Further Discussion on Proposed Approach for Assessing Balancing and Flexibility Reserves in the Region

System Analysis Advisory Committee Meeting

August 25, 2015

Review of Balancing and Flexibility Characteristics of the Power System

- Ability of the system to respond to changes in supply and demand of power both inside the scheduling time period (intra-schedule flexibility) and between multiple hours (inter-schedule flexibility).
- LSE’s and wind producers must often contract for balancing services and/or hold back reserve capacity to account for intra-schedule variability when a market is not available to alleviate any supply and demand differences.
- Definitions can be varied around US because scheduling time periods are varied and different regions have slightly different definitions.

Examples of Reserve Types

- Intra-Schedule Reserves

  Operating Reserves
  - Regulation
  - Load Following

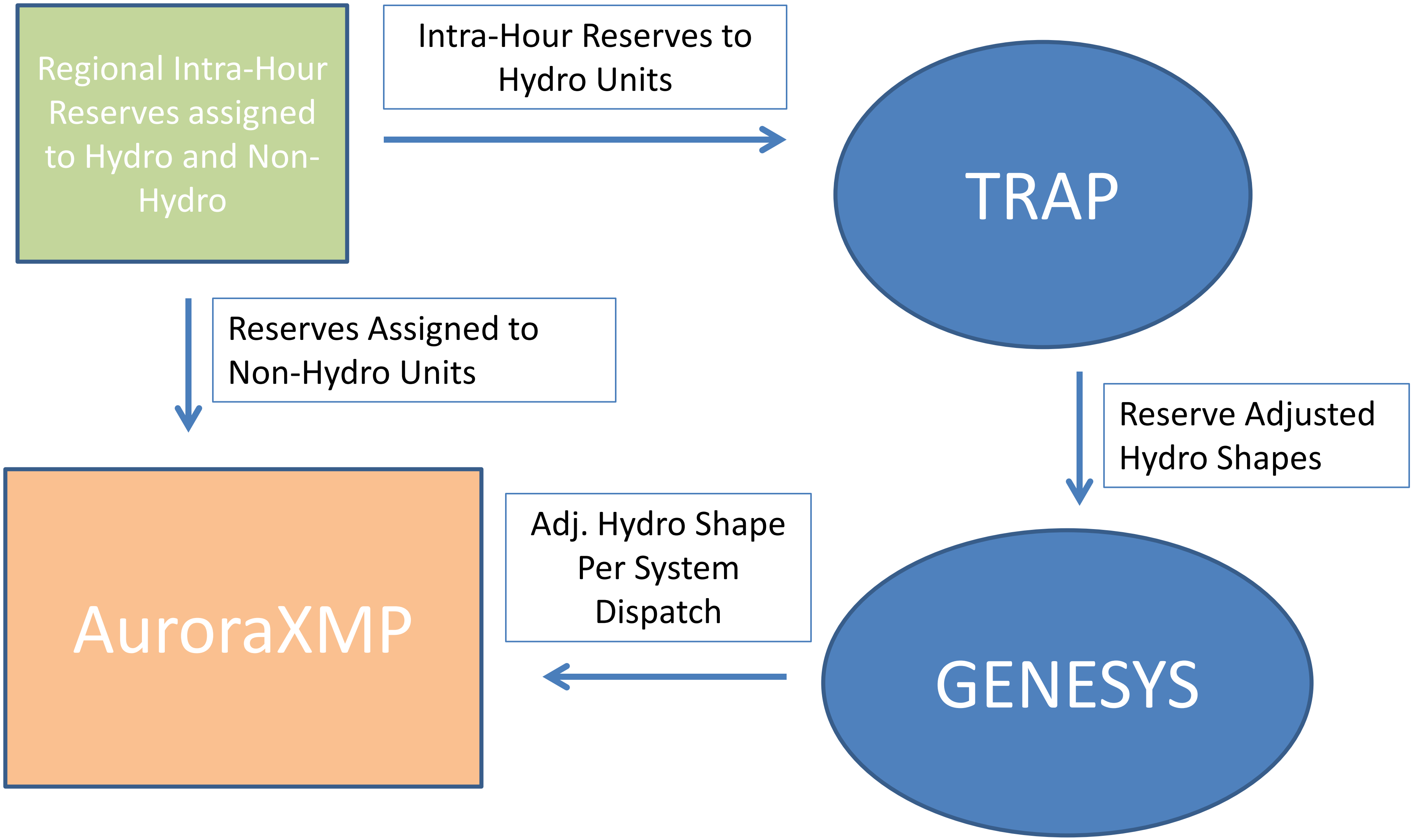
  Contingency Reserves
  - Spinning Reserves
  - Supplemental Reserves

