Appendix O: Calculation of Revenue Requirements and Customer Bills

INTRODUCTION

In this analysis we present the methodology used to estimate the average revenue requirement per megawatt-hour and average residential bills for the least risk resource plan under various scenarios. The scenarios are defined in Chapter 10 ("Resource Strategy") of the Plan. These average revenue requirements and bills reflect the impact of conservation investment, CO_2 costs and other resource options for each scenario.

It should be emphasized that these average revenue requirements per megawatt-hour are not intended as estimates of retail electricity rates, since our methodology is a gross simplification of the detailed calculations and regulatory approval process that rates have to go through. Actual rate setting procedures and calculations will vary across utilities, class of customers and regulatory jurisdictions. The average revenue requirements per megawatt-hour calculations presented here are averaged across all customer classes, so relative changes among classes are not reflected. The results should, however, be valid for comparison across scenarios.

It should also be emphasized that some events will affect the revenue requirements of some parts of the region more than others. The result will be more significant impacts on some ratepayers (and smaller impacts on other ratepayers) than if the effects were distributed evenly. For example, Table O-1 shows a difference of 4.4 percent between the levelized regional revenue requirement per megawatt-hour in the "Carbon Risk" case and the "$45/Ton CO_2 Cost" case. If only half of the region is affected by the difference in CO_2 costs, the impact would be concentrated on half the region's ratepayers. The result would be an impact of 8.8 percent on the levelized revenue requirements per megawatt-hour to be recovered from those ratepayers, while the other half of the region's ratepayers would see no change at all.

METHODOLOGY FOR ESTIMATING AVERAGE REVENUE REQUIREMENTS

To estimate the average revenue requirement per megawatt-hour, dollars of revenue requirements are divided by the total retail sales of electricity. To calculate dollars of revenue requirements; the continuing fixed cost of the existing power system was added to the development and operational cost of the future power system. That fixed cost of the existing

power system is assumed not to change, remaining at 2008 levels in real terms over the planning horizon. This implicitly assumes that depreciation in cost of existing power system is equal to capital additions to maintain the existing power system. The future system costs consist of the capital cost of the new resources and the non-capital cost of the existing and future power system. The future system cost is the cost measured in the Resource Portfolio Model (RPM). The consumer's contribution to conservation measures is netted from the total system cost calculated in the Resource Portfolio Model. It should be noted that the average revenue requirements and bills shown below are an average of the revenue requirements and bills under 750 possible futures.

Estimating Existing Power System Cost:

The total regional revenue requirement for the power system in 2008 is reported to be $11.6 billion dollars. It was estimated that about 85 percent of that requirement was due to fixed costs, which amounts to about $9.8 billion dollars per year. Figure O-1 illustrates the relative importance of this component; in the Carbon Risk case it accounts for about $60 per megawatt-hour of the total revenue requirement per megawatt-hour.

Estimating Future Power System Cost:

The cost of the future power system calculated in the Resource Portfolio Model (RPM) consists of levelized costs of conservation resources and capital and non-capital costs of other new resources as well as the variable cost of existing system. However, general practice among utilities for at least the last decade has been to "expense" their conservation expenditures, that is, to recover them in rates immediately rather than capitalize the expenditures and recover them (and accumulated interest) over the life of the conservation measures. To reflect this practice in the Council's estimates of average revenue requirement per megawatt-hour, estimated conservation costs "as incurred" were substituted for the levelized conservation costs[1] used in the RPM. Based on recent history, $300 million per year of conservation expenses were assumed to be included in the 2008 revenue requirement; so that conservation expenses in the future would only increase revenue requirements to the extent they are higher than $300 million per year.

To estimate these "as incurred" costs, Council staff converted the levelized costs of the conservation developed by the RPM into a single payment to be made at the time of the conservation measures' installation. This payment covers the full installation cost of the measures, and their administration cost over their lifetime, expressed as 2006 dollars per average megawatt of yearly savings.   The Council's ProCost model was run iteratively to produce levelized costs equivalent to the average cost of the conservation developed by the RPM at the average life of the conservation measures in the supply curve. This approach assures the calculation method is consistent with the method used to develop the conservation supply curve costs used by the RPM.

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[1] The conservation premium used to select the level of conservation acquisition does not change the cost of conservation resources and the levelized cost of conservation and the cash-flow of expensed conservation do not differ greatly if conservation acquisition levels are increasing smoothly and do not have significant jumps from one year to next.

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The average life of conservation measures was calculated by weighting each measure's lifetime by its contribution to savings in the conservation supply curve. These annual expense costs were reduced to reflect that approximately 65 percent of the costs are paid by the utility system and would be reflected in rates. The costs were then adjusted upward to compensate for the 10 percent Regional Power Act Conservation Credit which had been applied to costs in the ProCost model. The result is an average utility cost of $2.5 million per average megawatt of -yearly savings.

