Northwest Power and Conservation Council

January 8, 2013

MEMORANDUM

TO: Council Members

FROM: Charlie Black, Power Planning Division Director

SUBJECT: Primer on Power System Flexibility

A key theme that has emerged from development of the Sixth Power Plan Mid-Term Assessment is the need for the Council to expand its emphasis on assessing peaking capacity and system flexibility, in addition to its efforts on planning to meet energy needs.

One of the challenges for addressing peaking capacity and system flexibility is the lack of a shared understanding of basic concepts and common terminology for discussing the issues. Thus, it appears useful to begin building a conceptual framework for addressing capacity and flexibility topics, including for the upcoming Seventh Power Plan.

To begin this process, at the Council meeting on Wednesday, January 16, 2013, I will present a brief primer on power system flexibility. This primer will be at a similar level of discussion as the primer on carbon emission that was presented to the Power Committee last October.

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Presentation for Council Meeting

Power System Flexibility Primer

Charlie Black
Power Planning Division Director

January 16, 2013

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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

Who's Responsible for Each Component?

- Energy: utility or other load-serving entity (provides owned and procured resources)
- Peaking Capacity: utility or other load-serving entity (provides owned and procured resources)
- Flexibility: *balancing authority* (uses resource capabilities provided by LSE's and other suppliers)

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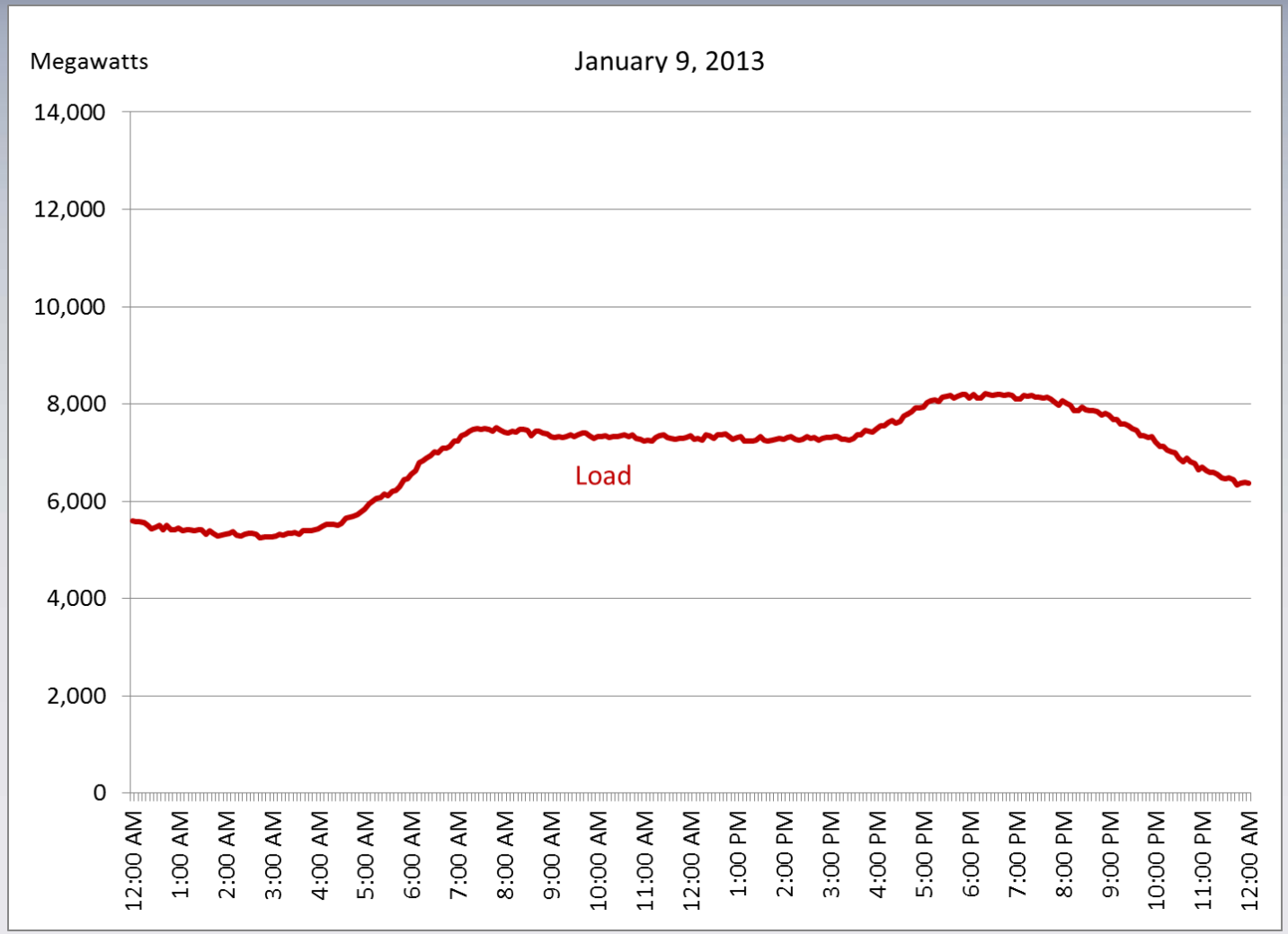
Simple Illustration: BPA Balancing Authority



