

Through the Looking Glass and What the Analyst Found There: Energy Storage Behind the Meter

A silhouette of a person standing on a rocky mountain peak, looking out over a vast, hazy mountain range under a bright sky. The person is wearing a red jacket and dark pants. The background is a soft, hazy landscape of mountains and valleys.

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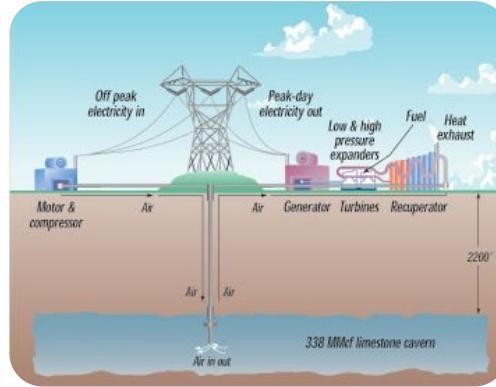
WHAT IS ENERGY STORAGE?

The capture of energy produced at one time for use at a later time

- » Can reduce demand (kW) but will always increase energy consumption (kWh) –2nd law of thermodynamics



Pumped Hydro

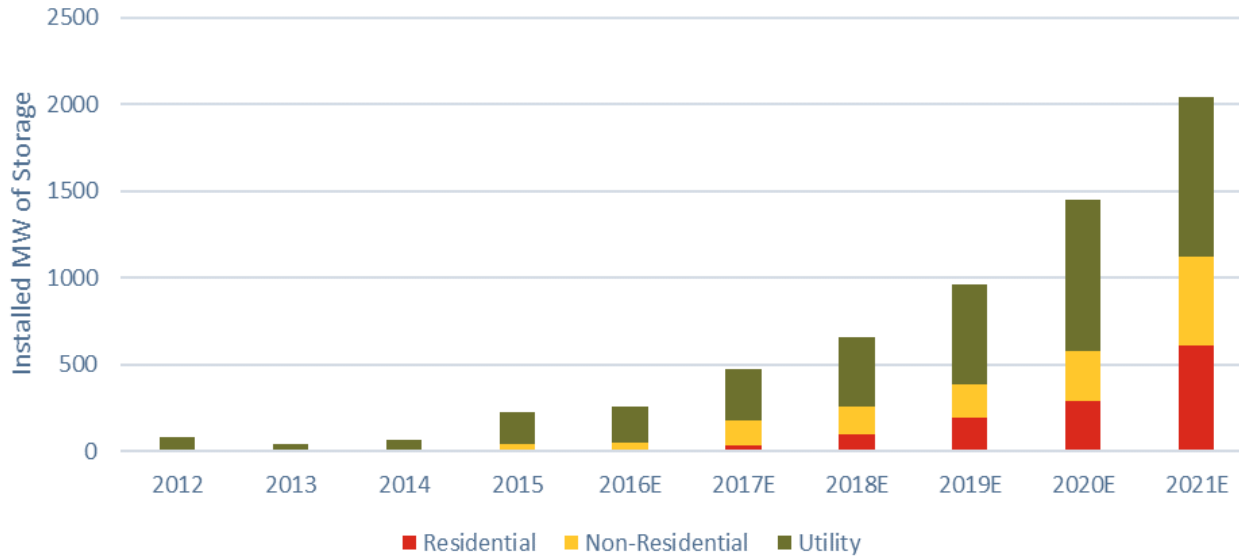


Compressed Air



Batteries

THE GROWTH OF ENERGY STORAGE



Mandates & Incentives:

