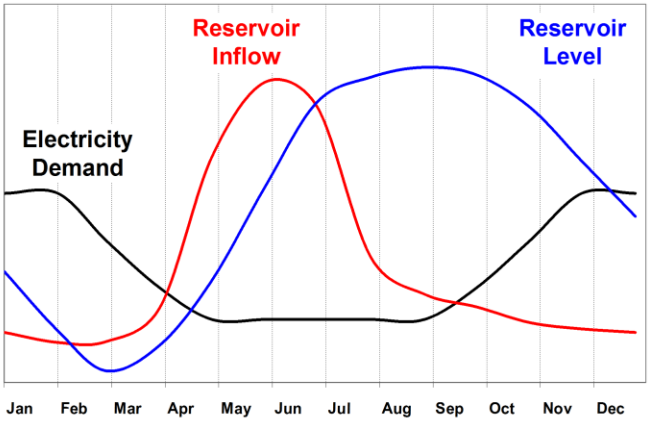
Columbia Operations Overview

Columbia Basin Advisory Committee

BC hydro
FOR GENERATIONS

Jim Gaspard
Generation Resource Management
12 March 2015

The Role of Reservoir Storage



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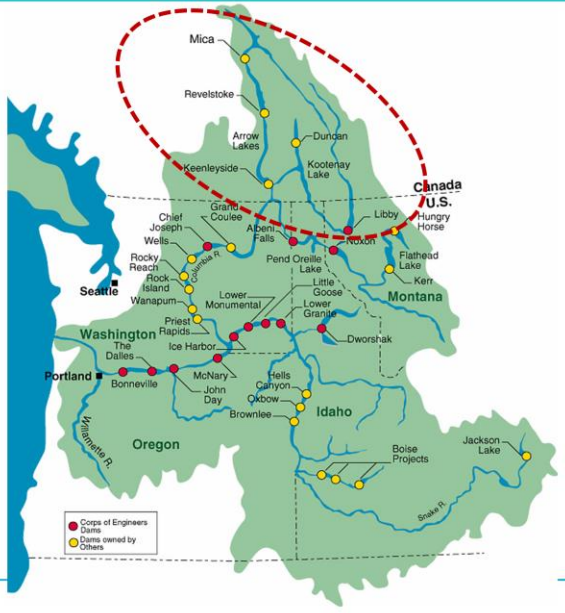
Step through animation.

Columbia Basin



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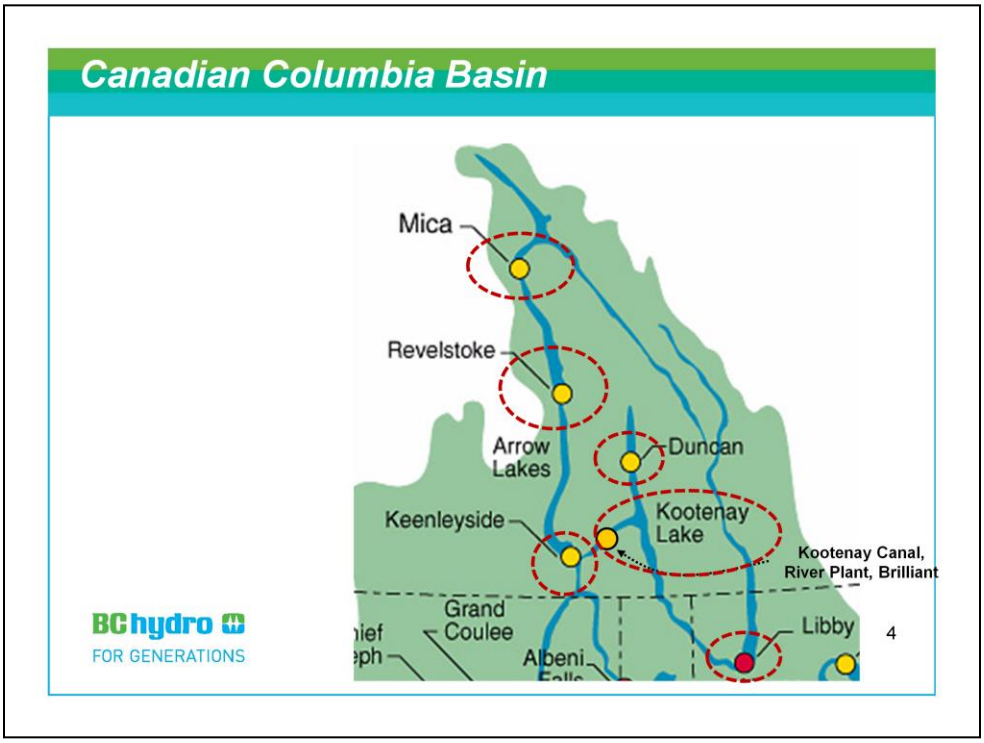
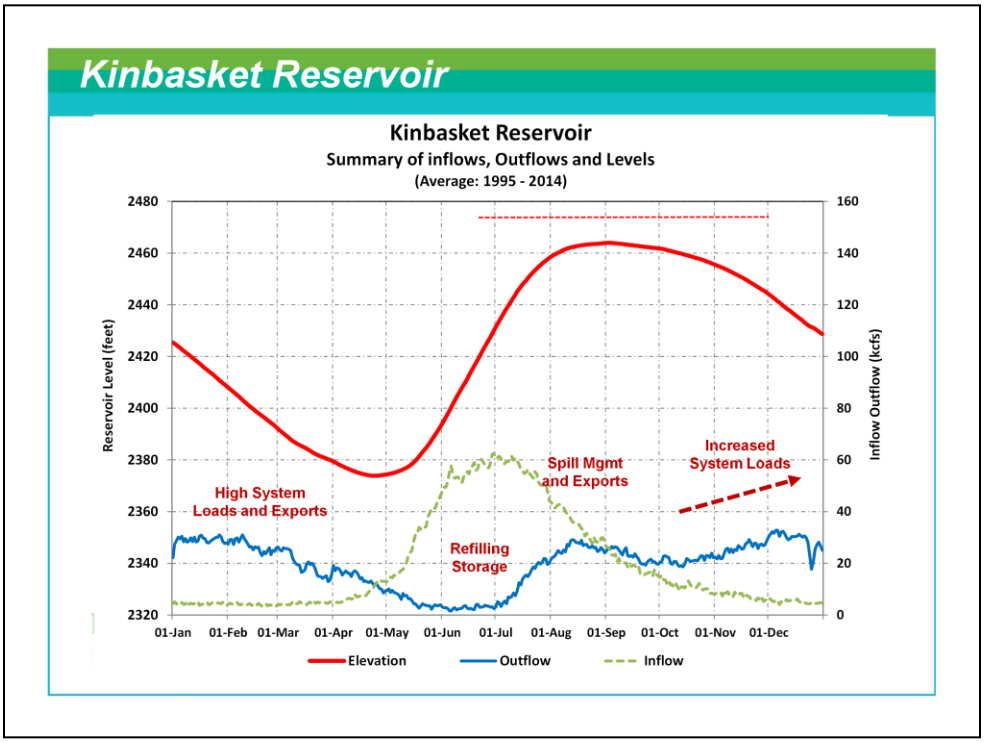


MCA/Duncan/Keenleyside: Controlled by Treaty for Keenleyside and Duncan. Keenleyside flows also adjusted with NTSA/STLA. MCA operated to serve load, but is constrained by Treaty requirements.

