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

May 9, 2017

MEMORANDUM

TO: **Power Committee**

FROM: **Ben Kujala**

SUBJECT: **Natural gas and electricity market price inputs and RPM**

BACKGROUND:

Presenter: Ben Kujala, Steve Simmons and John Ollis

Summary: The Power Committee had a high level overview of the RPM model presented in March. In April, there was a discussion of how load inputs are developed for RPM. This presentation will continue the discussion of the RPM model exploring the development and use of the natural gas and electricity market price inputs in the RPM.

Relevance: The Regional Portfolio Model has been used to inform the resource strategy included in the 5th, 6th and 7th Power Plans.

Workplan: C. Prepare for the 8th Plan.

Background: The Regional Portfolio Model was first used by the Council in the Fifth Power Plan. It was developed at the Council by staff. For the Seventh Power Plan, the Council contracted with Navigant to redevelop the model.

More Info: https://www.nwcouncil.org/energy/rpm/home/

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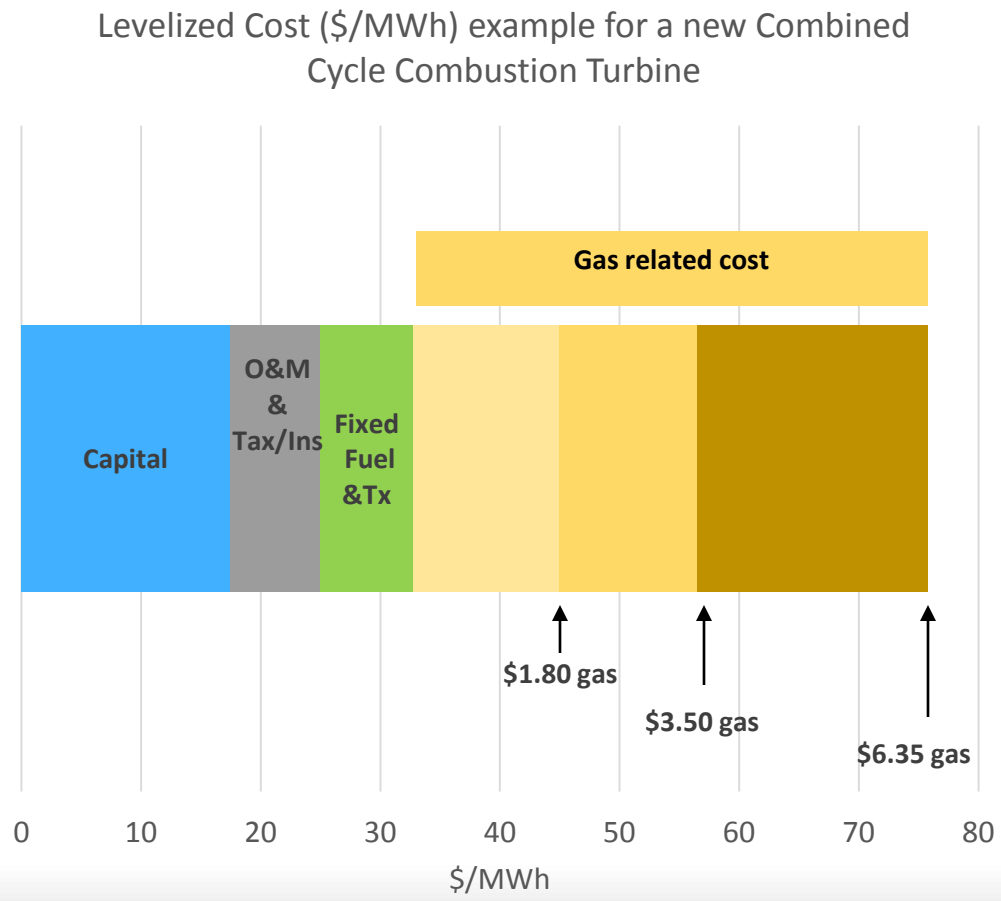
Natural Gas and Electricity Market Price Inputs for RPM

Why Gas Prices Matter in RPM

Gas Prices influence

1. Dispatch of existing gas plants
2. New resource build decisions (gas plant, type of gas plant)
3. Dispatch of new gas plants



Natural Gas Price Forecast

1. Begin with a long term forecast for natural gas prices
   - Annual Forecast with 20 year horizon
   - Typically a Low, Medium and High case
   - Informed by experts from the Natural Gas Advisory Committee, historic data, current trends, and other respected analytic sources

