DOCKETED

Docket Number:	16-TRAN-01
Project Title:	SB 350 Transportation Electrification (Publicly Owned Utilities)
TN #:	213899
Document Title:	Presentation - Key Considerations for Incorporating Transport Electrification into IRP by Nancy Ryan
Description:	October 5, 2016 Workshop
Filer:	Patty Paul
Organization:	Energy+Environmental Economics
Submitter Role:	Public
Submission Date:	10/5/2016 9:06:30 AM
Docketed Date:	10/5/2016

Energy+Environmental Economics

Key Considerations for Incorporating Transport Electrification into IRP

California Energy Commission

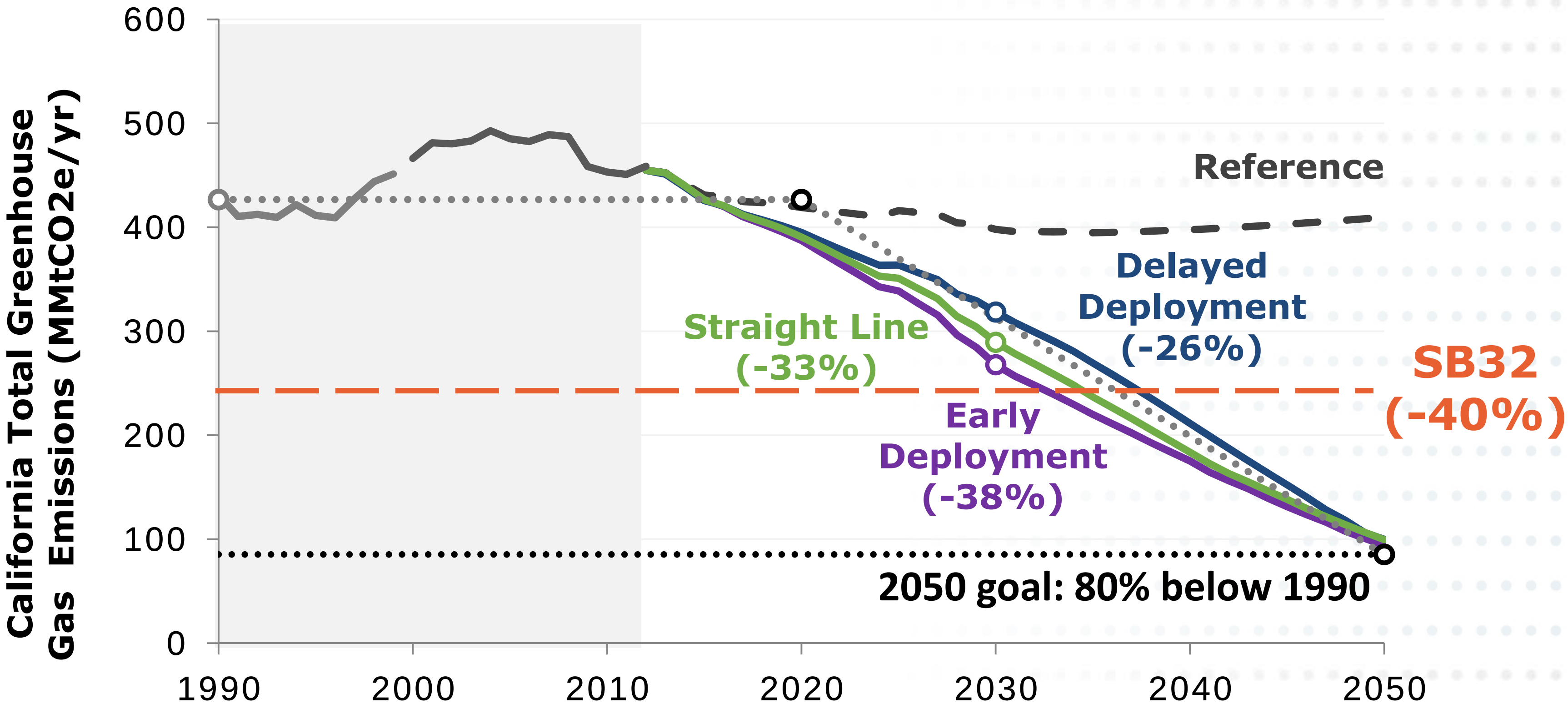
October 5, 2016

Nancy Ryan, Partner

About E3

- San Francisco-based consultancy with 40 professionals focusing on electricity sector economics, regulation, planning and technical analysis
- Leading consultant to California agencies governing renewables, energy efficiency, demand response, and distributed generation programs
- Consultant to many of the world's largest utilities and leading renewable developers
- Our experience has placed us at the nexus of planning, policy and markets

