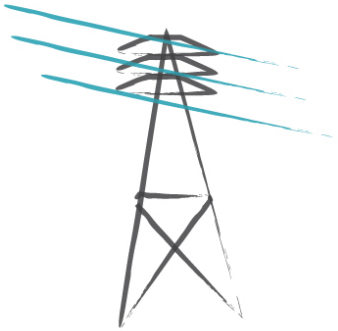


WECC

Reliability Considerations in Gas – Electric Integration

Jim Robb

Topics

- Some fundamentals about electric system planning and the Western Interconnection
- Renewable Integration challenges
- Gas implications

Key Electric Planning Concepts

- Electric Grid is designed *primarily* for reliability; few "economic" projects have proceeded
- Not all generation is created equal; key characteristics include:
  - Production of real power (MW)
  - Production of reactive power (MVars)
  - Intermittency
  - Location relative to load
  - Provision on essential reliability services (inertia, frequency response, ramping, etc.)

Key Electric Planning Concepts (continued)

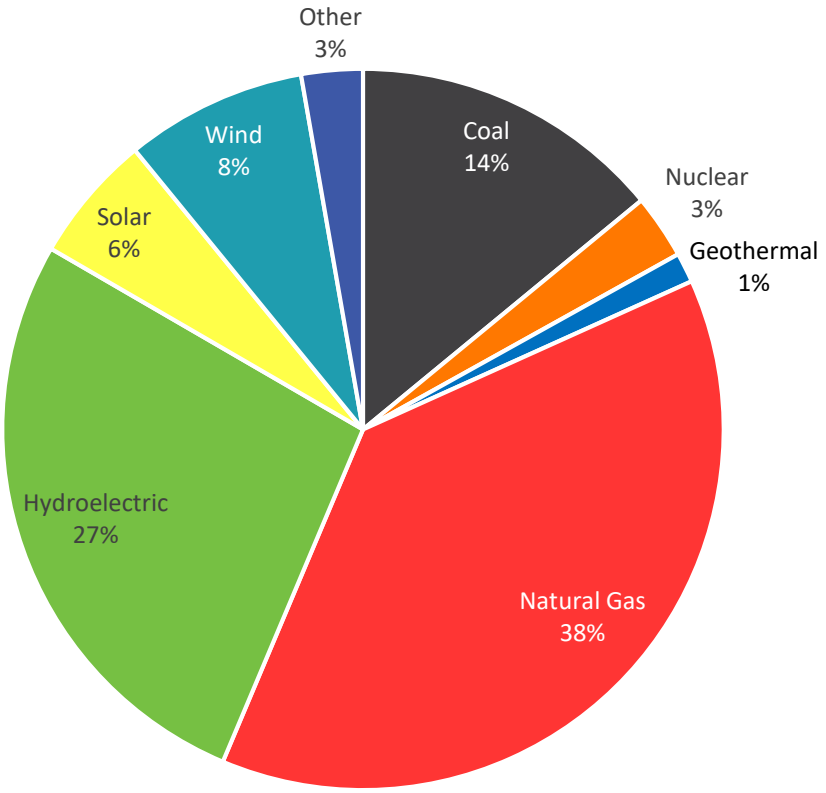
- AC grid is heavily networked; not point to point service
- Generation and load must be balanced in real time
- System designed to survive (at least) N-1 conditions (loss of any single element) without load loss
- Storage is limited and typically provides only momentary support

Key Electric Planning Concepts (continued)

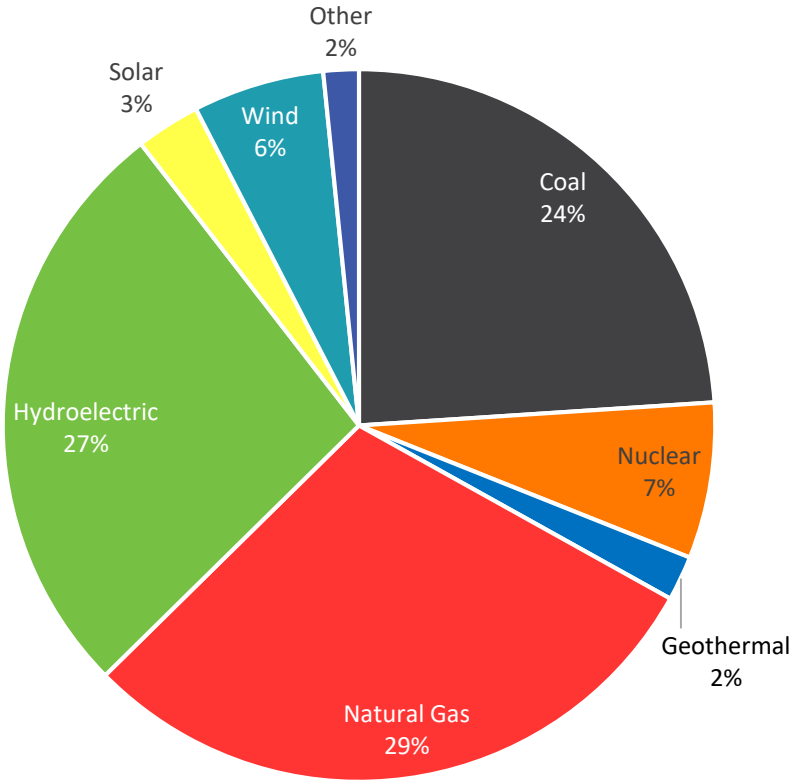
- Reliability is the result of
  - Adequate transmission and generation (plus a reserve margin) to meet *instantaneous* load; plus
  - Adequate provision of essential reliability services to keep transmission grid operating *stably* during system disturbances

