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A GENERATION AHEAD, *today*

Natural Gas and Renewable Energy Dialog on Grid Integration Issues

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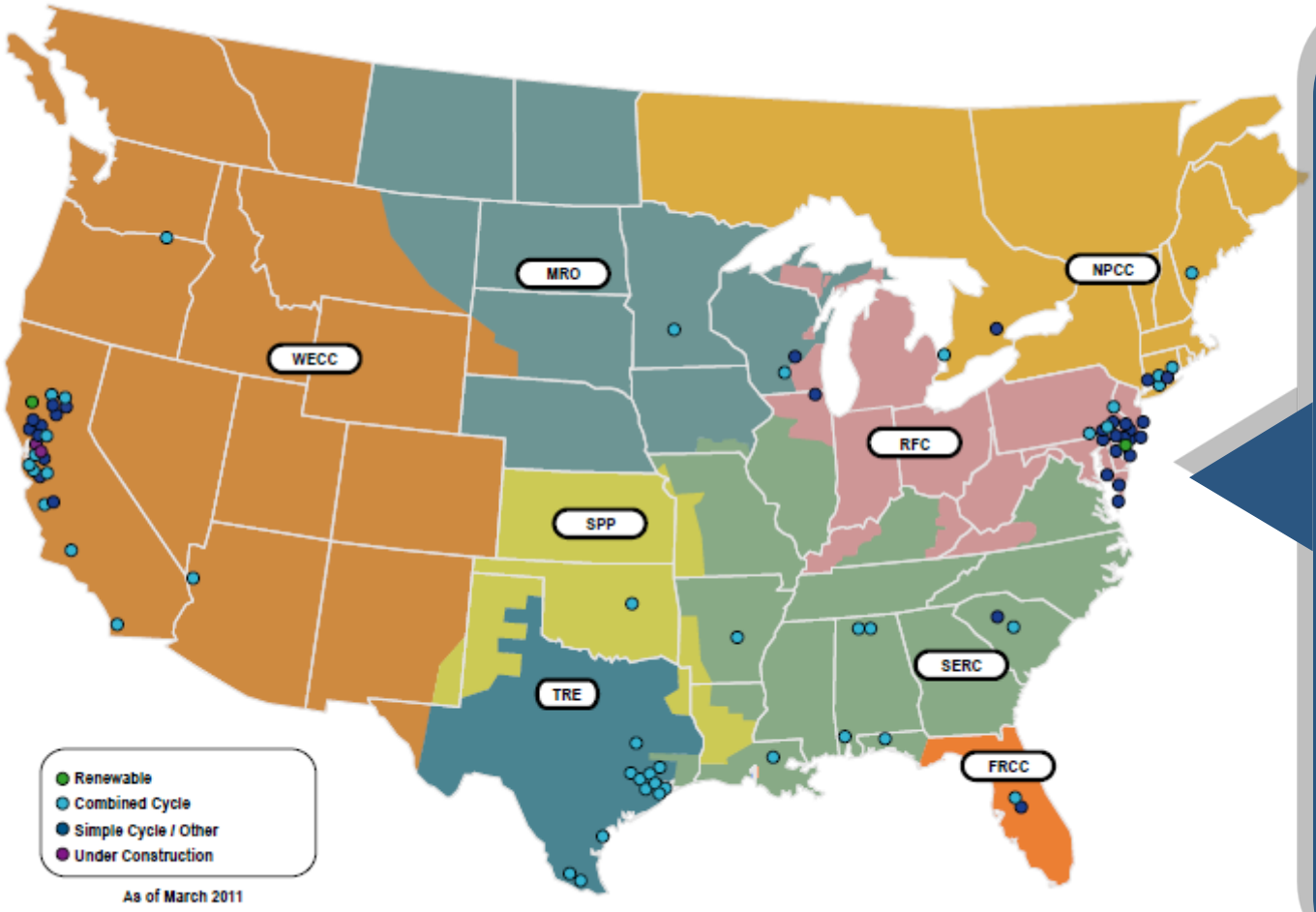
Calpine: At a Glance

Hay Road Energy Center (Wilmington, DE)

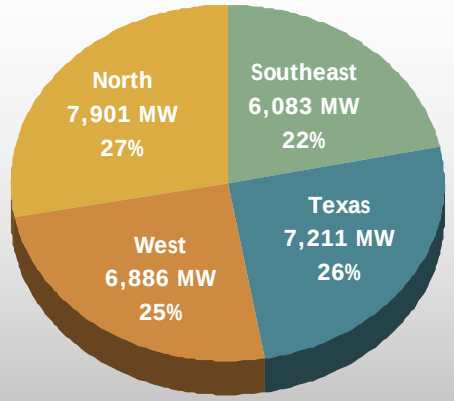
Pastoria Energy Center (Lebec, CA)

