Impacts of Renewables on Resource Adequacy in California and WECC

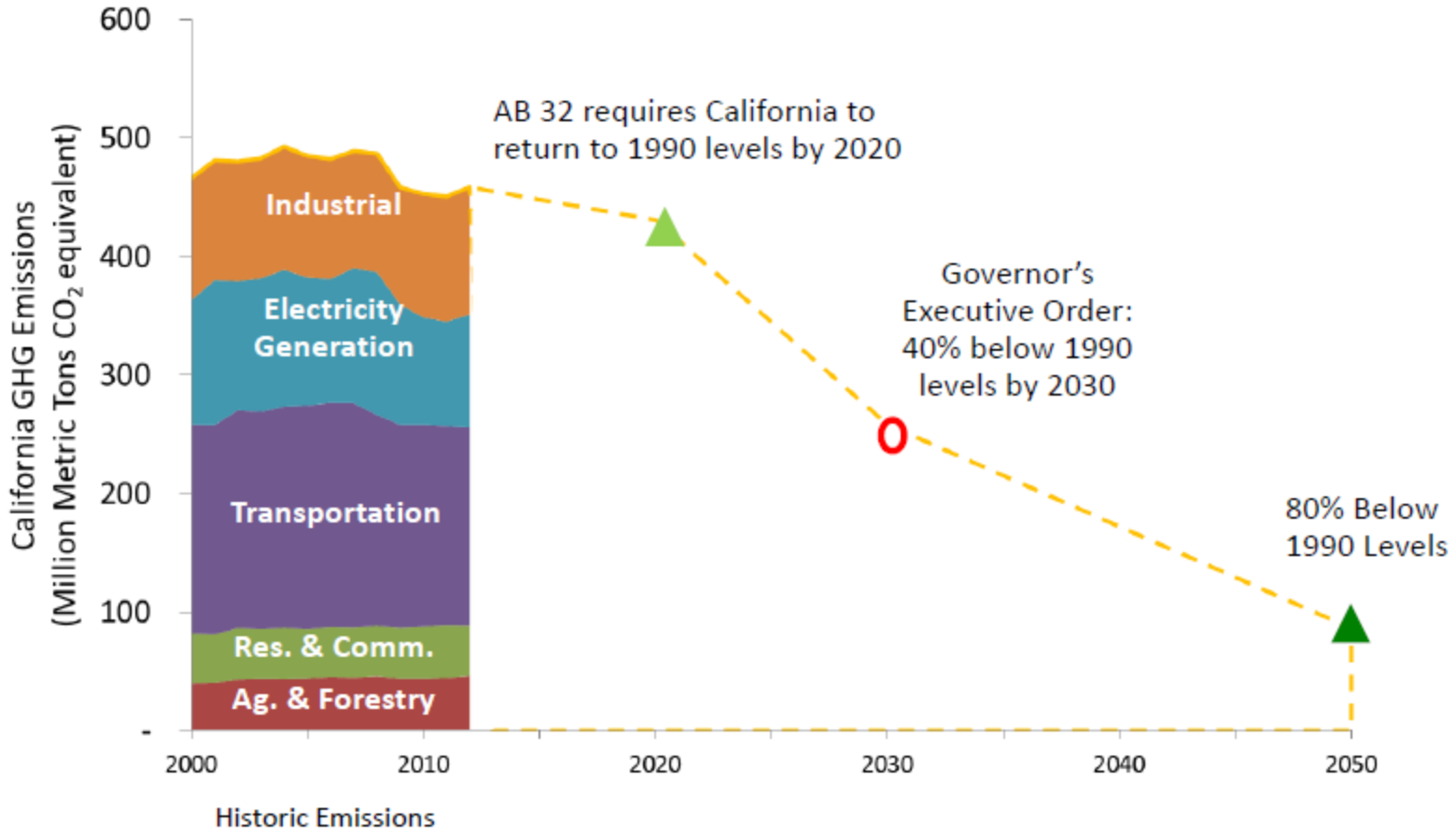
September 28, 2015
EPRI-IEA Workshop

Agenda

- **California GHG Reduction and Renewables Goals**

