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

March 7, 2017

MEMORANDUM

TO: **Power Committee**

FROM: **Ben Kujala**

SUBJECT: **Regional Portfolio Model Fundamentals**

BACKGROUND:

Presenter: Ben Kujala and John Ollis

Summary: This the last presentation for the Power Committee on the principal models used in the Seventh Power Plan. The previous presentations on the GENESYS and AURORAxmp models covered our reliability and electricity market models. The Regional Portfolio Model models the expansion of the regional power system while accounting for uncertainty about the future.

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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Regional Portfolio Model Fundamentals

March 14, 2017

It's a poor sort of memory that only works backwards

- Lewis Carroll, Alice's Adventures in Wonderland & Through the Looking-Glass

Caveat

- I am not the sole author of RPM model and thus my interpretation of any intent of the structure may not match other's interpretations
- All criticisms of modeling and methods are from my point of view and are likely not universally embraced by all researchers and power system professionals

What is a portfolio model?

Generally, a portfolio model estimates the cost or the range of costs associated with a defined set of new and existing resources. This estimate can include fuel costs, market costs/proceeds, capital expenditure, etc. Usually one or more of these costs is perturbed to find out how the set of resources performs under different assumptions.

What is the Regional Portfolio Model?

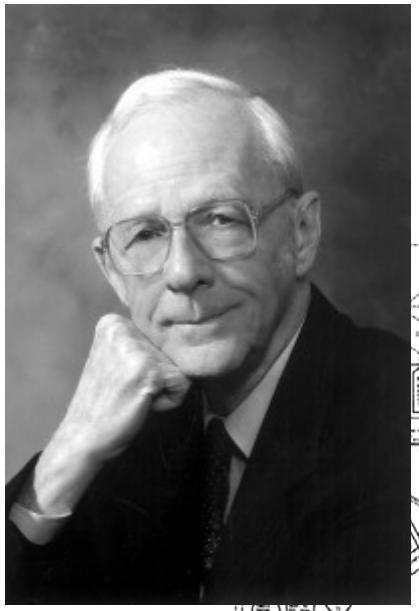
The Regional Portfolio Model is

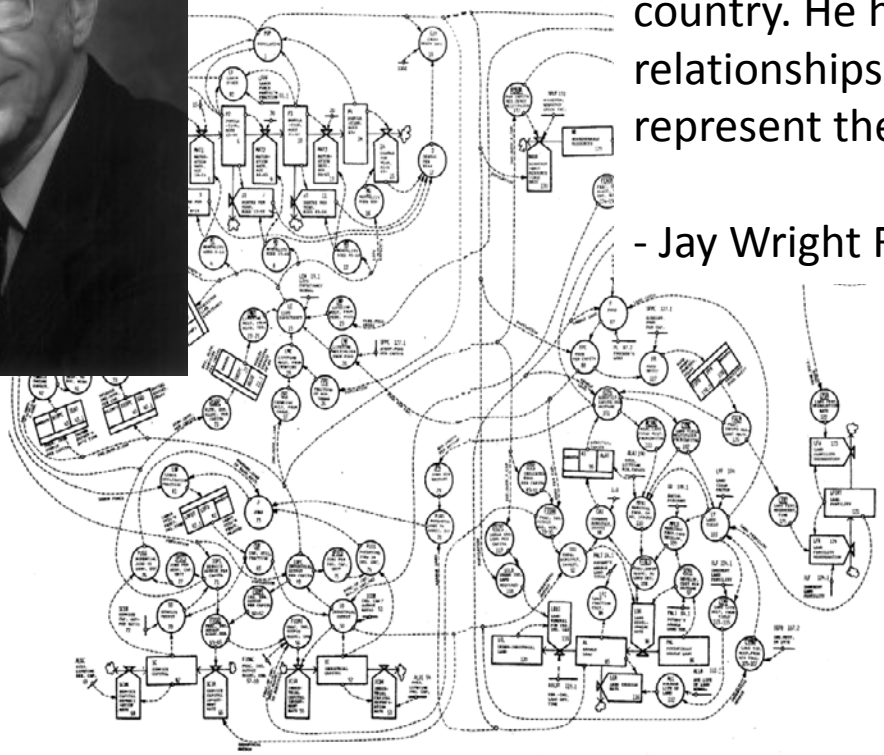
- A portfolio model
- An agent-based model
- Developed during the 5th Power Plan
- Gives a structured view of an optimal expansion of the Northwest power system under uncertainty and imperfect forecasting