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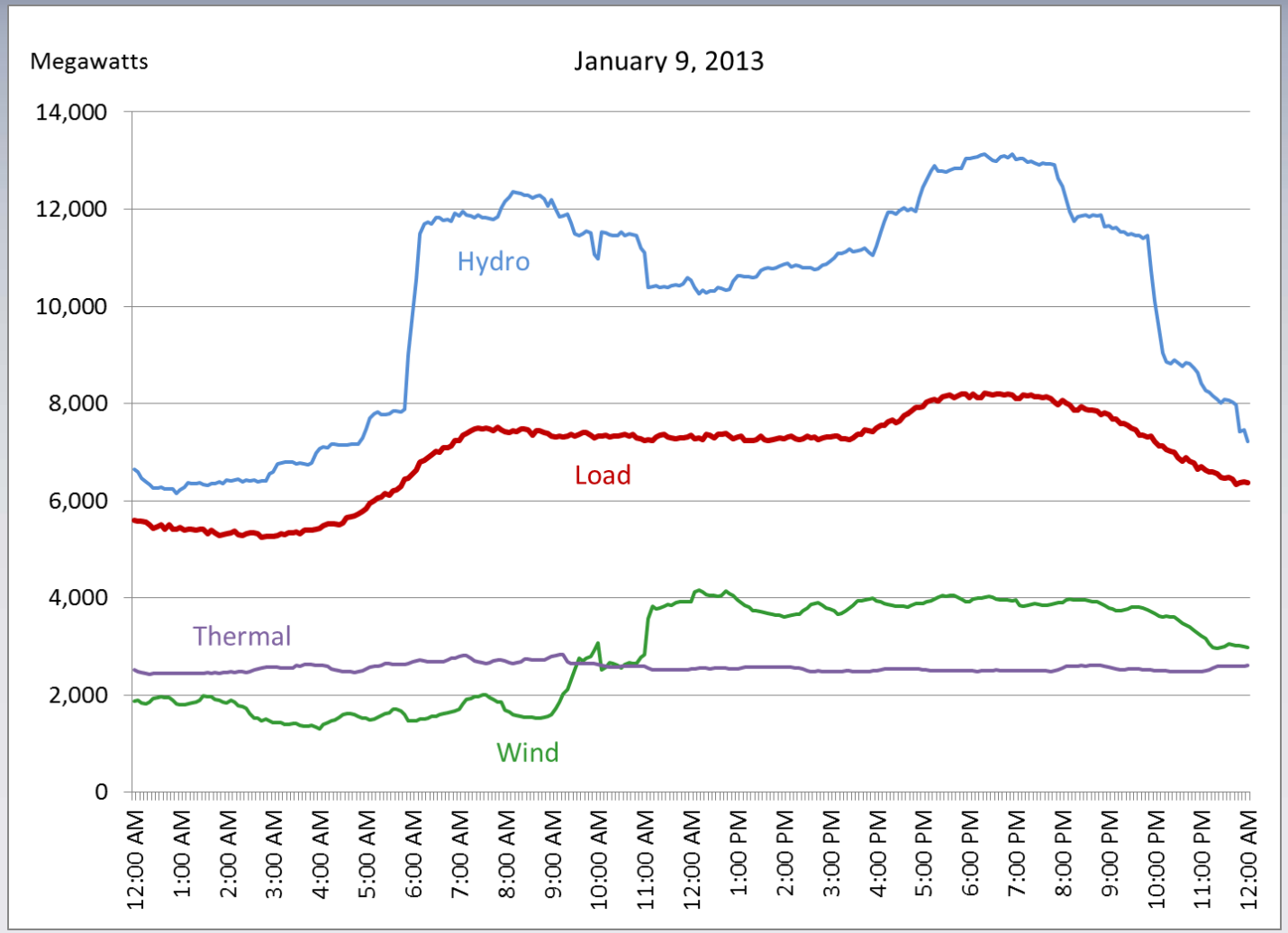
It Starts Getting More Complicated: BPA Balancing Authority