Figure O-1 illustrates that the fixed cost of the existing power system is about $60 per megawatt-hour, and the addition of the variable cost of the existing system and the full costs of new resources (including conservation) after 2009 raises the total revenue requirement per megawatt-hour by up to $23 per megawatt-hour, depending on the year and how CO_2 penalties are counted. The total revenue requirement per megawatt-hour declines after the mid-2020s mostly due to declining conservation and RPS acquisitions[2].

Cost of CO$_2$ Penalties

The default accounting in the Regional Portfolio Model includes cost of CO_2 penalties, when they are in force, as though a tax were paid on every ton of CO_2 emitted. However, given uncertainty regarding the impact of CO_2 costs on power system revenue requirements, the impacts on revenue requirements are calculated with and without CO_2 costs. To the extent that CO_2 penalties are included in the power system revenue requirement, they are recovered from the consumers served by the generators emitting the CO_2, regardless of whether the generators are physically in the region or not. That is, CO_2 emissions from power exported from the region are subtracted from CO_2 emissions due to regional load and CO_2 emissions from power imported to meet regional load are added to CO_2 emissions due to regional load. The addition of CO_2 penalties as though they are paid on every ton of emissions raises average revenue requirements by amounts that vary between $5 and $7 per megawatt-hour over most of the 2010-2029 period, as shown in Figure O-1.

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[2] Three factors contribute to drop-off in revenue requirement; a reduced level of discretionary conservation acquisition, a reduced level of RPS acquisitions and expensing of the conservation expenditure.

**Figure O-1: Average Revenue Requirement Disaggregated by Component
(Carbon Risk Case)**
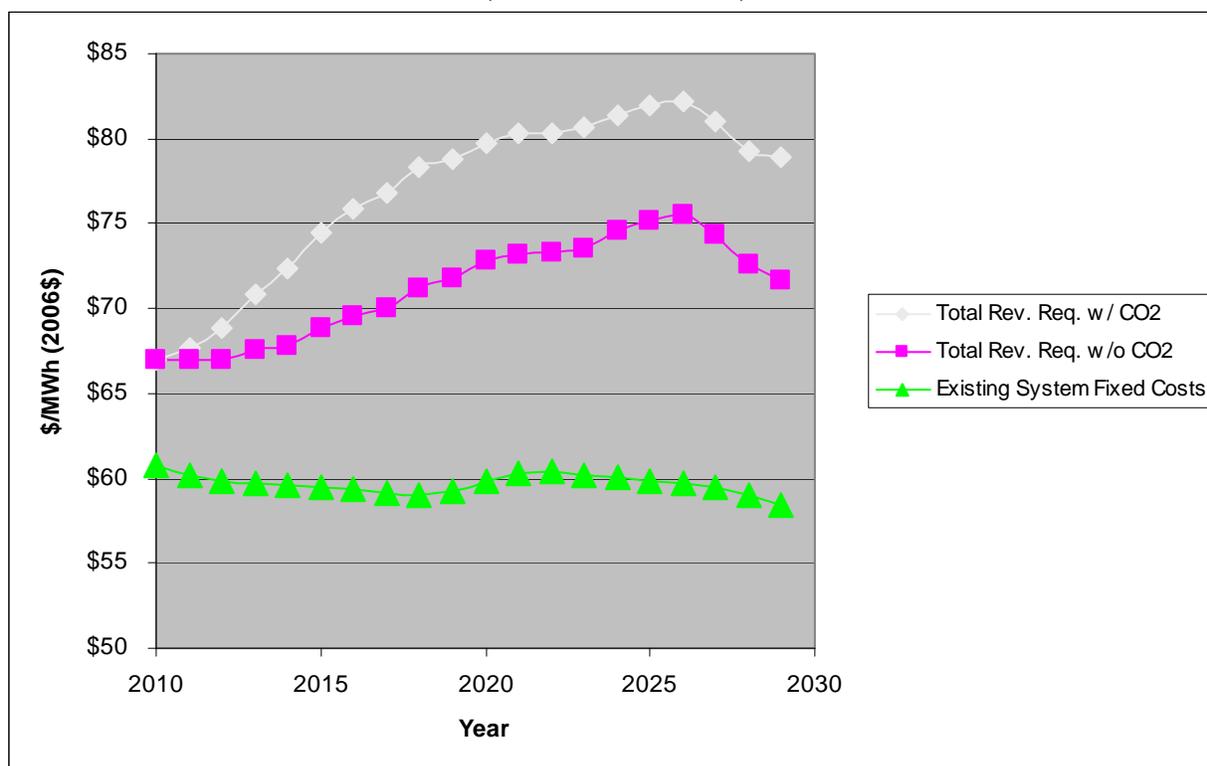
Calculated Average Revenue Requirements

The above methodology, averaged across the 750 futures simulated by the Regional Portfolio Model, results in the annual and levelized revenue requirements per megawatt-hour for the period 2010 through 2029. The results in Tables O-1 and O-2 represent 9 scenarios defined in Chapter 10 ("Resource Strategy"). The average revenue requirement in 2008 across all sectors was estimated to be about 6.5 cents per kilowatt-hour or $65 dollars per megawatt-hour of sales. As an illustrative example, the Carbon Risk" case projects the average revenue requirement to increase to about $67 per megawatt-hour by 2010. By 2030 the case projects revenue requirements to be between $72 and $79 dollars per megawatt-hour depending on whether CO_2 penalties are paid on all emissions (Table O-1) or whether allowances are distributed to utilities free (Table O-2).