Multiple scenarios are on a consistent trajectory to meet CA's 2050 GHG goal

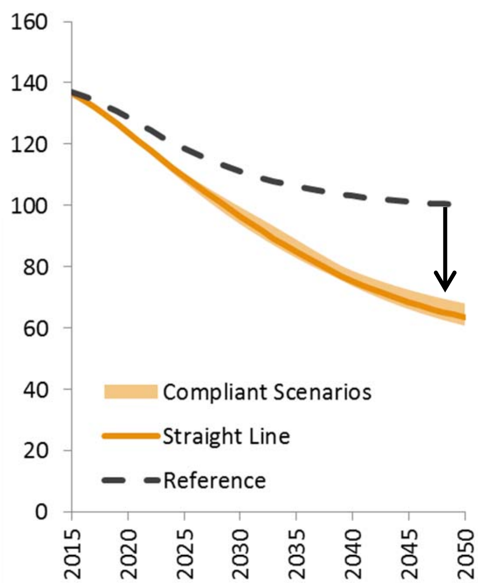


- **Timing scenarios** vary the pace of decarbonization: 2030 GHG emissions range from 26-38% below 1990 level
- **Technology scenarios** (not shown) assess impacts and interactions for specific technologies

Decarbonizing CA's economy depends on four energy transitions

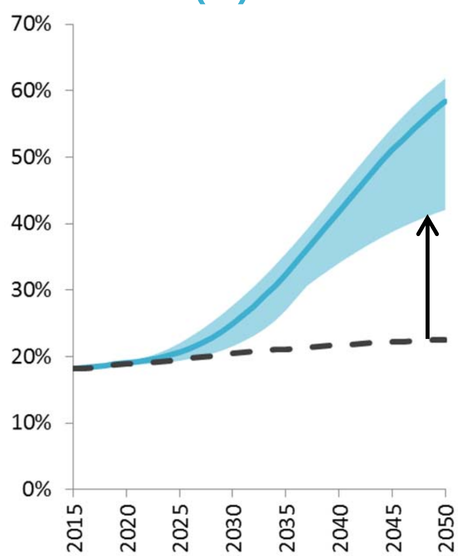
1. Efficiency and Conservation

Energy use per capita (MMBtu/person)



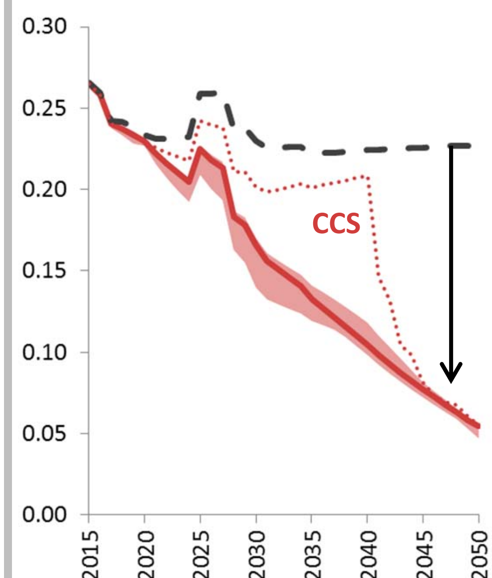
2. Fuel Switching

Share of electricity & H_2 in total final energy (%)



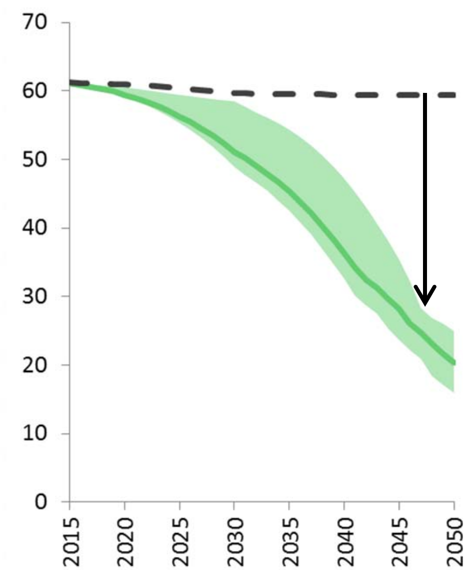
3. Decarbonize electricity

Emissions intensity (tCO2e/MWh)



