New Optimization User Methods

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New: Power Surface Approximation

1. What is it?

2. How does it compare to the existing plant power method?

3. When should the new method be used?

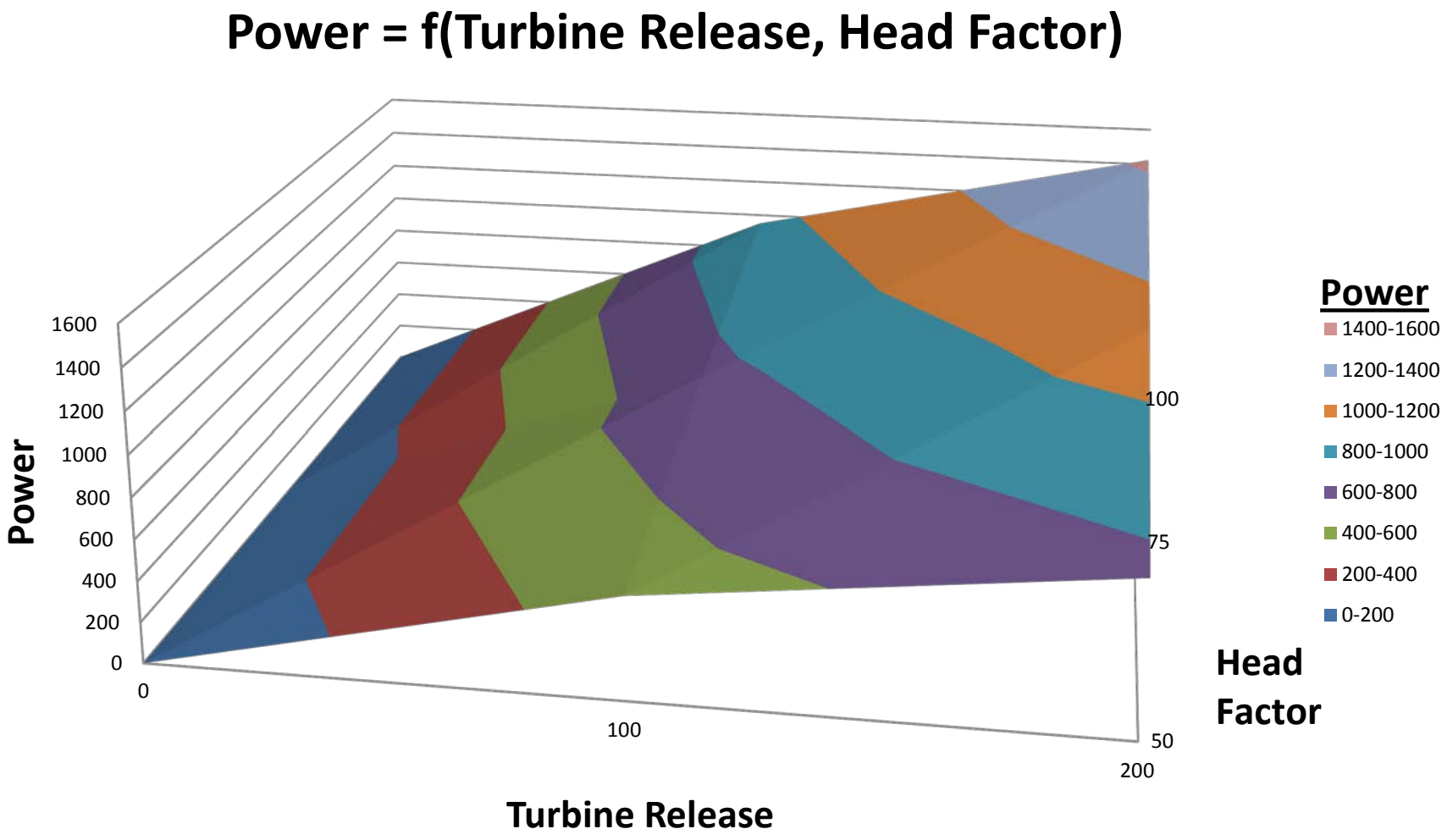
Power Surface Approximation Method

- What affects Power?
  - Turbine release, pool elevation, spill, and sometimes downstream pool elevation
  - Without approximation: turbine release, storage, spill, and sometimes downstream storage
- Head Factor – a variable that represents all of the variables that affect operating head, except turbine release
- Head Factor = a Storage + b Spill
  + (optionally) c Downstream Storage

Under the Hood

- How are the head factor coefficients calculated?
  - User specifies variable values
  - RiverWare evaluates power for combinations
  - RiverWare does several regressions
- How does RW generate the surface?
  - User specifies the resolution of the surface
    - Number of turbine release values and number of head factor values
  - RiverWare calculates power for these values
  - RiverWare adds planes (i.e. constraints) that define the surface

Power Surface Approximation



Existing Plant Power Method

- Power: function of Turbine Release & Head
- Operating Head estimated before optimization
- Approximation error corrected in post-optimization rules
- Good solution in many cases!

