Regional Portfolio Model Results

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for the

Power Committee Web Conference

Tuesday, May 19, 2009

Overview

- Changes in assumptions and data
- Plans on the efficient frontier
- Interpreting a plan
- Issue Studies
  - Carbon control and climate change
  - The economic effects of the Regional Portfolio Standards

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Changes in Assumptions and Data

- CO_2 penalty likelihood distribution
- Conservation base case
  - New programs and re-evaluation of energy distributions over seasons and subperiods
  - Limit of 160MWa per year on discretionary
  - Sampling of discretionary conservation
- Geothermal assumptions regarding build rate

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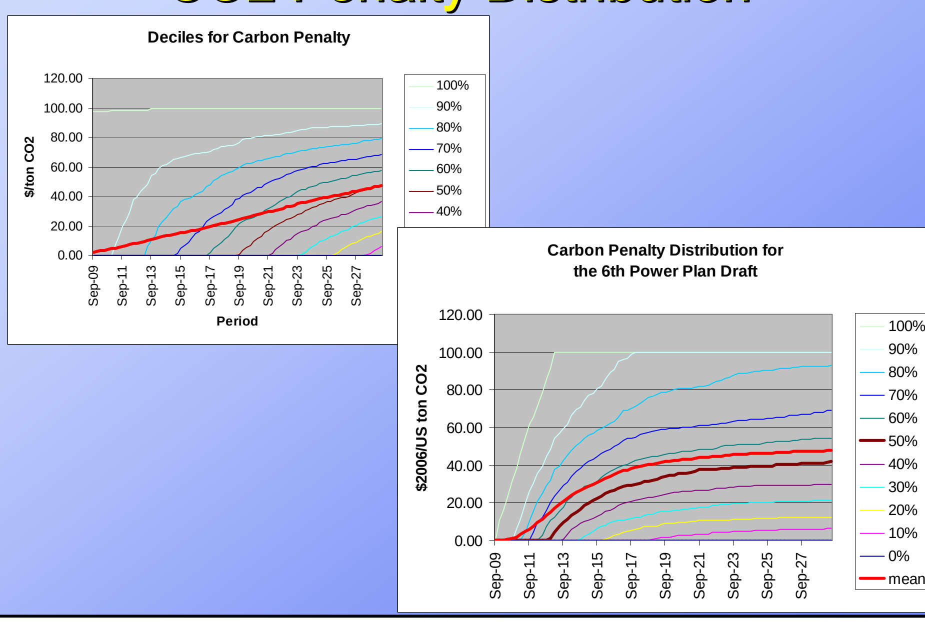
CO2 Penalty Distribution



Overview

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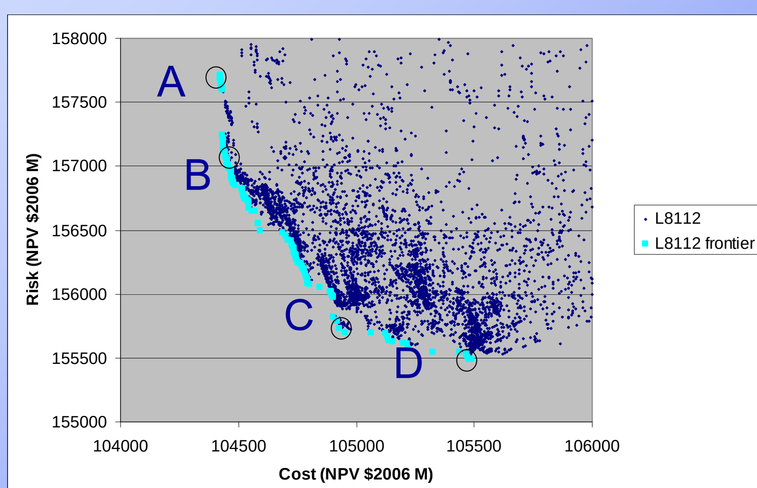
Efficient Frontier



Source: Analysis of Optimization Run_L811 090510 2101.xls

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Resources Selection by the Model – Least Risk (D)

Plan D Discretionary demand response: none

- **50** Lost opportunity conservation cost-effectiveness threshold, premium over market ($2006/MWh)
- **3253** Lost opportunity conservation by end of study (MWa)*
- **10** Discretionary conservation cost-effectiveness threshold, premium over market ($2006/MWh)
- **2573** Discretionary conservation by end of study (MWa) assuming 160MWa/year limit
- **5827** Total conservation (MWa)

Cumulative MW, by earliest date to begin construction

	Dec-10	Dec-13	Dec-15	Dec-17	Dec-19	Dec-23	Dec-25
CCCT	0	0	0	**415**	**830**	**830**	**830**
SCCT	0	0	**170**	**170**	**170**	**170**	**170**
Geothermal	0	0	0	**52**	**104**	**156**	**169**
and the *larger* of							
Wind	0	0	**1200**	**1200**	**3000**	**3000**	**3000**
RPS* req	0	**317**	**1182**	**1968**	**2825**	**3959**	**4229**

Source: Schedules for plan resources 090519.xls

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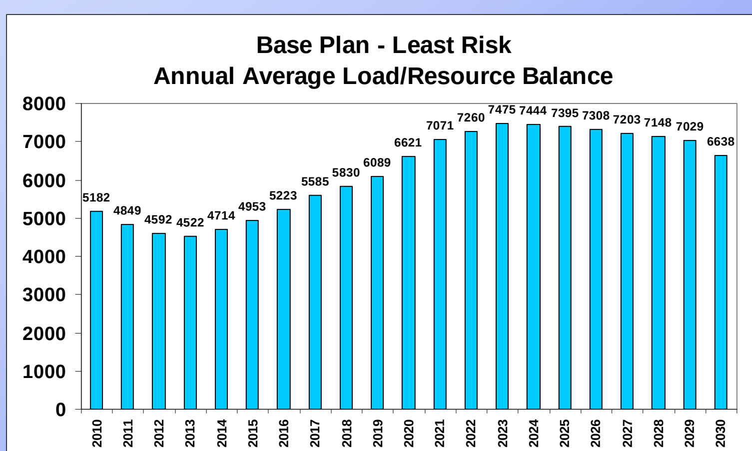
Reality Checks – Least Risk



