Presentation for Council Meeting

Power System Capacity Primer

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Caveat

In the electric utility industry, the term ‘capacity’ has many meanings and is used in many ways depending on context and purpose. In this presentation, we focus on capacity as it relates to planning for the Northwest power system.

Basic Taxonomy for Power System Analysis

- Energy: power generated or conserved across a period of time to serve system demands for electricity
- Peaking Capacity: capability of power generating and demand-management resources to satisfy maximum system demands for electricity at a specific point in time
- Flexibility: ability to continuously and reliably match generating and demand-side resources to system demands for electricity

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Three Different Time Dimensions

- Energy: provide service across periods much longer than an hour (e.g., months, years)
- Peaking Capacity: provide service for an hour or for a limited number of hours
- Flexibility: on an ongoing basis, increase or decrease generation moment by moment to balance within-hour scheduling mismatches

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In the Northwest, Peaking Capacity Has Two Important Sub-Timeframes

- Single-Hour Peaking Capacity: Maximum power system capability during the peak hour of demand
  - Typical metric used in other regions that rely on thermal generation
- Sustained Peaking Capacity: Maximum average power system capability during a limited number of heavy load hours for one or more days
  - Additional metric used in the Northwest due to limitations on our region's hydro storage
  - Example: Single-hour hydro capacity is over 34,000 MW but cannot sustain that over a cold snap or heat wave

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Utility Planning for Peaking Capacity

- Each utility plans for a portfolio of resources adequate to meet its energy, capacity and flexibility needs

- Utilities plan to meet their expected peak demands, plus a capacity reserve margin to cover
  - Extreme temperature events
  - Forced outages
  - Operating reserves

- Capacity reserve margins are usually 15 to 20%

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Council Planning Approach

- Main focus has been Council-adopted Resource Adequacy Standard
  - Metric is a maximum loss of load probability of 5%
  - LOLP analysis is performed using GENESYS
  - LOLP is translated into minimum planning requirements (annual energy load/resource balance and capacity reserve margin)
  - For Seventh Power Plan, minimum planning requirements will be fed into the Regional Portfolio Model

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Key Takeaway

- Energy, capacity and flexibility are not entirely distinct concepts – there are important interactions among all three
- Resource planning needs to address all three together

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Each Type of Resource Can Provide Unique Mix of Energy, Capacity and Flexibility

Resource Type	Provides Energy	Can be Dispatched	Provides Add'l Peaking Capacity[1]	Provides Flexibility
Hydro	Yes	Yes	Yes	Yes
Coal	Yes	Yes	Not normally	Not normally
Natural Gas	Yes	Yes	Yes	Not normally
Nuclear	Yes	Yes	No	No
Wind	Yes	No	No	No
Solar	Yes	No	No	No
Storage (e.g., battery)	No	Yes	Yes	Yes
Energy Efficiency	Yes	No	No	No
Demand Response	No	Yes	Yes	Yes

[1]If a resource provides energy then by definition it also contributes to meeting capacity needs.

