

Planning for Intermittent Renewables in California

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The Utility Planner's Challenge

Meet mandated environmental policy goals, while providing reliable electric service at reasonable cost to customers

- California's Global Warming Solutions Act (AB 32) calls for more energy efficiency, renewable generation, distributed generation
- The State's 33% renewable target adds ~18,000 MW of intermittent renewables

Planner's Challenge

- How will these additions affect grid reliability and operability?
- How much will these additions cost?
- How to balance conflicting objectives?



Overview

Today's presentation focuses on integrating renewables from a utility planner's perspective

- Analytical challenges
- Process, considerations for long-term resource decisions

Your Challenge

- Methodologies and tools to estimate grid's needs
- Planning and operating criteria for a grid with large amounts of intermittent generation



Balancing Objectives

Planner's job is to balance multiple, often conflicting objectives

- Cost, reliability and environmental impacts don't usually go together
- We help frame choices for regulators and other stakeholders on impacts of various courses of action ("procurement plans")
- Many stakeholders participate in regulatory process
 - Customers, suppliers, others, often with conflicting interests
- The California Public Utilities Commission has final say
 - Decides "need"
 - Authorizes procurement of resources, products to meet need

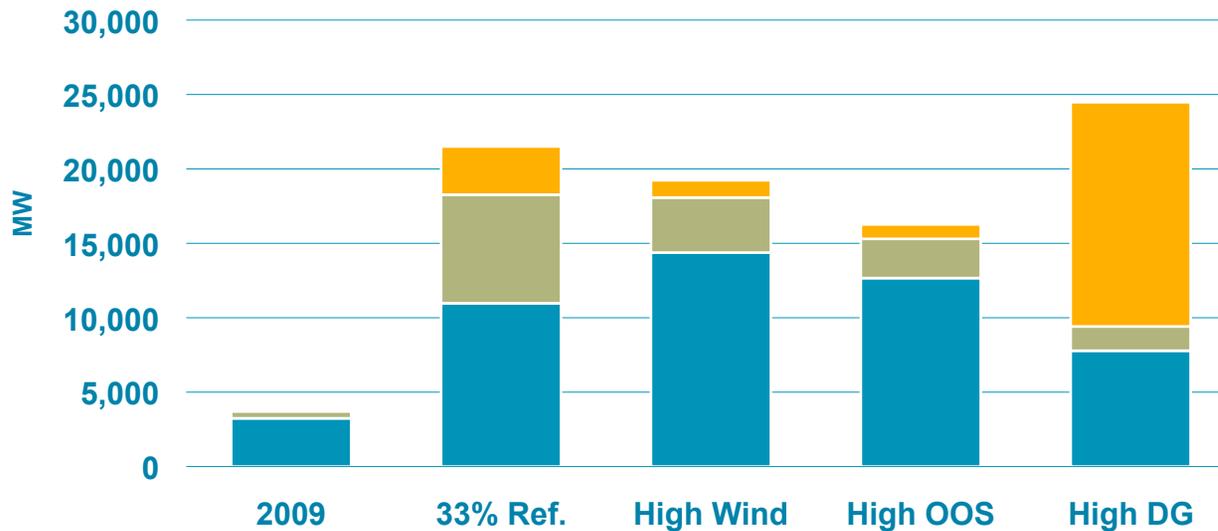


Meeting the 33% Renewable Goal

Our current challenge:

Integrate large amounts of wind and solar into the grid

California Wind and Solar Capacity Additions (MW) to Meet 33% RPS Target



Source: CPUC, *33% RPS Implementation Analysis Preliminary Results*.
June, 2009, California Public Utilities Commission