Source: Adequacy 6th Plan Base Case 051409 LR L8112 MJS 090519.xls

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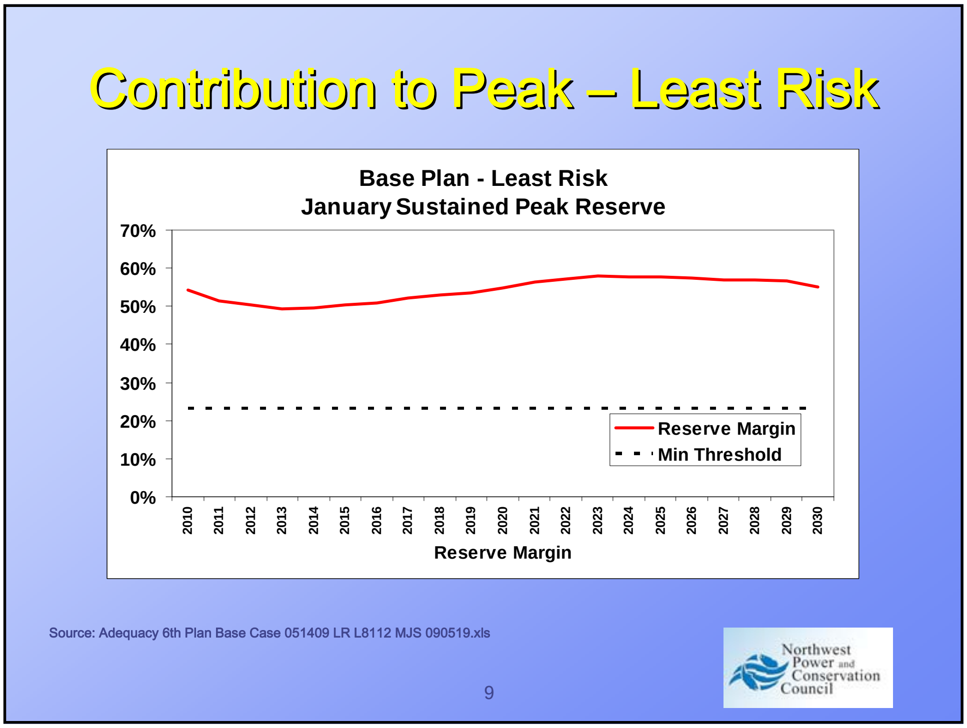
Contribution to Peak – Least Risk
Base Plan - Least Risk
January Sustained Peak Reserve
70%
60%
50%
40%
30%
20%
10%
0%
2010
2011
2012
2013
2014
2015
2016
2017
2018
2019
2020
2021
2022
2023
2024
2025
2026
2027
2028
2029
2030
Reserve Margin
Min Threshold
Reserve Margin
Source: Adequacy 6th Plan Base Case 051409 LR L8112 MJS 090519.xls
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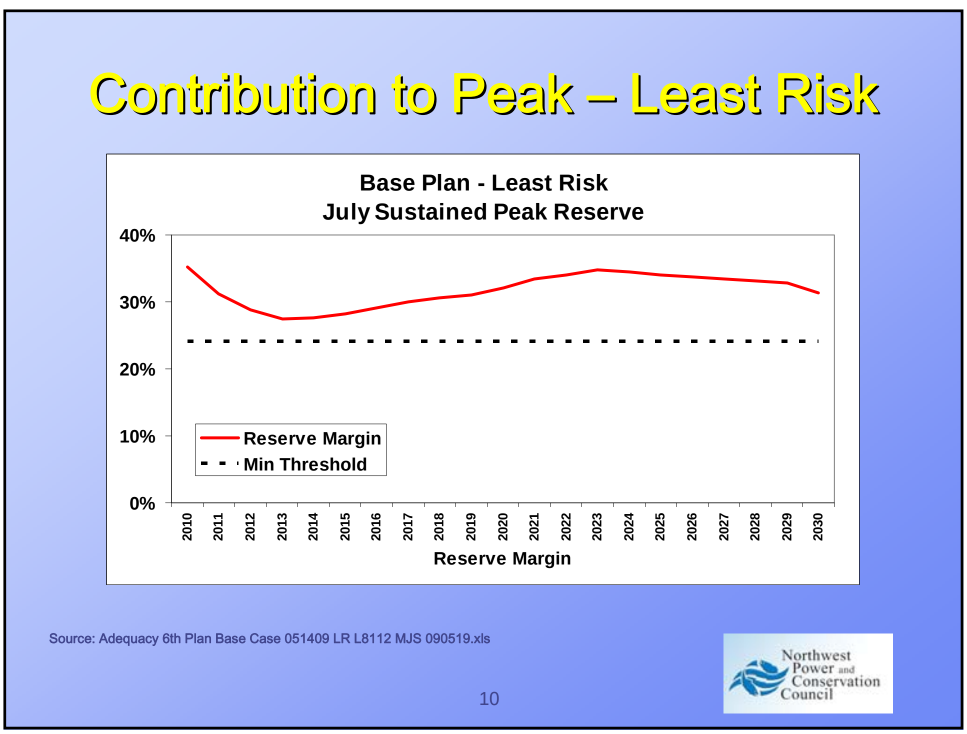
Contribution to Peak – Least Risk
Base Plan - Least Risk
July Sustained Peak Reserve
40%
30%
20%
10%
0%
2010
2011
2012
2013
2014
2015
2016
2017
2018
2019
2020
2021
2022
2023
2024
2025
2026
2027
2028
2029
2030
Reserve Margin
Min Threshold
Reserve Margin
Source: Adequacy 6th Plan Base Case 051409 LR L8112 MJS 090519.xls
10
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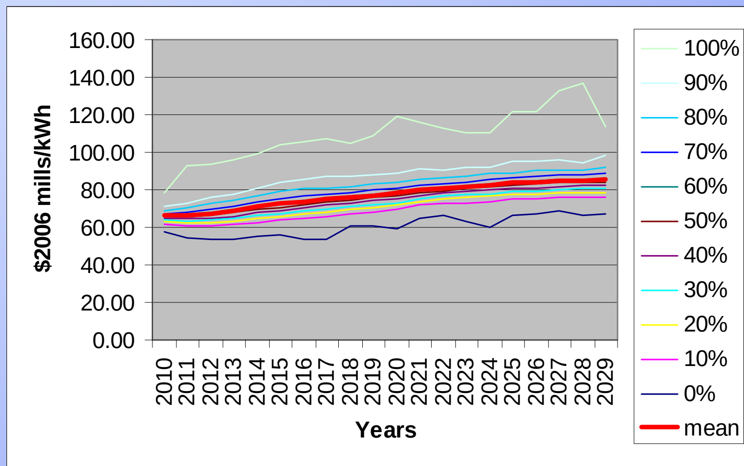
Rate Impacts – Least Risk



Source: L811x1_LR2.xls, wksheet Data (3)

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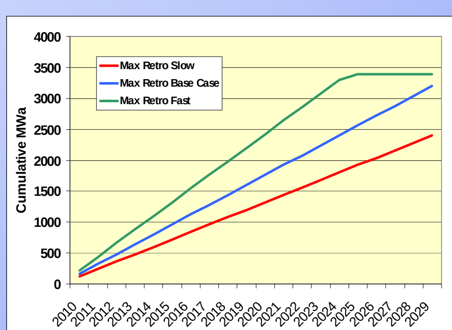
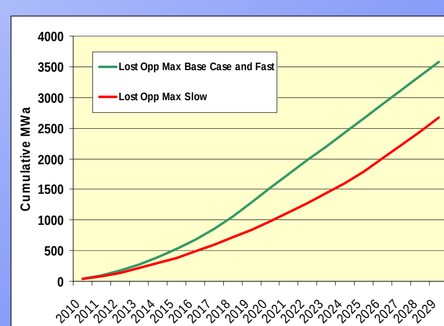
Results of Conservation Sensitivity Analysis

- Value of going faster
  - Retrofit 220 MWa/Year & Lost-Opp 12-Year Ramp Up
- Cost of going slower
  - Retrofit 100 MWa/Year & Lost-Opp 20-Year Ramp Up





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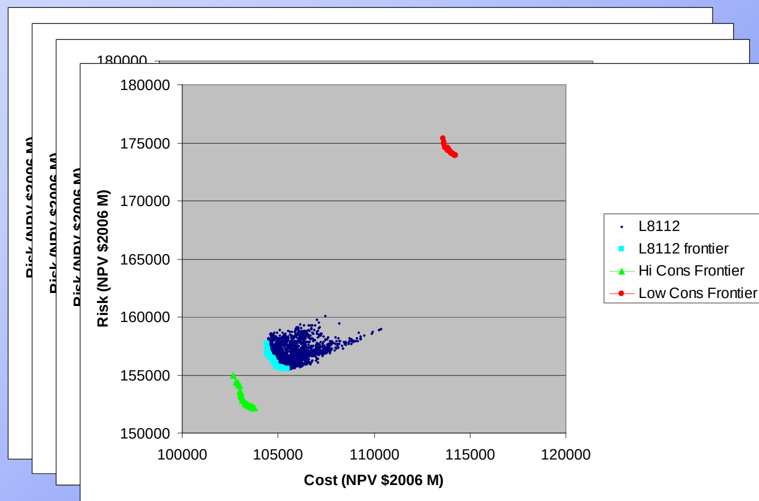
Efficient Frontiers for Conservation Sensitivities