- Inter-Schedule Reserves
  - Ramping Reserves
  - Imbalance Reserves

Capability of Current Models

- **AuroraXMP – Hourly Dispatch**
  – Limited intra-hour reserve accounting capability.
  – Extremely limited hydro dispatch capability
- **GENESYS – Hourly Dispatch**
  – Limited intra-hour reserve accounting capability.
  – Uses hydro shapes from TRAP
- **TRAP – Hydro Shaping Algorithm**
  – Accounts for intra-hour reserves held on hydro

Summary of Proposed Methodology



Determine Amount of Reserves Required by Balancing Authority

- Used the 95% Confidence Interval **load following** and **regulation** requirements for each of the 28 not generation-only BAs (Base Case for the PNNL NWPP EIM Study).
- The data set is described in more detail in the following report
  http://www.pnnl.gov/main/publications/external/technical_reports/PNNL-22877.pdf
- This is not the only dataset available, but seemed most reasonable to Council Staff based on data needs:
  1. Monthly and hourly reserve requirement data for all WECC BAs.
  2. Current regional portfolio conditions.

Assigning Reserves to Hydro/Non-Hydro Units

- Assumption:

  Total reserve requirements for each BA can be met by resources within each BA (with exception of long term Mid-C hydro Power Purchase Contracts).

- Identify resources that CAN provide reserves, and distribute reserves evenly amongst capable resources.

Range Available on Resources to Meet Reserve Requirements

- Hydro and Thermal units have a wide variety of operational capabilities including ramping, fuel supply/constraints, available transmission, and operating range of the generator.
- Since this Staff is trying to test whether the region has SUFFICIENT balancing resources, the focus will be on determining reasonable operating ranges
  - Crudely accounting for min and max generation levels, emissions constraints, etc.

Operating Range Capabilities

Fuel Type	Percent of Capacity Available to meet Reserves	Reasoning Behind Proxy Assumptions
Hydro	80%	Most hydro plants have a low minimum generation and can move through almost all of their range.
Natural Gas	50%	Combined Cycle units generally have a high minimum generation from 50% to 70% of the maximum generation. Simple Cycle units generally have a lower minimum generation level.

Initial estimates, awaiting input from SAAC members

Convert Ranges Into Hydro/Non-Hydro Resource Reserve Assignment

- Take the capacity reserve capable units in each BA multiplied by the operating range capability percentage by fuel type, and sum hydro and non-hydro operating ranges separately.

