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March 3, 2015

MEMORANDUM

TO: **Council Members**

FROM: **Tom Eckman and Ben Kujala**

SUBJECT: **Proposed Seventh Plan Scenarios, Priority Rankings and Analysis Schedule**

BACKGROUND:

Presenter: Tom Eckman and Ben Kujala

Summary: The Council's approach to development of its Power Plan involves the testing of alternative resource strategies across a range of potential future conditions. This process is referred to as "scenario analysis" and is carried using the Council Regional Portfolio Model (RPM). The primary purpose of these tests is to identify the risk and cost associated with different mixes of resources and the timing of their development. Staff has prepared a draft set of proposed scenarios for testing for the Council to consider. Staff is seeking the Council's guidance on whether these scenarios address those issues that are of most concern and or importance. In addition, staff is seeking Council guidance on the priorities for analyses.

Relevance: One of the primary tools used to inform the development of the Council's Seventh Power Plan are the results of its scenario analysis. Selection of the scenarios to be tested during the development process is a critical step in this process, since it establishes scope of the constraints and "stresses" to which potential resource strategies to which will be subjected.

Work plan: Work plan 1.D. - Develop Seventh Power Plan and maintain analytical capability. Develop draft scenarios and strategies to be analyzed and establish metrics for comparison

Background: The primary focus of this presentation will be on the potential scenarios to be analyzed for the Seventh Power Plan. A proposed set of “standard metrics” that would be used to compare scenario results will also be presented. Staff is proposing scenarios to investigate five major areas as follows:

- Carbon policy;
- Major resource loss;
- Pace of conservation development;
- Increased reliance on variable resources (PNW and CA); and
- Potential effects of climate change.

Staff is proposing for Council consideration fifteen specific scenarios to investigate these issues. Below the proposed scenarios are summarized briefly. A more detail description and purpose of these scenarios appears in the attached Table 3.

In Scenarios 1A and 1B the Regional Portfolio Model (RPM) would be run with existing policies, including those affecting renewable resource development and carbon emissions. These scenarios permit the quantification and comparison of the effects of the different carbon policy scenarios with existing policies. Scenario 1A is a run without future uncertainties regarding market electricity and natural gas prices, load growth and hydro-system output. Scenario 1B is a run without new carbon policies, but with all of the other key input uncertainties typically considered by the RPM. Comparison of 1A with 1B will illustrate how different resource strategies evolve to address the risks associated with unknown futures.

Three scenarios explore the effects of different carbon policy: Scenario 2A assumes the region will need to meet the policy goal of the Obama Administration “Clean Power Plan” (CPP) which, at the national level is a 30 percent reduction in carbon emissions over 2005 levels by 2030. Under the Environmental Protection Agencies (EPA) proposed regulation, this goal can be achieved either by reducing the *total* carbon emissions (metric tons) from existing power plants, or by limiting the total carbon emissions from both new and existing power plants or by reducing the *average emissions rate* (pounds per kilowatt-hour) from existing power plants in each state. EPA’s proposal also permits states to join together to comply as a region.

Table 1 below shows the total “mass based” and “rate based” CO_2 emissions limits proposed by EPA. The “massed based” limits shown below include CO_2 emissions from both existing generation affected by 111(d) and for new generation built during the compliance periods. If a state (or region) adopts this compliance option, new generation would not be required to satisfy the EPA’s proposed 111(b) requirements. While energy efficiency does not count directly as “equivalent” to generation in the determination of compliance under the “mass based” option, its impact on the need for new generation will reduce total future emissions.

The “rate based” target shown below is for only existing power plants covered by the EPA’s proposed 111(d). The “rate based” targets include kilowatt-hour savings from energy efficiency and renewable resource production developed through the compliance period in the determination of compliance. The “rate base” compliance options also does not include emissions from new power generating facilities covered by EPA’s proposed 111(b) regulations.

Table 1 - Proposed Baseline, Interim and Final Mass and Rated-Based Equivalent CO_2 Emissions Limits for Existing Affected and New Sources						
	2012 Baseline Mass Equivalent (Million Metric Tons)	**Interim Mass Equivalent (Million Metric Tons)**	**Final Mass Equivalent (Million Metric Tons)**	**2012 Baseline Rate (pounds/MWh)**	**Interim Rate (pounds/MWh)**	**Final Rate (pounds/MWh)**
Idaho	0.6	0.9	1.0	858	244	228
Montana	16.3	15.4	15.2	2,439	1,882	1,771
Oregon	7.0	5.2	5.3	1,081	407	372
Washington	6.6	4.4	4.8	1,379	264	215
Region[1]	30.5	25.9	26.2	1,634	658	571

The CO_2 emission goals for Scenario 2A could be based on satisfying either of the “mass based” or “rate based” emission requirements. However, staff recommends that this combined target be used in scenario 2A since it is a both a more complete measurement of the power system’s total CO_2 emissions and is also the metric tracked in the RPM and Aurora market model

Scenario 2B proposes to set a carbon cost equal to the social cost of carbon as estimated by the US Interagency Working Group on Social Cost of Carbon (SCC). According to the Working Group:

The SCC is an estimate of the economic damages associated with a small increase in carbon dioxide (CO2) emissions, conventionally one metric ton, in a given year. This dollar figure also represents the value of damages avoided for a small emission reduction (i.e. the benefit of a CO2 reduction).

Therefore, in theory, the cost and risk of the resource strategy that achieves CO2 reductions equivalent to the SCC would offset the cost of damage. Scenario 2C will model an uncertain cost of carbon varying by “future” similar to the approach in the Sixth Plan.

Table 2 shows the most recent Social Cost of Carbon estimates from the US Interagency Working Group and the average cost of carbon across all futures tested in the 6th Plan’s “Carbon Risk” scenario where carbon prices varied by year between $0

[1] Note: EPA emissions limits shown in Table 1 include generating resources located in Idaho, Montana, Oregon and Washington. They do not include emissions from power plants modeled in the RPM that are located in Wyoming and Nevada and that serve the Northwest Region.

and $100 per ton. As can be seen from Table 2, the average price of carbon assumed in the 6th Plan's "Carbon Risk" scenario are very similar to the Interagency Working Group's estimate of the SCC at a 3% discount rate. Staff is seeking guidance from the Council on which of the SCC estimates to use in Scenario 2B. Staff proposes to use the 6th Plan's "carbon risk" scenarios carbon price distribution in Scenario 2C. Comparison of the results of scenarios 2B and 2C should reveal the impact of uncertainty regarding future carbon cost/emissions limits on the cost and composition of successful resource strategies.

Table 2 - Social Cost of CO_2, 2015-2050 (2012$/Metric Ton)					
	Discount Rate and Statistic				
Year	**5% Average**	**3% Average**	**2.5% Average**	**3% 95th Percentile**	**6th Plan (Average $0 - $100 Futures)**
2015	$12	$40	$62	$118	$36
2020	$13	$47	$69	$139	$52
2025	$15	$51	$75	$156	$57
2030	$17	$56	$81	$173	$58
2035	$20	$61	$87	$190	
2040	$22	$66	$94	$208	
2045	$26	$71	$100	$224	
2050	$29	$77	$106	$239	

A fourth and fifth set of scenarios explore the largest feasible carbon reductions. Scenario 3A explores the maximum carbon emissions that are feasible with current commercially available technologies, while Scenario 3B will considers the role of new technologies might play in achieving this goal. The staff does not presently believe that it will be possible to model Scenario 3B in the RPM. However, staff does think that it will be feasible to use the results of Scenario 3A to define the role (and perhaps cost) new technologies would need to play in order to achieve further carbon reductions. Staff is looking for Council guidance on how such aggressive policies should be phased in.

The final scenarios explore resource uncertainties. Scenario 4A examines the effect of the unanticipated loss of a major base-load resource such as the Columbia Generating Station (CGS). This scenario is designed to address a situation similar to the unanticipated closure of the San Onofre nuclear plant in California or the Fukishima complex in Japan. Scenario 4B looks at the loss of a significant amount of hydro capability but on a prescribed schedule. Scenarios 4C and 4D test the costs and risks associated with assuming a faster or a slower pace of conservation deployment.

Two scenarios are proposed to explore the costs and risks associated with reliance on out-of-region electricity market resources. Scenario 5A assumes that California achieves a 50 percent renewable resource goal, thus exploring the "duck" problem.

Scenario 5B will evaluate the effects of different limits on the availability and price of southwest markets.

At the February Power Committee meeting, the staff originally proposed a single scenario, (6) to test the potential effect of climate change on regional loads and hydrogenation. Staff is now proposing that this scenario be split into two separate scenarios. Scenario 6A would test only the potential impacts of changes in regional electricity load growth and load shapes due to forecast climate changes. Scenario 6B would test both the load impacts and the impact on hydrogenation of forecast climate changes.

Staff proposes to separate these potential issues for two reasons. First, changes in future load growth and load shapes can be readily modeled in the RPM without modification, while modeling changes in hydrogenation over time will require modification of the model. Therefore, if the Council determines that prospective climate change impacts on load growth and load shape should be considered across all scenarios this can be accomplished without affecting the draft plan development schedule.

The second reason the staff proposes to separate the impact of potential climate change on hydrogenation from impacts on regional electricity loads is that those changes are forecast to occur late in the planning period covered by the Seventh Plan. Moreover, the projections for precipitation and run-off patterns required to develop revised hydropower generation estimates will not be available until next year. While staff believes that it can approximate these changes using existing data for purposes of a sensitivity study, the staff does not believe that use of such estimates across all scenarios would be analytical rigorous. Staff will present its preliminary analysis of the magnitude of changes in future loads and hydrogenation at the Power Committee meeting for Council guidance on this issue.

It is not clear whether there will be time for the staff to run all of these scenarios through the RPM and provide time for Council discussion of their results for the draft plan. For that reason staff is seeking the Council's guidance on whether these scenarios address those issues that are of most concern and/or importance as well as guidance on which scenarios should have the highest priority for analysis. Table 4 shows the staffs initial ranking and proposed analytical schedule for each scenario.

