December 8, 2020

MEMORANDUM

TO: **Power Committee**

FROM: **Ben Kujala**

SUBJECT: **Overview of Updates to the Regional Portfolio Model**

BACKGROUND:

Presenter: Ben Kujala and John Ollis

Summary: At the September Power Committee meeting, staff described some challenges with the underlying theory of the Regional Portfolio Model. Since the September meeting, staff has updated the logic in the model to address the concerns raised. This presentation will update the committee on the changes made to the model logic.

Relevance: The Regional Portfolio Model is used to test regional resource strategies and evaluate the cost and risk of those strategies to the region.

Workplan: A.6.5. Model-based Analysis

More Info:

September Presentation

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Overview of Updates to Regional Portfolio Model

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1

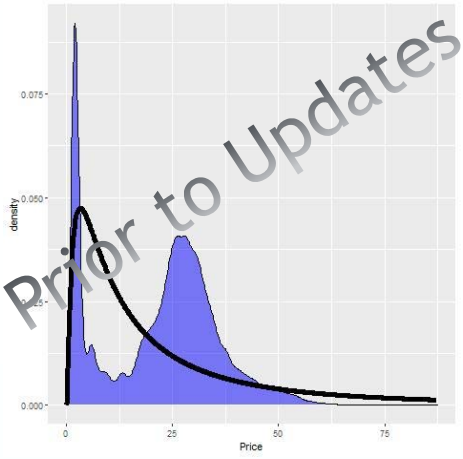
Intra-Quarterly Electricity Price Logic

2

2

Recall Comparing 2039 Prices to Lognormal Assumption

Oct 2019 Price Forecast



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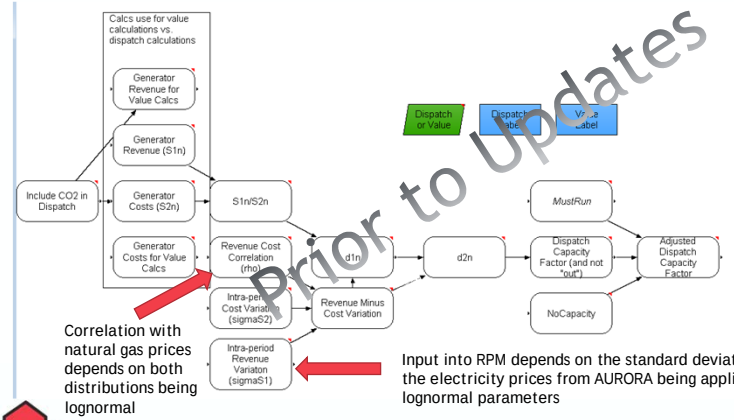
3

3

Previous Intra-Quarter RPM Assumptions



Correlation with natural gas prices depends on both distributions being lognormal

Input into RPM depends on the standard deviation of the electricity prices from AURORA being applied as lognormal parameters

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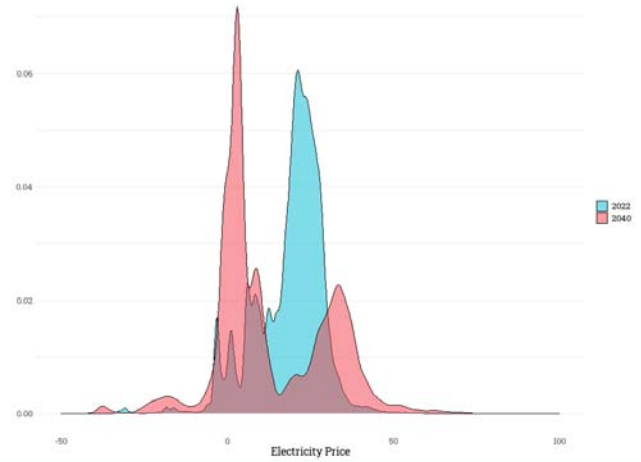
4

4

Hourly Price Distribution Baseline Conditions



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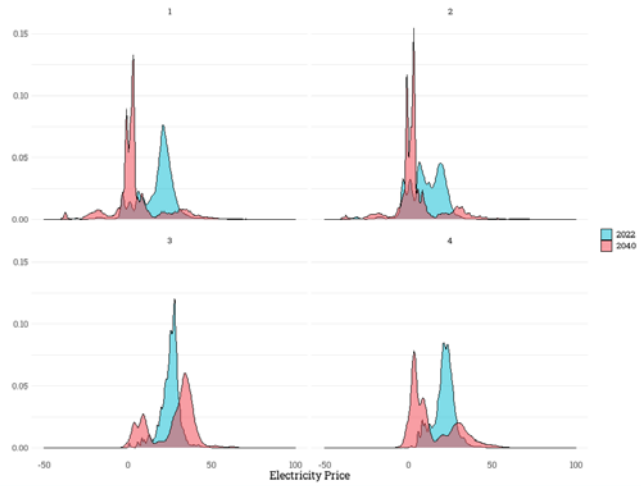
5