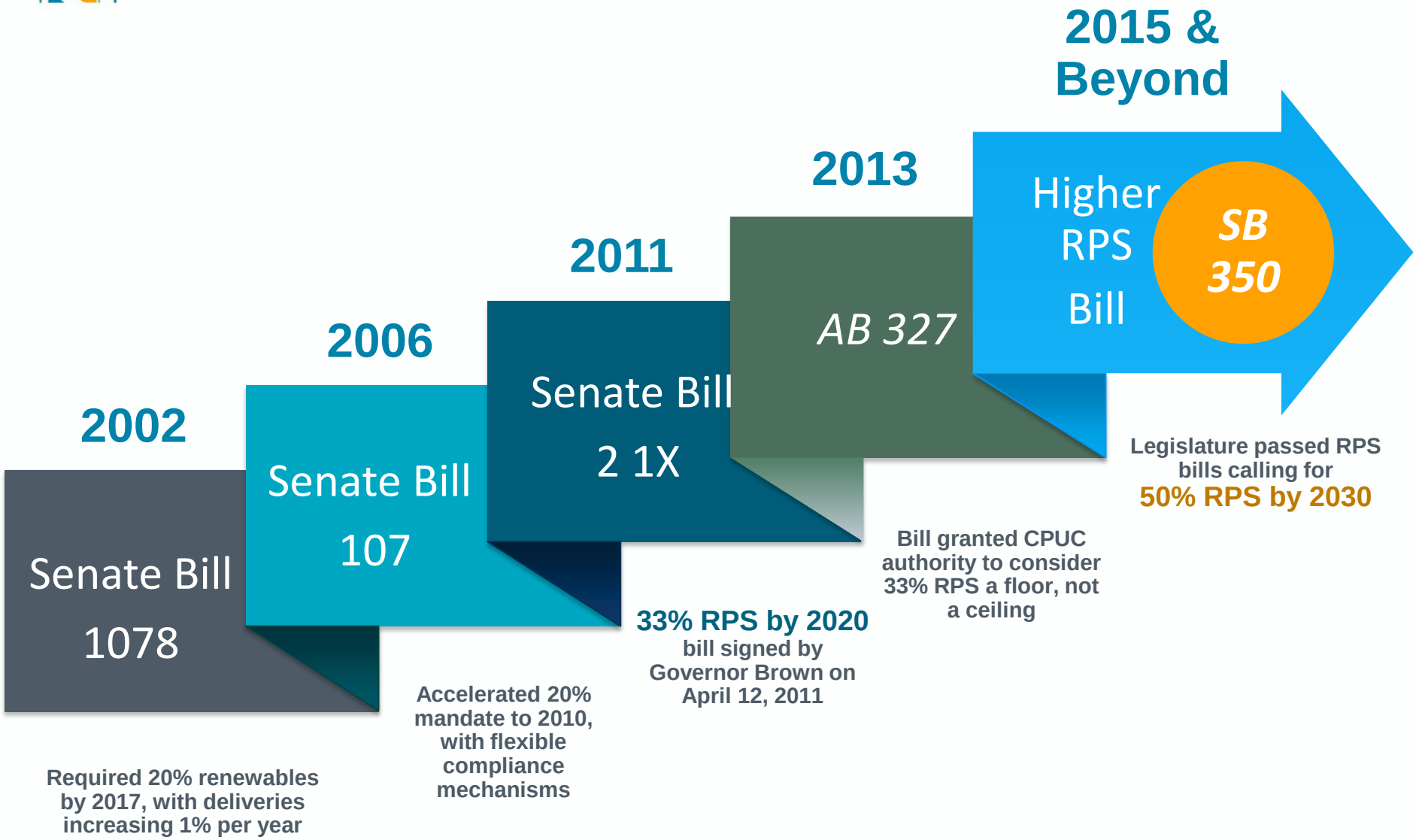
- **2002-2020-2030**
  - Electricity Resource Mix
  - Changing Load Shape and Grid Operations Challenges
  - Mitigating Actions to Maintain System Reliability