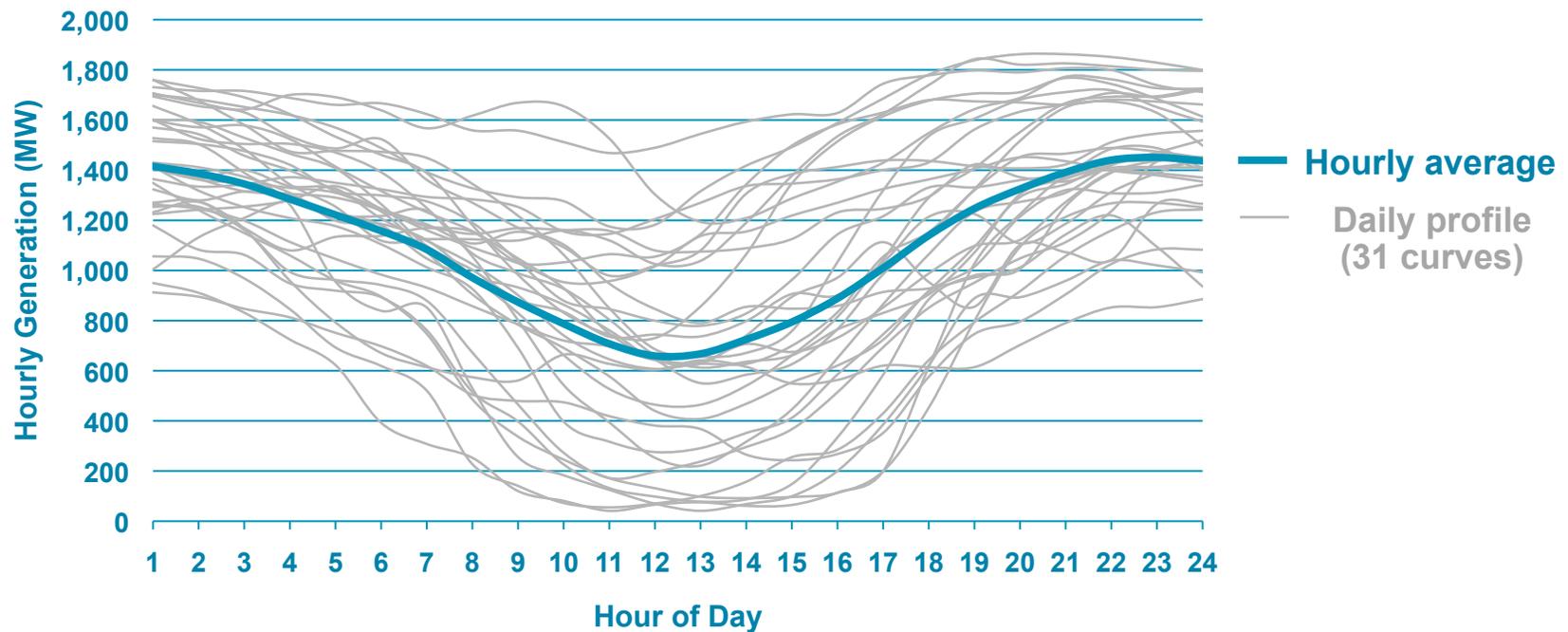


Fewer Emissions, More Challenges

More renewable generation needed to lower emissions

- Difficult to predict generation; depends on weather

CAISO July 2009 Wind Generation, MW

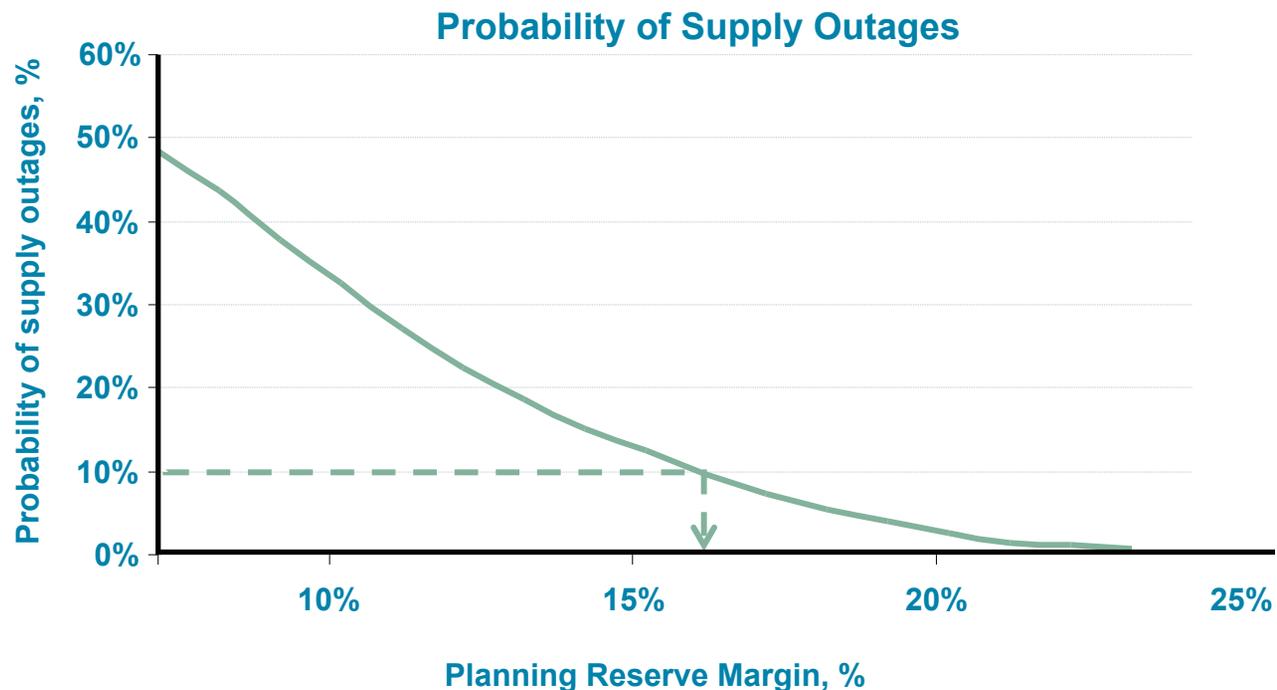


Source: <http://www.caiso.com/2747/274778eb12970.xls>



Traditional Planning Approach

- Reliability metric: ≤ 1 day in 10 year outage expectation (~ 10% chance of supply deficiency outages in a year)
- Today's planning criteria in California:
Supply \geq Expected peak demand + 15% to 17% reserves





