# Improving flexibility of generation assets to integrate renewables and DER

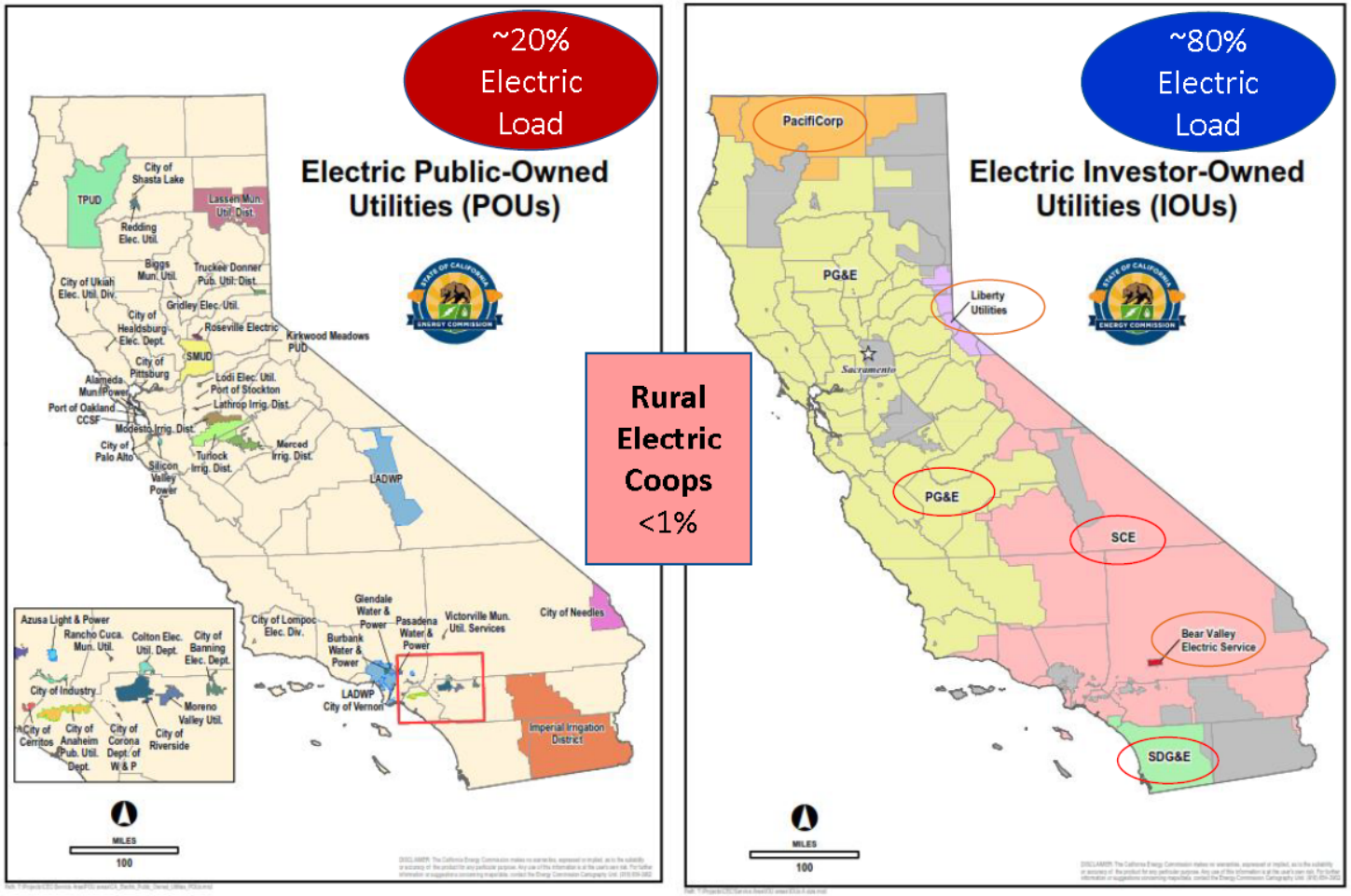
*XM Summit, Colombia*

**Vibhu Kaushik, Director – Grid Technology & Modernization**

Southern California Edison

September 5, 2019

# California Electric Utilities




**Utility Ownership:**

**6 IOUs (~75% of load)**

- **3 Large; 3 Small & Multi-Jurisdictional**

46 POUs (~25% of load)

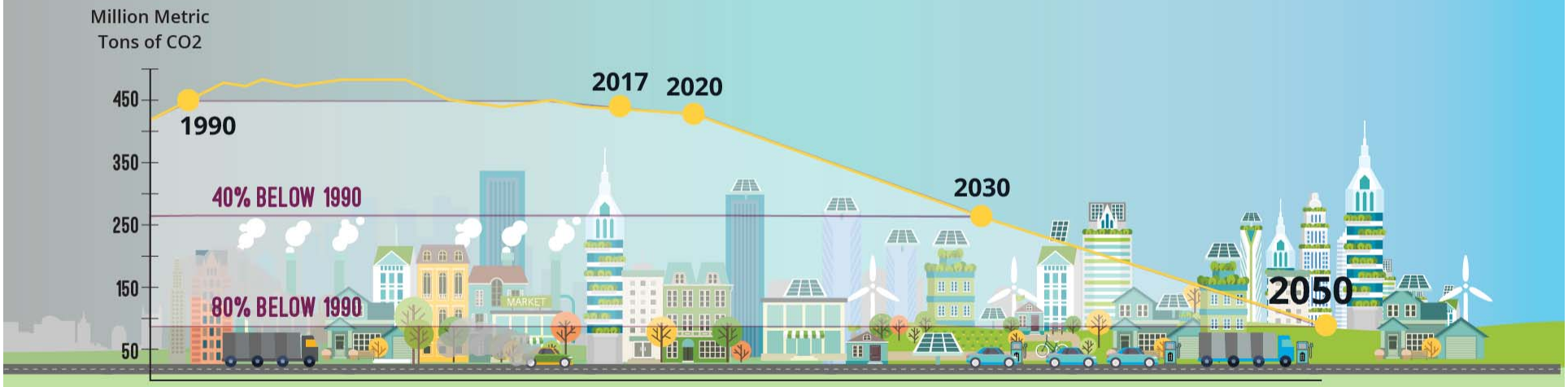
4 Rural Cooperatives

**IOU "Businesses":**

- **Transmission Owner**
- **Distribution Owner/Operator**
- **Load Serving Entity (provide generation)**

# Goals To Improve

- California set a goal to **reduce emissions 40%** below 1990 levels by 2030, and 80% by 2050.
- SB 100 passed mandating **100% carbon free electric grid** by 2045




If we want to get to **zero emissions**, eventually we have to **replace** many of the things we rely on today that require combustion.

