Wind, Spill and Chief Joseph Dam

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Seattle District
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Images from USACE Image database

US Army Corps of Engineers

- Power Market Management
  - Balancing
  - Reserves
- Wind
  - Market Penetration
  - Balancing Reserves
- Wind and Spill
  - Wind Variability
  - Effect at dams
  - Remediation

BPA – a Balancing Authority

- The Balancing Authority provides all services required to interconnect a generating resource.
- Total generation must be equal to total power demand at all times (e.g. maintain load/resource balance and frequency).
- Assure adequate reserves to cover contingencies and balance intermittent generating resources.

Balancing Authority - Reserves

- Contingency Reserves
  - At any instant, 5% of hydro plus 7% of thermal generation must be held in reserve.
  - At least half of the contingency reserve obligation must be physically spinning.
  - Reserve pooling reduces the individual BA's reserve obligation.
  - Upward reserve only, and only deployed when a qualified contingency occurs.

Balancing Authority - Reserves

- Balancing Reserves
  - Reserve obligation is based on covering 99.5% of the combined load and intermittent generation variability.
    - ▷ Amount is a function of the installed intermittent generating resource capacity.
  - Bidirectional Reserves
    - ▷ Covers increases [INCs] and decreases [DECs] in generation.
  - Constantly deployed to maintain load/resource balance.