Comparison of annual electric revenue collected in the region, for the past 19 years, with the forecasted future revenue requirement is presented in the figure O-2. To make the comparison across time appropriate all costs were converted to 2006 dollars and then indexed so that 2010 is has an index value of 100.   Between 1990 and 2008, revenue requirement increased by approximately 20 index points. In the future period, the revenue requirement is expected to increase from an index of 100 points to 110 to 120 points, depending on how CO_2 costs are incorporated into the revenue requirement. The future increase in rates is smaller than the historic experience.

Figure O-2   Comparison of Historic Revenue Collected and Future Revenue Requirement
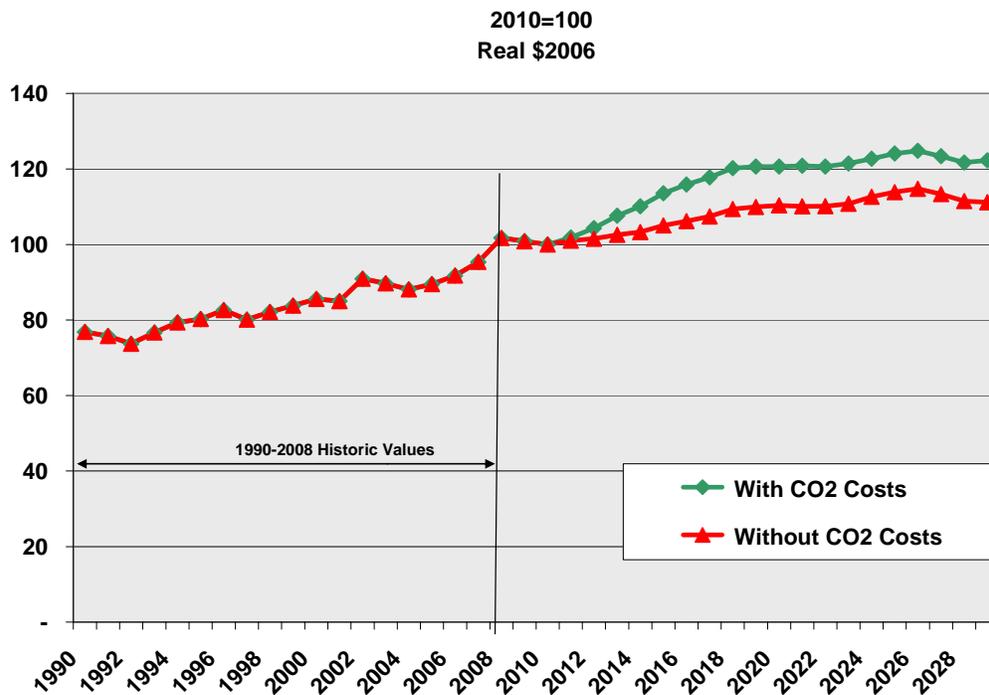
Calculated Monthly Bills

Representative residential bills are estimated beginning with the total revenue requirements calculated earlier, allocating the residential share of those annual revenue requirements (about 45 percent) to the residential sector, dividing by the projected number of households in future years and dividing by 12 to arrive at monthly bills per household. The results of those calculations are shown in Tables O-3 and O-4.

Table O-1: Average Revenue Requirements per Megawatt-hour for Least Risk Portfolios by Scenario - CO₂ Costs Included
(All average revenue requirements are expressed in $2006/MWh (=mills/kWh))

	Carbon Risk	Current Policy	No Policy	No RPS	$45/Ton CO₂ Cost	Coal Retirement w/o CO₂	Coal Retirement w/ CO₂	No Conservation	Lower Snake Dam Breach
Case Identifier	L813	L813 G	L813 I	L813 H	L813 D	L813 B	L813 J	L813 A	L813 K
2010	66.98	66.92	66.9	66.98	75.19	66.96	66.98	63.78	67.01
2011	67.62	66.98	66.9	67.62	75.86	67.04	67.62	64.07	67.65
2012	68.82	66.90	66.8	68.82	76.18	67.02	68.83	64.93	68.89
2013	70.89	67.39	67.3	70.89	77.13	67.75	70.92	66.73	70.98
2014	72.34	67.60	67.4	72.31	77.65	68.42	72.42	68.23	72.42
2015	74.47	68.40	67.8	74.21	78.61	69.87	74.59	70.43	74.55
2016	75.90	69.00	68.0	75.50	78.98	71.19	76.11	72.09	75.96
2017	76.84	69.30	67.9	76.47	79.28	72.18	77.12	73.38	76.90
2018	78.31	70.23	68.4	77.70	80.17	73.39	78.62	74.60	78.40
2019	78.85	70.80	68.6	78.23	80.39	74.23	79.22	75.31	78.96
2020	79.68	71.62	69.1	78.85	80.80	75.14	80.08	76.46	82.96
2021	80.33	71.75	69.2	79.61	81.02	75.31	80.68	77.28	83.56
2022	80.36	71.66	69.3	79.63	80.94	75.45	80.77	78.34	83.75
2023	80.65	71.52	69.3	80.28	80.96	75.68	81.10	79.69	84.23
2024	81.32	72.42	69.5	80.20	81.60	76.69	81.76	80.59	84.83
2025	81.96	72.76	69.8	80.63	81.84	77.35	82.39	81.48	85.47
2026	82.21	72.90	70.1	80.94	82.05	77.84	82.65	82.47	85.74
2027	80.99	71.33	69.1	80.26	81.43	76.79	81.53	82.74	84.95
2028	79.28	69.76	67.5	78.50	79.35	75.16	79.87	83.59	83.33
2029	78.86	69.12	66.8	77.62	78.61	74.39	79.41	84.19	82.35
Levelized Rates	$75.61	$69.49	$68.12	$75.15	$78.95	$71.96	$75.86	$73.20	$77.00
Annual Rate of Growth	0.9%	0.2%	0.0%	0.8%	0.2%	0.6%	0.9%	1.5%	1.1%
Percent Change from Carbon Risk case		-8.1%	-9.9%	-0.6%	4.4%	-4.8%	0.3%	-3.2%	1.8%