The Power Committee will have an extended opportunity to discuss these scenarios, priorities and schedule at its March meeting. Following the March meeting these scenarios, rankings and schedule will be discussed at Council's Resource Strategies Advisory Committee meeting on March 12th and staff will propose a final list and schedule for analysis at the Council's April meeting.

More Info: See Tables 3 and 4 below.

Table 3 - DRAFT Potential Scenarios for Testing in RPM (Revised)

Scenario Number	Scenario Name	Description/Purpose of Scenario	Key Stress Factors Tested	Modeling Approach
1A	Existing Policy ***without*** Uncertainty, w/o GHG reduction risk	Existing RPS, state and federal environmental regulations, including MATS and haze, CA and BC carbon costs, state carbon limits on new generation. Average value across all futures for all major sources[2] of uncertainty.	Known generation fleet retirements and regulatory compliance costs	Use single future with expected values for load growth, gas prices, hydro-output, market prices, etc...
1B	Existing Policy ***with*** Uncertainty, w/o GHG reduction risk	Existing RPS, state and federal environmental regulations, including MATS and haze, CA and BC carbon costs, state carbon limits on new generation. *Distribution of values for all major sources of uncertainty across all futures. No carbon regulation or cost risk.*	Cost and Value of uncertainty risk mitigation with known generation fleet retirements and regulatory compliance costs Delineated by 1B – 1A	Standard model setup with zero carbon tax and no emission limit. RPM enhancement needed to make SW market availability a risk variable. Council staff to modify RPM.
2A	Existing Policy ***with*** Uncertainty and ***with certain*** GHG reduction risk/target. Example Policy Target = Clean Power Plan/Clean Air Act 111(d) goal (e.g., 30% below 2005 level by 2030	Existing RPS, state and federal environmental regulations, including MATS and haze, CA and BC carbon costs, state carbon limits on new generation. Distribution of values for all major sources of uncertainty across all futures. *Scenarios will test specific carbon reduction targets or costs. Example:* Resource strategies must result in 30% less GHG emissions by 2030 compared to 2005 (or some variant of this policy)	Cost and Value of uncertainty risk mitigation with known generation fleet retirements and regulatory compliance costs Delineated by 2A – 1B	RPM enhancement needed to model physical emission limits as a constraint. Without model enhancement an external process must be used to establish schedule for retiring coal plants to meet emission limits. Council staff will assess options and present to Council for guidance.

[2] "Major variables" will be identified through Council, staff and stakeholder review.

2B	Existing Policy ***with*** Uncertainty and ***with certain*** GHG reduction risk/target. Example Policy Target = Mitigate to Estimated GHG Damage Cost	Existing RPS, state and federal environmental regulations, including MATS and haze, CA and BC carbon costs, state carbon limits on new generation. Distribution of values for all major sources of uncertainty across all futures. *Scenarios will test specific carbon reduction targets or costs. Example:* GHG emissions cost/price set equivalent to the US Interagency Working Group on Social Cost of Carbon (SCC)	Cost and Value of uncertainty risk mitigation with known generation fleet retirements and regulatory compliance costs. If SCC is used to represent damage cost, resulting portfolios theoretically achieve GHG mitigation equivalent to damage costs. Delineated by 2B – 1B	Model fixed carbon tax per year based on social cost of carbon, no stochastic variation. Implementing this scenario requires RPM enhancement that by Council staff.
2C	Existing Policy ***with*** Uncertainty ***and with uncertain*** GHG reduction risk/target.	Existing RPS, state and federal environmental regulations, including MATS and haze, CA and BC carbon costs, state carbon limits on new generation. Distribution of values for all major sources of uncertainty across all futures. *Scenarios will test specific carbon reduction targets or costs.* GHG emissions cost/price allowed to vary across futures between $X and $Y	Cost and Value of uncertainty risk mitigation without known generation fleet retirements and regulatory compliance costs Delineated by 2C – 1B	Standard model setup with carbon tax uncertainty and no emission limit.
3A	Lowering carbon emissions with current technology	Determine lowest feasible power system carbon emissions resource strategies using ***only available*** generation, storage and energy efficiency ***technologies***, including anticipated cost reductions. May include retirement of all regional coal plants and replacement with no or lower carbon emitting resources.	Cost and risk of minimizing power system GHG emissions feasible with existing technology Delineated by 3A – 2C	Retire all plants that exceed a maximum emissions standard. Retirement schedule to be determined.
3B	Lowering carbon emissions with emerging technology (e.g., storage, CO_2 heat pumps, SSL)	Determine lowest feasible power system carbon emissions resource strategies ***using emerging*** generation, storage and energy efficiency ***technologies***, including anticipated cost reductions. May include retirement of all regional coal plants and replacement with no or lower carbon emitting resources.	Cost and risk of minimizing power system GHG emissions feasible with emerging technology Delineated by 3B – 3A	Not possible to model this scenario directly. Staff will use contribution of remaining GHG emitting resources to derive proxy non-GHG emitting resource need from 3A.

4A	Major Resource Uncertainty - ***Unexpected*** Loss of Major Resource (e.g., CGS Forced Retirement)	Determine the resource strategies best suited to managing the unanticipated loss of a major (>1000 MW) non-GHG emitting resources	Cost and risk associated with unanticipated loss of major, non-GHG gas emitting resource Delineated by 4A – 2C	Generate a random time series that takes out CGS permanently, at an unexpected time. Model may need modification for this.
4B	Major Resource Uncertainty ***Anticipated*** Loss of Major Resource(s) (e.g., Snake River Dam Removal,)	Determine the resource strategies best suited to managing the loss of a major hydro resources	Cost and risk associated with replacement of existing hydro-generation. Delineated by 4B – 2C	Phased in reduction in hydro-system output, modeled by applying adjustment factor to existing system output
4C	Major Resource Uncertainty – Faster Pace of Conservation Deployment	Determine the resources that would be displaced if the deployment of energy efficiency is faster than anticipated	Cost and risk associated with assumed upper and lower limits on pace of conservation in resource strategies Delineated by 4C – 2C	Change ramp rates and rerun the conservation supply curves. Basically, just a different conservation supply curve.
4D	Major Resource Uncertainty – Slower Pace of Conservation Deployment	Determine the resources that would be developed if the deployment of energy efficiency is slower than anticipated	Cost and risk associated with assumed upper and lower limits on pace of conservation in resource strategies Delineated by 4D – 2C	Change ramp rates and rerun the conservation supply curves. Basically, just a different conservation supply curve.
5A	Integration of Variable Resources (i.e., Managing the NW Impact of the "Duck Curve"/50% CA RPS)	Determine the resource strategies that would best serve the region should CA achieve a 50 percent RPS using primarily solar PV	Cost and risk associated with potentially large extra-regional surpluses available at low prices during certain periods of the day and year Delineated by 5A – 2C	Need Aurora wholesale electricity market price curve by water year assuming scheduled solar build-out. Minor RPM enhancement required to synchronize water year and market electricity prices...
5B	Southwest Market Liquidity Variability	Determine the resource strategies that would best serve the region under severely reduced market availability from the Southwest.	Cost and risk associated with reduced liquidity associated with the Southwest Market. Delineated by 5B – 2C	Reduce fixed limit from external markets in RPM.
6A	Climate Change Load Impacts	Determine the impact on resource strategies under forecast future load conditions	Change in system load Delineated by 6 – 2C	Phased in change in system load

6B	Climate Change Load & Hydro Impacts	Determine the impact on resource strategies under forecast future hydro-power output conditions and load conditions	Change in hydro output and system load Delineated by 6 – 2C	Phased in change in hydro-system output and load

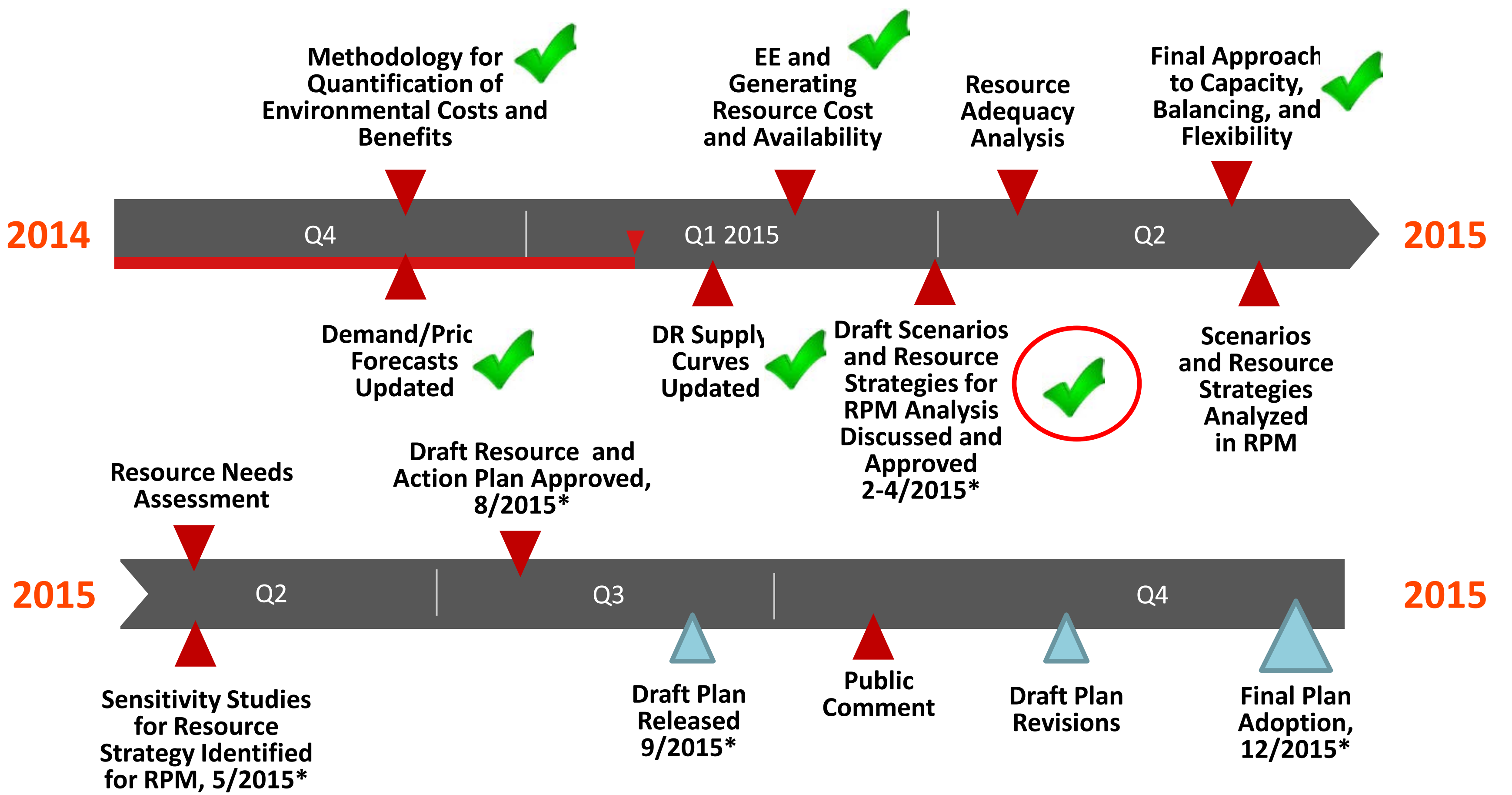
Table 4 - Proposed Scenario Analysis Priority Ranking and Analysis Schedule