Western Interconnection – Some Statistics

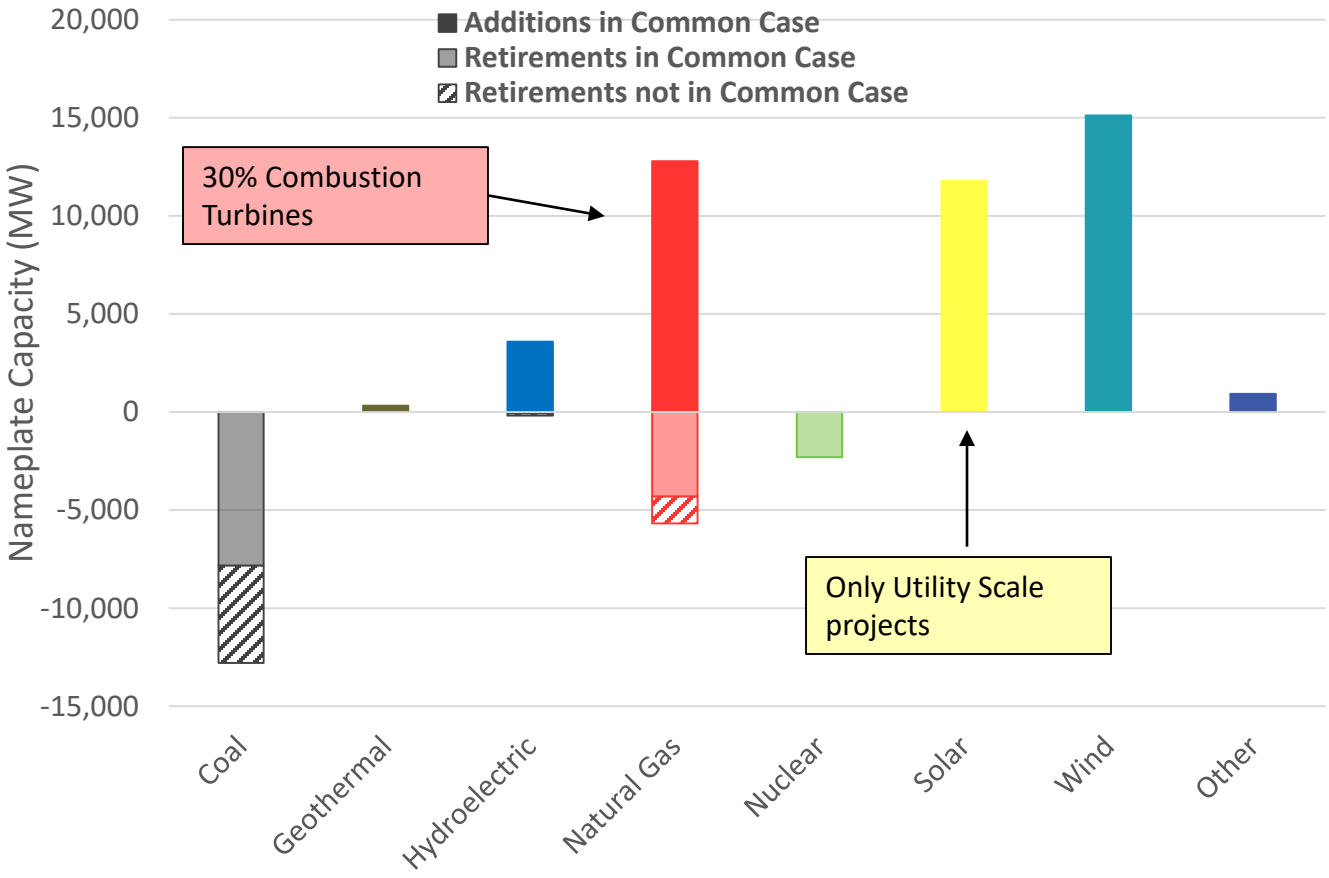
2016 Nameplate Capacity (MW)