Revelstoke: Effectively passes the inflow from MCA + local inflow between MCA and Revelstoke.

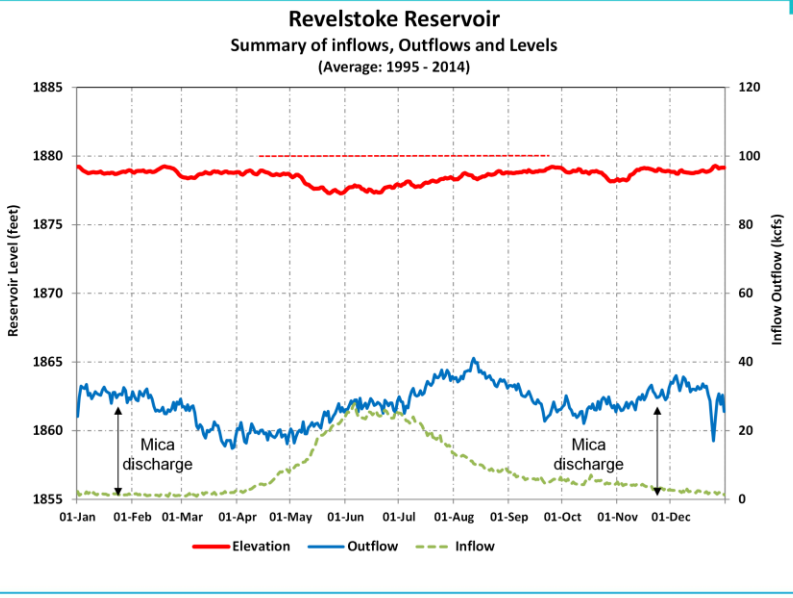
Kootenay Lake: Lake controlled by IJC Order that places threshold on reservoirs level, and rules for releases from the lake.

Libby: Controlled by the COE with FC and fish as primary objectives.



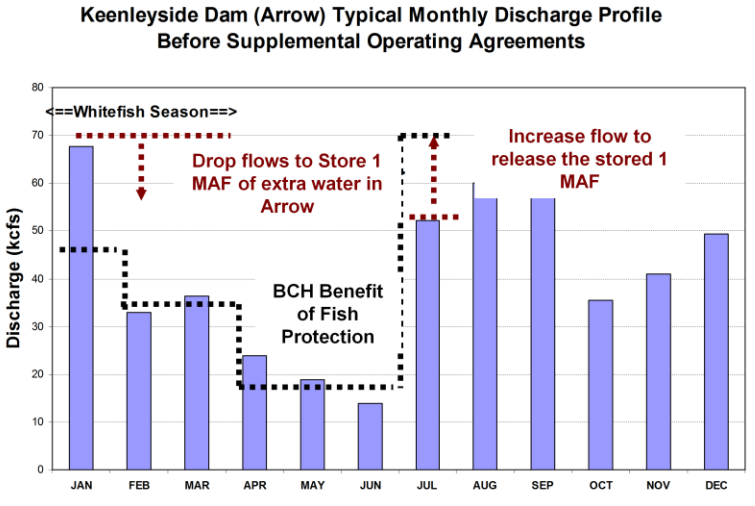
- Typical storage Profile with draft across fall/winter and refill in the freshet.
- Note wider profile on inflows into Kinbasket, due to portion of basin being very high.
- Gen in summer for export to California, and avoiding spill at Kinbasket
- Gen in winter to serve load.
- MCA typically shut down from second half of May through early July, to refill Kinbasket

Revelstoke Reservoir

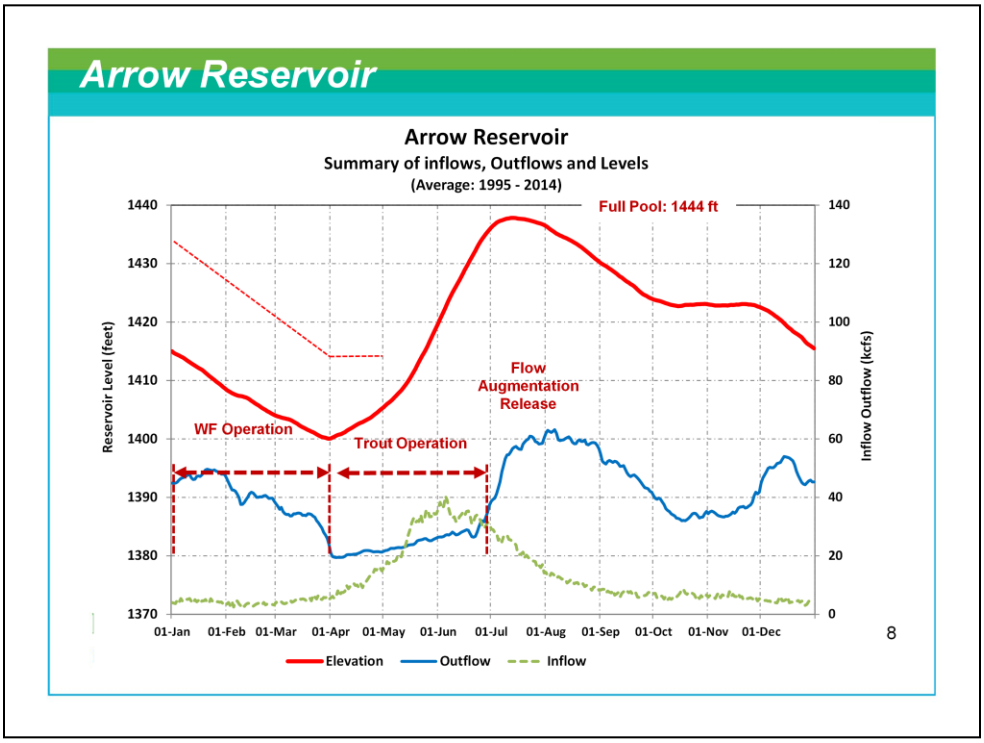


- Inflow shown is “local”. Substantially greater outflow across the year is the additional water from MCA
- Typical storage Profile with draft across fall/winter and refill in the freshet.
- REV reservoir typically held high for economic reasons.
- Dip in freshet due to cycling of the reservoir, to process high local inflow
- Gen in summer for export to California, and avoiding spill at Kinbasket
- Gen in winter to serve load.
- With MCA shut down, outflows in the freshet are typically the same as inflows.