CA – 1,350 MW + SGIP

MA – 200 MWh

OR – 5 MWh

MD – Tax Credit

NYREV

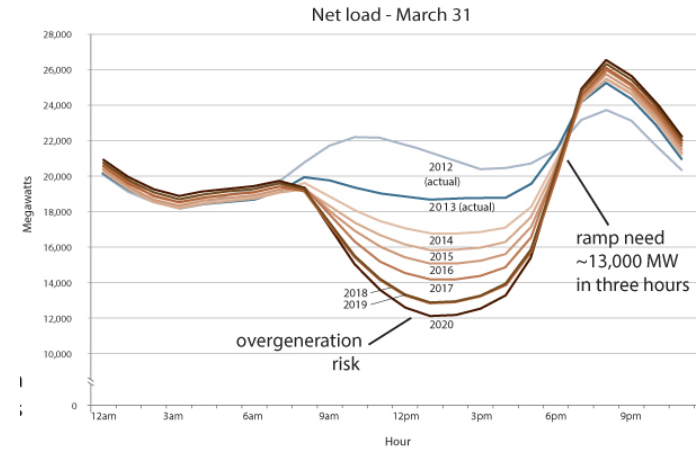
HI – no PV NEM

» Growing quickly; about a decade behind Solar PV



WHY ENERGY STORAGE?

- » Help balance supply and demand on the grid
- » Save Money by reducing Peak or Arbitrage:
 - Reduce emissions by charging during ‘clean’ hours and discharging during ‘dirty’ hours
- » To facilitate the integration of renewables
- » To defer investment in infrastructure



California Behind the Meter (BTM) Research

Self-Generation Incentive Program (SGIP)

SELF-GENERATION INCENTIVE PROGRAM

An Evolving Behind The Meter (BTM) Incentive Program – not like traditional EE programs

- » Started in 2001 to reduce peak demand
- » Administered mostly by utilities (Center for Sustainable Energy runs in San Diego Gas & Electric territory)
- » Added GHG reduction goal in 2010
- » Storage recently added and will be 75% of the program in 2017



EVALUATING THE SGIP

2014/2015 and Soon 2016

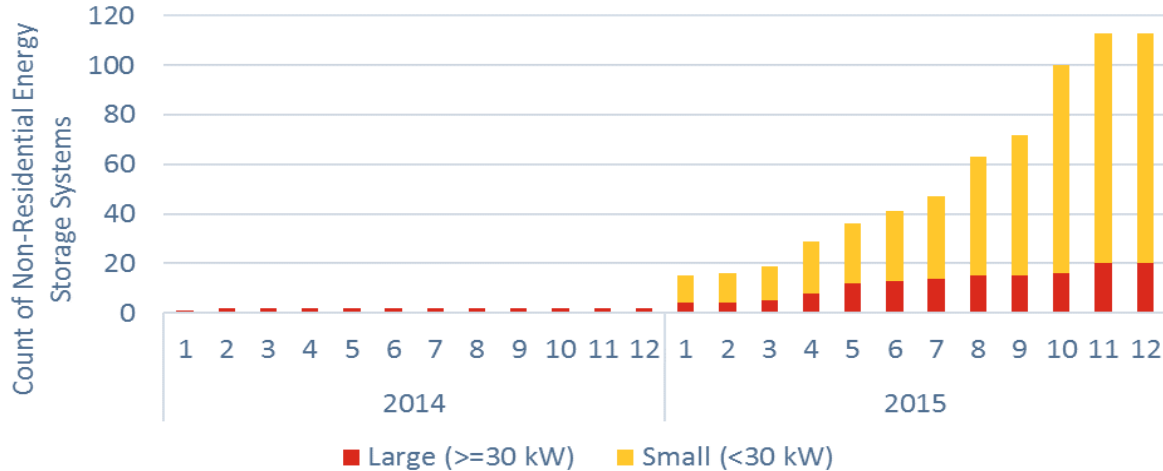
- » To assess peak demand impacts (Program Goal)
- » To assess the emissions impacts (Program Goal)
- » To assess the other benefits of energy storage

- » To evaluate this, we need data....