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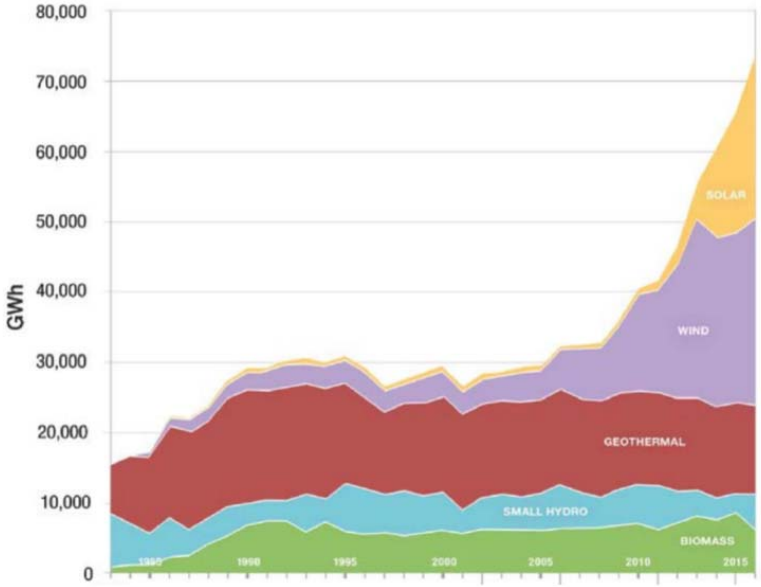
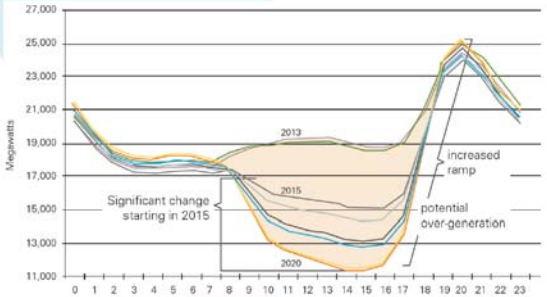
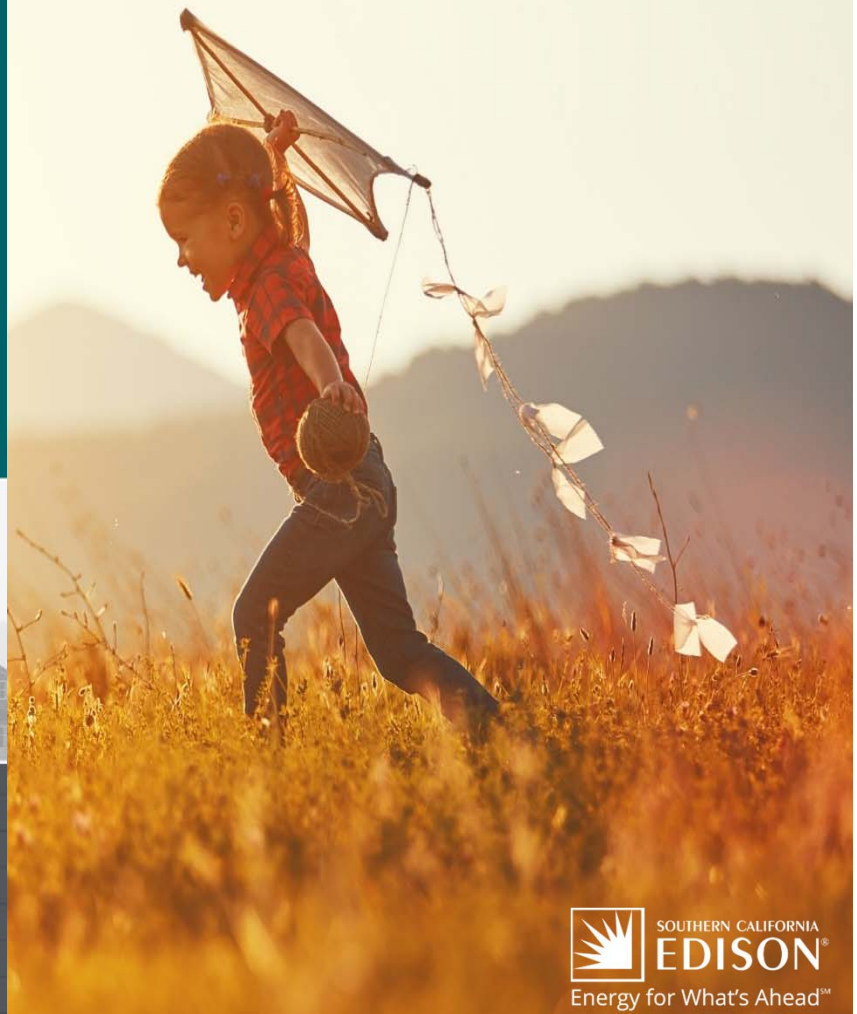



## California's "Duck Curve"




The abrupt fall-off of solar in the evening coincides with sharp rise in consumer demand, leading to the need for additional flexible generation including storage.