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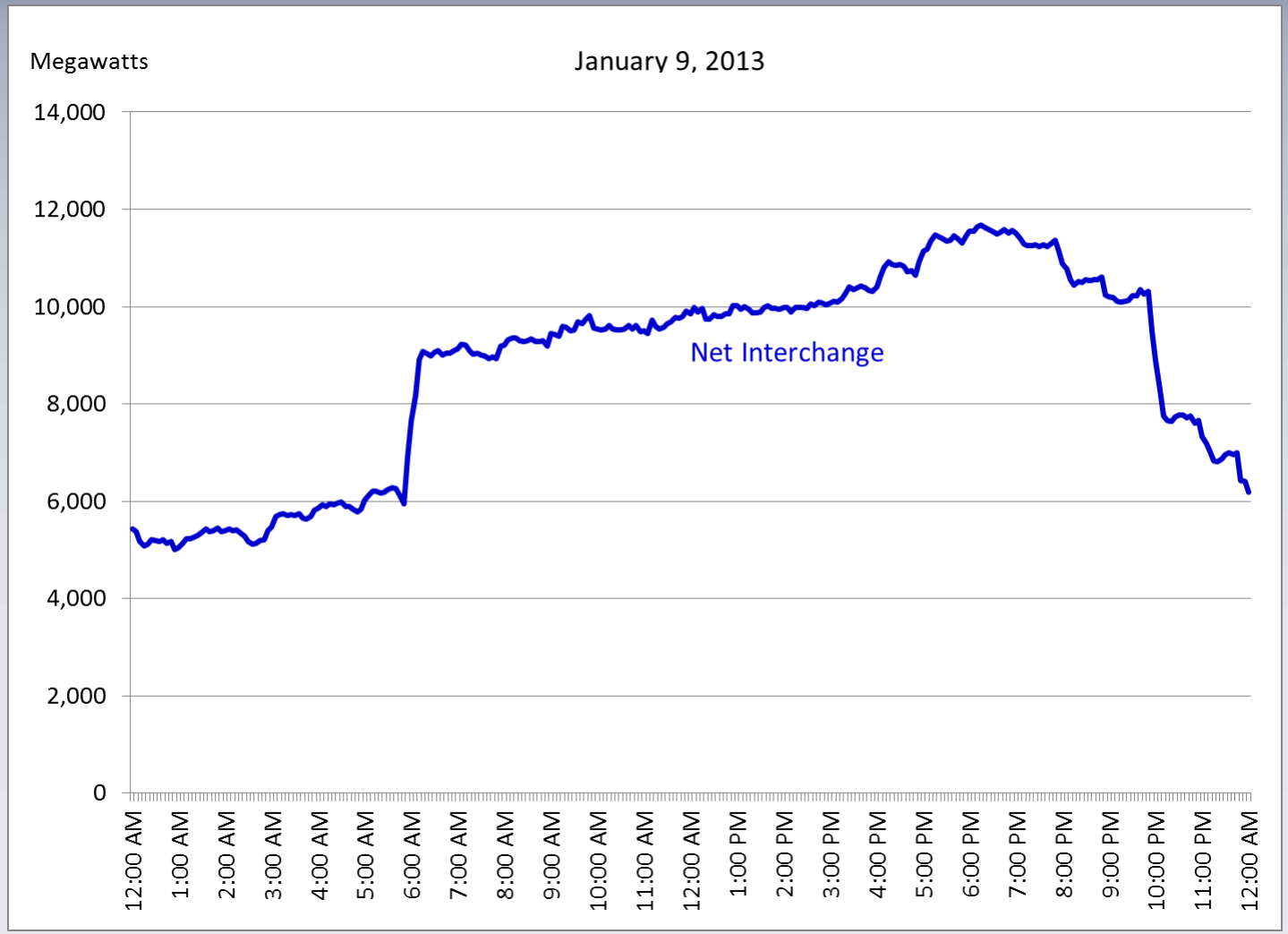

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What Is A Balancing Authority?