DATA FOR SGIP ENERGY STORAGE

2014/2015

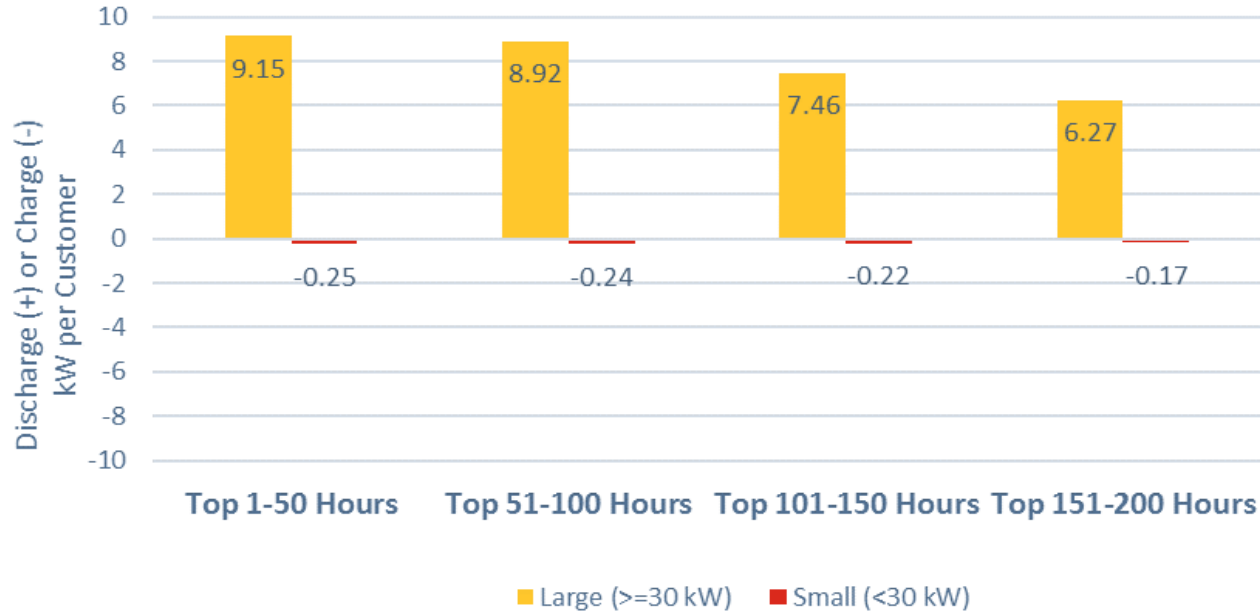


- » Load data from utilities
- » All Charge/Discharge data from manufacturers or 'Performance Data Providers'
 - Res data had issues (Efficiency > 100%) – Violating the 2nd Law of Thermodynamics
 - Small non-res was anonymized – no matching to load
- » Modeled Marginal Emissions (by E3; partner in this work)