Table O-2: Average Revenue Requirement per Megawatt-hour for Least Risk Plans by Scenario - CO₂ Costs Not Included
(All average revenue requirements are expressed in $2006/MWh (=mills/kWh))

	Carbon Risk	Current Policy	No Policy	No RPS	$45/Ton CO₂ Cost	Coal Retirement w/o CO₂	Coal Retirement w/ CO₂	No Conservation	Lower Snake Dam Breach
Case Identifier	**L813**	**L813 G**	**L813 I**	**L813 H**	**L813 D**	**L813 B**	**L813 J**	**L813 A**	**L813 K**
2010	66.96	66.92	66.89	66.96	69.01	66.96	66.96	63.75	66.98
2011	67.01	66.98	66.93	67.01	69.01	67.04	67.02	63.45	67.05
2012	66.95	66.90	66.82	66.95	68.97	67.02	66.96	62.96	67.01
2013	67.53	67.39	67.27	67.53	69.66	67.75	67.58	63.12	67.62
2014	67.84	67.60	67.39	67.79	70.01	68.42	67.97	63.27	67.93
2015	68.87	68.40	67.80	68.49	70.81	69.87	69.07	64.10	68.95
2016	69.53	69.00	67.96	68.88	71.40	71.19	69.88	64.79	69.61
2017	70.04	69.30	67.88	69.30	71.69	72.18	70.51	65.36	70.13
2018	71.22	70.23	68.42	70.14	72.68	73.39	71.75	65.94	71.33
2019	71.82	70.80	68.59	70.66	73.24	74.23	72.46	66.36	71.96
2020	72.85	71.62	69.06	71.40	74.03	75.14	73.55	67.26	74.50
2021	73.17	71.75	69.20	72.00	74.27	75.31	73.84	67.46	74.78
2022	73.35	71.66	69.27	72.30	74.22	75.45	74.11	68.52	75.06
2023	73.53	71.52	69.35	73.06	74.19	75.68	74.32	69.95	75.49
2024	74.62	72.42	69.53	73.26	75.18	76.69	75.39	70.78	76.46
2025	75.19	72.76	69.83	73.36	75.60	77.35	75.95	71.29	77.05
2026	75.55	72.90	70.08	73.71	75.88	77.84	76.30	72.14	77.42
2027	74.37	71.33	69.06	73.13	75.16	76.79	75.25	72.17	76.70
2028	72.59	69.76	67.46	71.39	72.94	75.16	73.54	72.83	75.06
2029	71.67	69.12	66.85	69.92	71.89	74.39	72.59	72.99	73.64
Levelized Rates	**$70.53**	**$69.49**	**$68.12**	**$69.82**	**$71.97**	**$71.96**	**$70.96**	**$66.52**	**$71.30**
Annual Rate of Growth	0.4%	0.2%	0.0%	0.2%	0.2%	0.6%	0.4%	0.7%	0.5%
Percent Change from Carbon Risk case		-1.5%	-3.4%	-1.0%	2.0%	2.0%	0.6%	-5.7%	1.1%

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Table O-3: Average Residential Bills for Least Risk Portfolios by Scenario - CO$_2$ Costs Included
(Bills are expressed in 2006$/month/household)