# Southern California Edison By the Numbers

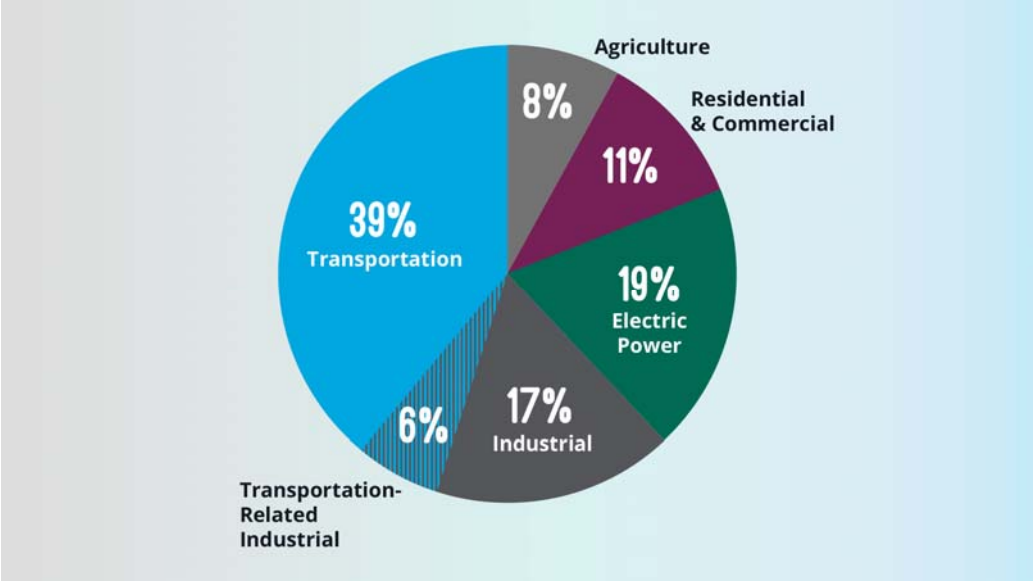

*Source: SCE 2018 Sustainability Report*
https://www.edison.com/home/investors/sustainability.html

# Emissions contributors

- The largest contributor is **transportation**, followed by the electric sector.

  Industrial, and commercial and residential sectors trail not too far behind.

- The most **practical and economical** way to create real change is for sectors to **work together** to find an affordable alternative to fossil fuels.

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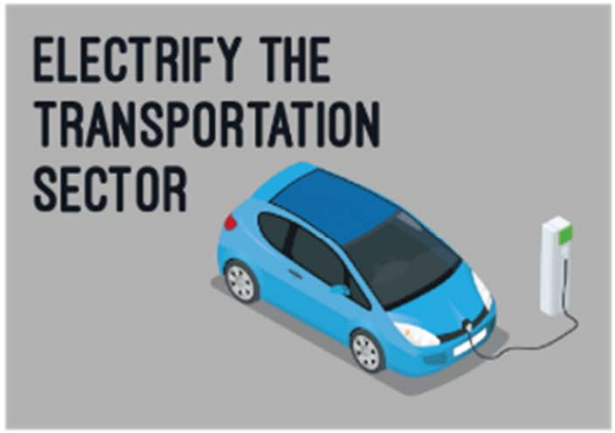
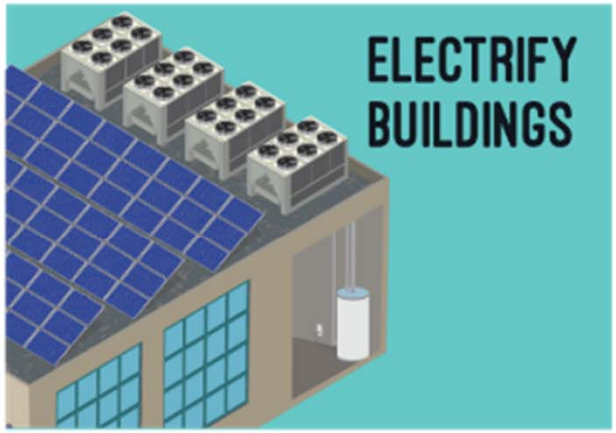
# SCE's integrated solution


**Clean the power grid. And electrify.**

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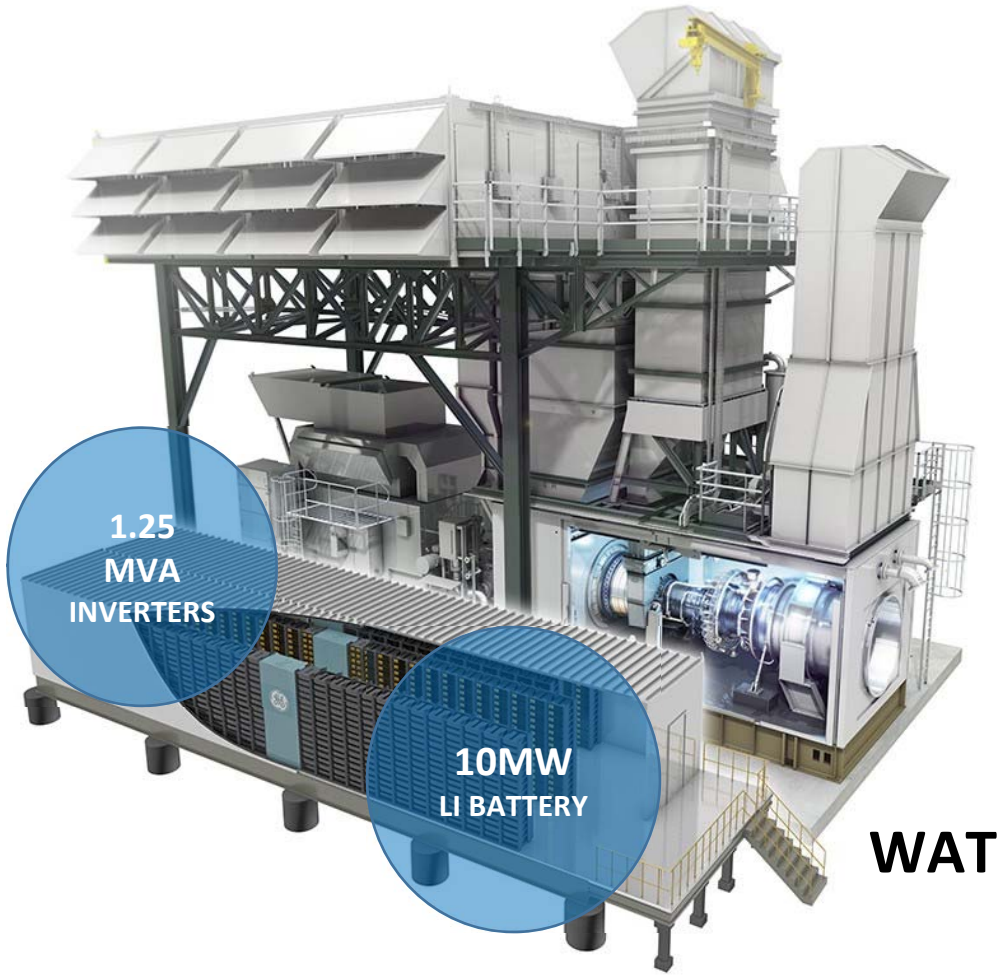
# Improving Flexibility of Simple Cycle Combustion Turbines (Peakers) By Adding Energy Storage