IMPACT ON CAISO PEAK

Non-Residential

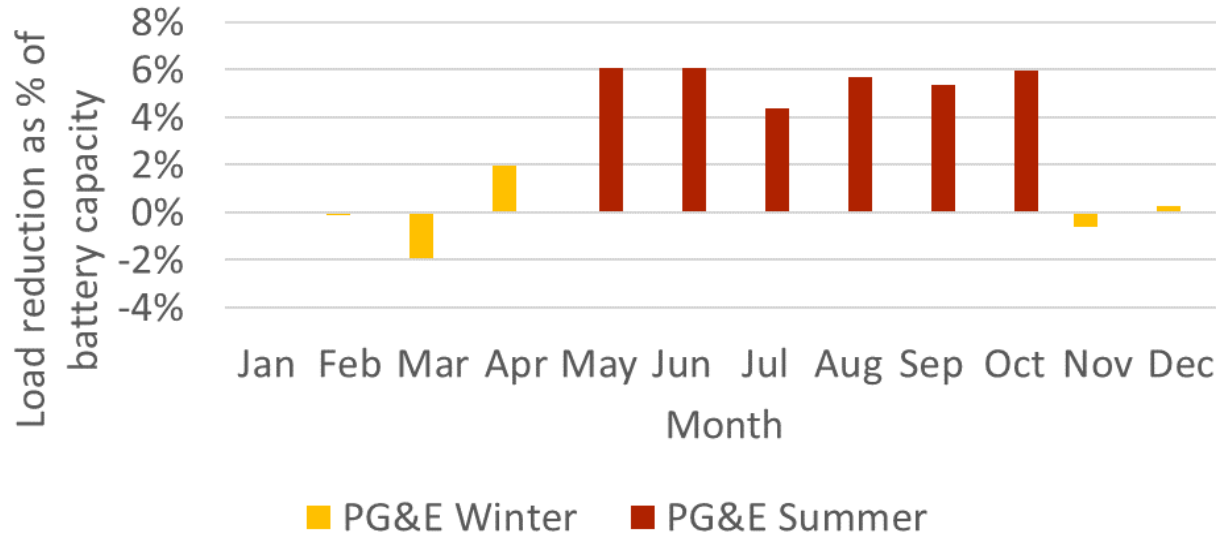


- » Larger systems reducing load during top hours
- » Smaller systems slightly *increasing* load during top hours



IMPACT ON CUSTOMER PEAK

Beware of small 'n': only based on 5 systems

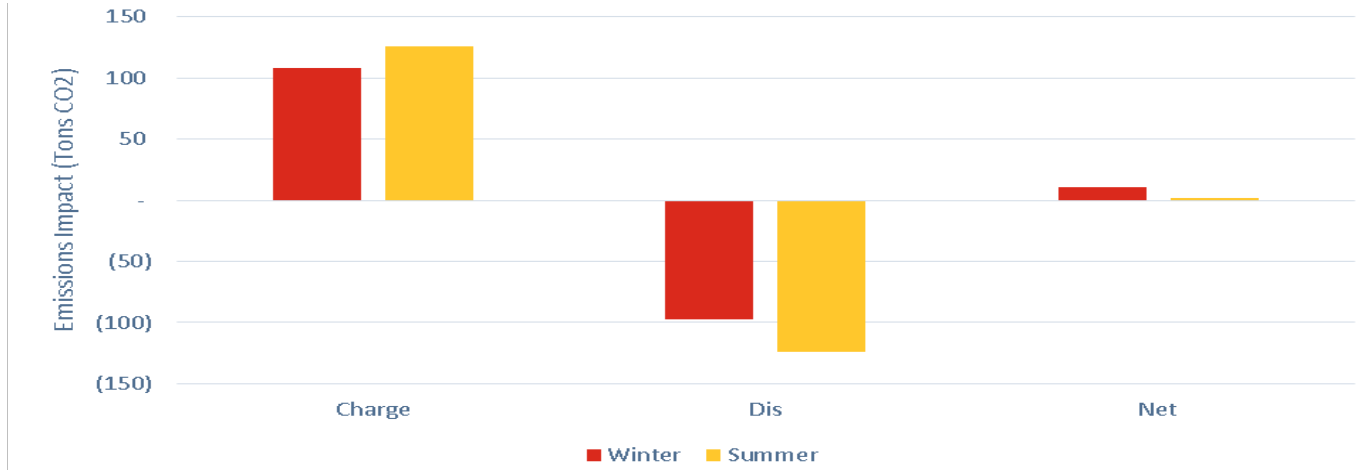


- » 2016 results with data for hundreds of systems showing much higher customer demand reductions



NET EMISSIONS IMPACT

Large Non-Res – Very few coupled to PV



- » Increasing *slightly* emissions
- » No clear price signal to do otherwise
- » More details in paper or talk to me after the session



DATA

It wasn't always great

Challenges

- » Getting data from manufacturers
- » Anonymized small non-res data
 - No customer load analysis for that group
- » Unbelievable Residential Charge/Discharge
 - Can't use data with efficiencies over 100%
 - Only qualitative Res analysis – see SGIP report