Scenario Number	**Scenario Name**	Priority	Modeling Effort	DRAFT Schedule
1B	Existing Policy ***with*** Uncertainty, w/o GHG reduction risk	1	Med	April
1A	Existing Policy ***without*** Uncertainty, w/o GHG reduction risk	2	Med	April
2C	Existing Policy ***with*** Uncertainty ***and with uncertain*** GHG reduction risk/target.	3	Low	April
6A	1B + Climate Change Load Impacts	4	Low	April
2B	Existing Policy ***with*** Uncertainty and ***with certain*** GHG reduction risk/target. Example Policy Target = Mitigate to Estimated GHG Damage Cost	5	Low	Early May
4C	Major Resource Uncertainty – Faster Pace of Conservation Deployment	6	Low	Early May
4D	Major Resource Uncertainty – Slower Pace of Conservation Deployment	7	Low	Early May
2A	Existing Policy with Uncertainty and with certain GHG reduction risk/target. Example Policy Target = Clean Power Plan/Clean Air Act 111(d) goal (e.g., 30% below 2005 level by 2030	8	Med	Late May
3A	Lowering carbon emissions with current technology	9	Med	Late May
4A	Major Resource Uncertainty - ***Unexpected*** Loss of Major Resource (e.g., CGS Forced Retirement)	10	Med/High	Late May
4B	Major Resource Uncertainty ***Anticipated*** Loss of Major Resource(s) (e.g., Snake River Dam Removal,)	11	Low	Late May
3B	Lowering carbon emissions with emerging technology (e.g., storage, CO_2 heat pumps, SSL)	12	High	Not Modeled
5A	Integration of Variable Resources (i.e., Managing the NW Impact of the "Duck Curve"/50% CA RPS)	13	Med/High	Early June
6B	Climate Change Load & Hydro Impacts	14	High	Early June
5B	Southwest Market Liquidity Variability	15	Low	Early June

Draft 7th Plan
Scenarios Proposed for Testing

March 11, 2015

Major Seventh Plan Development Milestones

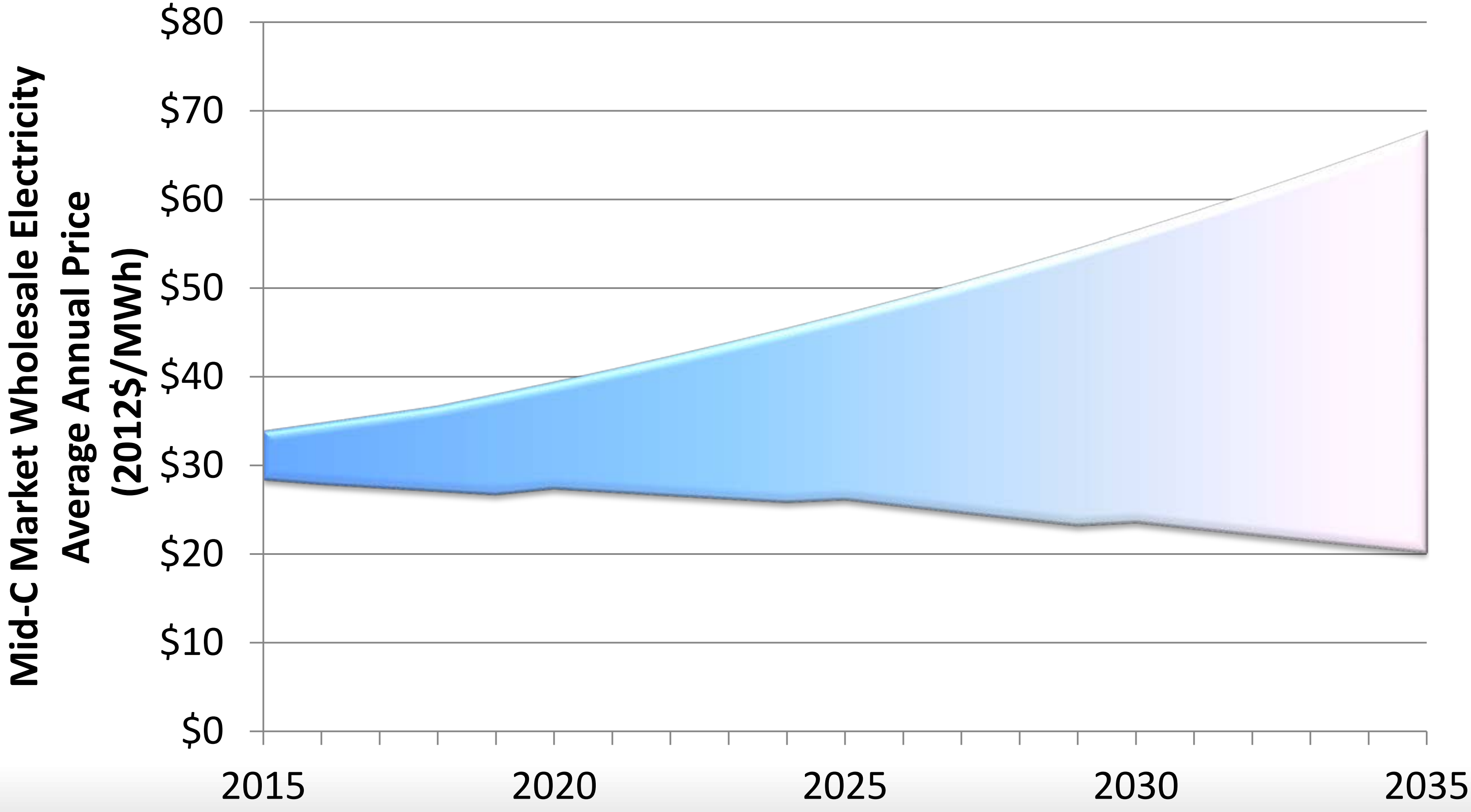


*Refers to the Council meeting in that month. Dates are DRAFT until each Council meeting agenda is finalized.

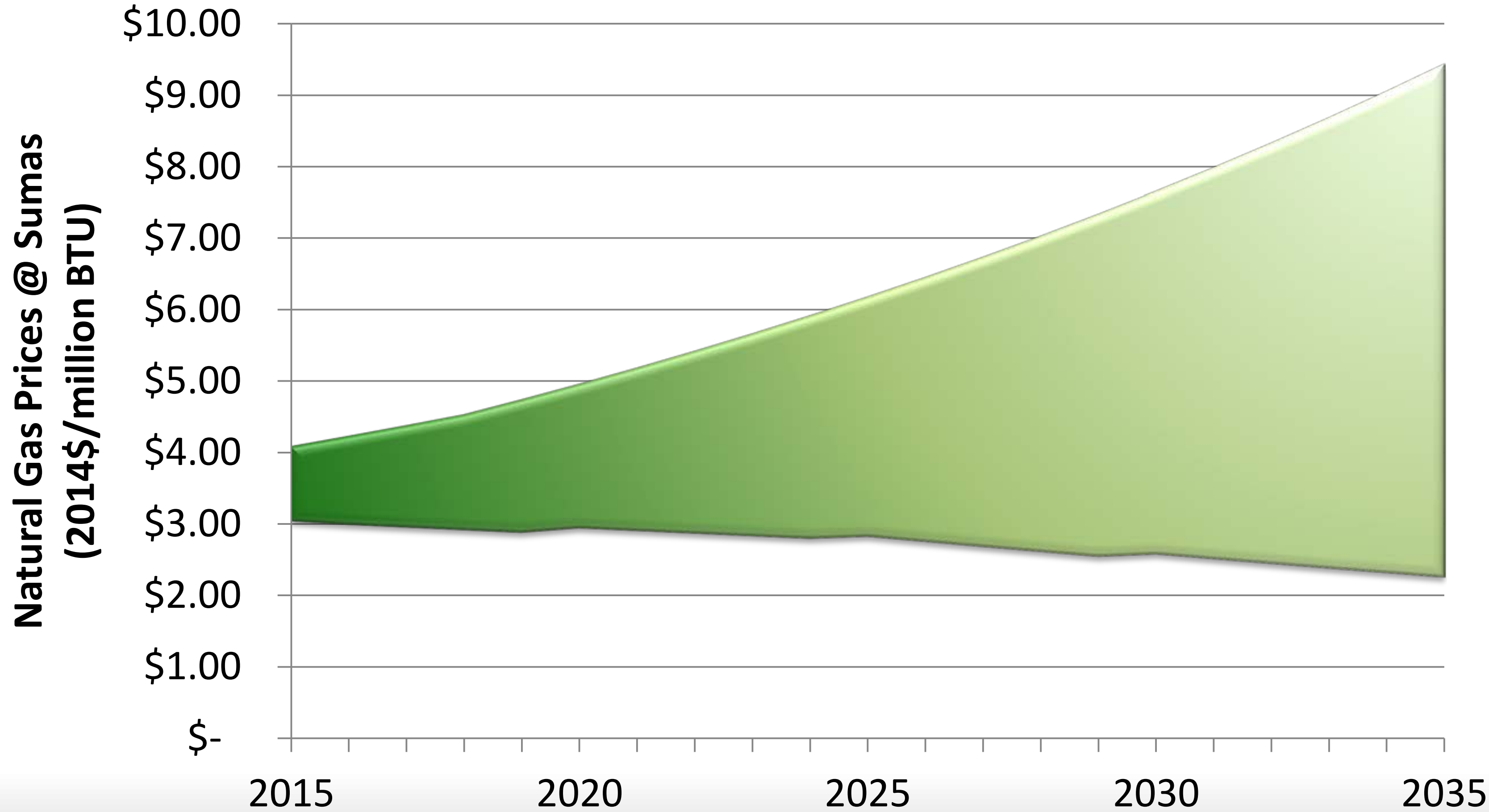
We're Now About To Try To Answer Those Simple Questions