$$Hydro\% = \frac{HydroOperatingRange}{TotalOperatingRange}$$

$$NonHydro\% = \frac{NonHydroOperatingRange}{TotalOperatingRange}$$

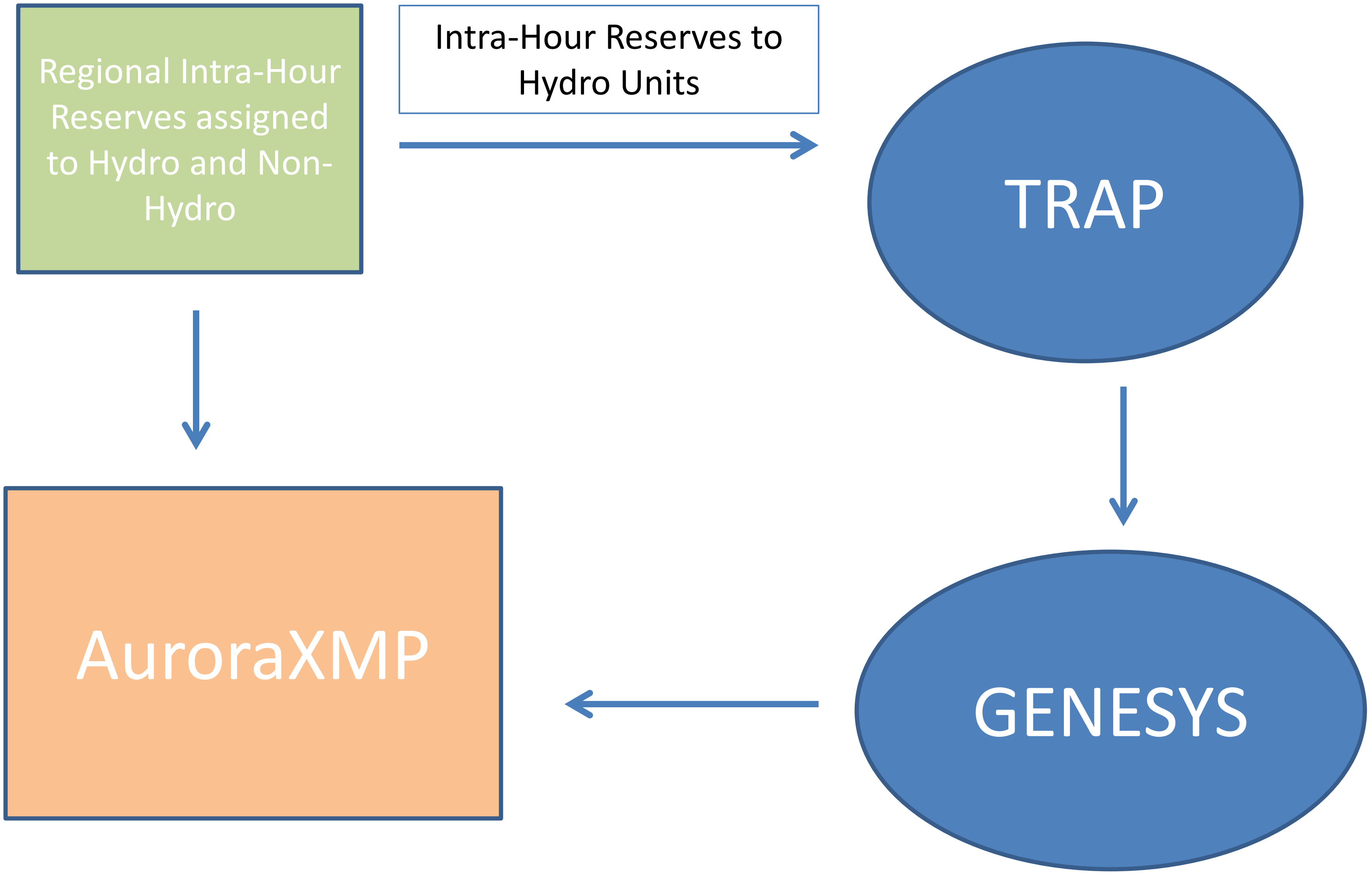
Distribute Reserves Evenly Amongst Capable Resources: In Region

BA	Hydro Q1	Non-Hydro Q1
Avista Corporation	71%	29%
Idaho Power Company	70%	30%
Northwestern Montana	50%	50%
Pacificorp	61%	39%
Portland General Electric	53%	47%
Puget Sound Energy	36%	64%
BPA, Seattle City Light, Tacoma Power and other PUDs	100%	0%

Known Issues

- Reserve Distribution: In Region
  - *Based on anecdotal information in IRP's and Staff judgment.*
  - *Unregulated hydro not counted in reserve provision.*
- Reserve Assignment: Out of Region, in WECC
  - *Probably mostly assigned to Non-Hydro except certain BA's like SMUD that have hydro resources.*
- Seasonality
  - *In operations, reserves are probably assigned differently by season (Spring Runoff considerations, etc.). Only Winter and Summer seasonal information available in PNNL dataset.*

