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

August 6, 2019

MEMORANDUM

TO: **Power Committee Members**

FROM: John Ollis, Power System Analyst

SUBJECT: **Analyze Resource Strategies Process**

BACKGROUND:

Presenter: John Ollis

Summary: In preparation for the 2021 Power Plan, staff will be providing the Power Committee a series of presentations on different aspects to developing the plan. This presentation is on the analysis of resource strategies.

Relevance: Every five years, the Council reviews a 20-year "regional conservation and electric power plan," with special focus on the regional resource strategy required to meet the region's power needs for the next five or six years. Council staff uses a portfolio of modeling tools to analyze different resources strategies to inform the Council on costs and risks associated with particular resource strategy choices for uncertain future conditions.

851 S.W. Sixth Avenue, Suite 1100
Portland, Oregon 97204-1348
www.nwcouncil.org

Steve Crow
Executive Director

503-222-5161
800-452-5161
Fax: 503-820-2370

The Regional Portfolio Model (RPM) is used to analyze the effectiveness of investments in new regional resources to meet power system needs and intra-regional policy requirements under uncertainty. AURORA incorporates a view of the extra-regional power system and associated policy drivers via market signals. GENESYS is used to check the capability of regional resource strategies to provide an adequate system at higher fidelity level than the RPM.

Updated frozen efficiency loads, external electricity prices, fuel prices, energy efficiency and demand response supply curve data, reference plant parameters, existing state policies and information about the existing system, system adequacy parameters and hydro condition data, and financial assumptions are incorporated into the RPM. The RPM inputs are then modified to reflect whatever scenario is being tested and the model can simulate many investment strategies over many future conditions. Whichever strategy is least cost (or least risk) is then tested in GENESYS and AURORA, respectively, to check if it meets the regional adequacy standard and evaluate its effect on the overall western power system.

Workplan: A.5.2 Update models to get ready for 2021 power plan modeling

More Info: Discussion of resource strategy methodology and analysis used in the 7th Power Plan is discussed in detail in Chapter 3 and 15.

Chapter 3: Resource Strategy
https://www.nwcouncil.org/sites/default/files/7thplanfinal_chap03_resstrategy_3.pdf

Chapter 15: Analysis of Alternative Resource Strategies
https://www.nwcouncil.org/sites/default/files/7thplanfinal_chap15_resourcestratanalysis_1.pdf