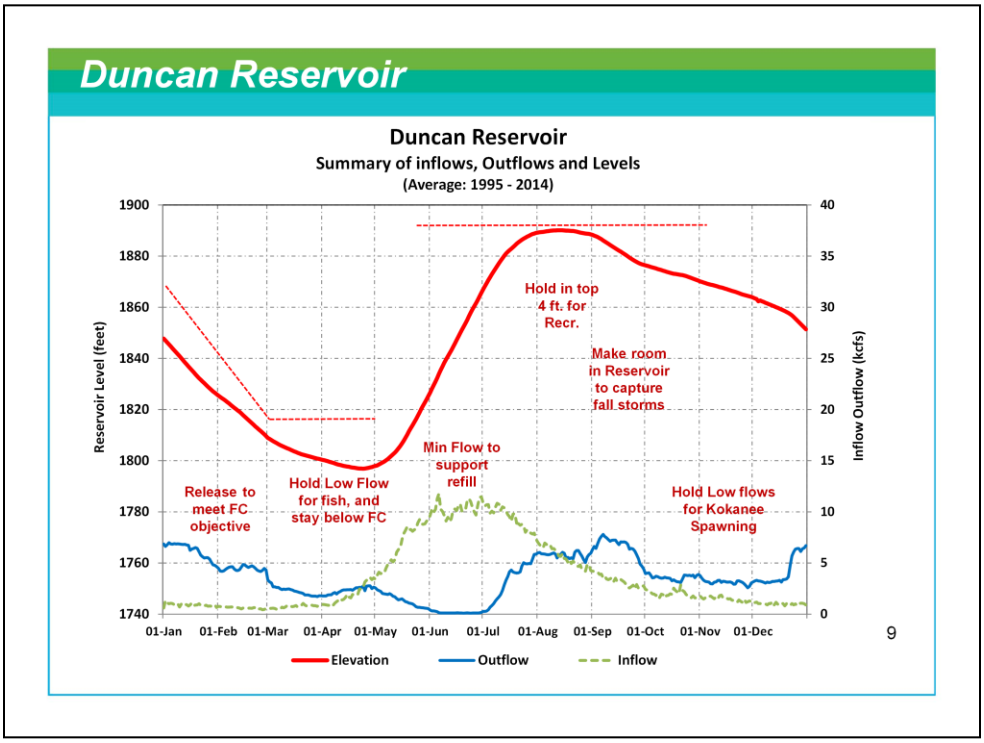
Arrow Fisheries Operation



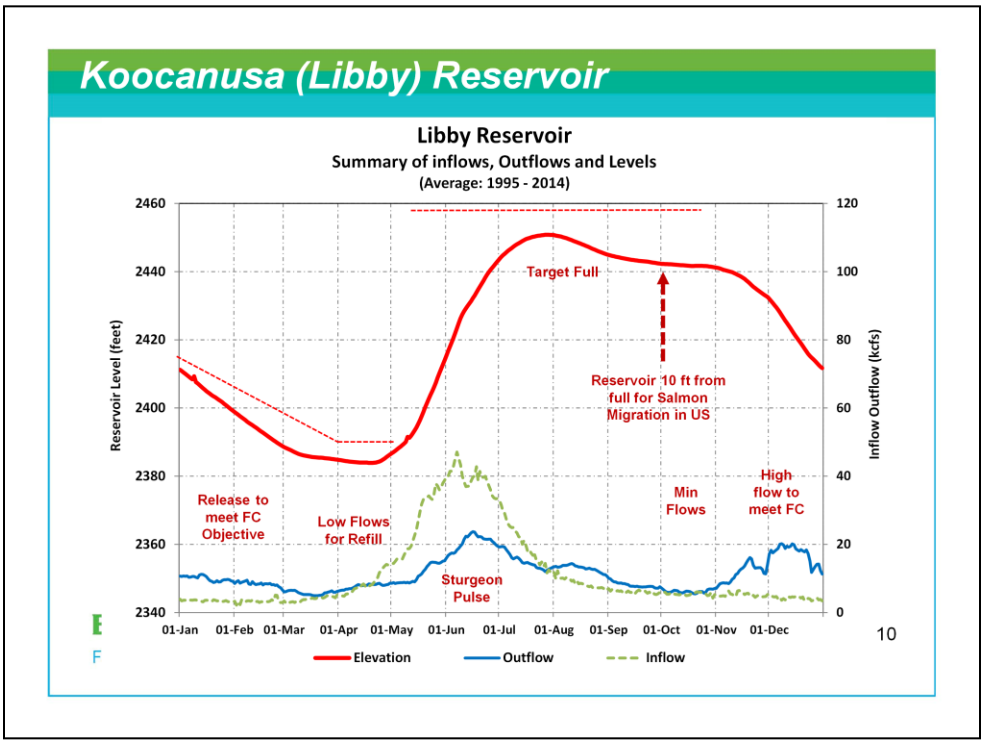
May not be a useful graph, but good at describing the operations at Arrow to support fish



- Typical storage Profile with draft across fall/winter and refill in the freshet.
- Outflows driven by:
  - Columbia River Treaty, which is very prescriptive
  - NTSA/STLA that effectively adjusts the flow at Arrow
- January – March Flows: Set flows based on Treaty, but adjust with Non-Power Uses Agreement.
  - Jan flows are lower than Treaty
  - Feb-Mar are typically the treaty flow, however some movement of release from Feb to Mar to smooth flows
  - April flows typically set at about 20 kcfs for rainbow trout, and river will only be allowed to increase in level



- Typical storage Profile with draft across fall/winter and refill in the freshet.
- Outflows driven by:
  - Columbia River Treaty, which is very prescriptive (with little modifications)
  - Possible to trade release at DCN for release at Arrow.
- Aug: top 4 ft for recreation
- Sep: Make extra space to support lower fish flows in Oct-Dec
- Oct-Dec: lower flows to support fish
- Dec-Mar: hold flows to stay below FC.
- Mar-May: challenge holding minimum flows for fish, and meeting Flood Control Elevation. BCH successfully fought with US to have the FC curve raised by 5 ft at end of Feb to support fish releases.

