Northwest **Power** and
**Conservation** Council



May 9, 2017

**MEMORANDUM**

**TO:** **Council Members**

**FROM:** **John Fazio, Senior Systems Analyst**

**SUBJECT:** **Standalone vs. Integrated Capacity Value for Resources**

## BACKGROUND:

Presenter: John Fazio

Summary: The Council will be briefed on how the inherent storage in the Pacific Northwest's hydropower system can add capacity value to renewable resources, energy efficiency measures and other resources.

Like a traditional battery, a hydropower system can save energy and generate it later. Unlike traditional batteries, however, there are many other constraints on the hydropower system that limit its ability to use its storage. Northwest dams not only provide power but must also be operated to provide flood control, water for irrigation, operations to enhance salmon survival, transportation, and recreation. These constraints limit the usability of hydropower storage differently by season, by month, by day and even by the hour of the day. Nonetheless, the hydropower system still has considerable storage potential that can be used in tandem with non-hydro resources to increase overall system peaking capacity.

Future work is required to further explore how to best integrate a constantly changing mix of resources with the existing hydropower system in order to maximize adequacy, efficiency, economy and reliability.

851 S.W. Sixth Avenue, Suite 1100
Portland, Oregon 97204-1348
www.nwcouncil.org

**Steve Crow**
Executive Director

503-222-5161
800-452-5161
Fax: 503-820-2370

Relevance: Understanding how non-hydro resources interact with the hydropower's storage system is key to ensuring that future Council resource strategies are efficient and economical. At the same time, knowing the interaction of renewable resources, energy efficiency measures and thermal resources with the hydropower system's operation is absolutely necessary to accurately assessing the adequacy of the region's power supply.

Background: The Council's Seventh Power Plan identified a need to assess the Associated System Capacity Contribution (ASCC) of all non-hydro resources, especially energy efficiency, wind and solar resources. The ASCC indicates the added capacity gained when a particular resource is operated in tandem with the hydropower system. Without the ASCC, the Council's Regional Portfolio Model cannot properly satisfy the adequacy reserve margin (derived from the Council's resource adequacy standard) and, therefore, would not produce resource strategies that ensure adequate supplies.

# Briefing on Standalone vs. Integrated Capacity Values

Council Meeting
May 16, 2017
Boise, Idaho
John Fazio, Senior Systems Analyst



# Standalone vs. Integrated

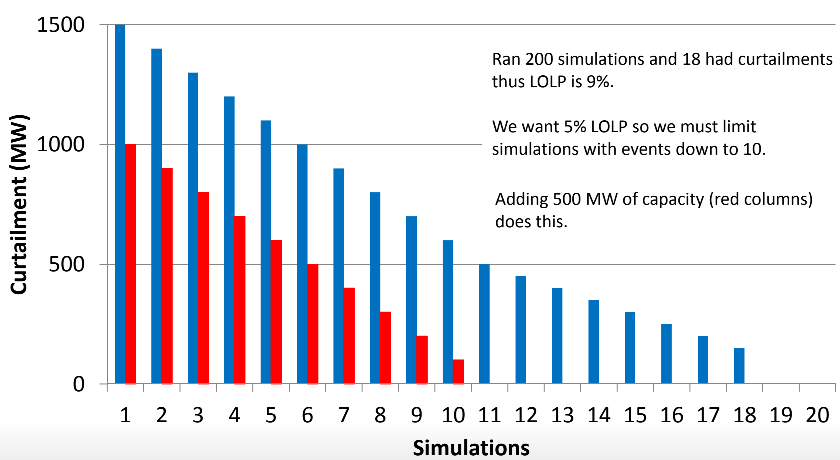
- Standalone capacity is the percentage of nameplate capacity that can be counted on to provide adequacy when a resource's generation is applied to the system with no interaction with the hydro system
- Integrated capacity is the percentage of nameplate capacity that can be counted on when allowed to interact with hydro storage

# Simple Approach

- Create a peak-hour curtailment probability curve (e.g. sort the peak-hour curtailment for each simulation from highest to lowest)
- Using that curve, estimate how much capacity is needed to lower the probability to a desired value