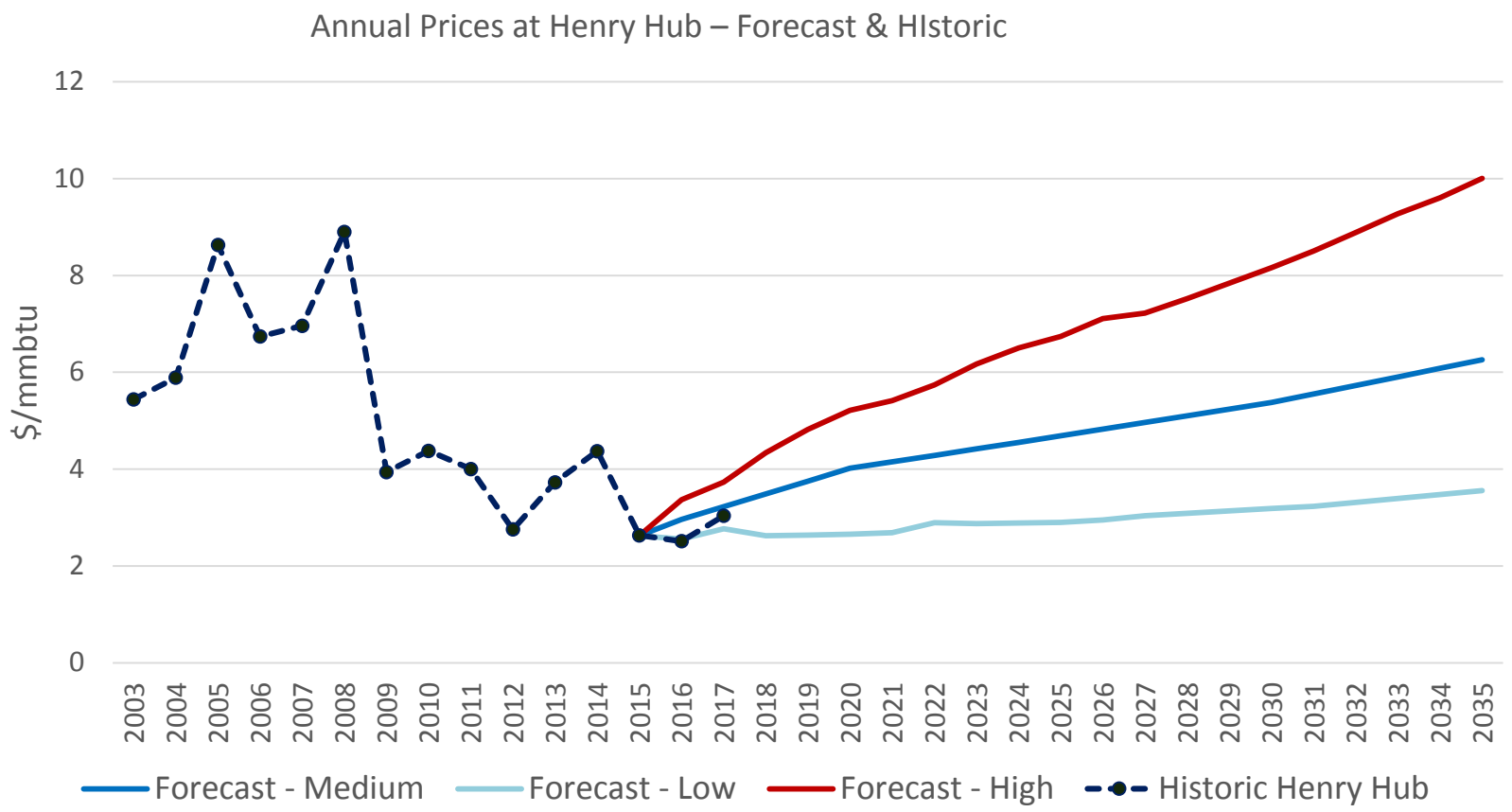
Natural Gas Price Forecast

2. Annual forecast is broken out into months – based on historic price patterns by gas hub
3. Monthly prices are adjusted to quarterly prices and divided into tow Northwest regions – West & East – and delivered to the System teams
4. RPM introduces volatility to create hundred of potential futures