1. *When Will We Need Resources?*
2. *How Much Will We Need?*
3. *What Should We Build/Buy?*
4. *How Much Will It Cost?*
5. *What's the Risk?*

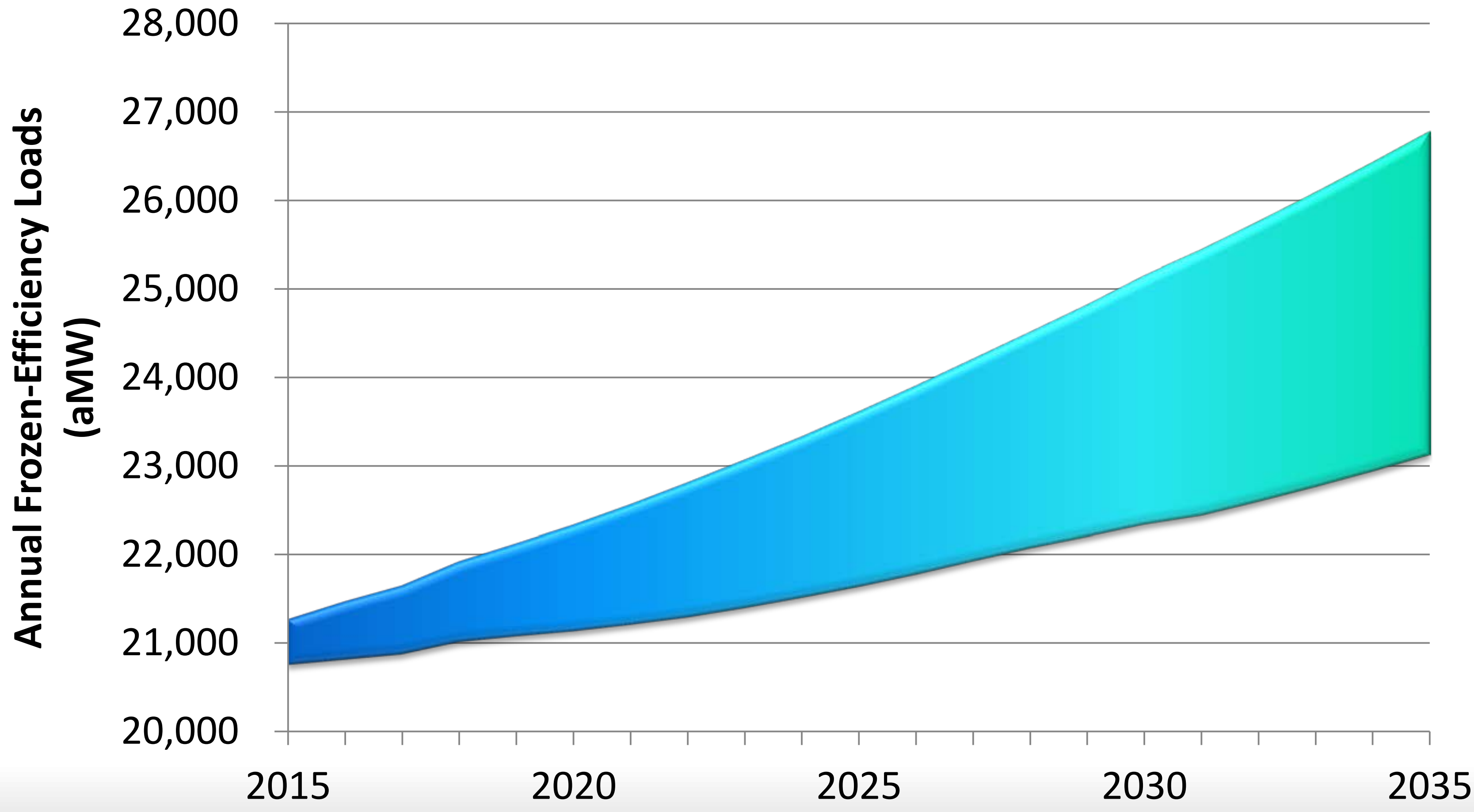
Draft 7th Plan Wholesale Electricity Market Price Forecast Range



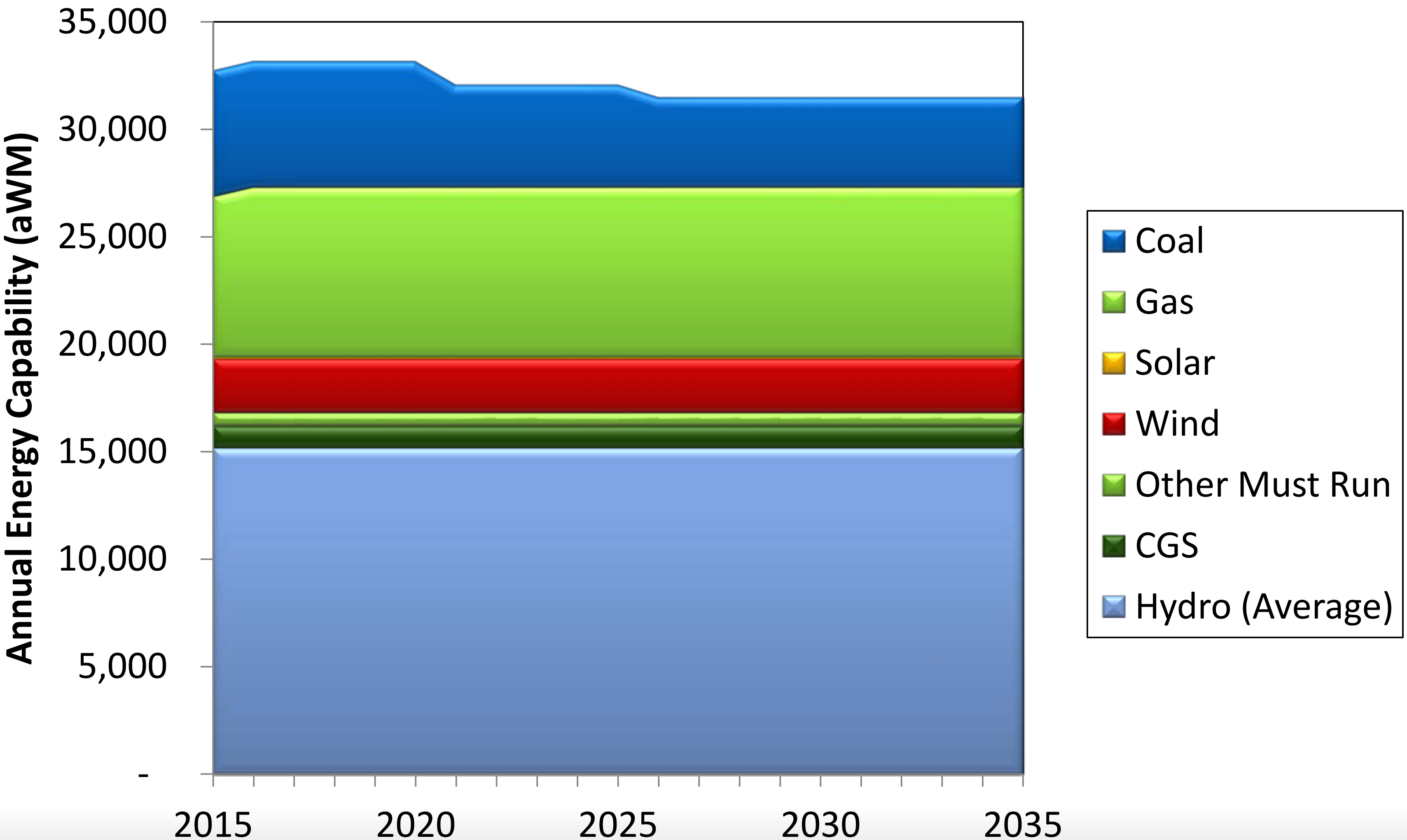
Draft 7th Plan Natural Gas Price Forecast Range