# Peak-Hour Curtailment per Simulation
(Sorted by Magnitude)

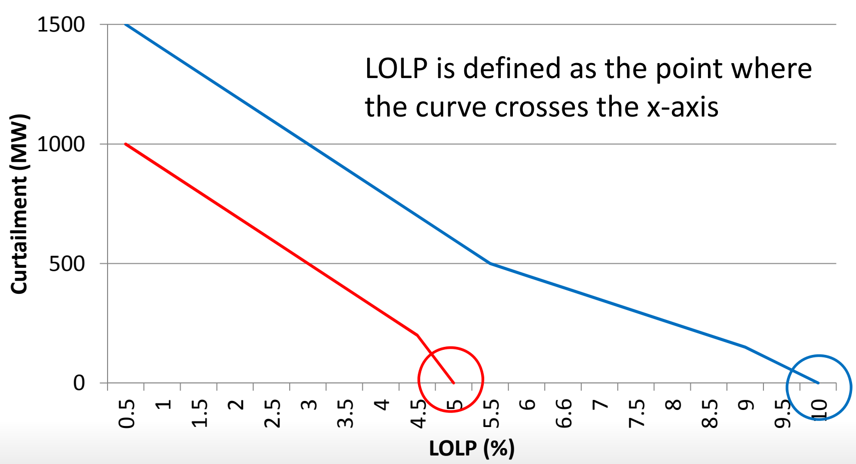


# Capacity Needed for 5% LOLP

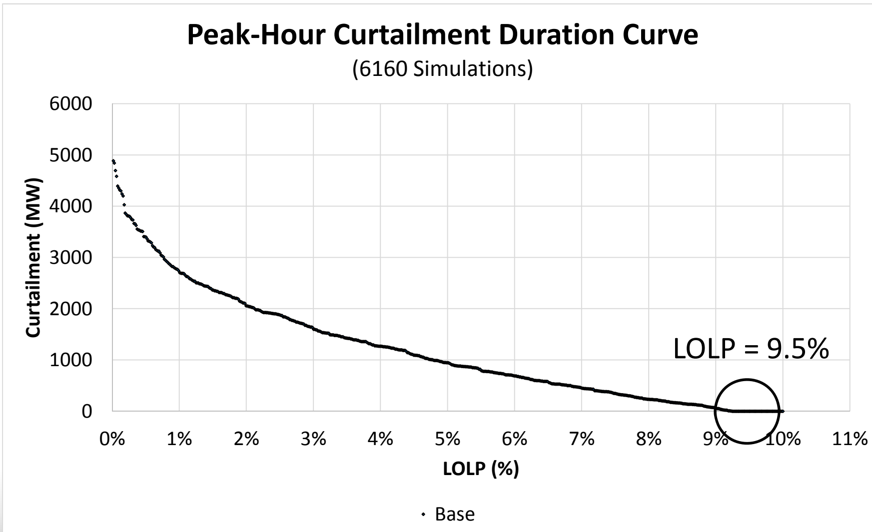
- **Blue Columns**
  - Total number of simulations = 200
  - Simulations with curtailment = 18
  - LOLP = 18/200 = 9%
- **Red Columns**
  - Added 500 MW of capacity
  - Simulations with curtailment = 10
  - LOLP = 10/200 = 5%