Traditional Planning Approach Doesn't Work Anymore

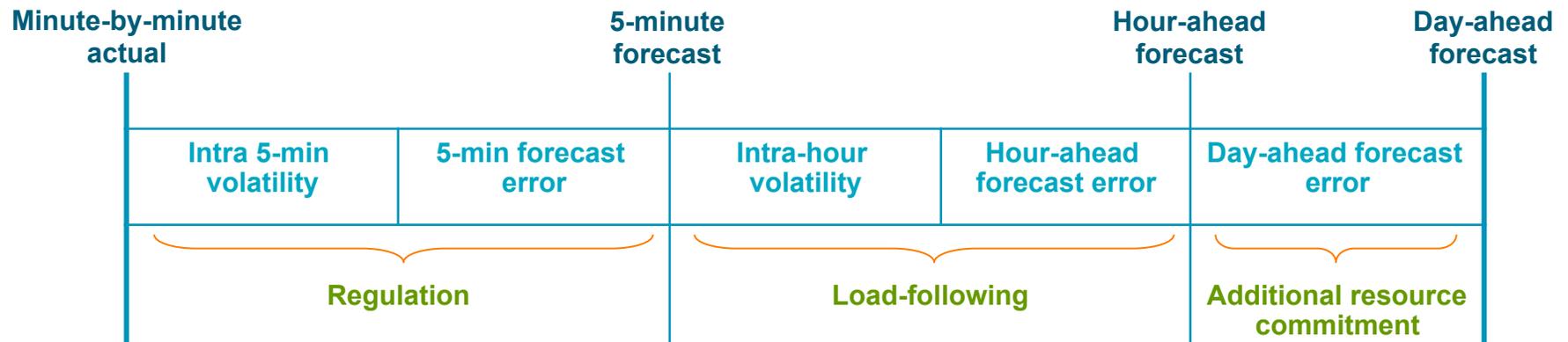
- Integrating large amounts of intermittent resources requires the grid to be more flexible
 - Current planning approach does not consider grid's operating flexibility need
 - Operators need to match load and resources continuously
 - Until now, dispatchable (hydro and natural gas fired) resources have met grid's flexibility requirements
- Planning standards need to be updated to account for grid's flexibility requirements



Procuring System Flexibility

Possible flexibility products/services available in markets:

