

Optimizing BC Hydro Generation Assets Using an Iterative Approach Based on System Marginal Prices

Tim Blair System Optimization, BC Hydro





Iterative Optimization Using System Marginal Prices

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# **BC Hydro**

- Government Owned
- Generation, Transmission and Distribution (only in BC)
- 4,000,000 Customers
- 2 Multi-Year Reservoirs
- 31 Hydro Plants
  - Snowmelt Dominated
  - 11,000 MW
- 3 Thermal Plants (1000 MW)
  + Provincial Carbon Tax
- >6000 employees

(~100 making operational decisions)





## **System Optimization: Mission**

Optimize the generation system, for operations, while accounting for uncertainty.





## **Modelling Balance Act**





# **BC Hydro System**





# **Constraints within the System**

- Fixed/Physical Constraints
- Asymmetrical Constraints
  - Flood control limits
- Probabilistic Constraints
  - Recreation and wildlife targets
- Persistent Probabilistic Constraints

Have a probably of occurring, but once they start they exist over multiple modelling stages

- River Level for Fish
- State-based Constraints
  - International Water Treaties
- Organizational Constraints
  - Separation of operations and marketing



## **Curses of System Modelling**

### **Curses of Stochastic Optimization At the utility scale**

- Curse of Dimensionality
- Stochastic models are tough
  - To build
  - To maintain
  - To transfer b/w generations
- Every sub-system is different and changing



# Modelling Details:

- Various Optimization Methods
  - SDP
  - LP
  - SLP
  - Sampling SDP (testing)
  - SDDP & RL (development)
  - Daily or Monthly Time Steps
  - State variables (with probabilities)
  - Weather ensembles (equal probability)



Use price signals to implement the optimal solution

• Enables real time optimal operation within open markets

**Buy/Sell Price** 

• Price to optimize market transactions.

**Reservoir Marginal Price** 

• Price (\$/MWh) of the next unit of generation at a given reservoir.

System Marginal Price

• Marginal Price of the of the marginal resource in the system



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### How can we optimize an entire system if every resource if optimized differently?

• System Marginal Prices











# **Optimize the System - Iteratively**





# **Updating Marginal Prices**

- Once you use the marginal resource,
  - The marginal price for that resource changes, and
  - It may no longer be the marginal resource.
  - -> Need to update all prices
- Frequency of updates based on the
  - Flexibility of the reservoir operations
    - Does it operate within tight elevation bounds?
  - Responsiveness of the reservoir level to changing operation
    - Does it fill quickly when the generation is backed off?
  - Routing time lag of your system
    - Does it take hours or weeks for water to move through the system?
- At BCH we update MPs weekly or monthly depending on the resource and season



#### **Kinbasket Price Elevation Curves**



### **Questions?**