Source: Analysis of Optimization Run_L811 090518 3101.xls

Conservation Sensitivity Analysis

Results for Least-Risk Plans (Mean Build Out)

	BASE	FAST	SLOW
Lost-Opp MWa by 2029	3245	3192	2569
Retro MWa by 2029	2568	2657	1999
Total MWa by 2029	5813	5849	4568
NPV Cost (Billion 2006$)	105.5	103.8	114.3
NPV Risk (Billion 2006$)	155.5	152.1	173.9
Lost-Opportunity Premium ($/MWh)	50	40	50
Retrofit Premium ($/MWh)	10	10	NA
Lost-Opportunity MWa 2010-2014	368	e348	e368
Retrofit MWa 2010-2014	798	e1100	e500
Total MWa 2010-2014	1165	e1448	e868

e = estimated

Effect on Carbon Mitigation – Least Risk

- The regional carbon footprint is roughly 60 million tons of CO_2
- Regional coal plants contribute about 55 million tons of CO_2 annually. Replacing these with gas fired generation would result in net reduction of about 25 million tons.
- While this plan introduces carbon neutral or carbon-free resources, the principal determinants of emissions, electricity price and carbon penalties, are not, per se, elements of the plan.

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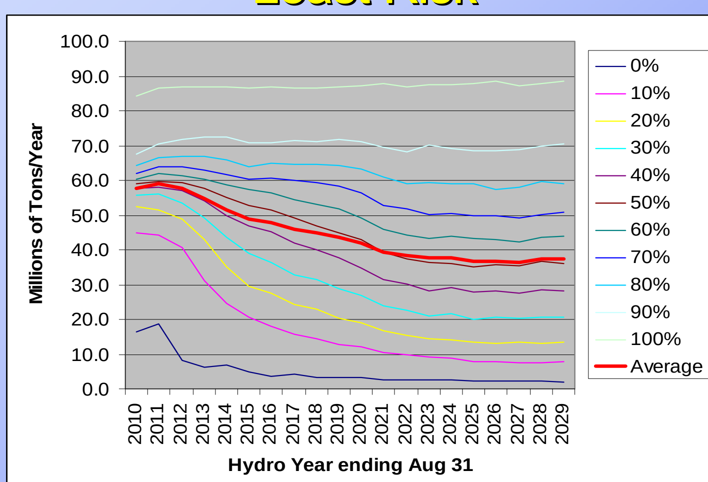
Effect on Carbon Mitigation – Least Risk



Source: "Studies\L811\L811 Extractions\Qtrly Rates, CO2, and others - LR+LC\L811x1_LR.xls", worksheet "Data (6)"; no imp/exp adjustment, includes standard year and regional resource definition adjustments

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Conservation Findings

- Maximum Achievable Pace is Very Important
- Faster annual pace reduces cost & risk
- Annual pace limits have dramatic impact on cost & risk
- Lost-Opp commands high adder over near-term market
  - $50/MWh over market price reduces risk along the frontier
- Retrofit commands lower adder over near-term market
  - Abundant conservation at low cost ($30/MWh average)
  - $10/MWh over market reduces risk along the frontier
  - More important question is: How fast can we develop it?

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Breaching The Lower Snake River Dams

- Loss occurs around 2019
- Modeled 70-year record for Ice Harbor, Lower Monumental, Lower Granite, Little Goose

Discretionary demand response: none

50 Lost opportunity conservation cost-effectiveness threshold, premium over market ($2006/MWh)
3257 Lost opportunity conservation by end of study (MWa)*
30 Discretionary conservation cost-effectiveness threshold, premium over market ($2006/MWh)
2730 Discretionary conservation by end of study (MWa) assuming 160MWa/year limit
5987 Total conservation (MWa)

Cumulative MW, by earliest date to begin construction

	Dec-10	Dec-13	Dec-15	Dec-17	Dec-19	Dec-23	Dec-25
CCCT	0	415	415	830	1245	1245	1245
SCCT	0	0	170	340	340	340	340
Geothermal	0	0	52	65	117	156	182
and the *larger* of							
Wind	0	0	900	900	2700	3000	3000
RPS* req	0	26	972	1842	2628	4979	5388

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Overview

- Changes in assumptions and data
- Plans on the efficient frontier
  - Least-risk plan
  - Least-cost plan
- Interpreting a plan
- Issue Studies
  - Carbon control and climate change
  - The economic effects of the Regional Portfolio Standards

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Resources Selection by the Model – Least Cost

Plan A Discretionary demand response: none

10 Lost opportunity conservation cost-effectiveness threshold, premium over market ($2006/MWh)
2941 Lost opportunity conservation by end of study (MWa)*
10 Discretionary conservation cost-effectiveness threshold, premium over market ($2006/MWh)
2585 Discretionary conservation by end of study (MWa) assuming 160MWa/year limit
5527 Total conservation (MWa)

Cumulative MW, by earliest date to begin construction

	Dec-10	Dec-13	Dec-15	Dec-17	Dec-19	Dec-23	Dec-25
CCCT	0	0	0	0	0	0	0
SCCT	0	0	0	0	0	0	0
Geothermal	0	0	0	0	0	0	0
and the *larger* of							
Wind	0	0	0	0	0	0	0
RPS* req	0	**321**	**1193**	**2007**	**3061**	**4930**	**5363**

Source: Schedules for plan resources 090519.xls

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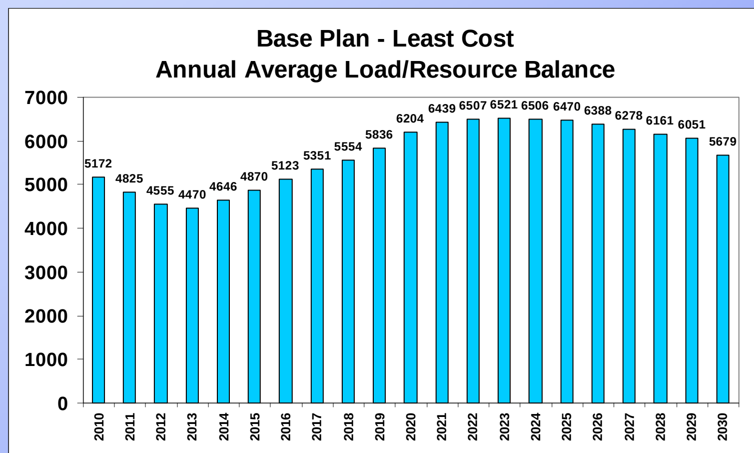
Reality Checks – Least Cost



Source: Least cost plan from "Analysis of Optimization Run_L811 090510 2101.xls"; adequacy calculation from "Adequacy 6th Plan Base Case 051409 LR L8112 MJS 090519.xls"