## SCE's Enhanced Gas Turbine (EGT) Installation

# EGT Concept



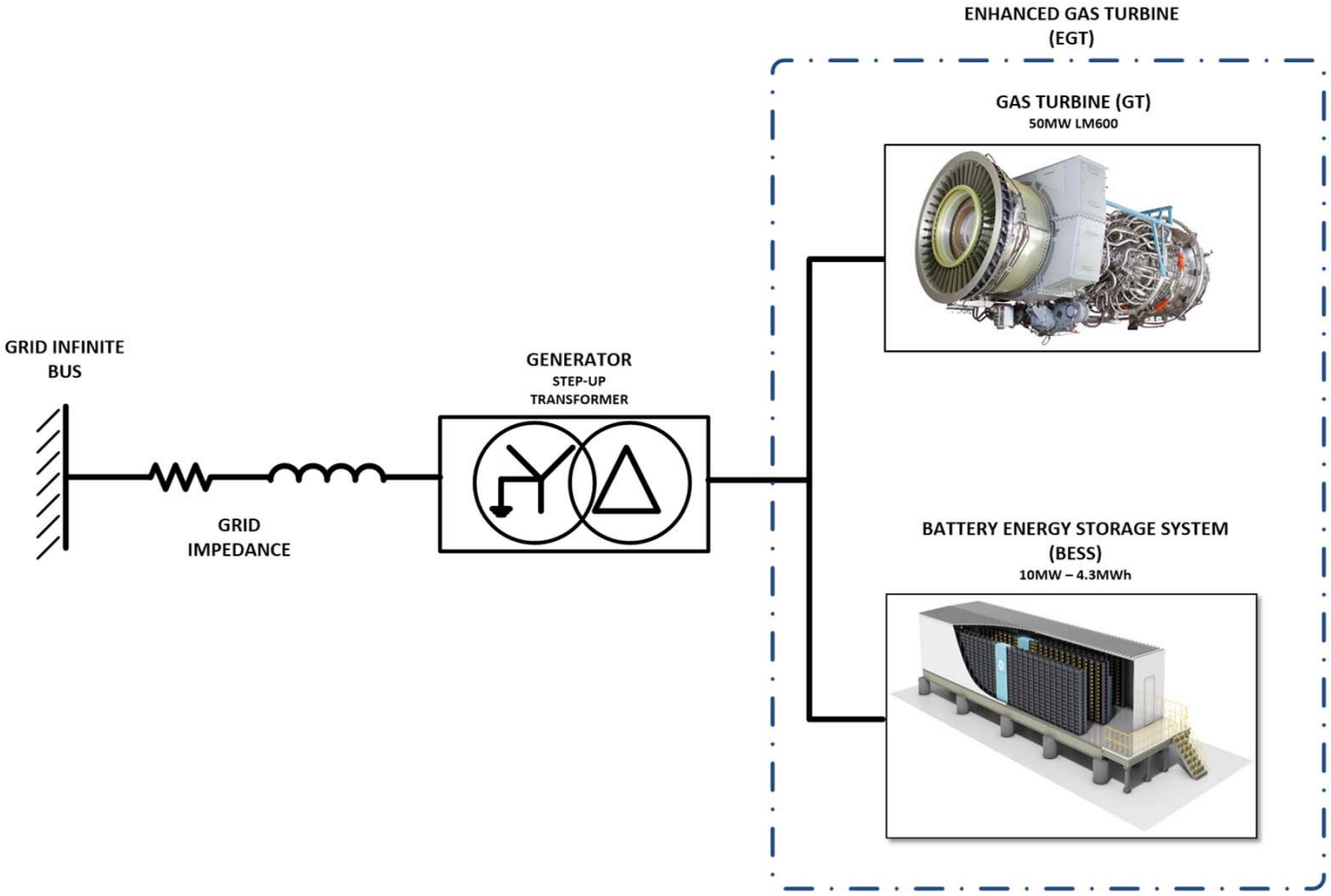

FUEL SAVINGS

MAINTENANCE

EMISSIONS

WATER CONSUMPTION

# EGT Concept and Integration Diagram



# Hybrid EGT Benefits

## Provides

### Greenhouse Gas Free Attributes

- Instant Response/Always Ready Technology
- 50MWs of Operating Reserve
- Primary Frequency Response
- -8 to +5 MVAR Voltage Support
- 134 MW-Secs Inertia
- Black Start Technology

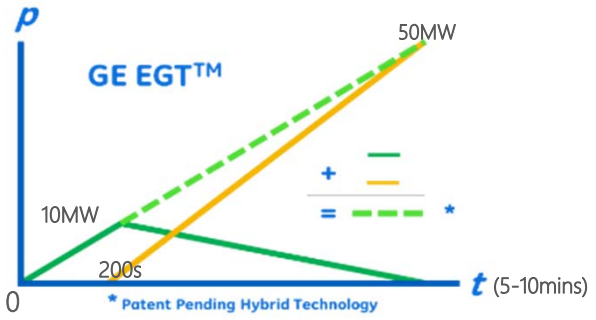
### With Fuel Consumption

- 50 MWs Peaking Energy for Local Contingency
- 25 MWs of High Speed Frequency Regulation
- Demand Charge Management
- Self Managed BESS SOC

## Enables

### Reduced System Costs & Increases Customer Value

- Optimized System Dispatch
- Lower System Fuel Use
- Lower Maintenance Costs
- Lower System GHG Emissions
- Renewable Energy Integration
- Increased Market Participation