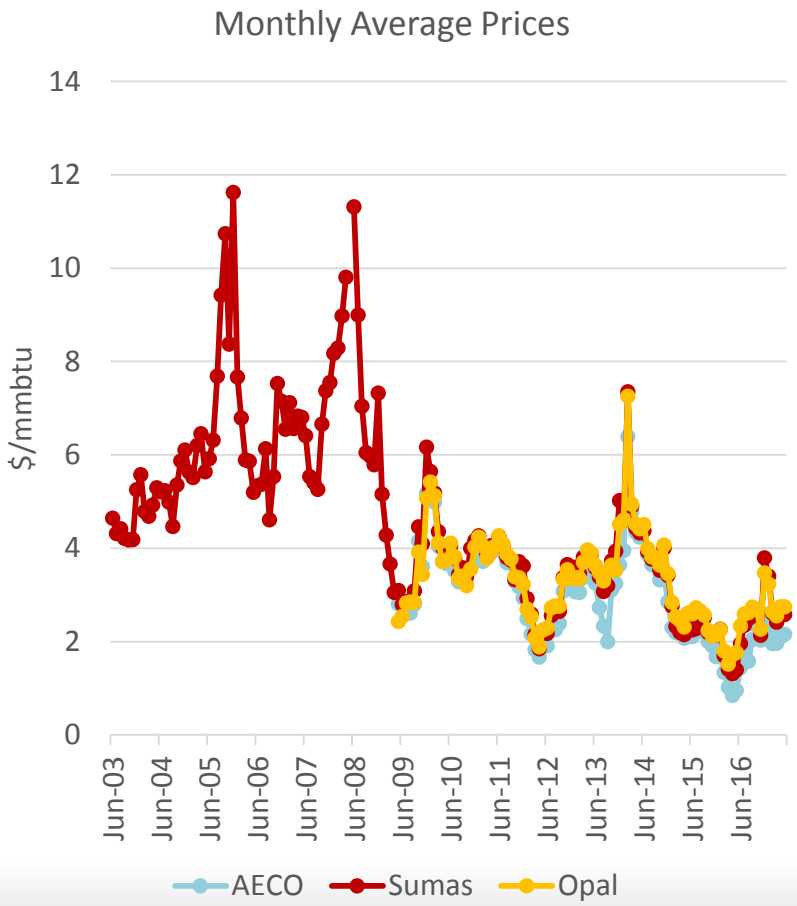
A word about Price Volatility

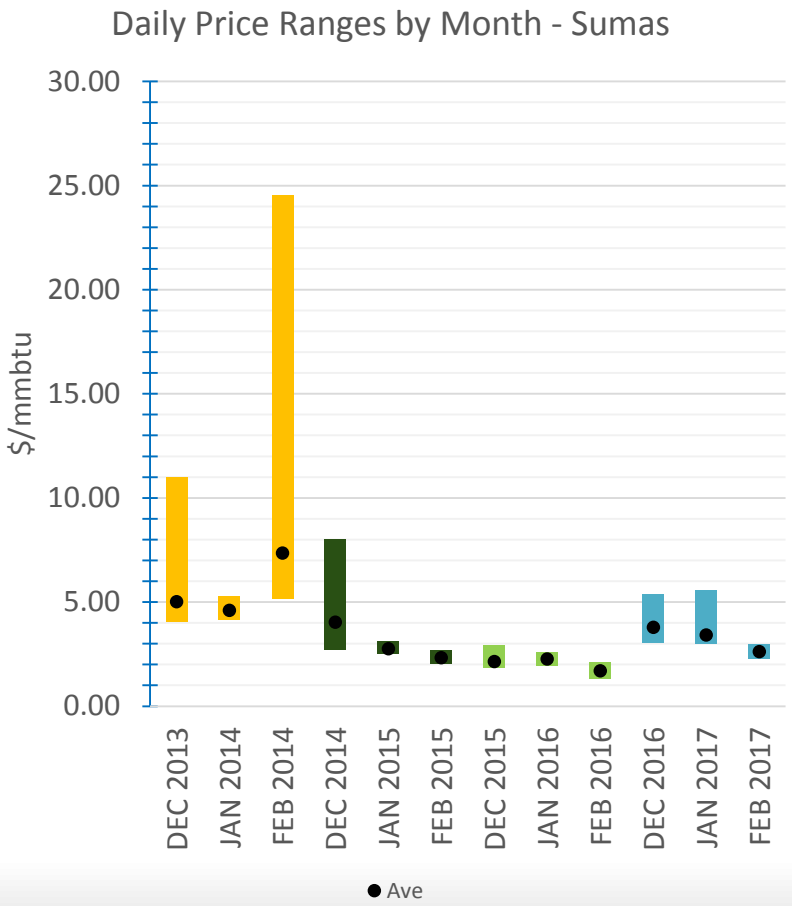
1. Long term changes in the supply & demand balance
   a. "Shale Gale" resulting in a surge of new supply
   b. Increased dependence on gas for electricity grid –with coal, and nuclear retirements and growth in renewable development
2. Seasonal – exceptionally cold or warm winters
3. Changes in storage levels - due to seasonal effects
4. Unexpected Disruptions
   a. Hurricanes hitting the US Southeast
   b. Storage constraints (such as Aliso Canyon CA)
   c. Extreme cold weather events shutting down wellheads or pipeline components
   d. Events like the Western Energy Crisis, low water year coupled with a jump in electricity demand resulting in a huge demand surge for gas, exacerbated by a major pipeline accident - price spikes reverberate across the West