Fixes

- » Earlier proactive engagement
 - California Public Utilities Commission
 - Program Administrators
 - Industry Groups
 - Manufacturers
- » Installing metering
 - 30 res and 30 non-res meters now in place



KEY TAKEAWAYS

Energy Storage is Still Evolving

- » BTM storage technologies appear to provide benefits customers
- » Some BTM storage appears to contribute additional load to system peak demand
- » BTM energy storage is *increasing* emissions
- » Need better frameworks to drive more optimal operation



THANK YOU

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SGIP Reports: <http://www.cpuc.ca.gov/General.aspx?id=7890>

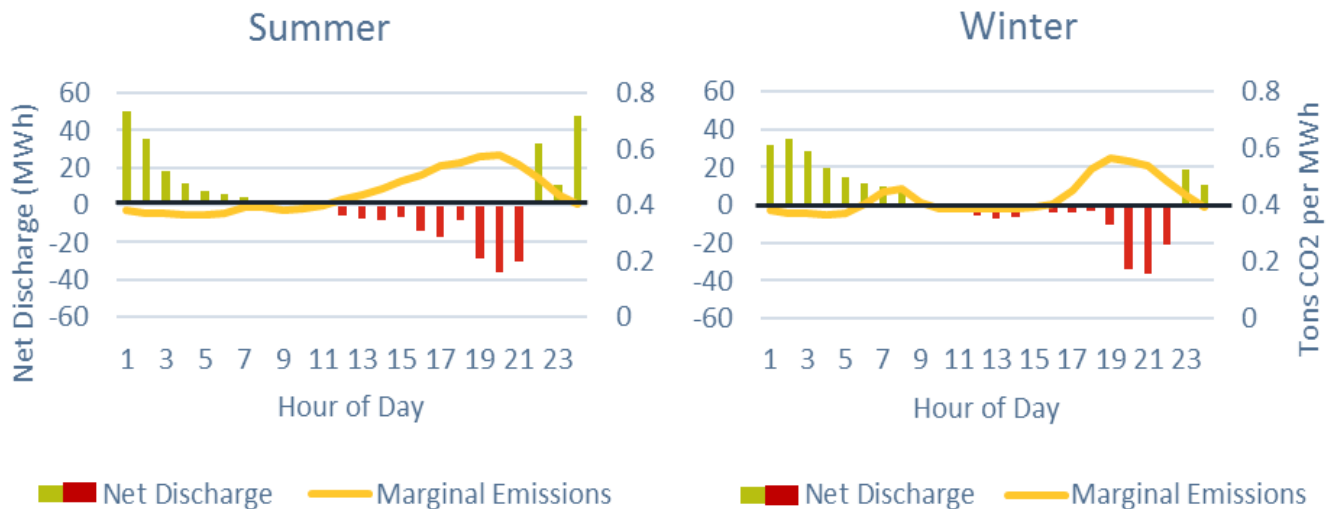


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EMISSIONS PROFILE