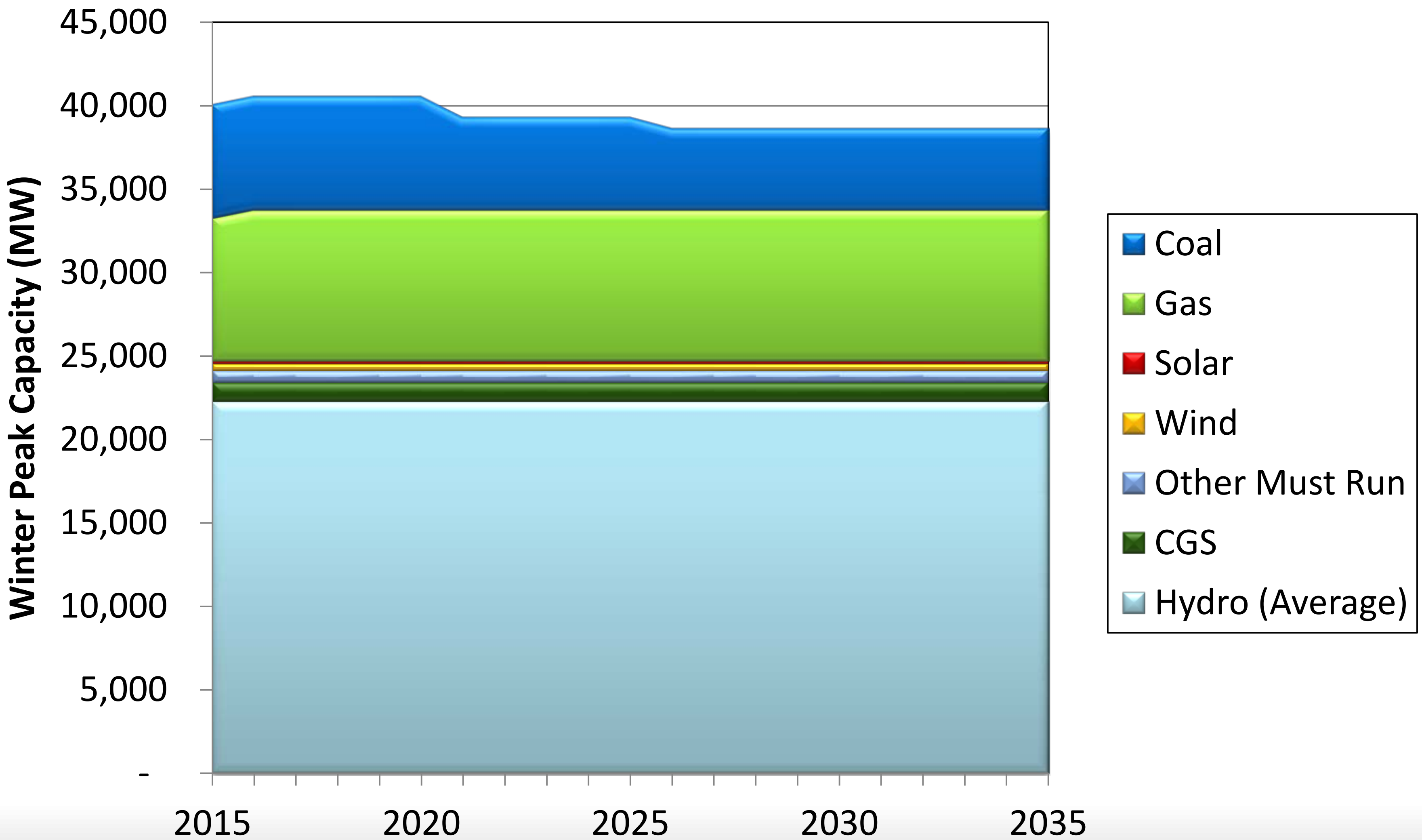
Draft 7th Plan Load Forecast Range (Pre-Conservation)



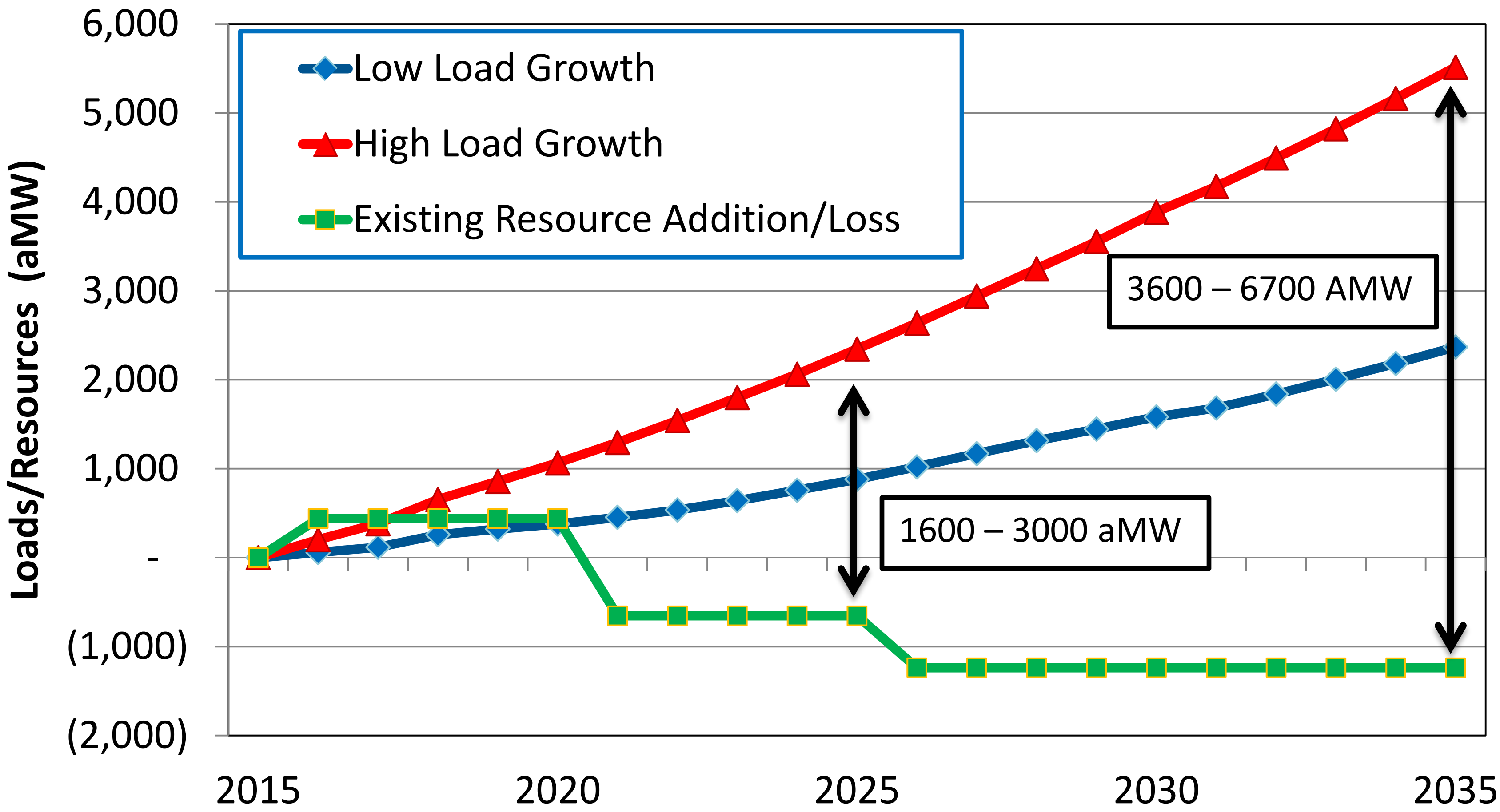
PNW Existing Energy Resources



PNW Existing Capacity Resources



Forecast Range for the Net Change in Loads & Resources*



*Reflects Average Water and Announced Resource Additions and Retirements

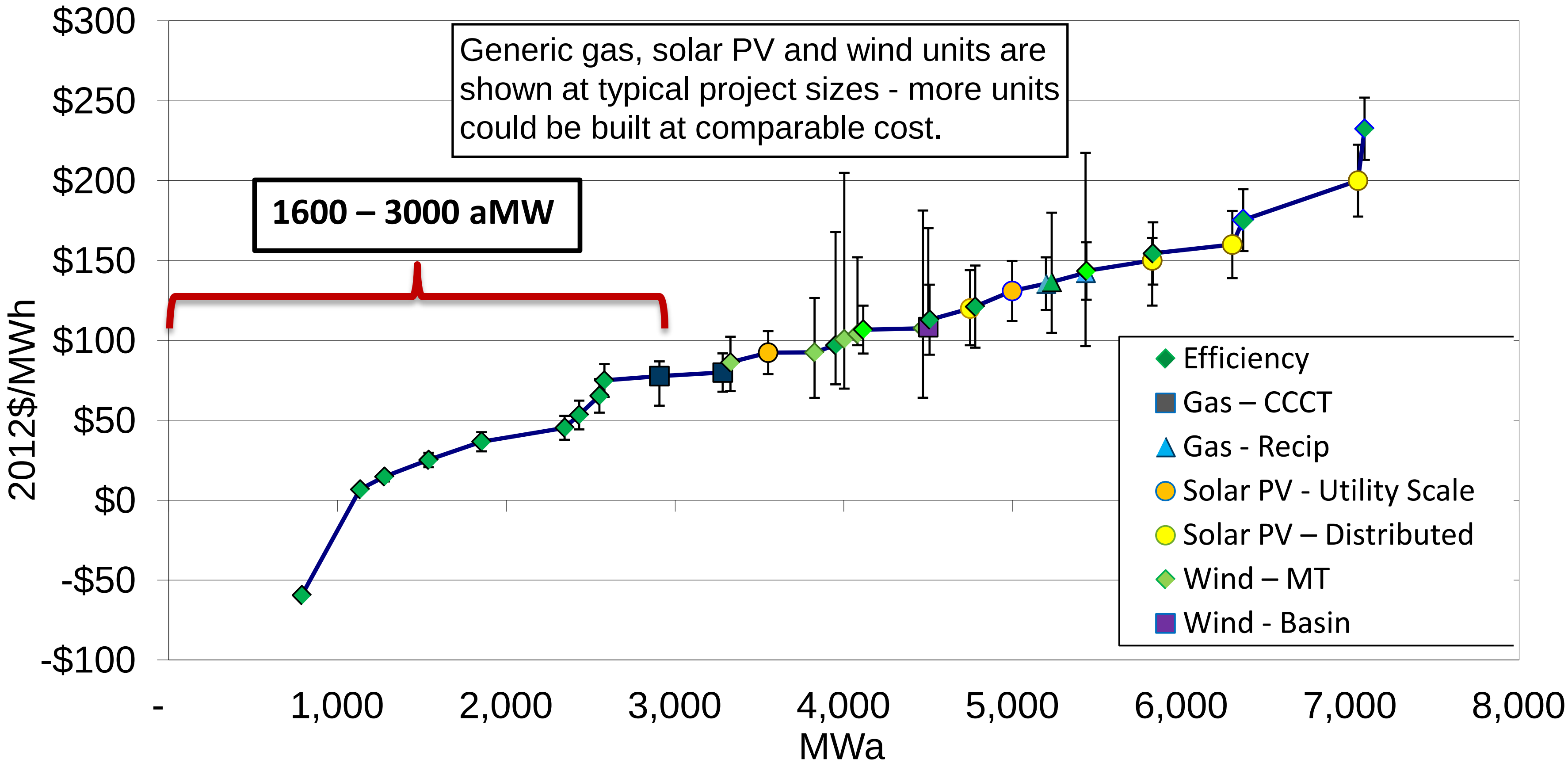
The Answer To One Question is Simple (Because It's Prescribed by Statute)