	Carbon Risk	Current Policy	No Policy	No RPS	$45/Ton CO$_2$ Cost	Coal Retirement w/o CO$_2$	Coal Retirement w/ CO$_2$	No Conservation	Lower Snake Dam Breach
Case Identifier	L813	L813 G	L813 I	L813 H	L813 D	L813 B	L813 J	L813 A	L813 K
2010	82.28	82.21	82.17	82.28	92.36	82.24	82.28	78.77	82.30
2011	82.44	81.67	81.63	82.44	92.50	81.73	82.44	79.25	82.47
2012	83.14	80.85	80.78	83.14	92.05	80.96	83.15	80.36	83.20
2013	84.47	80.35	80.26	84.47	91.92	80.73	84.51	82.34	84.53
2014	85.14	79.65	79.48	85.10	91.40	80.53	85.24	84.10	85.18
2015	86.47	79.56	78.97	86.18	91.27	81.15	86.62	86.68	86.49
2016	86.94	79.22	78.17	86.49	90.45	81.57	87.19	88.63	86.93
2017	87.11	78.79	77.37	86.69	89.85	81.88	87.43	90.43	87.08
2018	87.69	78.94	77.12	87.01	89.73	82.25	88.05	92.08	87.68
2019	86.84	78.34	76.15	86.16	88.49	81.84	87.25	92.85	86.83
2020	85.74	77.49	75.02	84.85	86.90	80.96	86.16	93.65	89.10
2021	84.81	76.24	73.87	84.05	85.49	79.65	85.17	94.39	88.04
2022	83.64	75.13	73.00	82.87	84.20	78.70	84.06	95.83	86.97
2023	83.24	74.43	72.57	82.85	83.51	78.30	83.69	98.08	86.72
2024	83.14	74.73	72.18	81.99	83.39	78.62	83.59	99.67	86.51
2025	83.14	74.55	72.01	81.79	82.99	78.71	83.57	101.37	86.46
2026	82.72	74.15	71.76	81.43	82.54	78.59	83.15	103.16	86.02
2027	80.89	72.12	70.27	80.08	81.24	76.95	81.41	104.02	84.51
2028	78.97	70.48	68.53	77.98	78.88	75.10	79.53	105.65	82.50
2029	78.50	69.84	67.92	77.01	78.11	74.30	79.02	106.95	81.42
Levelized Rates	**$84.18**	**$77.91**	**$76.66**	**$83.67**	**$88.12**	**$80.27**	**$84.44**	**$90.51**	**$85.46**
Annual Rate of Growth	-0.25%	-0.9%	-1.0%	-0.3%	-0.9%	-0.5%	-0.2%	1.6%	-0.1%
Percent Change from CO2 Risk case		**-7.4%**	**-8.9%**	**-0.6%**	**4.7%**	**-4.6%**	**0.3%**	**7.5%**	**1.5%**

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Table O-4: Average Residential Bills for Least Risk Portfolios by Case - CO₂ Cost Not Included
(Bills are expressed in 2006$/month/household)

	Carbon Risk	Current Policy	No Policy	No RPS	$45/Ton CO₂ Cost	Coal Retirement w/o CO₂	Coal Retirement w/ CO₂	No Conservation	Lower Snake Dam Breach
Case Identifier	**L813**	**L813 G**	**L813 I2**	**L813 H**	**L813 D**	**L813 B**	**L813 J**	**L813 A**	**L813 K**
2010	82.24	82.21	82.17	82.24	84.77	82.24	82.24	78.73	82.27
2011	81.70	81.67	81.63	81.70	84.15	81.73	81.71	78.48	81.73
2012	80.88	80.85	80.78	80.88	83.34	80.96	80.89	77.93	80.94
2013	80.46	80.35	80.26	80.46	83.01	80.73	80.52	77.88	80.53
2014	79.84	79.65	79.48	79.79	82.40	80.53	80.00	77.99	79.90
2015	79.97	79.56	78.97	79.53	82.22	81.15	80.20	78.88	80.00
2016	79.65	79.22	78.17	78.90	81.77	81.57	80.05	79.65	79.65
2017	79.40	78.79	77.37	78.57	81.24	81.88	79.94	80.55	79.41
2018	79.75	78.94	77.12	78.55	81.35	82.25	80.35	81.39	79.78
2019	79.11	78.34	76.15	77.82	80.62	81.84	79.81	81.82	79.13
2020	78.39	77.49	75.02	76.83	79.61	80.96	79.14	82.38	80.02
2021	77.24	76.24	73.87	76.00	78.37	79.65	77.95	82.40	78.79
2022	76.34	75.13	73.00	75.24	77.20	78.70	77.12	83.82	77.94
2023	75.88	74.43	72.57	75.39	76.53	78.30	76.70	86.09	77.72
2024	76.29	74.73	72.18	74.90	76.83	78.62	77.07	87.54	77.97
2025	76.28	74.55	72.01	74.42	76.67	78.71	77.05	88.69	77.95
2026	76.02	74.15	71.76	74.15	76.33	78.59	76.77	90.24	77.67
2027	74.28	72.12	70.27	72.97	74.98	76.95	75.14	90.72	76.30
2028	72.30	70.48	68.53	70.91	72.52	75.10	73.23	92.05	74.32
2029	71.34	69.84	67.92	69.37	71.44	74.30	72.24	92.72	72.81
Levelized Rates	**$78.66**	**$77.91**	**$76.66**	**$77.89**	**$80.29**	**$80.27**	**$79.11**	**$82.24**	**$79.33**
Annual Rate Of Growth	-0.7%	-0.9%	-1.0%	-0.9%	-0.9%	-0.5%	-0.7%	0.9%	-0.6%
Percent change from CO2 Risk case		**-1.0%**	**-2.5%**	**-1.0%**	**2.1%**	**2.0%**	**0.6%**	**4.6%**	**0.9%**

Analysis of Differences in Revenue Requirement per Megawatt-hour among Cases

The tables can be used to contrast rates and bills among cases in almost infinite combinations, but a few illustrations should make it possible for regional analysts to pursue their interests using the tables. For example, consider the impact of a reduction in conservation potential, assuming that carbon allowances are granted free so that carbon penalties are not included in retail revenue requirements.