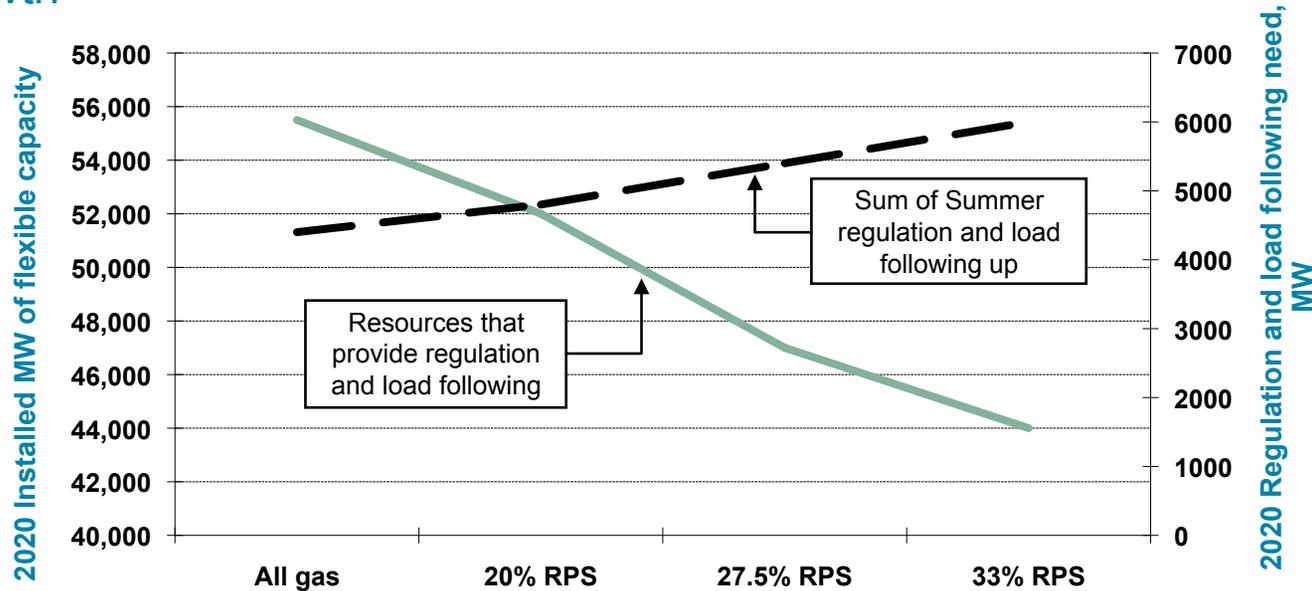
- **Regulation:** manage 5 to 10 minute forecast uncertainty
- **Load following:** manage remaining intra-hour uncertainty
- **Additional resource commitment:** manage deviation between day-ahead and hour-ahead schedules





California's Grid Flexibility Decreases As Flexibility Need Increases

- ~ 18,000 MW new installed wind/solar
- ~ 15,000 MW of once-thru cooling dispatchable gas-fired resources retire
- ~ Up to 15,000 MW of peak demand growth
- ~ 9,000 MW of new dispatchable gas-fired resources
- ~ 1,000 MW of new demand response



Source: CAISO Study of Operation Requirements and Market Impacts, August 24 and November 30, 2010 CPUC Renewable Integration Workshops



Sources of Grid's Flexibility

Grid flexibility does not have to come from gas fired generation

| Other sources | PG&E's efforts |
|--|--|
| Existing system | <ul style="list-style-type: none">• Increased downward flexibility of owned/contracted resources |
| Automated demand response | <ul style="list-style-type: none">• Currently testing feasibility of demand response thru pilots |
| Dynamic pricing | <ul style="list-style-type: none">• 2011 - Large/medium commercial, industrial customers• As early as 2013 - residential customers |
| Firming and shaping renewable imports | <ul style="list-style-type: none">• Entered into several transactions |
| Intra hour scheduling of renewable imports | <ul style="list-style-type: none">• Through CAISO, pending implementation of NOPR |
| Storage | <ul style="list-style-type: none">• Operates existing 1,200 MW pumped storage• 300 MW compressed air pilot with DOE/CEC funding• Application to study of Mokelumne site with 1,200 MW was filed• Sodium Sulfur 4 MW battery in initial demonstration stage• Zinc Bromine 500 KW flow battery was previously tested |
| Smart charging of electric vehicles | <ul style="list-style-type: none">• Pilot program |



How Much Flexibility Is Enough?

- Depends on specific portfolio characteristics
 - Variability and forecast uncertainty of load and generation
 - Amounts of non-dispatchable resources in portfolio
 - Correlation between variability of load and generation
- No simple, standard answer
 - Need to quantify flexibility requirements
 - Then, update planning and operating criteria to guide resource selection



