The SB100 Pathways Project: Reaching a Net Zero Carbon Grid in California

SCCS Affiliates Meeting
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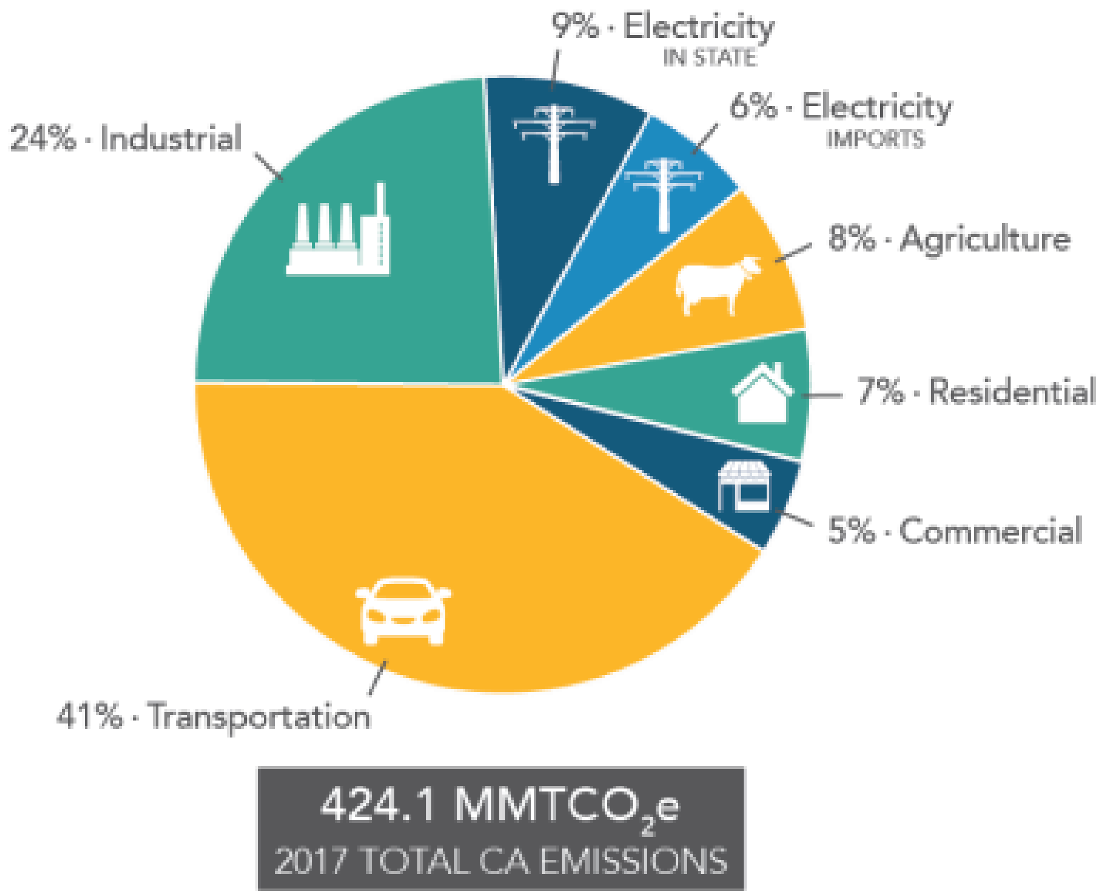
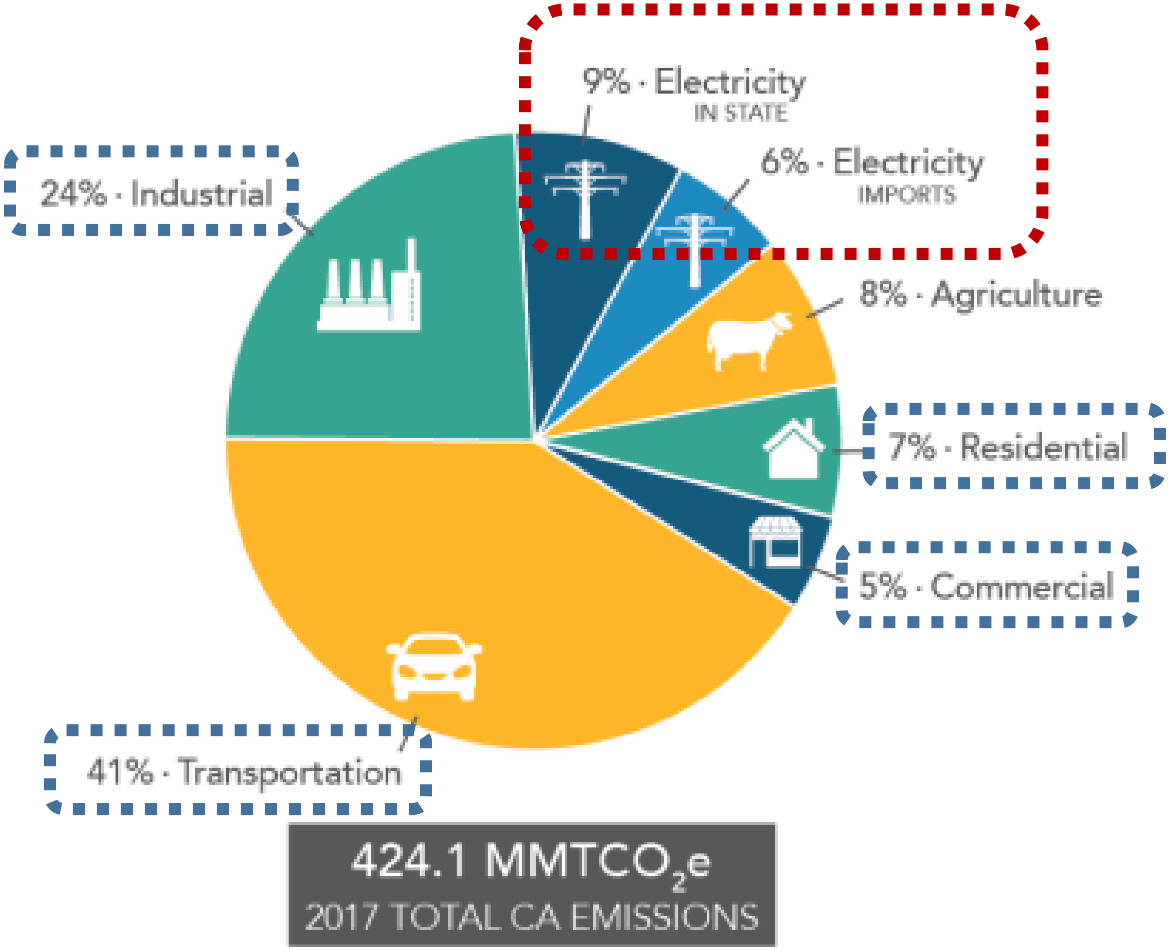
Key Takeaways