## Peak-Hour Curtailment Duration Curve (Same as before but LOLP on x-axis)



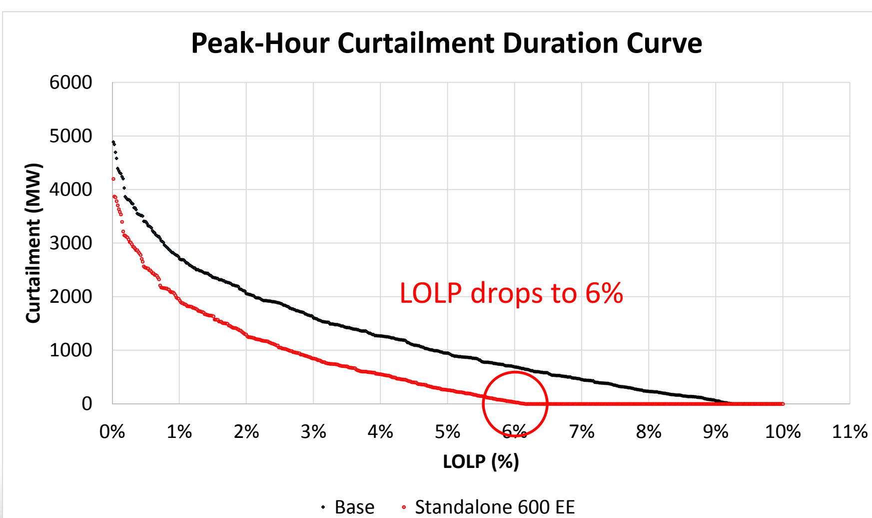
# Start with an Inadequate Base Case





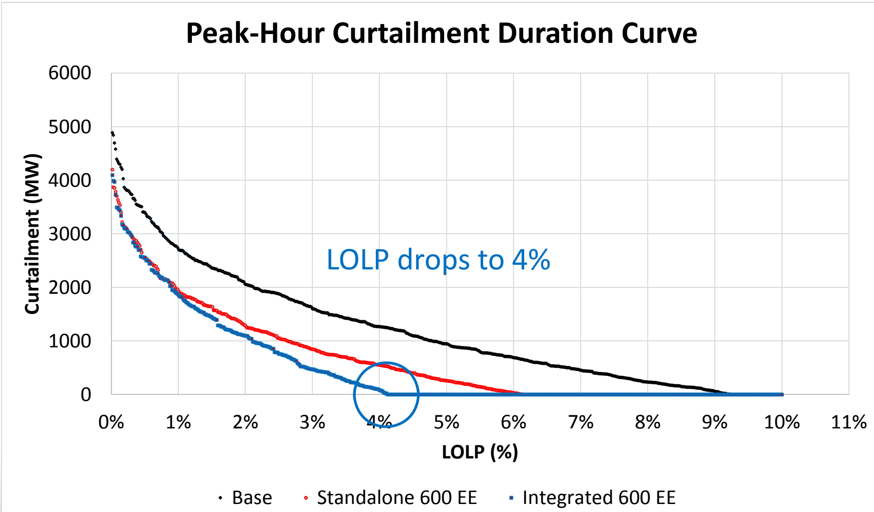

# Standalone 930 MW of EE

(no interaction with hydro system)



# Integrated 930 MW of EE

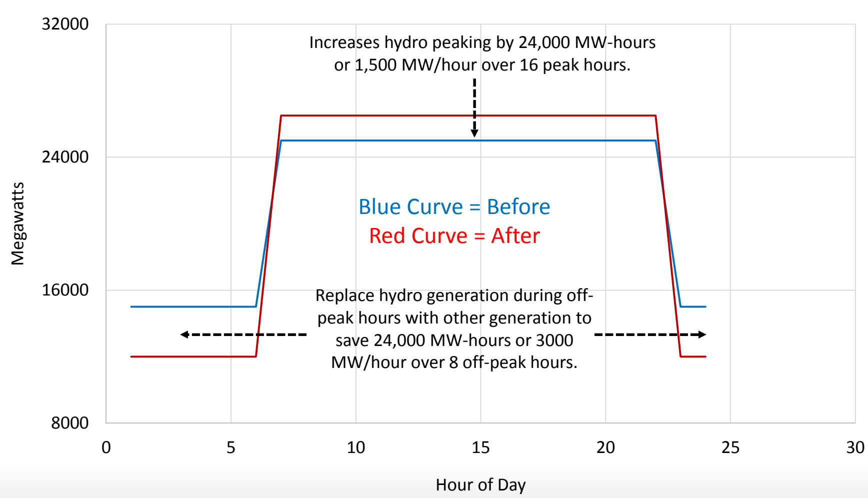
(uses hydro storage)






# Why Integrated Capacity is Higher

Using Hydro Storage to Increase Capacity



# Annual Capacity Estimate for EE
## (930MW[1] Energy Efficiency)

| | | | |
|---|---|---|---|
| Standalone EE Capacity Contribution | Reduction in MW need = | 713 | MW |
| | Added EE = | 930 | MW |
| | Standalone Capacity Value | 77% | |
| | | | |
| Integrated EE Capacity Contribution | Reduction in MW need = | 1184 | MW |
| | Added EE = | 930 | MW |
| | Integrated Capacity Value | 127% | |
| | | | |
| | Difference between integrated and standalone | 50% | |

[1]The 930 MW of EE capacity is the average of expected winter and expected summer peak-hour savings for 600 aMW of annual EE energy savings (winter peak factor is 1.9 and summer is 1.2).