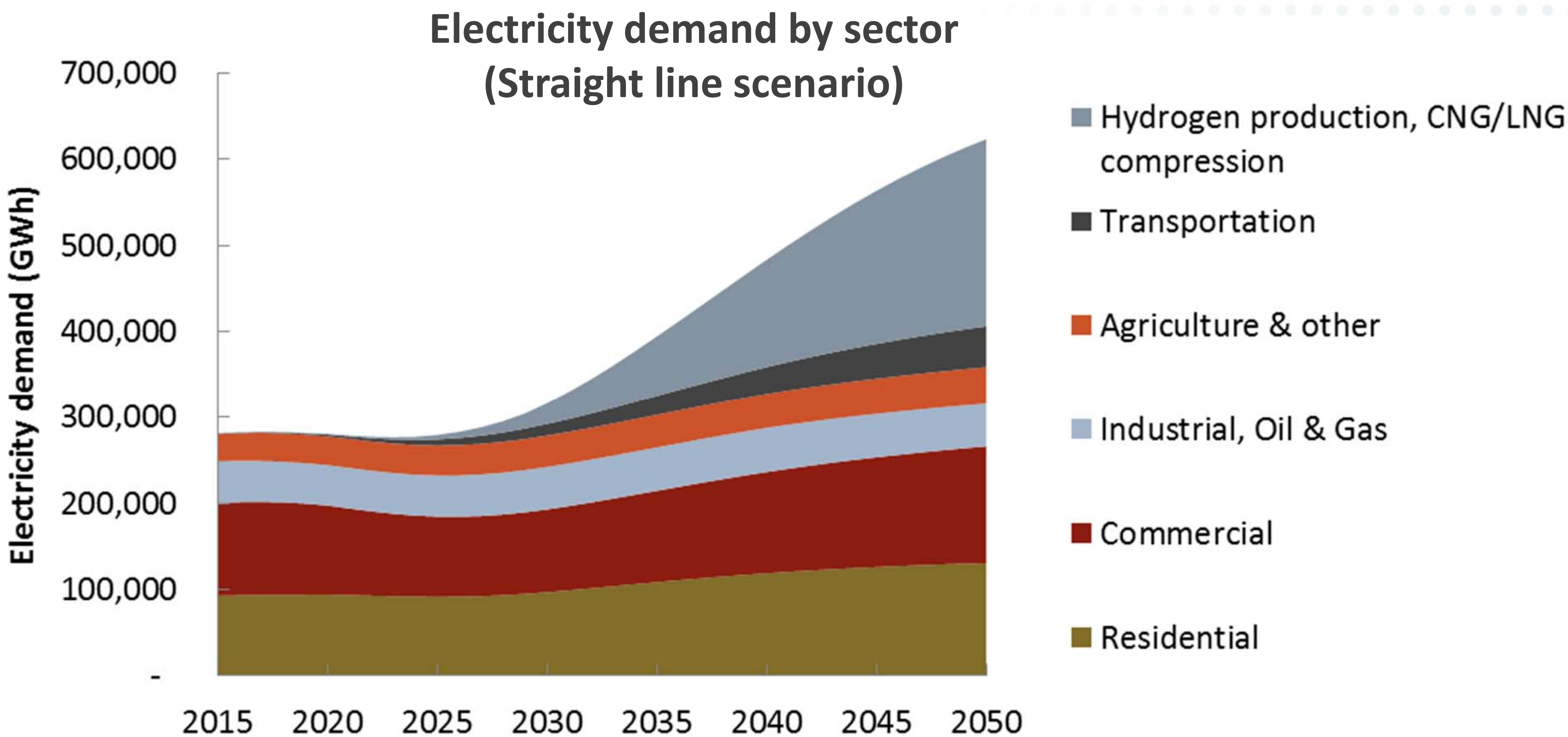
4. Decarbonize fuels (liquid & gas)

Emissions intensity (tCO2/EJ)



Fuel switching drives rapid growth in electric generation after 2030

- Energy efficiency offsets impact of electrification through 2030
- Beyond 2030 new loads offer potential for flexibility to help integrate solar and wind generation



California policy is driving significant renewable adoption

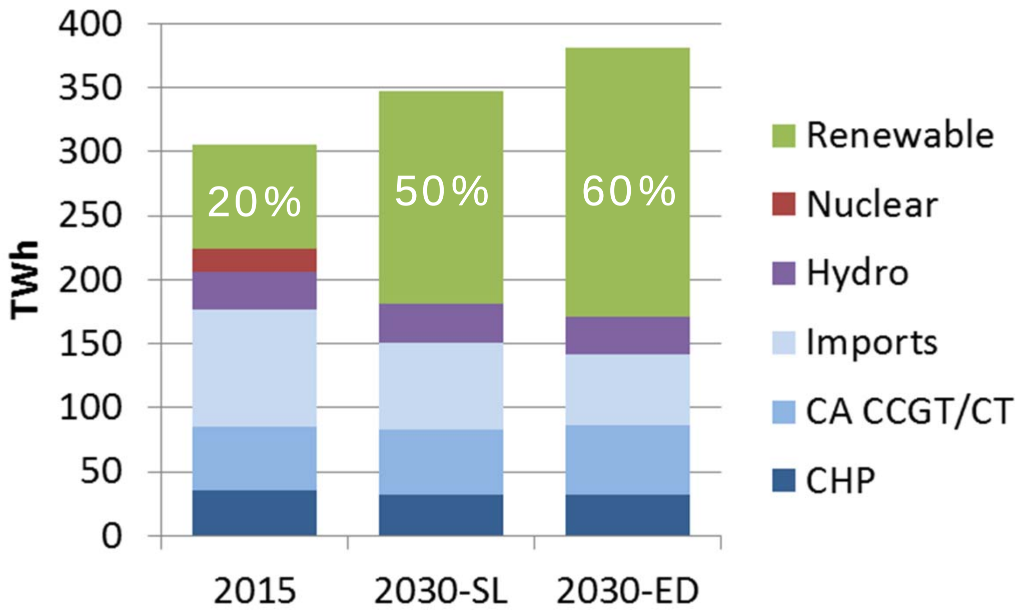
- **Gov. Brown's GHG goals: 40% reduction in economy-wide emissions, relative to 1990 levels, to be accomplished with:**
  - **50% renewable electricity**
  - **Doubling of energy efficiency savings** in existing buildings
  - Up to **50% reduction in petroleum use** in cars and trucks
- **Net energy metering decision will drive significantly more adoption of rooftop PV**

