Northwest Power and Conservation Council

July 1, 2009

MEMORANDUM

TO: Council Members

FROM: Terry Morlan

SUBJECT: Discussion of Climate Policy Analysis

Climate change policies and their potential effects on the power system was one of the major issues identified for the Council's Sixth Power Plan to address. The Council's recommended resource strategy incorporates existing climate policies such as renewable portfolio standards, new plant carbon emission limits, and renewable energy credits. In addition, it recognizes the likelihood of future carbon pricing policies that are being discussed or advocated, but also that the levels of those emission penalties are unknown. The Council has assumed these penalties could range from $0 to $100 per ton, but on average they are assumed to grow over time and reach $47 per ton by 2030.

The Council also has looked at several specific scenarios to further explore the uncertainties about potential policies. These include:

- Current policies only
- No policies at all
- Known carbon penalties of $100 and $20
- A case with uncertain carbon penalties, but no RPS requirements
- Cases to explore phasing out existing coal plants

These studies and their results are described in attached papers and a presentation. The first paper is a draft for part of Chapter 10 on climate change. It is the highest level summary of results. The second paper is a draft of a section of Chapter 9 on the resource portfolio and contains more detailed discussion of scenarios and results. The third attachment describes a survey of what carbon cost assumptions a sample of regional utilities have used in their integrated resource planning. Finally, there is a Power Point presentation on the carbon policy scenarios compared to the plan assumptions.

Attachments

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

Steve Crow
Executive Director

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

Effects of Alternative Scenarios on Sixth Power Plan

Northwest Power and Conservation Council

Whitefish, MT

June 2009

NORTHWEST 6th POWER PLAN

Northwest Power and Conservation Council

Scenarios

- Plan case
- Current Policy Case
- Carbon Policy Explorations
  - Suspend Carbon Policy
  - No RPS
  - $100/ton Carbon Cost
  - $20/ton Carbon Cost
  - Close Existing Coal Plants
  - Dam Removal

NORTHWEST 6th POWER PLAN

Northwest Power and Conservation Council

Plan Case Assumptions

- Forecasts of demand and fuel prices
- RPS renewables are acquired
- Carbon costs range from $0 to $100, grow over the planning period and reach average of $47 per ton by 2030
- Discretionary conservation limited to 160 average megawatts per year, lost op. phased in to 85% penetration maximum

NORTHWEST 6th POWER PLAN

Northwest Power and Conservation Council

Limitations of Carbon Price Analysis

- Carbon pricing policy is modeled as a penalty on carbon emissions from generation
  - Under a cap and trade policy, granting free carbon allowances to emitters will eliminate the cost impact to utilities
  - In our reporting of power system costs we have assumed free allowances are granted

NORTHWEST 6th POWER PLAN

Northwest Power and Conservation Council

Translating Costs to Rates and Bills

- Costs minimized in the Power Plan are not consumer rates or bills
- Estimating retail rate effects:
  - Add capital cost of existing generation, transmission and distribution systems
  - Exclude conservation costs not paid for by utilities
  - Exclude “end effects” costs
  - Divide adjusted costs by net loads

NORTHWEST 6th POWER PLAN

Northwest Power and Conservation Council

Current Policy Case

- Purpose
  - Determine the effects of excluding risks of carbon penalties in the future
- Assumptions
  - Start with “Plan Case” and eliminate the risk of future carbon penalties
  - Includes current RPS, REC, and new plant carbon emission standards
  - No new pulverized coal plants allowed

NORTHWEST 6th POWER PLAN

Northwest Power and Conservation Council

Effects of Current Policy Case

	Plan Case	Current Policy
NPV Cost	85.1	70.5
% Change in Rates from Plan Case		- 2.4 %
CO2 (Gen)	40.2	56.5
Conservation	5,827	5,197
Wind Development	1,800	1,845
Geothermal	52 (Dec-17); 169	13 (Dec-23); 13
Natural Gas CCCT	378 (Dec-17); 756	0
Natural Gas SCCT	162 (Dec-15); 162	162 (Dec-19); 648

Findings: Current Policy Case

- Power system cost reduced by 34 percent
- Retail rates reduced by 2.4 percent
- Carbon emissions increase by 38 percent; stabilized at 2005 levels
- Resource plan is more focused on renewable energy, backed up by simple-cycle turbines

No-Carbon-Policy Case

- Purpose
  - To provide a basis for answering questions about the cost of reducing carbon emissions
- Assumptions
  - No renewable portfolio standards
  - No renewable energy credits
  - No exposure to future carbon cost uncertainty
  - No new pulverized coal

NORTHWEST 6th POWER PLAN

Northwest Power and Conservation Council

Effects of No-Carbon-Policy

	Plan Case	No Policy Case
NPV Cost	85.1	56.5
% Change in Rates from Plan Case		- 5.0 %
CO_2 (Gen)	40.2	65.1
Conservation	5,827	5,432
Wind Development	1,800	0
Geothermal	52 (Dec-17); 169	52 (Dec-17); 52
Natural Gas CCCT	378 (Dec-17); 756	1,512 (Dec-17) 1,890
Natural Gas SCCT	162 (Dec-15); 162	648 (Dec-15); 648

NORTHWEST 6th POWER PLAN

Northwest Power and Conservation Council

Findings: No-Carbon-Policy Case

- NPV cost of the power system reduced by 34%
  - Rates reduced by 5.0 %
- Carbon emissions grow to 14% above 2005 level
- 2.5 times more natural gas CCCTs
- 4 times more natural gas SCCTs
- Conservation is only reduced by 7% from base case

NORTHWEST 6th POWER PLAN

Northwest Power and Conservation Council

$100 a Ton Carbon Cost

- Purpose
  - To consider how the resource strategy might change if a high carbon cost future were assured rather than just a likelihood
- Assumptions
  - A known $100 per ton carbon cost instead of uncertain costs between $0 and $100
  - RPS goals assumed to be met
  - RECs are retained by utilities, i.e. wind costs are not reduced by REC value

NORTHWEST 6th POWER PLAN

Northwest Power and Conservation Council

$100 CO_2 Cost Case

	Plan Case	$100 CO_2 Cost
NPV Cost	85.1	97.4
% Change in Rates from Plan Case		+7.1%
CO2 (Gen)	40.2	28.3
Conservation	5,827	6,025
Wind Development	1,800	1,790
Geothermal	52 (Dec-17); 169	52 (Dec-17); 156
Natural Gas CCCT	378 (Dec-17); 756	1512 (Dec-17); 2268
Natural Gas SCCT	162 (Dec-15); 162	None

Findings: $100 Per Ton CO2 Cost

- Power system cost increased by 14%
- Retail rates increased by 7.1%
- Carbon emissions reduced by 30% from the plan case
- Increased conservation and renewable development
- Three times more natural gas CCCTs optioned, no SCCTs optioned
- Base load coal being displaced

$20 a Ton Carbon Cost

- Purpose
  - To consider how the resource strategy might change if a moderate carbon cost future were assured rather than just a likelihood
- Assumptions
  - A known $20 per ton carbon cost instead of uncertain costs between $0 and $100
  - RPS goals assumed to be met
  - RECs are retained by utilities, i.e. wind costs are not reduced by REC value

NORTHWEST 6th POWER PLAN

Northwest Power and Conservation Council

$20 CO_2 Cost Case

	Plan Case	$20 CO_2 Cost
NPV Cost	85.1	72.3
% Change in Rates from Plan Case		-1.0%
CO2 (Gen)	40.2	47.1
Conservation	5,827	5,427
Wind Development	1,800	1,808
Geothermal	52 (Dec-17); 169	52 (Dec-15); 156
Natural Gas CCCT	378 (Dec-17); 756	0
Natural Gas SCCT	162 (Dec-15); 162	648 (Dec-23)648

NORTHWEST 6th POWER PLAN

Northwest Power and Conservation Council

Findings: $20 Per Ton CO2 Cost

- Power system cost decreased by 15%
- Retail rates increased by 1.0%
- Carbon emissions increased by 17% from the plan case
- Less conservation and same renewable generation
- No natural gas CCCTs optioned
- 4 times more SCCTs optioned

No Renewable Portfolio Standards

- Purpose
  - To assess the role of RPS policies relative to carbon pricing strategies
- Assumptions
  - RPS requirements eliminated
  - Wind credited with REC value
  - Region still faces base case carbon price uncertainty

No RPS Case

	Plan Case	No RPS Case
NPV Cost	85.1	79.3
% Change in Rates from Plan Case		-1.7%
CO2 (Gen)	40.2	43.7
Conservation	5,827	5,936
Wind Development	1,800	1,171
Geothermal	52 (Dec-17); 169	13 (Dec-13); 208
Natural Gas CCCT	378 (Dec-17); 756	378 (Dec-15); 378
Natural Gas SCCT	162 (Dec-15); 162	162 (Dec-13); 648

