Rate Design: Appropriate Price Signals to Encourage the More Efficient Use of Electricity, The Case for Inverted Block Rates for Residential Customers

Presentation and discussion for DSM Innovative Rate Design Workgroup

February 26, 2009 presented by Rich Collins

Introduction

- The task given to this group is to investigate innovative rate designs that provides incentives to customers to utilize their use electricity more efficiently.

- This discussion will concentrate on Residential Class and how to design rates that will encourage customers to utilize electricity more efficiently and dampen the need for future rate increases.

Rate Design for Residential Customers

- Different Classes of customers need different rate designs to affect their behavior.
- Larger customers have greater ability to handle time of use rate designs
- Residential customers are better candidates for inverted block rates
- Rates should be designed to encourage the use of electricity to both curtail wasteful use and to promote more the use of more efficient appliances

Residential Usage of Electricity

- The following charts outline consumption of electricity in the residential class by usage blocks during the Summer Months (May-September 2006-07 and 2007-08)
- Data on residential usage by 100 kWh block was provided by PacifiCorp
- Usage levels are divided into four blocks
  - Block 1 essential use 0- 400 kWh per month
  - Block 2 normal use 400 -1000 kWh per month
  - Block 3 high use 1000-2000 kWh per month
  - Block 4 highest use >2000 kWh per month
- Usage Levels per Block vary dramatically

"Lorenz Curve" Analysis for Block 1

2007 - 2008 Summer Summary

Summary of Usage by Proposed Blocks

	Min	Max
Block 1	0	400
Block 2	401	1000
Block 3	1001	2000
Block 4	2001	Over 5,000

Summary for Average Summer Customers in Block 1		
Total Number of Bills		829,721
Customers		165,944
Total kWh Usage		193,305,762
% of Total Bills		24%
% of Total kWh Usage		6%
Average Monthly Bills		165,944
Average Monthly kWh Usage		38,661,152
Average Monthly kWh Usage per Customer		233
Average Usage Above 400 kWh	0	
Average Usage Above 1000 kWh	0	
Average Usage Above 2000 kWh	0	
% of Average Usage Above 400 kWh		0%
% of Average Usage Above 1000 kWh		0%
% of Average Usage Above 2000 kWh		0%

2006 - 2007 Summer Summary

Summary of Usage by Proposed Blocks

	Min	Max
Block 1	0	400
Block 2	401	1000
Block 3	1001	2000
Block 4	2001	Over 5,000

Summary for Average Summer Customers in Block 1		
Total Number of Bills		805,781
Customers		161,156
Total kWh Usage		185,129,549
% of Total Bills		25%
% of Total kWh Usage		7%
Average Monthly Bills		161,156
Average Monthly kWh Usage		37,025,910
Average Monthly kWh Usage per Customer		230
Average Usage Above 400 kWh	0	
Average Usage Above 1000 kWh	0	
Average Usage Above 2000 kWh	0	
% of Average Usage Above 400 kWh		-
% of Average Usage Above 1000 kWh		-
% of Average Usage Above 2000 kWh		-

"Lorenz Curve" Analysis for Block 2

2007 - 2008 Summer Summary

Summary of Usage by Proposed Blocks

	Min	Max
Block 1	0	400
Block 2	401	1000
Block 3	1001	2000
Block 4	2001	Over 5,000

Summary for Average Summer Customers in Block 2		
Total Number of Bills		1,550,842
Customers		310,168
Total kWh Usage		1,034,061,985
% of Total Bills		45%
% of Total kWh Usage		34%
Average Monthly Bills		310,168
Average Monthly kWh Usage		206,812,397
Average Monthly kWh Usage per Customer		667
Average Usage Above 400 kWh		82,745,065
Average Usage Above 1000 kWh	0	
Average Usage Above 2000 kWh	0	
% of Average Usage Above 400 kWh		40%
% of Average Usage Above 1000 kWh		0%
% of Average Usage Above 2000 kWh		0%

2006 - 2007 Summer Summary

Summary of Usage by Proposed Blocks

	Min	Max
Block 1	0	400
Block 2	401	1000
Block 3	1001	2000
Block 4	2001	Over 5,000

Summary for Average Summer Customers in Block 2		
Total Number of Bills		1,481,547
Customers		296,309
Total kWh Usage		991,284,628
% of Total Bills		46%
% of Total kWh Usage		36%
Average Monthly Bills		296,309
Average Monthly kWh Usage		198,256,926
Average Monthly kWh Usage per Customer		669
Average Usage Above 400 kWh		79,733,187
Average Usage Above 1000 kWh	0	
Average Usage Above 2000 kWh	0	
% of Average Usage Above 400 kWh		40%
% of Average Usage Above 1000 kWh		0%
% of Average Usage Above 2000 kWh		0%