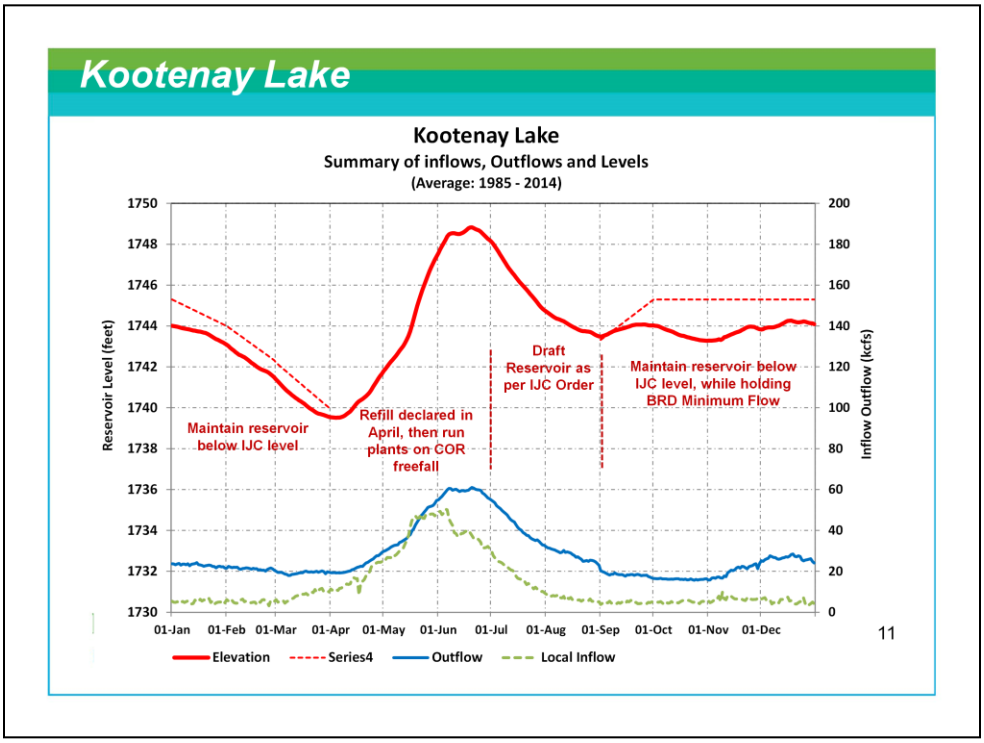


Significant changes in Libby operation since it was developed. Libby is managed for flood control and fish (salmon in the lower Columbia and white sturgeon and bull trout in the Kootenay River. (VARQ??)

Libby does provide significqnt flood protection for canada.

- End of Sep: Reservoir to be 10 ft from full (used to be 20 ft, but recreation and reservoir fish were impacted). Can be more than 10 ft in dry years.
- Oct – Nov: on minimum flow
- Dec: release as much as possible to meet FC curve
- Late May/Early June: flow pulse for strugeon, which causes additional impact on

- Impact to this operation is additional spill on the Kootenay River, and Power losses to the province. STLA is currently being used to mitigate the losses.



- Freshet Onset (Apr) to Mid-July, run at freefall at Groman Narrows
- Mid-July/Aug: Drafting as per IJC curve. With target of 1743.32 ft by Sep 1
- Sep – Dec: Rule curve shifts up by 2 ft, and operate below this curve.
- Jan to Freshet Onset: Typically drafting, until spring rise declared.

Operations Forecast

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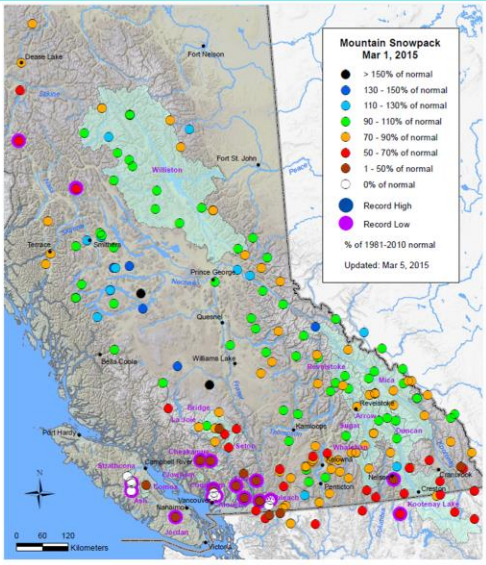
Snowpack



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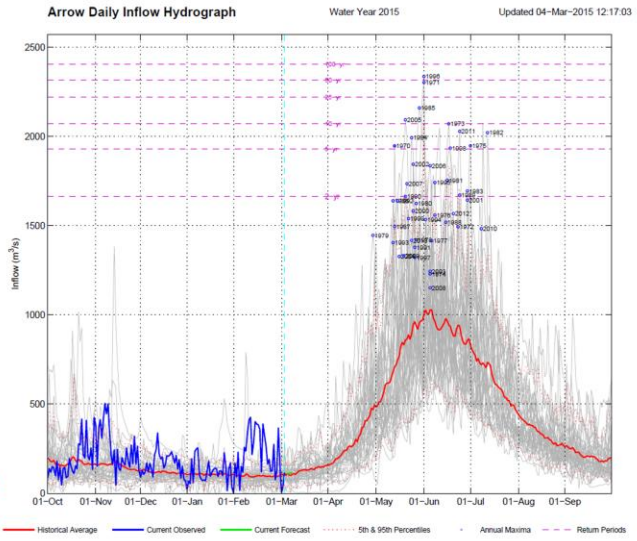
Generally average snowpack across all basins with the exception of the Nechako

Arrow Reservoir Inflow



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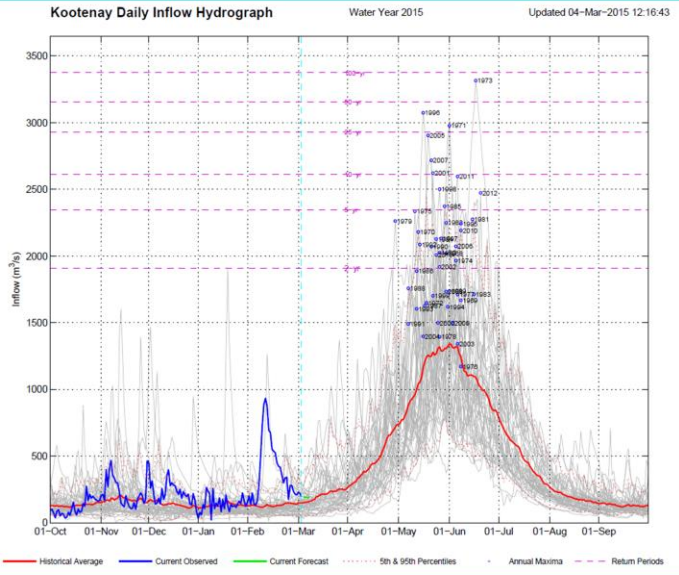
Inflows into our large basins as a result of the mild temperatures has been substantially higher than normal

This higher than normal inflow into Arrow does not have a lot of impact on Arrow elevations, as additional water will be passed through by the Treaty rules.