* Includes all wind because of no RPS assumption

Findings: No RPS Case

- Small reduction in cost and rates
- Increased carbon emissions by 3.5 MMtpy
- Slightly increased conservation
- Renewable development is significantly reduced
- Natural gas resources are optioned a little earlier, with fewer CCCTs, but more SCCTs

Retire Coal Plants Early

- Purpose
  - To compare the cost and effectiveness of a coal retirement strategy to carbon pricing risk of the base case
- Assumptions
  - Existing coal plants are phased out beginning in 2012 through 2020
  - RPS are included, but carbon penalties are removed

NORTHWEST 6th POWER PLAN

Northwest Power and Conservation Council

Retire Coal Plants Early Case

	Plan Case	Retire Coal
NPV Cost	85.1	94.7
% Change in Rates from Plan Case		+6.2%
CO2 (Gen)	40.2	15.2
Conservation	5,827	5,739
Wind Development	1,800	1,809
Geothermal	52 (Dec-17); 169	52 (Dec-15); 52
Natural Gas CCCT	378 (Dec-17); 756	2,268 (Dec-17); 2,268
Natural Gas SCCT	162 (Dec-15); 162	648 (Dec-23); 648

NORTHWEST 6th POWER PLAN

* Includes all wind because of no RPS assumption

Northwest Power and Conservation Council

Findings: Retire Coal Plants Early

- Cost is increased 11 percent
- Retail rates are increased 6.2%
- Carbon emissions are reduced by 62 percent from the Plan Case; down to 35 percent of 1990 levels
- Large increase in natural gas generation to replace coal

NORTHWEST 6th POWER PLAN

Northwest Power and Conservation Council

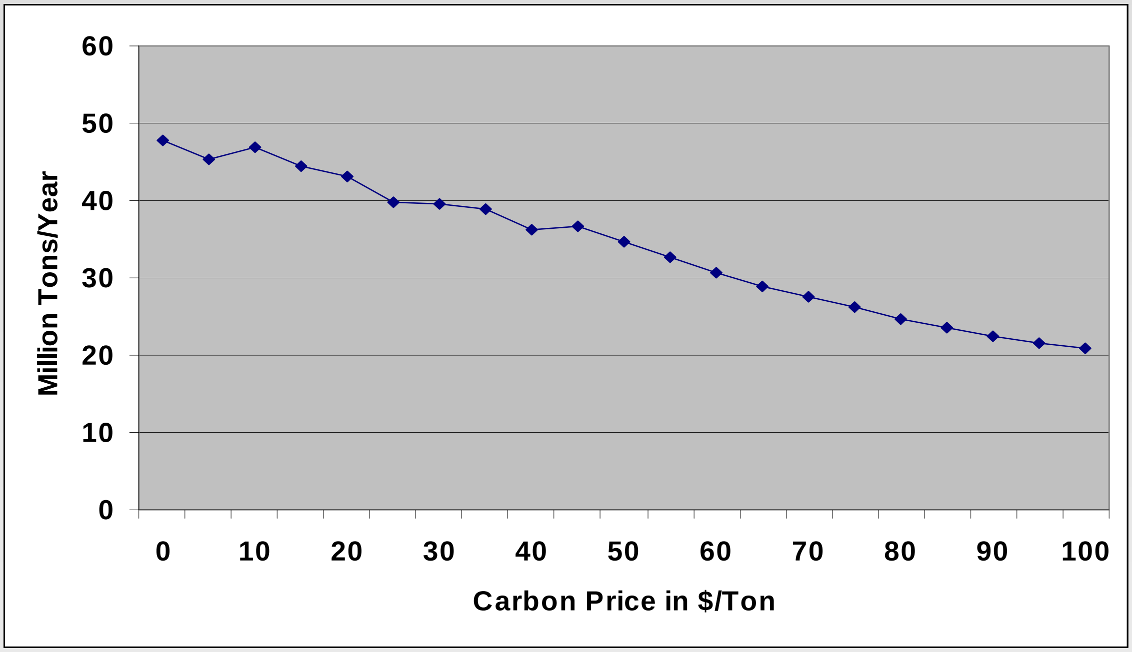
Sensitivity of the Plan Case to Varying Carbon Costs

- Purpose:
  - To test the sensitivity of the plan case resource plan to changing carbon costs (without uncertainties in all variables)
- Assumptions:
  - Operate the RPM without uncertainty to test power system response to changing carbon costs

NORTHWEST 6th POWER PLAN

Northwest Power and Conservation Council

Effect of Carbon Price on Emissions



NORTHWEST 6th POWER PLAN

Northwest Power and Conservation Council

Findings on Carbon Emissions

- Base case reduces carbon emissions below 1990 levels by 2030
- Without carbon policy, emissions would continue to grow, although more slowly
- RPS increases renewable development by 50 % compared to carbon cost risk only
- High ($100) carbon cost would reduce emissions to 2/3 of 1990 levels by 2030

NORTHWEST 6th POWER PLAN

Northwest Power and Conservation Council

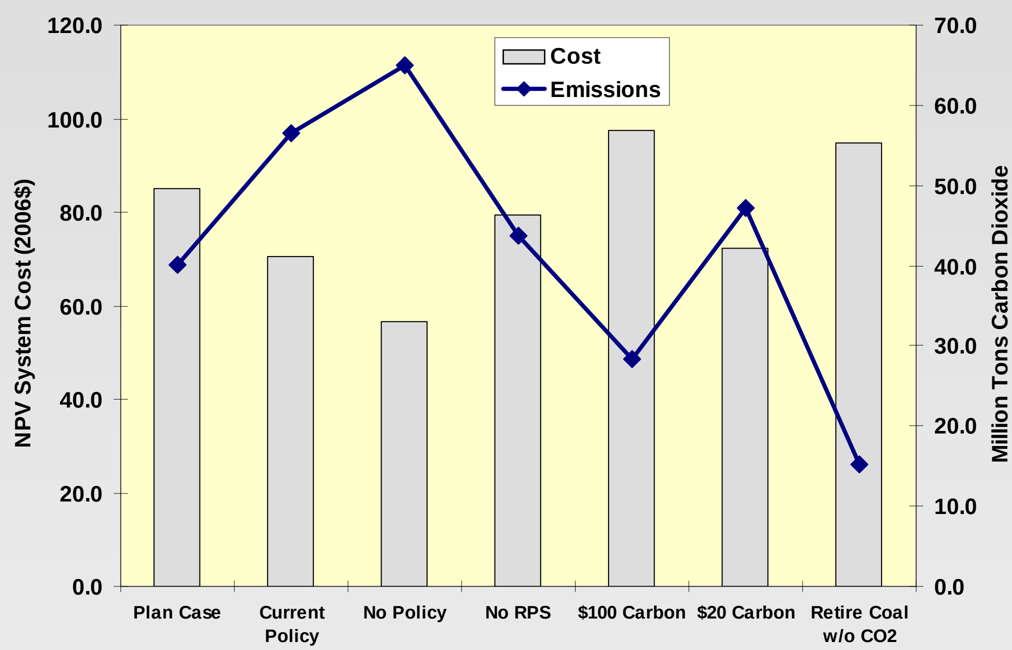
Findings on Carbon Emissions – Continued

- Retiring the existing regional coal plants would reduce carbon emissions to 35% of 1990 levels by 2030, at higher cost to the power system than carbon penalties