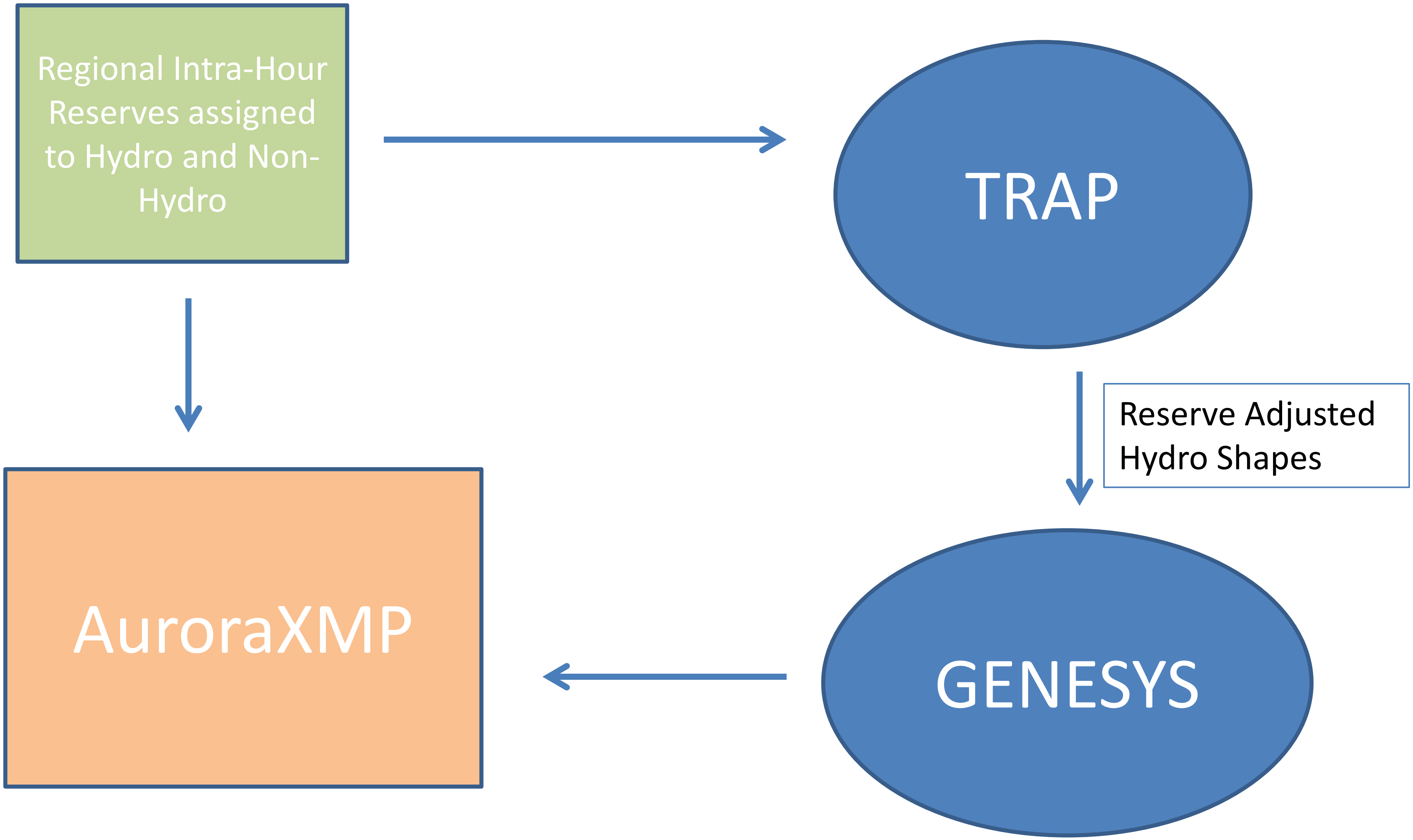
Proposed Methodology



TRAP Data Input and Calculation

- TRAP takes the information about INC and DEC reserve requirements held on particular plants and raises minimum hydro capability to account for DEC and lowers maximum hydro capability to account for INC reserves while pushing as much generation as possible into on-peak hours.
- Calculations repeated to determine 2, 4 and 10 hour max and min generation levels for each of the 14 hydro periods (Monthly, with 2 periods in April and August).