Kootenay Lake Inflow



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System Inflow Forecast

- BC Hydro Inflow Forecast (Feb – Sep)
  - Kinbasket Reservoir: 95%
  - Arrow Reservoir; 96%
  - Duncan Reservoir: 99%
  - Kootenay Lake: 97% (90% residual)
  - *Libby Reservoir (Apr-Aug): 80%*

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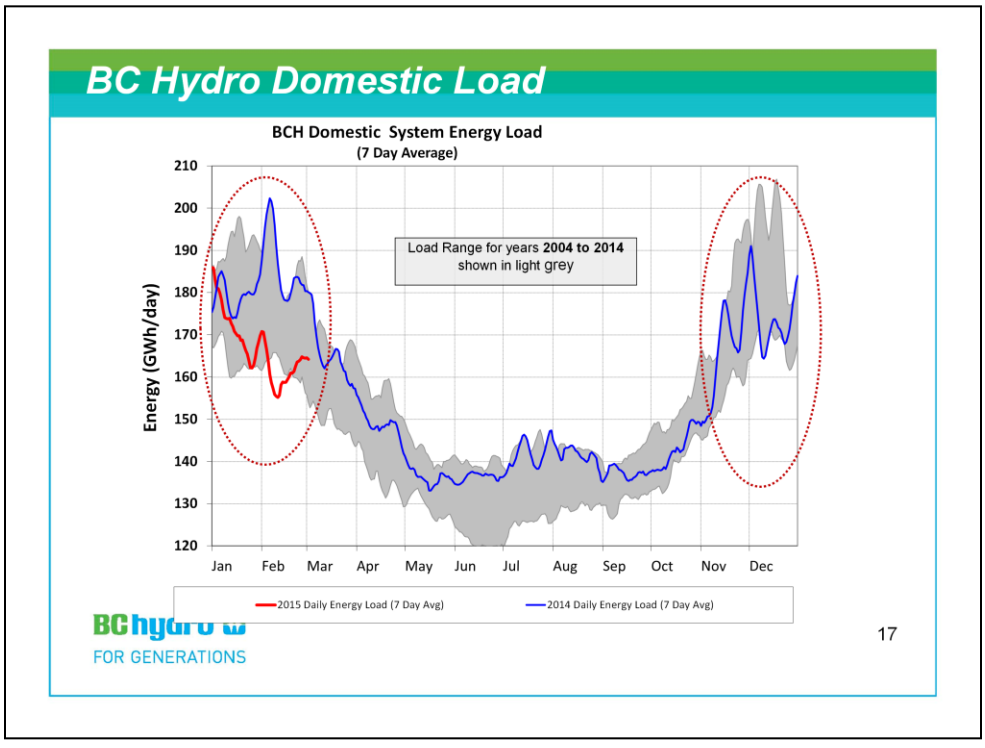
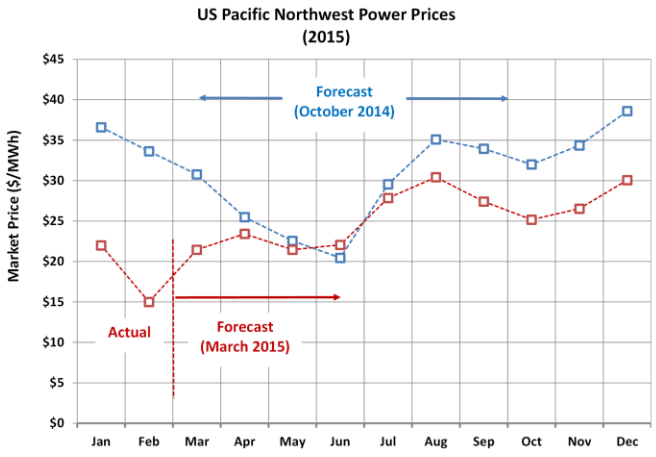


The exceptionally mild weather, particularly in the lower mainland has resulted in substantially lower inflow

US Pacific Northwest Market Prices



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Summary of Operational Drivers

- Snowpack:
  - Canadian Columbia: Average
  - US (TDA): 80% (Low)
- System Loads:
  - Exceptionally mild winter, resulting in extremely low winter loads.
- System Generation:
  - SEV/KCL running far higher than average across winter.
- Power Markets:
  - Exceptionally Weak, resulting in limited winter exports from system.