## CENTER EGT

**Purpose:**
Emergency Proclamation→CPUC Resolution E-4791 & Operational Flexibility

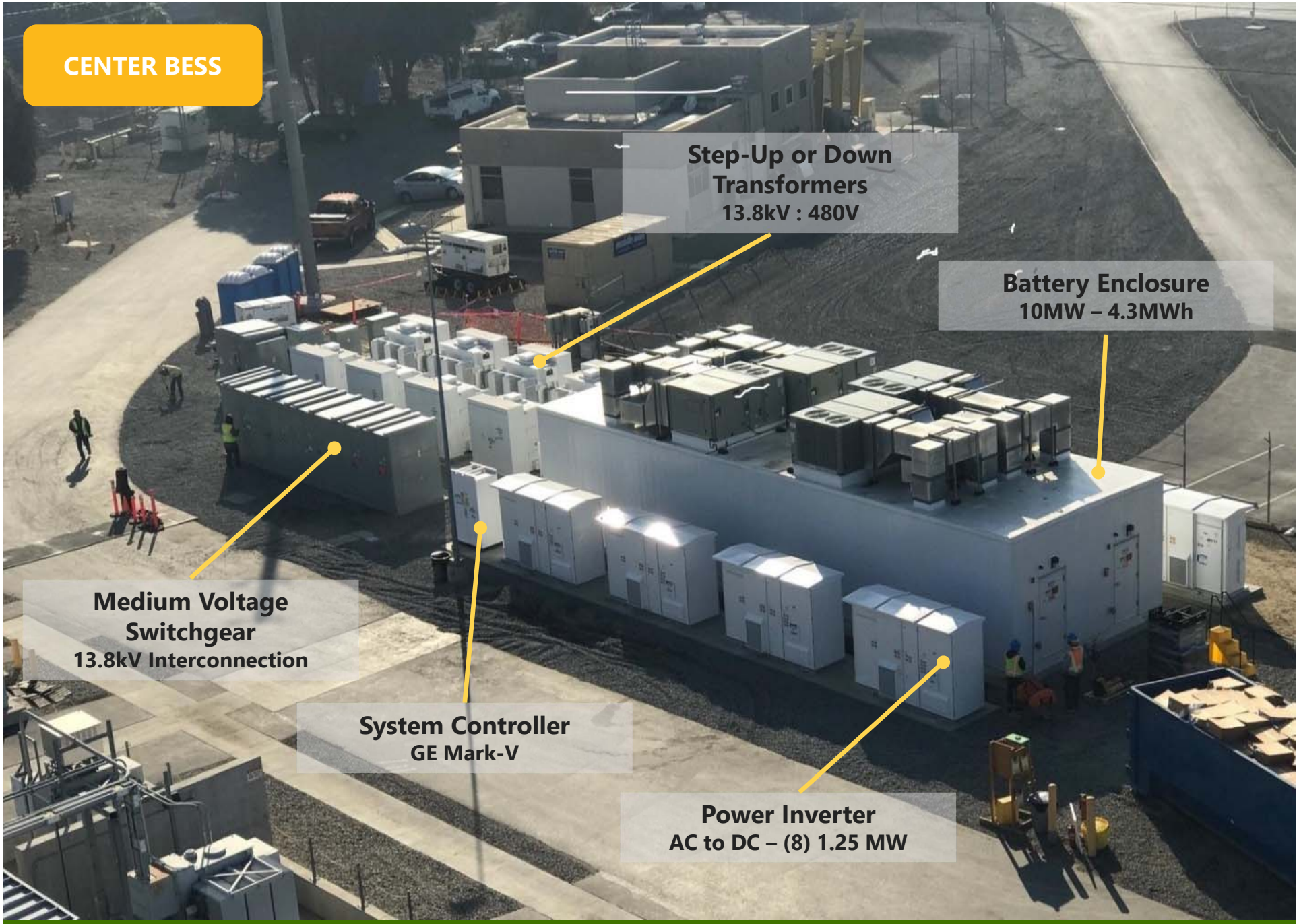
**Location:**
Norwalk, CA

**BESS Size:**
- 10 MW/4.3 MWh

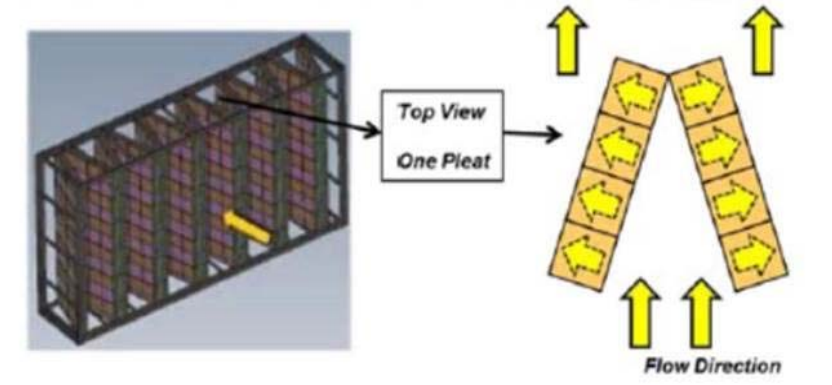
**Gas Turbine Size:**
- 50 MW

**Commercial Operation:**
Received CAISO confirmation on 12/30/16

Systems are bid into CAISO wholesale generation market for spinning & non-spinning reserve and regulation


CENTER BESS
Step-Up or Down Transformers
13.8kV : 480V
Battery Enclosure
10MW – 4.3MWh
Medium Voltage Switchgear
13.8kV Interconnection
System Controller
GE Mark-V
Power Inverter
AC to DC – (8) 1.25 MW

## Emissions Control System Enhancement




- Increase the catalyst cross-sectional area without increasing existing enclosure size
- Improve the SCR ammonia-injection and NOx water-injection tuning
- Increase ammonia concentration from 19% to 29%
- Upgrade sampling probes