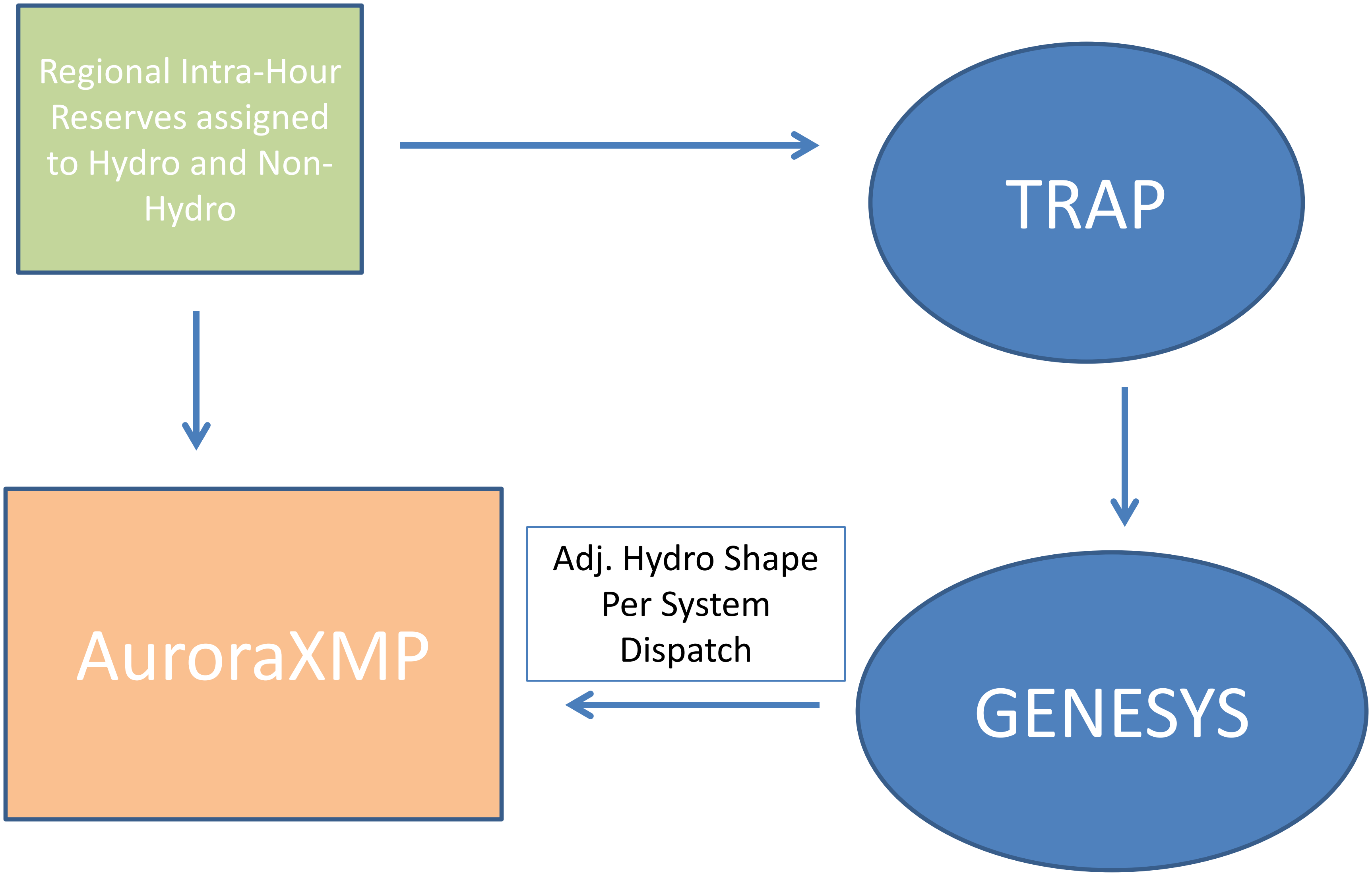
Proposed Methodology



GENESYS Data Input and Calculation

- GENESYS takes the 2, 4, and 10 hour reserve adjusted max and min generation constraints for all 14 periods, and develops hourly hydro flows for each of the 80 water years.
- The hourly hydro shaping for a particular simulation considers the sampled hourly load and wind generation data, a simple resource stack of other non-hydro resources, and any other flow/spill information not in TRAP.