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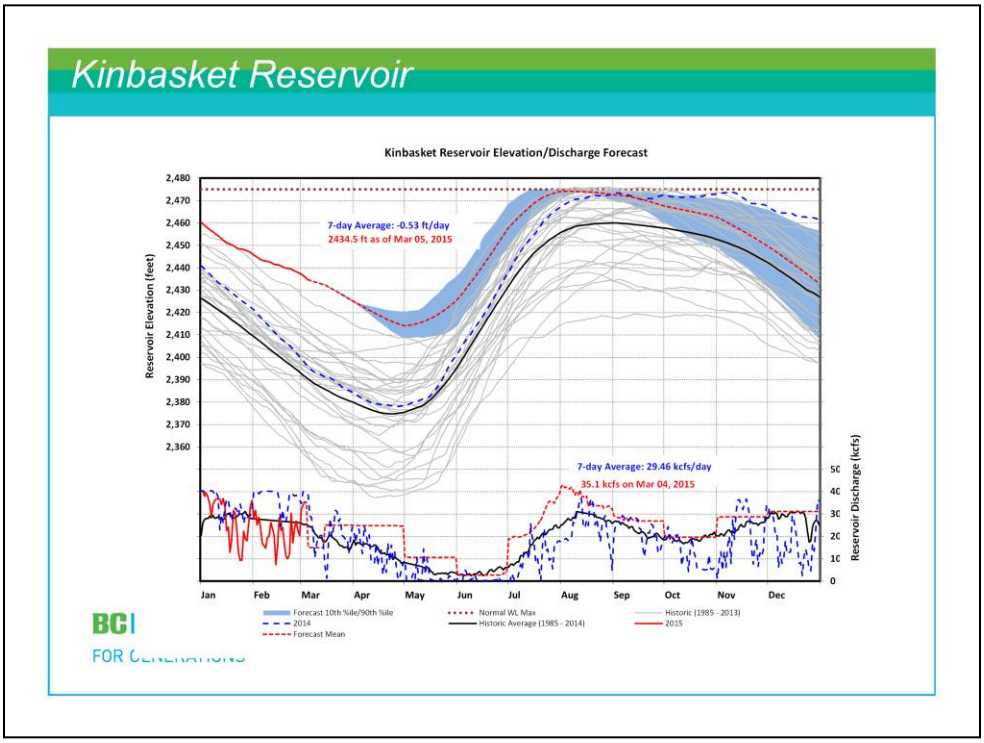
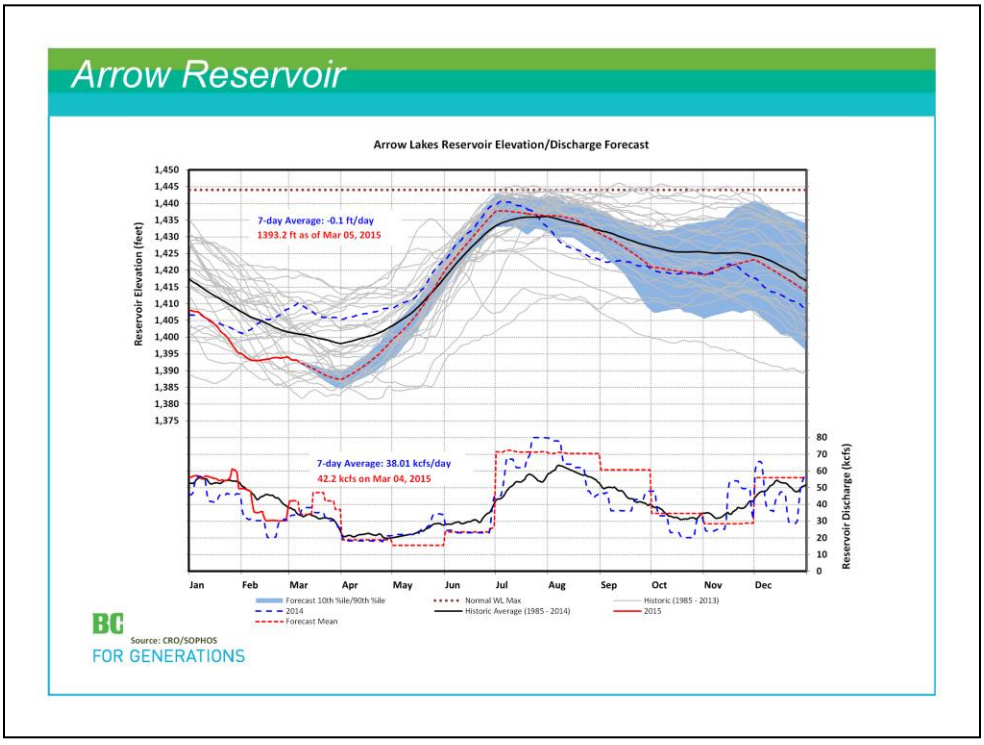
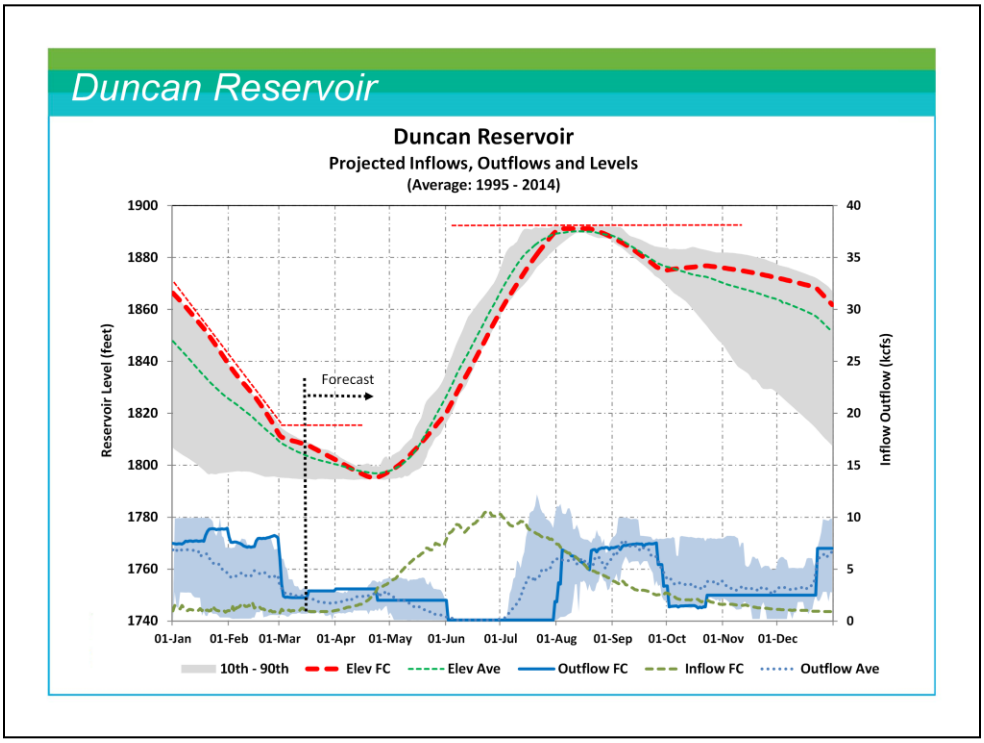