# Annual Capacity Estimate for Wind
## (3,000 MW Gorge Wind)

| | | | |
|---|---|---|---|
| Standalone Wind Capacity Contribution | Reduction in MW need = | 90 | MW |
| | Added Wind = | 3000 | MW |
| | Standalone Capacity Value | 3.0% | |
| | | | |
| Integrated Wind Capacity Contribution | Reduction in MW need = | 286 | MW |
| | Added Wind = | 3000 | MW |
| | Integrated Capacity Value | 9.5% | |
| | | | |
| | Difference between integrated and standalone | 6.5% | |

## Annual Capacity Value for Solar
(3,000 MW Southern Idaho Solar)

| | | | |
|---|---|---|---|
| Standalone Solar Capacity Contribution | Reduction in MW need = | 109 | MW |
| | Added Solar = | 3000 | MW |
| | Standalone Capacity Value | 3.6% | |
| | | | |
| Integrated Solar Capacity Contribution | Reduction in MW need = | 1157 | MW |
| | Added Solar = | 3000 | MW |
| | Integrated Capacity Value | 38.6% | |
| | | | |
| | Difference between integrated and standalone | 35% | |



## More Precise Method

- Calculate LOLP explicitly, with and without new resource
- Calculate the net system capacity gain
- Integrated capacity value equals net system capacity gain divided by new resource nameplate capacity
- Capacity gain exceeding standalone CV must be attributed to hydro storage
- Can calculate quarterly values

# Integrated Capacity Values[1,2]

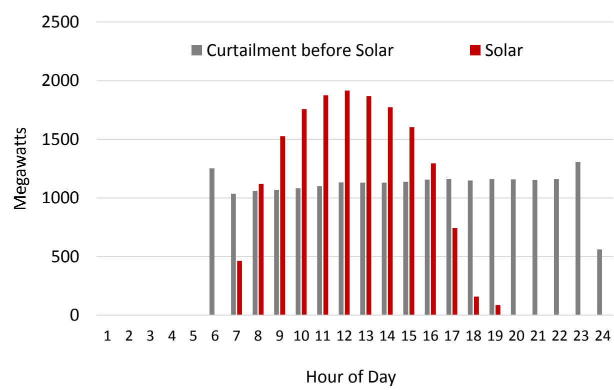
(AKA Associated System Capacity Contribution)

| Resource | Q1 | Q2 | Q3 | Q4 |
|---|---|---|---|---|
| Solar PV | 0.26 | 0.81 | 0.81 | 0.42 |
| Energy Efficiency | 1.24 | 1.01 | 1.14 | 1.16 |
| Wind | 0.03 | 0.11 | 0.11 | 0.08 |
| Gas-Fired Turbine | 1.28 | 1.00 | 1.02 | 1.20 |
| Geothermal | 1.28 | 1.00 | 1.02 | 1.20 |

[1]The net gain in peaking capability should be attributed to the hydro system.
[2]Incremental capacity gains diminish as more resource is added.

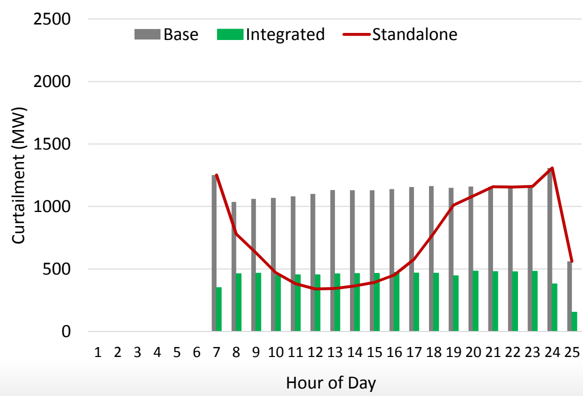


# Standalone vs. Integrated Capacity for Solar




- Some curtailments occur when solar is not generating
- As a standalone resource, surplus solar generation cannot be shifted into other hours

# Average Curtailment
## Standalone and Integrated Solar






# Integrated Solar affects both Hydro and Thermal Resources