- **SB100 Pathways Project (Long et al. 2020, *in review*)**
  - Reaching a net zero carbon grid in 2045 in California can be done cost-effectively if we develop ~30 GW of Clean Firm Resources
- **An Action Plan for Carbon Capture and Storage in California: Opportunities, Challenges, and Solutions (EFI and Stanford University, 2020)**
  - Utilizing NGCC-CCS in the electricity grid as early as 2030 to meet emissions reductions goals is cost-effective and puts California on path to meet its 2045 goals

Executive Order (B-55-18) commits California to a carbon-neutral economy by 2045



Decarbonizing the electricity grid and electrifying other end-uses of energy has significant implications



One of California's key climate policy is Senate Bill 100

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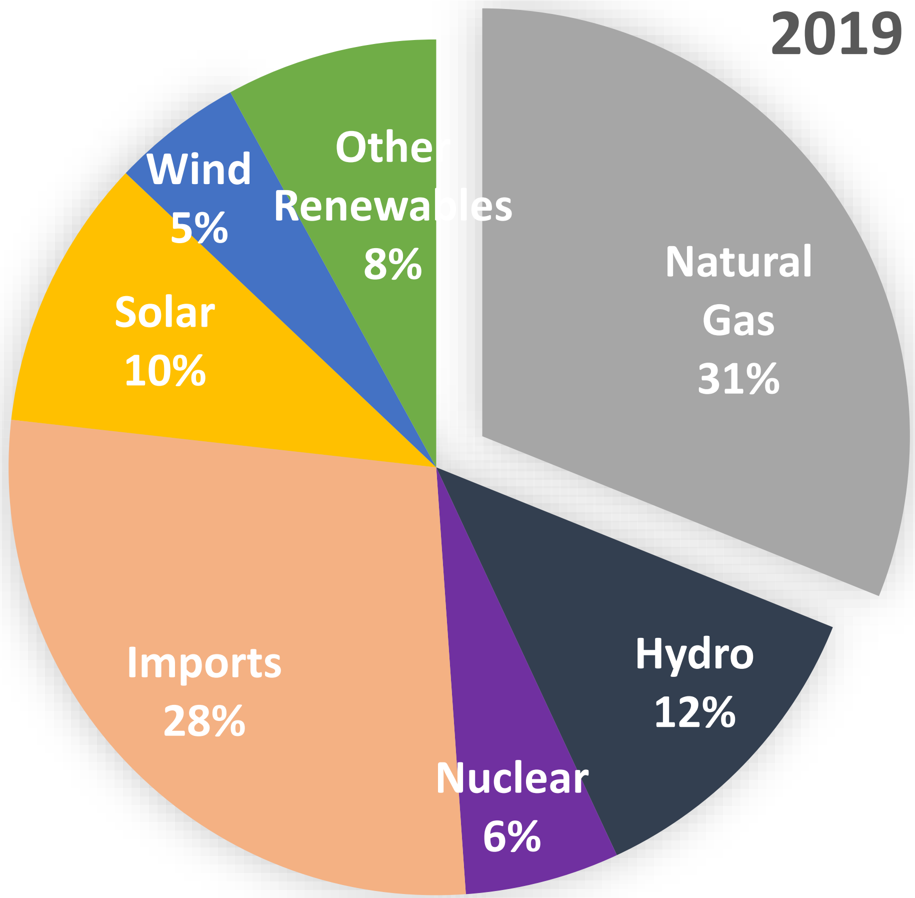
2030	60% Renewable Portfolio Standard (RPS)
2045	Zero-Carbon Grid

California currently gets over 30% of its electricity from natural gas

California's Generation Mix



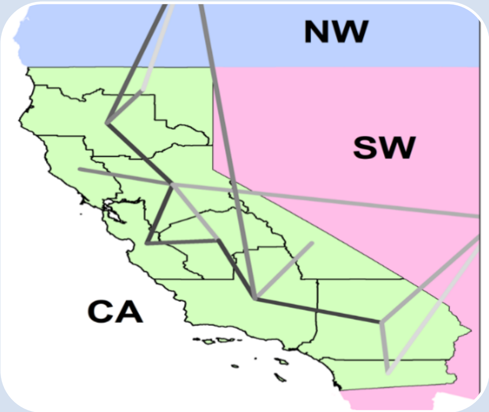
Source: CEC, 2019

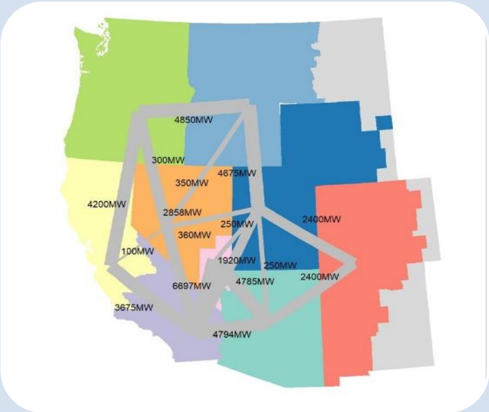
2045

The **SB100 Pathways Project** utilized three independent capacity expansion and dispatch models to assess several different pathways of reaching a net zero carbon grid in California to meet its SB100 and carbon neutrality goals in 2045.

Three distinct capacity expansion and dispatch models were used for The SB100 Pathways Project

Capacity expansion and dispatch models find the cost-optimal grid subject to meeting future annual load and policy goals (cost-optimal indicates minimizing both the capital cost of building new resources and annual operating costs)





E3's RESOLVE

Stanford's urbs

Princeton's GenX

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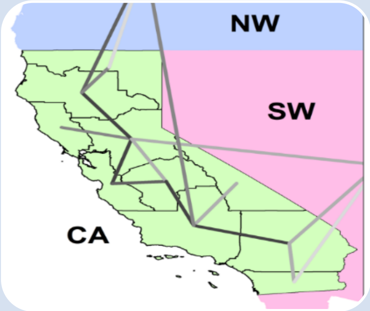
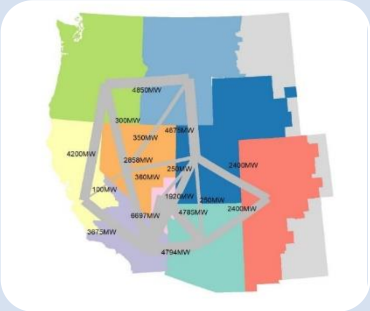




	E3 RESOLVE	Stanford urbs	Princeton GenX
Spatial Resolution	3 zones: CA, SW, NW	10 CA zones; 2 out of state zones	2 CA zones; 7 out of state WECC zones
Zones Optimized	California	California	WECC-wide
Temporal Resolution	37 representative days	1 year in hourly time steps (8760)	16 representative weeks with hourly resolution time steps (2,688 hours)

Technologies considered in the analysis include:

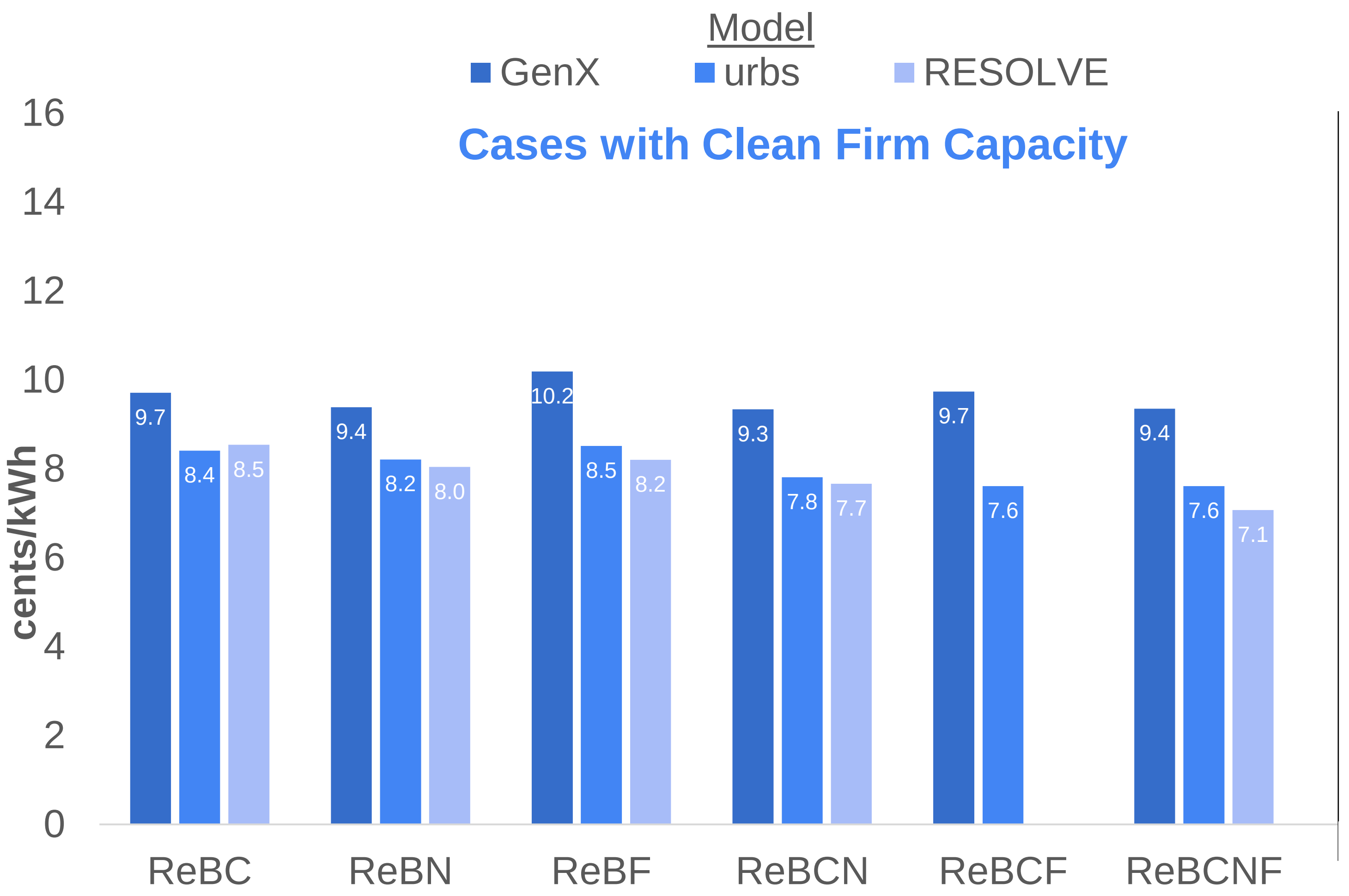
- Solar (Re)
- Onshore Wind (Re)
- Offshore Wind (Re)
- Energy Storage (B)

Renewable Resources

- Nuclear Power (N)
- Natural Gas with Carbon Capture and Storage (C)
- Zero Carbon Fuel (F)

Clean Firm Resources

With the development of clean firm resources, California can build a net zero carbon grid at approximately historic generation and transmission rates



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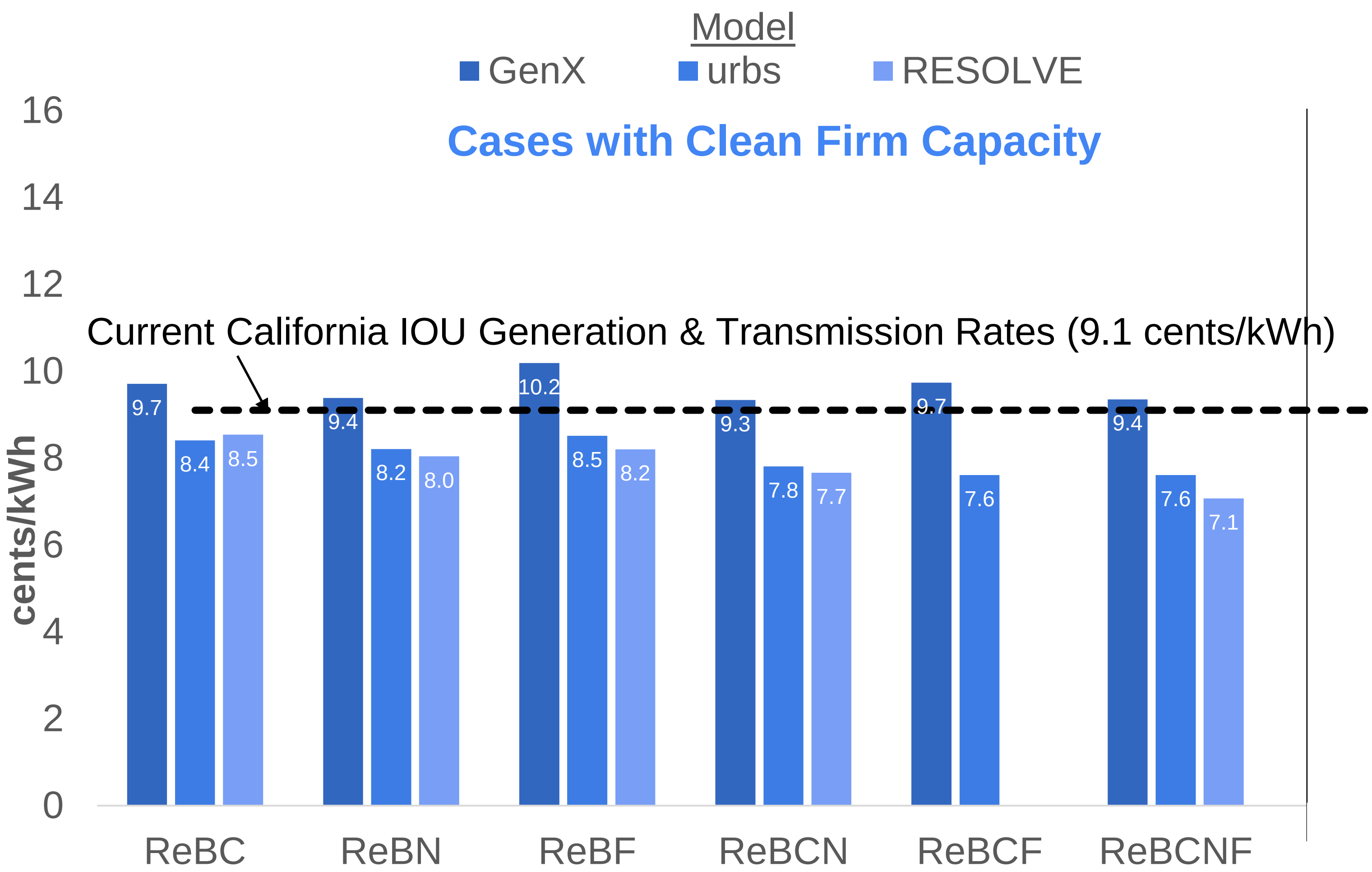