Balancing Authority - Reserves

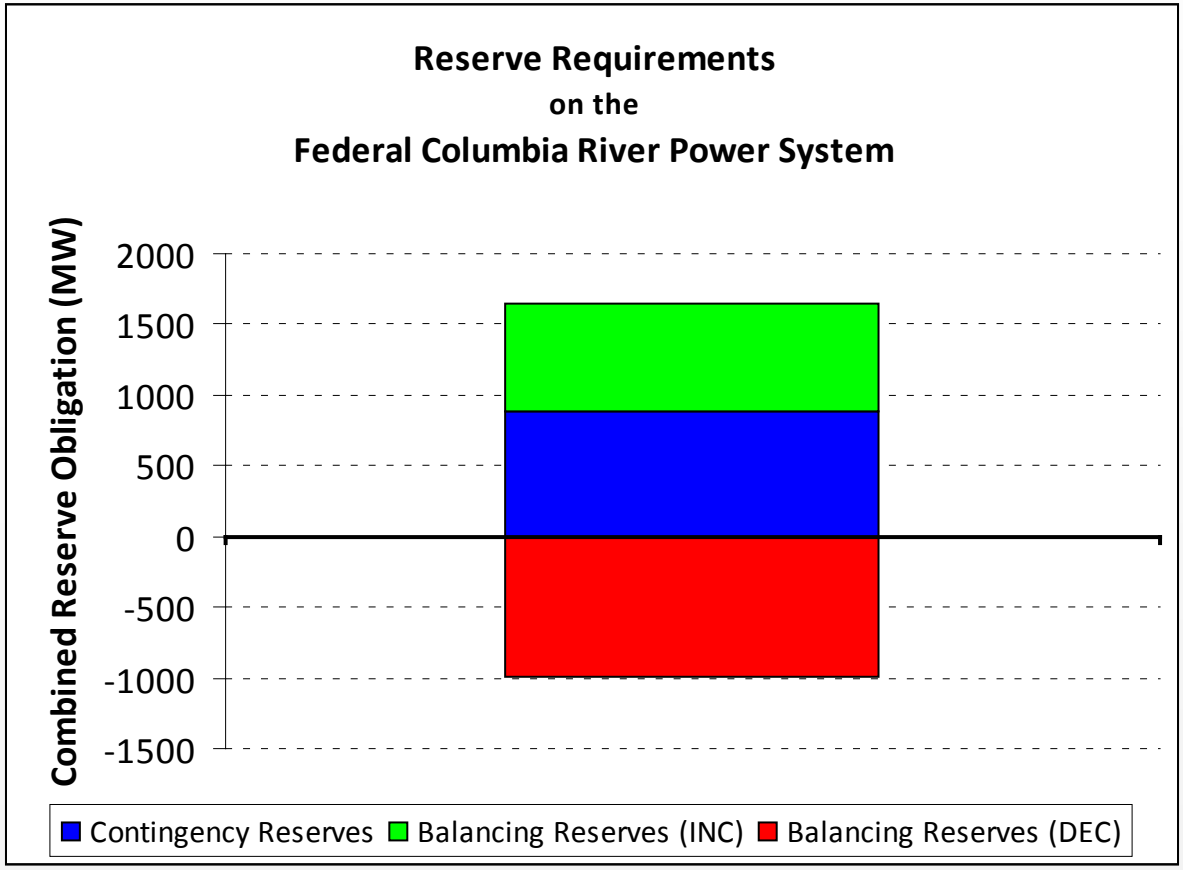


Chart: BPA

Balancing Authority - Reserves