# GRAPELAND EGT

**Purpose:**
Emergency Proclamation→CPUC Resolution E-4791 & Operational Flexibility

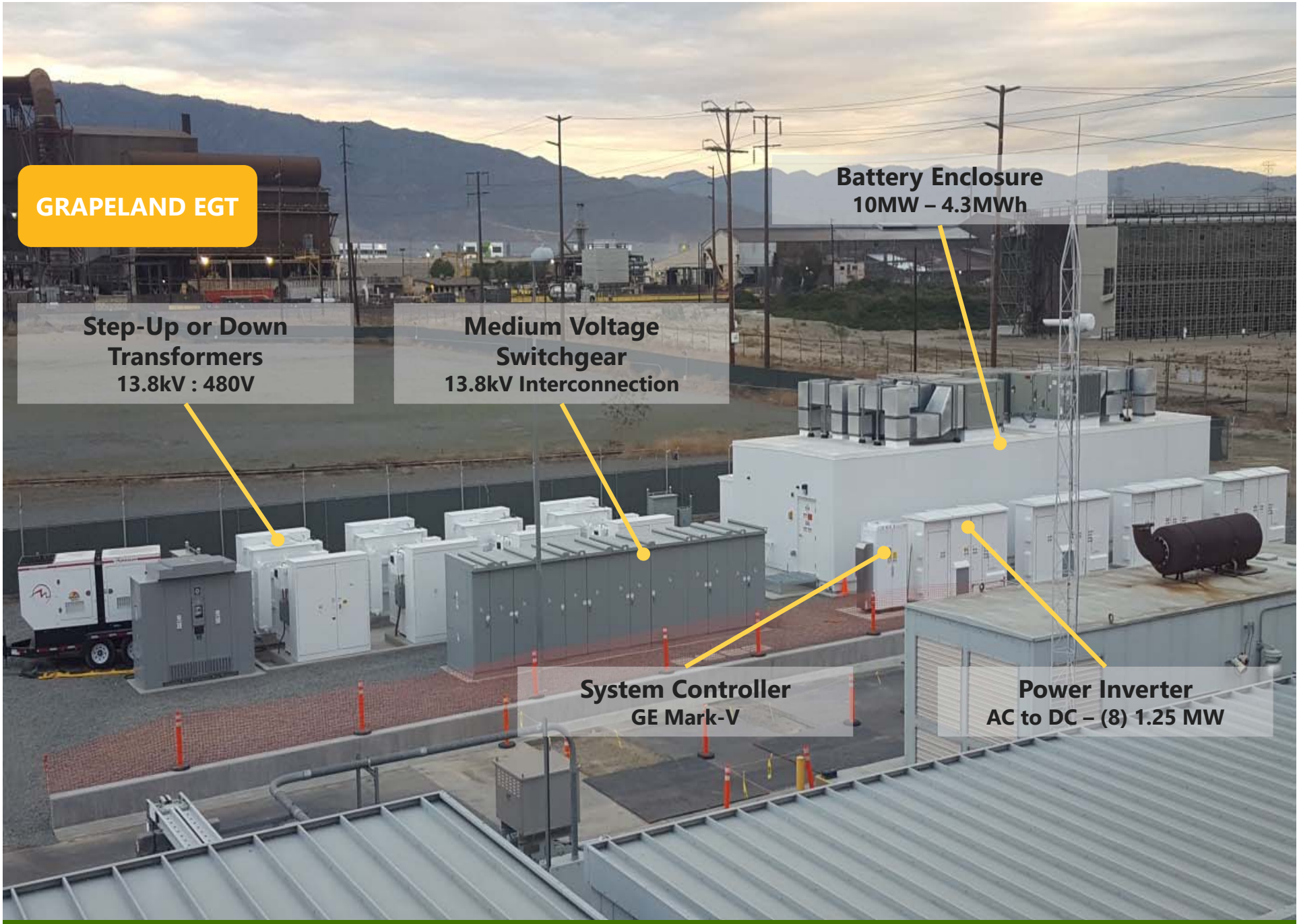
**Location:**
Rancho Cucamonga, CA

**BESS Size:**
- 10 MW/4.3 MWh

**Gas Turbine Size:**
- 50 MW

**Commercial Operation:**
Received CAISO confirmation on 12/30/16

Systems are bid into CAISO wholesale generation market for spinning & non-spinning reserve and regulation


GRAPELAND EGT
Battery Enclosure
10MW – 4.3MWh
Step-Up or Down Transformers
13.8kV : 480V
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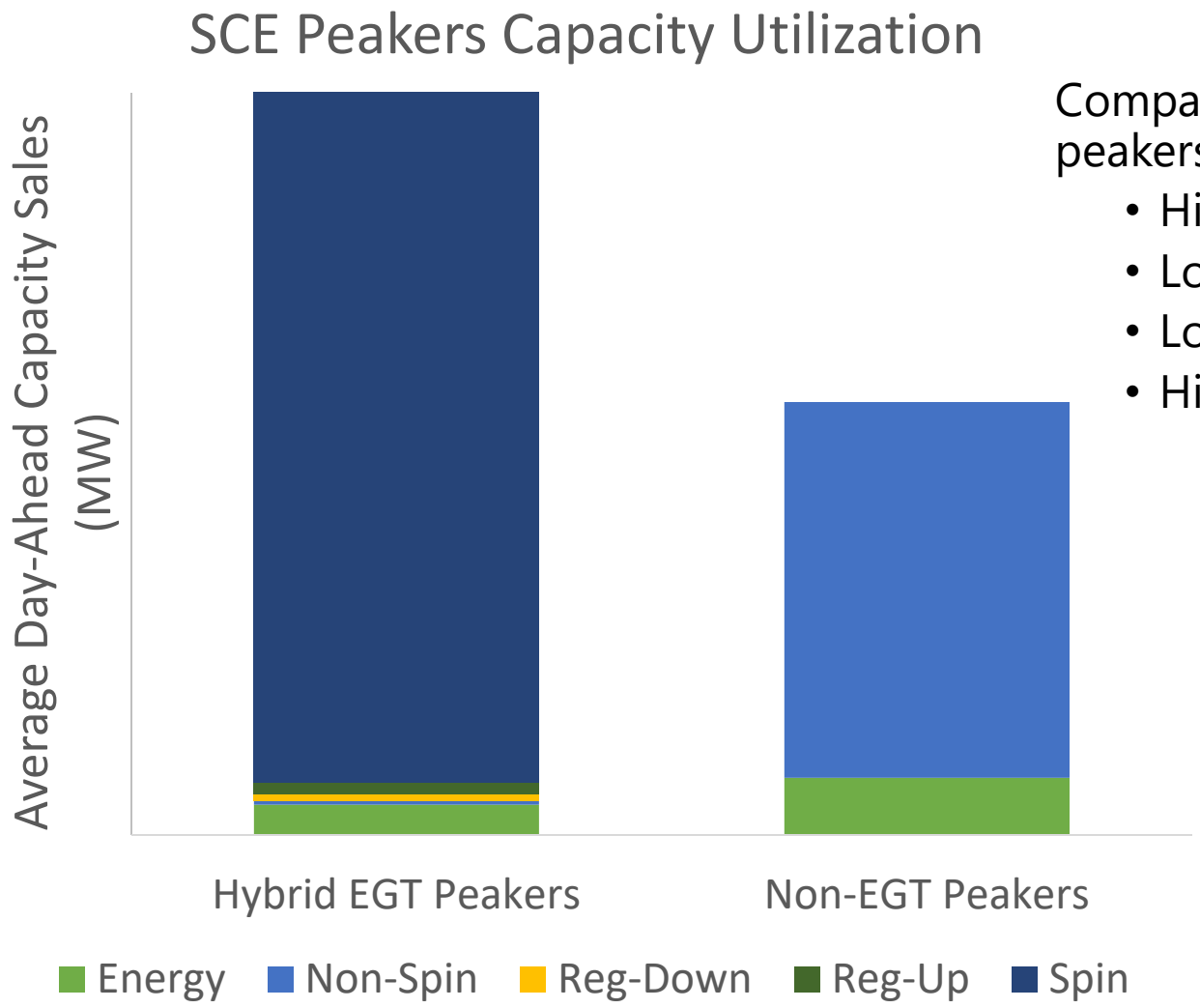
# Hybrid EGT Market Results Since Go-Live