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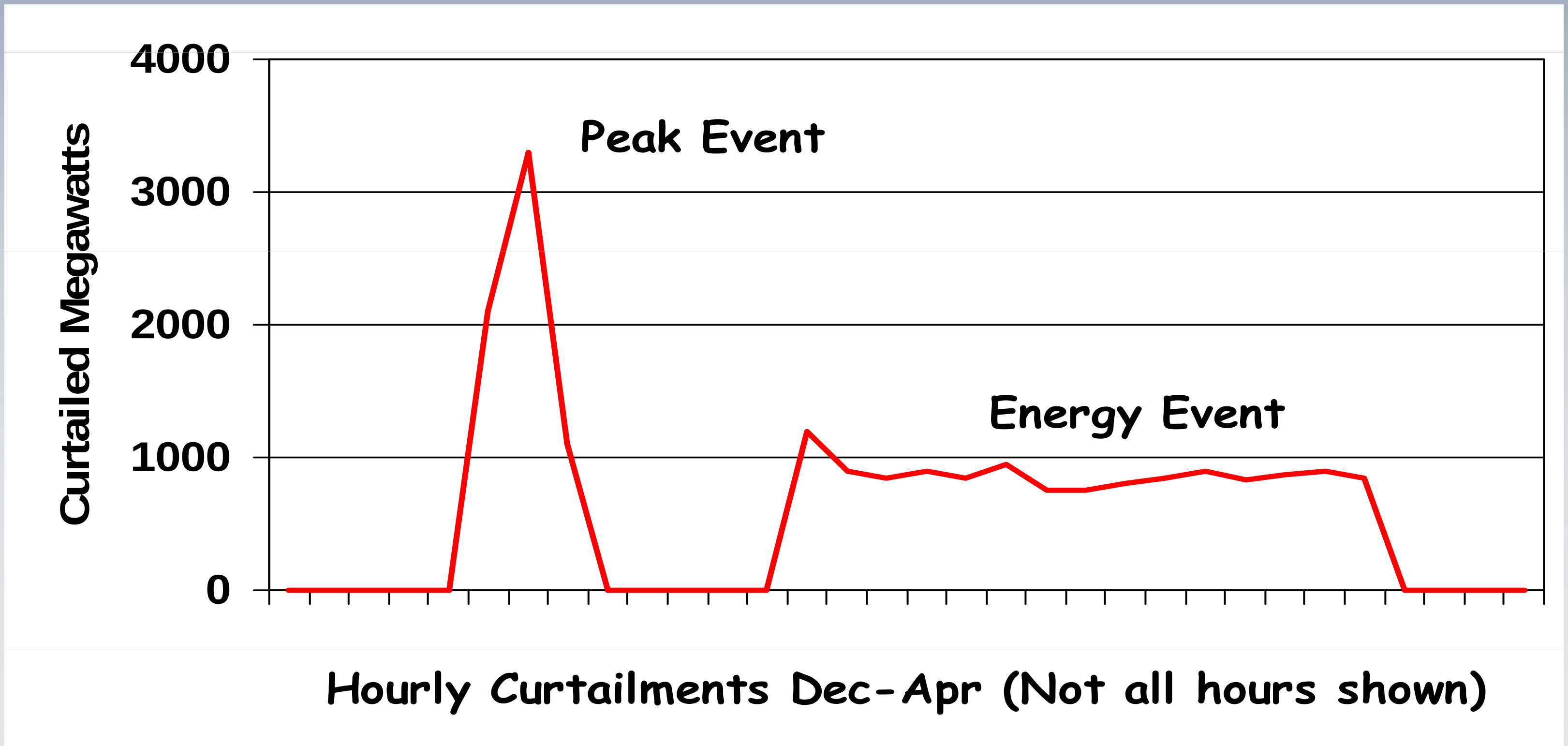
How Do Council Analyses Differentiate Capacity and Energy Shortfalls?

- Capacity shortfalls
  - can be caused by lack of machine capability, water or other reasons
  - have short duration
- Energy shortfalls
  - generally involve a lack of fuel (water)
  - have longer duration
- Can have both capacity and energy deficiencies during one shortfall

What do Capacity and Energy Shortfalls Look Like?