"Lorenz Curve" Analysis for Block 3

2007 - 2008 Summer Summary

Summary of Usage by Proposed Blocks

	Min	Max
Block 1	0	400
Block 2	401	1000
Block 3	1001	2000
Block 4	2001	Over 5,000

Summary for Average Summer Customers in Block 3		
Total Number of Bills		839,647
Customers		167,929
Total kWh Usage		1,159,282,871
% of Total Bills		24%
% of Total kWh Usage		38%
Average Monthly Bills		167,929
Average Monthly kWh Usage		231,856,574
Average Monthly kWh Usage per Customer		1,381
Average Usage Above 400 kWh		164,684,825
Average Usage Above 1000 kWh		63,927,200
Average Usage Above 2000 kWh	0	
% of Average Usage Above 400 kWh		71%
% of Average Usage Above 1000 kWh		28%
% of Average Usage Above 2000 kWh		0%

2006 - 2007 Summer Summary

Summary of Usage by Proposed Blocks

	Min	Max
Block 1	0	400
Block 2	401	1000
Block 3	1001	2000
Block 4	2001	Over 5,000

Summary for Average Summer Customers in Block 3		
Total Number of Bills		778,758
Customers		155,752
Total kWh Usage		1,064,088,257
% of Total Bills		24%
% of Total kWh Usage		39%
Average Monthly Bills		155,752
Average Monthly kWh Usage		212,817,651
Average Monthly kWh Usage per Customer		1,366
Average Usage Above 400 kWh		150,517,035
Average Usage Above 1000 kWh		57,066,109
Average Usage Above 2000 kWh	0	
% of Average Usage Above 400 kWh		71%
% of Average Usage Above 1000 kWh		27%
% of Average Usage Above 2000 kWh		0%

"Lorenz Curve" Analysis for Block 4

2007 - 2008 Summer Summary

Summary of Usage by Proposed Blocks

	Min	Max
Block 1	0	400
Block 2	401	1000
Block 3	1001	2000
Block 4	2001	Over 5,000

Summary for Average Summer Customers in Block 4	
Total Number of Bills	229,917
Customers	45,983
Total kWh Usage	640,096,027
% of Total Bills	7%
% of Total kWh Usage	21%
Average Monthly Bills	45,983
Average Monthly kWh Usage	128,019,205
Average Monthly kWh Usage per Customer	2,784
Average Usage Above 400 kWh	109,625,885
Average Usage Above 1000 kWh	82,035,904
Average Usage Above 2000 kWh	36,052,603
Average Customer Usage Above 2000 kwh	784
% of Average Usage Above 400 kWh	86%
% of Average Usage Above 1000 kWh	64%
% of Average Usage Above 2000 kWh	28%