SB350 renewable energy target probably too low to meet 2030 GHG goal

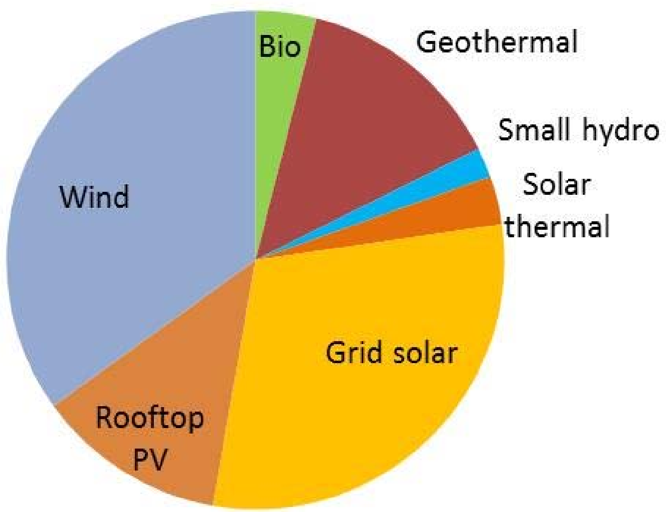
+ **Renewables account for 50-60% of annual energy use by 2030**

+ **Integration solutions are needed in all high renewables cases:**
  - Regional coordination, renewable diversity, flexible loads, more flexible thermal fleet, curtailment energy storage, flexible fuel production for ZEVs

Annual Energy



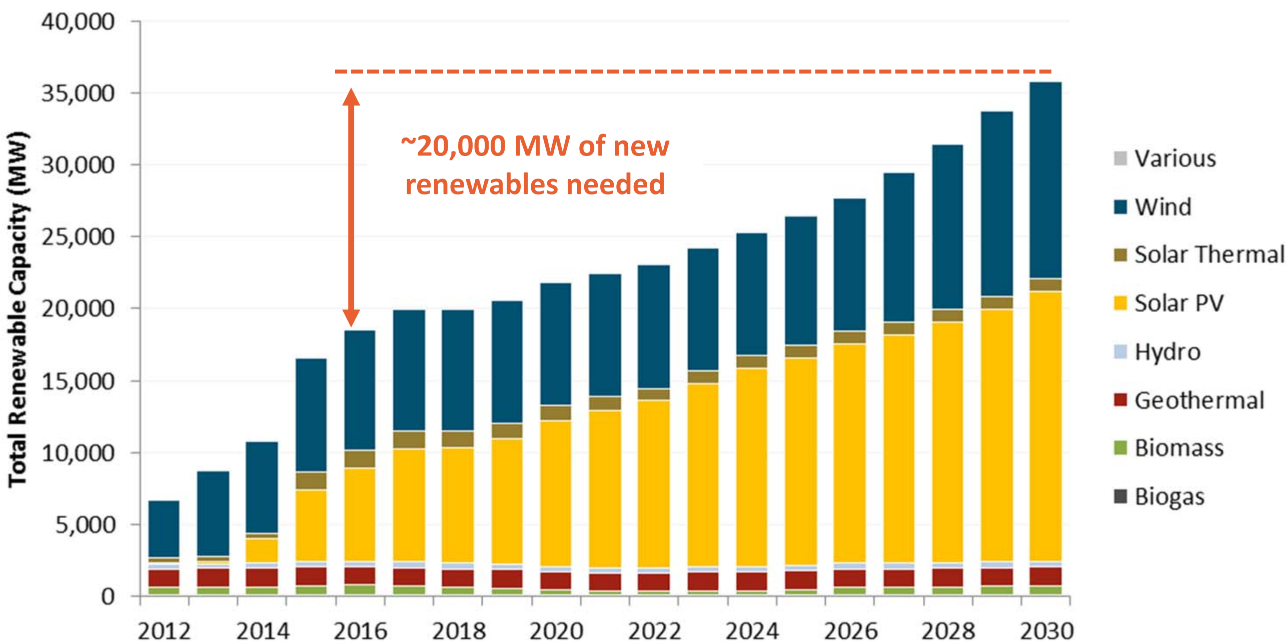
2030 Renewable Generation by Type (%) – Straight Line