RPM has elements of:

- System dynamics
- Black-Scholes finance theory
- Statistical risk modeling
- Linear and non-linear optimization
- Hundreds of inter-related mathematical formulas

Just because it's not a black box doesn't mean it's a simple box

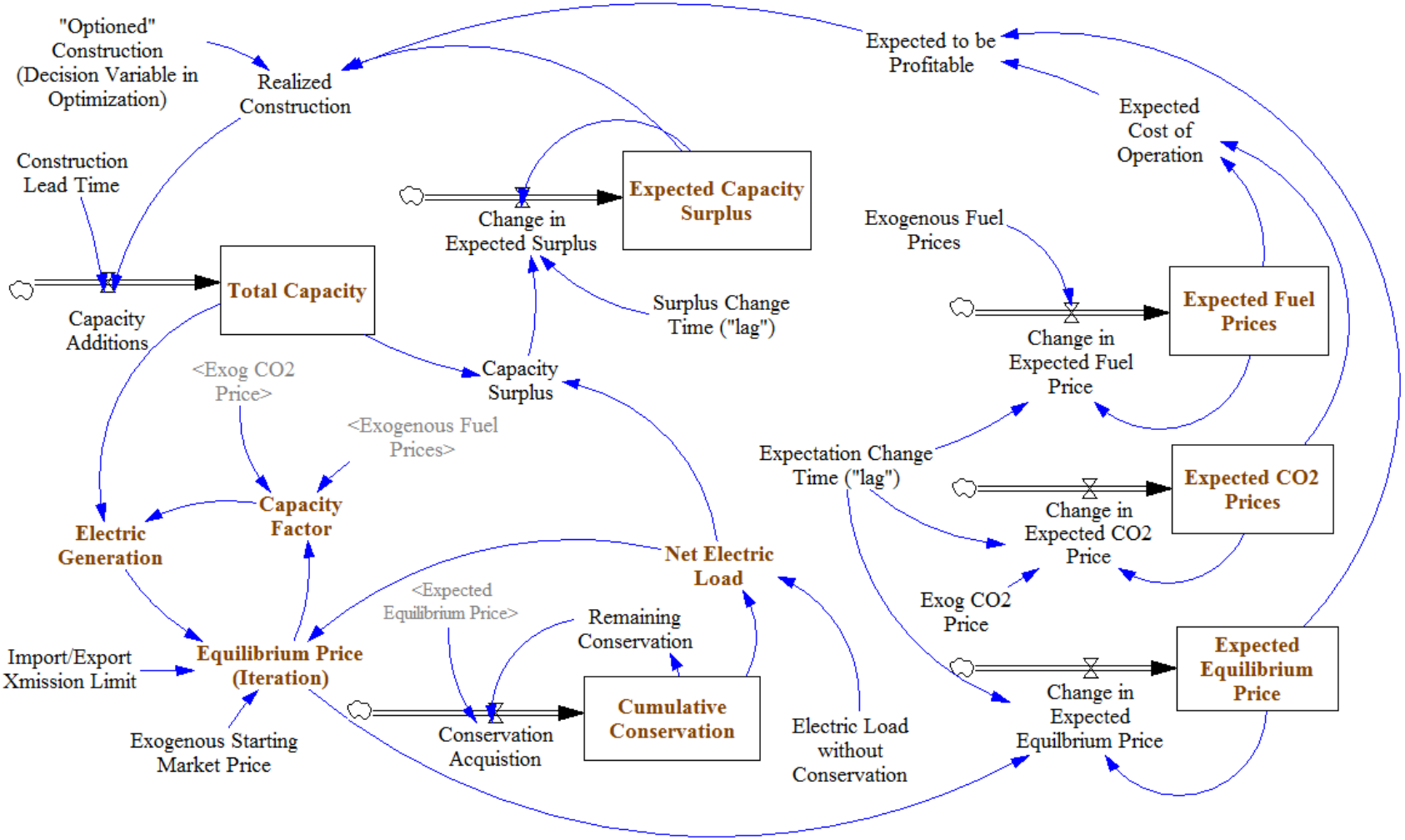




The image of the world around us, which we carry in our head, is just a model. Nobody in his head imagines all the world, government or country. He has only selected concepts, and relationships between them, and uses those to represent the real system.