Emissions Impact Based on What the Grid is Doing vs. the Battery



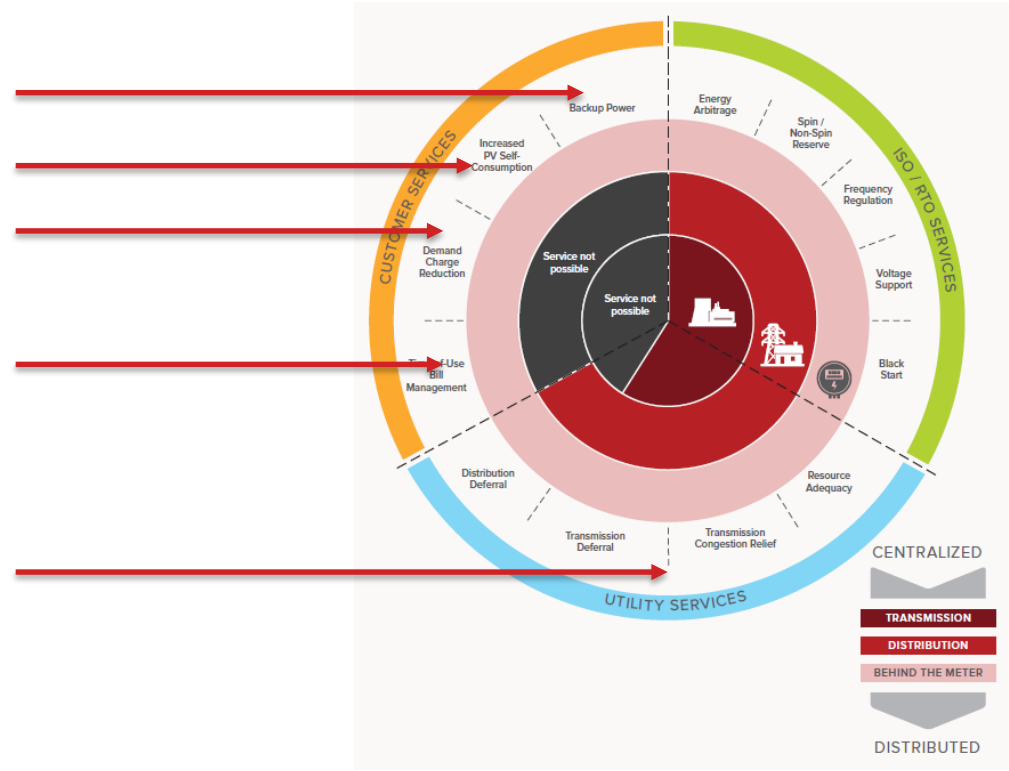
» Net Impact is due to Timing and Efficiency



BATTERY ENERGY STORAGE

California Behind The Meter (BTM)

- » Backup Power
- » PV Self-Consumption
- » Demand Charge Reduction
- » TOU Bill Management
- » Aggregated Demand Response



BATTERY ENERGY STORAGE

Behind the Meter – C&I



BATTERY ENERGY STORAGE

Behind the Meter – Residential



ROUND TRIP EFFICIENCY

How to talk about battery efficiency

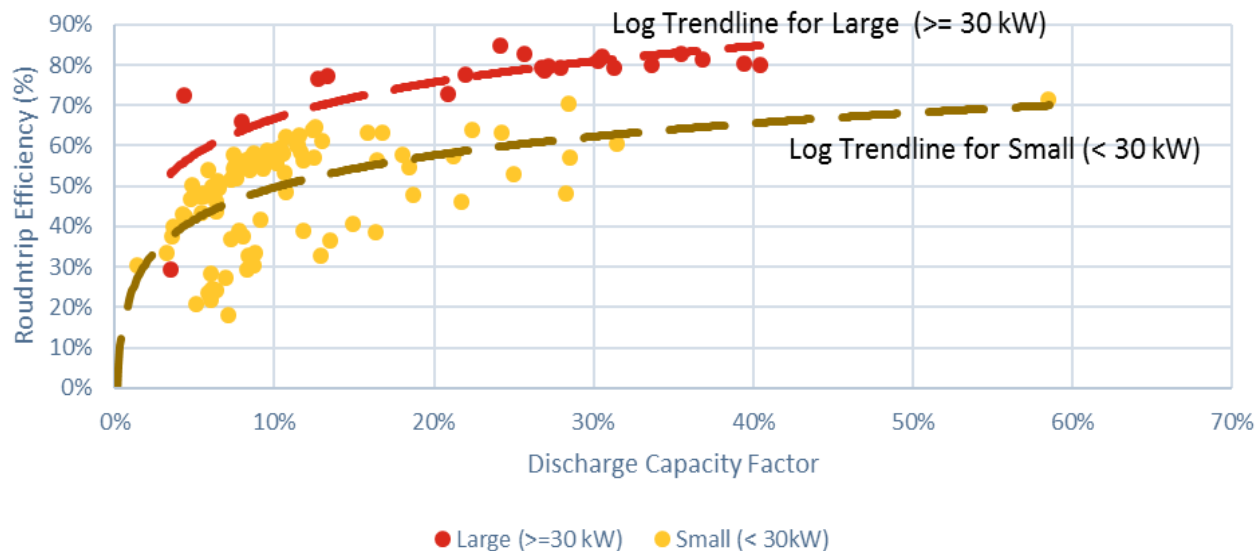
- » The energy available to discharge is always less than the energy used in charging due to:
 - Power electronic parasitic loads
 - Inverter/power converter efficiencies