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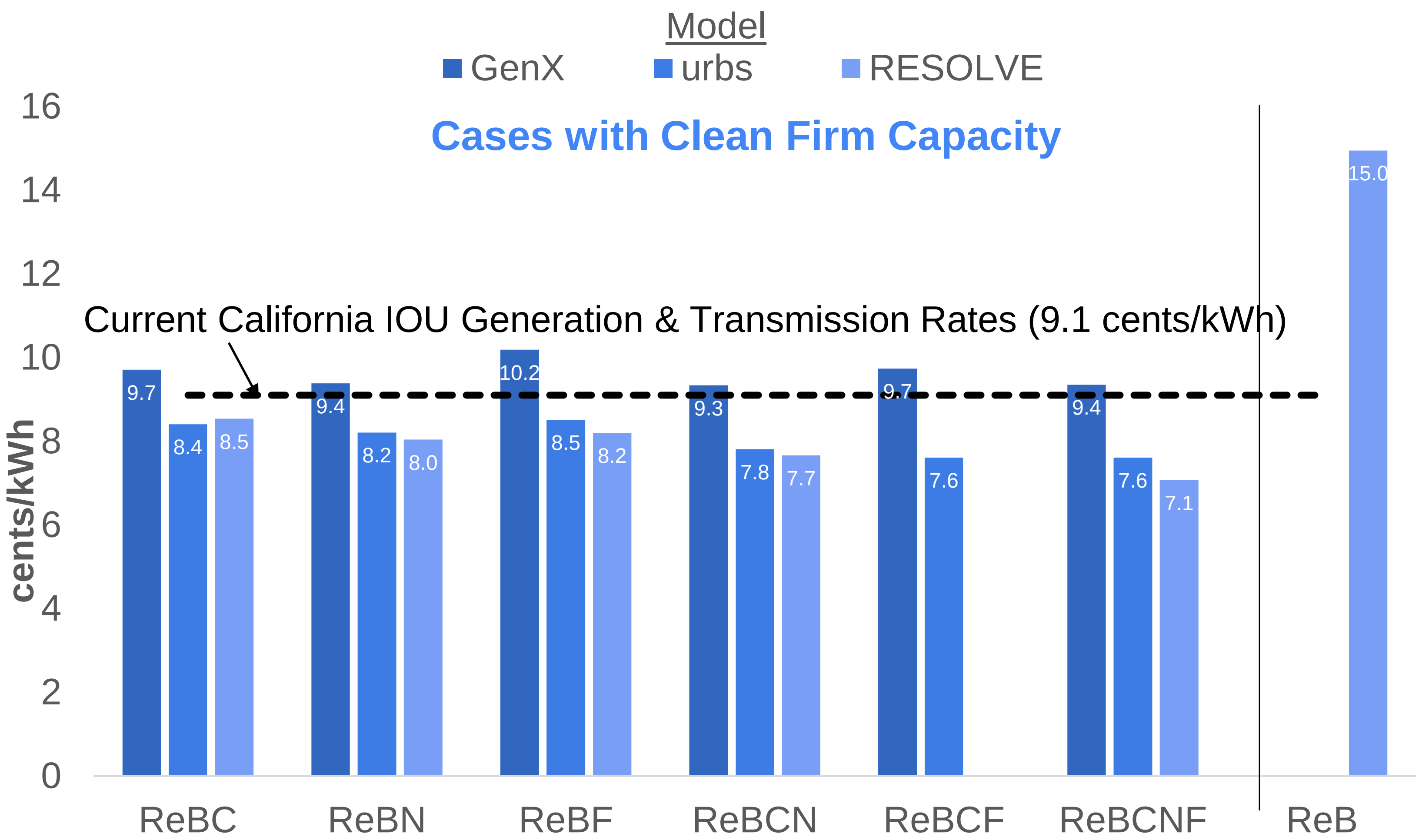