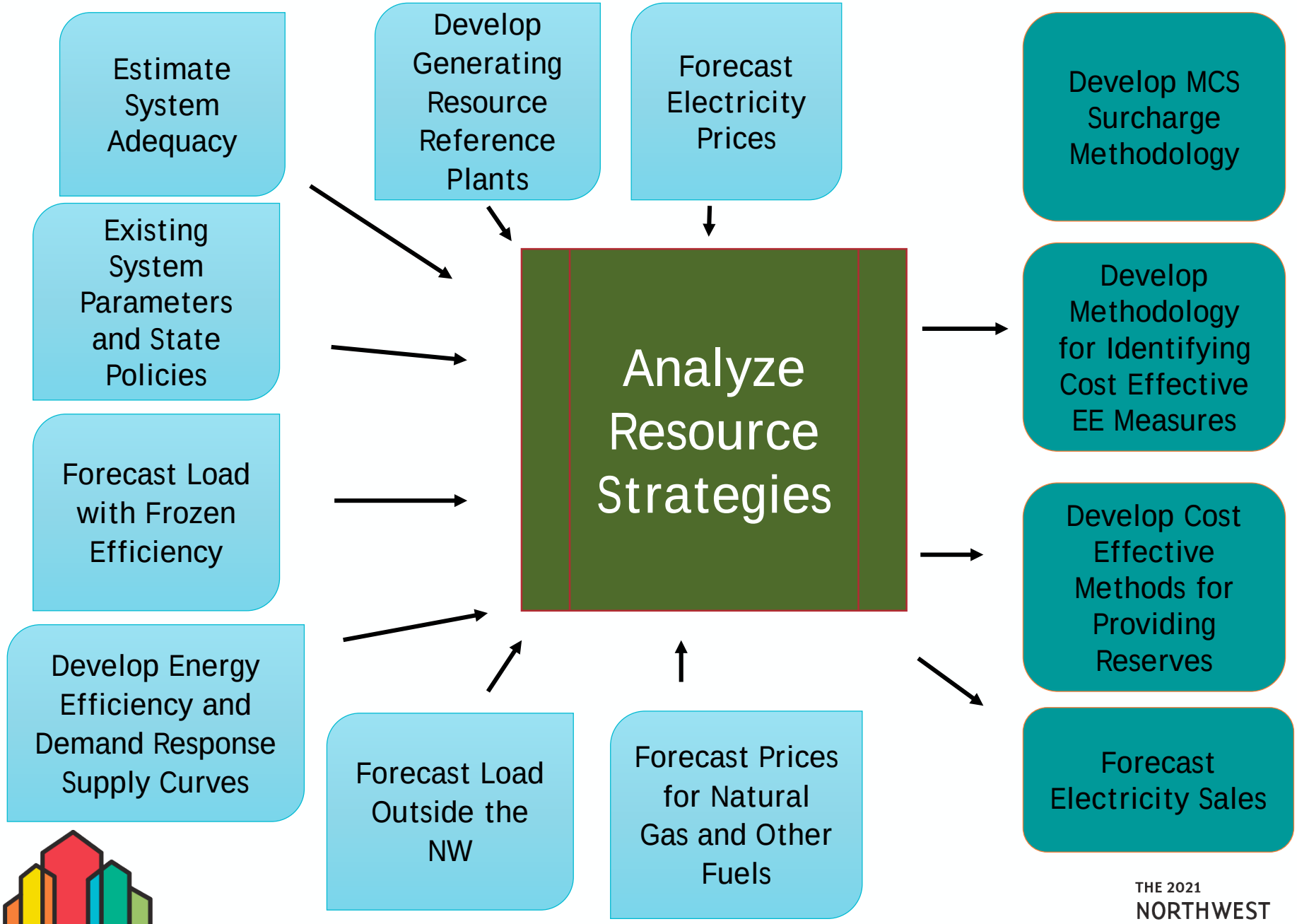
Analyze Resource Strategies

Power Committee

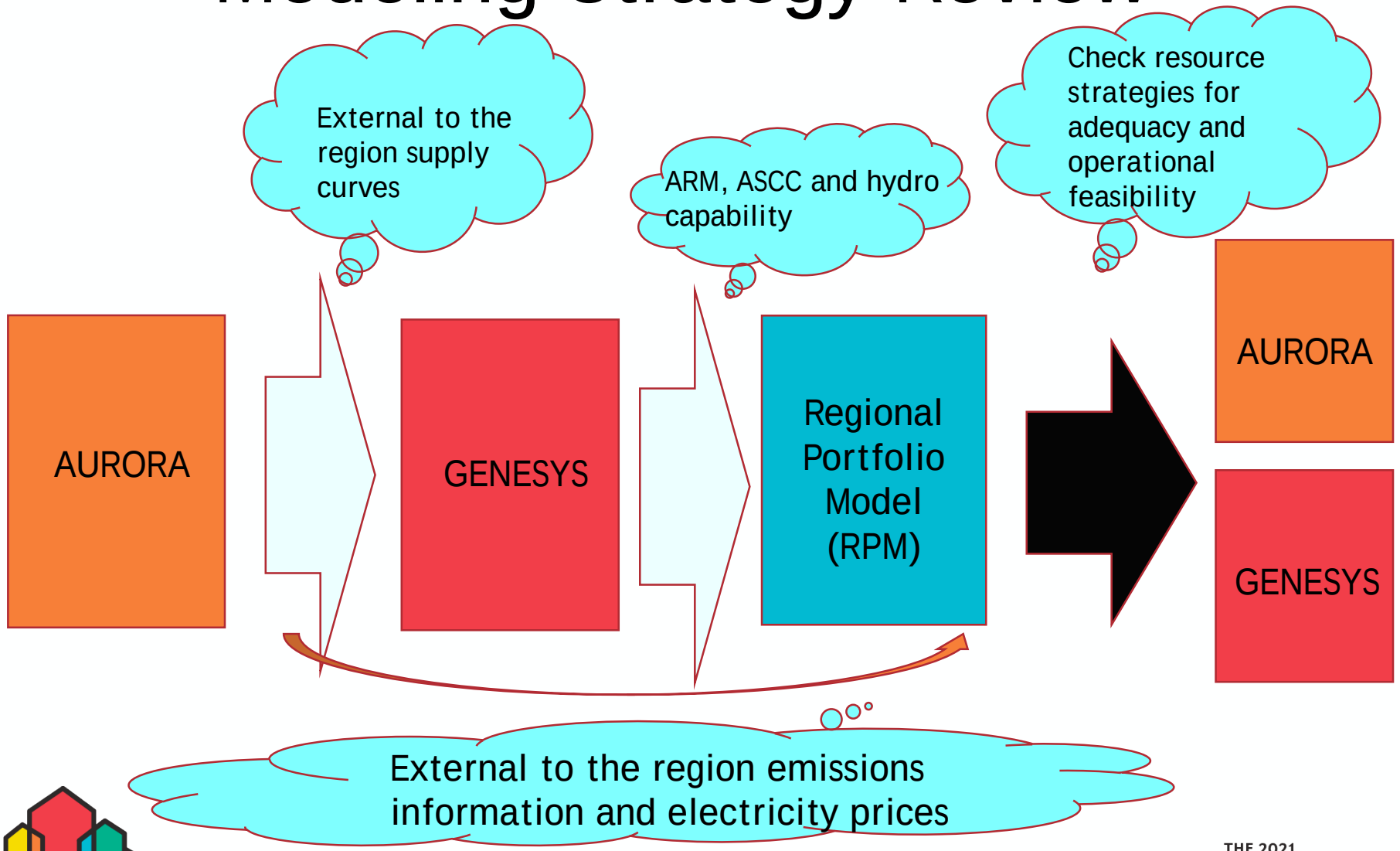
August 13, 2019

John Ollis

THE 2021
NORTHWEST
POWER PLAN
FOR A SECURE & AFFORDABLE
ENERGY FUTURE

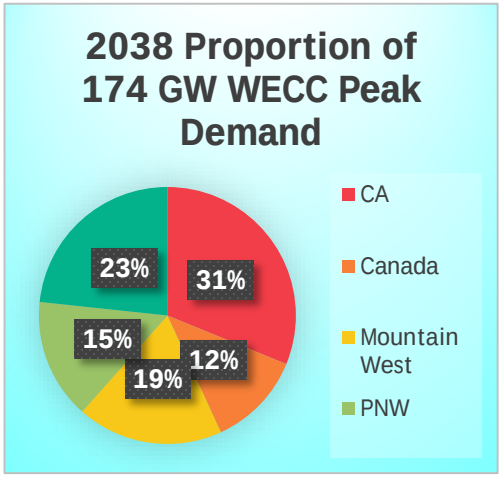

Estimate System Adequacy
Develop Generating Resource Reference Plants
Forecast Electricity Prices
Develop MCS Surcharge Methodology
Existing System Parameters and State Policies
Develop Methodology for Identifying Cost Effective EE Measures
Forecast Load with Frozen Efficiency
Analyze Resource Strategies
Develop Cost Effective Methods for Providing Reserves
Develop Energy Efficiency and Demand Response Supply Curves
Forecast Load Outside the NW
Forecast Prices for Natural Gas and Other Fuels
Forecast Electricity Sales

