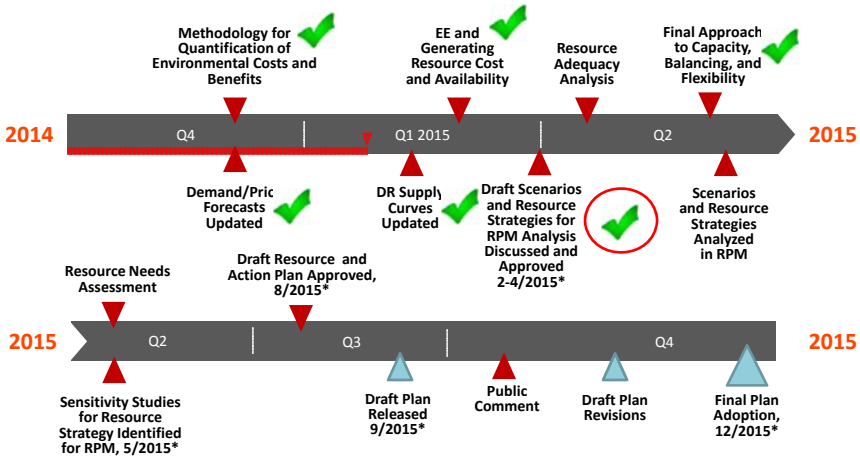
Draft 7th Plan
Scenarios Proposed for Testing

RSAC
March 12, 2015

Northwest Power and Conservation Council

SEVENTH NORTHWEST POWER PLAN

Major Seventh Plan Development Milestones



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

Northwest Power and Conservation Council

SEVENTH NORTHWEST POWER PLAN

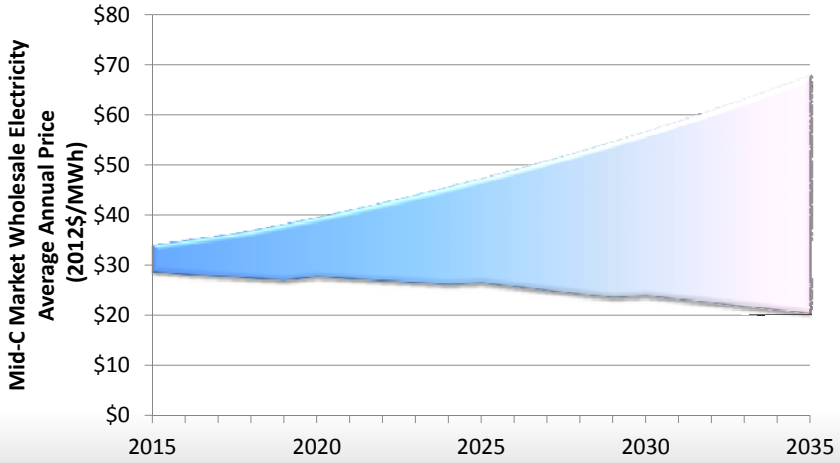
We're Now About To Try To Answer Those Simple Questions