The "Carbon Risk" case can be compared to the "Zero Conservation" case, which eliminates conservation from the resource portfolio. Comparison of the "Carbon Risk" and "Zero Conservation" columns of Tables O-2 and O-4 shows that when conservation is eliminated, average revenue requirements per megawatt-hour decrease until the 2028 and then increase. Bills are lower with no conservation for a few years, but by 2017 they are higher.   The same results are shown graphically in Figures O-2 and O-3 (i.e. the "Zero Conservation" bars are lower than the Carbon Risk" bars until the mid-2020s, then higher). The data shown in Figure O-2 are from the Carbon Risk" and "Zero Conservation" column in Table O-2 and the data shown in Figure O-3 are from the same columns in Table O-4.

**Figure O-2 Average Revenue Requirements per Megawatt-Hour Comparison
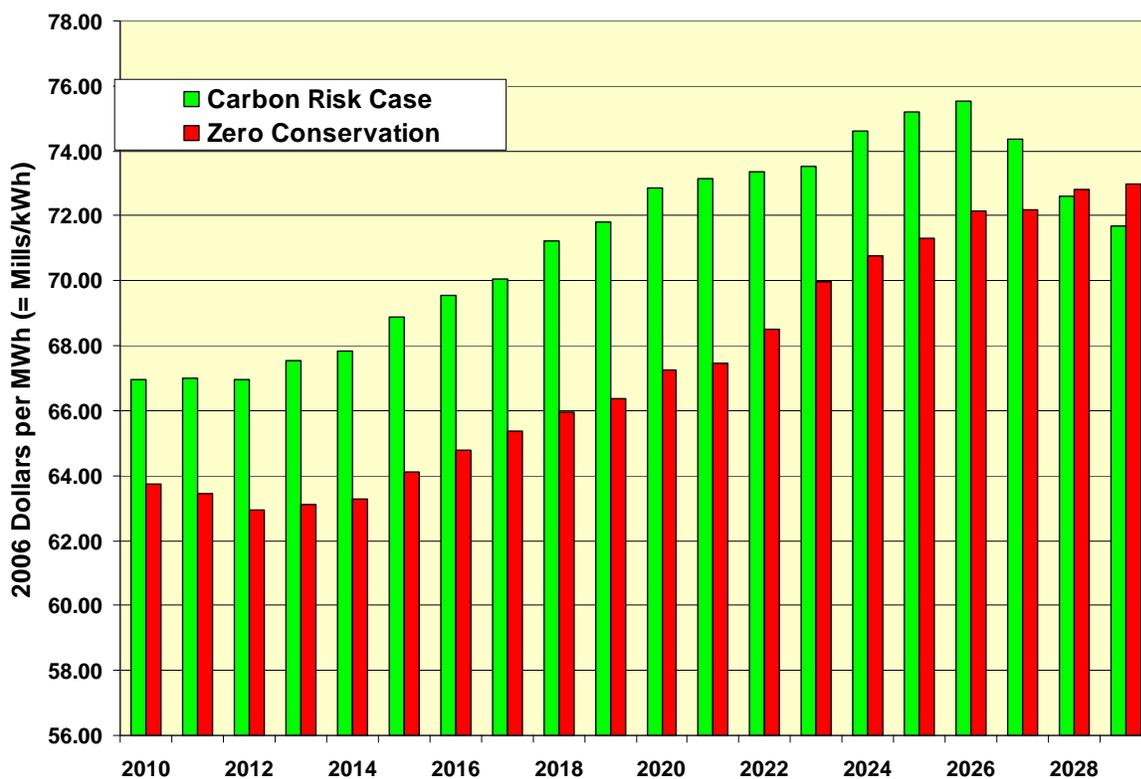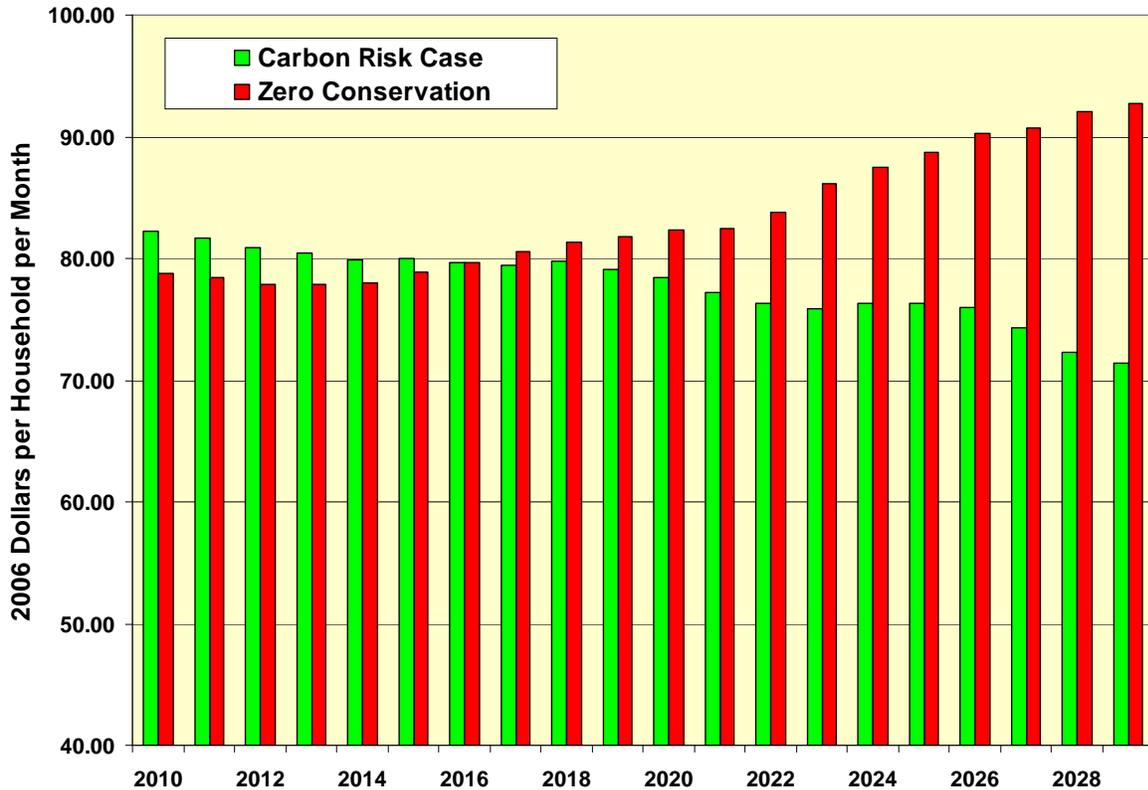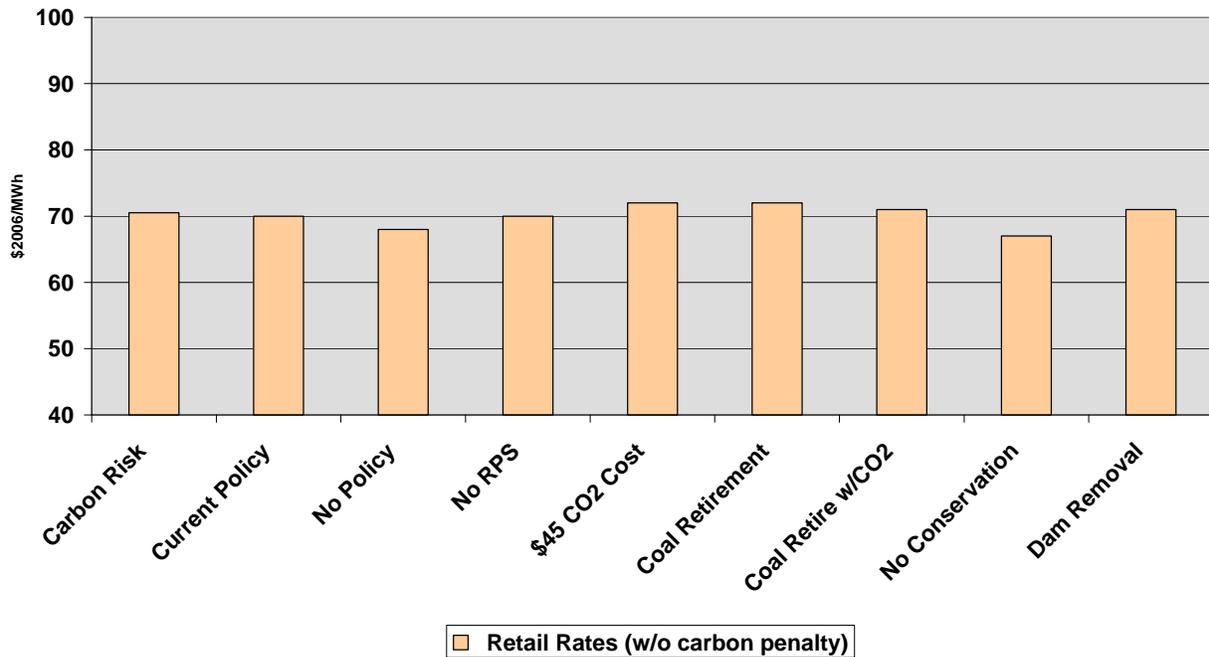CO2 Costs Not Included**

Figure O-3 Typical Residential Electricity Bill Comparison - CO2 Costs Not Included