- Jay Wright Forrester

The diagram below is a simplified Stock/Flow and Feedback Diagram of the Regional Portfolio Model. It is provided to illustrate the overall model structure and feedbacks at a very high level. This figure is not meant to be used for model navigation, and does not contain every stock/flow structure in the model.



Do the inputs to the model sufficiently represent the data that are needed to make predictions about the future power system?

- The RPM does not have every possible variable, could we be missing something that would give us substantial information about the future power system?

Are the model structures sufficient to explain the impact of the inputs?

- The RPM has many assumptions in the formulation of how the inputs are used to calculate system cost and other model results.

RPM contains several statistical models, but is not itself a statistical model

RPM is an optimization, which is intended to get an optimal answer to the problem as defined

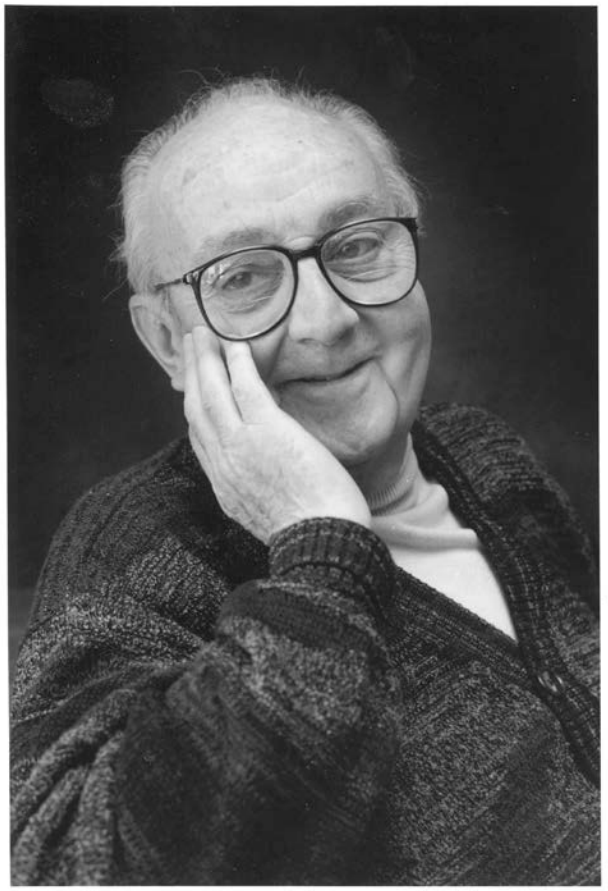
Ultimately, RPM is a structure for understanding the impact of inputs and assumptions on future resource choices defined in the model

Independent review panel assessment (2012, prior to redevelopment):

The Panel has concluded RPM ***has the capability, with correct inputs****, to adequately address the analytic criteria for regional resource planning. RPM solidly captures the central economic tenants of resource planning under uncertainty, […]*

The Perfect Model

"Essentially, all models are wrong, but **some** are useful" – George E. P. Box



Even a good model can be used inappropriately or poorly:

- RPM does not give an answer to “exactly” what the region should build, **there is no right portfolio**
- RPM does not produce the resource strategy or the power plan, it informs them

RPM provides a structure for staff and the Council to examine known risks and policies and learn about their potential impacts

Counter-intuitive results in RPM and other models are opportunities to learn or question basic pre-conceptions, not a reason to abandon all critical and rational understanding not contained in the models' structure