- Balancing authorities are system operators who ensure resources continuously match system demands
  - Anticipate and respond to variations in demands and resources
  - Actually involves a range of timeframes, from instantaneous to day-ahead or longer
- Each balancing authority manages and controls system flexibility for a specific geographic area
- Examples: BPA, six NW IOUs, five NW POUs, BC Hydro, California ISO

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Balancing Authority Functions

- FERC defines balancing authority functions to include wholesale transmission ancillary services
- Balancing authorities provide ancillary services to meet various parties' needs
  - Affiliated load-serving entities and power suppliers
  - Unaffiliated load-serving entities and power suppliers

Ancillary Services: System Flexibility Provided by Balancing Authorities

1. Scheduling, system control and dispatch
2. Reactive power and voltage control
3. Regulation and frequency response service
4. Energy imbalance service
5. Operating reserve – synchronized reserve service
6. Operating reserve – supplemental reserve service

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Balancing Authority Functions
BPA as an Example

- At all times, BPA must match the sum of the following to its actual BA area loads:

  + Federal resources (e.g., FCRPS hydro)

  + Non-federal resources in BPA BA (e.g., wind, gas)

  + Receipts from other in-region BAs

  - Deliveries to other in-region BAs

  + Intertie imports from other regions (Canada and SW)

  - Intertie exports to other regions (Canada and SW)

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It Gets Even More Complicated: Variabilities Drive Flexibility Needs

- Balancing authorities match resources and loads, where both are moving targets
  - Load forecasts are imperfect
  - Scheduled resources are imperfect
    - Wind schedules are imperfect up and down

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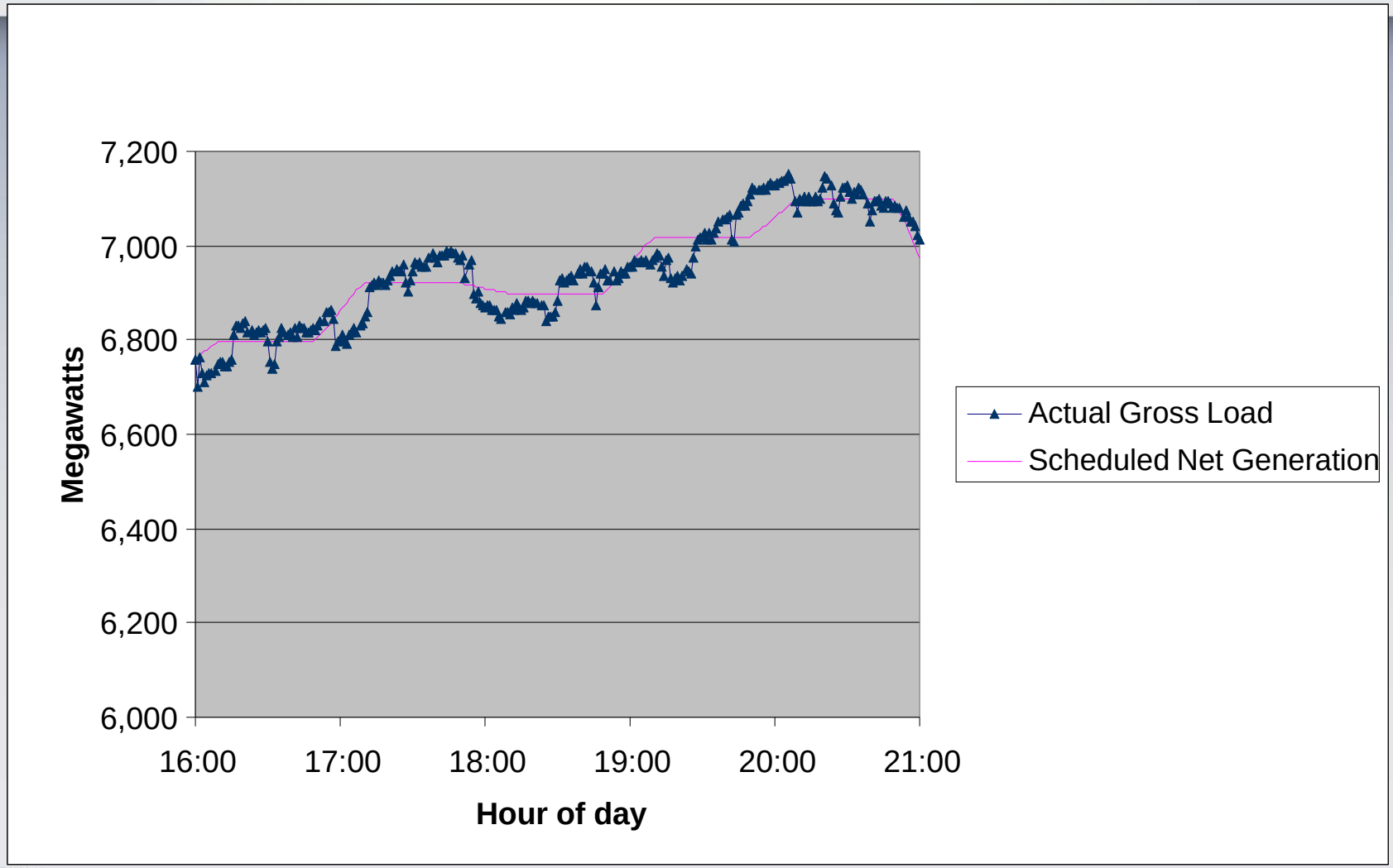
Illustration: Actuals Vary from Schedules, Requiring Flexibility