California's GHG Reduction Goals

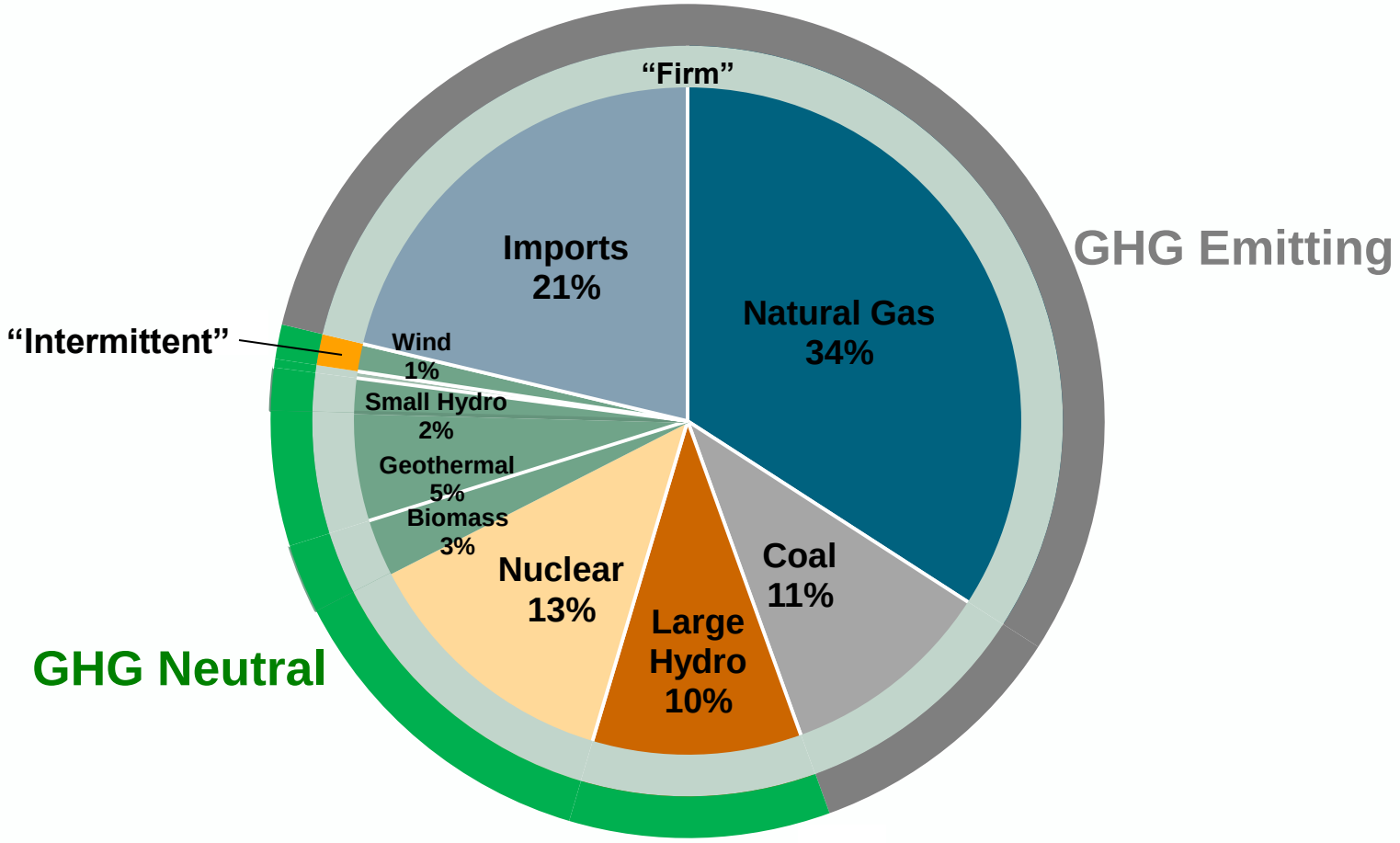


- The electricity sector has reduced emissions nearly 20% below 1990 levels, according to Air Resources Board's 2013 Emissions Inventory
- Utilities continues to be key players to achieve California's climate goals

California's Renewable Energy Policy Landscape



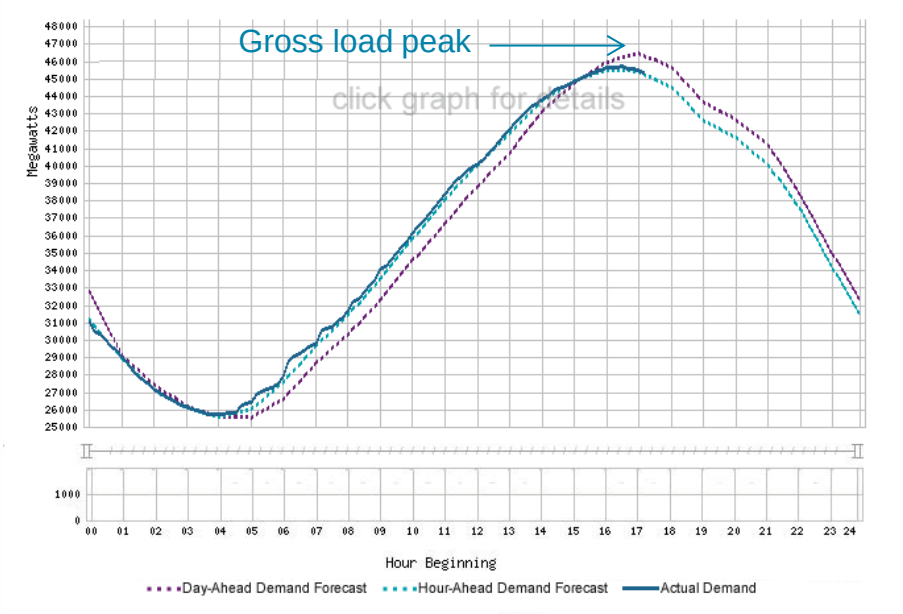
California Electricity Resource Mix (2002)