1. *When Will We Need Resources?*
2. *How Much Will We Need?*
3. *What Should We Build/Buy?*
4. *How Much Will It Cost?*
5. *What's the Risk?*

The lowest cost, lowest risks resources first.

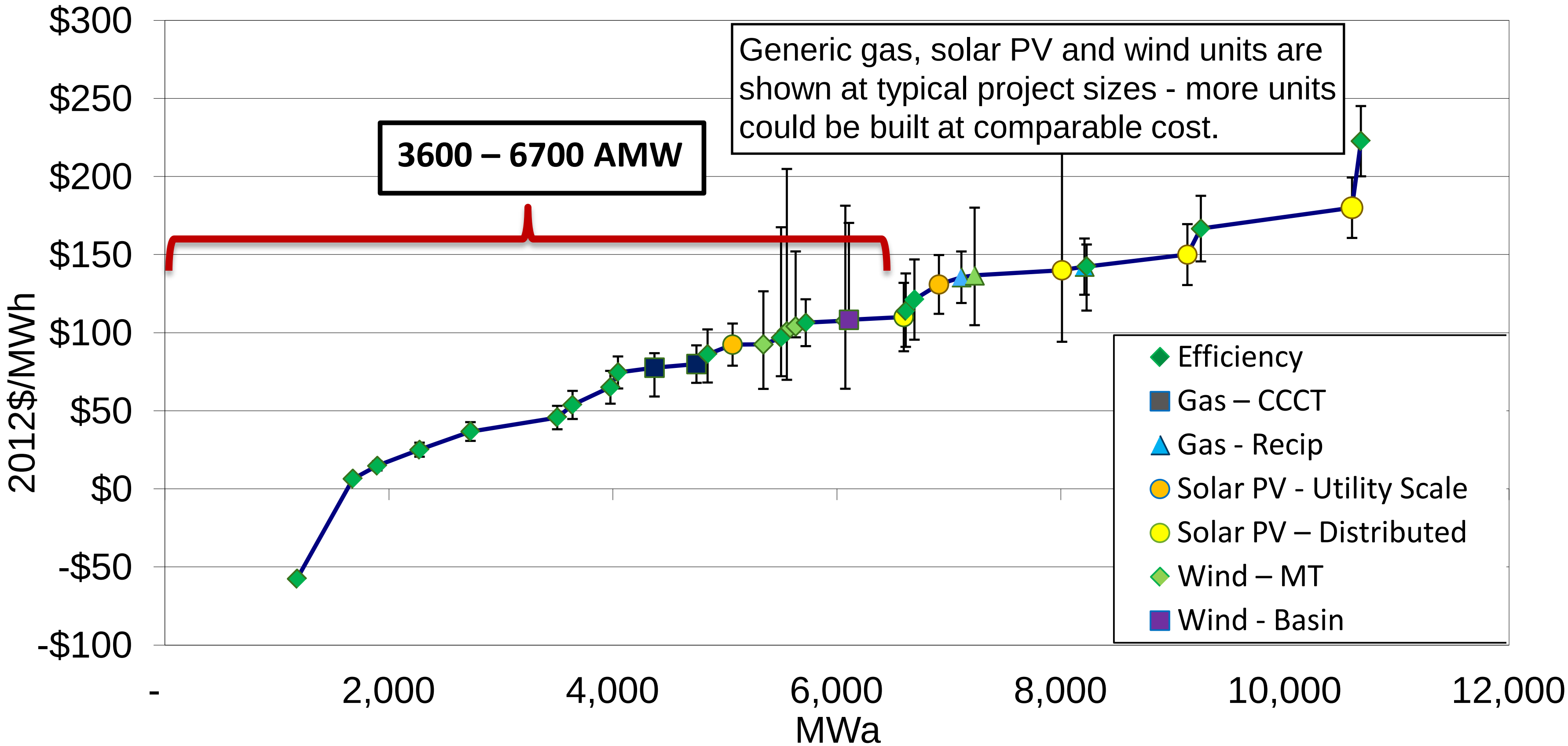
2025 Resource Portfolio Analysis on One Slide

Almost ^



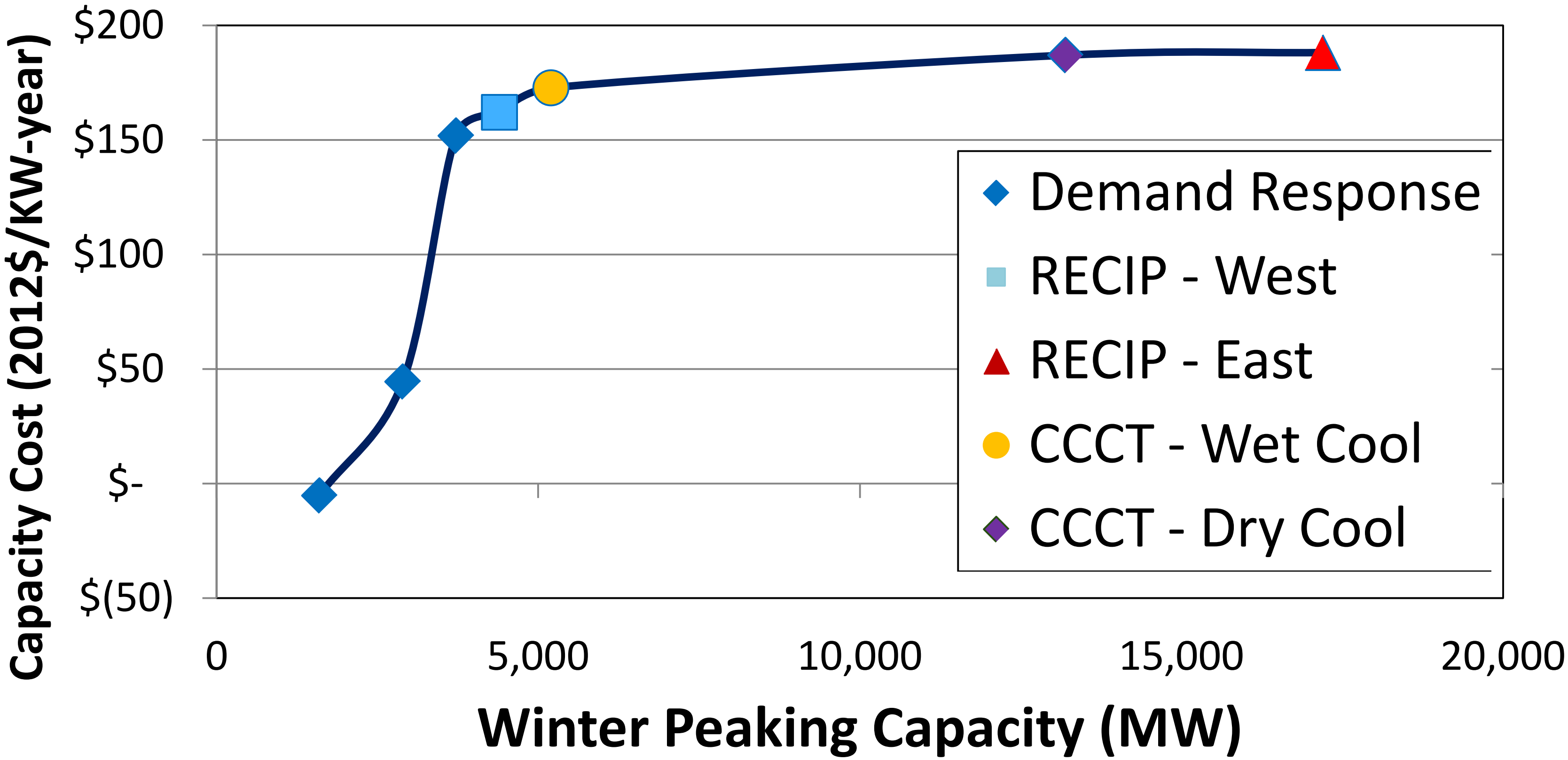
While the "All Resource Energy Supply Curve" tells use what to acquire, it doesn't tell us *how much, when or the costs and risks* of acquisition!