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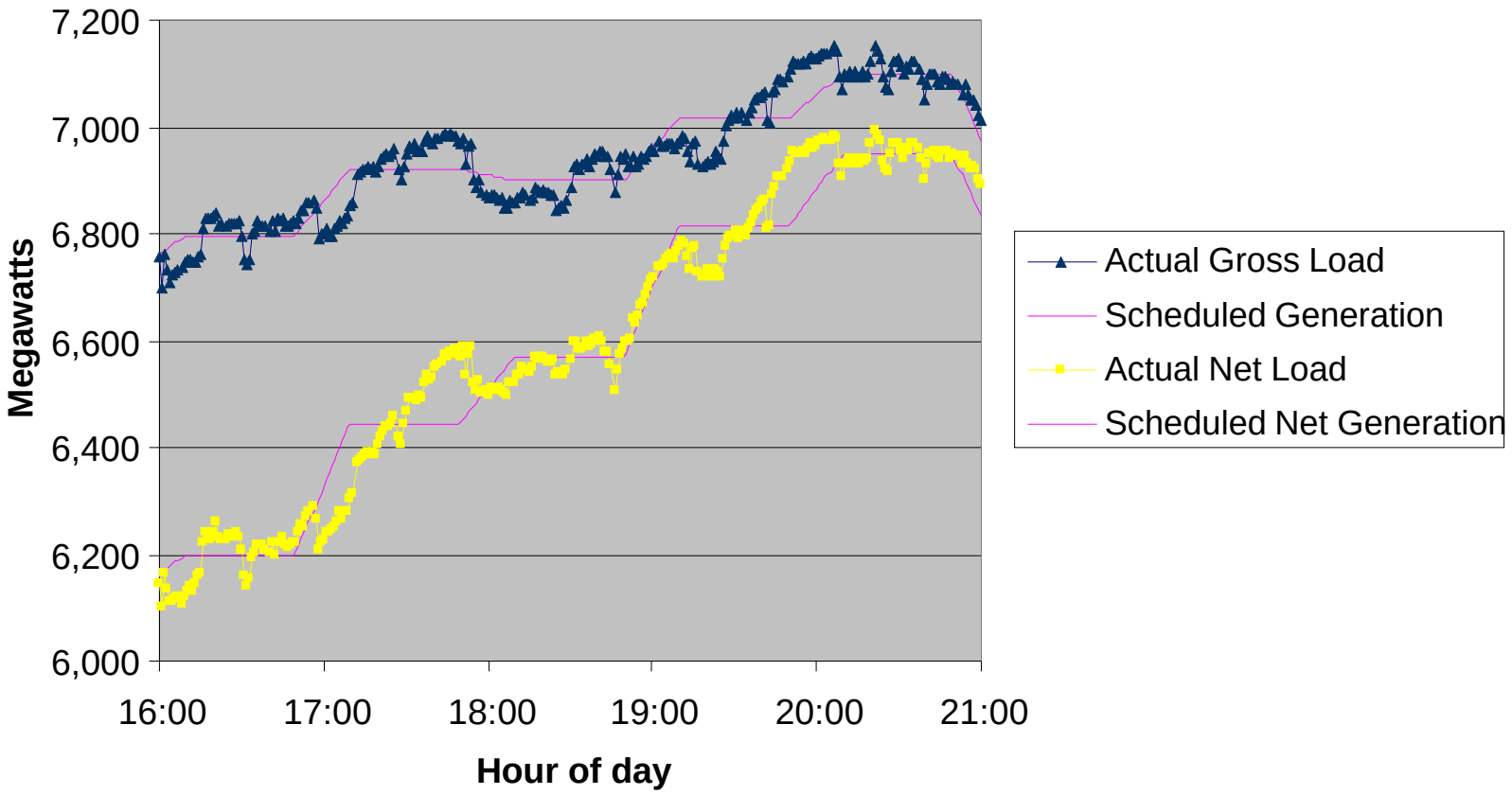