Estimating Grid's Flexibility Need

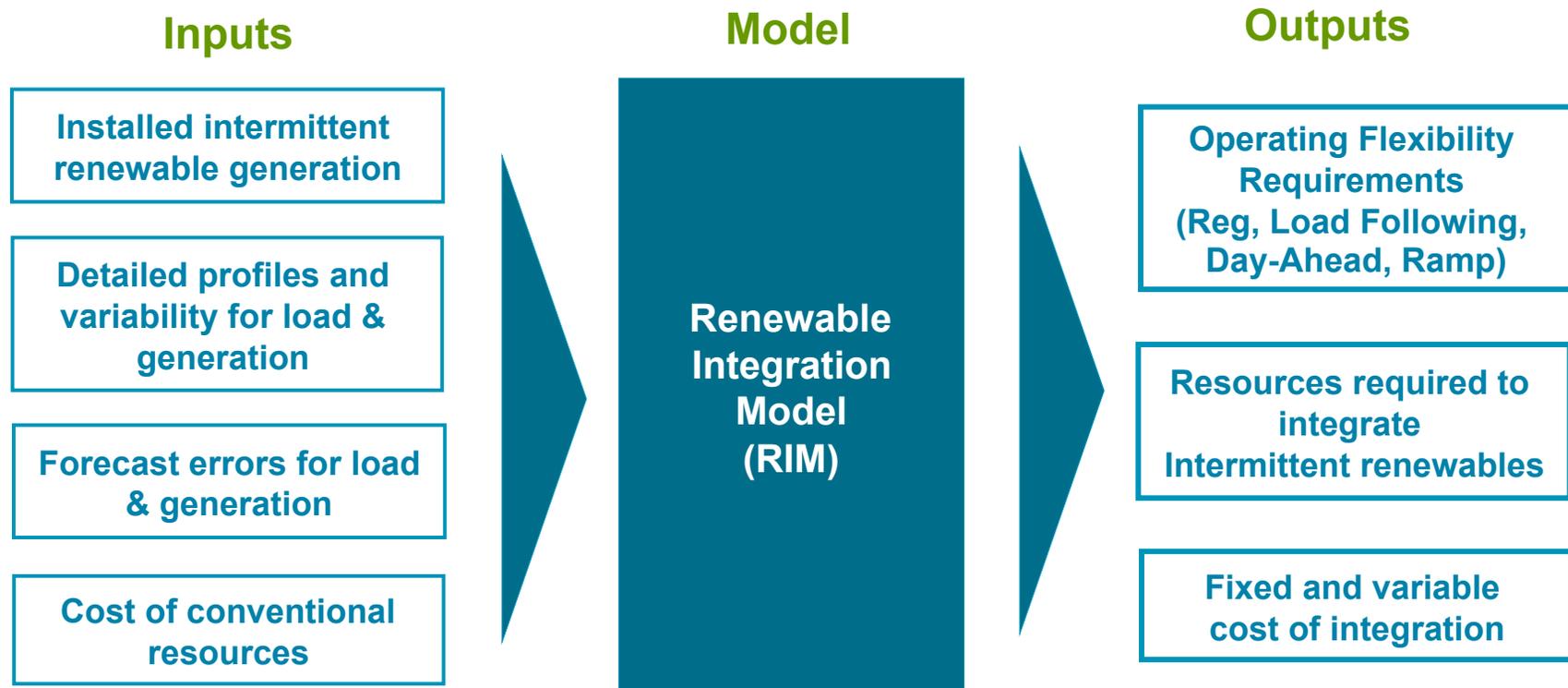
There is no standard approach to estimate flexibility needs

| Approaches | Production simulation models | Analytical techniques |
|----------------------|--|---|
| Explanation | <ul style="list-style-type: none">• Simulate operation of grid hourly• Build and test portfolio that meets traditional planning criteria• Identify and solve operating violation by adding flexible capacity | <ul style="list-style-type: none">• Estimate flexibility need analytically• Simplified representation of key drivers of flexibility need |
| Advantages | <ul style="list-style-type: none">• Detailed representation of grid• Existing and new resource limitations represented | <ul style="list-style-type: none">• Produces results in minutes• Can vary/test sensitivity of results• Accessible (uses simple tools) |
| Disadvantages | <ul style="list-style-type: none">• Requires thousands of assumptions• Slow (takes days) to estimate need• Becomes outdated fast | <ul style="list-style-type: none">• Simplified representation of grid• Need to calibrate results |



Renewable Integration Model (RIM)