NORTHWEST 6th POWER PLAN

Northwest Power and Conservation Council

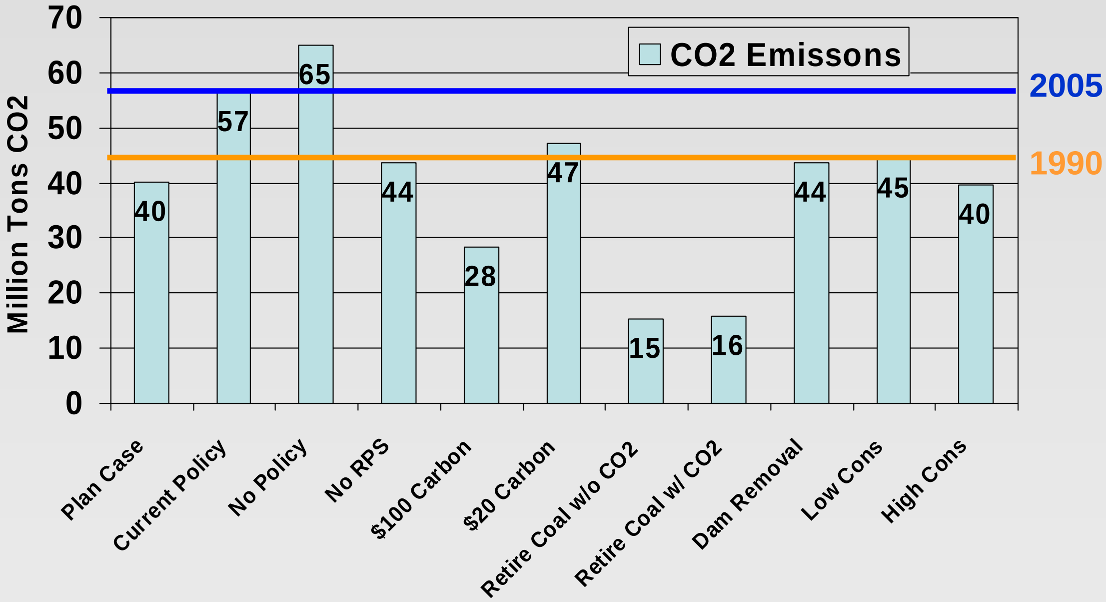
Power System Cost and Carbon Emissions



NORTHWEST 6th POWER PLAN

Northwest Power and Conservation Council

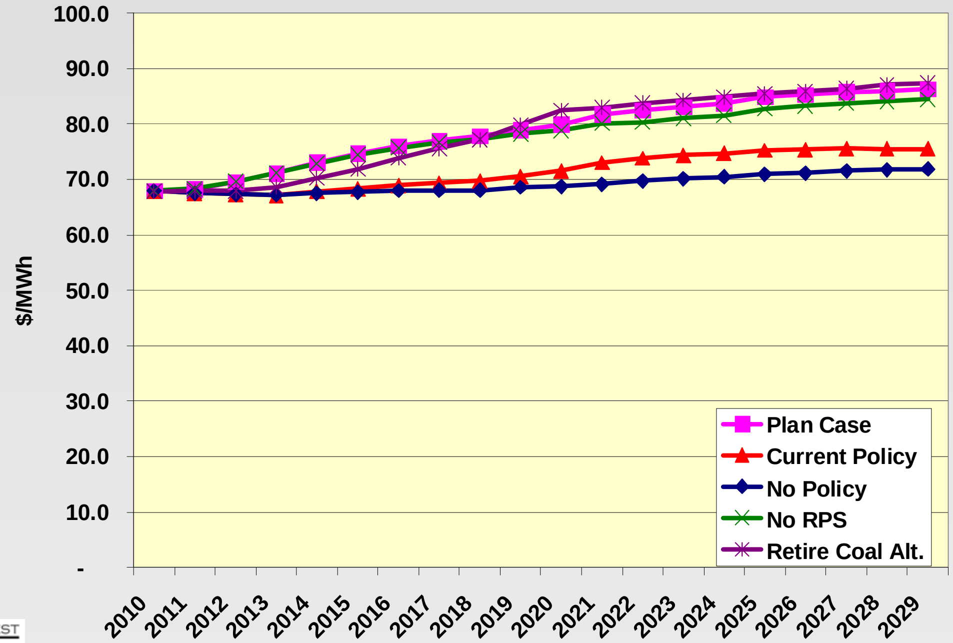
Carbon Emission Effects of Scenarios



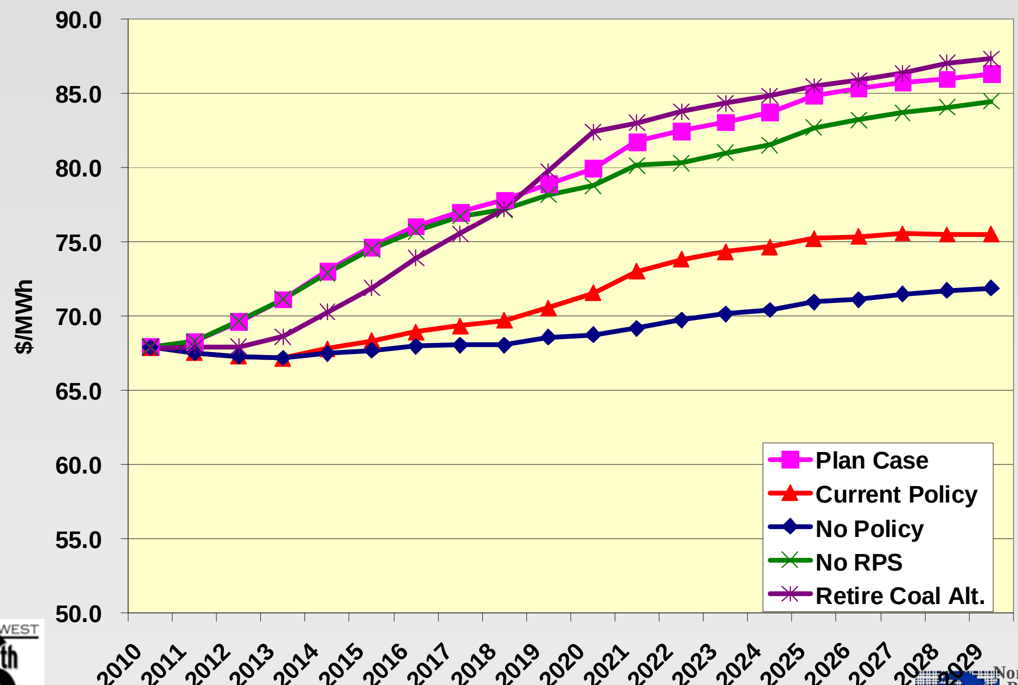
Estimating Retail Rates

Going forward power system cost	$ 106
Subtract end effects cost	- $38
Subtract conservation costs not paid by utilities	- $ 4
Add fixed cost of existing system	+ $130
Subtract carbon penalties not borne by utilities	- $21
Equals Revenue Requirement	$ 173

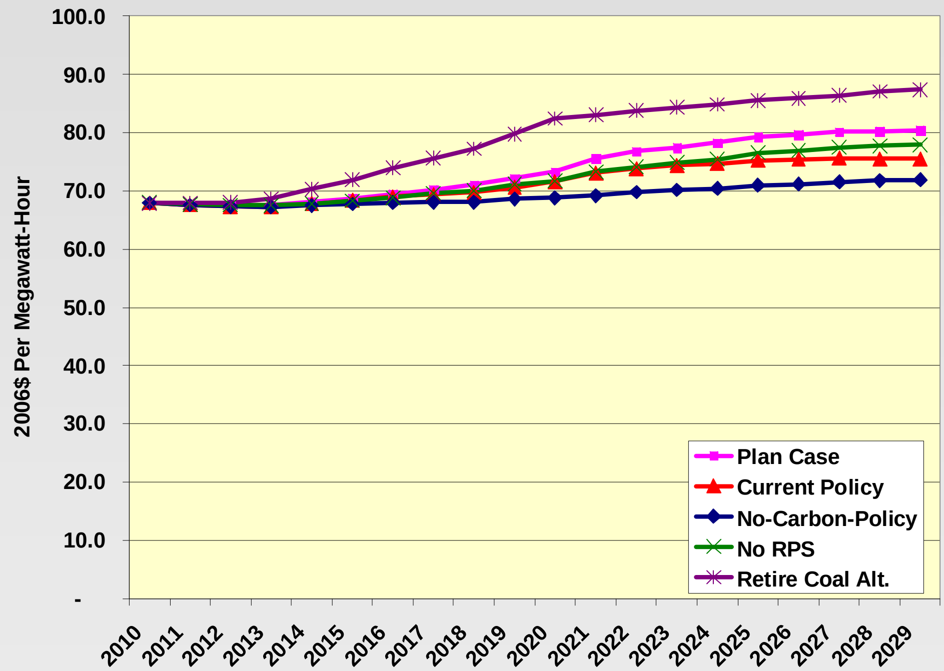
Retail Rate Effects of Carbon Policies: Including Penalty Cost



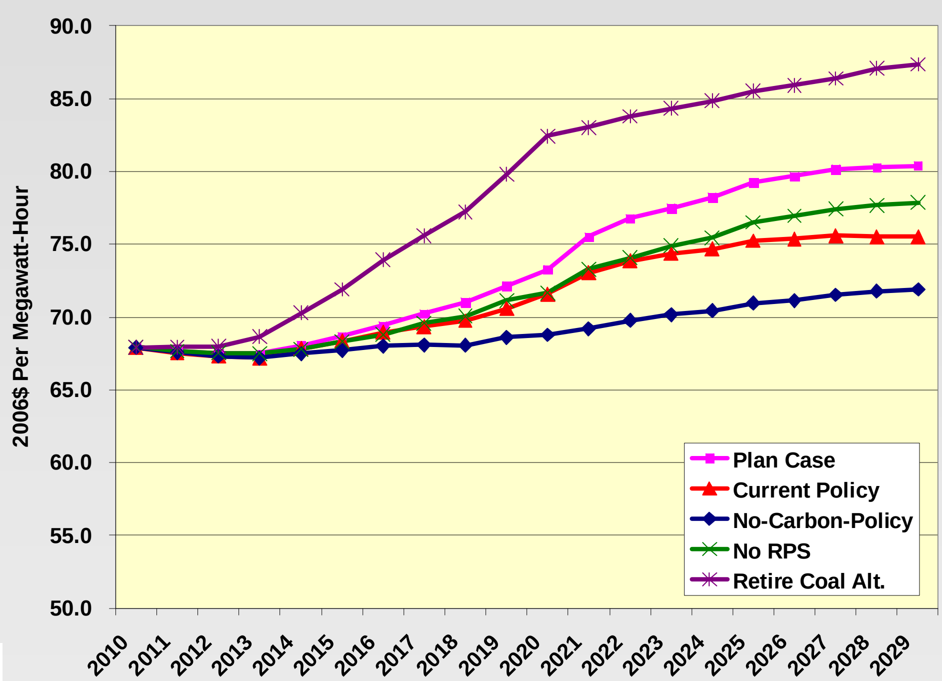
Retail Rate Effects of Carbon Policies: Including Penalty Cost