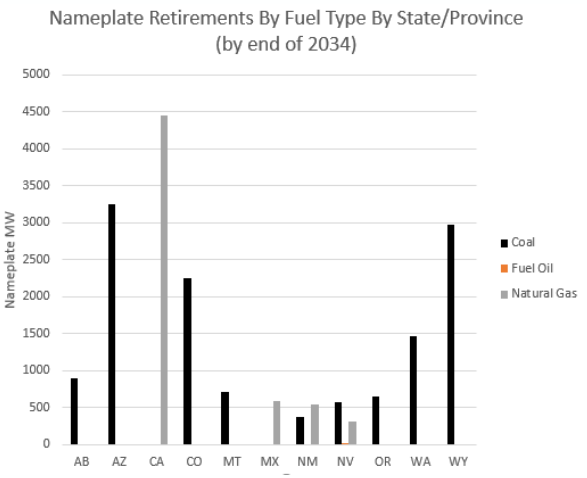
Modeling Strategy Review

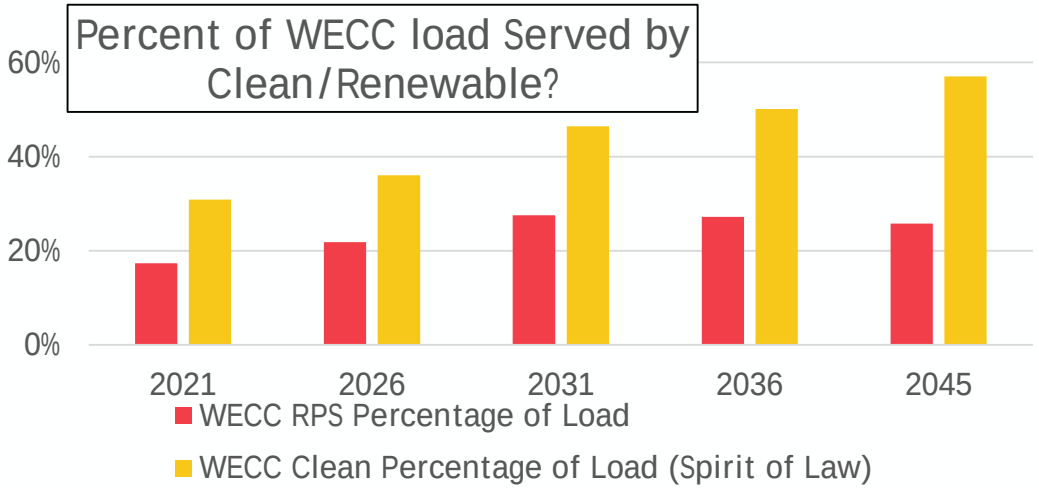


Review of Upstream Processes

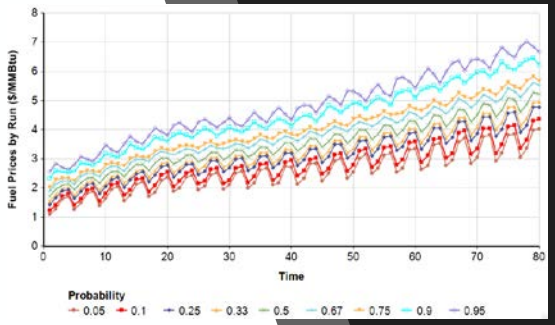
- Forecast of WECC loads by balancing authority (BA)
- Forecast of fuel and electricity prices throughout WECC
- Development of potential new resources
- Interpretation of existing state policies and update existing resource retirements
- Development of adequacy information



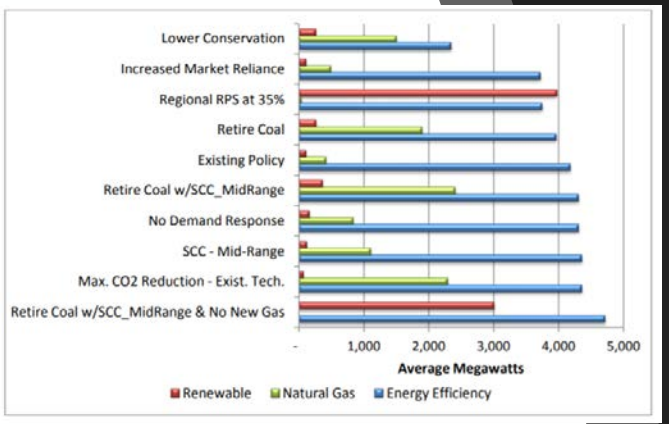




Review of Resource Strategy Development (Part 1)



What If????