Annual Natural Gas Price



Monthly & Daily Natural Gas Prices

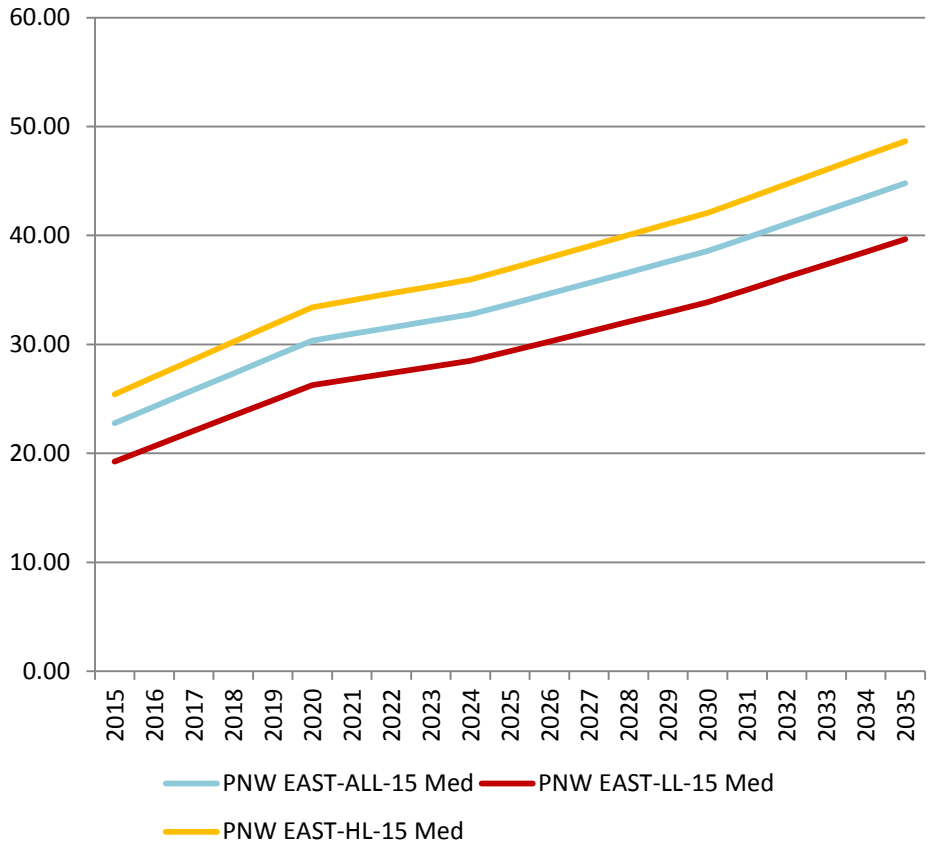




Benchmark Wholesale Electricity Prices from AURORAxmp

Wholesale Electricity Prices

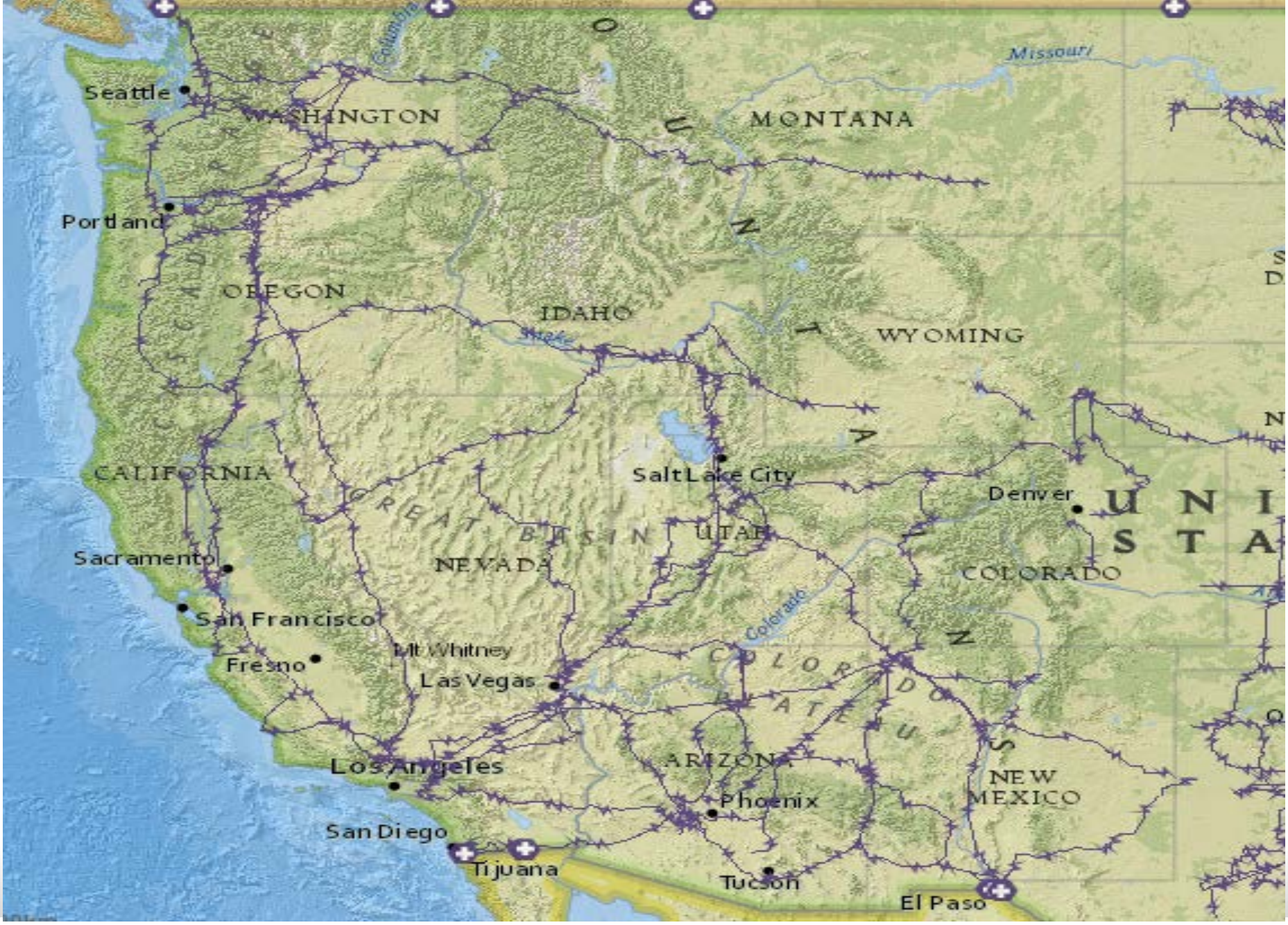
- AURORAxmp produces a 20-year monthly forecast of future electricity prices traded on the wholesale spot market at the Mid-Columbia trading hub.
- The following key data is used to calculate a benchmark quarterly power price for the RPM.
  1. Medium natural gas forecast
  2. Medium load forecast
  3. Average hydro and wind conditions



Review of Methodology

- In a 20 year future electricity price study of the entire WECC, there may be a need to build resources to maintain a level of adequacy.
- AURORAxmp can build out an economic resource plan from existing and new resources.
  - Real, levelized net present value is used to evaluate existing (for retirement) and new resources (for builds).
  - Builds to load plus planning reserve margin and contingency reserves
- Concurrent to the build-out wholesale future power prices are generated as all plants in the WECC are dispatched (via resource stacking).

- PNW East zonal prices are used as a proxy for Mid-Columbia spot market price.
  - AURORAxmp calculates a different electric price for each of the 16 zones that are a simplified representation of the WECC transmission system
  - PNW East, PNW West and Idaho South represent the regional loads.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AURORA Output → RPM Input

- Monthly heavy and light load hour electricity prices for PNW East and West are output from AURORAxmp.

- RPM uses the heavy and light load hour monthly average prices
  1. To calculate the quarterly average PNW East prices from AURORAxmp to use as the ***benchmark electricity price*** in RPM.
  2. To calculate the price differential between the PNW East and PNW West to use as ***wheeling charges*** in RPM.