Compared with SCE's non-hybrid peakers over the same period:

- Higher capacity utilization
- Lower fuel gas usage
- Lower emissions
- Higher market revenues

# Hybrid EGT Recognition and Accolades

- *"The SCE-GE project is a perfect example that distributed energy resources can be used in innovative ways and still fully participate in the wholesale energy market managed by the ISO."*

  *Steve Berberich*

  *President and CEO*

  *California Independent System Operator*


- SCE's Hybrid EGT won several awards:
  - Edison Electric Institute (EEI) Edison Award
  - Energy Storage North America (ESNA) Innovation Award
  - South Coast Air Quality Management District (SCAQMD) Innovative Clean Air Technology Award
  - Power Magazine's Top Plant Award

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Improving Flexibility of Combined Cycle Combustion Turbines (CCGTs) to Integrate Renewables

SCE's **Mountainview Generating Station (MVGS)** turn-down upgrade project

# Mountainview 3 & 4 are Multi Stage Generating (MSG) units.

**Prior to Turn-Down Upgrade**

- Under configuration one, “1 x 1”, the turbines had a minimum operating level of 160 MW and a maximum operating level of 240 MW.
- The second configuration, “2 x 1”, had a minimum operating level of 300 MW and a maximum operating level of 525 MW.
- The range from 240 MW to 300 MW was a “forbidden zone” in that the combined cycled unit can be transitioned through the range, but not dispatched to – or held at – at operating level within this 240 to 300 MW range.
- The ducting firing capability enabled the unit to generate from 496 MW to 525 MW.

# Need for Operational Flexibility

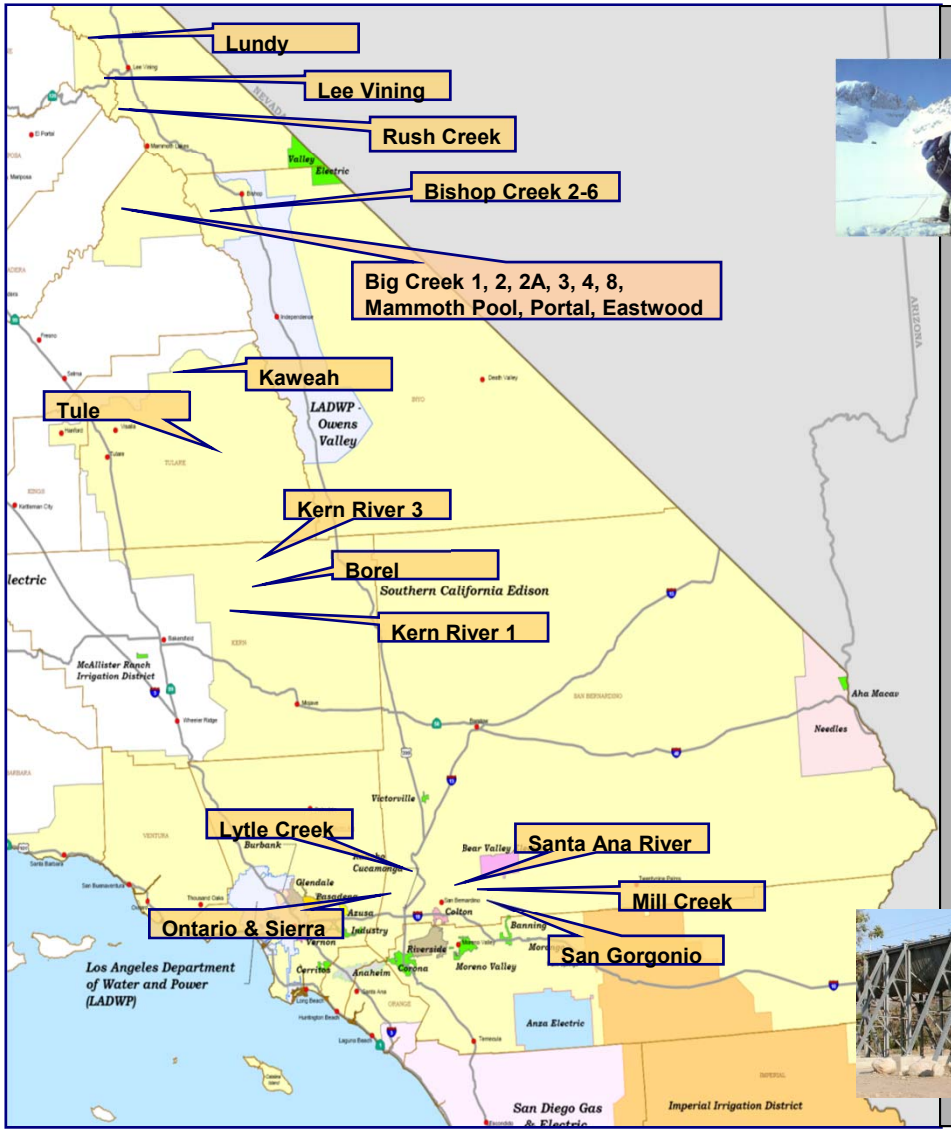
- CAISO markets co-optimize energy and all Ancillary Services (AS). AS prices in recent years have cleared much higher implying that operational flexibility is highly valued.
- Further increasing penetration of intermittent renewable resources require conventional facilities to respond faster.
- There are primarily three ways that a fossil plant can provide more operational flexibility:
  - ❑ Shorter start up times
  - ❑ Faster ramp rates
  - ❑ Wide operational ranges (Maximize turn down ratio)

# Improving Operating Flexibility

- Turn Down Upgrade:
  - Mountainview SCE explored opportunities to improve operational flexibility.
    - Performed tests to determine to what extent ramp rate could be improved.
    - These tests were completed in early 2012 and resulting in certifying an increase in ramp rate from 4MW/min to 16MW/min per unit
    - 120 MW of incremental Regulation/Spin from each unit every hour translated to total benefit of ~ $ 6 M + per year to the customers.
  - Incremental turn down upgrade reduced minimum loading to 120MW in 1x1 and 225MW in 2x1 configurations.
    - The lower Pmin of the 1x1 allows the unit to stay at Pmin of 1x1 rather than shutting down during early morning hours in the spring run off period avoiding start-up costs.
    - The lower Pmin of the 2x1 allows the unit to stay at Pmin of 2x1 rather than transition to configuration 1. This saves the transition cost when the unit ramps up again.
  - Eliminated the operational gap between 1x1 and 2x1 operation.