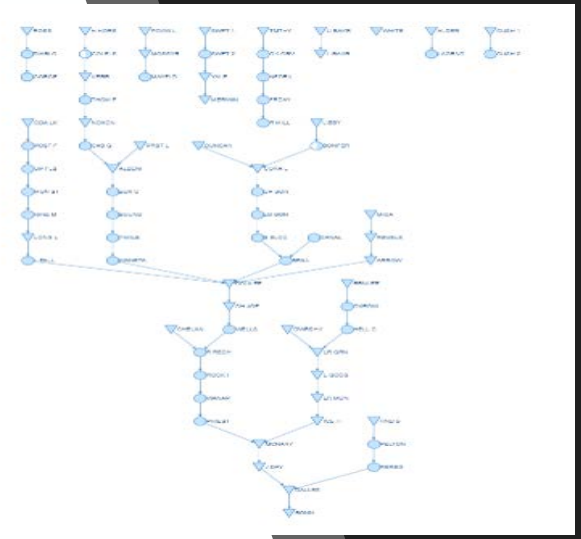
- Define a list of futures

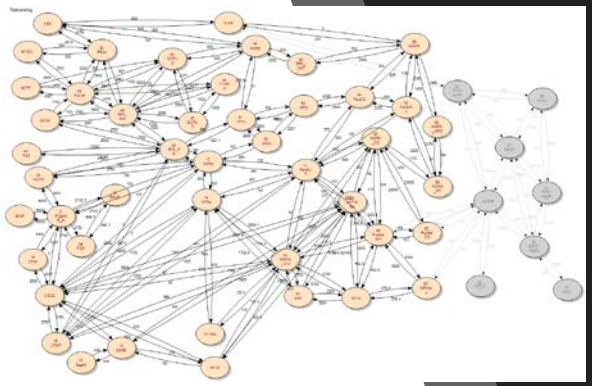
  - Elements of risk over which we have no or little control, like fuel prices, regional demand, wholesale market electricity price, and hydro conditions.

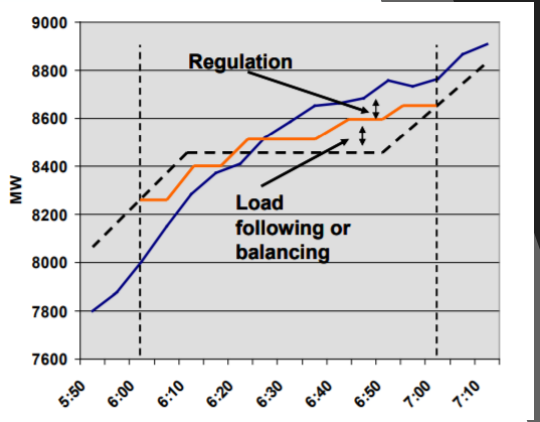
- Define a list of scenarios

  - Policies or outcomes over which we may have some control

- Use the Regional Portfolio Model (RPM) to test regional resource strategies from 2021 to 2040.
  - A resource strategy could include investments in new generating and demand-side resources.
  - Each resource strategy is tested over all the futures for every scenario, and the RPM is used to seek the least cost/risk strategy for each scenario.