Price Risk Models

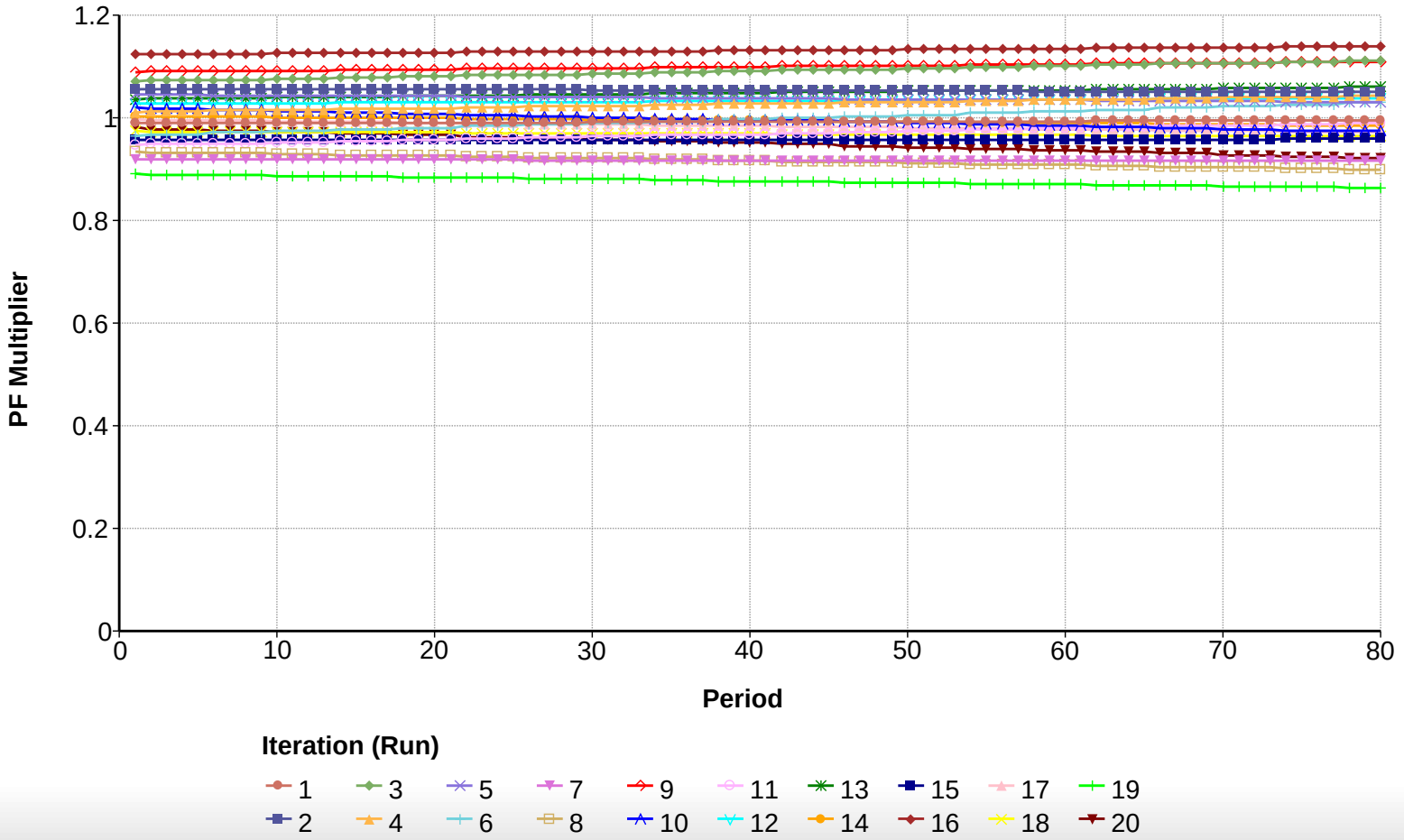
Risk Model DNA

- Annual Trend Factor * Seasonal Factor * Jump Factor * Forecast
  - Annual Trend – varies the long-term economic projection
  - Seasonal – effectively makes some quarters more volatile than others
  - Jump – simulates temporary or permanent deviations