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

Source: CEC California Gross Power for 2002 http://energyalmanac.ca.gov/electricity/system_power/2002_gross_system_power.html

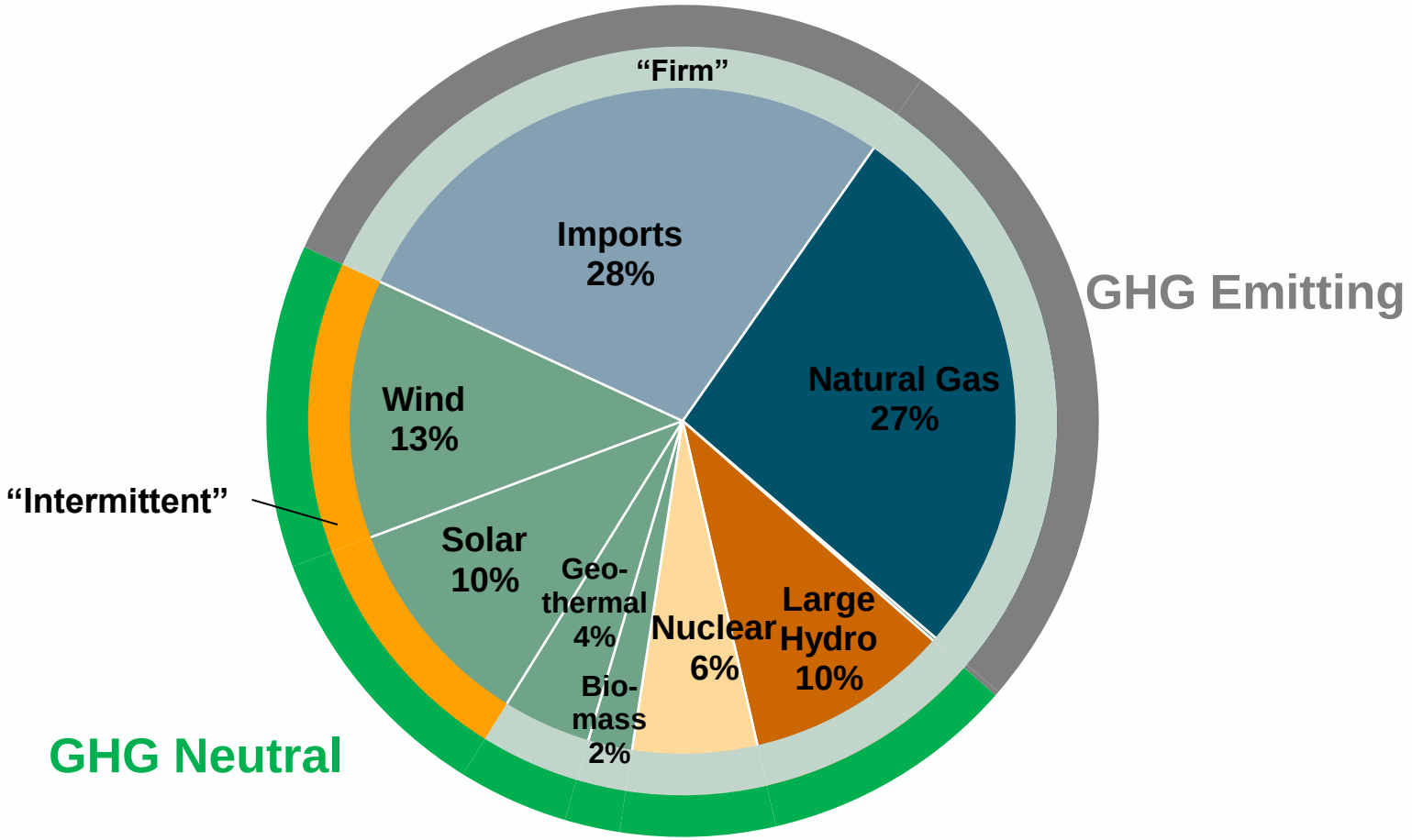
Resource Adequacy in 2002



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**