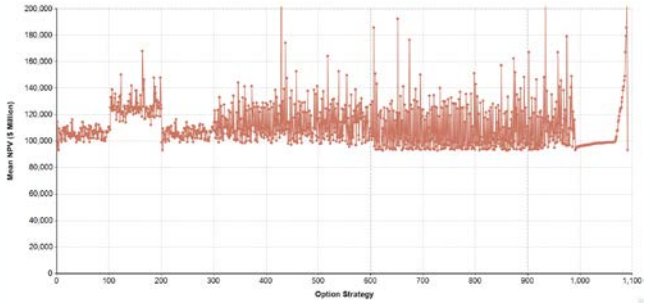
Review of Resource Strategy Analysis and Adequacy Check

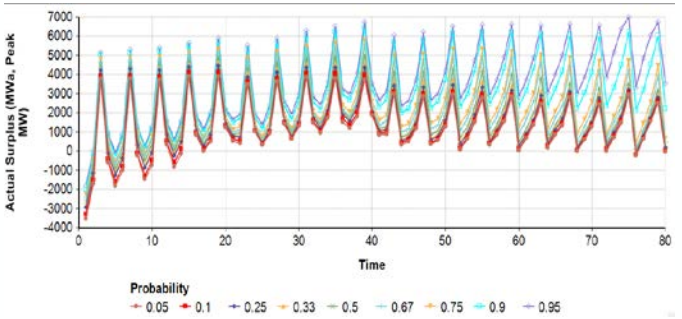
- To perform a regional resource expansion from 2021 to 2040 considered implicitly in RPM but not in detail.
  - Plant retirements and additions (out of the region)
  - Reliance on planning reserve margins for outside the region WECC planning areas for excess market availability
  - Existing state and regional policies (i.e. RPS, clean policies, carbon cap and trade policies, etc.)
  - Operational feasibility of a resource strategy
- Use AURORA to examine the repercussions of resource strategies on a WECC-wide basis
- Use GENESYS to check whether a regional resource strategy of interest meets the Council's adequacy standard.
  - This will include a consideration of whether balancing reserves and operational constraints of the system are maintained.

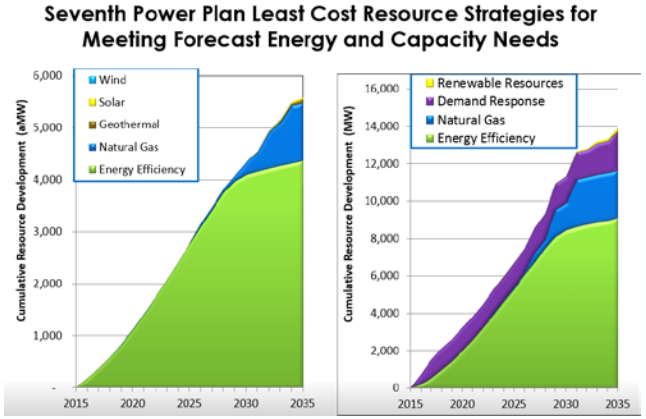
Regional Strategy Analysis – What We Do?

Assess the cost and risk associated different regional investment strategies in RPM, and check strategies of interest in AURORA and GENESYS.

- Test optioning and building generic new resources at different times during the 20 year time horizon to determine the least cost investment strategy.
- Consider market reliance and adequacy but do not model hourly and topological detail in the RPM.
  - Focus on capital investment decision making to meet adequacy and policy constraints in the most economic way
  - Economic signals external to the region are reflected to some extent in external market electricity price and emissions forecast
  - Regional adequacy standard is reflected via the adequacy reserve margin, associated system capacity contribution and hydro available under critical conditions.







