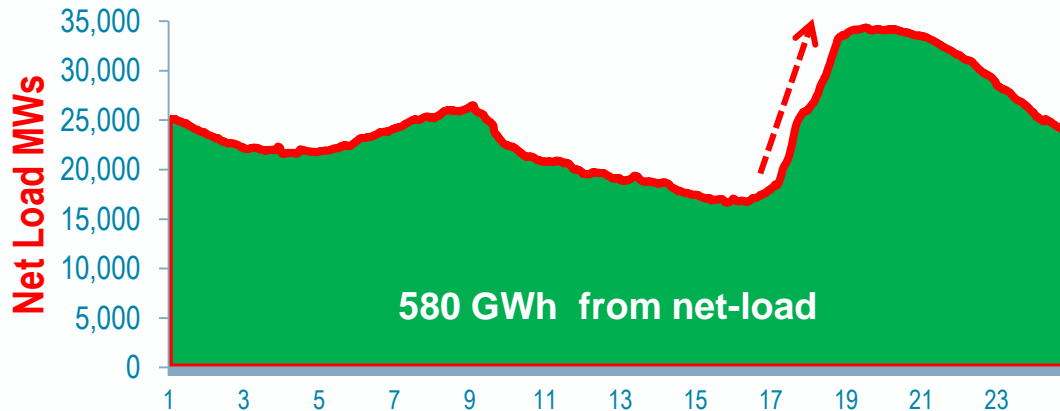
Physical trend \neq Financial trend = Reliability Concerns

Max Ramping Day: January 2012 Net-Load (Actual)



Physical Trend
(Red lines steepening)

Max Ramping Day: January 2020 Net-Load (Forecast)



Economic Trend
(Green area shrinking)

Sources: Internal graphs using CAISO Data and CPUC LTPP 2010 Forecast

The **physical trend** and **economic trend** are moving in opposite directions, creating a reliability challenge in California



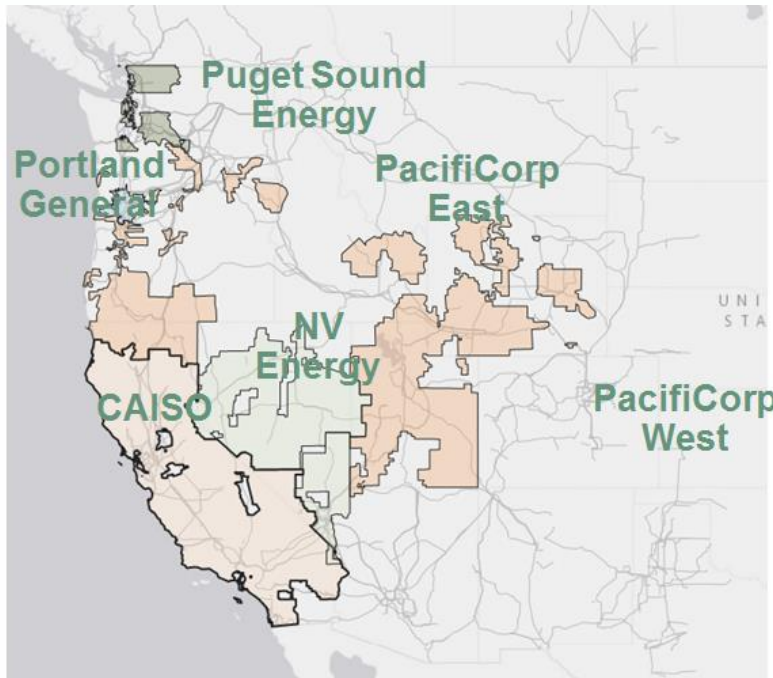
Initiatives to Integrate Renewables

Procurement

- Storage Goals of procuring 1.32 GW of storage by 2024
- Flexible resources and curtailment provisions

Market Design Initiatives

- Flexible Ramping Product: Market-based mechanism to set aside upward and downward ramping capacity in real-time
- CAISO and the Energy Imbalance Market (EIM)