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?*

Northwest Power and Conservation Council

SEVENTH NORTHWEST POWER PLAN

Draft 7th Plan Wholesale Electricity Market Price Forecast Range



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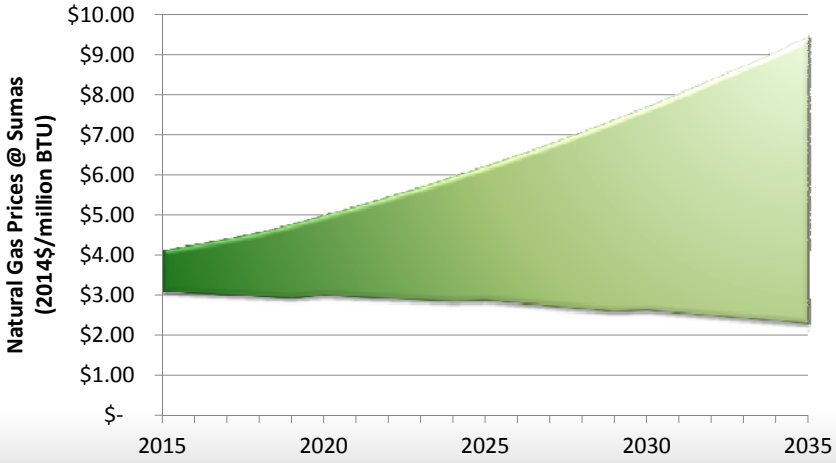
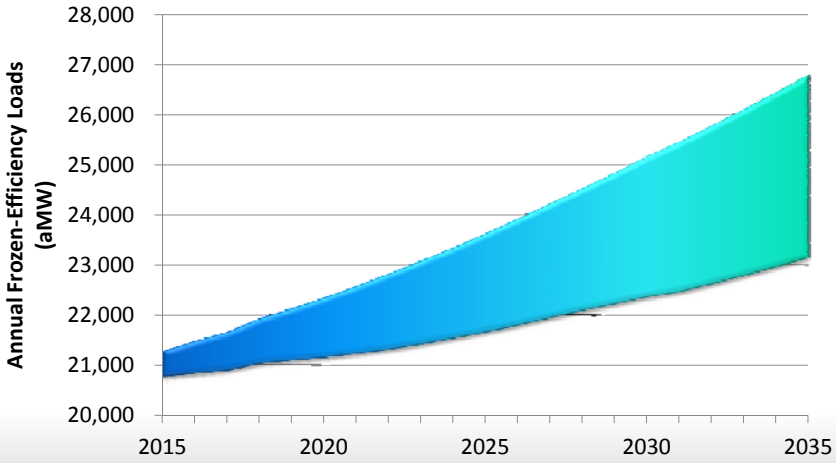
SEVENTH NORTHWEST POWER PLAN

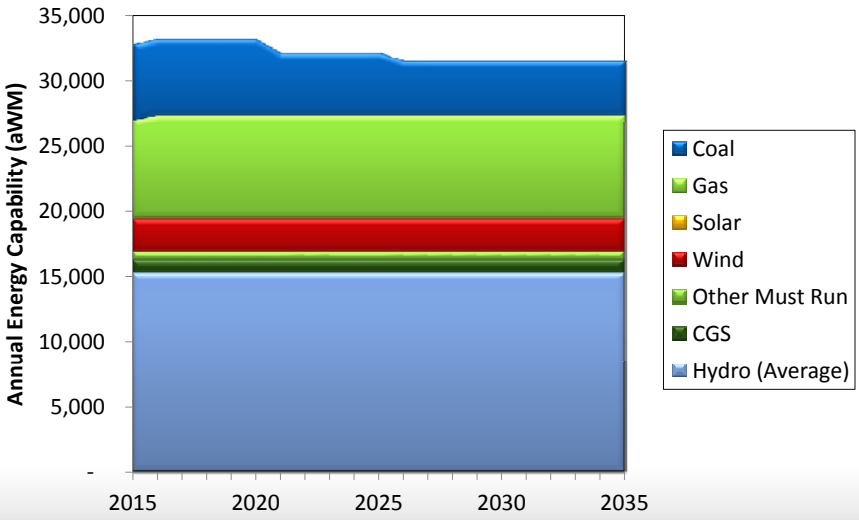
Draft 7th Plan Natural Gas Price Forecast Range



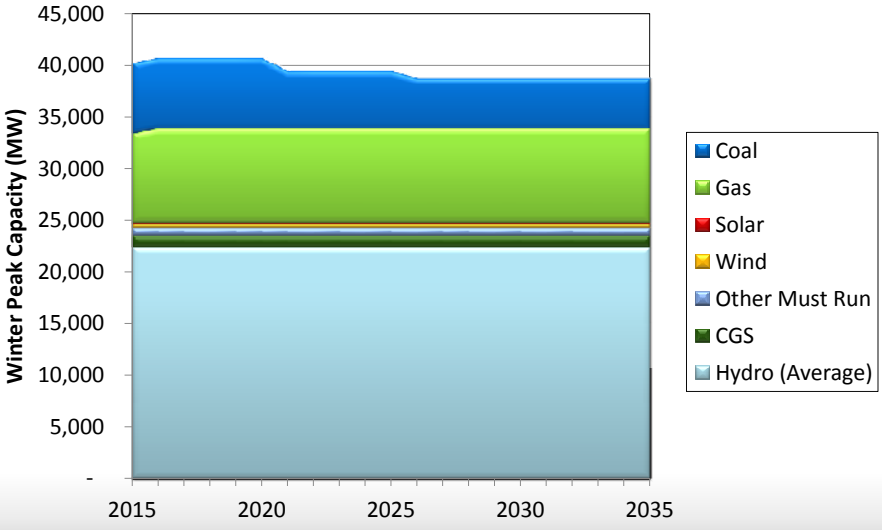
Draft 7th Plan Load Forecast Range (Pre-Conservation)