- Largest IPP in U.S. by megawatt hours produced
- The fleet:
  - 28,081 MW of capacity from 92 plants in 20 States and Canada
  - Primarily natural gas-fired plants
  - Smallest greenhouse gas footprint among our peers
  - Nation's largest:
    - Operator of natural-gas fired and combined-cycle plants
    - Fleet of highly efficient CHP plants
    - Baseload renewable generator with 15 geothermal plants at The Geysers in northern California

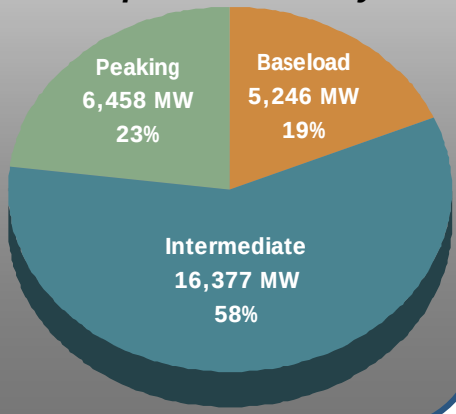
National Portfolio of More Than 28,000 MW



Geographic Diversity



Dispatch Flexibility



What are the Challenges to "Traditional" Generators with Integration of VERs?

- Operational challenges for conventional resources
  - Significantly more ramping or generator movement
  - More starts and stops
    - Higher O&M expenses
    - Higher risk (operational and subsequent financial)
  - Higher demand for ancillary services
    - Load-following capability
    - Regulation reserves
  - Generally asked to operate much differently than their engineering design basis

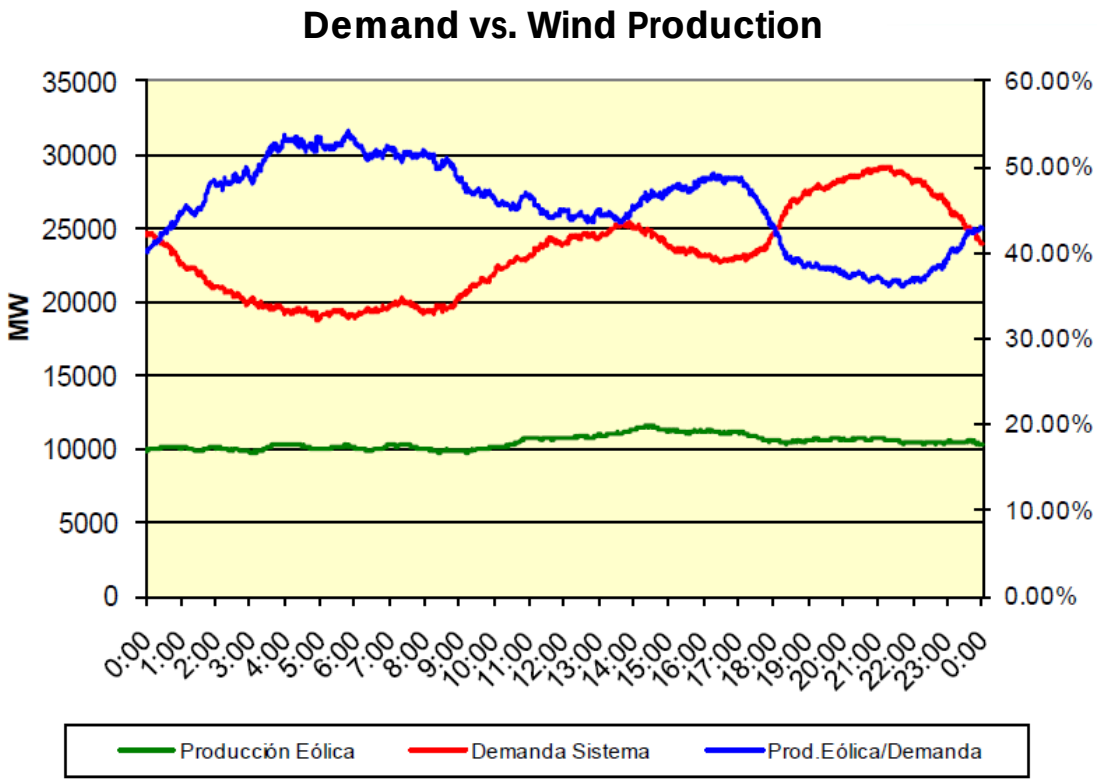
- Financial challenges
  - Lower off-peak pricing = much more cycling
  - Lower on-peak pricing = lower energy margins

- **All of these increase costs or decrease revenues for traditional generators**