Balancing Reserves Deployed

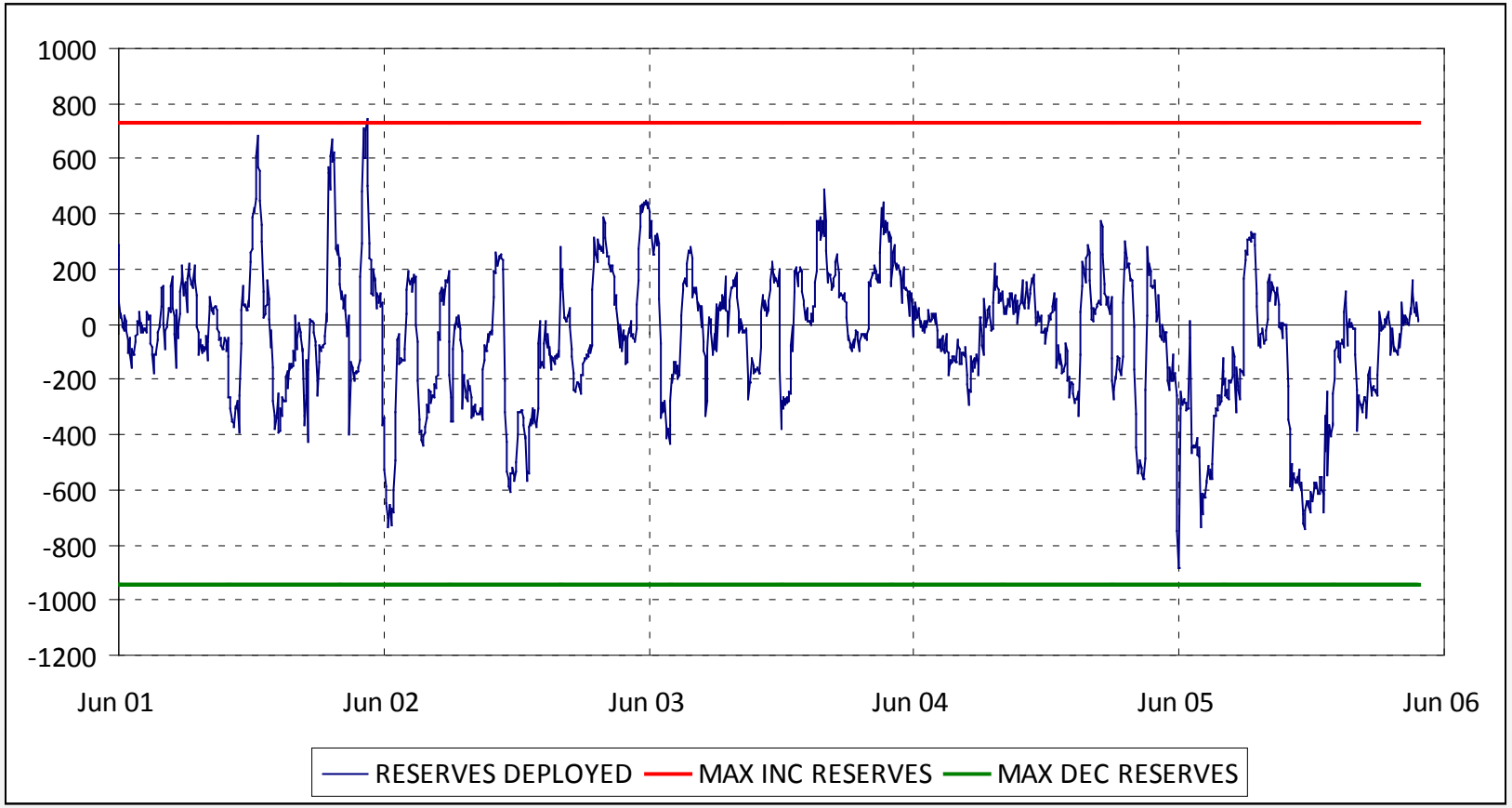
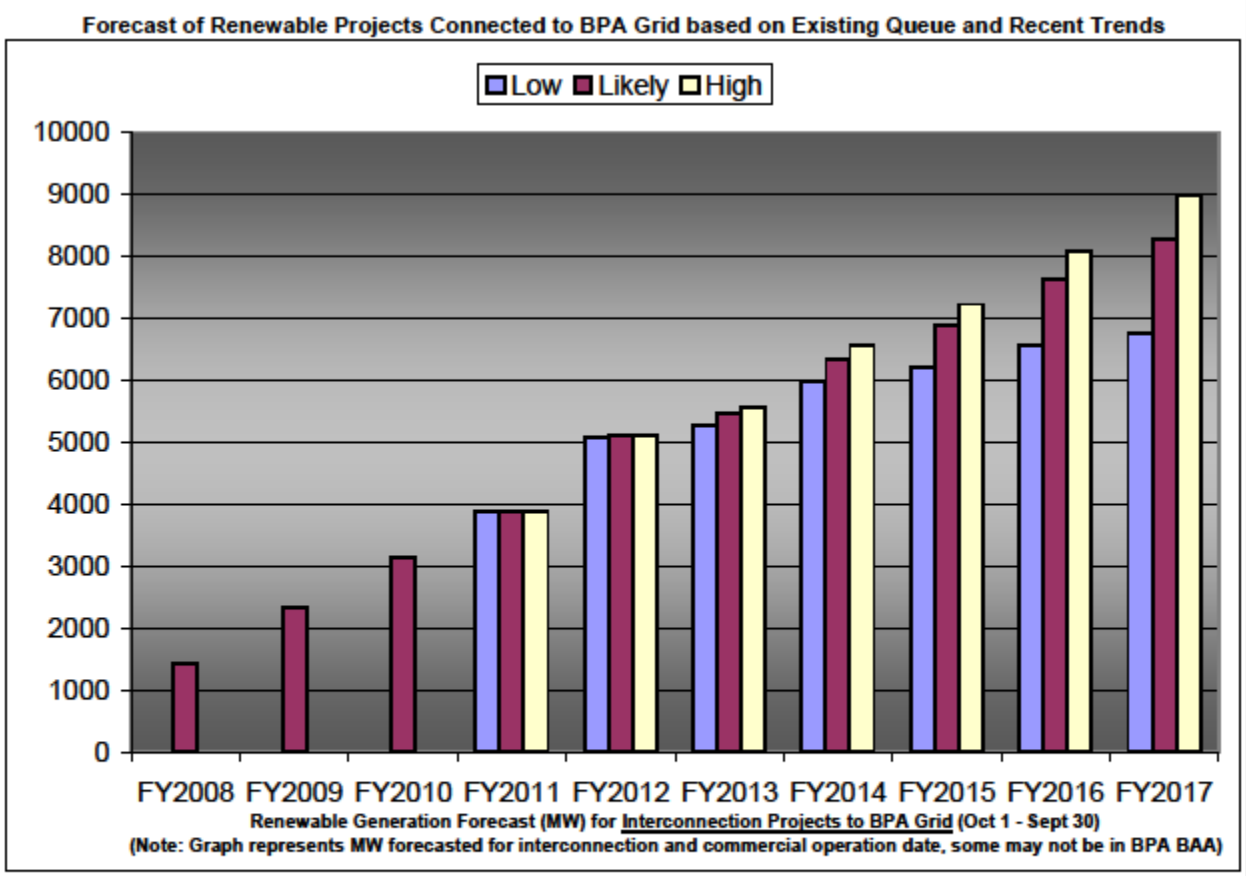