Retail Rate Effects of Carbon Policies: Excluding Penalty Cost



Retail Rate Effects of Carbon Policies: Excluding Penalty Cost



Northwest Power and Conservation Council

June 22, 2009

MEMORANDUM

TO: Council

FROM: Massoud Jourabchi/Ken Corum

SUBJECT: Assumed CO2 Penalty Costs in Utility IRPs

Subsequent to the Council's June meeting, staff conducted an informal survey of CO2 penalty cost assumptions in Integrated Resource Planning analysis conducted by IOUs and Public utilities in the Northwest. The IRP managers for the following utilities were contacted and asked about the level and timing of CO2 cost in their current IRP. The results are as follows:

PacifiCorp: Contacted Greg Duvall, IRP manager
PacifiCorp used a range of $45 to $100 dollars per ton, with start date of 2013. Their preferred portfolio of the resources was selected under a $45/ton of CO2 cost. This portfolio performed best (from a cost and risk strand point) under the full range of CO2 cost uncertainty range ($45-$100). To calculate the costs, they also ran a $0 cost case.

Portland General Electric: Contacted Stefan Brown,
In their 2009 IRP PGE used an average levelized price of $32 dollars per ton in 2009 prices for their Base case. They evaluated their resource plan with a range of CO2 prices from zero to $65 levelized. The zero dollars was for a point of cost comparison. They shape the CO2 prices using an EIA study.

Avista: Conversation with Clint Kalich, IRP Manager
Avista explicitly incorporates CO2 cost per ton in their IRP. Starting with 2010 at $6.5/ton going up to $105 dollars per ton by 2029 (all dollars in nominal terms with annual inflation rate of 1.9%). In constant 2006 dollars, CO2 cost per ton used by Avista, translates to $6 dollars per ton in 2012 and $69 dollars per ton by 2029.

Idaho Power: Contacted Rich Haener
Idaho Power expects to use $43/ton beginning in 2012, w/ no real escalation. They also have a high carbon cost case that is $56/ton in 2012.

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

Steve Crow
Executive Director

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

Seattle City Light: Conversation with David Clement IRP Manager
Although SCL does not have direct CO2 emitting power generation, SCL is mandated through city resolution 30359 (Seattle City Light's strategy for meeting the goal of zero net greenhouse gas emissions) to reduce its footprint. In their last IRP SCL used CO2 pricing from an EPA analysis of S. 2191, the Lieberman-Warner Climate Security Act of 2007 ($61-$83/ton in 2005 $). In their current IRP they are considering using Waxman/ Markey bill, but SCL is not certain at this time if the Waxman/Markey bill is realistic given its assumptions on the availability of cheaper international offsets and timing and availability of carbon capture and sequestration technology.

Tacoma Utilities: Contacted Nicolas Garcia,
Tacoma expects to base their assumption on a combination of EPA and CBO estimates. The EPA study Nicolas quoted was a preliminary study released in April 2009, with results that range from $28-$36/ton in 2030 for EPA's expected case. EPA's more recent analysis was released in June, 2009, with results of $26-$27/ton in 2030, and a scenario assuming no international offsets that results in $49/ton in 2030. The CBO estimate is $26/ton in 2019.

BPA: Bonneville is using Council's assumed distribution of carbon penalties. Janelle Schmidt said they might not have chosen exactly the same assumptions, but they were comfortable with ours, although they think the penalties increase a little too quickly in the early years.

NorthWestern: Contacted Dave Fine
NorthWestern is in the early stages of making their assumptions, but their early thinking is in the "high 20s."

Snohomish PUD: Snohomish was contacted, but they are not sure what CO2 price they will be using at this time.

Puget Sound Energy: in their 2009 IRP assumes CO2 emission costs to start at $34 per ton in 2012 escalating to $77 per ton by 2029. All prices are in constant 2008 dollars.

Based on above survey of largest regional utilities, one can conclude that Council's assumed CO2 costs are reasonably consistent with the range of assumptions being considered by utilities in their planning. None of the utilities consider a zero CO2 cost as their Base Case.

P.S. On utility reliance on market purchases

During the June meeting there were some concerns raised about Resource Portfolio's reliance on market purchases to reach load and resource balance. Staff asked two Oregon IOU utilities about their reliance on the market.

PacifiCorp's IRP manager indicated that PacifiCorp does count on market purchases in their IRP for a portion of their need, about 500 MW for the west side of the system.

Stefan Brown from PGE also indicated that PGE uses 300 MW of firm market purchases in their IRP.

Contact with OPUC staff, Maury Galbraith, indicates that Oregon Commission has routinely acknowledged (and in several instances pushed for) market purchases in both PGE and PacifiCorp's recent IRPs.

EVALUATION OF CARBON STRATEGIES

The Council's plan provides a resource strategy that minimizes the cost of the future power system given ~~assumed~~ **possible financial consequences of** climate policy risks. A combination of aggressive conservation development, renewable resources, and in the longer-term new gas-fired resources results in a reduction of power system carbon emissions from 57 million tons per year in 2005 to 40 million tons in 2030. 40 million tons falls below the 1990 emission level of 44 million tons. These reductions are generally consistent with the targets adopted by Northwest states.

However climate policies are still in a state of flux. It is not clear what policy will be adopted or how it might be structured. That is why the Council's plan includes a wide range of potential carbon costs and develops a resource strategy that guards against the risk posed by unknown, but likely, carbon costs in the future. In addition, the Council explored a number of scenarios to better understand the effects of climate policy assumptions and choices. The cost and effect of current regional policies was assessed by looking at a current policies only scenario and a scenario that included no carbon policies at all. The Council also explored the relationship between different assumed carbon cost levels and the resulting reductions in carbon emissions. This relationship was examined using different models, scenarios, and sensitivity studies. Other analyses were done to see what effect removing RPS requirements would have, how retiring existing coal plants would affect carbon emissions and power system costs, and how loss of hydroelectric capability would change the results. These various scenarios are described below

Current Policy Case

The current policy case was run to see what the effect of excluding carbon costs associated with proposed cap and trade systems or carbon taxes would be on the plan's resource strategy. As the name implies it includes current RPS requirements, new plant **carbon dioxide performance standards** ~~emissions limits~~, and renewable energy credits, but ignores the potential risk of carbon pricing policies in the future as are being discussed by individual states, the WCI, and in proposed federal legislation.

This case shows that carbon emission levels of the regional power system could be stabilized with existing policies, but carbon emission reduction from 2005 levels as ~~adopted~~ **included** in many policy statements **and proposed legislation** would not be achieved. Compared to the plan resource strategy forward going power system costs would be reduced by 17 percent compared to the Council plan if utilities are provided free emission allowances for most of the planning period. **In this case, the effects on electricity retail rates would be very small.** ~~-~~The **cost** reduction~~s~~ would be nearly one third larger if the plan carbon emissions allowances are assumed to be entirely auctioned in the plan case**, that is if utilities had to pay the full cost of allowances**. Current policy proposals at the national level ~~are much closer to the free allowance end of the range. Current proposed federal legislation~~ would provide free allowances to utilities for most of the planning period **and therefore are much closer to the free allowance end of the range**. ~~In the rest of~~**Tables in** this section **show power system cost both with** free allowances **and with allowance costs paid entirely by the power system in cases that include**

carbon pricing policy.~~will be assumed for comparison in cases that include carbon pricing policy~~.

Compared to the ~~plan~~ **plan** portfolio the current policy case would develop ~~more renewable energy and~~ less conservation **and natural gas-fired combined-cycle generation would shift to simple-cycle turbines to provide capacity** ~~. Natural gas options would be more focused on meeting capacity needs~~ for integrating wind power into the regional power system. **Because the current policy case does not include carbon pricing policy risk, the region's existing coal plant continue to provide base load energy for the power system, whereas in the plan case coal plants are dispatched less to mitigate carbon costs.** Table 9-x compares the current policy case to the plan case. ~~[Michael, note that I've assumed an earlier explanation of measurues used.]~~

Table 9-X: The Current Policy Case Versus the Plan Case

	Plan Case	Current Policy
Cost (billion 2006$ NPV)		
With Carbon Penalty	$105.6	$70.5
Without Carbon Penalty	$85.1	$70.5
Retail Rates - Change (%) from Plan Case		
With Carbon Penalty		-9.3%
Without Carbon Penalty		-2.4%
Carbon Emissions (Gen) (Millon Tons/year)	40.2	56.5
Resources 2030		
Conservation (MWa)	5,827	5,197
RPS Renewables (MWa)	1,800	1,845
Geothermal Options (MWa)	169	13
CCCT Options (MWa)	756	0
SCCT Options (MWa)	162	648

No Carbon Policy Case

One question the Council has been asked to address is what will be the cost of reducing carbon emissions from the power system. To address that question a scenario was developed that excluded not only the potential future carbon pricing penalties, but also excluded the RPS requirements, new plant **carbon dioxide performance standards**~~emission standards~~, and RECs. However, the no-carbon-policy case did not assume that new pulverized coal plants would be ~~permitted~~**available for development**.