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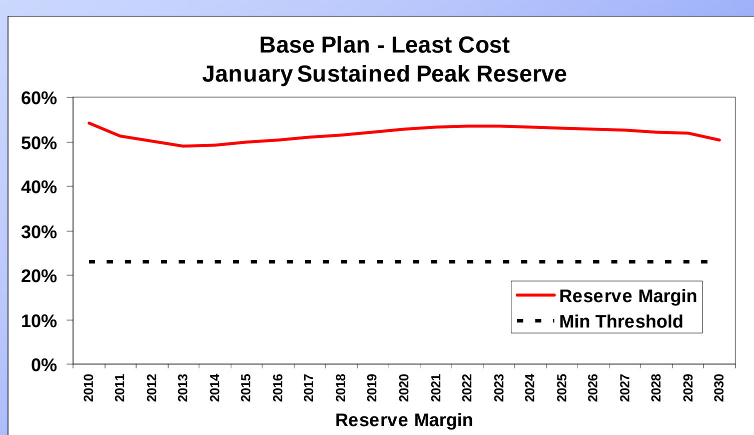
Contribution to January Peak Least Cost



Source: Least cost plan from "Analysis of Optimization Run_L811 090510 2101.xls"; adequacy calculation from "Adequacy 6th Plan Base Case 051409 LR L8112 MJS 090519.xls"

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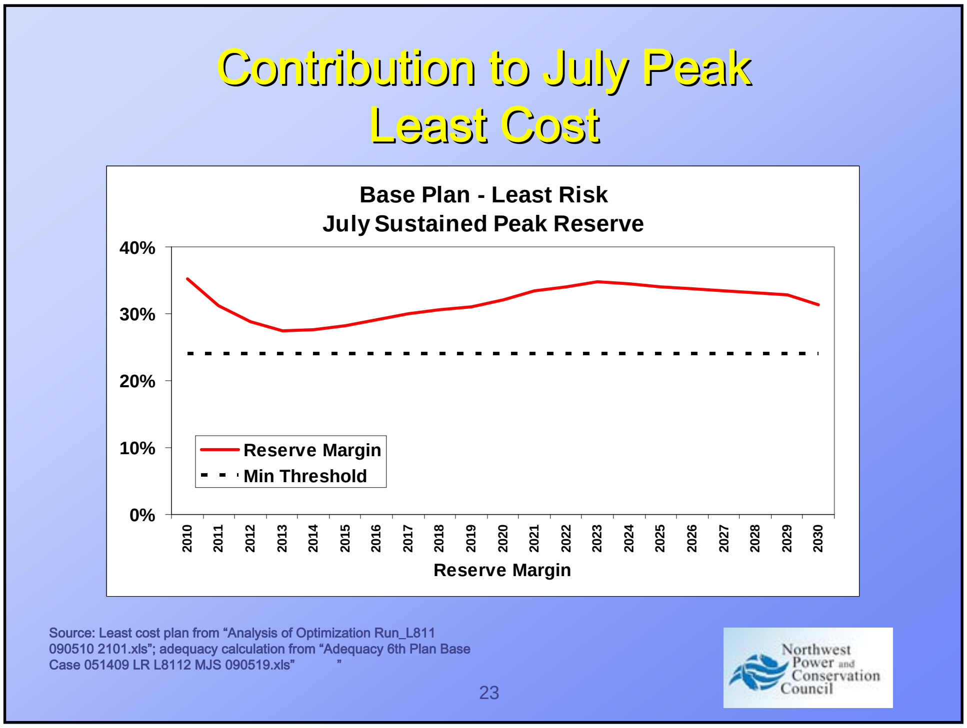
Contribution to July Peak
Least Cost
Base Plan - Least Risk
July Sustained Peak Reserve
40%
30%
20%
10%
0%
Reserve Margin
Min Threshold
2010 2011 2012 2013 2014 2015 2016 2017 2018 2019 2020 2021 2022 2023 2024 2025 2026 2027 2028 2029 2030
Reserve Margin
Source: Least cost plan from "Analysis of Optimization Run_L811 090510 2101.xls"; adequacy calculation from "Adequacy 6th Plan Base Case 051409 LR L8112 MJS 090519.xls"
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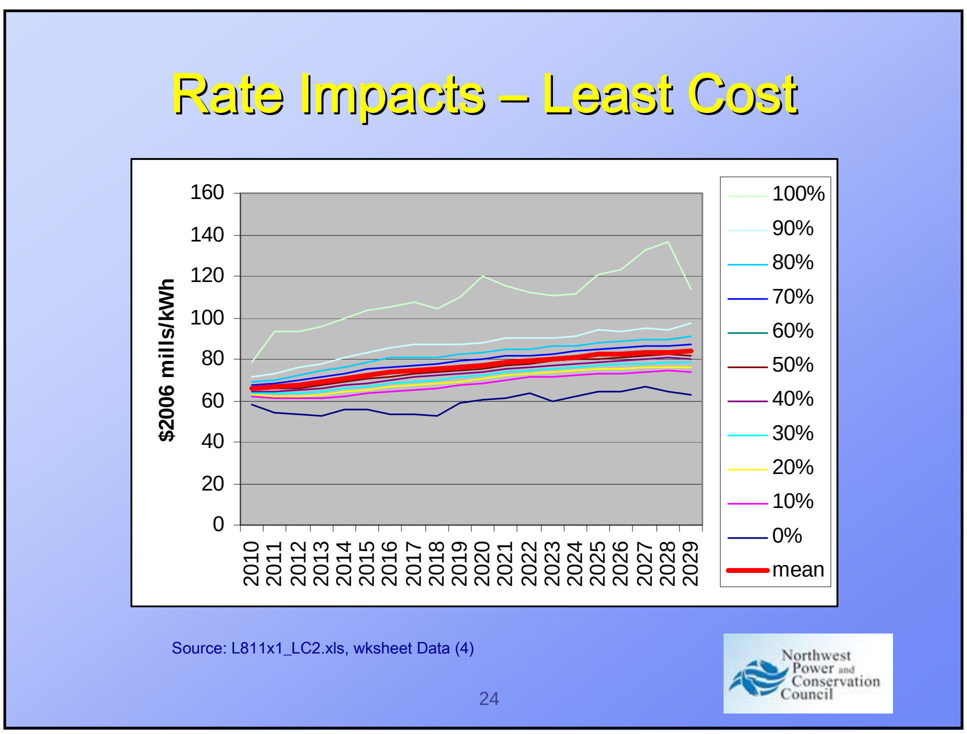
Rate Impacts – Least Cost
$2006 mills/kWh
160
140
120
100
80
60
40
20
0
2010 2011 2012 2013 2014 2015 2016 2017 2018 2019 2020 2021 2022 2023 2024 2025 2026 2027 2028 2029
100%
90%
80%
70%
60%
50%
40%
30%
20%
10%
0%
mean
Source: L811x1_LC2.xls, wksheet Data (4)
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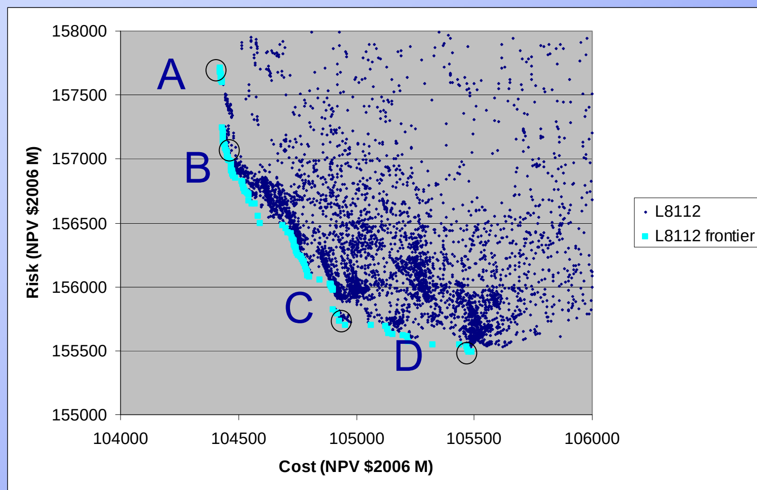
Efficient Frontier



