



Mid Term Planning on the Federal Columbia Power System

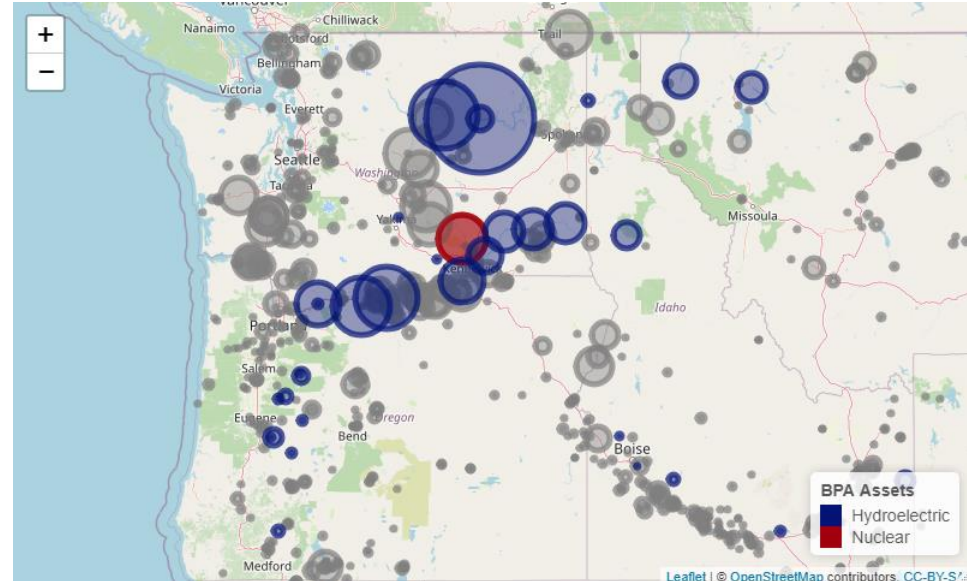
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BPA is a Federal Power Marketing Administration responsible for the disposition of the energy produced by the Federal Columbia River Power System (FCRPS).

- Legal mandate to sell power at cost to public customers
 - Surplus (Deficit) may be sold (purchased) on the Bulk Market
 - Market energy forward, day-ahead, and real-time
- BPA has been a RiverWare user for some time
 - Short-term group (up to 2-weeks)
 - Day-ahead trading
 - Mid-term group (2 weeks to 18 month)
 - Hourly component of operating year outlook
 - Forward trading

We use RiverWare to model our generating resources for purposes of estimating our marketing position



Hydrology

- Washington, Oregon, Idaho, parts of Montana and Canada
- Projects have about 25 MAF of combined storage, annual runoff is 104 MAF on average
- Columbia River Treaty with Canada governs operation of Canadian projects
- Updated streamflow forecasts every week
 - 38 ESP traces
 - Flood control elevations
 - Volume dependent targets
 - Meet once/week to discuss marketing and operational needs



Legacy system

- BPA has used Hydro Simulator (HYDSIM) for decades to simulate seasonal (i.e. operating year) output of the FCRPS.
- Highly iterative, manual (i.e. error-prone) process

WHILE NOT STUDY == DONE:

SL	1890	1991A	5825.1	5790.0	5825.1	5750.0	4562.3	4256.2	3524.9
SL	1890	1992A	5825.1	5825.1	5825.1	5750.0	4371.5	4048.3	3186.7
SL	1890	1993A	5295.9	5394.8	5076.4	4623.1	4859.8	4537.0	3799.2
SL	1890	1994A	4590.8	4724.5	4776.3	4775.1	4977.1	4649.5	3820.1



END WHILE

- Lots of Excel, can take up to 1 week to finish, making results stale by the time they're published

Project: Use RiverWare to create 'live' model, with results available as soon as (same day) forecasts become available