ro·bust·ness

/rōˈbəstnəs/

noun

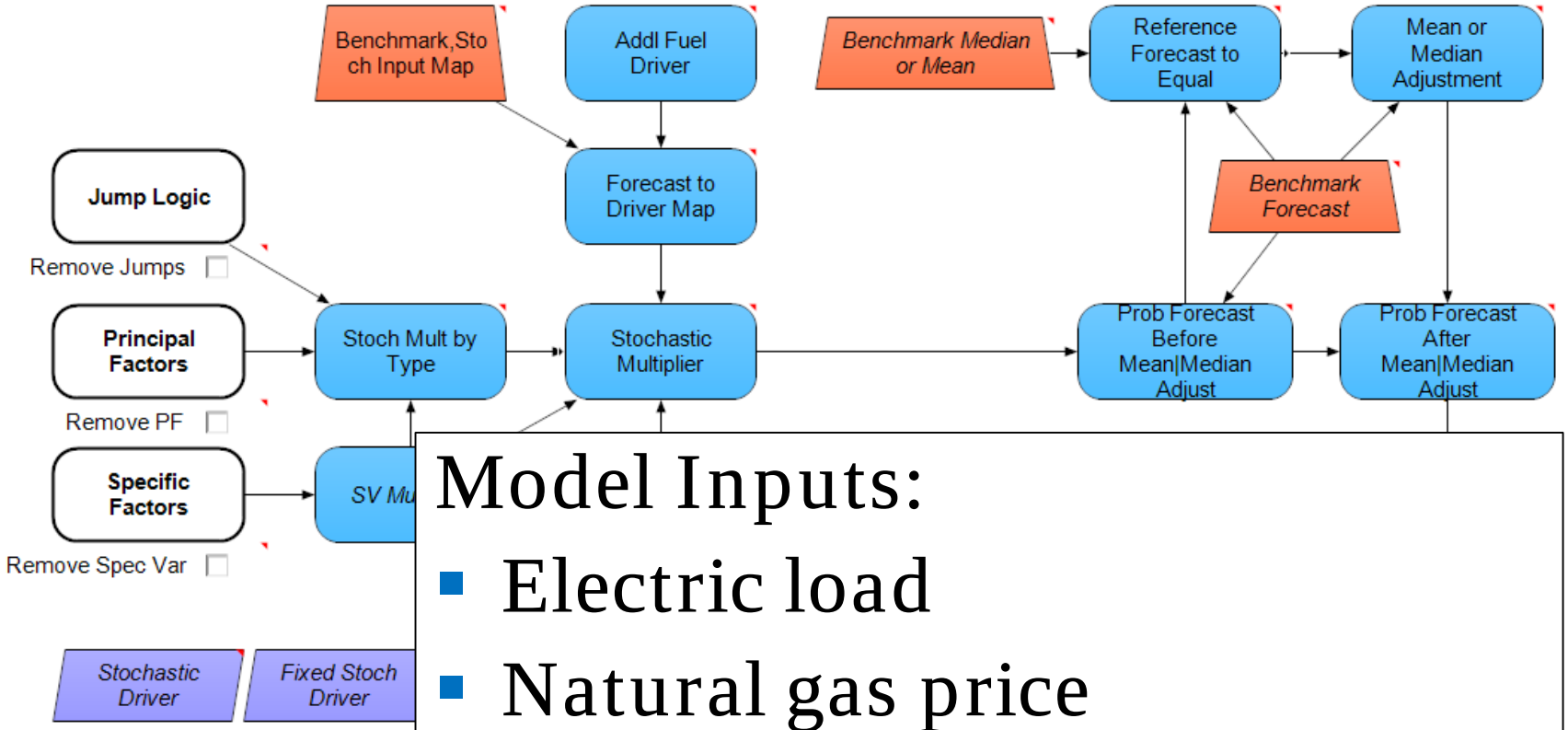
noun: **robustness**

the quality or condition of being strong and in good condition.

"the overall robustness of national and international financial systems"