Chart: BPA

Current and Expected Installed Wind Capacity within the BPA BA



NOTES:

S. Enyeart As of: 11/9/2011

1. Projections beyond FY12 may be impacted or delayed due to a need for Transmission system expansion.
2. Projected totals based on previous experience and present growth factors including Production Tax Credits and RPS Demand.
3. Generation shown is interconnected to BPA-T; amount within BPA Balancing Authority Area is not estimated.

Wind - Map

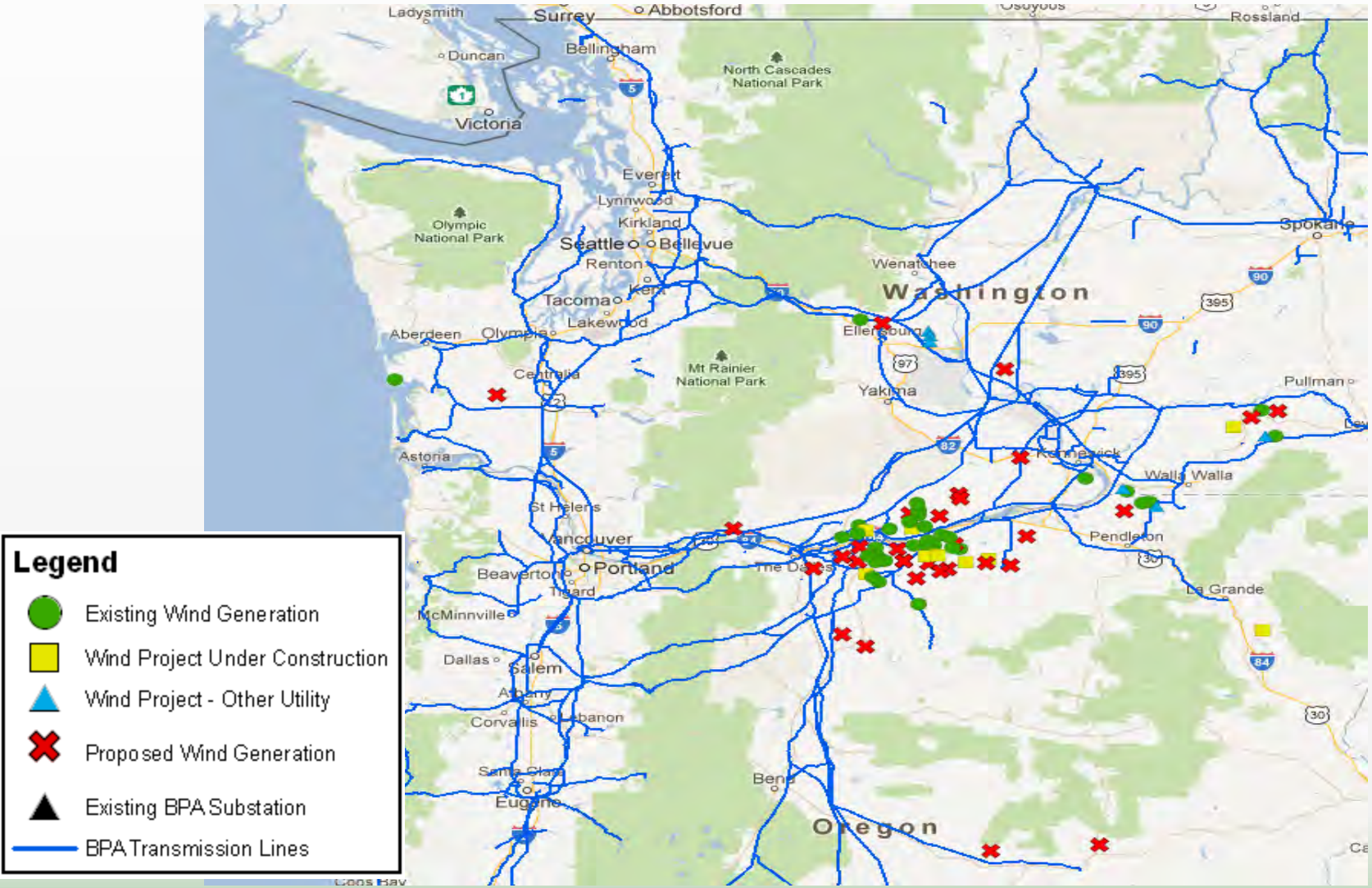
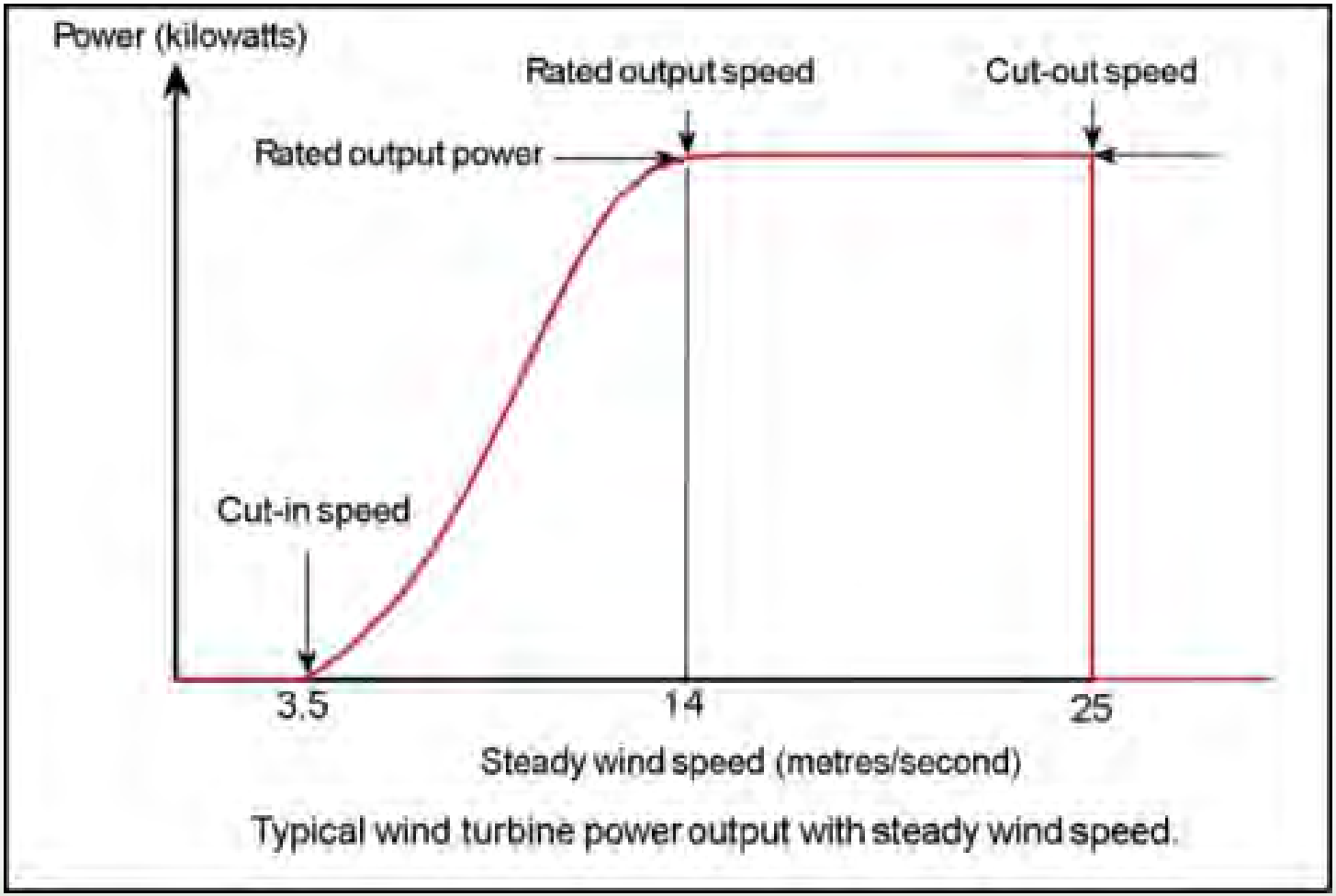