Renewable Needs to Meet 50%

+ In 2015, California is achieving ≈25% RPS

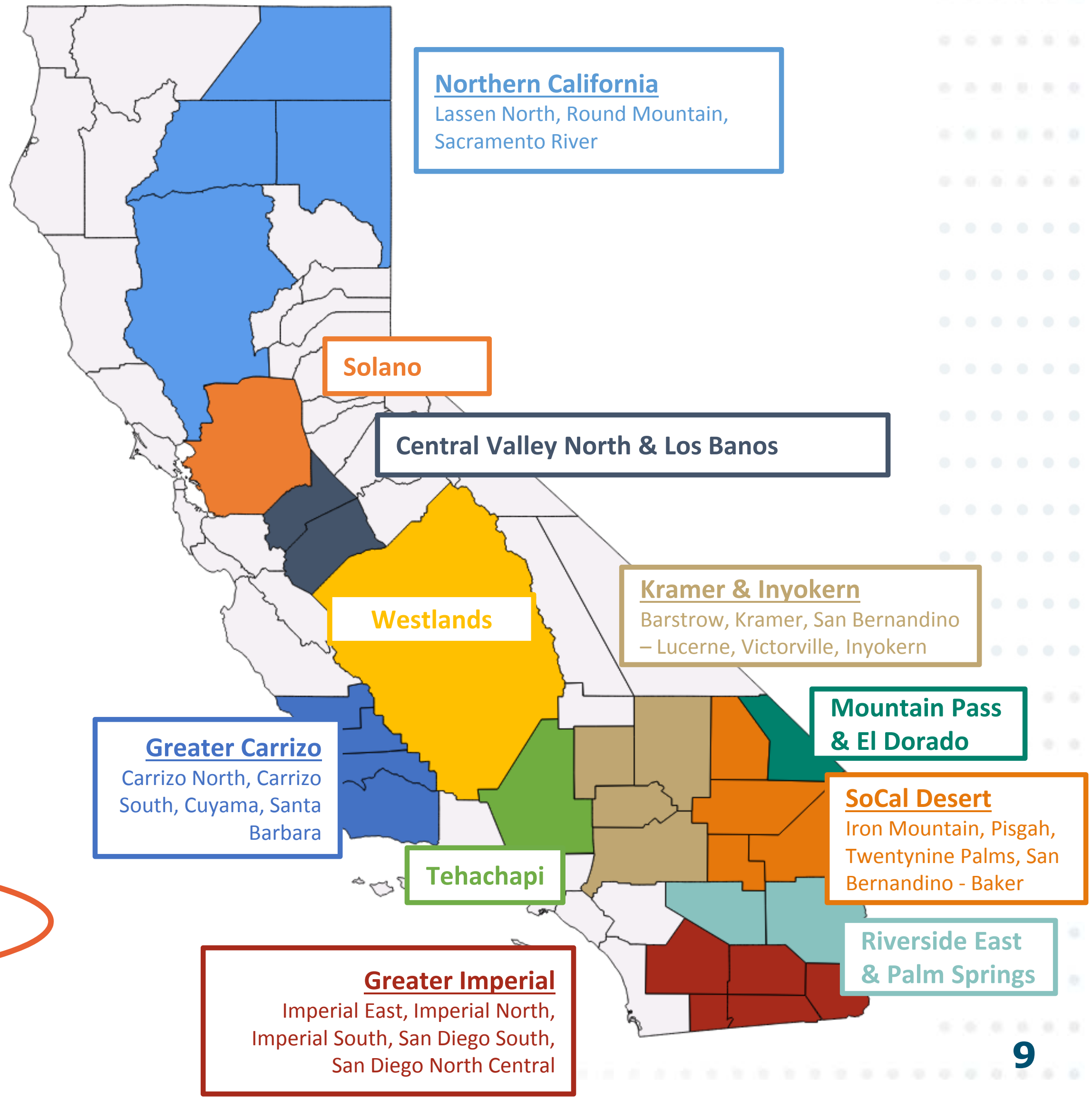
- Some resources out of state
- California resources will need to double by 2030 to reach a 50% RPS



Source: CPUC RPS Calculator (v.6.1)