Another illustration of potential analysis using Tables O-1 through O-4 (and the Excel workbook that lies behind them) is a comparison of the average revenue requirement per megawatt-hour and bills, each levelized across the 2010-2029 period, across the 9 scenarios included in the tables. Figure O-4 compares levelized average revenue requirement per megawatt-hour across all scenarios, and Figure O-5 compares levelized bills, both with CO2 costs excluded. Levelized revenue requirement per megawatt-hour (from Table O-2) range from a low of $67 per megawatt-hour for the "Zero Conservation" scenario to $72 per megawatt-hour for the "$45/Ton CO2 Cost" scenario. Levelized bills range from $77 for the "No Policy" scenario to $82 for the "Zero Conservation" scenario.

**Figure O-4: Levelized Revenue Requirement per Megawatt-Hour by Scenario
CO2 Costs Not Included**

Retail Rates (w/o carbon penalty)

**Figure O-5: Levelized Typical Residential Electricity Bills by Scenario
CO2 Costs Not Included**

Monthly Residential Bills (w/o carbon penalty)
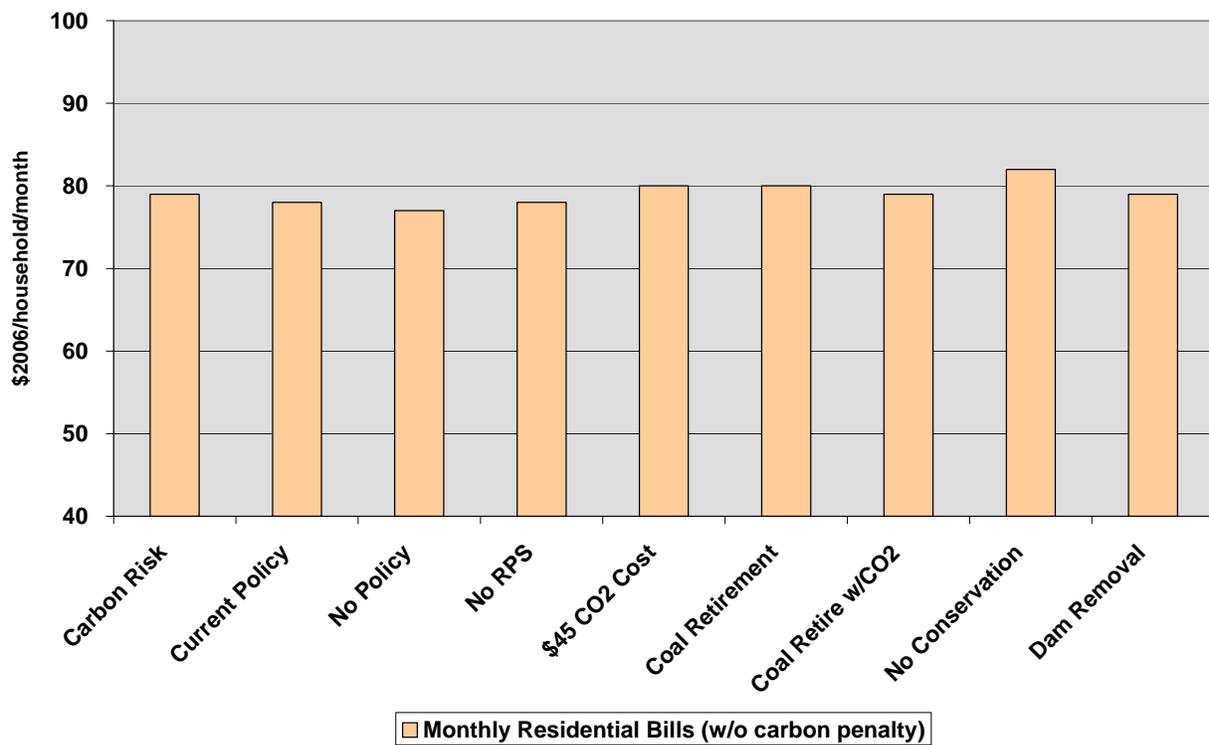
Difference in Growth Rates

In the above analysis we have shown the average annual increase in revenue requirement, rates and bills. The growth rate for revenue requirement and bills are different, due to the impact of growth in number of households in the region. The number of households is growing at a higher rate than the revenue requirement, resulting in a slower growth rate for residential bills.   The growth rate for the revenue requirement is also different than the growth rate in average rates due to growth in sales. The following two tables show the decomposition of the residential bills and average rate for the least risk plan for Carbon Risk scenario, excluding cost of CO_2 tax.

Table O-5: Decomposition of growth rate in Revenue Requirement and Bills

Annual Growth Rate in Revenue requirement	Annual growth rate in number of households	Net effect on average residential bill
0.5%	1.2%	-0.7%

Table O-6: Decomposition of growth rate in Revenue Requirement and Average Rate

Annual Growth Rate in Revenue requirement	Annual growth rate in Sales	Net effect on average revenue requirement per kilowatt hour
0.5%	0.2%	0.3%