Regional Strategy Analysis – Why We Do It This Way

Time and analytical focus on risk

- Explicitly scheduling and dispatching all the plants in the WECC or the region, and ensuring that river flows meet all constraints in RPM would increase run time on an already complex problem.
    - Thus, it would take away time to evaluate optimal investment strategies over as many future outcomes

- Resource strategy operational feasibility and adequacy can be tested in GENESYS and AURORA

- Consistency with external state policies and other regions planning reserve requirements can be tested in AURORA

$$V = \sum_{h \in H} C \cdot \max(0, (p_e(h) - p_g(h)))$$

where

H is the set of hours (672 in this case)

$p_e(h)$ is the price of electricity in this hour ($/MWh)

$p_g(h)$ is the price of gas in this hour, assuming a fixed heat rate ($/MWh)

C is the capacity of the turbine (1 MW in our case)

Rearrangement gives the value in terms of the expected return from the market.

$$V = C \sum_{h \in H} \max\left(0, p_e(h) - p_g(h)\right)$$

$$= CN_H \frac{\sum_{h \in H} \max\left(0, p_e(h) - p_g(h)\right)}{N_H}$$

or

$$V = CN_H E\left[\max\left(0, p_e(h) - p_g(h)\right)\right] \qquad (3)$$

Solving the expectation takes some statistical derivation; assuming $p_e(H)$ is a random variable and X is constant, notice that

$$\int \max(0, p_e(H) - X) f(p_e(H)) dp_e(H) = \int_X^\infty (p_e(H) - X) f(p_e(H)) dp_e(H)$$

$$= \int_X^\infty p_e(H) f(p_e(H)) dp_e(H) - X \int_X^\infty f(p_e(H)) dp_e(H)$$

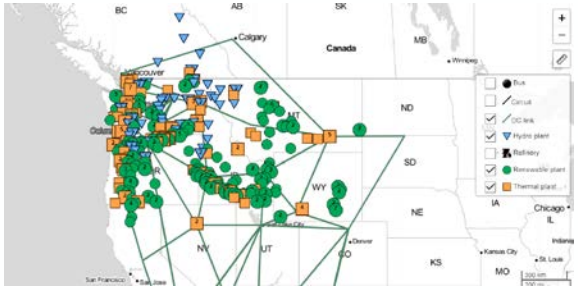
In the last expression, the first integral is partial expectation and the second is a survival function. Assuming $p_e(H)$ has a lognormal distribution with $E[p_e(H)] = \bar{p}_e$ and $Var[p_e(H)] = \sigma_e$ then both of these can be expressed in terms of the standard normal distribution Φ, thus

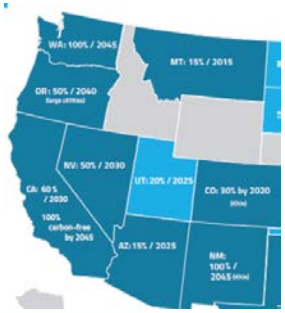
$$\int_X^\infty p_e(H) f(p_e(H)) dp_e(H) - X \int_X^\infty f(p_e(H)) dp_e(H) = \bar{p}_e \Phi\left(\frac{-\ln X + \bar{p}_e + \sigma_e^2}{\sigma_e}\right) - X\Phi\left(\frac{-\ln X + \bar{p}_e}{\sigma_e}\right)$$

A little rearrangement then gives

$$E[max(0, p_e(H) - X)] = \bar{p}_e \Phi(d) - X\Phi(d - \sigma)$$

where





Review of Downstream Processes

- Develop a methodology for determining cost-effective EE
- Forecast regional retail electricity sales
- Develop a cost-effective methodology for providing reserves

Develop Methodology for Cost Effective EE

- Resource strategy analysis from RPM can inform the following in determining whether an EE measure is cost-effective:

1. Help how much conservation is cost-effective compared to other resources on a generic basis.
2. Each resource strategy has an associated equilibrium market price forecast which can be used as a market price assumption in the *value of energy savings* calculation.
3. Information from the resource strategy can be used to help determine the *deferred generation credit* and *risk mitigation factor*.

$$\frac{Benefit}{Cost} = \frac{NPV(energy + capacity + other\ fuel + NEI + avoided\ periodic\ replacement)}{NPV(capital\ cost * (1 + admin) + annual\ O\&M + other\ fuel + NEI + periodic\ replacement)}$$