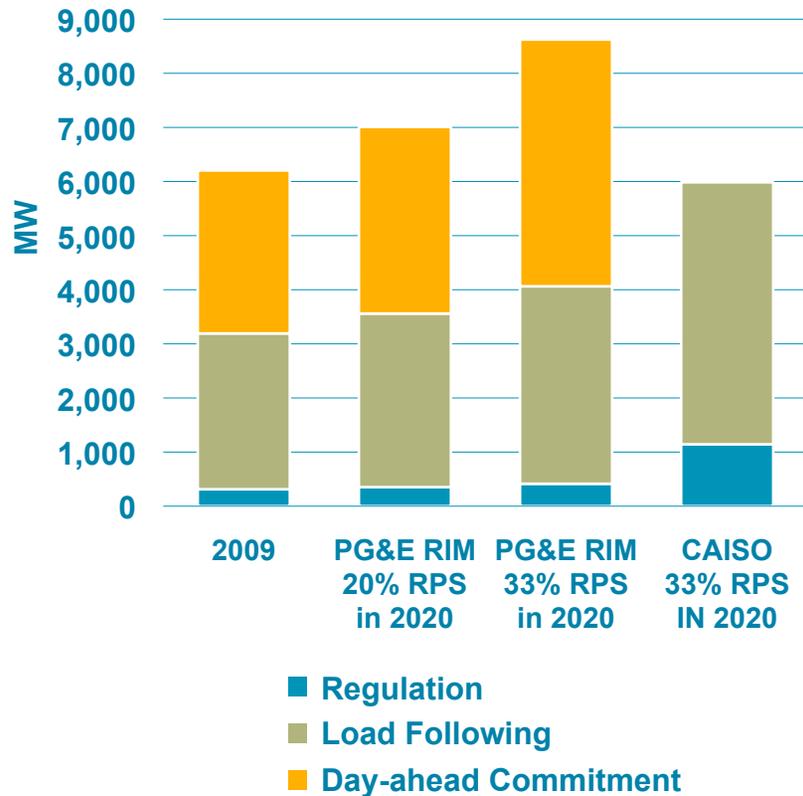
PG&E has developed a model to quantify the incremental integration needs and cost



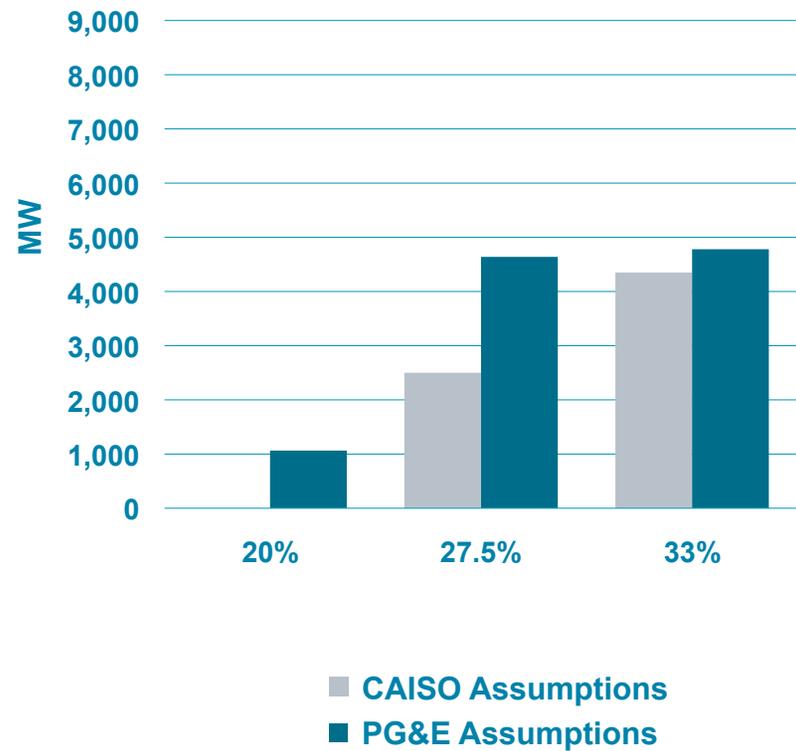


RIM Results Compared with CAISO

Statewide Maximum Operating Flexibility Requirements (Summer Season)



Statewide Flexible Capacity Requirements





Plans to further develop RIM

- Represent existing system's operating flexibility (High priority)
- Limit operating flexibility requirements to day-ahead hourly wind/solar forecast
- Incorporate operating characteristics of alternatives to provide flexibility
- Calibrate input variables used to estimate variable integration cost to available CAISO simulations



Partnership Opportunities

We are looking for partners to

- Develop analytical tools for the grid of the future
- Update operating and planning criteria

What we are doing

- Making RIM available at no cost, provided interested parties share improvements

Our philosophy

- Methodology, tools and results need to be transparent to facilitate conversation with policymakers, suppliers and customers

Thank You

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