Source: Analysis of Optimization Run_L811 090510 2101.xls

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Plan A

Plan A Discretionary demand response: none

10 Lost opportunity conservation cost-effectiveness threshold, premium over market ($2006/MWh)
2941 Lost opportunity conservation by end of study (MWa)*
10 Discretionary conservation cost-effectiveness threshold, premium over market ($2006/MWh)
2585 Discretionary conservation by end of study (MWa) assuming 160MWa/year limit
5527 Total conservation (MWa)

Cumulative MW, by earliest date to begin construction

	Dec-10	Dec-13	Dec-15	Dec-17	Dec-19	Dec-23	Dec-25
CCCT	0	0	0	0	0	0	0
SCCT	0	0	0	0	0	0	0
Geothermal	0	0	0	0	0	0	0
and the *larger* of							
Wind	0	0	0	0	0	0	0
RPS* req	0	**321**	**1193**	**2007**	**3061**	**4930**	**5363**

Source: Schedules for plan resources 090519.xls

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Plan B

Plan B Discretionary demand response: none

20 Lost opportunity conservation cost-effectiveness threshold, premium over market ($2006/MWh)
3042 Lost opportunity conservation by end of study (MWa)*
10 Discretionary conservation cost-effectiveness threshold, premium over market ($2006/MWh)
2581 Discretionary conservation by end of study (MWa) assuming 160MWa/year limit
5623 Total conservation (MWa)

Cumulative MW, by earliest date to begin construction

	Dec-10	Dec-13	Dec-15	Dec-17	Dec-19	Dec-23	Dec-25
CCCT	0	0	0	0	0	**415**	**415**
SCCT	0	0	0	0	0	0	**170**
Geothermal	0	0	0	0	0	**13**	**39**
and the *larger* of							
Wind	0	**300**	**300**	**600**	**600**	**600**	**600**
RPS* req	0	**320**	**1189**	**1994**	**2982**	**4607**	**4985**

Source: Schedules for plan resources 090519.xls

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Plan C

Plan C Discretionary demand response: none

40 Lost opportunity conservation cost-effectiveness threshold, premium over market ($2006/MWh)
3198 Lost opportunity conservation by end of study (MWa)*
10 Discretionary conservation cost-effectiveness threshold, premium over market ($2006/MWh)
2575 Discretionary conservation by end of study (MWa) assuming 160MWa/year limit
5773 Total conservation (MWa)

Cumulative MW, by earliest date to begin construction

	Dec-10	Dec-13	Dec-15	Dec-17	Dec-19	Dec-23	Dec-25
CCCT	0	0	0	0	0	**415**	**415**
SCCT	0	0	**170**	**170**	**170**	**170**	**170**
Geothermal	0	0	0	**52**	**104**	**156**	**156**
and the *larger* of							
Wind	0	0	**300**	**300**	**2100**	**2100**	**2100**
RPS* req	0	**319**	**1186**	**1981**	**2904**	**4283**	**4607**

Source: Schedules for plan resources 090519.xls

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Plan D

Plan D Discretionary demand response: none

50 Lost opportunity conservation cost-effectiveness threshold, premium over market ($2006/MWh)
3253 Lost opportunity conservation by end of study (MWa)*
10 Discretionary conservation cost-effectiveness threshold, premium over market ($2006/MWh)
2573 Discretionary conservation by end of study (MWa) assuming 160MWa/year limit
5827 Total conservation (MWa)

Cumulative MW, by earliest date to begin construction

	Dec-10	Dec-13	Dec-15	Dec-17	Dec-19	Dec-23	Dec-25
CCCT	0	0	0	**415**	**830**	**830**	**830**
SCCT	0	0	**170**	**170**	**170**	**170**	**170**
Geothermal	0	0	0	**52**	**104**	**156**	**169**
and the *larger* of							
Wind	0	0	**1200**	**1200**	**3000**	**3000**	**3000**
RPS* req	0	**317**	**1182**	**1968**	**2825**	**3959**	**4229**

Source: Schedules for plan resources 090519.xls

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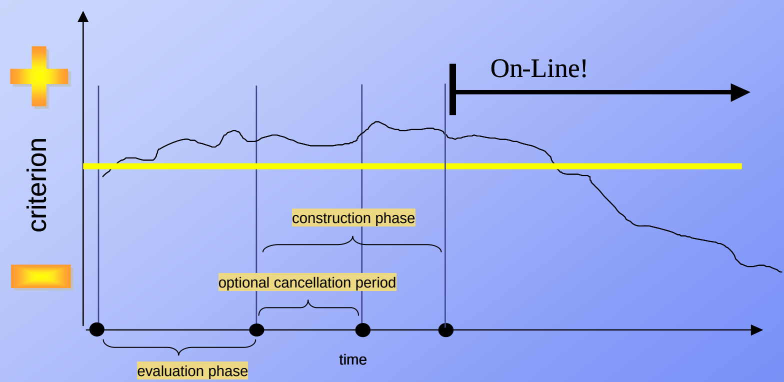
Decision Criteria For Construction



Decision Flexibility

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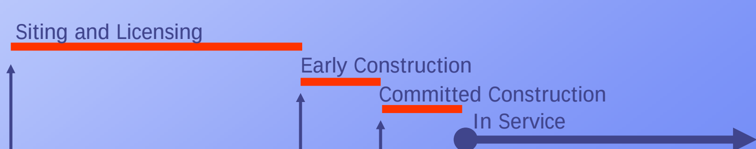
Interpreting and Using a Plan

- As a ceiling for what should be sited and licensed
- To develop signposts for re-evaluation

Additions in Megawatts

Beginning of year	2008	2010	2012	2014	2016	2018	2020
CCCT	0.00	0.00	0.00	0.00	0.00	610.00	1,220.00
SCCT	0.00	0.00	0.00	0.00	0.00	100.00	800.00
Coal	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Demand Response	500.00	750.00	1,000.00	1,250.00	1,500.00	1,750.00	2,000.00
Wind_Capacity	0.00	100.00	1,500.00	2,400.00	4,400.00	5,000.00	5,000.00
IGCC	0.00	0.00	425.00	425.00	425.00	425.00	425.00
Conservation cost-effectiveness premium over market	10.00	5.00					
avg New Conservation	443	746	1071	1416	1774	2020	2198



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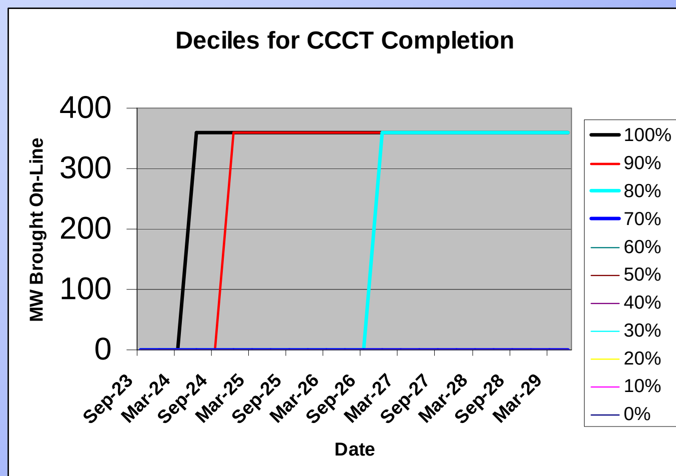
Build Decision for CCCT