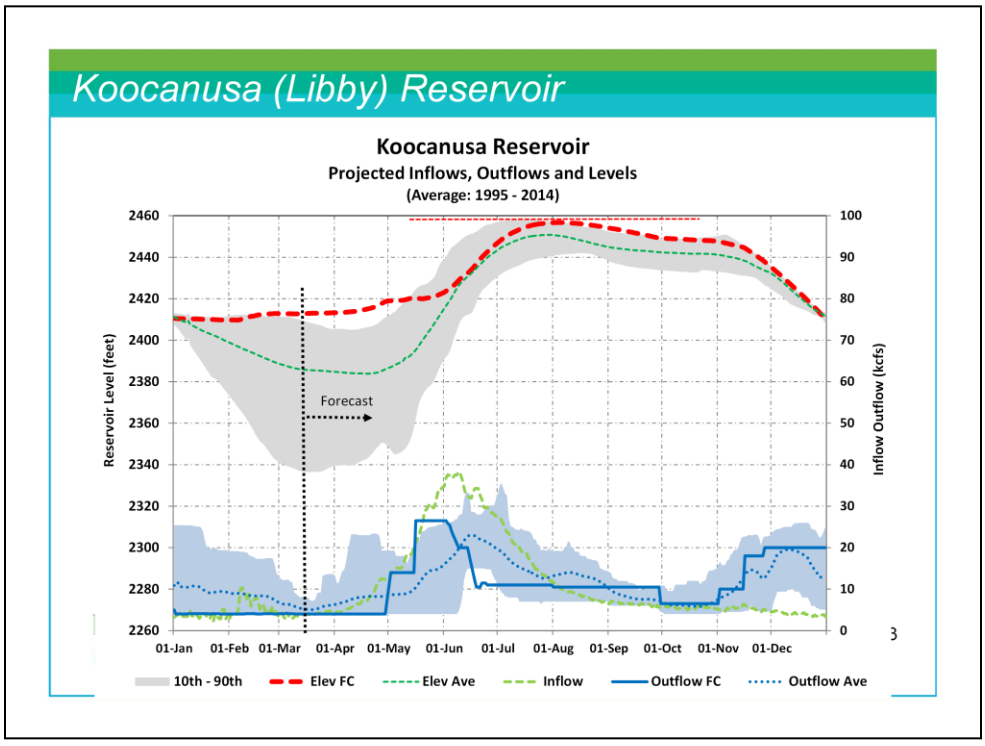
Exceptionally high Kinbasket Levels



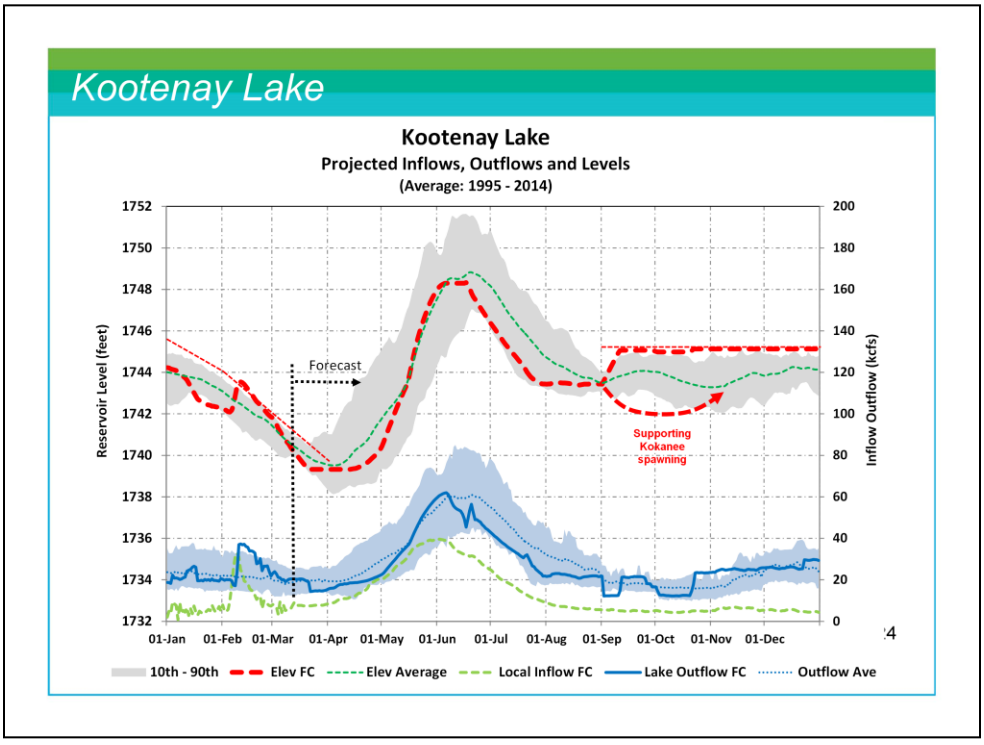
Very Low Arrow levels.



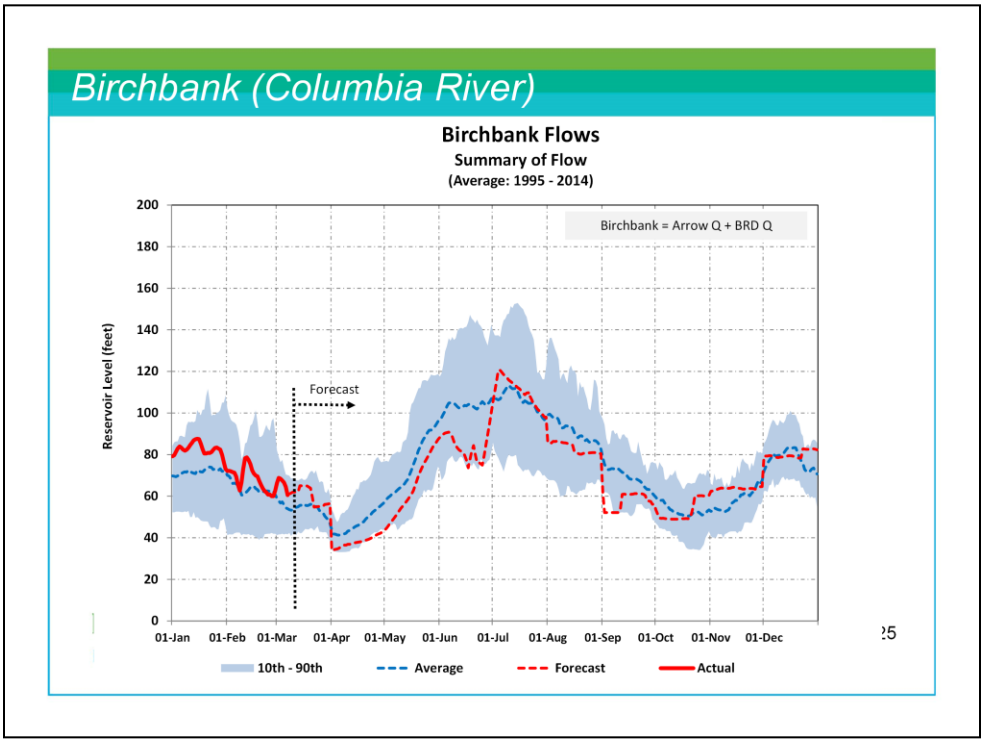
Status quo operation anticipated for Duncan with inflow forecast that is close to normal



Need to see what the Brichbank forecast looks like….probably pretty normal



Status quo operation for Kootenay with average inflows being forecasted.