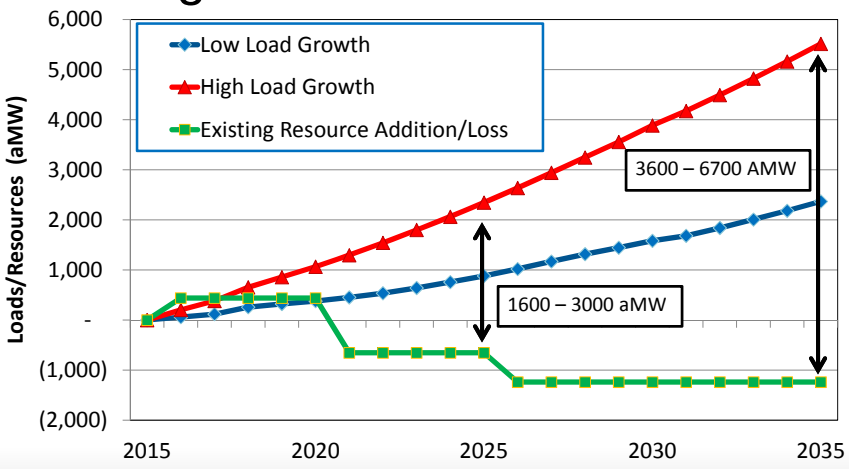
PNW Existing Energy Resources



PNW Existing Capacity Resources



Forecast Range for the Net Change in Loads & Resources*



*Reflects Average Water and Announced Resource Additions and Retirements

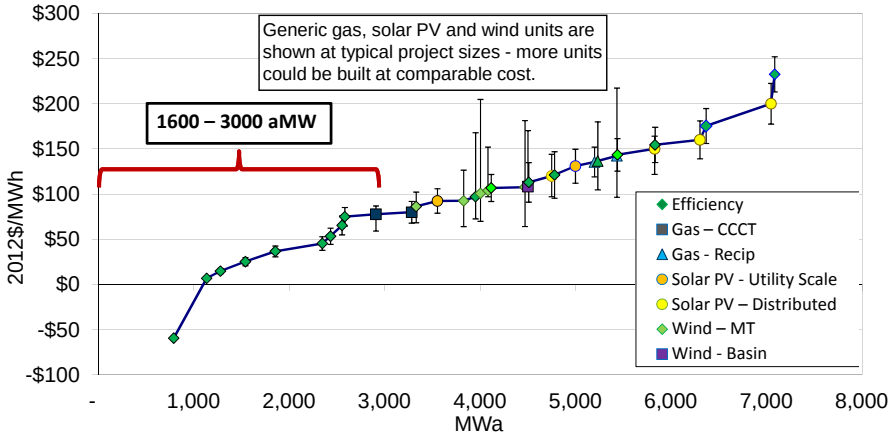
The Answer To One Question is Simple (Because It's Prescribed by Statute)

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.

Almost

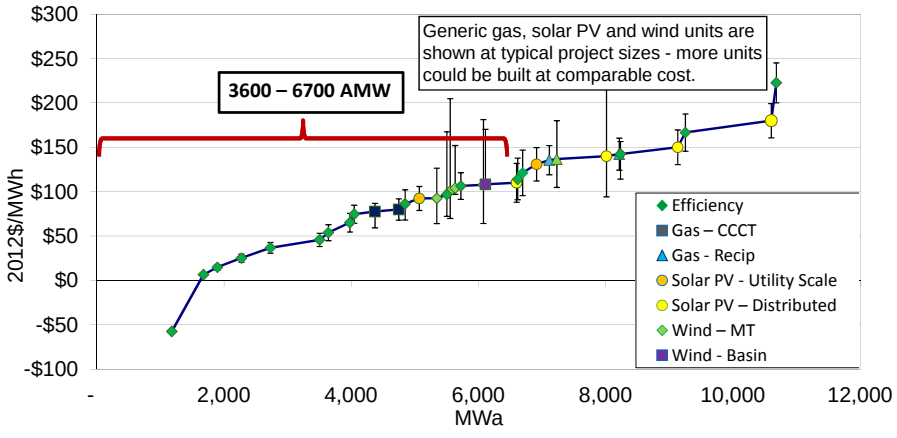
2025 Resource Portfolio Analysis on One Slide



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!