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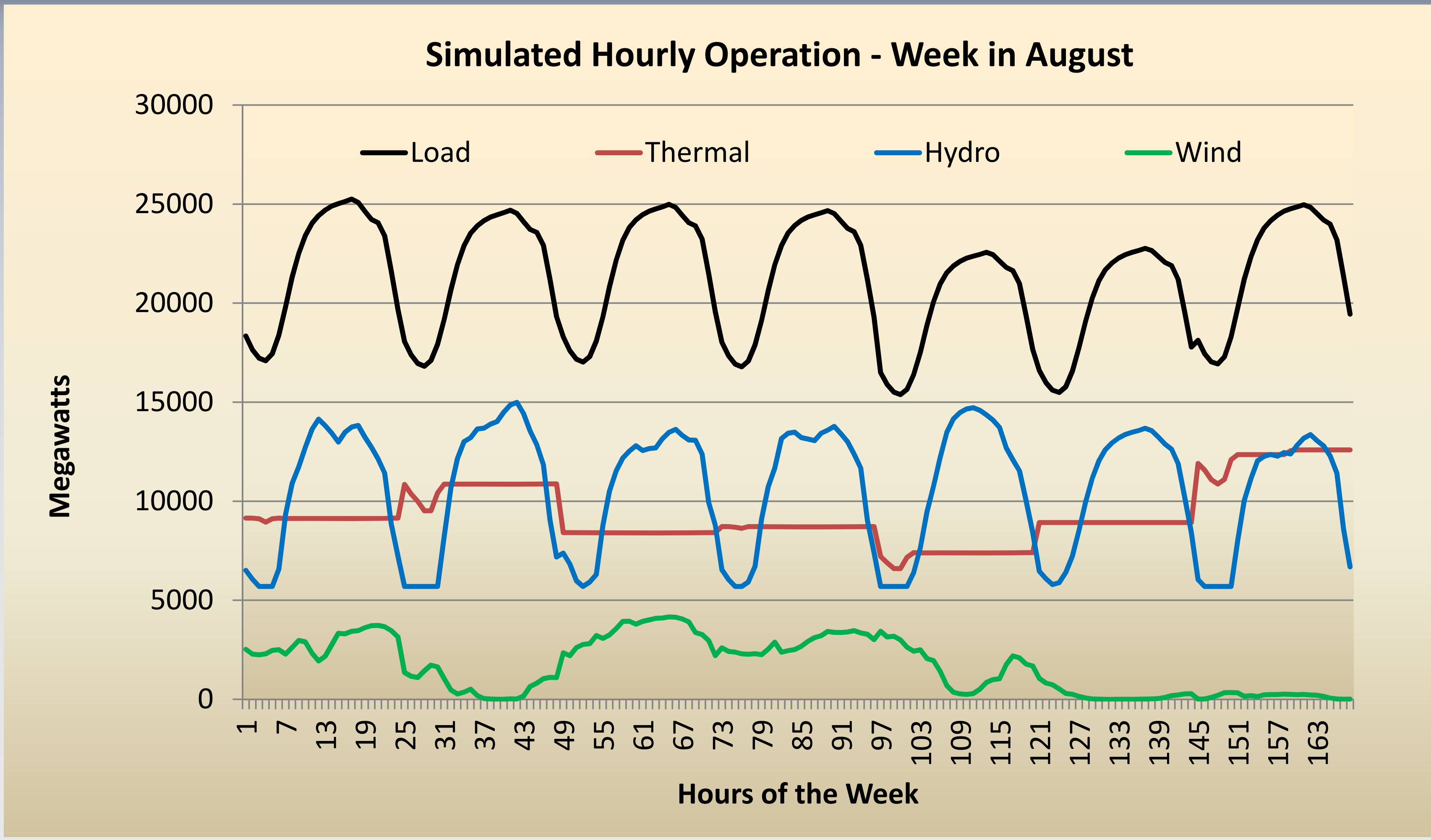
Simulated Hourly Dispatch for a Week (Source: GENESYS)



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Notes for Previous Chart

- **Load**
  - Single hump load typical summer shape
  - 5th and 6th days are the weekend days
- **Wind**
  - High generation in 1st, 3rd and 4th days
  - Very low in 7th day
- **Thermal**
  - Backs off when wind picks up
  - Increases when wind not generating
- **Hydro**
  - Fairly constant generation for each day
  - Picks up smaller load following fluctuations
  - Hits minimum generation limit after 1st, 4th and 6th days
- **When generation is less than load, we have a shortfall**