In-state resource potential is largely solar

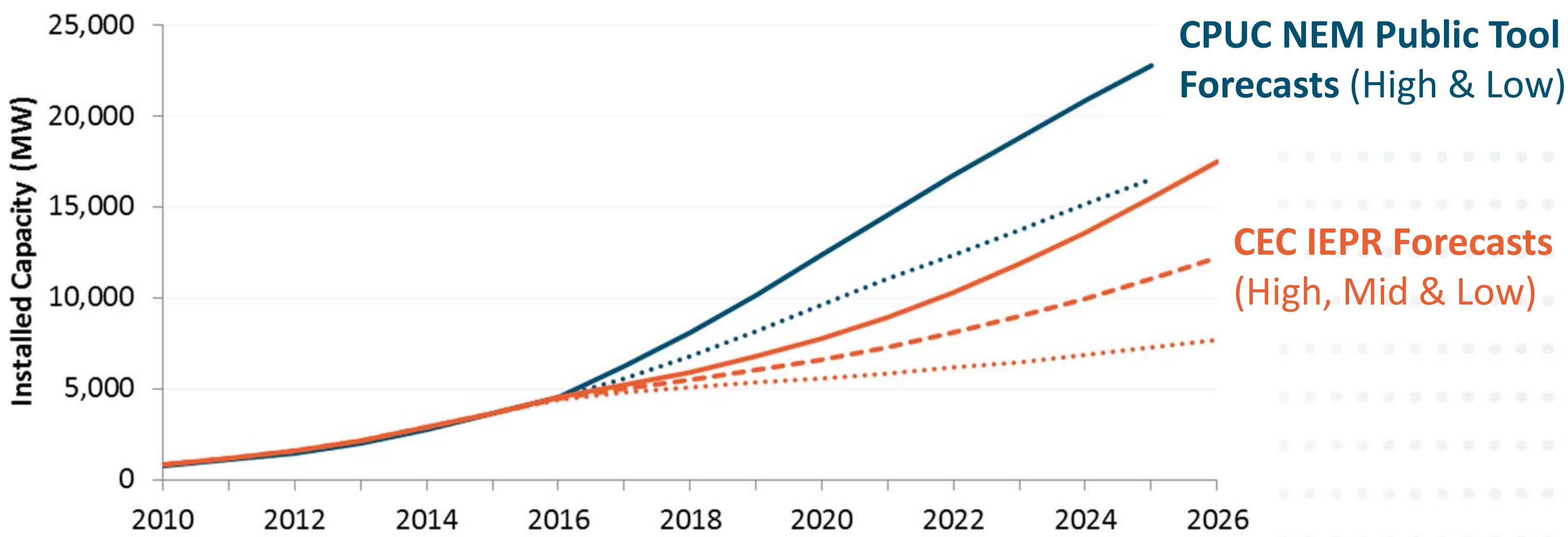
+ **"Bucket 1" resources must be 75% of RPS portfolio by 2020**
  - Must interconnect to or be dynamically scheduled to a California BA
  - Applies to LSEs, CCAs
+ **Developable in-state potential:**
  - Geothermal: 1800 MW
  - Wind: < 3000 MW
  - Solar: **100,000+ MW**



Current policy driving robust growth in distributed solar

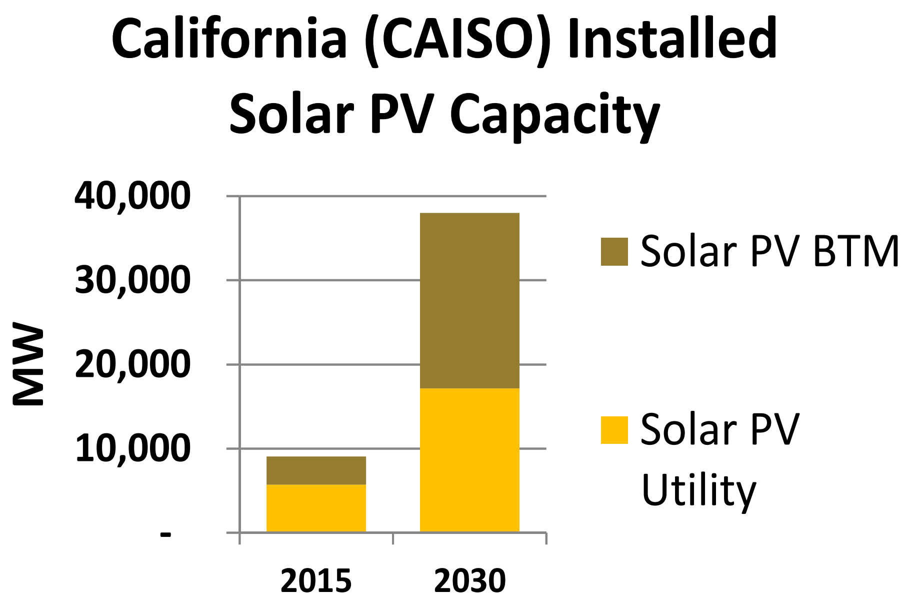
+ **Recent CPUC decision on NEM successor tariff ensures a significant rooftop solar market in California**
+ **Future adoption is highly uncertain, but most projections suggest 10-20 GW of customer PV by 2025**

Predicted Growth of Customer-Adopted Solar PV



40 GW of solar expected in California by 2030

- **Unless procurement practices are changed, total solar installations in IOU service areas could reach 35–39 GW by 2030**
  - 15-20 GW utility scale
  - 15-20 GW customer-owned
  - Additional 2-5 GW from muni service areas (SMUD, LADWP)
- **Non-solar renewables will add another 15-20 GW**