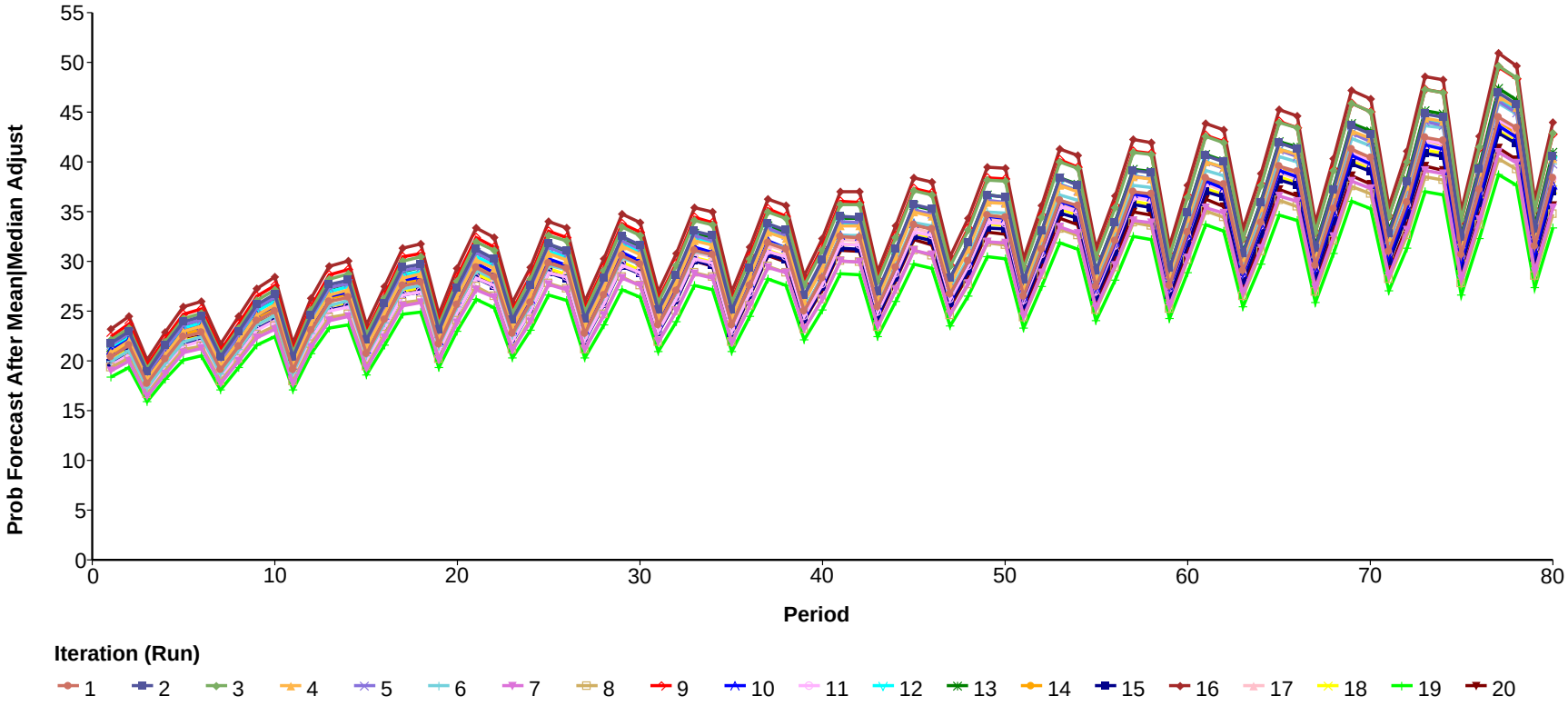
Price Trends

- Range of trend is informed by the forcasts
- Annual trend is based on the “medium” input forecasts
- RPM creates multipliers based on the “high” forecast assuming it represents the 85th Percentile of the possible future prices
  - Prices are assumed to be log-normal, i.e. the future prices have more room to go up than they have to go down

Forecast Multipliers for Electricity Prices



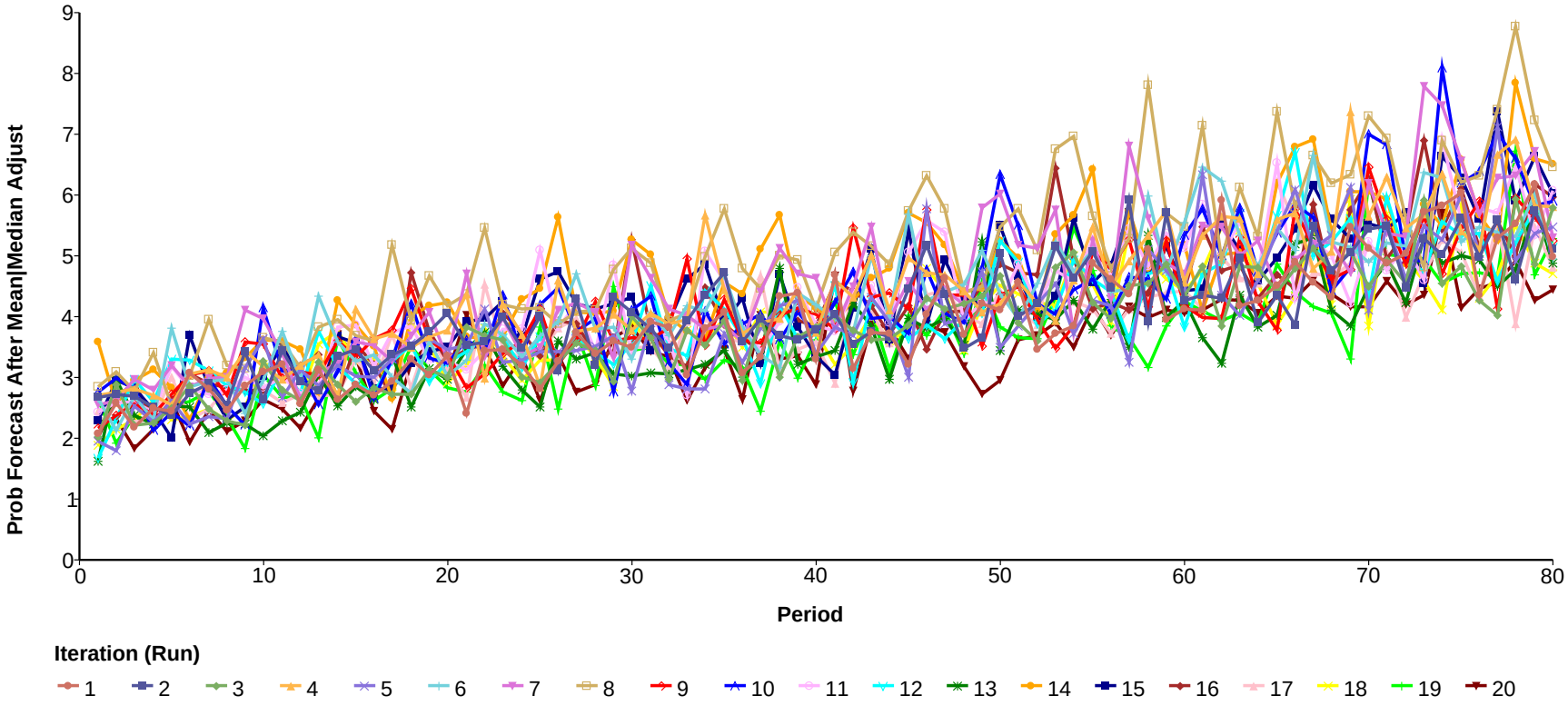
Values after Multiplying by Electricity Price Forecast