Chart: BPA

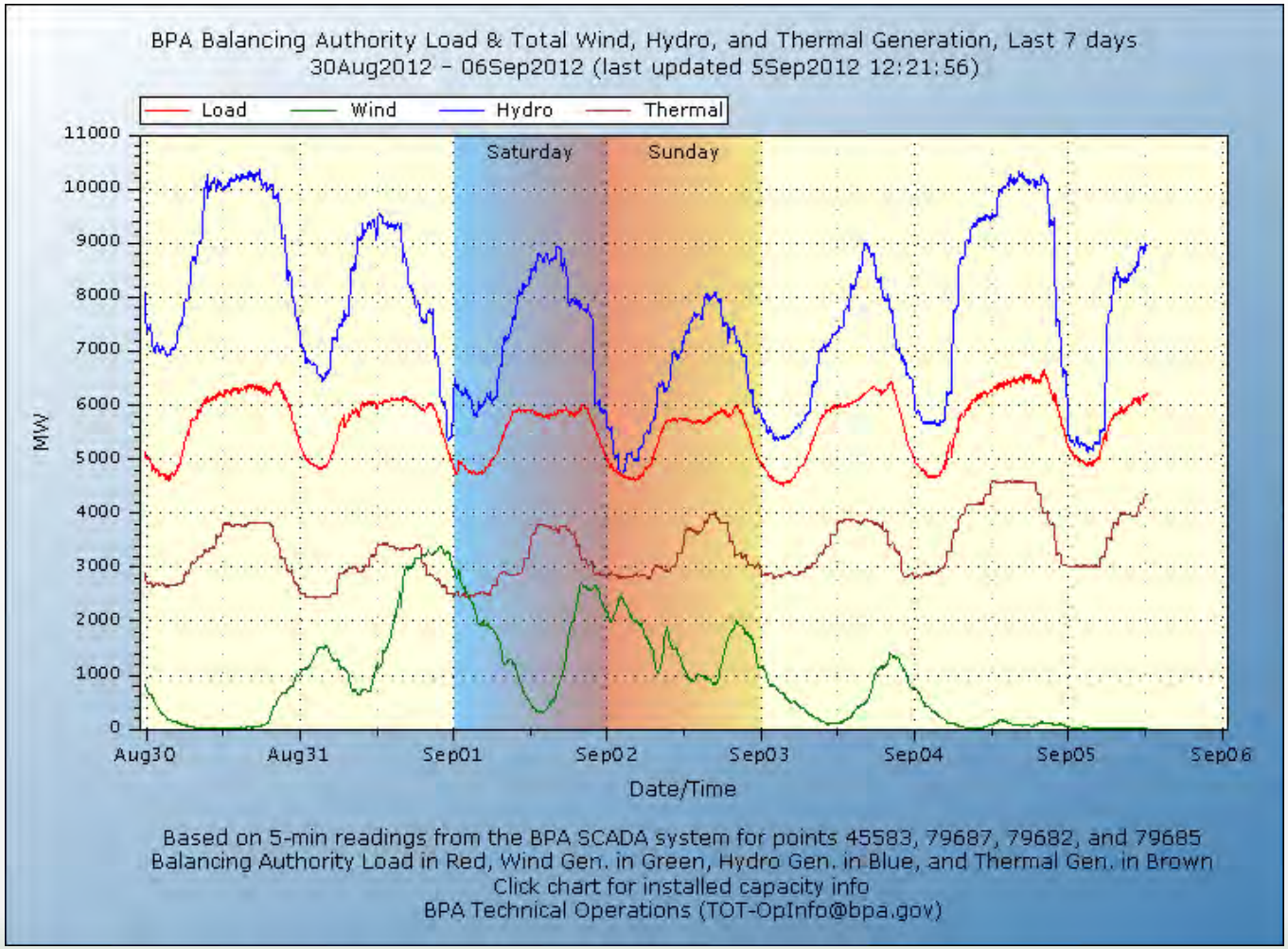
Wind Turbine Gen Curve



Typical wind turbine power output with steady wind speed.