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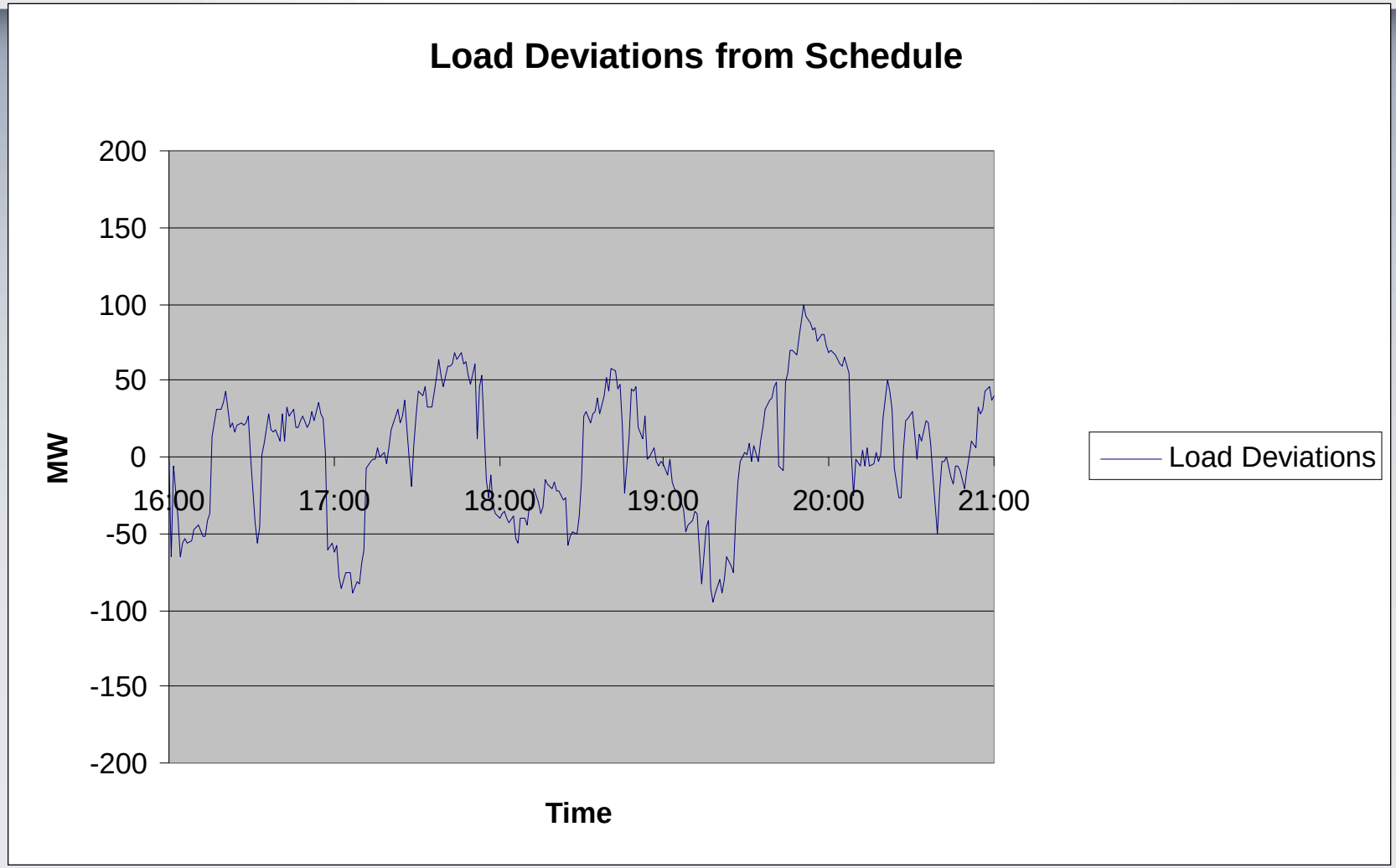