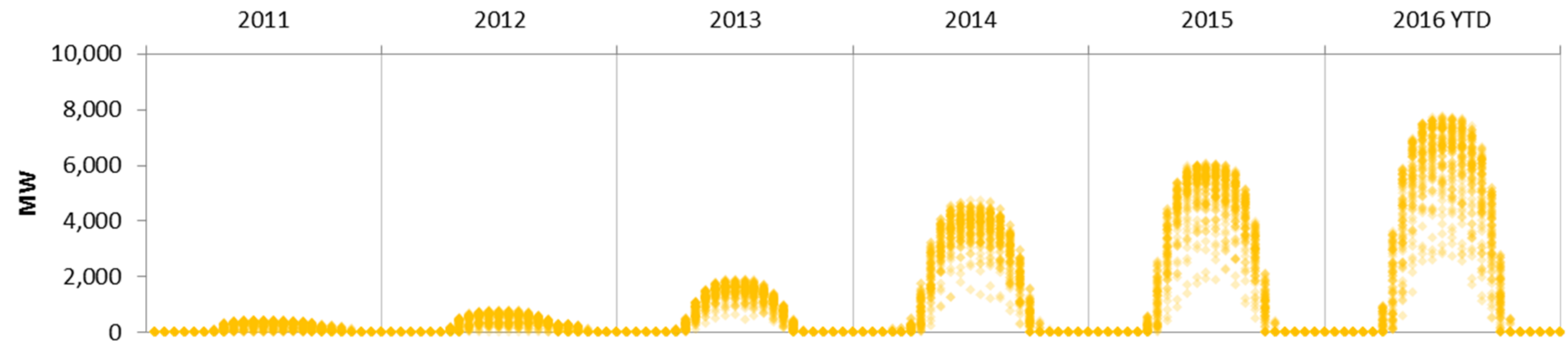


Source: CPUC's NEM 2.0 Public Tool
https://www.ethree.com/public_projects/cpucPublicTool.php

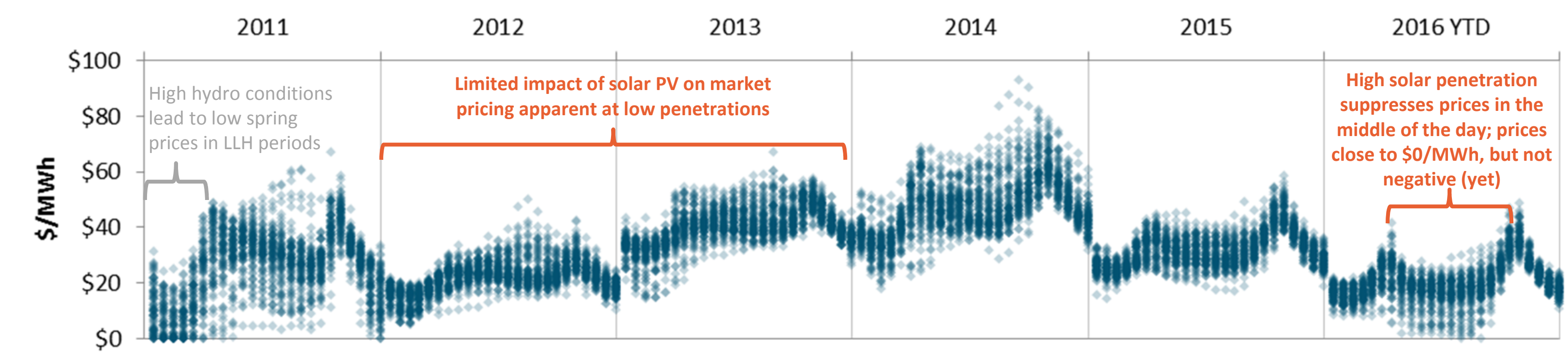
Solar generation is already suppressing market prices

+ **Rapid increase in solar buildout has clearly begun to suppress daytime market prices—but negative pricing has not yet been observed in the day-ahead market**

CAISO Hourly Solar Generation by Year (March – May only)