Source: Illustrations for the 090512 P4 PPT.xls based on L810X.sls

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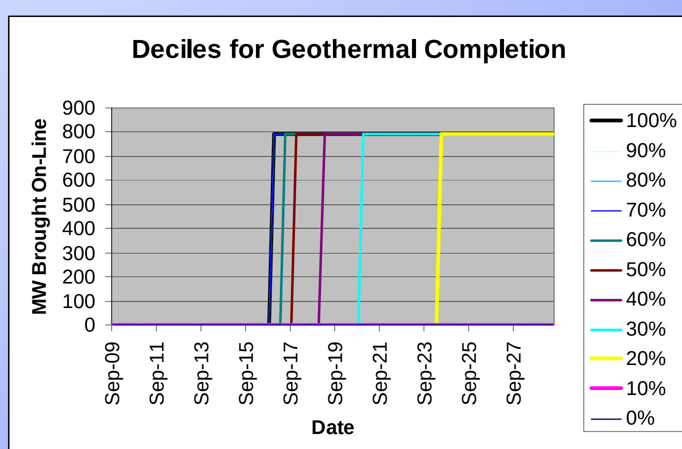
Build Decision for Geothermal*



Source: Illustrations for the 090512 P4 PPT.xls based on L810X.sls

*This illustration developed from earlier, unconstrained geothermal schedule.

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The Value of Using Construction Options for a Resource Plan

- More realistic
- Necessary for capturing construction cost risk
- Consistent with earlier Council Plans
- Consistent with statutory requirement for 20-year resource plan

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Issue Studies

- Carbon control and climate change
  - Cost, risk, and carbon emission considerations in plan selection
  - Displacement by renewables and conservation
  - Reduction through dispatch penalties
  - Direct curtailment of coal-fired power production
  - The effects of climate change on energy production and requirement
- The economic consequences of the Regional Portfolio Standards

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Cost, Risk, And Carbon Emission Considerations In Plan Selection

- Mechanisms: displacement, dispatch, direct curtailment
- Resource-oriented versus requirement-oriented perspective
- Definition of regional resources
- Transfer costs and the use of collected revenues

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Mechanisms

- Displacement
  - Example: building renewables
- Dispatch penalty
  - Example: tax of fuels, emission; trading regimes
- Direct curtailment
  - Example: new source requirements

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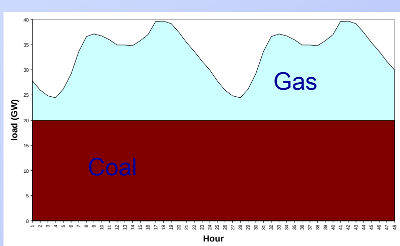
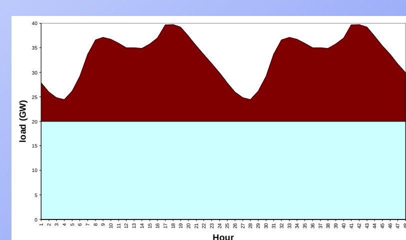
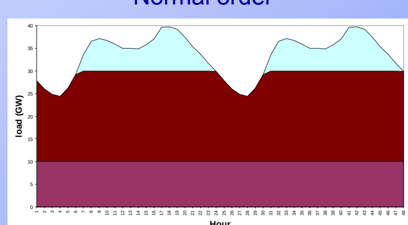
Mechanisms



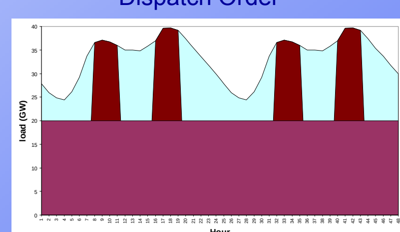
Normal order



Dispatch Order



Displacement



Curtailment

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Mechanisms

- Different Effects
  - Wholesale electricity price
  - Cost to ratepayers
- Different Advantages and Disadvantages
  - Administrative control
    - Administrative boundary issues
    - Geographic boundary issues
    - Reversibility
  - Efficiency & Flexibility

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Cost, Risk, And Carbon Emission Considerations In Plan Selection

- Mechanisms: displacement, dispatch, direct curtailment
- Resource-oriented versus requirement-oriented perspective
- Definition of regional resources
- Transfer costs and the use of collected revenues

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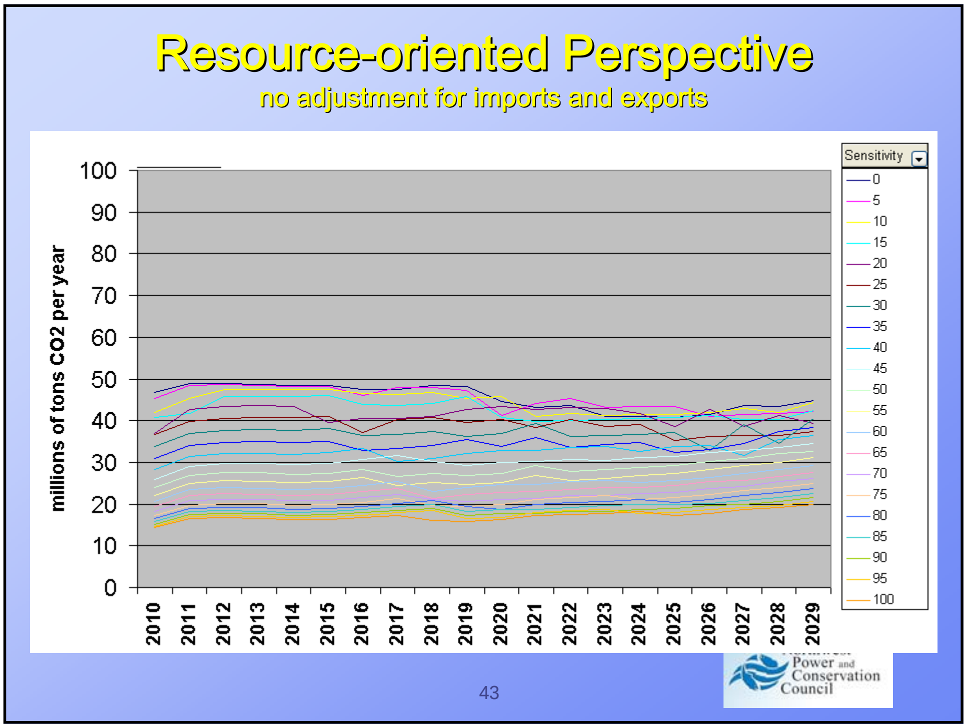
Resource-oriented Perspective
no adjustment for imports and exports
millions of tons CO2 per year
100
90
80
70
60
50
40
30
20
10
0
2010
2011
2012
2013
2014
2015
2016
2017
2018
2019
2020
2021
2022
2023
2024
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2026
2027
2028
2029
Sensitivity
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100
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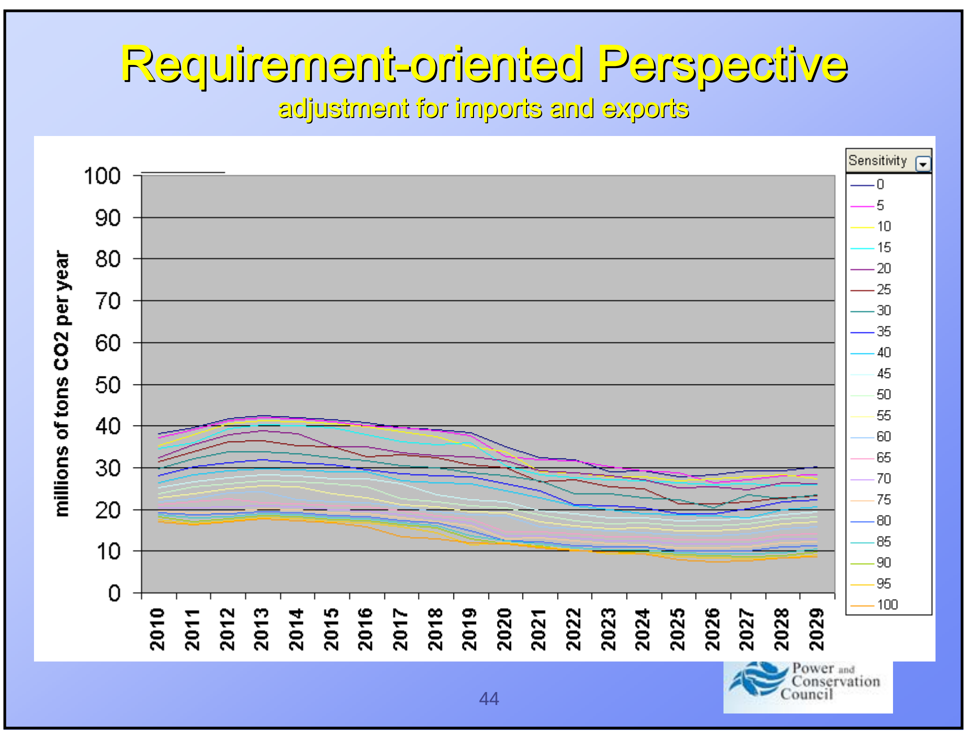
Requirement-oriented Perspective
adjustment for imports and exports
millions of tons CO2 per year
100
90
80
70
60
50
40
30
20
10
0
2010
2011
2012
2013
2014
2015
2016
2017
2018
2019
2020
2021
2022
2023
2024
2025
2026
2027
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2029
Sensitivity
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15
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45
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Resource-oriented Versus Requirement-oriented Perspective