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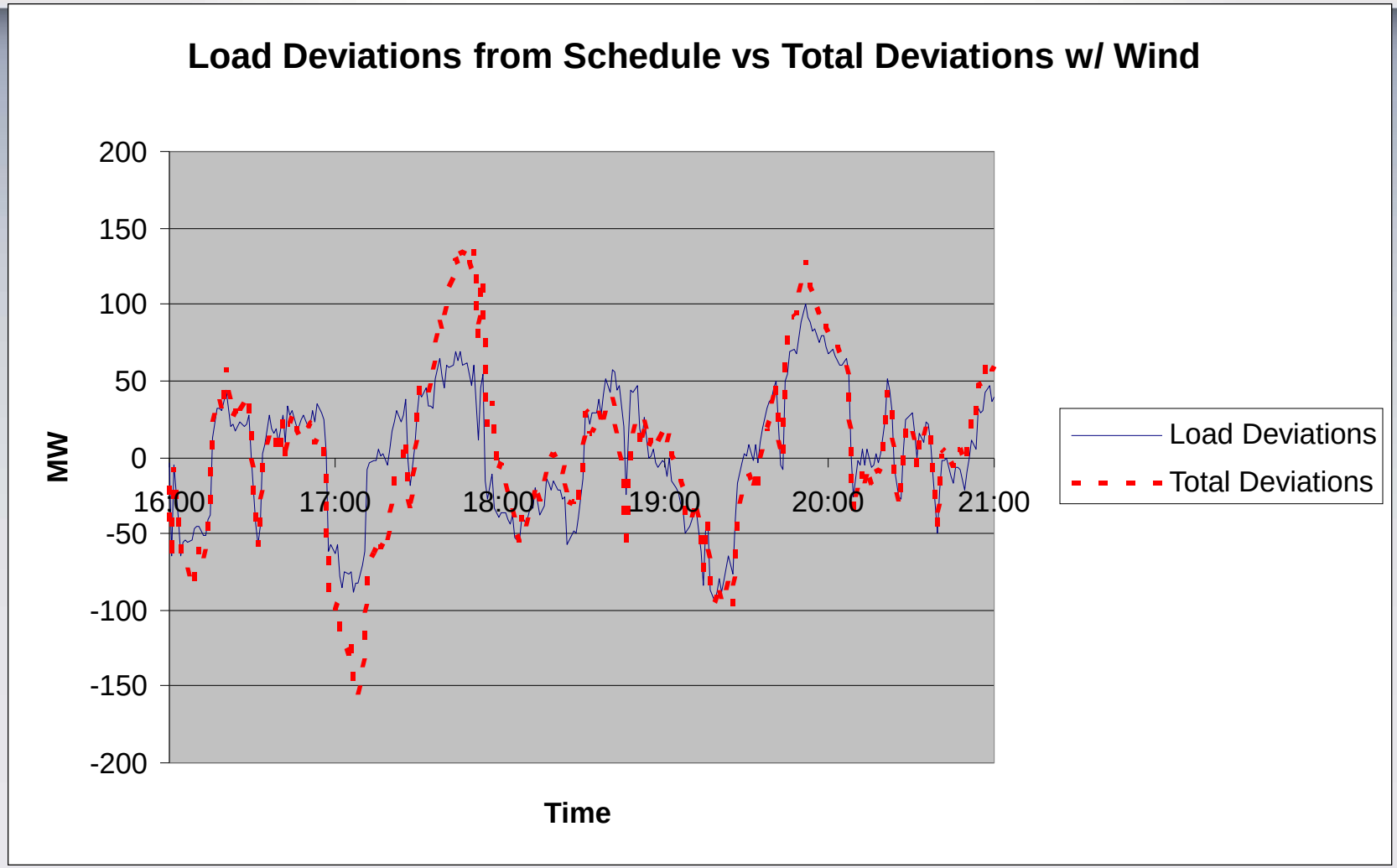

The Northwest Has Not Traditionally Faced System Flexibility Constraints

- Prevalence of hydro generation provided relatively ample flexibility (e.g., reserves)
- Development of energy efficiency helped extend system flexibility
- Other regions that rely more on baseload thermal generation have typically faced greater flexibility constraints

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System Flexibility in the Northwest is Becoming Constrained

- Load growth
- Hydro now a smaller share of total generation
- Addition of significant quantities of variable generation
  - Over 7,000 megawatts in the region
  - 4,750 megawatts in BPA balancing authority area