Chart: BPA

Wind - Variability



BPA BAA WIND FLEET GENERATION

EXAMPLE OF GENERATION IMBALANCE AFFECTING HYDRAULIC OPERATIONS

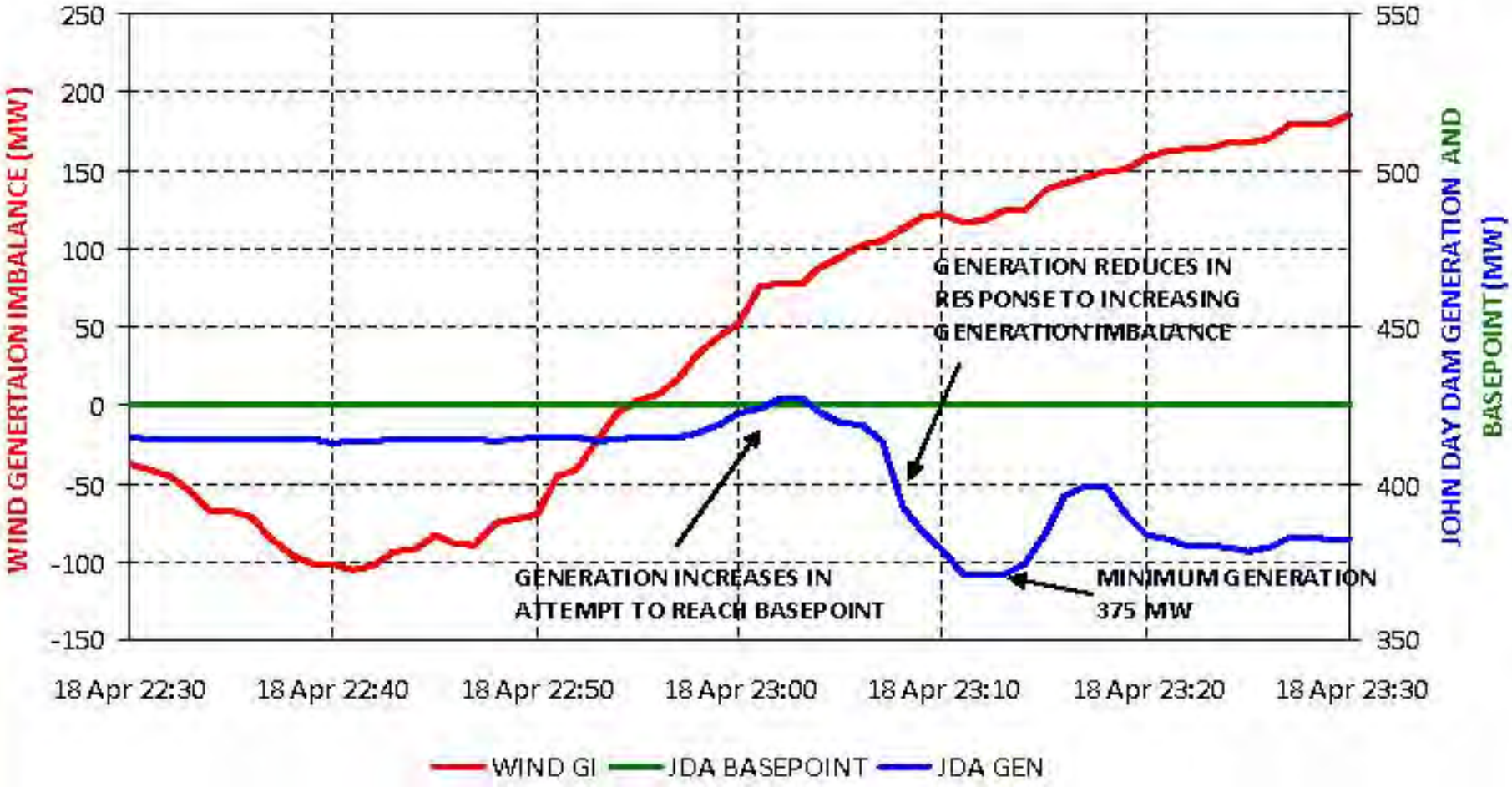
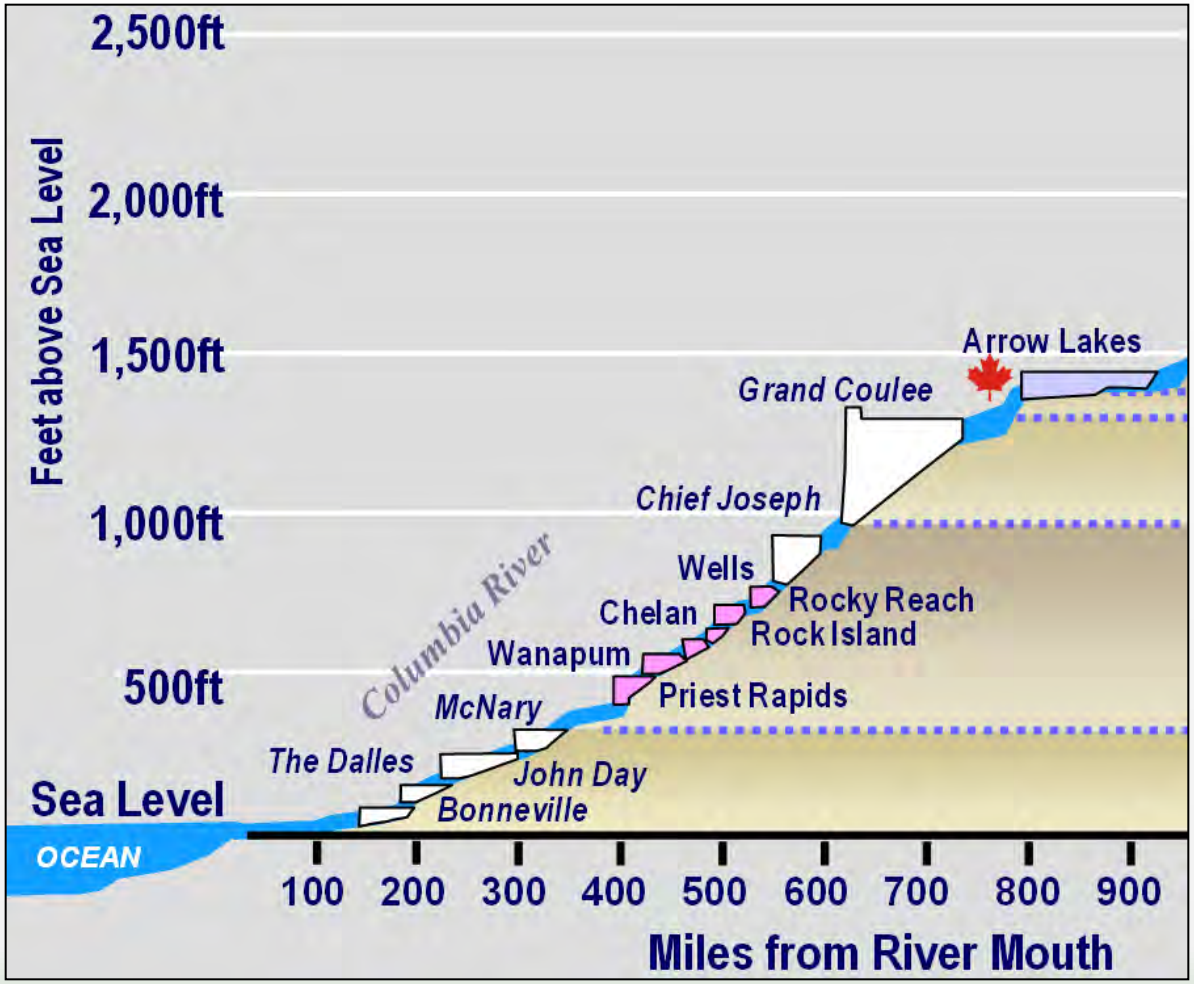


Chart: BPA

Hydro as Reserve



Extracted from larger graphic by Dennis Stocks, USACE

Some impacts of increased wind penetration

- Projects must operate to greater hourly minimum discharges
- Projects must operate to lower hourly capacities
- Projects “on response” will see larger fluctuations in actual generation
- Project may need to spill more to provide reserves
- Scheduling of out-of-service periods requires more coordination.