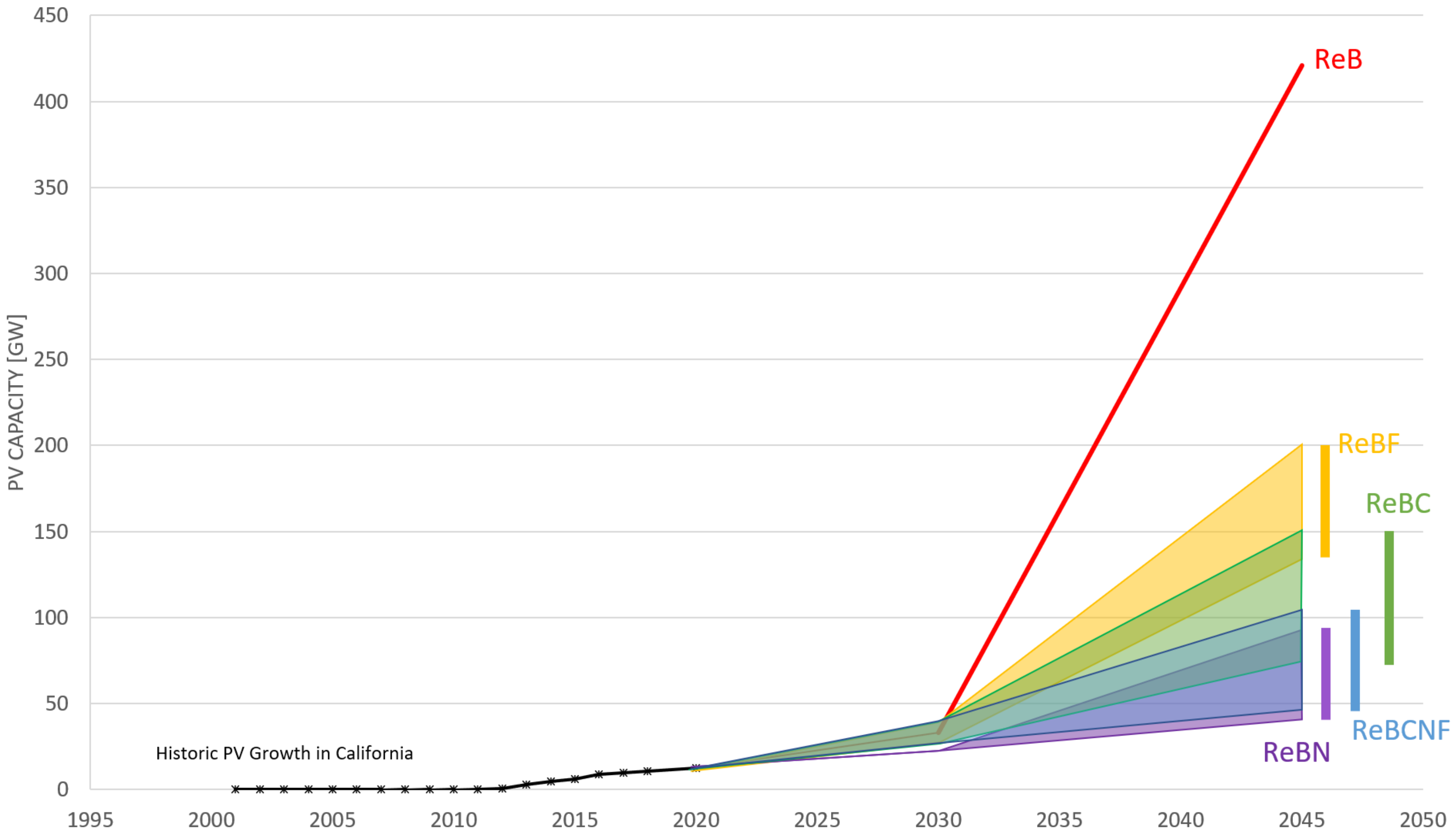
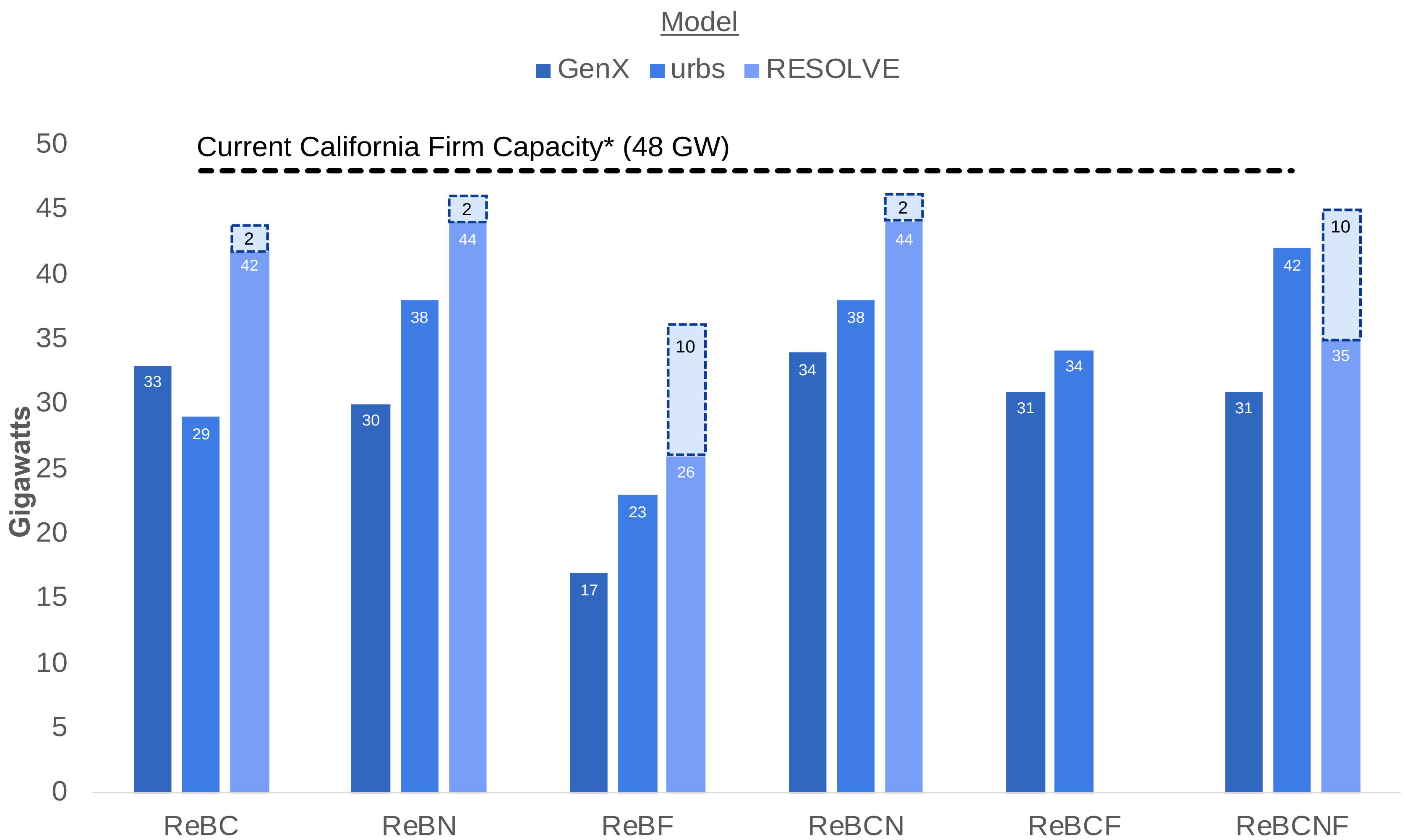