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Generation Revenue, etc

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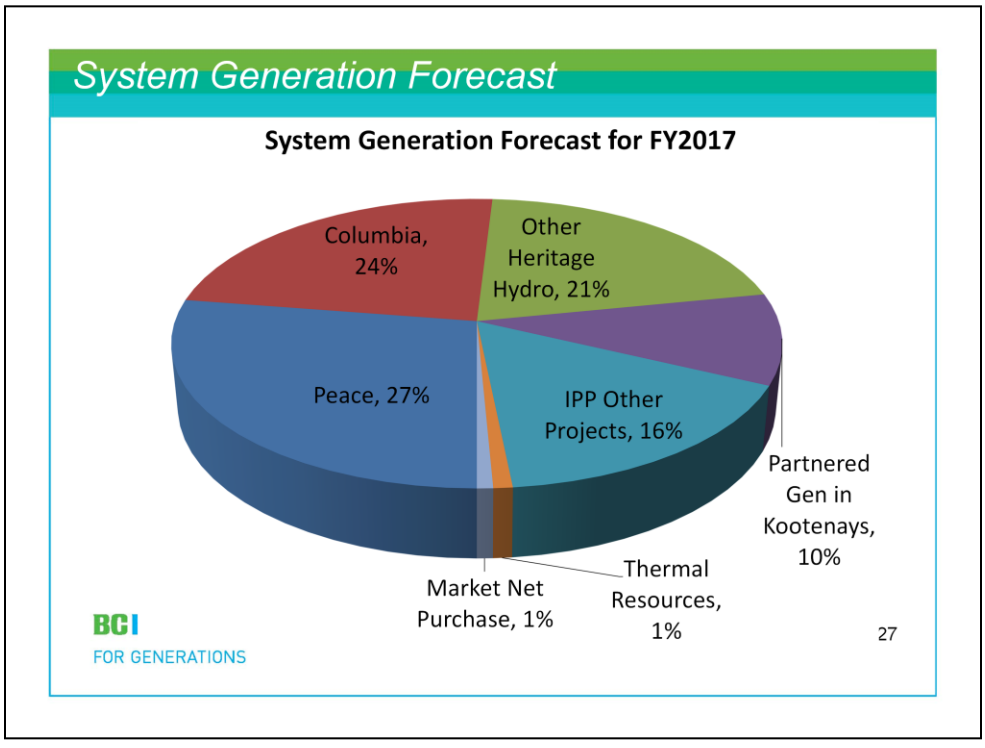
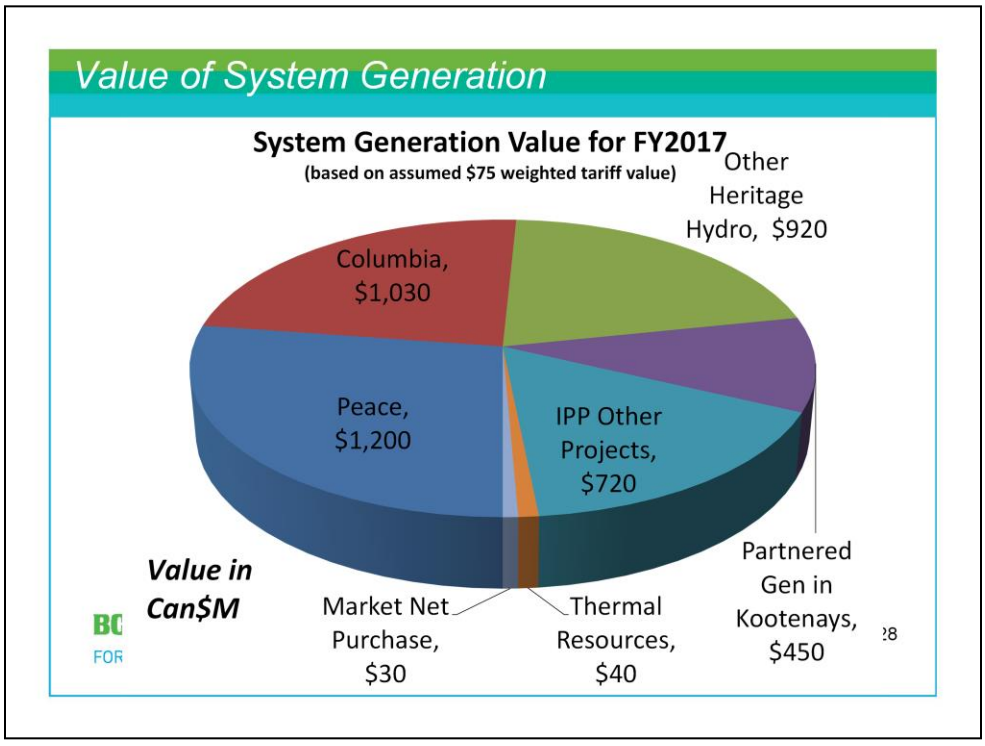
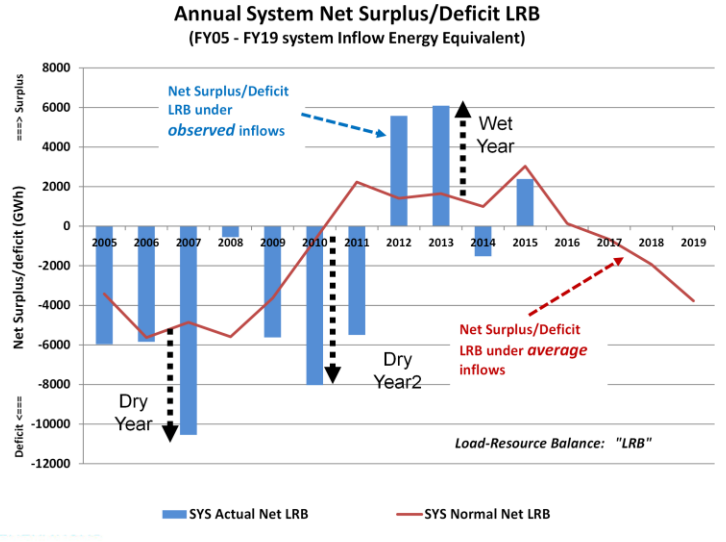


FY17 energy in modeling.



Dave estimating $75 and applied to FY17 energy in modeling.
Will check Asset Mgmt numbers

System Load-Resource Balance



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Domestic Vs Trade Operations (1)

- The BC Hydro system is about 80% Heritage Hydro
  - Majority of resources are flexible
  - Fully dispatchable by BC Hydro
- The BC Hydro system is built to reliably serve domestic load under a wide range of inflow conditions.
- As such, the system will inherently have surplus energy flexibility

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Domestic Vs Trade Operations (2)

- The BC Hydro "Domestic System" operates to:
  - Meet load on each hour
  - If seasonally deficit or surplus, then will import/export energy
  - If exceptionally high Domestic Load, then will import to maintain high degree of energy *reliably*.
- Trade will utilize residual system flexibility (both storage and capacity) to maximize profit, within the constraints set by BC Hydro.
  - Environment and social constraint
  - Trade Income:
    - ~$100M/yr (+/- $50M)
    - Equates to about 3% reduction to rates

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Dispatch of Kootenay Generation

- Kootenay Canal:
  - BCH heritage resource, fully controlled by BCH
  - Operated to meet upstream and downstream obligations.
- Kootenay River Plants
  - Includes COR, UBO, LBO, SSL
  - BCH provides ***flow*** instruction to Fortis for implementation.
  - Fortis has responsibility for management of Kootenay Lake, so has veto on BCH instruction.
- Brilliant and Waneta:
  - BCH specifies ***generation*** dispatch
  - Fortis implements dispatch
- Arrow Lakes Hydro:
  - BCH instructs CPC regarding ***unit*** dispatch.

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Questions ?

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