Spill at Chief Joseph

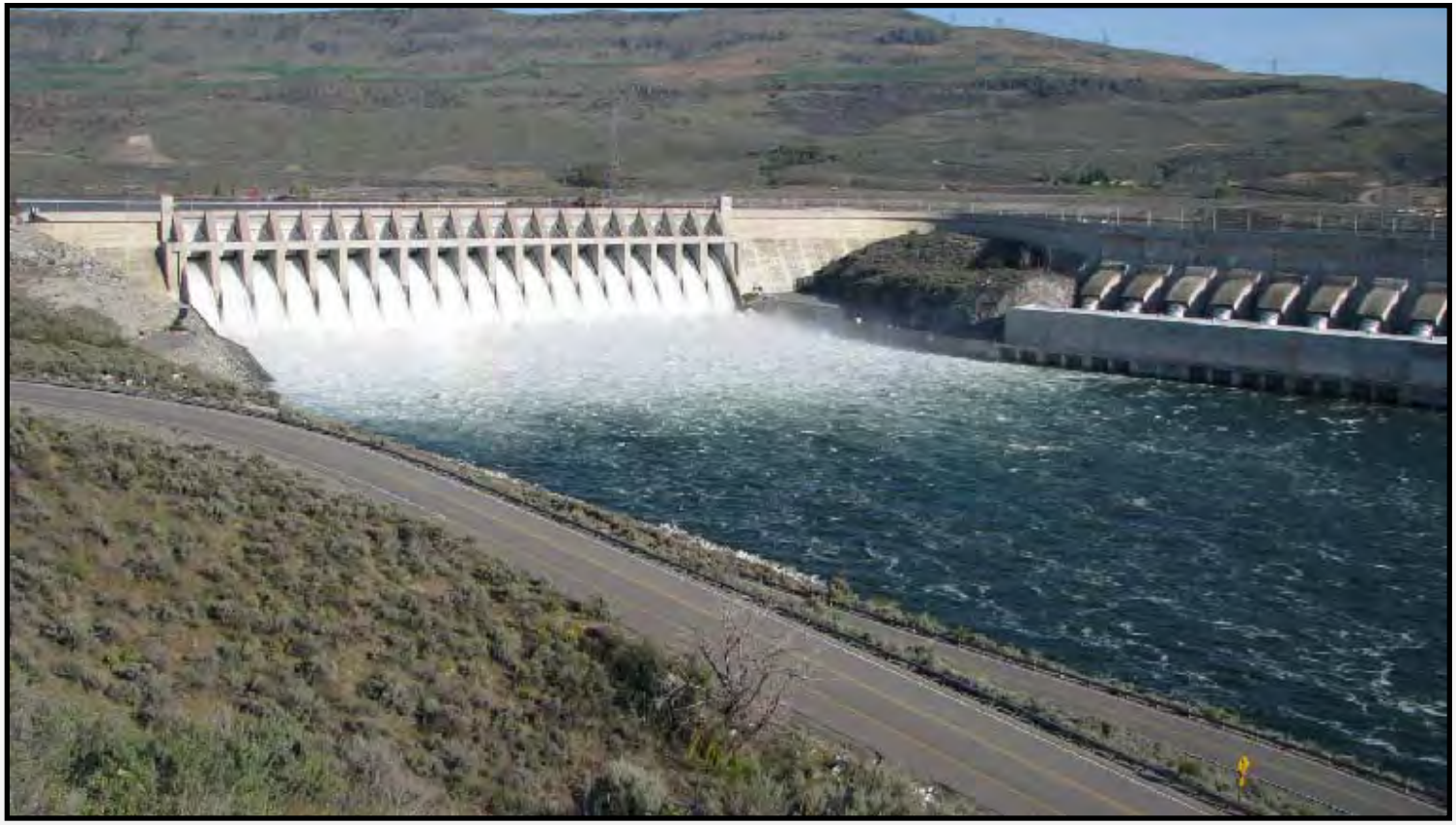
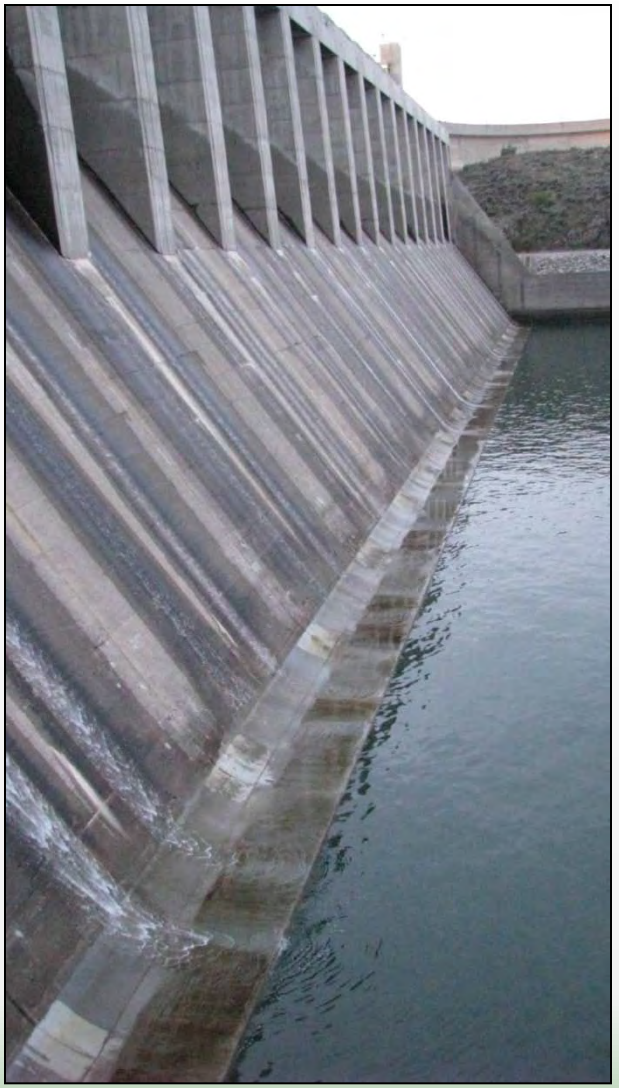