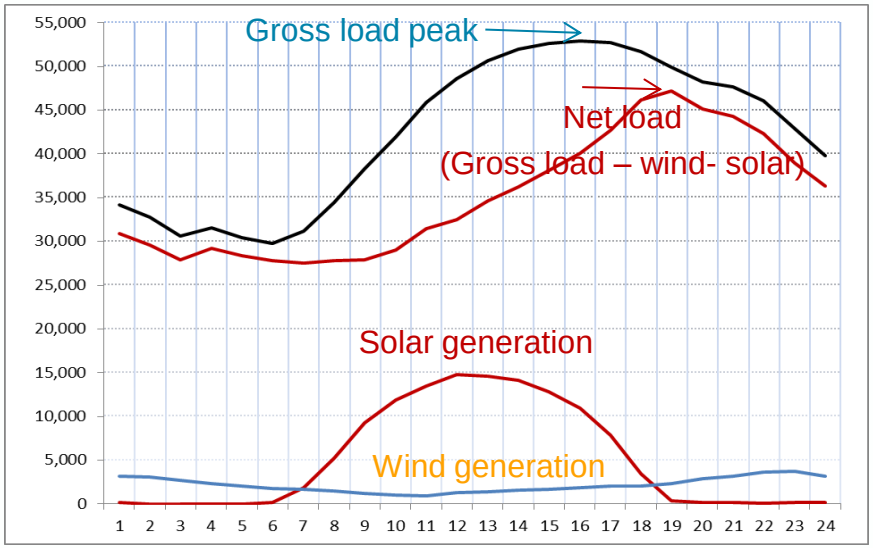
California Electricity Resource Mix (2020)

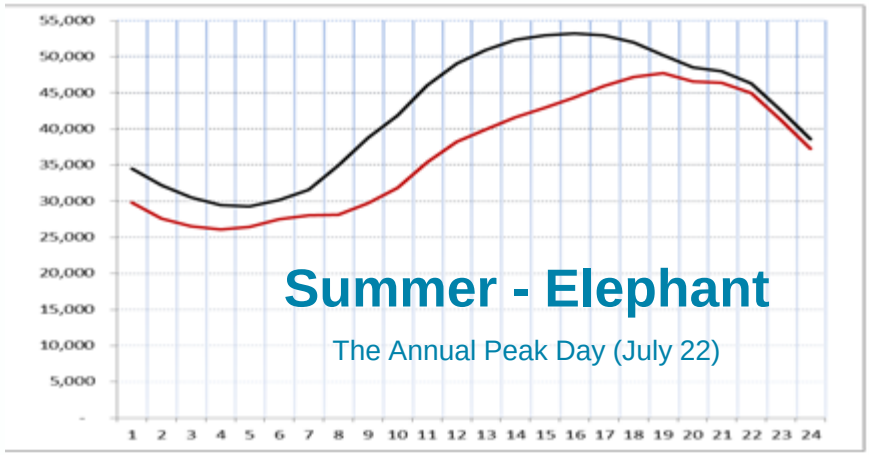


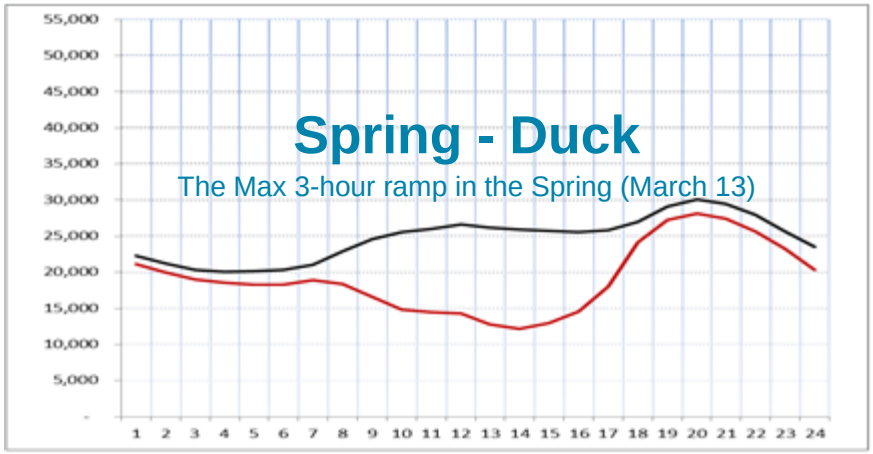
- Carbon Intensity – reduced; increased renewables, no coal
- Substantial increase in the intermittent renewables