- Very distinct pictures emerge
- If all the fossil-fired generation in the region were curtailed, would the region have solved its carbon emission problem?

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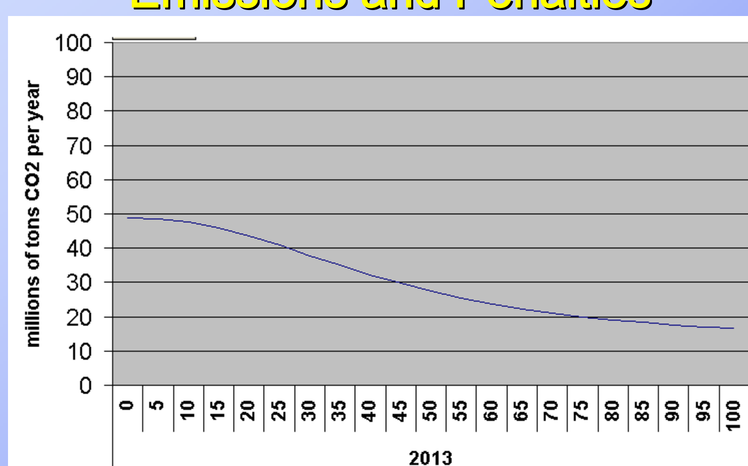
Trade-Off Curves for Emissions and Penalties



Source:: L811s - Sensitivity study on Carbon.xls, with sensitivity moved to the horizontal axis and 2013 selected

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Cost, Risk, And Carbon Emission Considerations In Plan Selection

- Mechanisms: displacement, dispatch, direct curtailment
- Resource-oriented versus requirement-oriented perspective
- → Definition of regional resources
- Transfer costs and the use of collected revenues

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Definition of Regional Resources

Name	Installed Capacity (MW)	Availability (%)	Capability (MWa)	Average Heat Rate (Btu/kWh)	tons CO2/MWh	RPM & Genesys (%)	Council's Carbon Footprint paper
Boardman	601.0	84%	504.8	10840	1.149	75%	100%
Centralia 1 (85% IPP)	730.0	84%	613.2	10240	1.085	100%	100%
Centralia 2 (100% IPP)	730.0	84%	613.2	10240	1.085	100%	100%
Colstrip 1	358.4	84%	301.1	11170	1.184	50%	100%
Colstrip 2	358.4	84%	301.1	11170	1.184	50%	100%
Colstrip 3	778.0	84%	653.5	10870	1.152	70%	100%
Colstrip 4	778.0	84%	653.5	10870	1.152	92%	100%
Corrette (J.E. Corette)	172.8	84%	145.2	11010	1.167	0%	100%
Jim Bridger 1	577.9	84%	485.4	10570	1.120	100%	100%
Jim Bridger 2	577.9	84%	485.4	10570	1.120	100%	100%
Jim Bridger 3	577.9	84%	485.4	10570	1.120	100%	100%
Jim Bridger 4	584.0	84%	490.6	10570	1.120	100%	100%
North Valmy 1	254.3	84%	213.6	10450	1.108	50%	50%
North Valmy 2	267.0	84%	224.3	10450	1.108	50%	50%
Steam Plant 2 (retired)	2.0					0%	100%

- At 84% capacity factor, the Council's Carbon Footprint Paper estimates regional coal plant carbon emission would be 16.6% higher than the Regional Portfolio Model (58.9 vs 50.5 M tons)
- Note that Centralia is an Independent Power Producer

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Transfer Cost Effects

- Some carbon control policies rely on taxes that would be collected somewhere along the fuel stream (production, conversion, use)
- The identity of winners and losers, and whether these costs should be considered "real", depends on what happens to those tax revenues
- Regional Portfolio Model produces costs and risks both with and without the carbon penalty cost
- While the costs and rates would differ significantly, preliminary studies suggest the plan selection ***would be the same irrespective*** of the treatment of these costs.

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Issue Studies

- Carbon control and climate change
  - Cost, risk, and carbon emission considerations in plan selection
  - → Displacement by renewables and conservation
  - Reduction through dispatch penalties
  - Direct curtailment of coal-fired power production
  - The effects of climate change on energy production and requirement
- The economic consequences of the Regional Portfolio Standards
- Conservation implementation rate
- Breaching the lower Snake dams

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Displacement By Renewables and Conservation

- How effective is the RPS in reducing carbon emissions?
- Can the region meet carbon emission targets through RPS resources and conservation alone?