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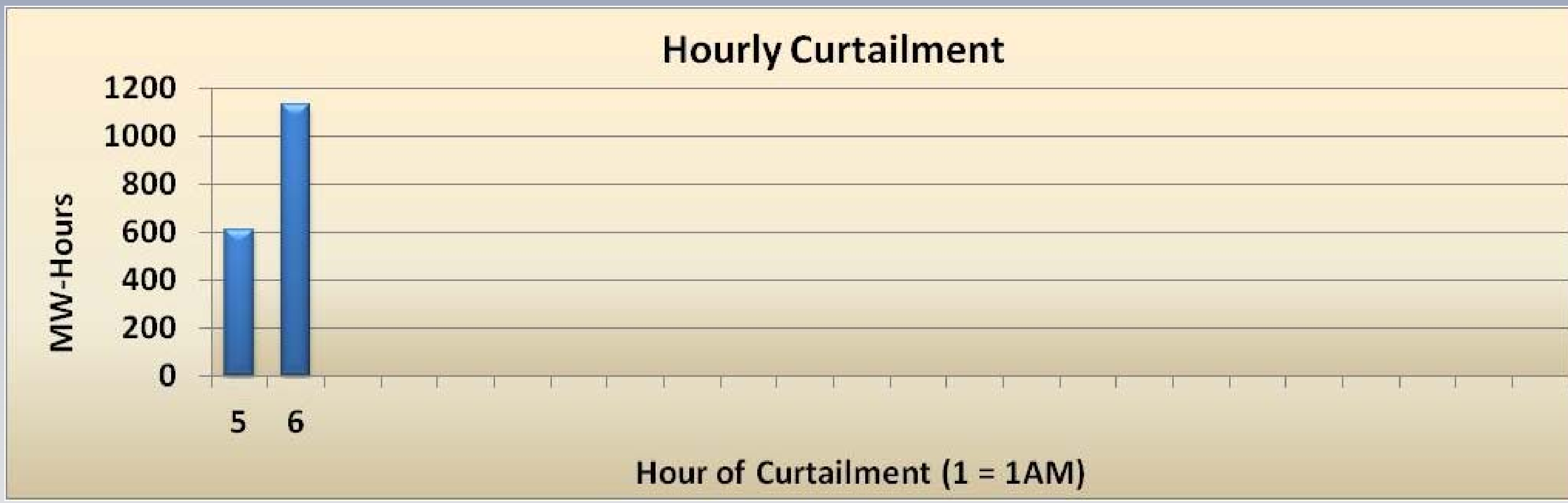
Capacity Shortfall (January 2017 Simulation)



2-Hour capacity shortfall during morning peak:

1. Warm temperature for February (95th percentile)
2. Low runoff year (13th percentile)
3. Thermal generation is 97% available and operational
4. Wind generation is zero
5. **Probable Cause**: Even though load was not high, thermal was at maximum and hydro was not able to make up for the loss of wind generation

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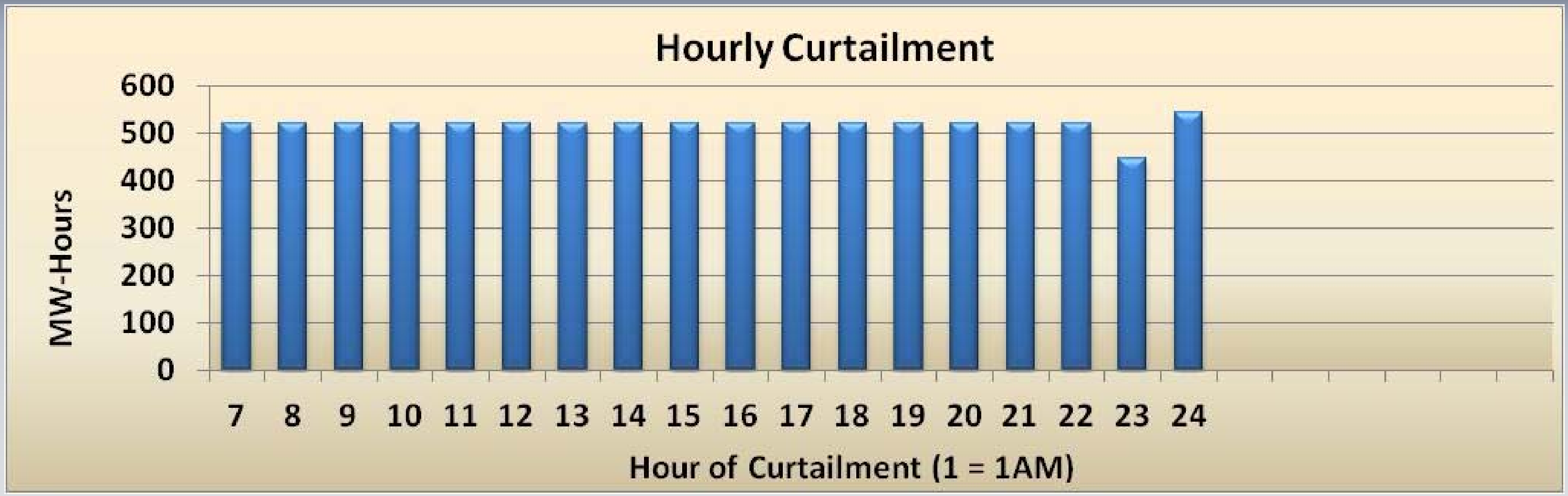
Energy Shortfall (August 2017 Simulation)