Source:E3 Pathways Study, Reference Scenario Electricity Supply https://ethree.com/public_projects/energy_principals_study.php

Changing Net Load Shape by 2020





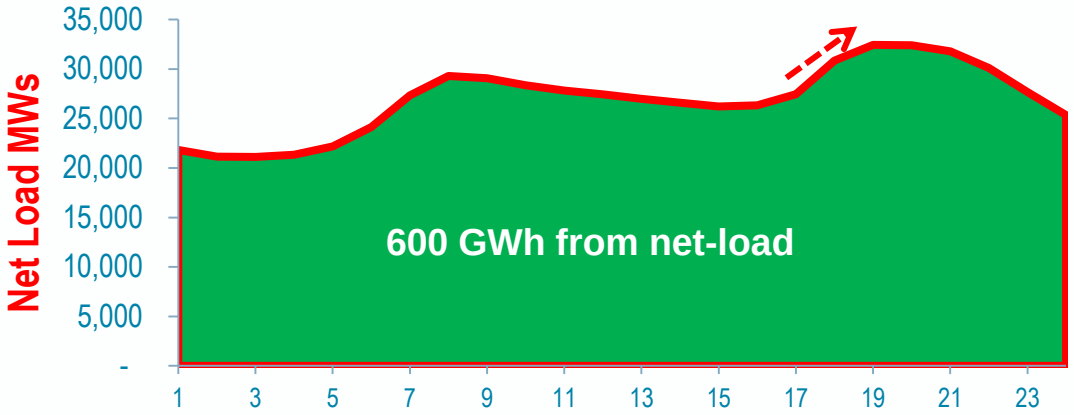


- **Spring and winter days look like a duck**
- **Summer days require *more* capacity than "duck" days**

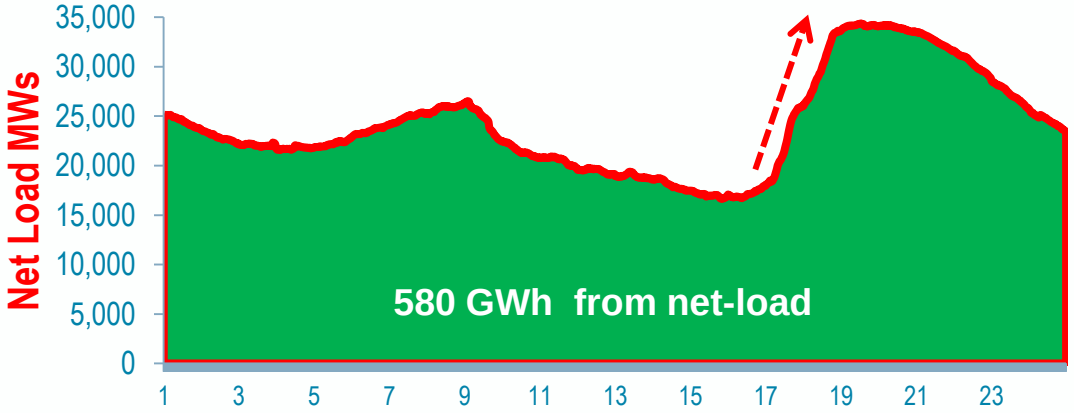
Charts are illustrative of 2020 and 2022 forecasted inputs for CAISO. Subject to change after CAISO updates flexible capacity requirements.

Physical trend ≠ Financial trend = Reliability Concerns

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



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



Physical Trend (Red lines steepening)