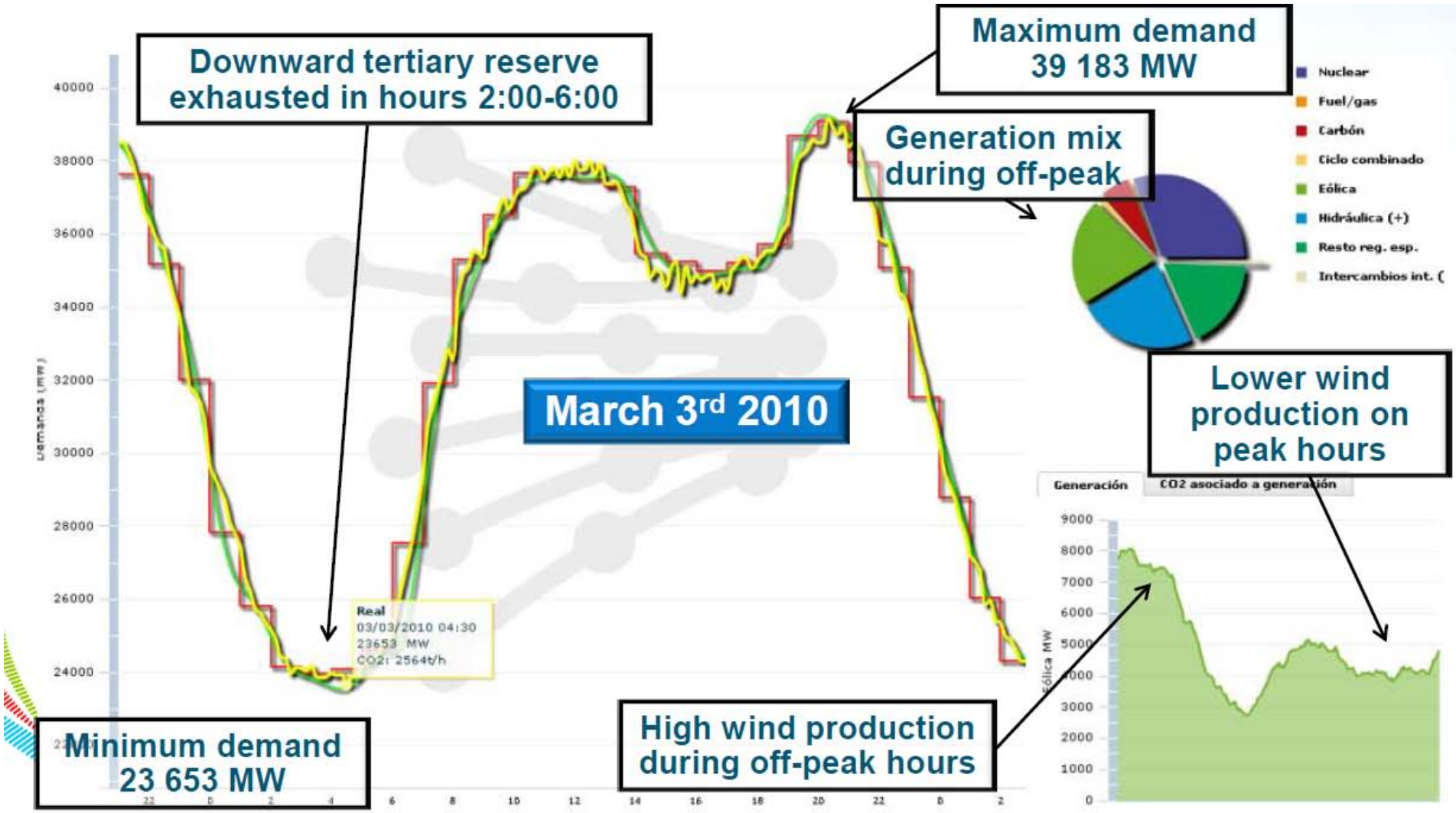
- **All of these increase operational and financial risk for traditional generators**

Technical Challenges (Spanish Utility RED Electrica de Espana): Balance Feasibility During Off-Peak Hours

- Wind generation capacity factors are much higher at night (off-peak) when loads are lower
- Traditional generators are required to dispatch to their lowest operating level or to cycle off-line
- Some external BAs may buy off-peak power for pennies, or may receive $$ to take excess power as a result of managing over-production
- Some traditional generators can cycle off-line and return for the following peak period, but many cannot and must stay on-line



Technical Challenges (Spanish Utility RED Electrica de Espana): Balance Feasibility During Off-Peak Hours (Continued)



Ancillary Services Need to Evolve to Better Integrate VERs

- ***We still use basically the same Ancillary Services that we have for <u>decades</u>***

- A lot of attention recently has been on Regulation Reserves driven mostly by new technology
  - Think of regulation, or primary frequency control, as "fine tuning"
  - Designed to help maintain frequency, not balance energy