2016 Net Generation (GWh)



Resource Additions and Retirements



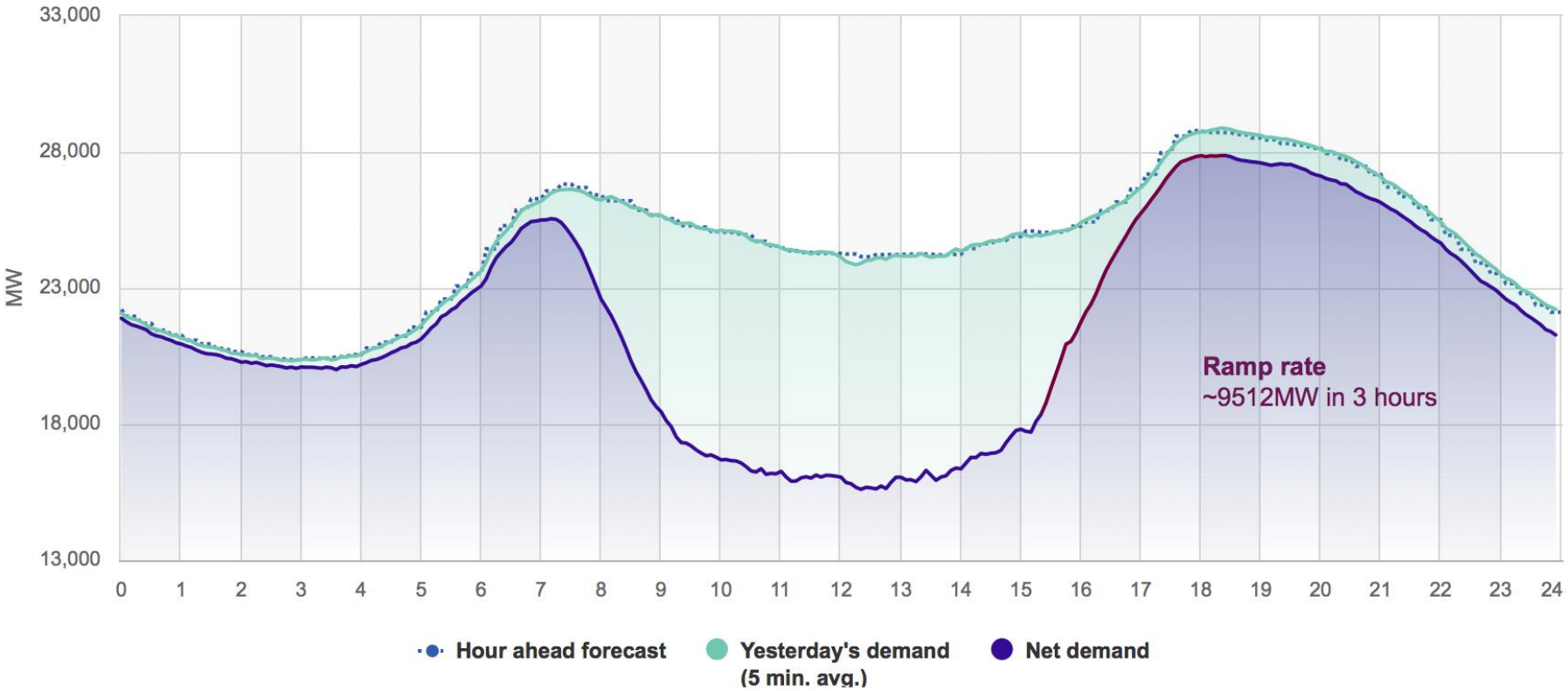
30% increase in gas consumption for generation anticipated 2016-2026

Solar Challenges for Reliability

Solar peak and electric peak don't match	→	Other system resources (typically gas) need to ramp up or down quickly to match load
Solar currently doesn't provide much voltage support	→	Other sources (typically gas) are required to maintain transmission system stability
Inverters tend to act in concert and are optimized to protect the panels	→	Solar interruptions can be very large (~1200 MW in Blue Cut fire incident)
Rooftop solar is invisible to system operators and planners	→	More volatile loads to manage New control paradigms required Reserve calculations more challenging

Challenges Integrating Solar

CAISO Net Demand
1-24-2018



Gas Implications

Dimension	Implications

Planning	• Volumes for power generations are increasing (~30% increase across Western Interconnection anticipated by 2026)
	• Flexibility requirements are only going to increase
	  • Market area storage
	  • Pack and draft

Scheduling	• Electric market moving to 15 minute (and maybe 5 minute) scheduling and gas scheduling/imbalance protocols need to harmonize with that reality • Nominating gas over weekends will be increasingly problematic (gas burn for power generation increasing volatile and unpredictable)
Operations	• Pipelines and electric operators will need to adopt new situation awareness and visualization protocols