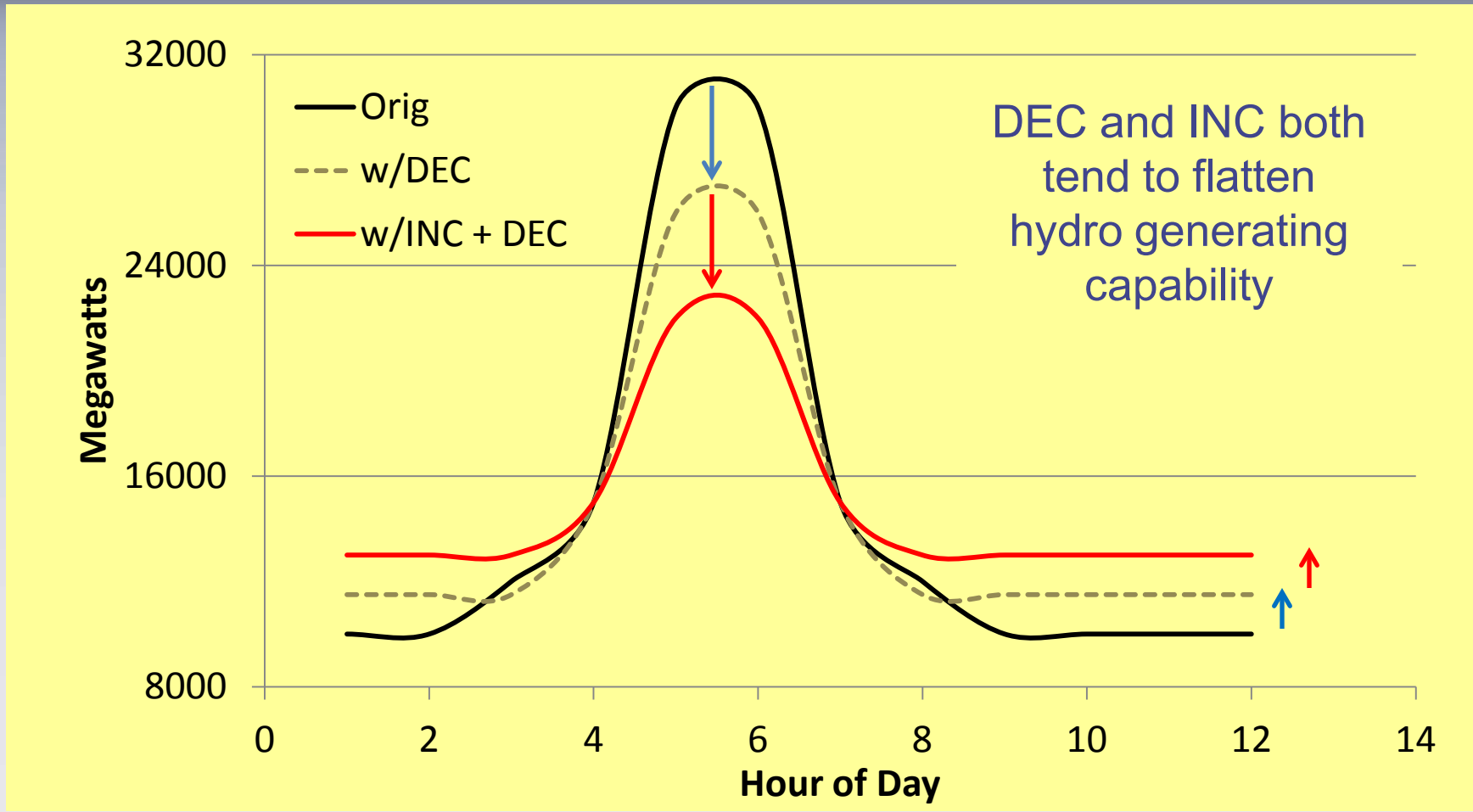
What Resources Provide Flexibility?

- Any resource that can be dispatched rapidly upward or downward
  - Hydro is excellent
  - Gas-fired generation can also be used
- A flexibility resource can have dual functions
  - Decrease generation when VERs produce more than scheduled = Decremental reserve or "DEC"
  - Increase generation when VERs produce less than scheduled = Incremental reserve or "INC"

Providing System Flexibility Reduces A Resource's Capability

- The resource must be running to be ready to provide flexibility reserves
- Example: BPA hydro is used to provide 900 MW of INC and 1,100 MW of DEC reserves
  - INC reduces hydro peaking capacity
  - DEC increases hydro minimum generation and also reduces peaking capacity

Effects of INC and DEC Reserves on Hydroelectric Capability



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Additional Sources of System Flexibility

- Reduce need for flexibility
  - Shorter scheduling periods
  - Better wind and load forecasting
  - Sharing resources
    - Energy imbalance market
    - Dynamic transfers
    - Consolidation of balancing authorities

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Additional Sources of System Flexibility

- Power resources
  - Batteries, pumped storage, CAES, ARES
- Demand response
  - Electric vehicles
  - Thermal storage (water heat, space heat, refrigeration)
  - Intermediate products (pulped wood, municipal reservoirs)
  - Rescheduled use (data centers)