5

Price Distributions by Quarter



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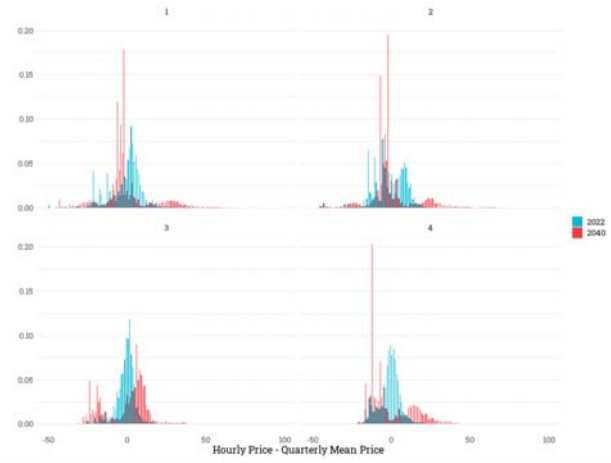
6

6

Input Empirical Hourly Price Distributions



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7

Advantages of Empirical Hourly Price Distributions

- Based on AURORA prices
  - Distribution based on Hourly Price – Quarterly Mean Price
- Adaptable to different futures – distribution can be added to a range of potential quarterly prices
- RPM dispatch:
  - Based on *generator cost* < *generator revenue*
  - Closely ties to AURORA dispatch of similar resource
  - Highly adaptable to negative prices and economic renewable curtailment

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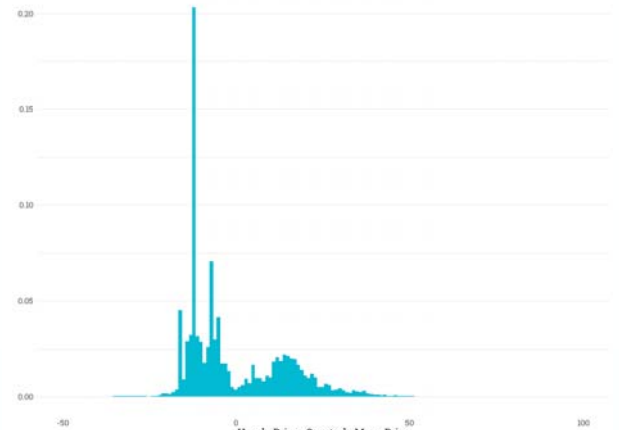
8

Dispatch Example Q4 2040 RPM Intra-Quarterly Price Distribution



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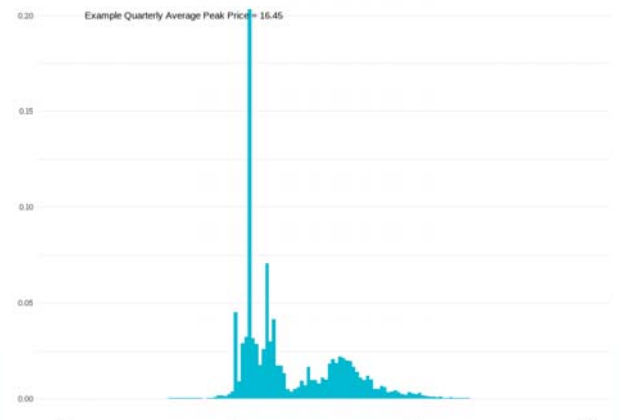
9

9

Add to Quarterly Average Price to Get Intra-Quarterly Prices



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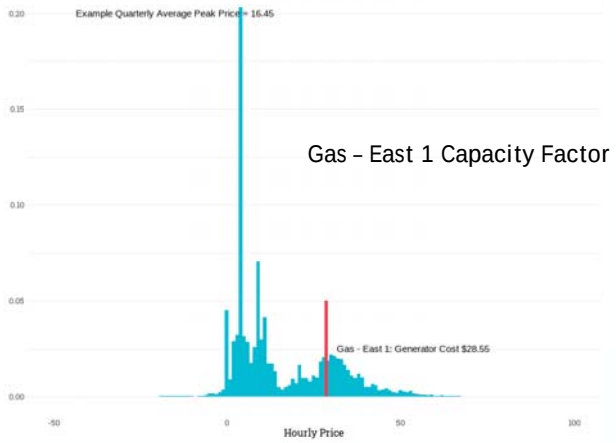
10

10

Dispatch Capacity Factor
(Hours over Generator Cost / Hours in Quarter)



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11

11

Summary – Empirical Hourly Distributions for Intra-Quarterly Dispatch

Compared to the previous lognormal convolution approach this:

- Substantially improves estimated quarterly dispatch
- Allows for negative hourly prices
- Adapts to situations with different fuel types on the margin
- Has a simpler more intuitive explanation without loss of precision
- Dispatch does not correlate distribution of generator costs (hourly fuel prices) with hourly prices, fuel costs are assumed to be locked in at the quarterly average price