2035 Resource Portfolio Analysis Almost ^ on One Slide



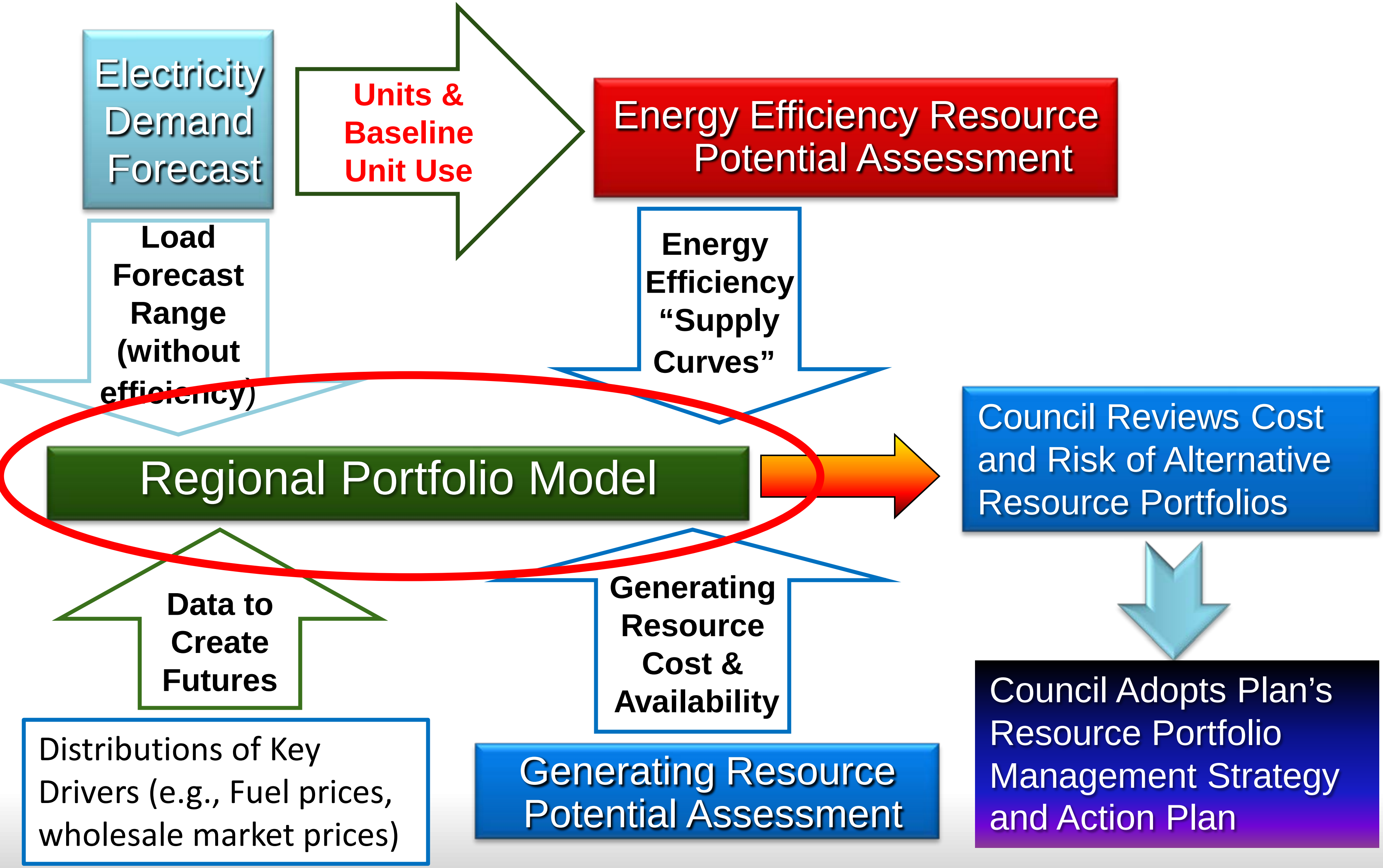
While the "All Resource Energy Supply Curve" tells use what to acquire, it doesn't tell us *how much, when or the costs and risks* of acquisition!

Winter Capacity Resource Supply Options



While the "All Resource Capacity Supply Curve" tells use what to acquire, it doesn't tell us *how much, when or the costs and risks* of acquisition!

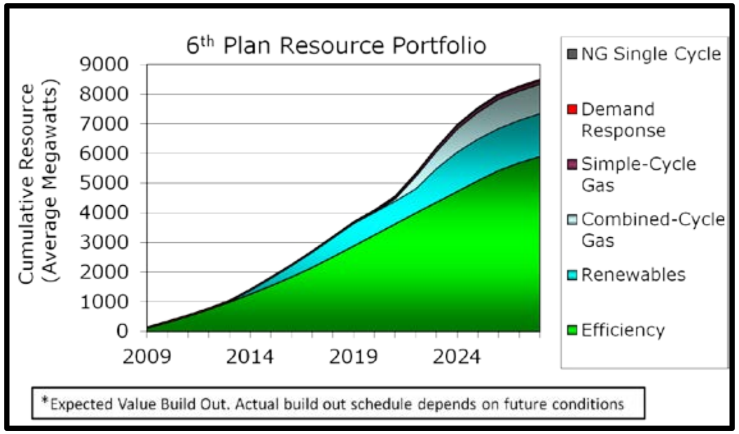
We Are Now At Regional Portfolio Modeling



The Insight to Answer the Other Questions Comes (in part) From Scenario Analysis

Resource Strategies – actions and policies over which the decision maker *has control* that will affect the outcome of decisions

Futures – circumstances over which the decision maker *has no control* that will affect the outcome of decisions



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- Load Uncertainty
- Resource Uncertainty
  - Output
  - Cost
  - Construction Lead Times
- Wholesale Electricity Market Price Uncertainty

=

Scenarios – Combinations of *Resource Strategies* and *Futures* used to "stress test" how well what we control performs in a world we don't control

Proposed Scenarios Were Designed By Varying "Stresses" and "Constraints"

- Some scenario's subject potential resources strategies to futures that impose one or more ***stresses***. *Examples:*
  - *Uncertain GHG emissions limits or costs*
  - *Unanticipated Loss of major resource(s)*
  - *Climate change impacts on loads and hydro-system output*
- Some scenario's ***constrain*** potential resources strategies across ***all*** futures: *Examples:*
  - *GHG emissions limits or costs*
  - *Maximum pace of conservation development*
  - *Fixed retirement schedule for existing coal generation*
  - *Increased reliance on variable resources across the PNW/CA*
  - *Availability of emerging technology (generation, storage and EE)*
- Some scenarios place *no limits on the uncertainty* surrounding future conditions or on potential resource strategies?

Proposed Scenarios Were Selected by Considering . . .

- What insight/information do we expect to get from this scenario?
  - Resource strategies that are "robust" across range of future conditions
  - Need for near term resource development actions (EE and generation)
- What insights/information might be gained by comparing the results of this scenario with those of other scenarios? Examples:
  - Cost of risk mitigation reduction
  - Cost of carbon emission reduction compared to estimated societal cost of damage
  - Impact of carbon cost/emissions constraints on energy efficiency and/or renewable resource developments
  - Potential value of storage, etc.
- What insights/information might be gained by comparing the *least risk* and/or *least cost* resource strategies under this scenario?
  - With resource strategies that have equivalent *cost* but higher *risk*?
  - With resource strategies that have equivalent *risk* but higher *cost*?

Scenario Number	Scenario Name	Scenario Description	Key Stress Factors /Constraints Tested
1A	**Existing Policy without Uncertainty**, w/o GHG reduction risk	Existing RPS, state and federal environmental regulations, including MATS and haze, CA and BC carbon costs, state carbon limits on new generation. Average value across all futures for all major sources of uncertainty.	Known generation fleet retirements and regulatory compliance costs
1B	**Existing Policy with Uncertainty**, w/o GHG reduction risk	Existing RPS, state and federal environmental regulations, including MATS and haze, CA and BC carbon costs, state carbon limits on new generation. Distribution of values for all major sources of uncertainty across all futures. No carbon regulation or cost risk.	Cost and Value of uncertainty risk mitigation with known generation fleet retirements and regulatory compliance costs Delineated by 1B – 1A

Scenario Number	Scenario Name	Scenario Description	Key Stress Factors /Constraints Tested
2A	**Existing Policy *with* Uncertainty and *with certain* GHG reduction risk/target**. Proposed Policy Target = Clean Power Plan/Clean Air Act 111(d) goal (e.g., 30% below 2005 level by 2030	Existing RPS, state and federal environmental regulations, including MATS and haze, CA and BC carbon costs, state carbon limits on new generation. Distribution of values for all major sources of uncertainty across all futures. *Scenarios will test specific carbon reduction targets or costs. Example:* Resource strategies must result in 30% less GHG emissions by 2030 compared to 2005 (or some variant of this policy)	Cost and Value of uncertainty risk mitigation with known generation fleet retirements and regulatory compliance costs Delineated by 2A – 1B
2B	**Existing Policy *with* Uncertainty and *with certain* GHG reduction risk/target**. Proposed Policy Target = Mitigate to Estimated GHG Damage Cost	Existing RPS, state and federal environmental regulations, including MATS and haze, CA and BC carbon costs, state carbon limits on new generation. Distribution of values for all major sources of uncertainty across all futures. *Scenarios will test specific carbon reduction targets or costs. Example:* GHG emissions cost/price set equivalent to the US Interagency Working Group on Social Cost of Carbon (SCC)	Cost and Value of uncertainty risk mitigation with known generation fleet retirements and regulatory compliance costs. If SCC is used to represent damage cost, resulting portfolios theoretically achieve GHG mitigation equivalent to damage costs. Delineated by 2B – 1B
2C	**Existing Policy *with* Uncertainty *and with uncertain* GHG reduction risk/target**.	Existing RPS, state and federal environmental regulations, including MATS and haze, CA and BC carbon costs, state carbon limits on new generation. Distribution of values for all major sources of uncertainty across all futures. *Scenarios will test specific carbon reduction targets or costs.* GHG emissions cost/price allowed to vary across futures between $X and $Y	Cost and Value of uncertainty risk mitigation without known generation fleet retirements and regulatory compliance costs Delineated by 2C – 1B