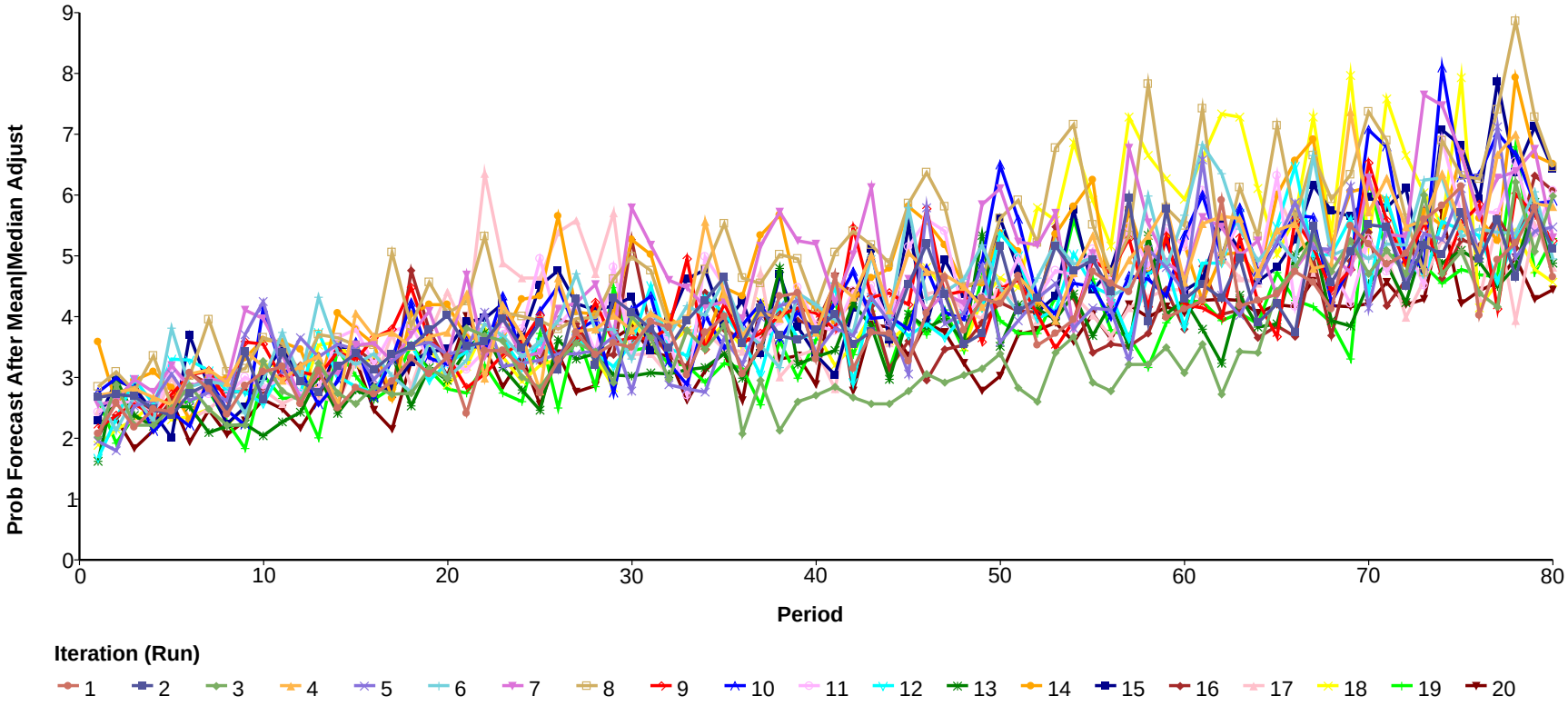
Price Jumps

- Range of price jumps was based on advisory committee experience
- Price jumps capture sudden price changes that:
  - Can go up or down
  - Have a 50% chance of occurring in any given future and can start at any time
  - Potentially 2 different jumps per future
  - Can last any amount of time from 1 quarter to 8 years
  - Can up to quadruple the price, though likelihood is based on log-normal so an extreme deviation is less likely