Costs of the power system would be reduced from $85 billion **in the plan case** (net present value, 2006$) to $57 billion. The plan case increases the cost of the regional power system by 50 percent compared to a case that ignores current climate policy and potential future climate policy risks. **If carbon penalties were borne by the power system the cost decrease would be greater, nearly cutting costs in half. The effect on retail rates is a reduction between 5 and 12 percent on average over the planning period.**

~~At the same time i~~**I**n the absence of any climate policy**,** carbon emissions would continue to grow from 2005 levels. By 2030 carbon emissions from the power system would increase by ~~15~~ **14** percent. Interestingly, the amount of conservation that is developed**, although smaller -than** ~~is similar to~~ the plan case, ~~and~~ **is** more than the current policy case. However, no **new** renewable resources are developed except for a small amount of geothermal, and a large amount of natural gas-fired resources are added. Table 9-X~~-1 summarized~~ **summarizes** the comparison.

Table 9-X: The ~~No~~ No-Carbon-Policy Case Versus the Plan Case

	Plan Case	No Policy
Cost (billion 2006$ NPV)		
With Carbon Penalty	$105.6	$56.5
Without Carbon Penalty	$85.1	$56.5
Retail Rates - Change (%) from Plan Case		
With Carbon Penalty		-12.4%
Without Carbon Penalty		-5.0%
Carbon Emissions (Gen) (Millon Tons/year)	40.2	65.1
Resource options 2030		
Conservation (MWa)	5,827	5,432
RPS Renewables	1,800	0
Geothermal Options	169	52
CCCT Options	756	1,890
SCCT Options	162	648

No Renewable Portfolio Standards

Three of the four states in the region have some form of renewable portfolio standard that requires a certain share of electricity consumption to be supplied ~~with~~ **from qualifying** renewable generation. This policy favors one particular solution to carbon emissions, but encourages development of new forms of electricity generation. ~~One q~~**Q**uestions the Council considered ~~is~~ **were** whether an RPS would be necessary if there is a perceived risk that a substantial carbon penalty could be imposed in the future**, and whether other policies might be as effective in reducing carbon emissions**. To explore this question, a scenario was run that removed RPS requirements from the plan case.

Table 9-X compares the results of the plan case and the no RPS scenario. The results show that the additional effect of RPS on the **cost of the** ~~least~~ **least-**cost ~~low~~ **low-**risk resource portfolio is small. Cost is slightly lower **without the RPS,** and carbon emissions are ~~a little~~ higher.

Significantly less renewable generation is ~~Because RPS is removed no RPS resources are~~ developed **and more conservation is acquired and more natural gas-fired generation is optioned**. ~~The model does not choose to develop additional wind, but there is an increased reliance on geothermal, conservation and simple-cycle gas turbines.~~

Table 9-X: The No RPS Case Versus the Plan Case

	Plan Case	**No RPS**
Cost (billion 2006$ NPV)		
With Carbon Penalty	$105.6	$101.4
Without Carbon Penalty	$85.1	$79.3
Retail Rates - Change (%) from Plan Case		
With Carbon Penalty		-1.2%
Without Carbon Penalty		-1.7%
Carbon Emissions (Gen) (Millon Tons/year)	40.2	43.7
Resources 2030		
Conservation (MWa)	5,827	5,935
RPS Renewables (MWa)	1,800	1,171
Geothermal Options (MWa)	169	208
CCCT Options (MWa)	756	378
SCCT Options (MWa)	162	648

This scenario indicates that RPS requirements make an additional contribution to meeting carbon targets at a modest cost. ~~However, it is important to note that the RPS may be inhibiting more cost effective solutions to carbon emissions. At the same time,~~ RPS is a policy that can be, and has been, put in place to move the region toward a lower carbon future while other policy solutions are being developed at the national, regional, and state level. These potential future policies can have an effect on resource decisions even though they are not yet enacted because of the risk they pose for future carbon penalties. Unfortunately one of those effects may be to delay needed resource decisions because of the uncertainty. A similar situation occurred in the mid-1990s with electric industry restructuring and led to an inadequate power system and the 2000-01 electricity crisis.

Retiring Existing Coal Plants

Existing coal plants account for over 85 percent of power system carbon emissions in the Pacific Northwest. Therefore any significant reduction in carbon emissions from the power system must come to a large extent from these plants. In the plan case, the reduction of carbon emissions to below 1990 levels is partly a result of coal plants being displaced in dispatch by renewable generation and conservation. In futures with high carbon cost, natural gas plants can become lower cost than coal in the dispatch order and as a result coal operates at a lower capacity factor.

One of the effects of assuming that coal plants could remain available to run under some future conditions is that carbon emissions become more variable. When low carbon prices are drawn for a future, the coal plants will operate and they may operate more in a low water condition or high load future. As a result, reduced carbon emissions are not assured even though they are lower on an expected or average basis. There are also questions about **the viability of continued operation of these plants** ~~how coal plants could be expected to operate~~ if they are only used **infrequently or** at low capacity factors. It may be unrealistic to expect coal plants to run as natural gas plants currently do. Coal plants are less flexible and have higher **fixed operating and maintenance** ~~capital~~ costs.

An alternative approach was considered in a coal retirement scenario. It was assumed that the regional coal plants are phased out between 2012 and 2020. They could be retired or mothballed, but they are not considered available to meet loads and their output must be replaced with other resources. This scenario was examined with two different assumptions regarding the existence of carbon ~~costs~~**pricing policies**, with carbon ~~cost~~ **penalties** and without carbon ~~cost~~**penalties**. Table 9-X shows the results of these scenarios compared to the plan case.

Table 9-X: The No Retire Coal Case Versus the Plan Case

	Plan Case	Retire Coal w/CO2	Retire Coal w/o CO2
Cost (billion 2006$ NPV)			
With Carbon Penalty	$105.6	$122.2	$94.7
Without Carbon Penalty	$85.1	$109.7	$94.7
Retail Rates - Change (%) from Plan Case			
With Carbon Penalty		**+4.6%**	**-0.4%**
Without Carbon Penalty		**+8.0%**	**+6.2%**
Carbon Emissions (Gen) (Millon Tons/year)	40.2	15.9	15.2
Resource options 2030			
Conservation (MWa)	5,827	6164	5,739
RPS Renewables	1,800	1,787	1,809
Geothermal Options	169	156	52
CCCT Options	756	2268	2268
SCCT Options	162	648	648

The retirement of the coal plants results in a dramatic reduction of carbon emissions. In 2030 the average emissions are reduced by 70 percent from 2005 levels. These reductions are approaching some of the targets proposed by the IPCC for 2050.

The power system cost is increased by 11- percent without the carbon ~~tax~~ **penalty** and by 29 percent with carbon ~~taxes~~**penalty when free allowances are assumed**. **In the case where coal plants are treated as a substitute for carbon pricing policies (Retire Coal w/o CO2), costs**

are decreased compared to the plan case without free allowances. However, if coal is retired in combination with carbon pricing policy and free allowances are not granted the power system costs increase by 16 percent. In rough terms, these cost increases would translate into real (without general economic inflation) average retail electricity price increases of ~~4~~ **6** and ~~10~~ **8** percent **with free allowances**.

The amounts of conservation acquired change moderately. The bulk of the coal capability is replaced by additional **options on combined-cycle** gas-fired generation ~~options~~, which has about 38 percent of the carbon emissions of an existing coal plant.

Like the RPS, a policy of retiring coal plants is an alternative to some form of carbon pricing policy. It **also** focuses on one particular solution without creating ~~wide~~ **wide-**spread incentive to find creative and ~~low~~ **low-**cost solutions to reducing carbon emissions in all sectors. Nevertheless, the results are more predictable and the policy could be implemented through regulations at the state level. It could be a viable alternative in a region like the Pacific Northwest where coal is not the dominant power supply, but is the dominant carbon emissions source. Replacement by natural gas is the alternative assumed here, but in the longer term other options may become available such as carbon capture and sequestration, advanced nuclear, or other options.