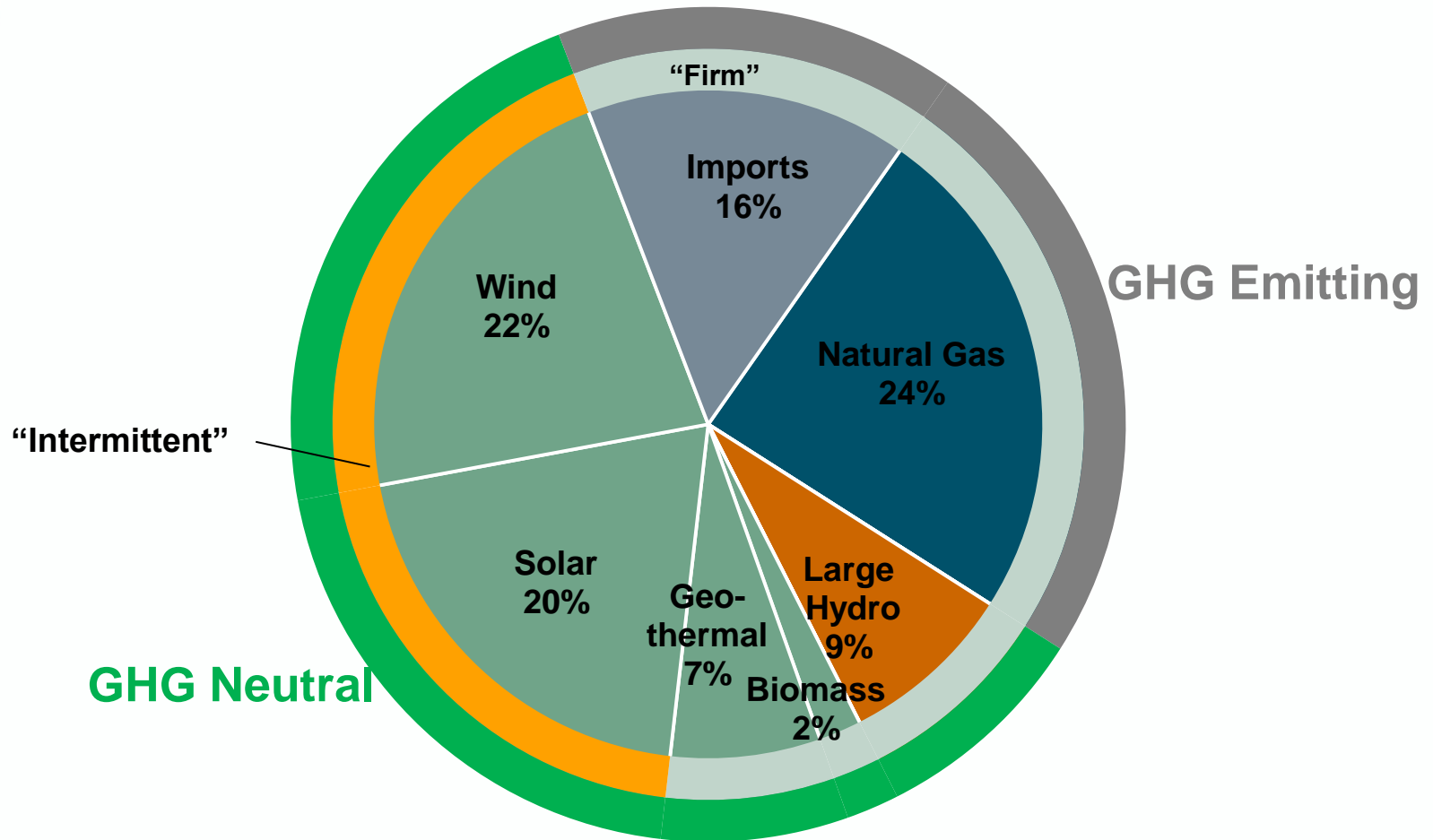


Legend

	<u>GW of capacity</u>	<u>EIM start date</u>
PacifiCorp	11.9	11/2014
NV Energy	6.1	10/2015
Puget Sound Energy	3.7	10/2016
Portland General	3.6	
CAISO	65.2	