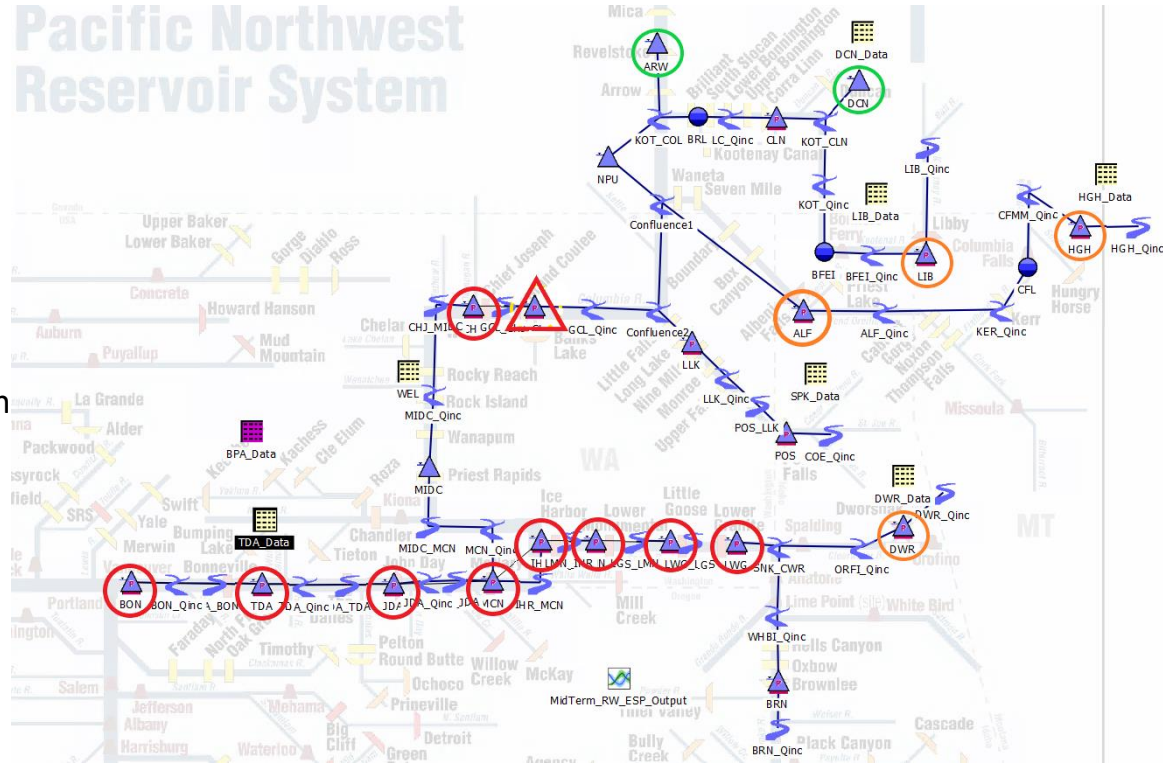
RiverWare model format

- **Daily model**
 - Monthly too coarse, given proliferation of day-specific targets and within-month variation of streamflows.
 - Hourly model (developed by CADSWES) already exists. Daily model will serve as upstream system.
- **Rule-based simulation**
 - Optimizer takes considerably more time to run
 - Despite what some imply, BPA has little to no flexibility with respect to the daily operations of the FCRPS
 - Flood control, fish, spill, refill
- **MRM**
 - 38 ESP traces for within-year work.
 - 30 traces for long-term work
 - 80/90 traces for climate change analysis
 - Single trace worth anything more than two weeks out?
- **Developed in-house**
 - Success will require that BPA analysts be fluent in RPL and the model structure
 - Short turn-around for new operations, deviations, etc.
- **Direct-to-api/python input, direct-to-SQL output**

Project types

- **Headwater**
 - Prescribed seasonal operations
 - Complicated, but scripted
 - Federal, BPA does not dispatch
- **Canadian**
 - Subject to Columbia River Treaty
 - Non-Federal, BPA does not dispatch
- **Big 10**
 - Constitute 96% of generation
 - Federal, BPA dispatches
 - May hold reserves
 - Only GCL (▲) is not run-of river for planning purposes
- All others are non-Federal

Pacific Northwest Reservoir System



RiverWare visualization with Shiny

- What is Shiny?
 - Shiny is a javascript abstraction layer implemented in R
 - Allows access to a rich set of api's for visualization/interaction with data managed in R

Technology choice

- Python
 - Fast, stable, general purpose interpreted language
 - Excel tends to be fragile for data management purposes
 - Can process data and invoke RCL within same environment
- SQL
 - Standard, scalable, widely supported
 - Integrates seamlessly with downstream users