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

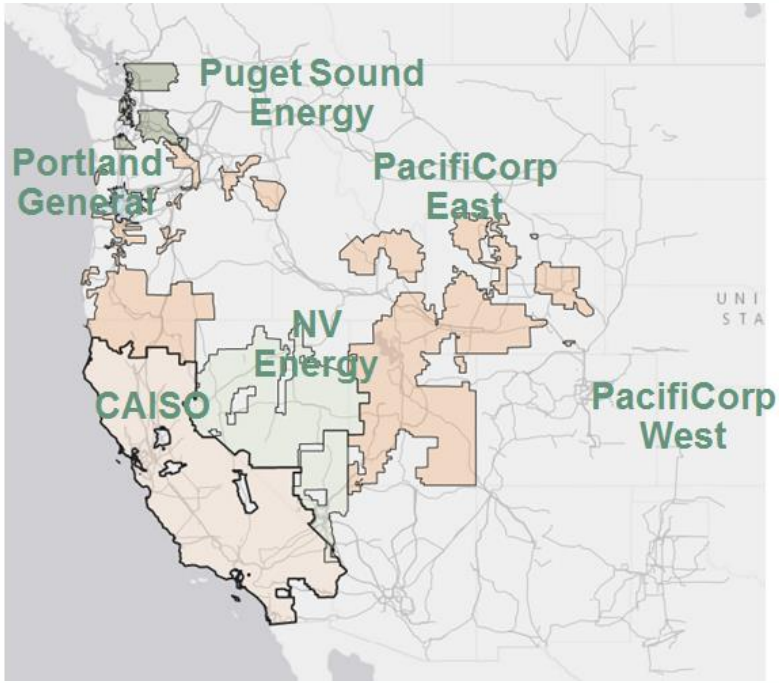
Initiatives to Integrate Renewables

Procurement

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

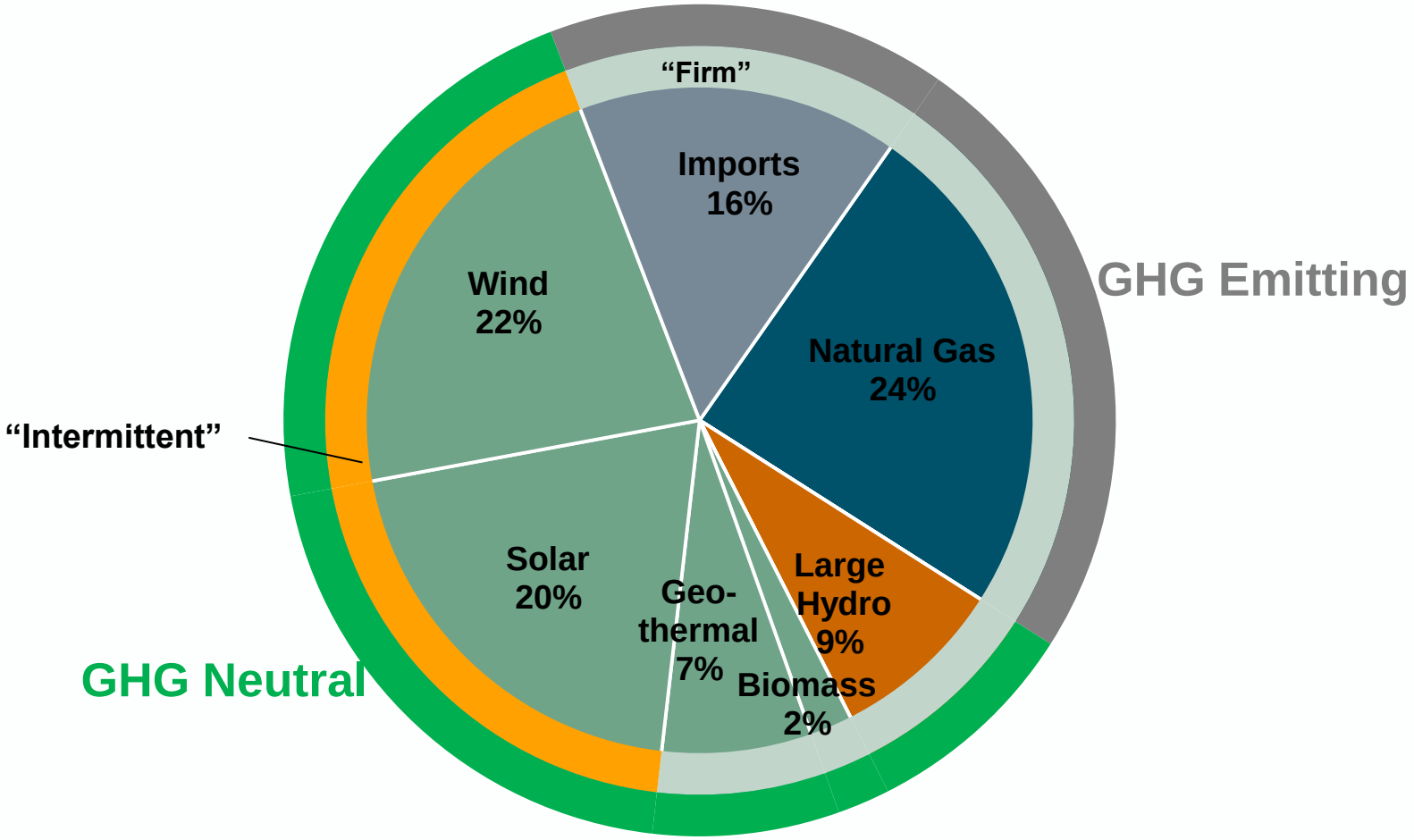
Market Design Initiatives

- 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	GW of capacity	EIM start date
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	