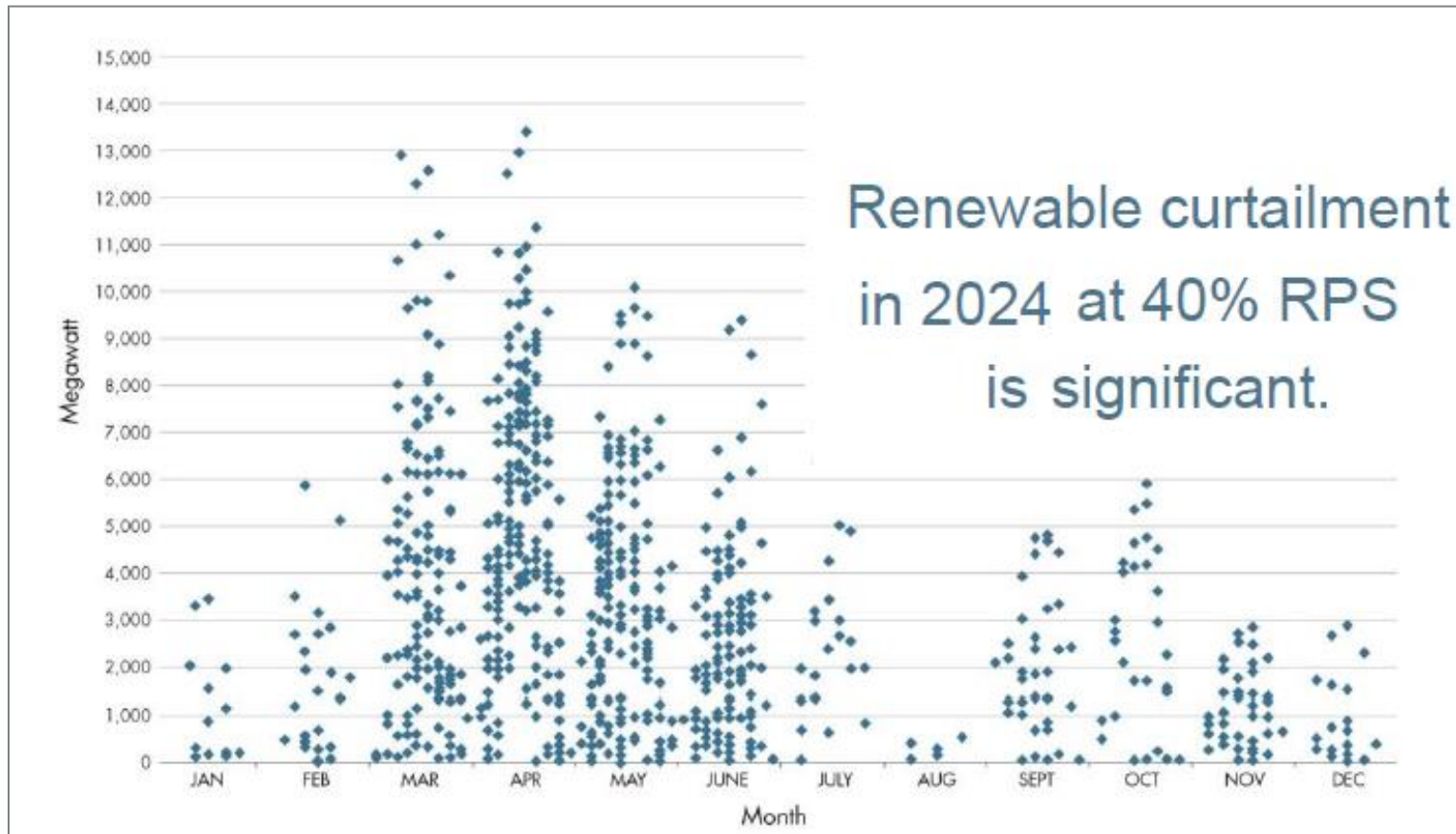
California Electricity Resource Mix (2030)



- 50% of the electricity coming from RPS-eligible renewable resources
- Intermittent renewables becoming prominent part of the portfolio



Rising Over-generation & Curtailment Concerns



Source: CAISO presentation at July 9, 2015 Joint Agency Symposium

<http://www.arb.ca.gov/cc/pillars/renewables/slides.pdf>

- **Frequency and magnitude of the unsolved over-generation reflect conditions that do not support reliable grid operations**



Potential Solutions for Increased Renewables

Grid- side

- **Increase flexibility of thermal fleet**
- **Increase storage**
- **Diversify renewables portfolio**
- **Curtail renewables**
- **Broaden regional coordination**

Customer-side

- **Align rates design with system conditions**
- **Increase flexible loads and demand response**
- **Transportation electrification and batteries**