- Not much attention on load-following ability and overall generation flexibility
  - RTO/ISO markets dispatch at five-minute intervals — this is effectively load-following capability
  - Think of load-following as "coarse tuning"
  - Balancing areas not in formal markets must arrange unique service for intra-hour load-following — there are no markets

- **Facts that traditional generators must deal with under current market designs:**
  - **There is some financial advantage for load-following capability in RTOs/ISOs but none elsewhere (no intra-hour energy pricing)**
  - **Very little advantage for working to lower a generator's operating limit ("turndown value")**
  - **No compensation and a LOT of additional risk for the ability to cycle off-line and return at a later interval (intra-day or overnight)**

Challenges to Thermal Generators in Providing More Flexibility

- Almost all thermal generation is designed to be most efficient at Higher Operating Limit (HOL)
  - Efficiency/heat rate losses at lower operating levels
  - Some fuel savings at lower operating levels
- Thermal generation is dispatchable, but with varying limitations
  - Steam turbines introduce “turbine lag”
  - Can create real power output lagging effect, which can result in deviation penalties
- Cost and effort for activities required to lower a generator’s operating limit
  - Engineering efforts and costs
  - Permitting efforts and costs
- Increased operations and maintenance (O&M) costs
  - More start-ups mean more stress on equipment
  - Increased operation of support components
- ***Significantly increased financial risk***

VER Integration Issues in RTO/ISO Wholesale Power Markets

- RTO/ISO wholesale power markets typically work on five-minute dispatches
  - Serves as load-following
  - Helps system flexibility by increasing system "headroom," which is inherently good for integration of VERs
- Providing regulation is the only avenue to receive compensation for unit flexibility
- Generator ramp rates may very well differ
  - Faster ramping rate for regulation
  - Slower ramping rate for load-following
- Very little incentive for flexible output from:
  - Peaking units (it used to be a slight advantage to be able to set RT price)
  - Nuclear units (nukes can down-power, especially Boiling Water Reactors)
- Limited incentive for flexible output from:
  - Coal-fired units
  - Combined-cycle units
  - Any units that are currently non-dispatchable

VER Integration Issues in Non-Market Areas – Balancing Areas not in RTOs/ISOs

- Any provision of AS products from non-utility generation is controlled by bilateral contracts
  - No transparent pricing
  - Products not defined except via bilateral contracts
  - Difficult to negotiate
  - ***Not even an illiquid bilateral market!***
- Most BAs rely on their own resources that have traditionally supplied such services
  - May not be cost efficient
  - May not be the best for system reliability
  - Does not take into account merchant units
- In general, integration of VERs is ***much, much*** more difficult in non-market areas
  - Hourly scheduling for non-utility generation = limited load-following
  - Much smaller BAs = less scale to balance the intermittent nature of VERs
  - Somewhat a function of marginal fuel

What Are Potential Solutions?

- RTOs and ISOs
  - Revise/devise rules that encourage unit operational flexibility
    - Pay for speed and/or range?
  - Analyze penalties that discourage unit flexibility
    - Better align output precision with resource flexibility in order to optimize overall value to the system
    - take advantage of economies of scale
  - Improve economic modeling of generation
    - The old LMP "consistent movement across the dispatchable spectrum" restricts flexibility and raises cost of energy
    - Better modeling of multi-stage resources
      - Duct-firing should be modeled as a peaking resource
      - Power augmentation should be modeled as a peaking resource
      - ERCOT is currently "best in class" by far
  - Evolve ancillary service products to meet the needs of today's system with new technologies and renewable energy resources
    - Load-following incentives
    - Turn-down incentives
    - Ability to cycle off-line and return to operation incentives

What Are Potential Solutions? (continued)

- Areas that are not in RTOs/ISOs ("Non-market areas")
  - Move from hourly to intra-hour scheduling
    - Labor intensive
    - FERC NOPR addressing
  - Open up "markets" for AS provision
    - Devise a process to compensate ALL generators for AS products
      - Require IOUs to develop competitive "best prices" and/or tariff rates for compensation of AS services (regulation, load-following, and operating reserves) that recognizes generator costs and risks
      - Develop strict rules and oversight processes to ensure non-discriminatory procurement of AS products
      - Develop standards for testing and performance (regional entities perhaps?)
  - Balancing Area consolidation or "pseudo-consolidation/ACE sharing"
    - Takes advantage of scale and generation diversity
    - Shares cost and risk, but loses some control
  - Continue to actively encourage transmission systems to join RTOs
      - Work with state commissions to help them understand benefits
      - "The economies of scale ALWAYS bring value – both from an economic perspective and from a reliability perspective!"

"They always say time changes things, but you actually have to change them yourself."

The Philosophy of Andy Warhol

Andy Warhol (1928 - 1987)

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