PSA Method vs. Plant Power Method

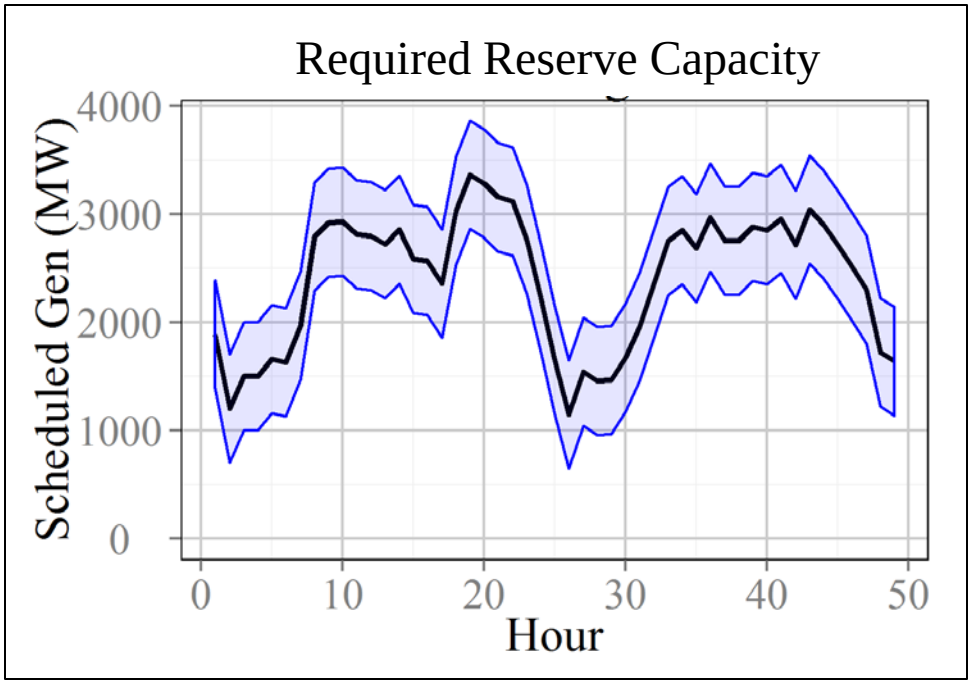
- Approximation error
  - Both methods have approximation error that can be fixed with post-optimization rules
  - PSA can reduce error when operating head fluctuations are due to pool elevation, spill and downstream elevations
  - Example - Grand Coulee: error reduced from ~15% to ~3%
- Optimizing Operating Head
  - Plant power method can only optimize with turbine capacity
  - PSA can optimize with all of the variables
- Model complexity and problem size
  - Can be substantially larger for PSA

When to convert to PSA?

- Large power errors during the run
- Large operating head fluctuations beyond those caused by turbine release
- The model is intended to manipulate operating head for power gains.
- The model doesn't have an incentive to under report power for a given turbine release
  - Examples – minimize power, power ≤ value
  - Not a show stopper, but please let us help you

New Optimization Reserves Method

- Upward and downward reserves – capacity (flexibility) to modify generation on a given time step
- Incorporates physical capacity and limits from policy constraints
- Only reserves that would not violate constraints get "counted"
- Allows for reserve requirements for individual reservoirs or as a system total



New Optimization Reserves Method

- Duplicate variables introduced – variable at full reserve deployment
- User writes "reserve versions" of constraints that cannot be violated when deploying reserves

$$Res.Pool\ Elevation\ [t] \geq Min\ Elevation$$

$$Res.Pool\ Elevation\ with\ Up\ Reserve\ [t] \geq Min\ Elevation$$

- User writes reserve requirements for individual reservoirs or groups of reservoirs

$$ResA.Down\ Reserve[t] \geq ResA\ Data.Min\ Down\ Reserve[t]$$

$$\sum_{all\ res} res.Down\ Reserve[t] \geq SystemData.Min\ Down\ Reserve[t]$$

New Optimization Reserves Method