Where *NPV* is the net present value and:

$$energy = kWh_{i,bb} * ((MP + C)_i + RMC) * (1 + 10\%)$$

and

$$capacity = kW_{peak,bb} * (T_{avoid} + D_{avoid} + Gen_{avoid}) * (1 + 10\%)$$

The terms are defined as:

NEI = non-energy impacts

admin = administration cost adder (assumed 20%)

kWh = energy saved by time segment *i* (e.g. heavy/light load hours, monthly)

kW_{peak} = winter peak power saved

bb = busbar

MP = market price forecast ($/kWh) by time segment *i*

C = carbon cost forecast ($/kWh) by time segment *i*

RMC = risk mitigation credit for stochastic variation in inputs ($/kWh)

T_{avoid} = deferred transmission capacity credit ($/kW-yr)

D_{avoid} = deferred distribution capacity credit ($/kW-yr)

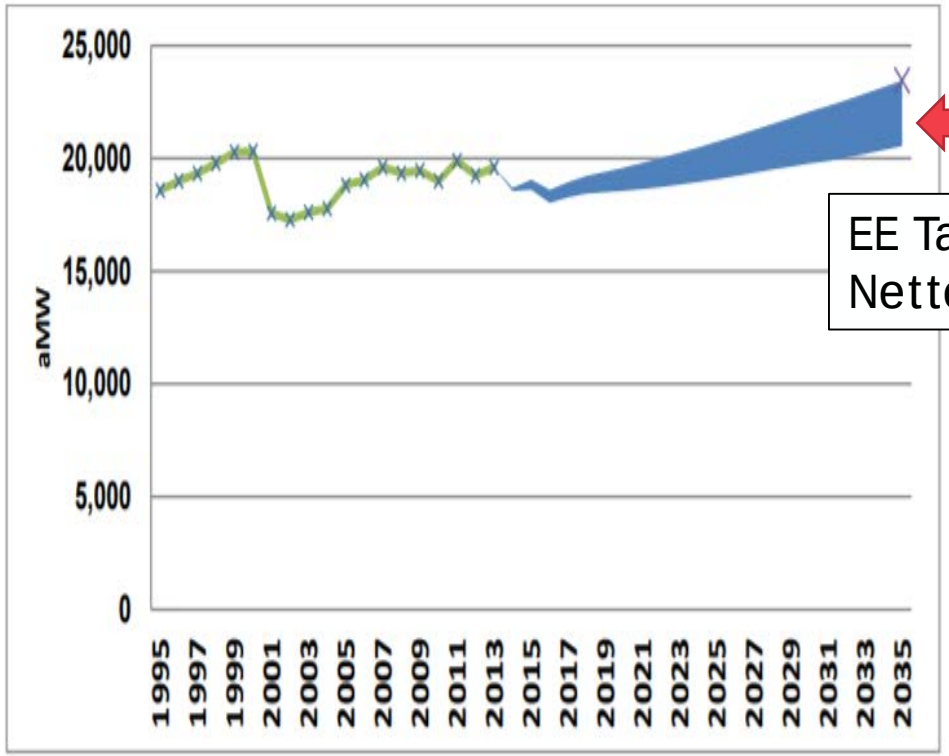
Gen_{avoid} = deferred generation capacity credit ($/kW-yr)

10% = Regional Act conservation credit

Forecast regional retail electricity sales

- Resource strategy analysis from RPM can inform the following in forecasting regional energy sales:

1. Energy efficiency and demand response per the resource strategy can be netted from the frozen efficiency loads by end use and sector
2. Implementation of a resource strategy from RPM has an associated percent change in revenue requirement which can be interpreted as a percent change in retail rates.



Develop Methodology for Cost Effective Reserves

- Resource strategy analysis must consider all the regional needs considering cost-effective approaches, including reserves:

1. Evaluate capability and risk associated with least cost resource strategies (flexibility, availability and magnitude) to meet reserve and adequacy needs in GENESYS and AURORA.
2. Test costs associated with providing changing seasonal balancing reserve needs associated with variable energy generation.
3. Test costs associated with maintaining adequacy (regional planning reserve margin).