# Improving Operating Flexibility of Hydro Power Plants to Integrate Renewables

# SCE Hydro Generation




**SCE Service Territory**
*– Yellow*

**Northern Region (Big Creek)**
*– Orange*

7 FERC licenses
9 powerhouses
23 generating units
1015 MW
>560,000 ac-ft storage

**Eastern Region**
*– Aqua*

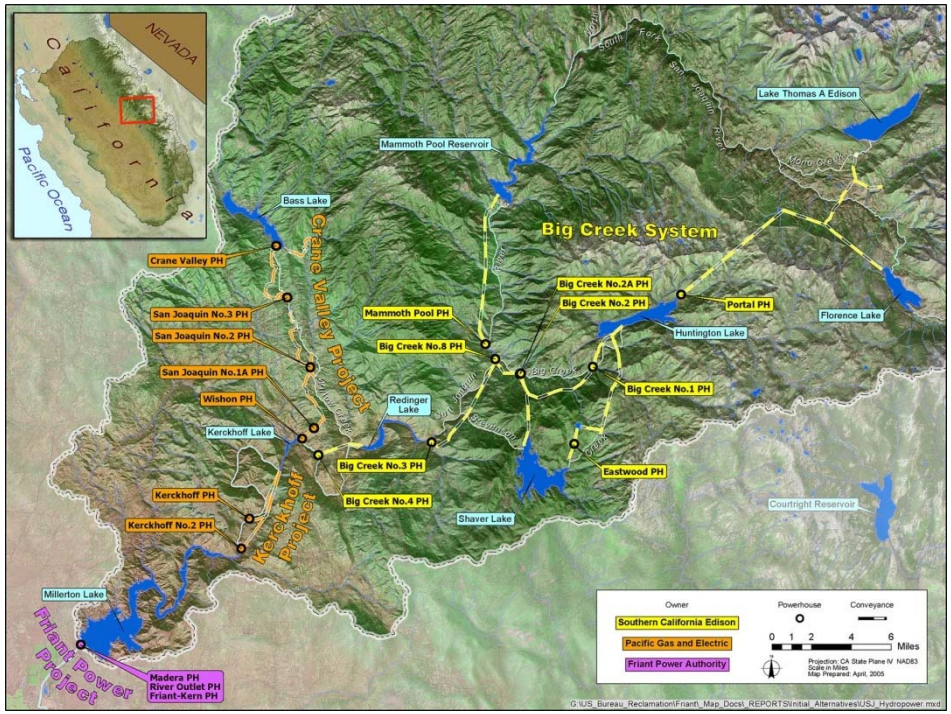
13 FERC licenses
24 powerhouses
53 generating units
161 MW

# Big Creek Hydro

9 powerhouses, 23 generating units, 1020 MW, 560,000 AF storage, 6 Major Dams

*"The hardest working water in the world"*

- 1st large scale integrated hydroelectric project in the world
- Construction began in 1911 – *said to be a greater challenge than building the Panama Canal*
- Longest water tunnel in the world




## SCE Big Creek Hydro Project
## Upper San Joaquin River Basin

- runoff: 1,800,000 acre-feet
- drainage area: 1,300 square miles
- elevations: 1,400 to over 13,000 feet
- topography: glaciated valleys
- geology: predominately granite

# Improving Operating Flexibility

- Implemented Hydro Optimization - Decision Support System (DSS) using Vista model for short-term and long-term inflow forecasting, and market optimization using outage information and water management constraints
- Changed practice to offer maximum possible operating range to the California ISO market (minimum load - maximum load)
- Tested and Increased unit ramp rates, chain ramp rates for upstream/downstream effects, and total project ramp rates to increase flexibility to integrate intermittent renewable resources
- Implemented optimization logic to create price/volume bid curves for California ISO markets to maximize value of hydro plant while offering maximum flexibility to the market.
- Successfully tested and implemented for drought years, median water years and very wet water years.

# Hoover Dam

SCE's scheduling share: 525 MW out of approximately 1810 MW

- 17 Generation Units: A1 – A9 and N1 – N8
- Total Capacity: 1810 MW, SCE's Share: 525 MW
- USBR does water management
- SCE and other Hoover contractors are notified of Monthly/weekly water targets.
- Must hit water targets within +/- 2%.
- Provides significant portion of Regulation Up and Down services for SCE in the CAISO markets

# Improving Operating Flexibility

- Enhanced Hydro Optimization - Decision Support System (DSS) for short-term and long-term inflow forecasting, and optimization using outage information and water management constraints in collaboration with US Bureu of Reclamation (USBR) and Western Area Power Administration (WAPA)

- Quantified Synchronous and Motoring losses incurred by Hoover Dam turbines to provide regulation and online spinning services.

- Tested and offered a high ramp rate of 100 MW/min for SCE's share of capacity. Actual possible ramp rate was much higher.

- Implemented optimization logic to create price/volume bid curves for California ISO markets to maximize value of hydro plant while offering maximum flexibility to the market and meeting tight water target for downstream water consumers

- Upgraded turbines to wide operating head to reduce operating losses at low load during drought years when Lake Mead elevation is lower.

# Summary: Integrating Intermittent Renewables

- In today's world, intermittent renewable generation plays a significant role in serving the energy needs for the end customers and its share is expected to go up further (33% by 2020 in California)
- Reliable Integration of intermittent renewable generation by BA/ISO/RTO may require new ancillary services and/or additional procurement of current A/S products. The key is Operational flexibility (quick start, fast ramping, dispatchable, AGC, Operating reserves)
- Flexible generation sources (fast ramping hydro, CCGTS, Hybrid EGTS, Batteries) would play a significant role in providing this operational flexibility and grid support not all of which is compensated in today's market (e.g. inertia, VAR support, black start capability, fast vs. slow ramping etc.).
- Synchronous and Motoring losses are quantifiable and represents the change in operations and ways in which hydro compensates for integration of other intermittent renewables on the grid

# This is Our Clean Energy Future…

Imagine a world where the energy that powers our lives and propels us forward is provided by the Earth's clean resources.

**Vibhu Kaushik**
Director, Grid Technology & Modernization
Southern California Edison
Vibhu.Kaushik@sce.com

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