Some challenges remain that also existed in the lognormal convolution approach:

- Hourly price distribution shape doesn't change based on market balancing price iteration – the distribution shifts up or down
- Dispatch of the resources does not respect unit commitment constraints such as minimum up and down time

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12

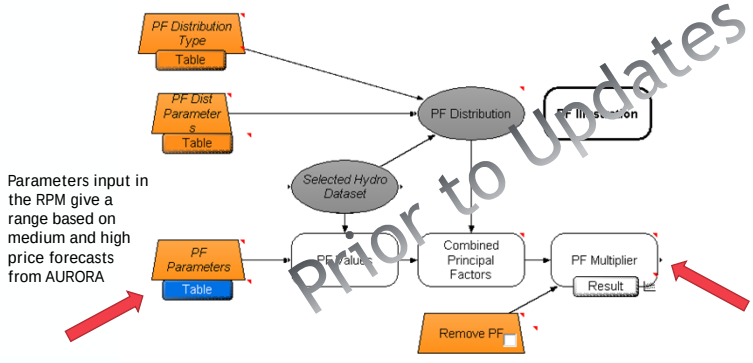
12

Quarterly Electricity Price Distributions

13

13

Previous Distribution of Possible Quarterly Prices



Parameters input in the RPM give a range based on medium and high price forecasts from AURORA

Principal risk distribution formed by creating a lognormal multiplier that is applied to external forecasts

Principal Factor Name | PF Param Name | PF Dist Name | Princ Factors Dist Input

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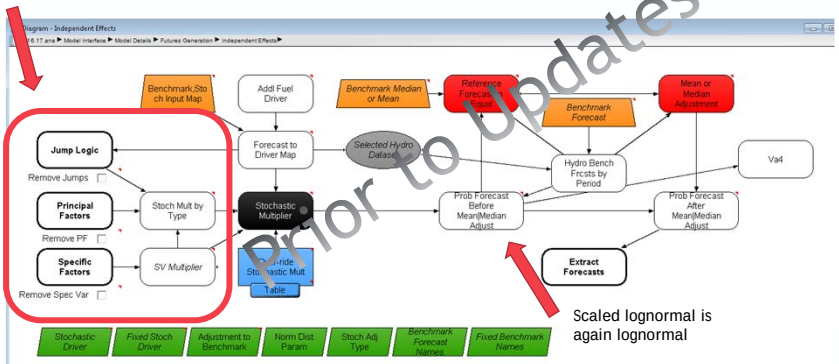
14

14

Previous Distribution of Possible Quarterly Prices

Product of independent lognormal distributions is again lognormal



Prior to Updates

Scaled lognormal is again lognormal

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15

Does This Logic Need to Change?

- Main challenge with quarterly electricity price distributions was the previous RPM logic did not allow for negative quarterly prices
- Lognormal distribution still has advantages in this situation

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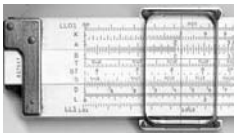
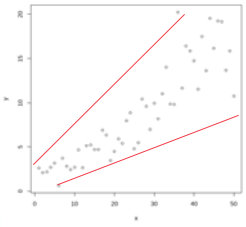
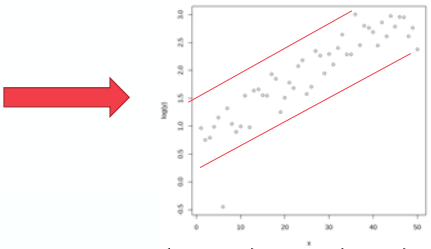
Why Do We Use Log Again?

Log-transformation makes multiplicative problems additive





$y = 1.05^x(1 + \varepsilon)$



$\log y = (\log 1.05)x + \log(1 + \varepsilon)$

$y^* = ax + \varepsilon^*$

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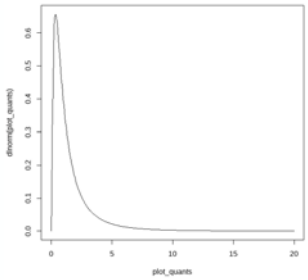
17

Log Transformation Makes Sense

- Forecast risk generally has "cone-shaped" multiplicative growth – generally representing increasing uncertainty through time
- This still seems applicable to electricity price forecasting



BUT…

- You cannot take the log of negative electricity prices

AND

- Lognormal distributions close to zero have extremely compressed density

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18

Distribution of What?

- Log of electricity prices doesn't work well because of the potential for negative quarterly average electricity prices
- So we adjusted the distribution to be:

  Electricity Price – Floor Price

- Since *Floor Price* < *Electricity Price* for all prices we know:

  0 < Electricity Price – Floor Price

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19

19

Summary – Quarterly Electricity Price Distributions

- Preserves current approach to seasonal and jump factors
- Reduces compression around electricity prices close to $0
- Requires an extra step in extracting electricity prices

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20

20

21