Fixed Carbon Price Scenarios

The Sixth Power Plan assumes an uncertain carbon pricing policy in the future. One question that was raised is**,** would the plan resource strategy change if a fixed **carbon** price was assumed. Two scenarios were tested; one with a high $100 per ton carbon cost, and one with a $20 a ton carbon tax. These scenarios generally cover the range of prices used in utility and other analyses. Table 9-X shows the results of these two scenarios compared to the plan case.

Table 9-X: The Fixed Carbon Price Cases Versus the Plan Case

	Plan Case	**$100 Carbon**	**$20 Carbon**
Cost (billion 2006$ NPV)			
With Carbon Penalty	$105.6	$152.7	$89.7
Without Carbon Penalty	$85.1	$97.4	$72.3
Retail Rates - Change (%) from Plan Case			
With Carbon Penalty		+14.3%	-2.1%
Without Carbon Penalty		+7.1%	-1.0%
Carbon Emissions (Gen) (Millon Tons/year)	40.2	29.6	47.1
Resource options 2030			
Conservation (MWa)	5,827	6,025	5,427
RPS Renewables	1,800	1,790	1,808
Geothermal Options	169	156	156
CCCT Options	756	2268	0

SCCT Options	162	0	648

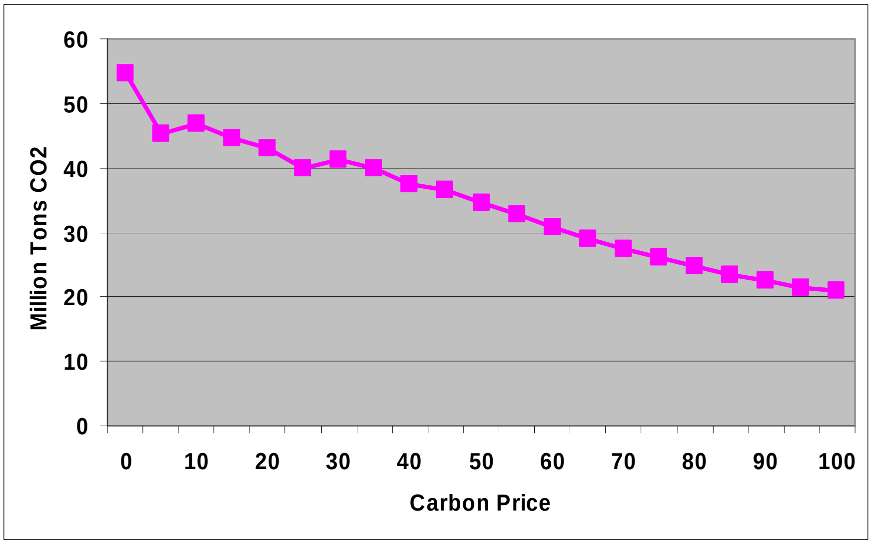
As would be expected**,** the $100 carbon cost case reduces carbon emissions substantially from the plan case, and the $20 carbon cost does not achieve as large reductions. Conservation does not increase substantially with $100 carbon costs because most of the available conservation was developed in the plan case. There is a 400 average megawatt (7 percent) reduction of conservation in the $20 case. **The development of renewable generation changes little among these cases. Their development appears to be driven by RPS requirements.**~~With $100 carbon costs more renewables are developed.~~

An interesting result is apparent in the changes in the optioning of natural gas-fired generation. With carbon prices of $100 there is a large increase in the optioning of natural gas combined-cycle turbines, whereas with $20 carbon costs more simple-cycle turbines are optioned. In the $100 carbon cost case the significant reductions in carbon emissions are being attained by displacing existing coal plants. The combined-cycle plants are being optioned to provide base load energy and capacity to displace the coal plants. In the $20 carbon cost case the coal plants remain viable base load plants and additional capacity is provided by simple-cycle turbines to back up wind. In the $100 case the question again arises of whether coal plants would **remain viable**~~be economic~~ ~~to operate~~ at low capacity factors.

These results are consistent with preliminary estimates done by the Council of carbon emissions using the AURORA$^{xmp®}$ Electric Market Model. The results of those studies showed that carbon prices of between $40 and $70 per ton are required to change the dispatch order of coal and natural gas-fired generation. The exact point of change will depend on the price of natural gas relative to the carbon price and will vary for individual plants. The future price of natural gas and carbon costs cannot be known. The plan case, therefore, models the risks of alternative futures for both carbon cost and natural gas price to find a resource strategy that reduces the risk associated with these uncertainties.

Another approach to the question of how carbon prices are related to emission levels was done using the Regional Portfolio Model in a deterministic mode (i.e. using expected values of variable**s** instead of stochastic analysis). The plan case resource strategy was tested with costs for carbon emissions varying in $5 increments from $0 to $100. Figure 9-X shows the results. Increasing carbon costs lead to reduced emissions. Again prices of carbon above $40 per ton begin to push carbon emissions below 40 million tons by 2030, and emissions could be cut in half from that level with carbon cost of $100 per ton. These results should not be expected to match closely to results for the plan case in the tables in this section because of the effects of varying levels of demand, natural gas prices, hydro conditions, and other varying future conditions modeled in the plan case.

Table 9-X: An Estimated Relationship Between Carbon Cost and Emissions



Value of the Hydroelectric System

The Pacific Northwest power system only emits about half the carbon dioxide **per kilowatt-hour** of the nation ~~of~~ **or** the rest of the western states. This is due to the large role played by the hydroelectric system of the region. The value of this system is sometimes overlooked. In making decisions about the fish and wildlife impacts of the hydroelectric system, consideration should be given to other environmental benefits of the system. To illustrate this tradeoff a scenario was run to examine the effects of removing the lower Snake River dams, a policy advocated by some, on costs, carbon emissions, and replacement resources for the power system. The sensitivity, however, could apply to other changes that reduce the capability of the hydroelectric system for any reason. For this scenario it was assumed that the dams ~~were~~ **are** removed in 2020 and the energy and capacity are replaced by the Regional Portfolio Model. The results are compared to the plan case in Table 9-X.

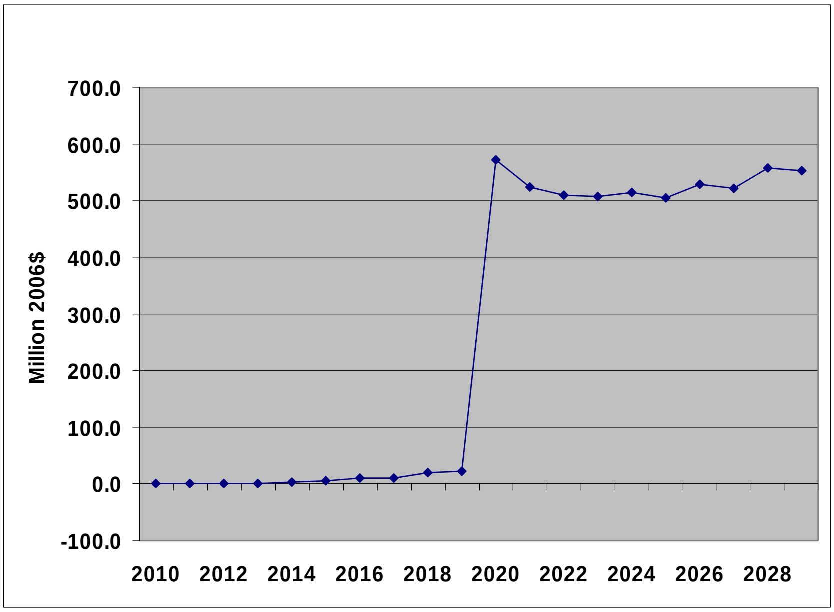
Table 9-X: The Dam Removal Case Versus the Plan Case

	Plan Case	**Dam Removal**
Cost (billion 2006$ NPV)		
With Carbon Penalty	$105.6	$112.5
Without Carbon Penalty	$85.1	$88.8
Retail Rates - Change (%) from Plan Case		
With Carbon Penalty		+1.7%
Without Carbon Penalty		+1.0%
Carbon Emissions (Gen) (Millon Tons/year)	40.2	43.6
Resources 2030		
Conservation (MWa)	5,827	5,923

RPS Renewables	1,800	1,801
Geothermal Options	169	208
CCCT Options	756	1134
SCCT Options	162	324

Dam removal increases both the carbon emissions and cost of the power system. Small increases in conservation and renewable resources occur in this scenario, but the primary replacement of the dams is provided by natural gas-fired combined-cycle combustion turbines. Figure 9-X shows the annual pattern of cost changes for the dam removal scenario. Annual cost of the power system increases in 2020 by about $550 million dollars and remains higher.