Natural Gas Prices without Jumps



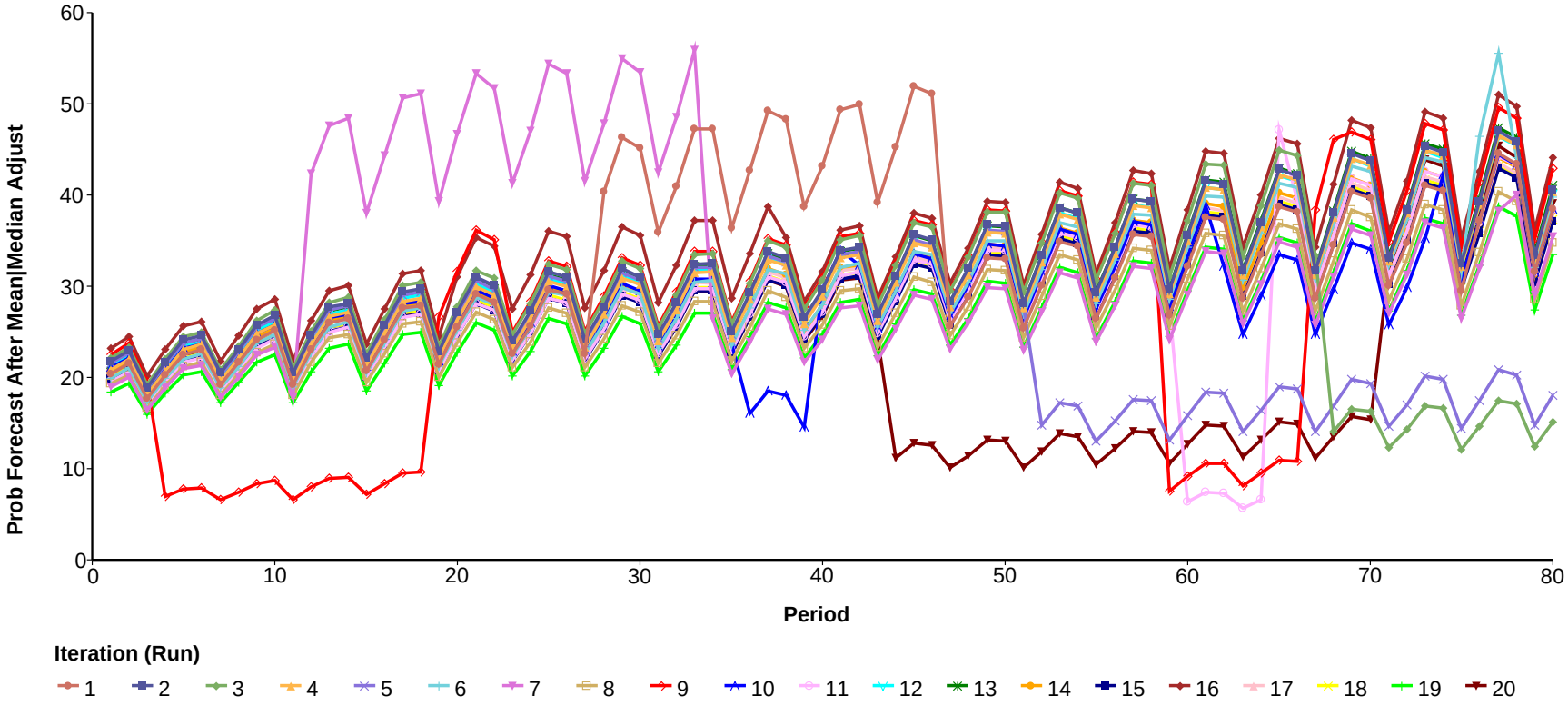
Natural Gas Prices with Jumps



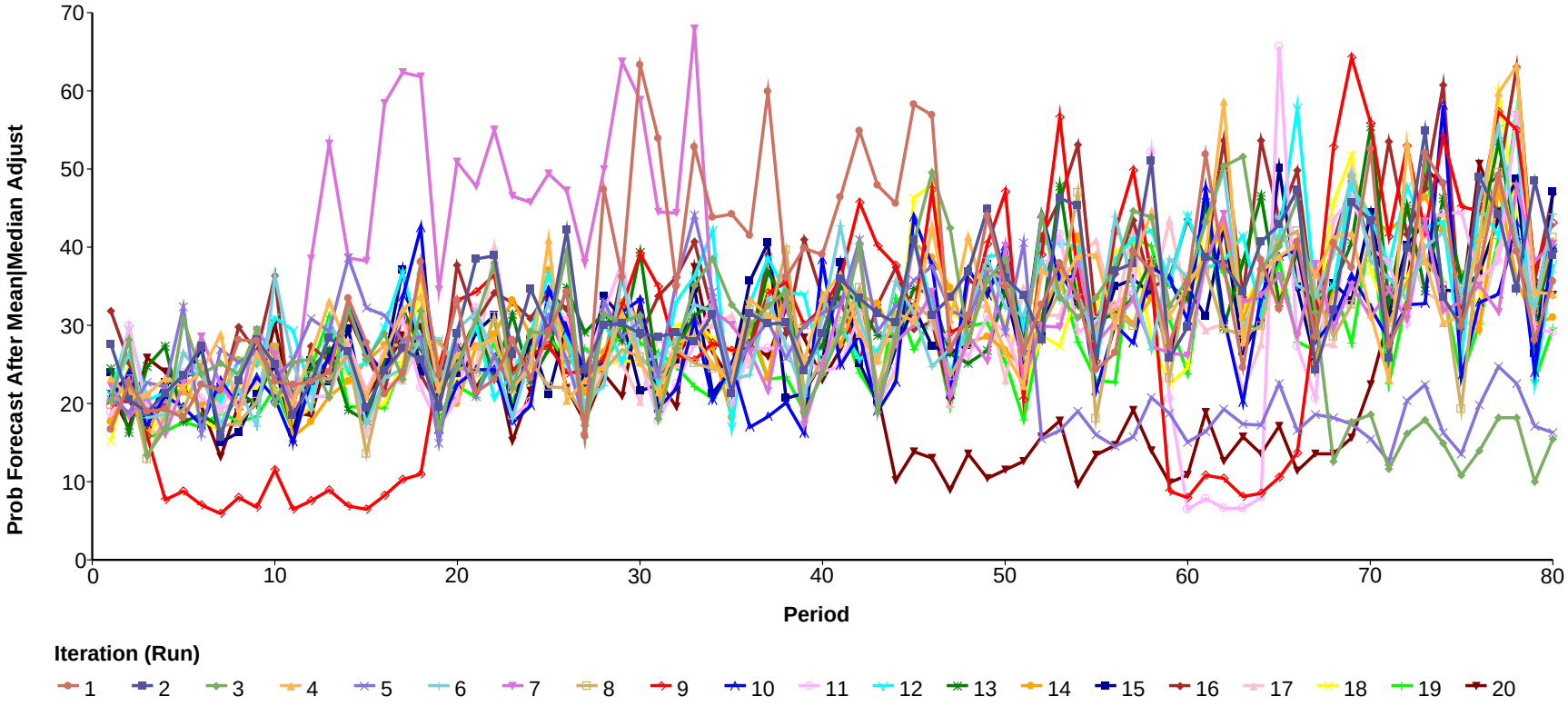
Price Seasonality

- Range of seasonality is based on historic prices
- Uses a measure of how far deviations went from annual averages
  - i.e. if we observed winter prices of 150% of the annual average in the past then that would be possible for the future winter prices as well

Electricity Off-Peak Prices without Seasonality



Electricity Off-Peak Prices with Seasonality



- Combined price risk is based on:
  - Forecast ranges
  - Advisory Committee input
  - Observed historic prices
- RPM gives a robust range informed by these available sources of information
- Balances what markets and experts expect of the future with risk models that avoid assuming perfect foresight

"An approximate answer to the right question is worth a great deal more than a precise answer to the wrong question."

John Tukey