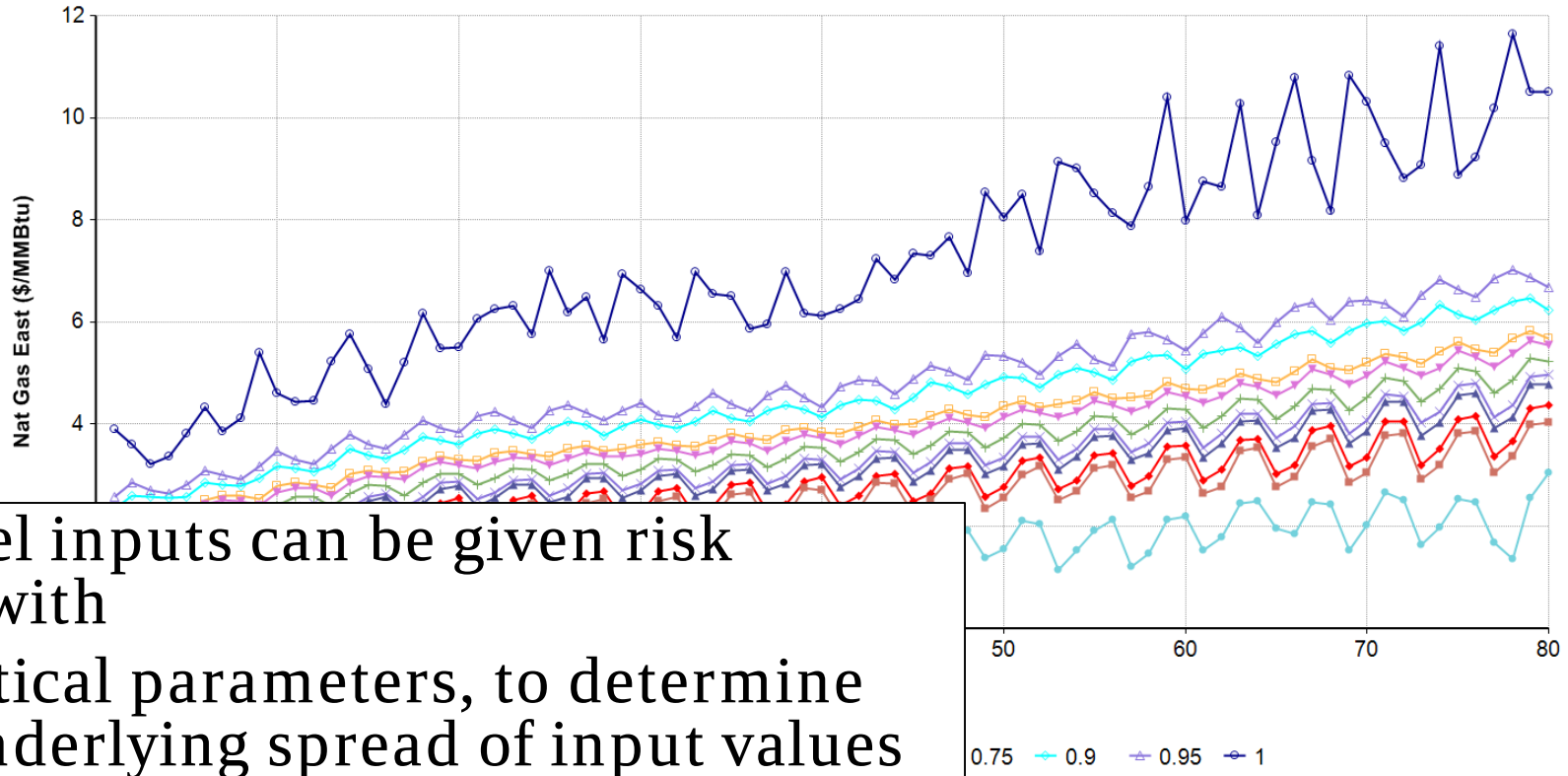
- the ability to withstand or overcome adverse conditions or rigorous testing.

"we can examine the robustness of our results"



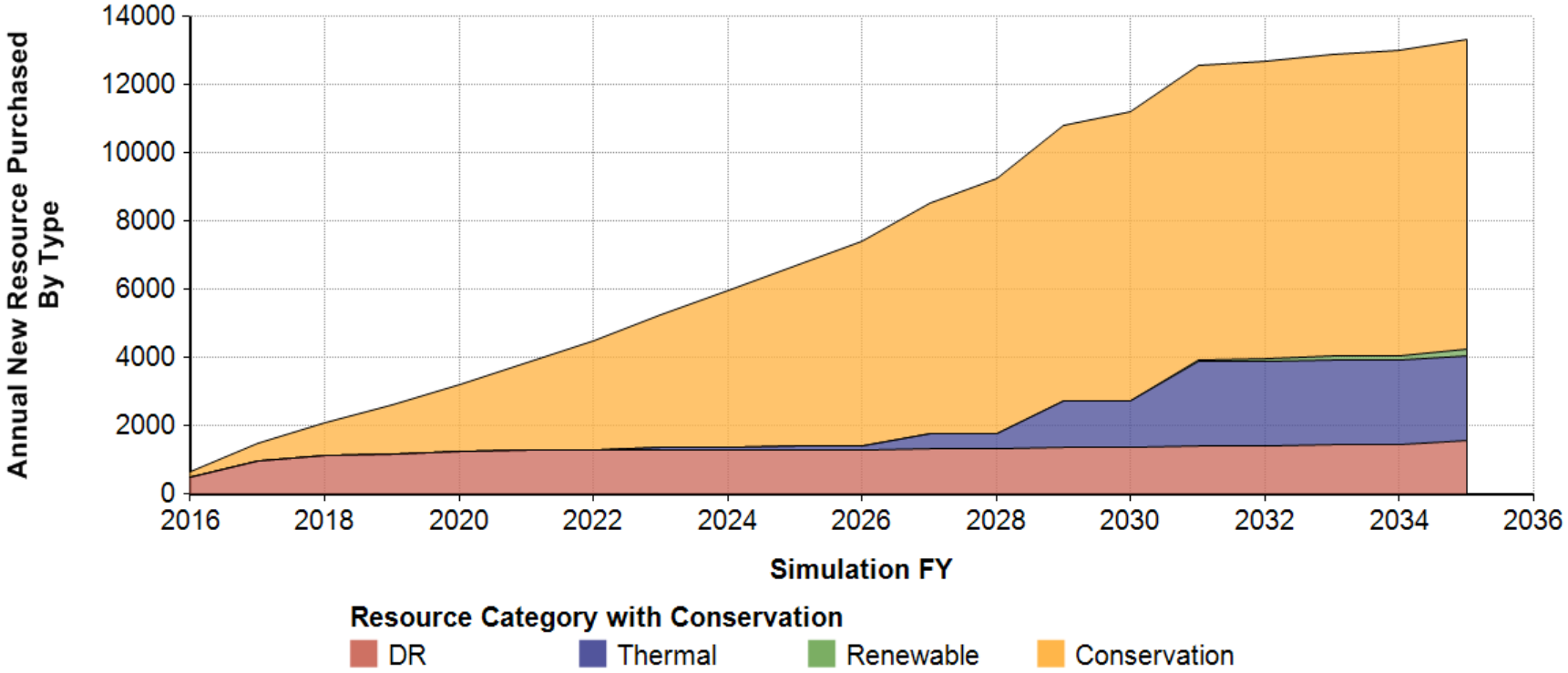
Model Inputs:

- Electric load
- Natural gas price
- Electricity price
- Renewable energy credit price
- CO2 price



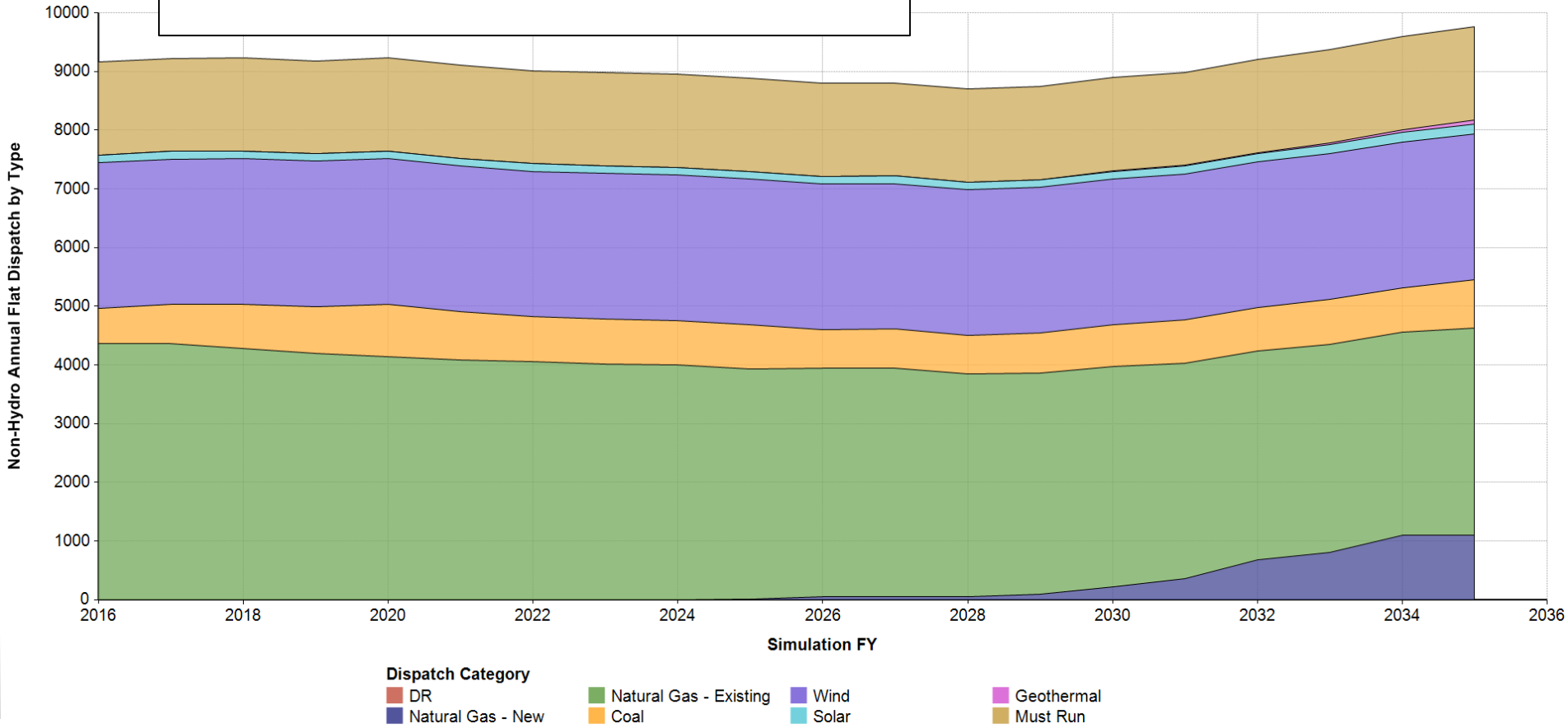
All model inputs can be given risk models with