Without clean firm resources, California's PV capacity will have to grow at unprecedented rates and reach more than double the PV build in the scenarios with clean firm resources

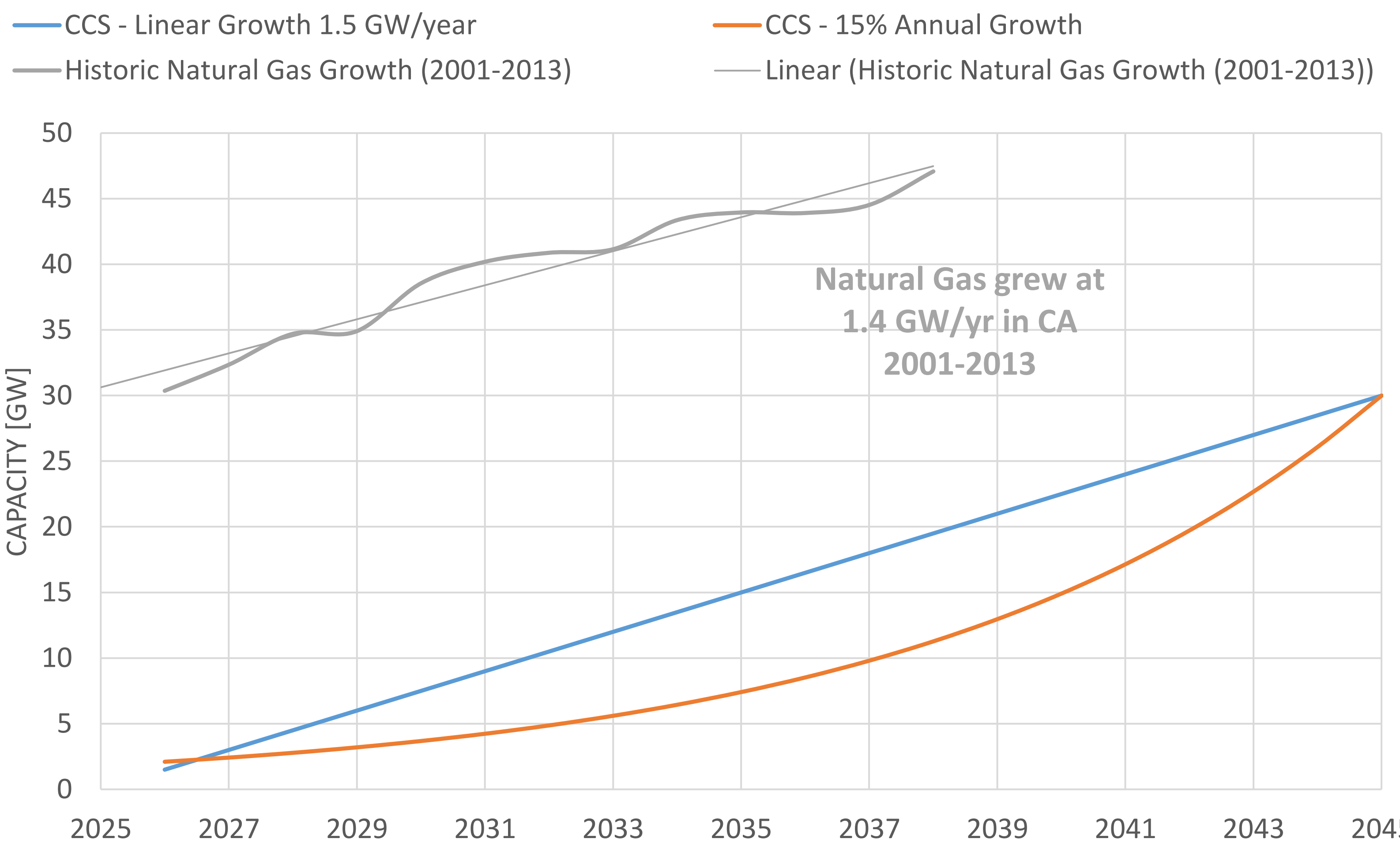


So how much clean firm resources do we need? – approximately 30 GW



*Dotted boxes indicate imported firm capacity

Developing ~30 GW by 2045 will require action before 2030



2030

An Action Plan for Carbon Capture and Storage in California: Opportunities, Challenges, and Solutions (EFI and Stanford University, 2020)

We assess the role of NGCC-CCS in California’s grid in 2030 in meeting California's climate goals

One of California’s key climate policy is Senate Bill 100

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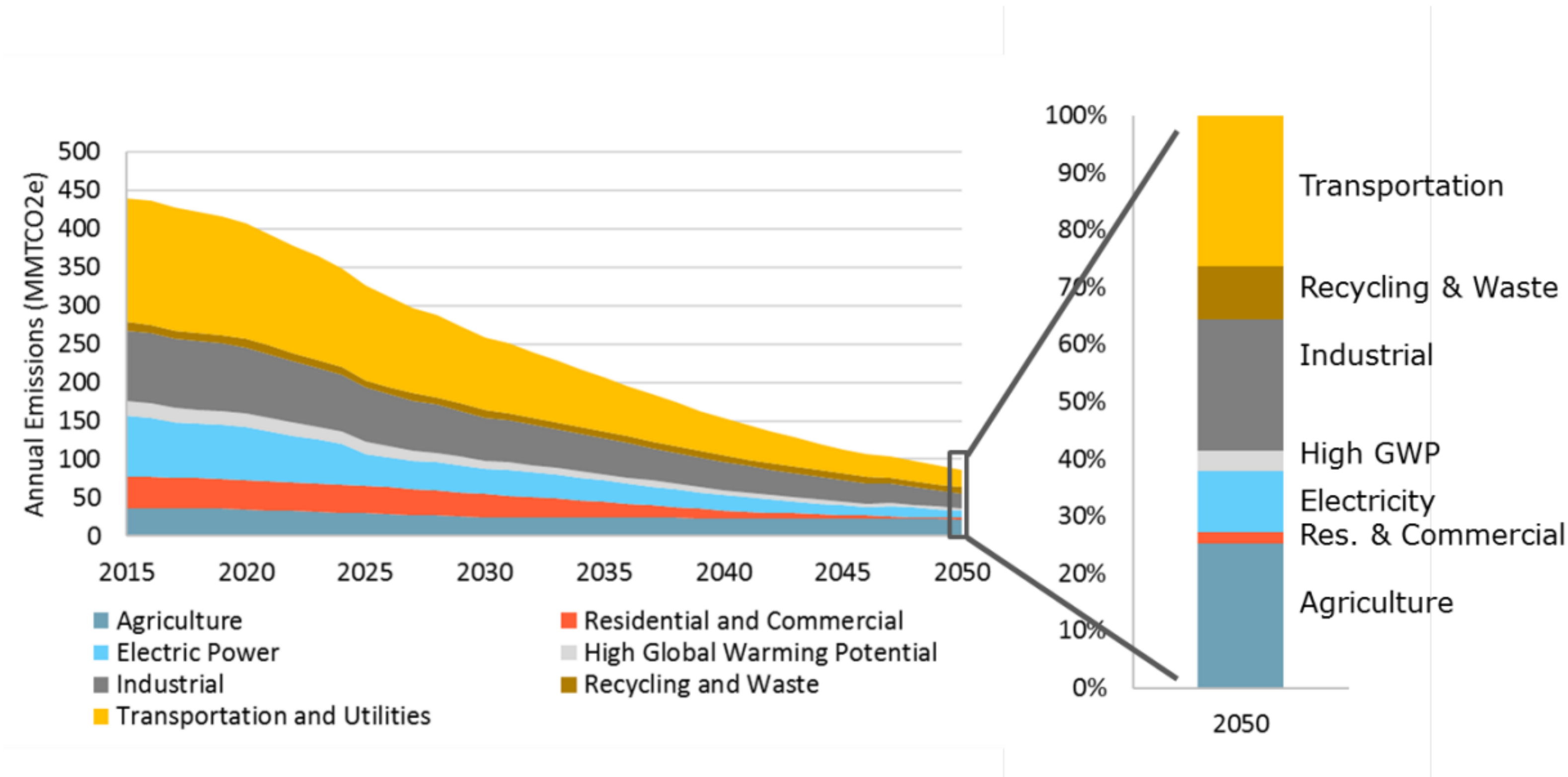
2030	60% Renewable Portfolio Standard (RPS)
2045	Zero-Carbon Grid