Table 9-X: Annual Cost Changes For The Dam Removal Case



Summary

Table 9-X summarizes the results of the various scenarios described above. Clearly, as a general rule, significantly reducing carbon emission from the regional power system will increase costs of electricity. **The costs shown in this summary assume that carbon penalties are excluded from utility revenue requirements through granting of free emissions allowances or otherwise mitigated.** Policies in place now in the region can stabilize emissions near 2005 levels in 2030, but not reduce them. Without the policies in place now, however, carbon emissions from the power system would continue to grow. Because over 85 percent of these carbon emissions are from the existing coal plants serving regional loads, any significant reduction requires reduced reliance on these coal plants. Carbon prices above $50 per ton can reduce coal plant use, but an alternative policy would be to phase out coal plants. In either case, **the** future cost of electricity would be increased.

Another way of looking at these results is to compare scenarios in terms of changes relative to the Council's plan case. Figure 9-X shows changes in net present value system costs as bars and changes in carbon emissions as diamonds measured from the left hand scale. There ~~are~~ **is** only ~~two~~ **one** scenario~~s~~ in which costs and carbon emissions move in the same direction. ~~One is the retiring coal plants without carbon costs. In that case the reduction in cost is directly a result of the assumption that carbon pricing policy is not enacted. It is better compared to the current policy case which also assumes no carbon pricing policy. Based on that comparison, cost increases significantly, but carbon emissions are reduced dramatically. The only other case where both cost and carbon emissions increase~~**That** is the dam removal case where the policy choice is not intended to reduce carbon emissions, but rather to help salmon and steelhead survival.

Table 9-X: Summary of Costs and CO2 Emissions in Climate Policy Scenarios

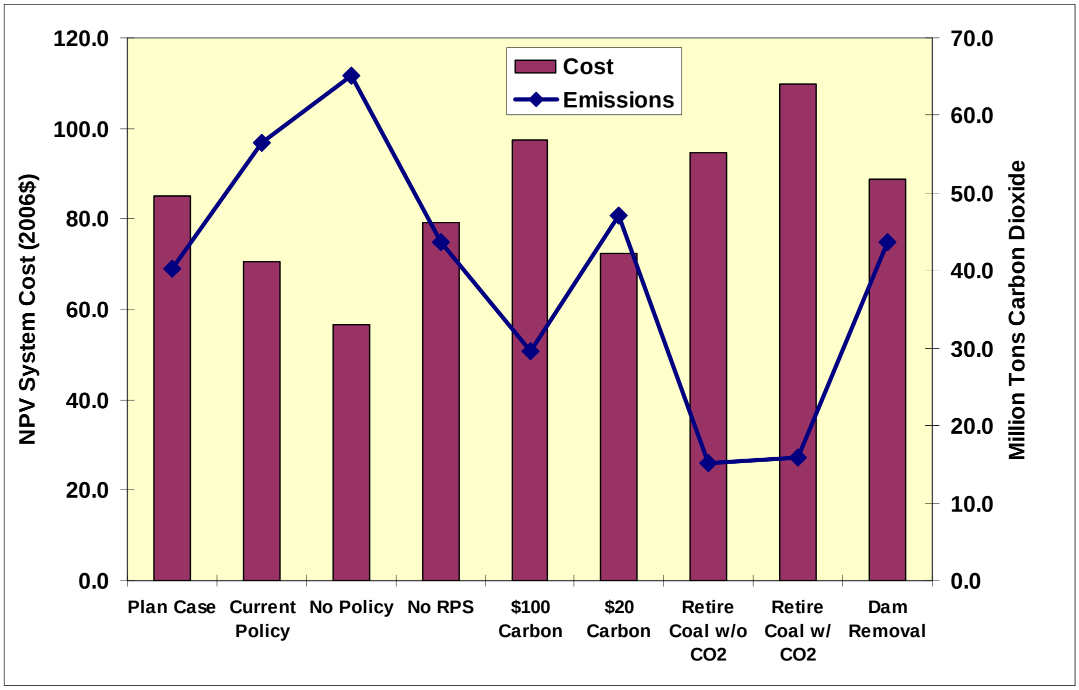
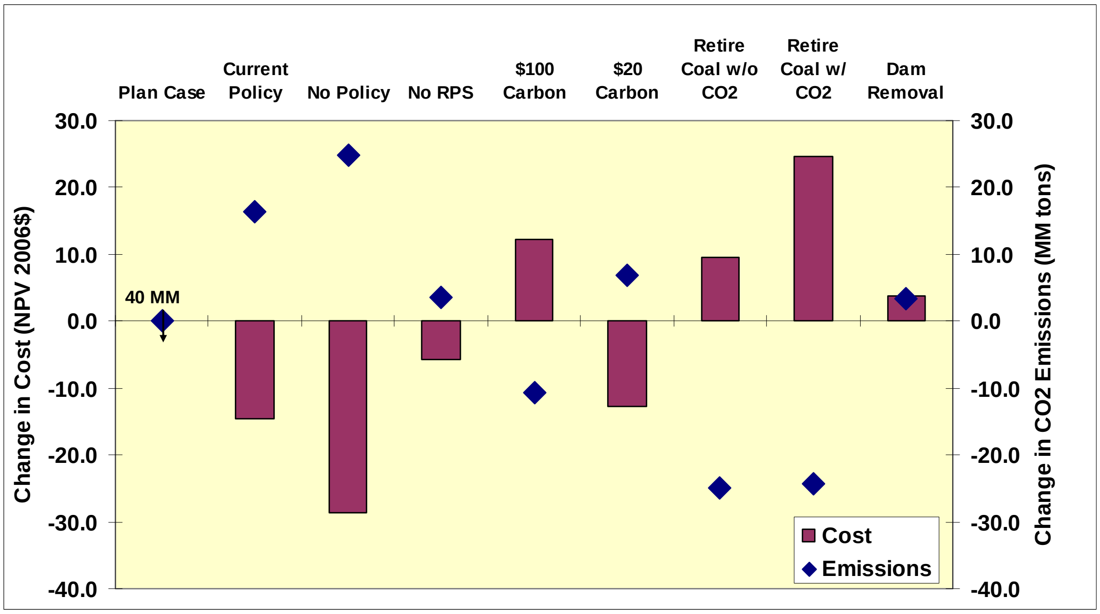
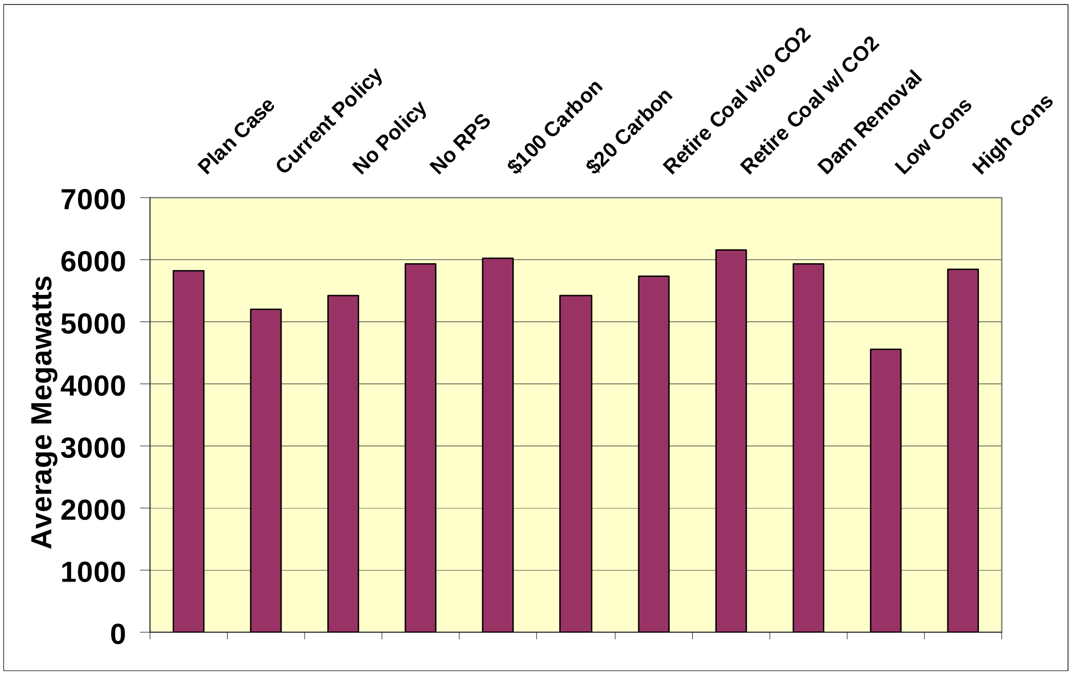


Table 9-X: Summary of Costs and CO2 Emissions Changes From Plan Case



One of the most important findings of this scenario analysis is the consistency of the role of conservation. Regardless of the assumptions about carbon policy, conservation remains an attractive resource. The amount of conservation varies between 5000 and 6000 average megawatts across the scenarios examined, even in the scenario where no climate policies are included.

Figure 9-X: Conservation Acquisition in Carbon Policy Scenarios



Climate Change Analysis [draft, Chapter 10]

Existing climate change policies and proposed future policies have had a very significant effect on the development of the Sixth Power Plan resource strategy. In this section the effects of alternative policy assumptions are described. The intent is not to recommend any particular approach, but to provide information to policy makers about the likely effects of different approaches on the cost of the power system and its future carbon emissions.