Image from USACE Image database

Gas Abatement: Flow Deflectors

- Since 1995, FCRPS Biological Opinions require gas abatement at GCL/CHJ
- Flow Deflectors and CJD were determined to be the most cost efficient means for gas abatement
- Project construction was completed in 2008



Flow Deflectors

Gas Abatement: Results

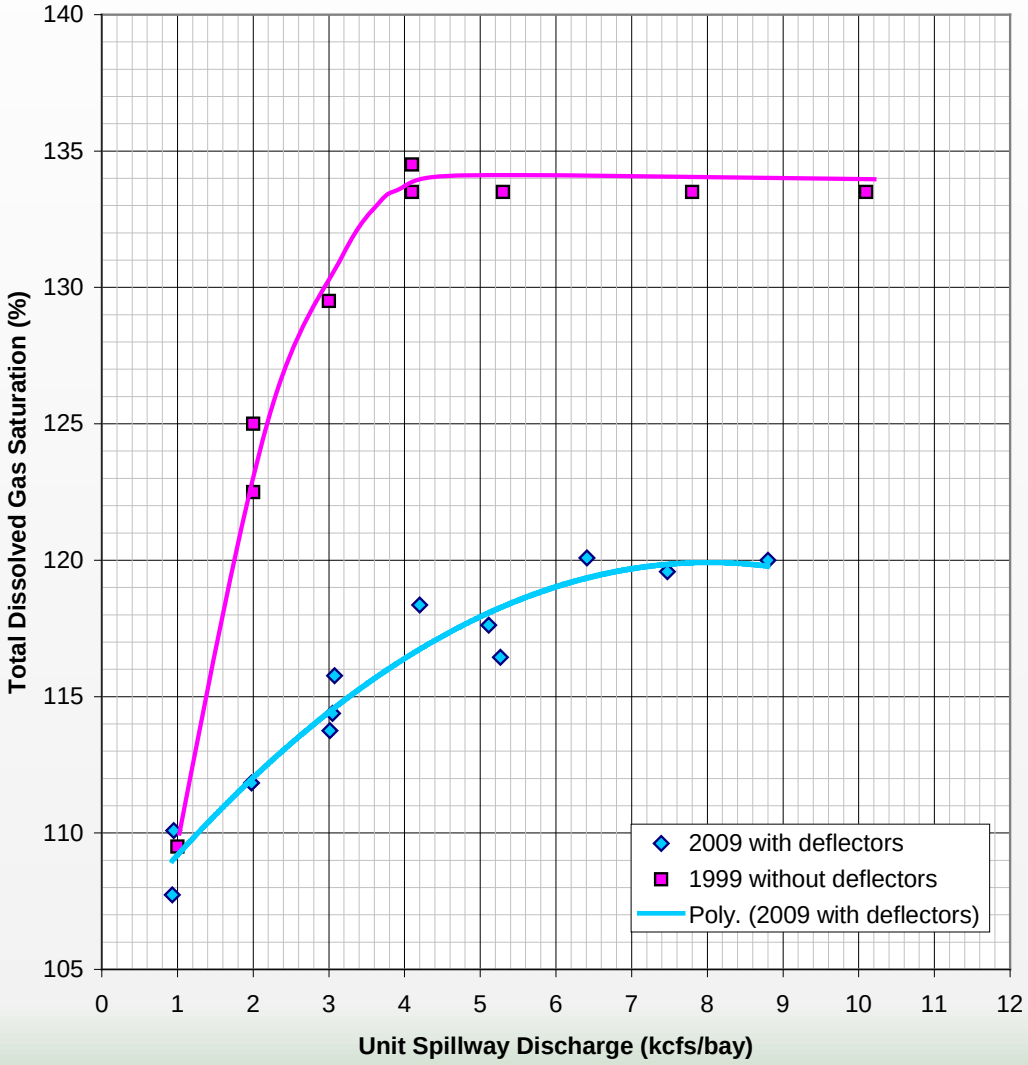
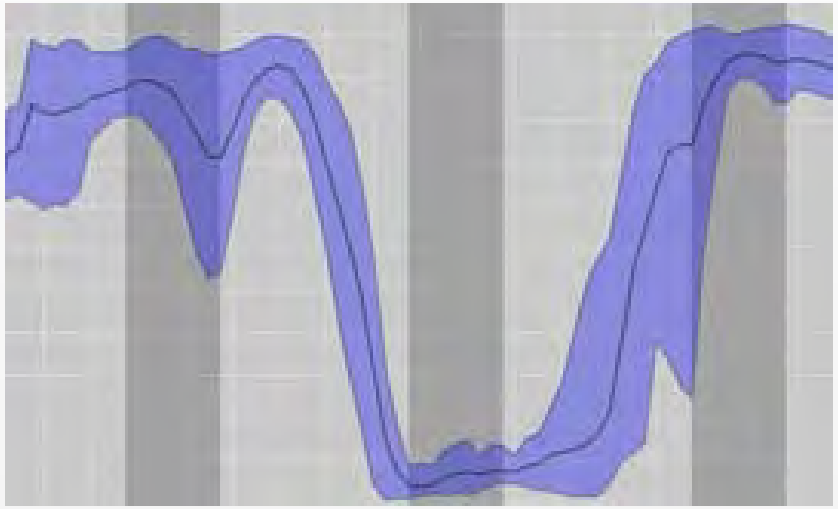


Image: Adam Price

Opportunities for innovation



- BPA

- http://iphone.pandaapp.com/news/03082012/235821774.shtml

Image: Adam Price

Huge Thanks to Steve Barton, BPA