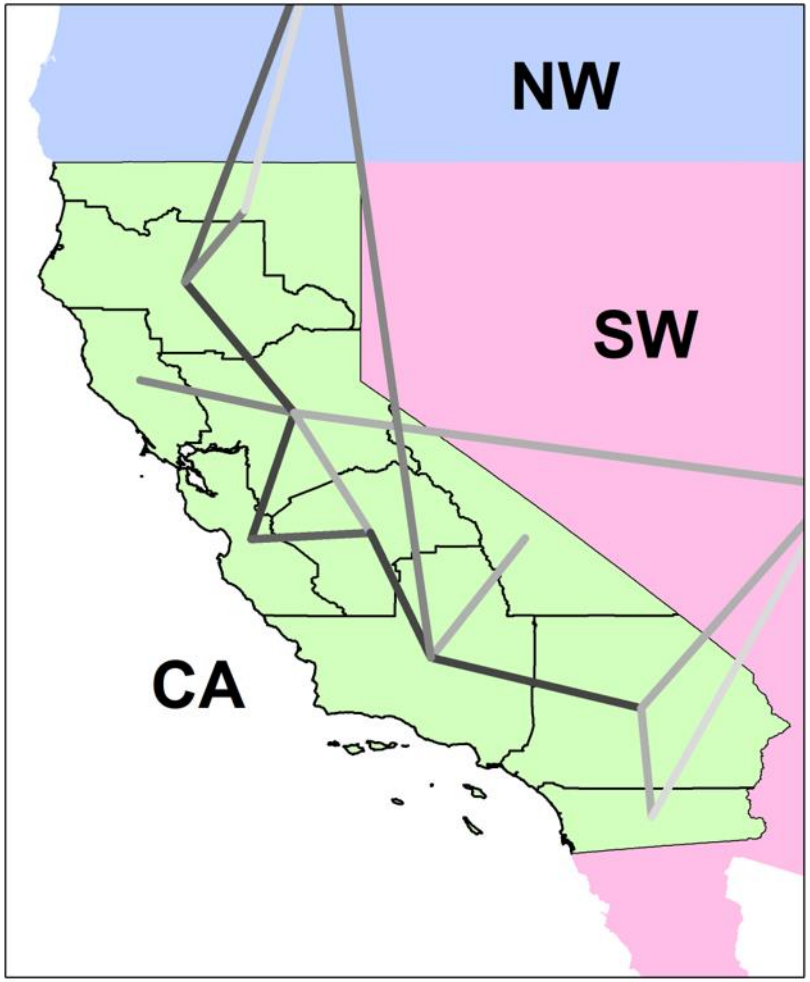
In addition to meeting the RPS, cost-effective decarbonization of the economy will need meeting emissions reduction goals for the electricity sector in 2030 as well

Figure 6: California Greenhouse Gas Emissions by Sector in the High Electrification Scenario



Source: E3, 2018

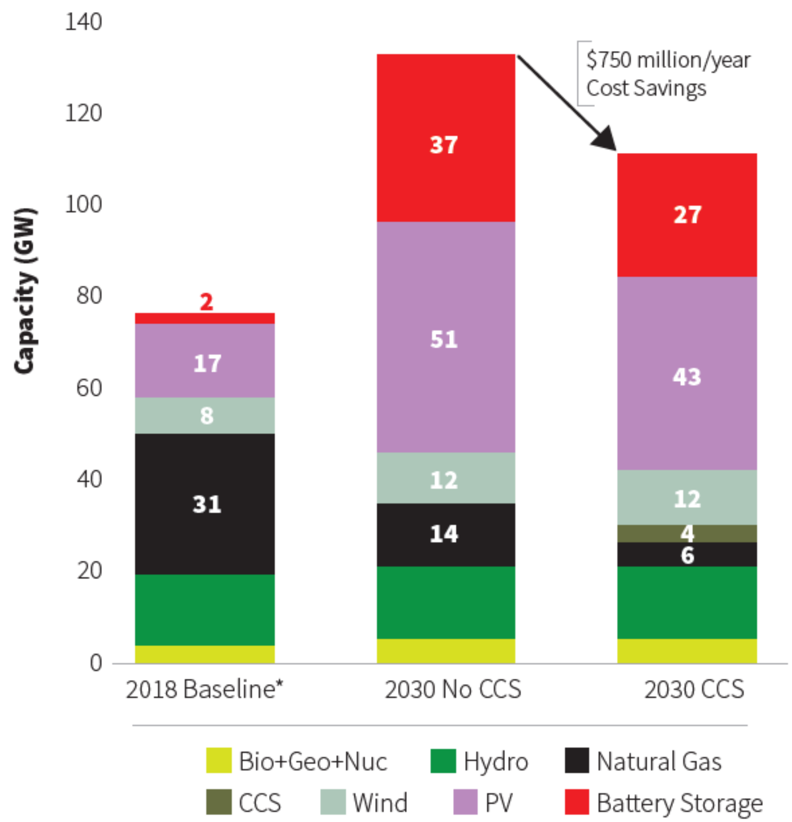
Given climate goals for 2030, what does an optimized California grid look like?



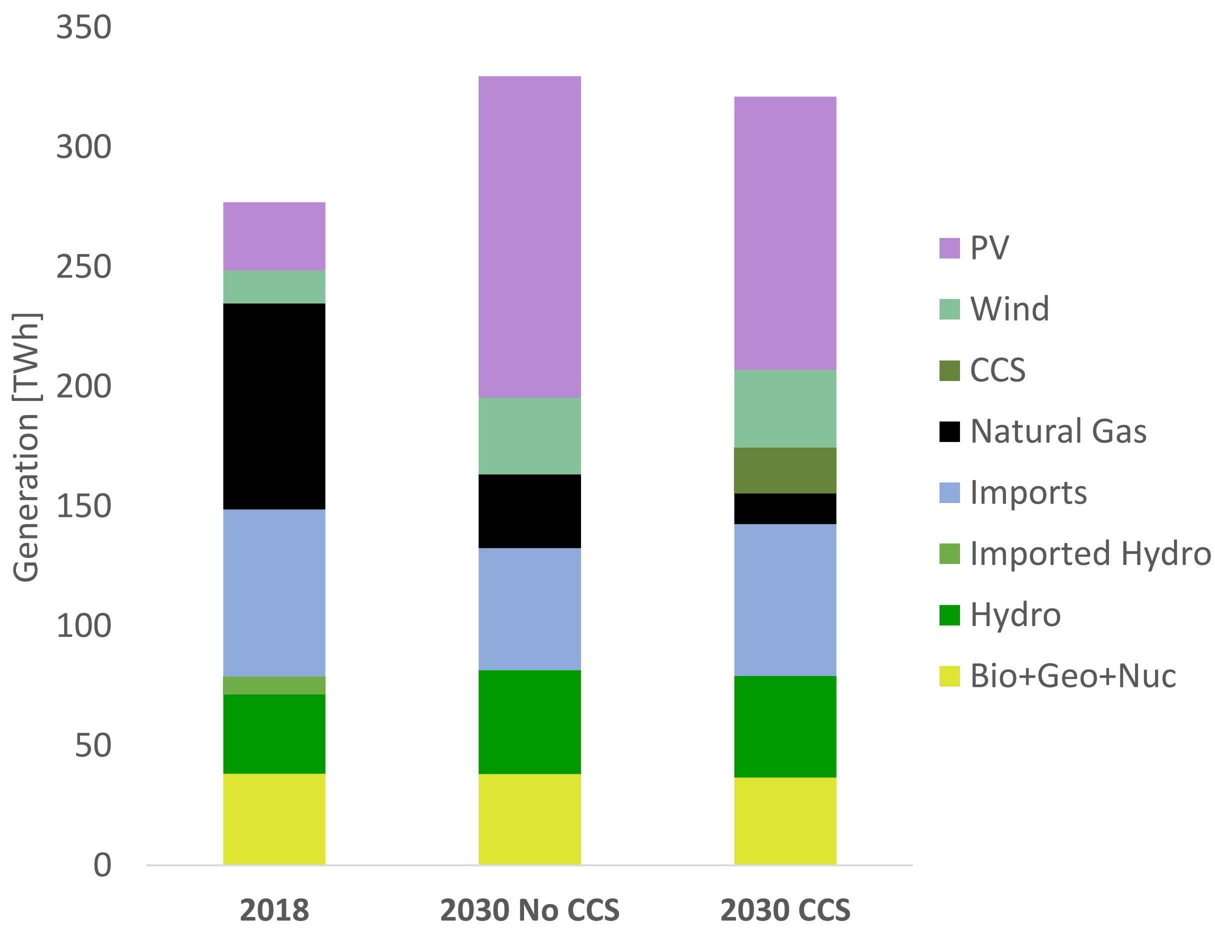
Meeting California's 2030 RPS and emissions reduction goals for the electricity sector with NGCC-CCS in the system saves ~$750 Million/year relative to a scenario without NGCC-CCS