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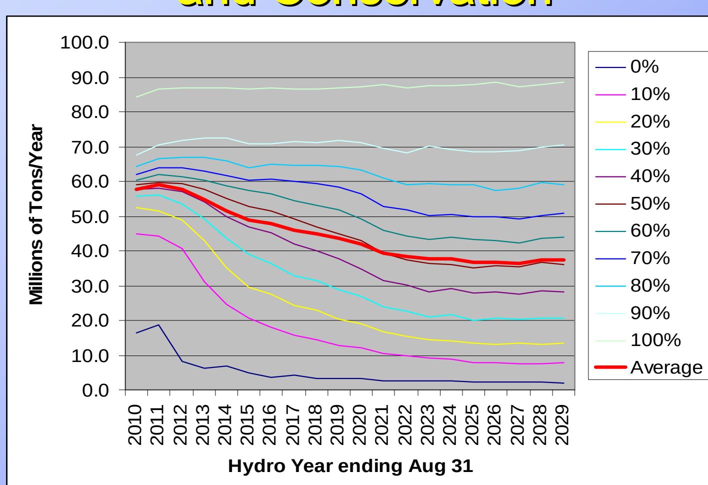
Displacement By Renewables and Conservation



Source: "Studies\L811\L811 Extractions\Qtrly Rates, CO2, and others - LR+LC\L811x1_LR.xls", worksheet "Data (6)"; no imp/exp adjustment, includes standard year and regional resource definition adjustments

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Carbon-constrained, Least-cost Plan

Discretionary demand response: none

100 Lost opportunity conservation cost-effectiveness threshold, premium over market ($2006/MWh)
2390 Lost opportunity conservation by end of study (MWa)*
100 Discretionary conservation cost-effectiveness threshold, premium over market ($2006/MWh)
3049 Discretionary conservation by end of study (MWa) assuming 160MWa/year limit
5439 Total conservation (MWa)

Cumulative MW, by earliest date to begin construction

	Dec-10	Dec-13	Dec-15	Dec-17	Dec-19	Dec-23	Dec-25
CCCT	0	0	0	**756**	**1512**	**3780**	**3780**
SCCT	0	0	**170**	**340**	**340**	**340**	**340**
Geothermal	0	0	**630**	**630**	**630**	**630**	**840**
Woody Biomass	0	0	0	0	0	**850**	**850**
Advanced Nuclear	0	0	0	0	**2200**	**2200**	**2200**
Eastern MT Wind	**4500**	**4500**	**4500**	**4500**	**4500**	**4500**	**4500**
and the *larger* of							
Wind	**3500**	**3500**	**5500**	**5500**	**5500**	**5500**	**5500**
RPS* req	0	**26**	**972**	**1842**	**2628**	**4979**	**5388**

Source: Schedules for plan resources.xls

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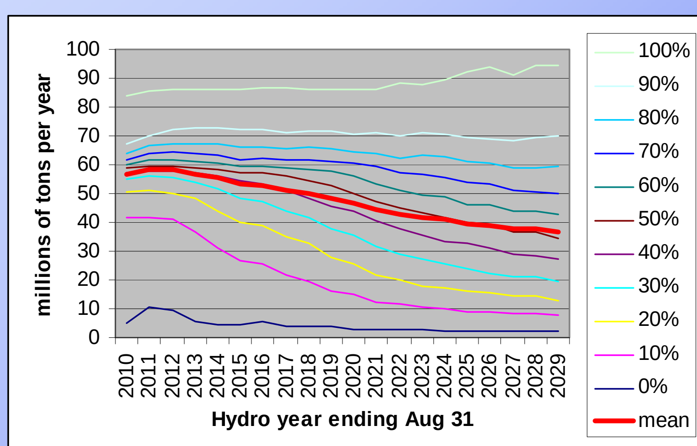
Carbon-constrained, Least-cost Plan



Source: Data conversion workbook 011 L810c.xls

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Displacement Conclusions

- Displacement does not guarantee carbon reduction
- Electricity price – properly speaking, the relationship between electricity price, fuel price, and carbon dispatch penalty – will trump displacement

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Issue Studies

- Carbon control and climate change
  - Cost, risk, and carbon emission considerations in plan selection
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  - Direct curtailment of coal-fired power production
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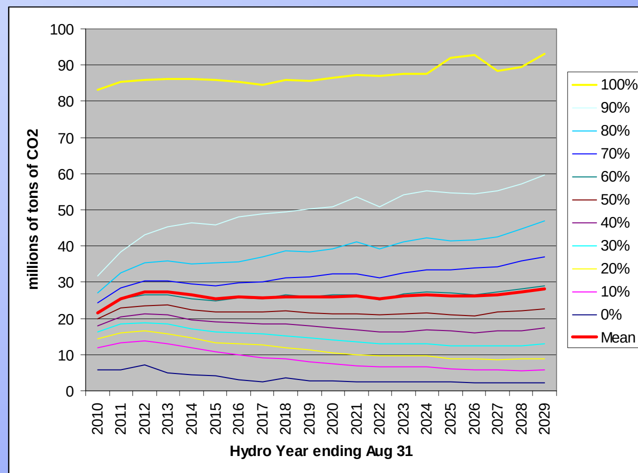
Reduction through Dispatch Penalties

- fixed $100/ton CO2 tax in all futures



Source: "Plan 6\Studies\L810\L810a $100 per ton carbon penalty\Extraction for carbon effect\L810a.xls" , worksheet "Data (3)"

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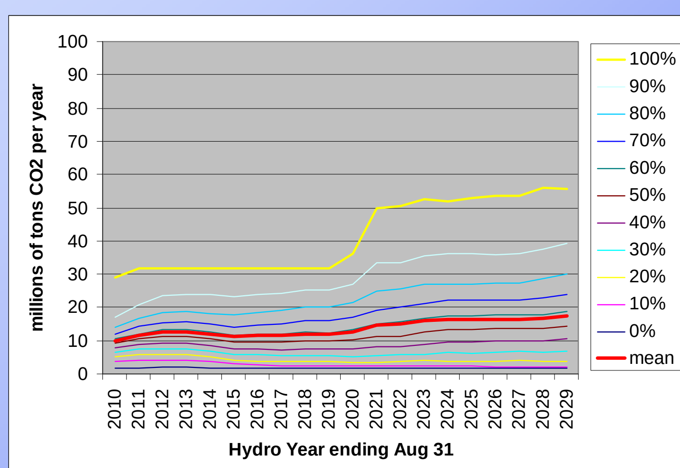
Curtailment Of Existing Coal-fired Power Production



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The Effects Of Climate Change

- Hydro generation
- Loads
- This study is outstanding, but we believe we have in hand the necessary data.

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Issue Studies

- Carbon control and climate change
  - Cost, risk, and carbon emission considerations in plan selection
  - Displacement by renewables and conservation
  - Reduction through dispatch penalties
  - Direct curtailment of coal-fired power production
  - The effects of climate change on energy production and requirement
- The economic consequences of the Regional Portfolio Standards

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Regional Portfolio Standards

- What should the region have done in the absence of RPS requirements?
- Are the RPS requirements expensive relative to the “no-RPS” alternative?
- How effective is the RPS approach in reducing carbon emissions?

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RPS Conclusions

- In the absence of the RPS requirement, the region probably should have acquired about the same amount of renewables as the RPS statues require.
- Matching the schedule of renewable construction to economic requirements might have saved some money, but probably not much.
- Constructing renewables and other non-carbon producing resources is necessary but not, in itself, sufficient to guarantee reduced CO_2 emission rate.

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Summary

- Changes in assumptions and data
- Plans on the efficient frontier
- Interpreting a plan
- Issue Studies
  - Carbon control and climate change
  - The economic effects of the Regional Portfolio Standards

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Conclusions

- Conservation dominates the Least-Risk and Least-Cost plans
- The Least-Risk and Least-Cost plans appear to be adequate from an energy and a peak contribution perspective
- The recommendation has considered the possibilities of breaching the Lower Snake River dams. We hope soon to have a study that assesses the likely change in loads and hydrogeneration that scientists believe might result from climate change.

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Conclusions

- The Least-Risk plan reduces expected carbon emission rates, but significant risk remains that regional coal plants would continue emitting carbon at nearly the same rates
- Investment in renewables and energy efficiency, coupled with arrangements for the direct curtailment of the six coal plants in the region, offer the surest, lowest risk solution to meeting regional carbon emission standards
- If we curtail coal-fired generation too abruptly, we limit our options for replacing the energy. If we have to replace this energy with gas-fired generation, for example, our possible reductions would be cut by half. Curtailment must be tempered by prudence and our assessment of potential for carbon-free sources of energy.

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End