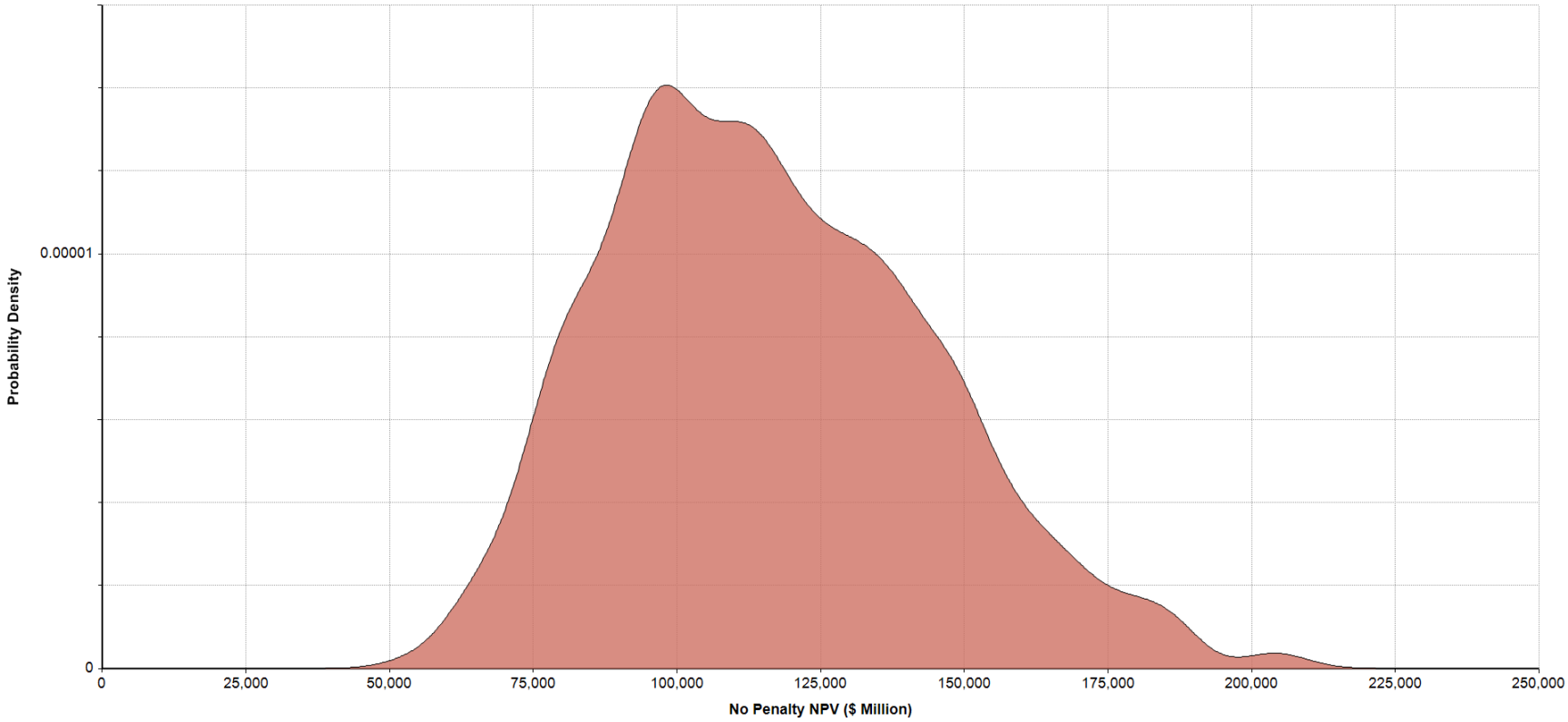
- Statistical parameters, to determine the underlying spread of input values
- Jump logic, to model sudden regime changes
- Seasonal logic, to model differences in expectation and volatility by quarter