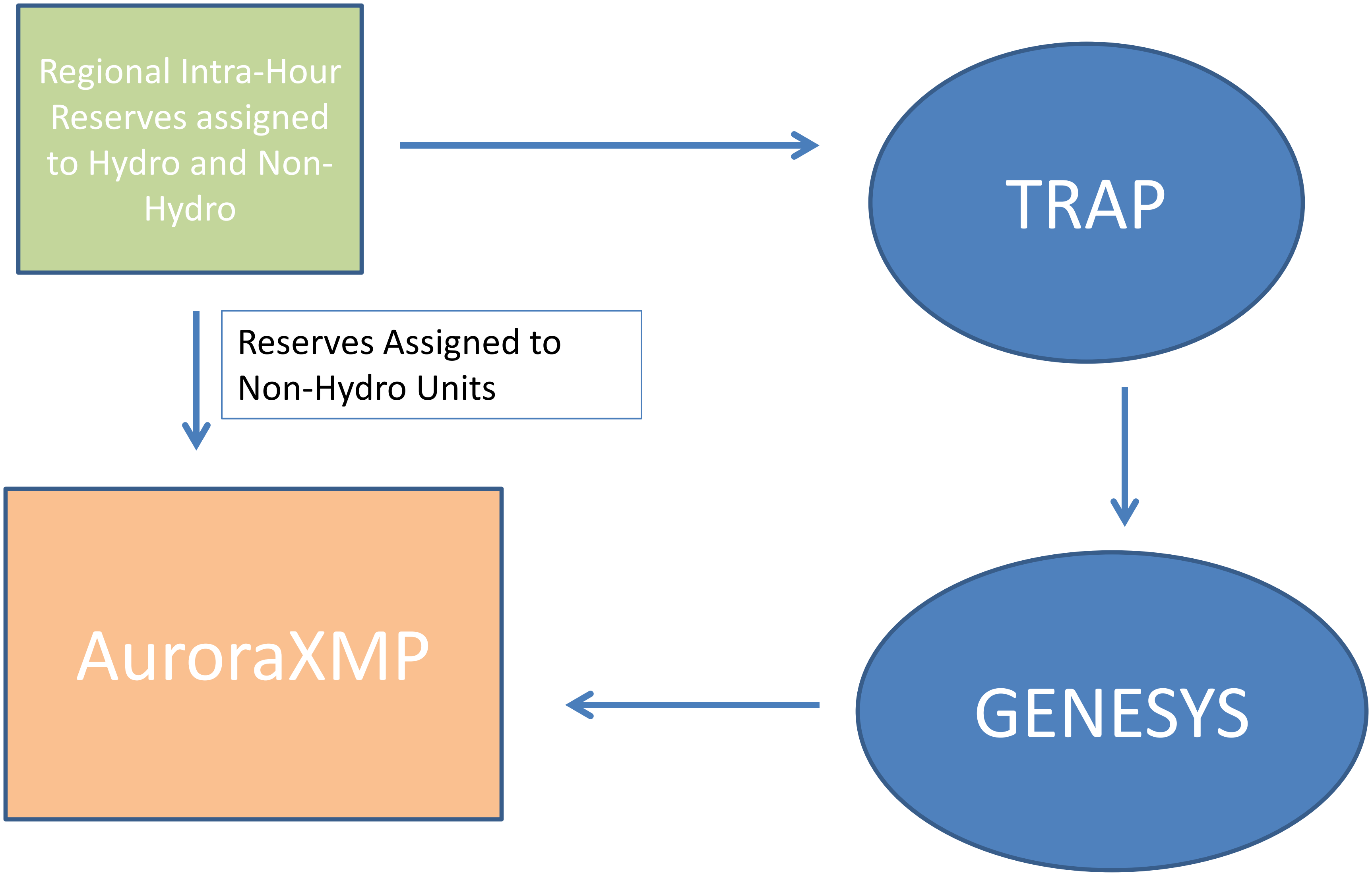
Proposed Methodology



Aurora Inputs from GENESYS

- GENESYS will output an hourly hydro shape for a particular sample year of load, hydro and wind.
  - Staff proposes doing 80 sample years to start.
- Hourly loads and wind data can be input to Aurora, and hydro ranges for Aurora dispatch can be derived by taking the max and min of the hourly hydro generation during each on and off peak period.
  - *This will limit Aurora's ability to dispatch hydro within a tight band, but will still allow for some flexibility in the Aurora hydro dispatch.*
  - *Hourly data sets ($Load_i$, $Wind_i$, $HydroMax_i$, $HydroMin_i$) where,*
    $HydroMax_i = Max(HourlyHydroGen_i \{on/off\ peak\})$
    $HydroMin_i = Min(HourlyHydroGen_i \{on/off\ peak\})$

Proposed Methodology



Aurora Non-Hydro Inputs and Dispatch

- Assign the remaining operating reserve requirements to the previously identified non-hydro reserve carrying units in the region.
- Utilize Aurora to determine unit commitment and hourly dispatch of plant's within the region for each of the 80 simulations
  - This should stress test the region's reserve capability under a variety of hydro, load, and wind years.
  - During dispatch, Aurora will also assign contingency reserves (spinning and supplemental) to the appropriate units.

Analysis of Aurora Dispatch

- Since intra-hour reserve information input to Aurora via explicit assignment to plants and hydro shaping, and Aurora assigns contingency reserves...
- In each hour of the dispatch for each water year
  1. Using AURORA we will pull the dispatch from the committed thermal resources and compute the potential for thermal resource output to be increased or decreased within the hour and for up to ten hours into the future
  2. Using GENESYS and TRAP we will calculate the ability of the hydro system output to be increased and decreased for each hour and for up to ten hours into the future
  3. These numbers will be added together to get a potential for generation to increase or decrease from a given point in time
  4. The minimum upward and downward potential numbers will be reported along with any spilled energy or load shedding from AURORA and the conditions leading to these minimums will be examined in a narrative.

Questions/Comments?