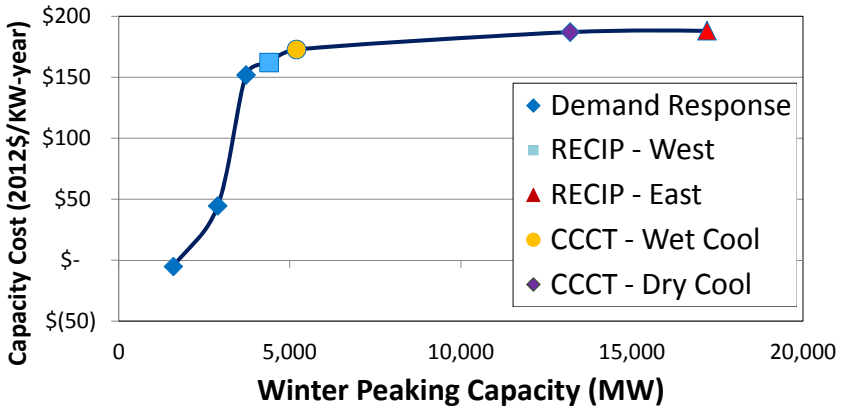
Almost

2035 Resource Portfolio Analysis on One Slide



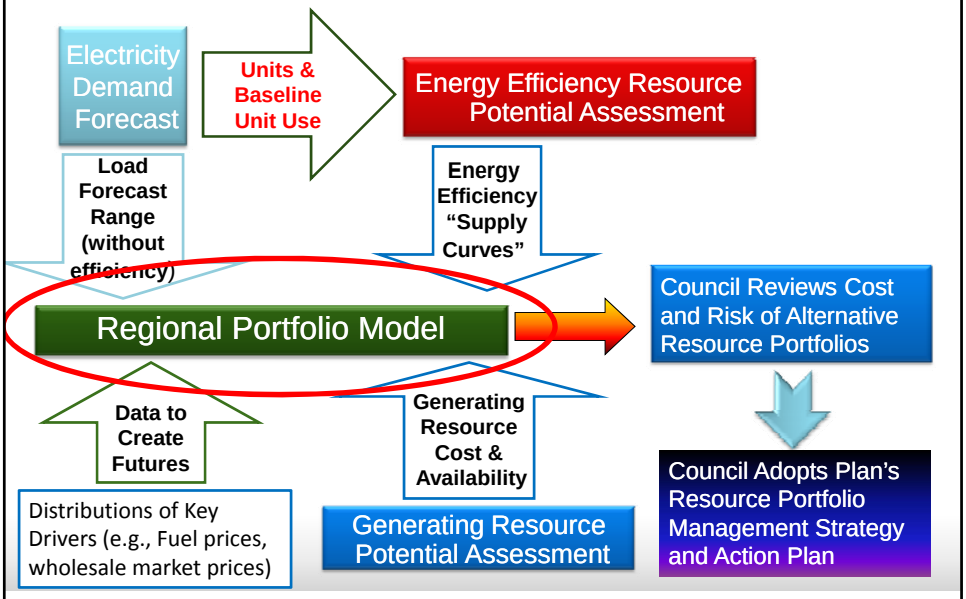
While the "All Resource Energy Supply Curve" tells use what to acquire, it doesn't tell us *how much, when or the costs and risks* of acquisition!

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!

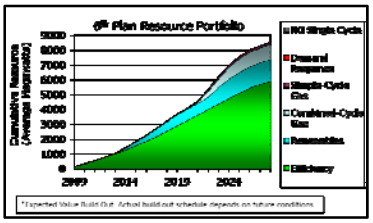
We Are Now At Regional Portfolio Modeling



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**

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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 <u>*stresses*</u>. *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 <u>*constrain*</u> potential resources strategies across <u>*all*</u> 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.

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