FIGURE 3-6

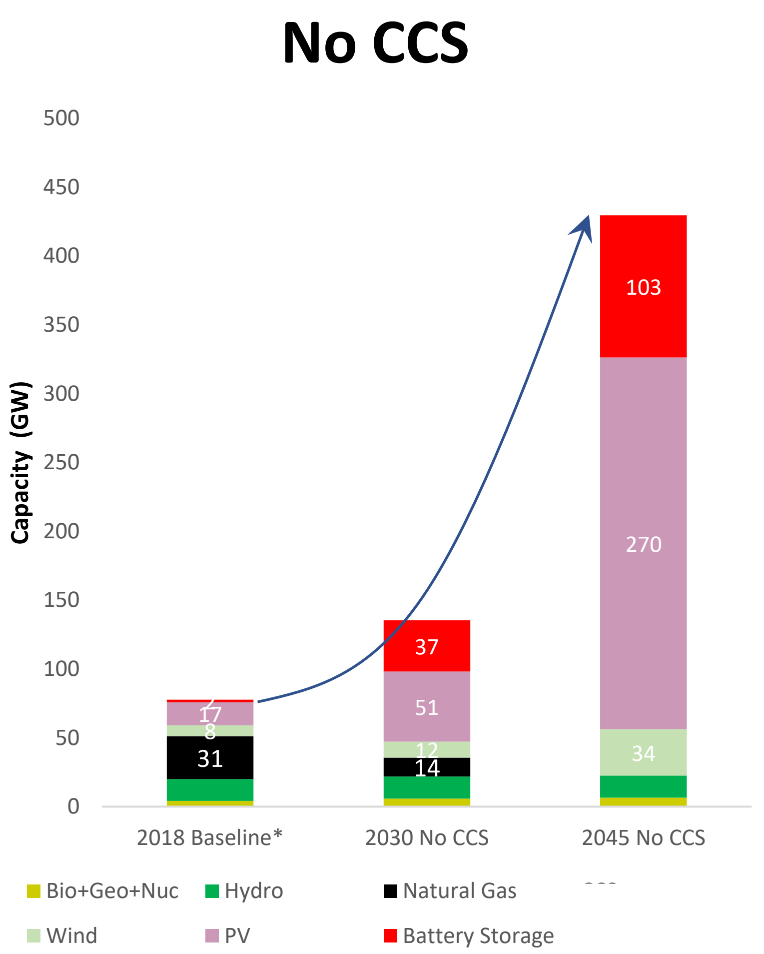
CAPACITY OF CALIFORNIA'S ELECTRICITY SYSTEM IN 2030 WITH AND WITHOUT CCS

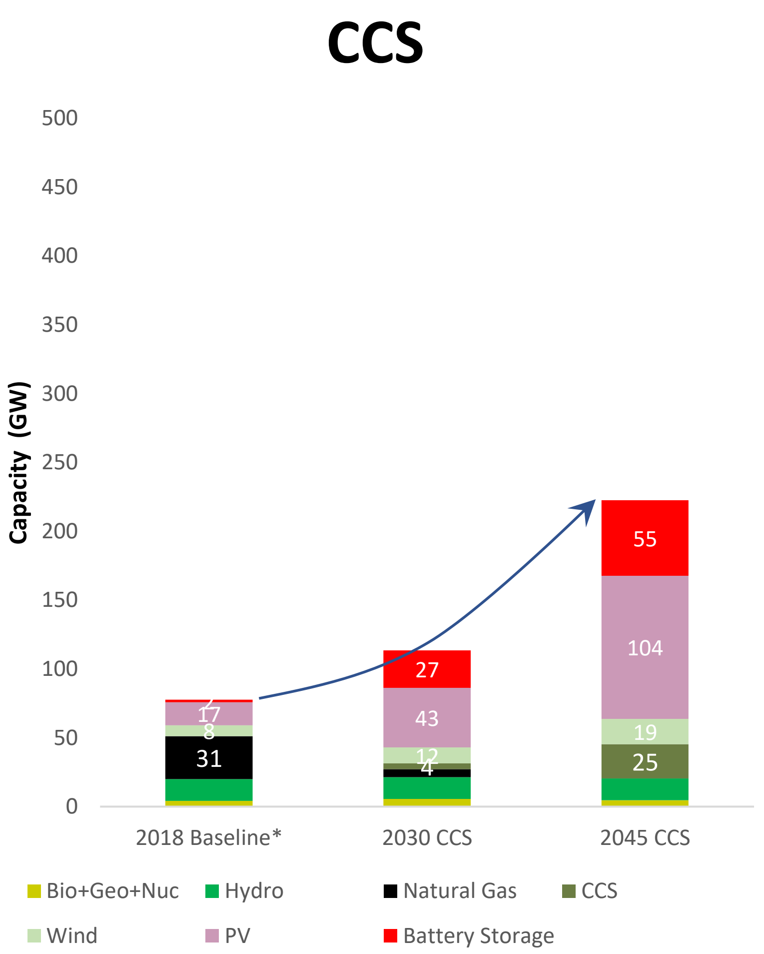


A decrease in natural gas generation relative to 2018 is made up largely with more PV generation



Developing CCS in 2030 can put California on path to meet its 2045 goals effectively





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Thank you for listening!

I'd be happy to take Questions: @ebaik@stanford.edu