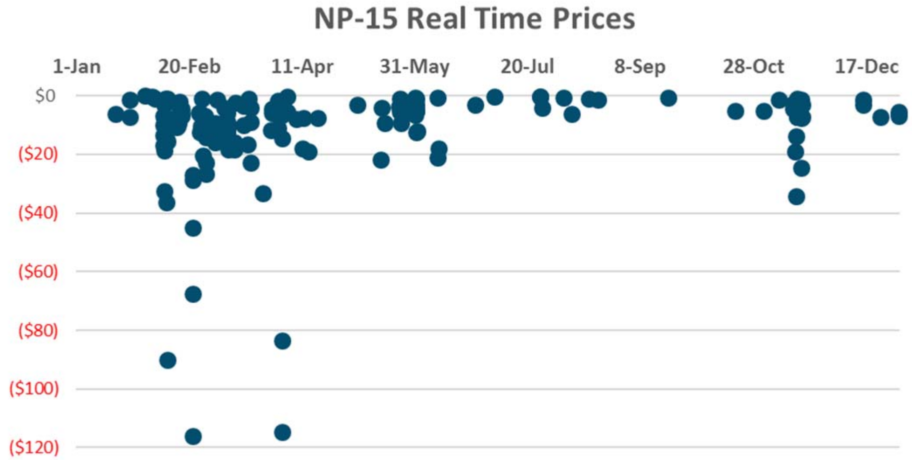


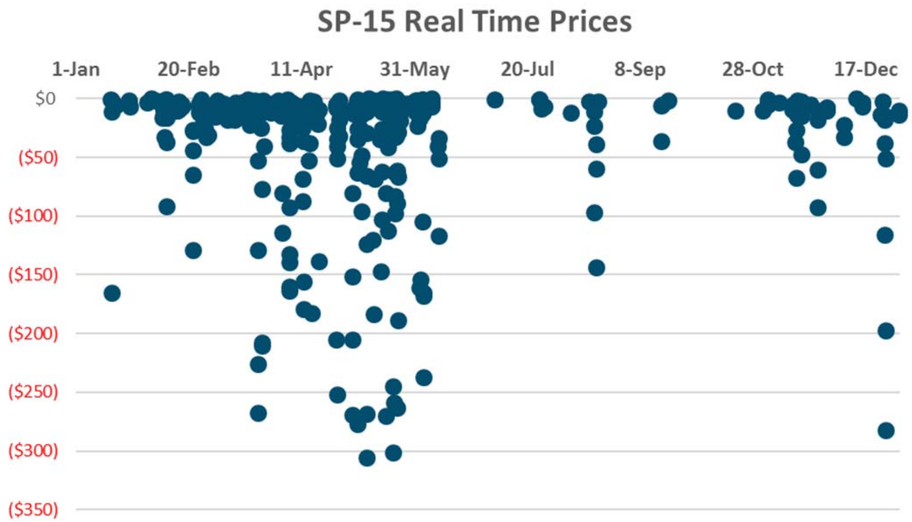
NP15 Day-Ahead Hourly Market Price (March – May only)



Negative prices observed in real-time market

Negative prices have been observed in the real-time market in 2015





- Negative prices seen more frequently in spring
- Negative price magnitudes and frequency are higher in SP-15
- Day ahead markets have still not experienced negative prices
- We anticipate the real time and day ahead markets will both have considerable number of hours with negative prices with increasing solar

Integration solutions are needed in all high renewables scenarios

+ **Increased regional coordination**
  - Make best use of latent flexibility in current system
+ **Renewable resource diversity**
  - Reduces overgeneration and need for flexible resources
+ **Flexible loads**
  - Shifting loads from one time period to another, sometimes on short notice
+ **Flexible generation**
  - Need generation that is fast ramping, starts quickly, and has min. gen. flexibility
+ **Energy storage**
  - Deep-draw (diurnal) storage is important

ZEV pathways require different electricity infrastructure

Zero Emissions Vehicles

New Infrastructure

Mix of fuels cell (FCVs) and battery electric vehicles (BEVs)

(new vehicle sales)

In Straight Line scenario **flexible grid electrolysis for hydrogen FCVs balances renewables on the grid**

Electric vehicle charging load: 7,000 MW

Flexible grid electrolysis: 9,000 MW

H_2 fueling stations

No new energy storage

OR

Focus on BEVs if FCVs don't materialize

In High BEV scenario **long-duration energy storage provides bulk of renewable balancing services for the grid**

Electric vehicle charging load: 20,000 MW

New 4-8 hr energy storage: 5,000 MW

No grid electrolysis

No H2 fueling stations

Thank You!

Energy and Environmental Economics, Inc. (E3)
101 Montgomery Street, Suite 1600
San Francisco, CA 94104
Tel 415-391-5100
www.ethree.com

Nancy Ryan, Partner (nancy@ethree.com)

E3's "Pocket Guide" to Renewable Integration Solutions

	Integration solution	Findings
Net benefits even w/o renewables	Regional coordination	More efficient dispatch and reduced curtailment
Low cost solutions with potentially large benefits	Time of use rates	Shifts energy consumption toward daylight hours
	Subhourly renewable dispatch	Allows system to operate with fewer thermal resources during overgeneration events
	Renewable portfolio diversity	Avoids curtailment by spreading renewable production over more hours of the year
Costs and benefits should be evaluated on specific project or program basis	Flexible loads Advanced DR	Shifts energy consumption toward hours with overgeneration, but cost and potential are unknown
	Additional storage	Reduces curtailment but requires significant investment
	Gas retrofits	Makes existing resources more flexible at a low cost
	New flexible gas resources	Provides limited dispatch flexibility at a high cost
Valuable, though not as much for integration	Energy efficiency	Provides significant cost and GHG savings but may not reduce curtailment
	Conventional demand response	Provides cost savings but does not significantly reduce curtailment