18-Hour energy shortfall:

1. Coldest August on record, thus relatively low load
2. Low runoff year (11th percentile)
3. 22% of thermal generation is unavailable due to forced outages
4. Wind generation is at 11%
5. **Probable Cause**: Even though load was not high, low hydro and wind generation combined with high thermal outage caused this energy shortage. Notice that hydro was operated to uniform the shortfall.

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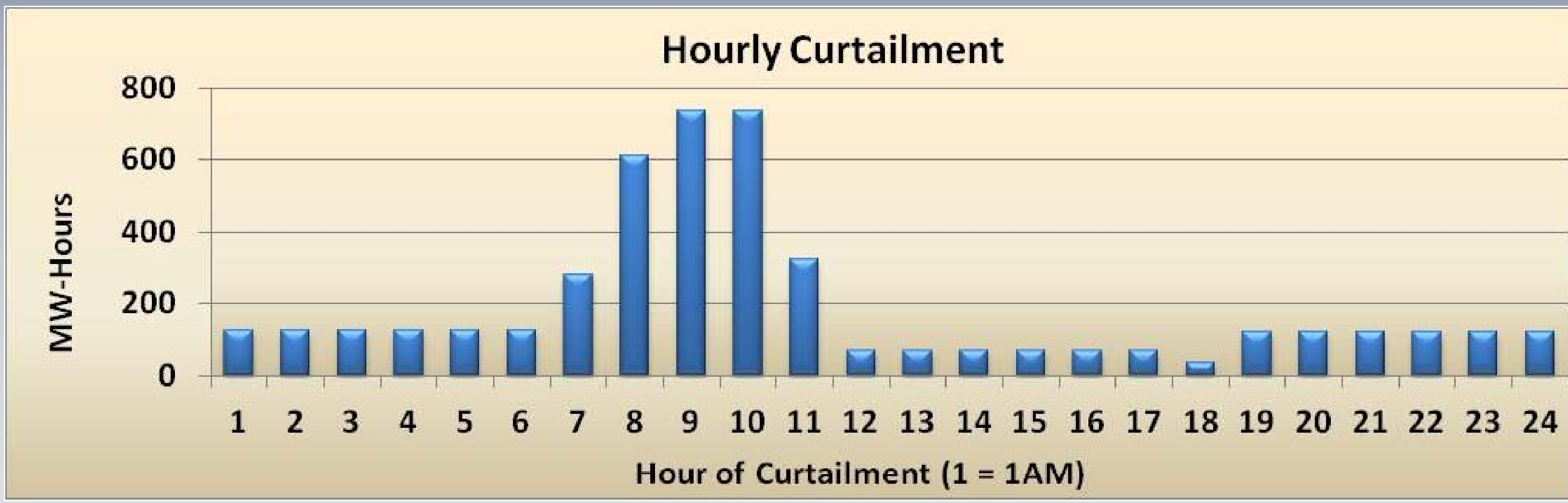
Energy & Capacity Shortfall (January 2017 Simulation)



24-Hour energy and capacity shortfall:

1. Warm temperature for February (85th percentile), relatively low load
2. Low runoff year (8th percentile)
3. 15% of thermal generation is unavailable due to forced outages
4. Wind generation is at 24%, a little below average (32%)
5. **Probable Cause**: Even though load was not high, low hydro in combination with thermal outages contributed to the relatively small energy shortfall but the system had trouble keeping up during the morning peak hours

Is the Region Limited in 2017 for Capacity or Energy? Answer: Both