$$\text{RTE} = \frac{\sum \text{Energy Discharged}}{\sum \text{Energy Charged}} < 1$$



Key takeaway: batteries will **ALWAYS** increase energy consumption

ROUND TRIP EFFICIENCY



Energy storage WILL ALWAYS INCREASE kWh

More use = less parasitic losses



STORAGE REGULATORY/LEGISLATIVE DECISIONS

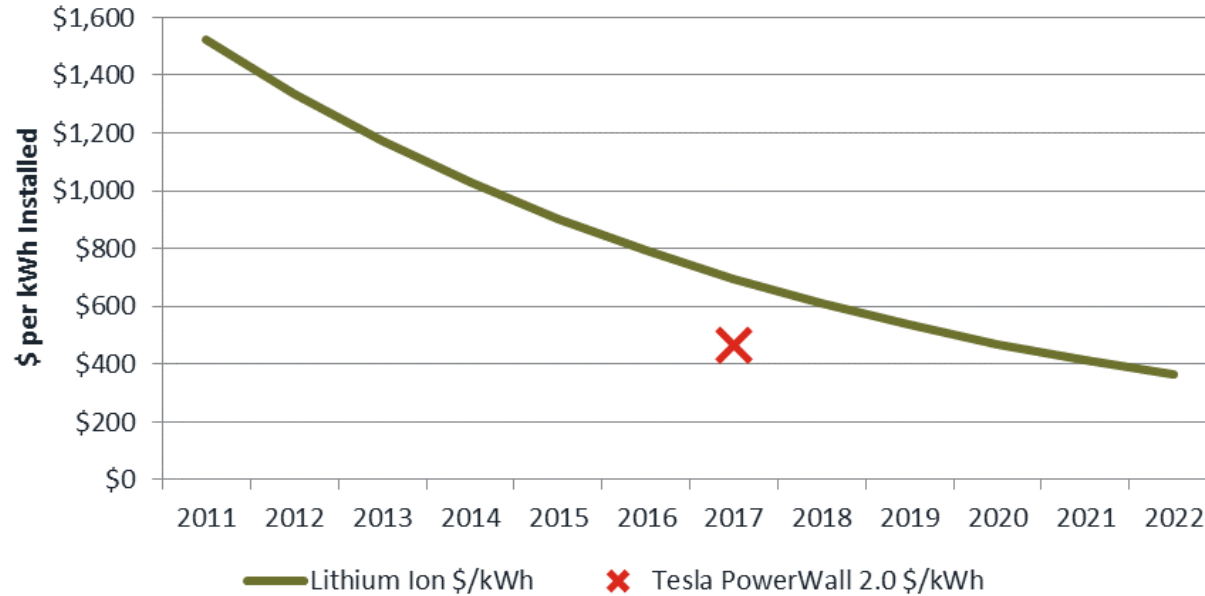
Background

- » SGIP modified to include standalone storage in 2011
 - Most recently program funding doubled to \$166 million per year (85% storage allocation)
- » CPUC mandated 1,325 MW of storage by 2024
- » CA Senate Bill 700 would set up dedicated energy storage incentive program (2018 through 2027)



CAPITAL COSTS

Lithium Ion BTM



Source: Itron DG Cost Effectiveness Model (SGIPce)