Using the inputs the model estimates the need for new resources to minimize the cost of meeting load

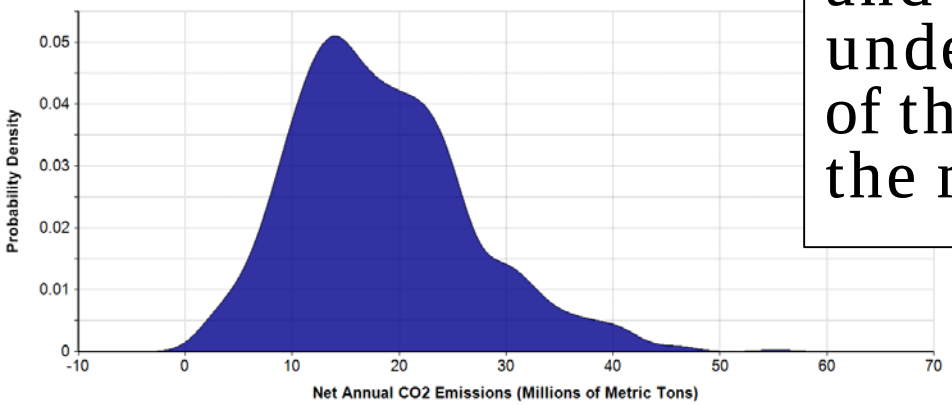
New and existing resources are dispatched against a market price that makes sure load and resources are balanced with imports and exports

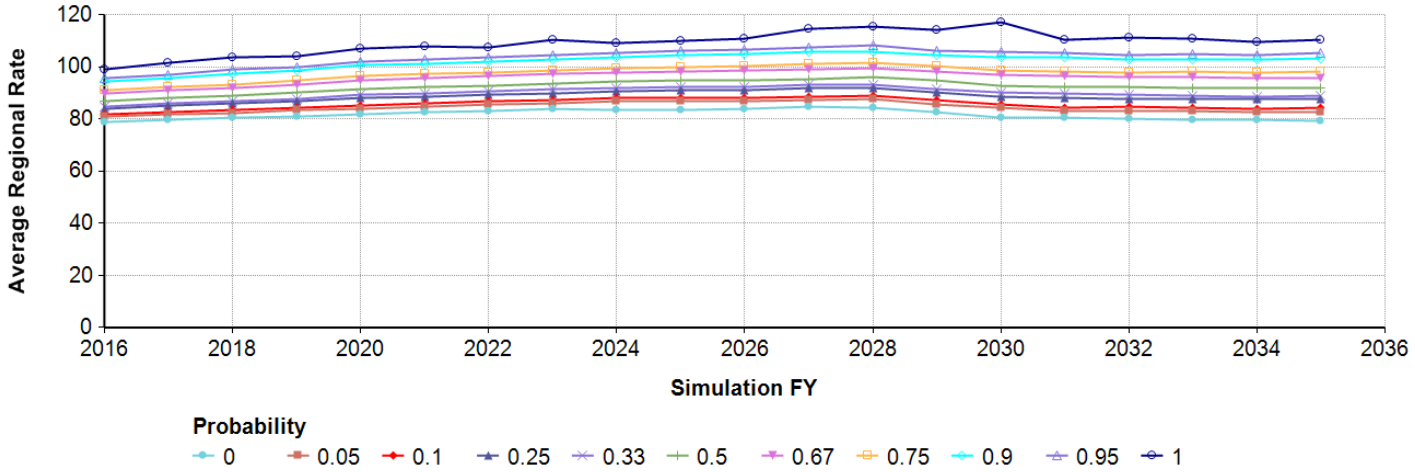




Using this information the system cost is estimated and discounted to “Net Present Value” dollars

Additional results are tracked and reported to help understand the implications of the resource expansion in the model





Wash, Rinse, Repeat

- The optimization takes these results for a candidate resource strategy and uses them to guess what a better strategy would be
- Ultimately, what is reported is the best strategy for a given scenario

QUESTIONS?