The recommended resource portfolio for the Sixth Power Plan reflects specific assumptions about carbon emissions policy. Existing policies are assumed to continue. That is, the renewable portfolio standards (RPS) that have been adopted in most states, the new generation emissions standards, and renewable energy credits are included in the analysis and assumed to be enforced. In addition, the plan recognizes that there are adopted goals for greenhouse gas emissions reductions at the state and regional level as well as proposed federal legislation with similar goals. Most proposed policies to attain these goals rely on some system for imposing a cost on carbon emissions. Whether these costs are the price of emission allowances under a cap and trade system, or some form of carbon tax, the costs imposed on the power system are a risk that the plan addresses. The plan includes resource actions that mitigate carbon risk along with the other costs and risks faced by the regional power system.

The Council's assumptions on carbon price risk were based on consultation with a range of utility and other analysts and comparison with a report by Ecosecurities Consulting Ltd. The assumptions are included in the Regional Portfolio Model as a distribution of 750 carbon price trajectories that range from zero to $100/ton, with an expected value of about $47 per ton in 2030. A partial survey of regional utilities indicated that the range of prices the Council has included in its analysis is generally consistent with assumptions used in utility IRP analysis.

Accounting for the carbon emissions of the regional power system requires a decision regarding the treatment of emissions associated with electricity that is imported and exported. The approach used for the Council's modeling is to count emissions by several generators that are located outside the region but whose output is committed to serving regional loads. These generators include parts of the Colstrip generation complex in eastern Montana, all of the Jim Bridger complex in Wyoming, and part of the Valmy generation complex in Nevada.

Other imports and exports of energy are treated in two alternative accounting frameworks. One is referred to as "generation based" and counts emission from plants located within the region or contracted to regional utilities. The other approach is referred to as "load based" and counts emissions associated with imports and excludes emissions associated with the electricity exported from the region. For ease of exposition and comparability, most of the discussion in the plan refers to generation based carbon counting. In addition, the generation based carbon emissions are adjusted to be consistent with the accounting reflected in the Council's 2007 Carbon Footprint paper.[1]

There are also some complications in how to account for the estimated cost to the regional power system of carbon pricing policies. The default accounting of power system costs includes carbon

[1] Northwest Power and Conservation Council. Carbon Dioxide Footprint of the Northwest Power System. November 2007. (Council Document 2007-15)

penalties as though they were paid as a tax on every ton of carbon emitted. This approach is valid for modeling the penalties' effect on the development and operating decisions of the power system. However, the default accounting can significantly overestimate the total costs that the power system must recover from ratepayers, depending on the specific form of carbon penalty that the system faces. In particular, the current language of the U.S. House of Representatives proposal on climate policy includes a cap-and-trade system that grants free allowances to utilities that roughly offset their emissions until 2026. This approach would greatly reduce the cost impact on the power system, compared to a carbon tax on all emissions. To allow the reflection of different forms of carbon penalties, the portfolio model has an alternative accounting that excludes the amount of tax revenues. This alternative accounting provides a better estimate of the cost of a cap-and-trade free allowances mechanism to the power system. In most of the discussion of carbon policy effects on power system, the alternative accounting approach is used.

The Council's plan provides a resource strategy that minimizes the cost of the future power system given the policy risks described above. A combination of aggressive conservation development, renewable resources, and in the longer-term new gas-fired resources results in a reduction of power system carbon emissions from 57 million tons per year in 2005 to 40 million tons in 2030. 40 million tons falls below the 1990 emission level of 44 million tons. These reductions are generally consistent with the targets adopted by Northwest states.

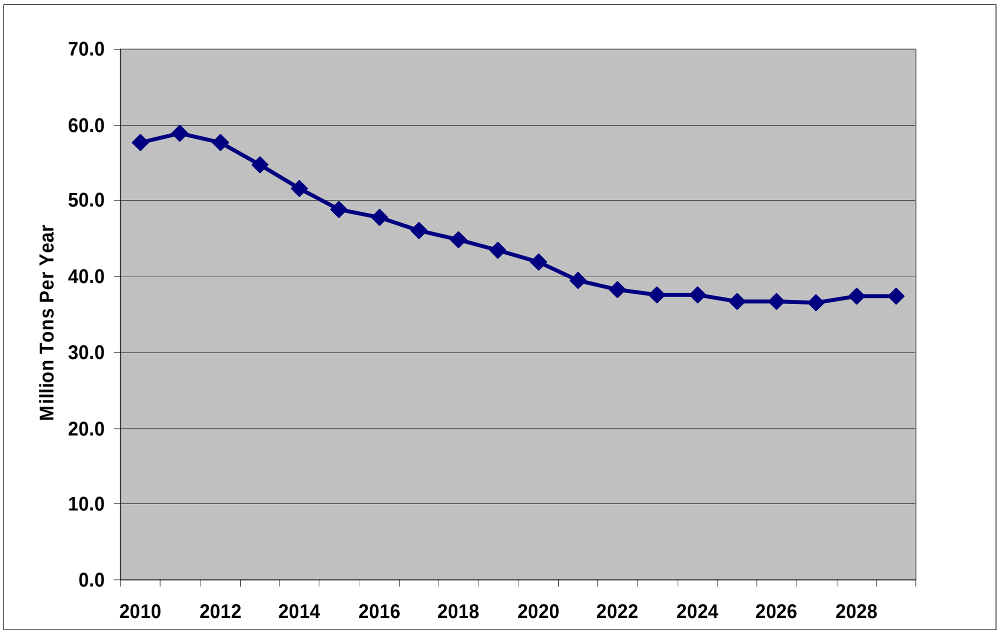
The carbon cost risk assumptions play an important role in these results. If only current policies are assumed in the future, that is if no carbon pricing policies are implemented or expected, a least cost resource strategy would only stabilize carbon emissions from the power system at about current levels. Existing policies will not achieve the carbon emissions goals that exist in the WCI or some individual states in the region.

The cost of moving from current policies to the Council plan case is significant. Response to these carbon penalties increase power system costs by between 20 and 50 percent. The range in cost estimates depends on how policy is structured as described above. Current proposed federal policy provides free emission allowances under a cap and trade system for many years, which would put the cost impacts at near the lower end of the range.

The accomplishment of significantly lower carbon emissions from the power system rely on reduced use of existing coal-fired generation. This is not a surprising result because existing coal plants account for over 85 percent of the carbon emissions from the regional power system. In the plan case, these plants are simply used much less frequently. If they are used in that way maintaining the plants may not be feasible for utilities. An alternative policy would be to phase out the existing coal plants or some portion of them. An analysis of phasing out all of the regional coal plants between 2012 and 2020 showed that power system 2030 carbon emissions could be reduced from 40 million tons in the plan case to about 15 million tons. Replacing the energy and capacity from the coal plants would increase average power system costs by about ~~30~~ **11 to 16** percent. While this is an alternative policy approach to consider, it would not have the broad effects on other sectors and resource decisions that a cap and trade or tax system would have.

A number of scenarios addressed the issue of what level of carbon penalty would be required to meet carbon emission reduction levels in 2030. The plan case, with average carbon prices growing to $47, but with possible futures between zero and $100, reduces carbon average emissions in 2030 to about 15 percent below 1990 levels. That is the WCI target for total greenhouse gas reduction by 2020. As shown in Figure 10-X, the plan case attains these reductions by 2020. However, these average reductions are not assured. In some futures, depending on demand, natural gas prices, hydroelectric conditions, and other factors, emissions may not be reduced at all. These are cases where existing coal plants are utilized more intensively. The case where coal plants are retired results in more assured carbon reductions.

Figure 10-X: Average Sixth Power Plan Annual Carbon Emissions



Sensitivity analysis with the Regional Portfolio model and the AURORA$^{xmp®}$ Electric Market Model indicate that carbon costs of between $40 and $70 per ton would likely be required to reduce carbon emissions from the regional power system to below 1990 levels.

Just as coal-fired generation is the source of most of the power system's carbon emissions, the regional hydroelectric system is the source of most of the region's energy, capacity, and flexibility supply. As a carbon free resource, it is extremely valuable to the region. Because of the hydroelectric system, combined with the region's past accomplishments in conservation, the region's carbon emissions are half of that of the nation in terms of carbon emission per kilowatt-hour of energy consumption. Meeting the region's responsibilities for mitigating the fish and wildlife losses caused by the dams has depleted the capabilities of the hydroelectric system over time. The region should improve salmon migration with care because loss of hydroelectric capability will increase carbon emissions which will also harm fish and wildlife in the long term. For example, an analysis showed that removing the lower Snake River dams would undo 40 percent of the carbon reductions expected to be accomplished through the existing carbon policies in the region while also increasing the cost of the power system.

q:\tm\council mtgs\2009\jul09\(p-5,c-5) climate summary.doc