Scenario Number	Scenario Name	Scenario Description	Key Stress Factors /Constraints Tested
3A	**Lowering carbon emissions with current technology**	Determine lowest feasible power system carbon emissions resource strategies using ***only available*** generation, storage and energy efficiency ***technologies***, including anticipated cost reductions. May include retirement of all regional coal plants and replacement with no or lower carbon emitting resources.	Cost and risk of minimizing power system GHG emissions feasible with existing technology Delineated by 3A – 2C
3B	**Lowering carbon emissions with emerging** technology (e.g., storage, CO_2 heat pumps, SSL)	Determine lowest feasible power system carbon emissions resource strategies ***using emerging*** generation, storage and energy efficiency ***technologies***, including anticipated cost reductions. May include retirement of all regional coal plants and replacement with no or lower carbon emitting resources.	Cost and risk of minimizing power system GHG emissions feasible with emerging technology Delineated by 3B – 3A

Scenario Number	Scenario Name	Scenario Description	Key Stress Factors /Constraints Tested
4A	**Major Resource Uncertainty** - ***Unexpected*** Loss of Major Resource (e.g., CGS Forced Retirement)	Determine the resource strategies best suited to managing the unanticipated loss of a major (>1000 MW) non-GHG emitting resources	Cost and risk associated with unanticipated loss of major, non-GHG gas emitting resource Delineated by 4A – 2C
4B	**Major Resource Uncertainty** ***Anticipated*** Loss of Major Resource(s) (e.g., Snake River Dam Removal,)	Determine the resource strategies best suited to managing the loss of a major hydro resources	Cost and risk associated with replacement of existing hydro-generation. Delineated by 4B – 2C
4C & D	**Major Resource Uncertainty** – Pace of Conservation Deployment	Determine the resources that would be developed/displaced if the deployment of energy efficiency is faster or slower than anticipated	Cost and risk associated with assumed upper and lower limits on pace of conservation in resource strategies Delineated by 4C/4D – 2C

Scenario Number	Scenario Name	Scenario Description	Key Stress Factors /Constraints Tested
5A	**Integration of Variable Resources** (i.e., Managing the NW Impact of the "Duck Curve"/50% CA RPS)	Determine the resource strategies that would best serve the region should CA achieve a 50 percent RPS using primarily solar PV	Cost and risk associated with potentially large extra-regional surpluses available at low prices during certain periods of the day and year Delineated by 5A – 2C
5B	**Southwest Market Uncertainty:** Liquidity and Variability	Determine the resource strategies that would best serve the region under different scenarios of Southwest market availability.	Cost and risk associated with reduced liquidity associated with the Southwest Market. Delineated by 5B – 2C

Scenario Number	Scenario Name	Scenario Description	Key Stress Factors /Constraints Tested
6A	Climate Change Load Impacts	Determine the impact on resource strategies under forecast future load conditions	Change in system load Delineated by 6 – 2C
6B	Climate Change Load & Hydro Impacts	Determine the impact on resource strategies under forecast future hydro-power output conditions and load conditions	Change in hydro output and system load Delineated by 6 – 2C

Options for Representing Clean Power Plan Policy Goal

Proposed Baseline, Interim and Final Mass and Rated-Based Equivalent CO_2 Emissions Limits for Existing Affected and New Sources						
	2012 Baseline Mass Equivalent (Million Metric Tons)	Interim Mass Equivalent (Million Metric Tons)	Final Mass Equivalent (Million Metric Tons)	2012 Baseline Rate (pounds/MWh)	Interim Rate (pounds/MWh)	Final Rate (pounds/MWh)
Idaho	0.6	0.9	1.0	858	244	228
Montana	16.3	15.4	15.2	2,439	1,882	1,771
Oregon	7.0	5.2	5.3	1,081	407	372
Washington	6.6	4.4	4.8	1,379	264	215
Region	30.5	25.9	26.2	1,634	658	571

Note: EPA emissions limits shown in this table include generating resources located in Idaho, Montana, Oregon and Washington. They do not include emissions from power plants modeled in the RPM that are located in Wyoming and Nevada and that serve the Northwest Region.

Options for Representing Clean Power Plan Policy Goal

	Total Emissions			Emissions Rate		
State	**2012 Baseline**	**Interim Target (% Change from Baseline)**	**Final Target (% Change from Baseline)**	**2012 Baseline**	**Interim Target (% Change from Baseline)**	**Final Target (% Change from Baseline)**
Idaho	100%	36%	55%	100%	72%	73%
Montana	100%	-5%	-7%	100%	23%	27%
Oregon	100%	-25%	-24%	100%	62%	66%
Washington	100%	-34%	-28%	100%	81%	84%
Region	100%	-15%	-14%	100%	60%	65%

Note: EPA emissions limits shown in this table include generating resources located in Idaho, Montana, Oregon and Washington. They do not include emissions from power plants modeled in the RPM that are located in Wyoming and Nevada and that serve the Northwest Region.

Interagency Working Groups Estimated Social Cost of CO_2, 2015-2050 and 6th Plan Carbon Risk Scenario Average (2012$/Metric Ton)

	Discount Rate and Statistic				
Year	5% Average	3% Average	2.5% Average	3% 95th Percentile	6th Plan Carbon Risk Scenario (Average Across All Futures
2015	$12	$40	$62	$118	$36
2020	$13	$47	$69	$139	$52
2025	$15	$51	$75	$156	$57
2030	$17	$56	$81	$173	$58
2035	$20	$61	$87	$190	
2040	$22	$66	$94	$208	
2045	$26	$71	$100	$224	
2050	$29	$77	$106	$239	

Proposed Scenario Analysis Priority Ranking and Analysis Schedule					
Scenario	Scenario Name	Priority	Modeling Effort	DRAFT Schedule	Model Enhancement
1B	Existing Policy with Uncertainty, w/o GHG reduction risk	1	Med	April	Standard model setup with zero carbon tax and no emission limit. RPM enhancement needed to make SW market availability a risk variable. Council staff to modify RPM.
1A	Existing Policy without Uncertainty, w/o GHG reduction risk	2	Med	April	Use single future with expected values for load growth, gas prices, hydro-output, market prices, etc...
2C	Existing Policy with Uncertainty and with uncertain GHG reduction risk/target.	3	Low	April	Standard model setup with carbon tax uncertainty and no emission limit.
6A	1B + Climate Change Load Impacts	4	Low	April	Phased in change in system load

Proposed Scenario Analysis Priority Ranking and Analysis Schedule					
Scenario	Scenario Name	Priority	Modeling Effort	DRAFT Schedule	Model Enhancement
2B	Existing Policy with Uncertainty and with certain GHG reduction risk/target. Example Policy Target = Mitigate to Estimated GHG Damage Cost	5	Low	Early May	Model fixed carbon tax per year based on social cost of carbon, no stochastic variation. Implementing this scenario requires RPM enhancement that by Council staff.
4C	Major Resource Uncertainty – Faster Pace of Conservation Deployment	6	Low	Early May	Change ramp rates and rerun the conservation supply curves. Basically, just a different conservation supply curve.
4D	Major Resource Uncertainty – Slower Pace of Conservation Deployment	7	Low	Early May	Change ramp rates and rerun the conservation supply curves. Basically, just a different conservation supply curve.

Proposed Scenario Analysis Priority Ranking and Analysis Schedule					
Scenario	Scenario Name	Priority	Modeling Effort	DRAFT Schedule	Model Enhancement
2A	Existing Policy with Uncertainty and with certain GHG reduction risk/target. Example Policy Target = Clean Power Plan/Clean Air Act 111(d) goal (e.g., 30% below 2005 level by 2030	8	Med	Late May	RPM enhancement needed to model physical emission limits as a constraint. Without model enhancement an external process must be used to establish schedule for retiring coal plants to meet emission limits. Council staff will assess options and present to Council for guidance.
3A	Lowering carbon emissions with current technology	9	Med	Late May	Retire all plants that exceed a maximum emissions standard. Retirement schedule to be determined.
4A	Major Resource Uncertainty - Unexpected Loss of Major Resource (e.g., CGS Forced Retirement)	10	Med/High	Late May	Generate a random time series that takes out CGS permanently, at an unexpected time.

Proposed Scenario Analysis Priority Ranking and Analysis Schedule					
Scenario	Scenario Name	Priority	Modeling Effort	DRAFT Schedule	Model Enhancement
4B	Major Resource Uncertainty Anticipated Loss of Major Resource(s) (e.g., Snake River Dam Removal,)	11	Low	Late May	Phased in reduction in hydro-system output, modeled by applying adjustment factor to existing system output
3B	Lowering carbon emissions with emerging technology (e.g., storage, CO_2 heat pumps, SSL)	12	High	Not Modeled	Not possible to model this scenario directly. Staff will use contribution of remaining GHG emitting resources to derive proxy non-GHG emitting resource need from 3A.
5A	Integration of Variable Resources (i.e., Managing the NW Impact of the "Duck Curve"/50% CA RPS)	13	Med/High	Early June	Need Aurora wholesale electricity market price curve by water year assuming scheduled solar build-out. Minor RPM enhancement required to synchronize water year and market electricity prices...

Proposed Scenario Analysis Priority Ranking and Analysis Schedule					
Scenario	Scenario Name	Priority	Modeling Effort	DRAFT Schedule	Model Enhancement
6B	Climate Change Load & Hydro Impacts	14	High	Early June	Phased in change in hydro-system output and load
5B	Southwest Market Liquidity Variability	15	Low	Early June	Reduce fixed limit from external markets in RPM.