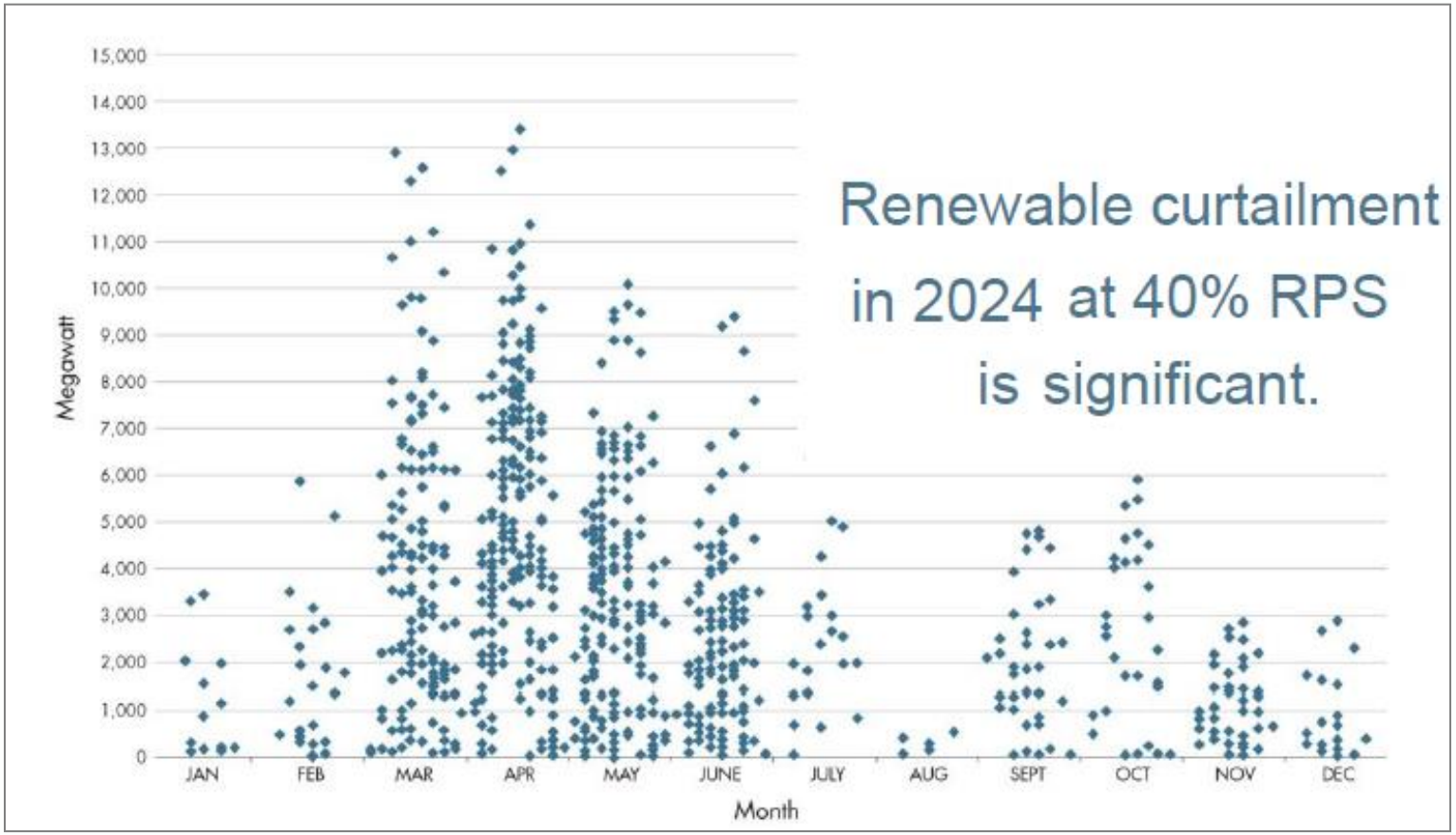
California Electricity Resource Mix (2030)



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

Source:E3 Pathways Study, Early Adoption Scenario Electricity Supply https://ethree.com/public_projects/energy_principals_study1.php

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

Source: E3 Pathways Study and CAISO presentation at 2015 Joint Agency Symposium - http://www.arb.ca.gov/cc/pillars/renewables/slides.pdf