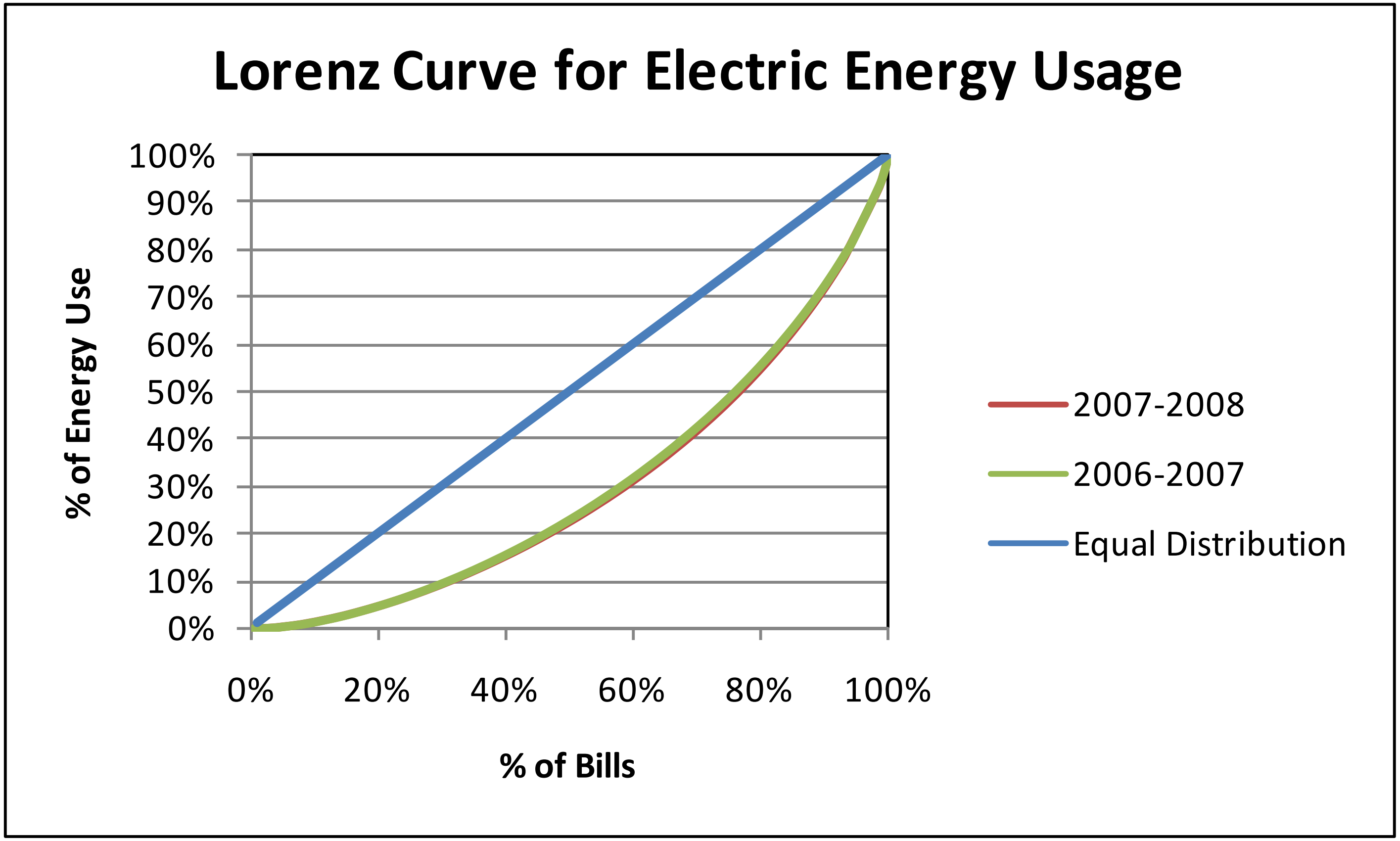
2006 - 2007 Summer Summary

Summary of Usage by Proposed Blocks

	Min	Max
Block 1	0	400
Block 2	401	1000
Block 3	1001	2000
Block 4	2001	Over 5,000

Summary for Average Summer Customers in Block 4	
Total Number of Bills	180,403
Customers	36,081
Total kWh Usage	503,270,539
% of Total Bills	6%
% of Total kWh Usage	18%
Average Monthly Bills	36,081
Average Monthly kWh Usage	100,654,108
Average Monthly kWh Usage per Customer	2,790
Average Usage Above 400 kWh	86,221,850
Average Usage Above 1000 kWh	64,573,464
Average Usage Above 2000 kWh	28,492,820
Average Customer Usage Above 2000 kwh	790
% of Average Usage Above 400 kWh	86%
% of Average Usage Above 1000 kWh	64%
% of Average Usage Above 2000 kWh	28%

"Lorenz Curve" Analysis



"Lorentz Curve" Conclusions

2007-2008	% of customers	% of usage
Block 1	24%	6%
Block2	45%	34%
Block 3	24%	38%
Block 4	7%	21%

- So the first two blocks have 69% of the customers and they consume 40% of the electricity in the Summer months
- The last two blocks has 31% of customers and uses close to 60% of the electricity

“LORENTZ CURVE” CONCLUSIONS

Growth in Summer Customers and Usage between 2006-2007 & 2007-2008

Total % Increase in Customers	**6.3%**	**Total Increase in kWh**	**10.3%**
Total % Increase in Customers Block 1	3.0%	Total Increase in kWh Block 1	4.4%
Total % Increase in Customers Block 2	4.7%	Total Increase in kWh Block 2	4.3%
Total % Increase in Customers Block 3	7.8%	Total Increase in kWh Block 3	8.9%
Total % Increase in Customers Block 4	27.4%	Total Increase in kWh Block 4	27.2%

Summer Growth (% of Total for each Block) 2006-2007 & 2007-2008

Total Increase in Customers	**40,728**	**Total Increase in kWh**	**282,973,672**
% of Total Increase Attributable to Block 1	11.8%	% of Total Increase Attributable to Block 1	2.9%
% of Total Increase Attributable to Block 2	34.0%	% of Total Increase Attributable to Block 2	15.1%
% of Total Increase Attributable to Block 3	29.9%	% of Total Increase Attributable to Block 3	33.6%
% of Total Increase Attributable to Block 4	24.3%	% of Total Increase Attributable to Block 4	48.4%

"Lorentz Curve" Conclusions

- So we see approximately a 10% increase in summer residential usage between 2006-07 and 2007-08.
- The lower two tiers only contributed 18% of this growth but the top two tiers are responsible for over 80% of this summer increase.
- It is commonly accepted that summer time usage is driving costs for the Company
- Thus the high use customers are driving the large majority of the growth in revenue requirement for the residential class.

Appropriate Number and Size of Blocks

- Blocks should be should be sized in a way that reflects the natural boundaries of use and reflect the costs that the usage levels place on the system.
- Blocks should be sized so they are easily understandable to ratepayers
- The four block system separates usage levels into
  - Essential use
  - Normal use
  - High use
  - Highest use

"Lorentz Curve" Conclusions

- Rate Design should send an appropriate price signal to high use customers that reflects the costs that they are placing on the system.

- Company and regulators should support rate design policy that encourages efficient usage of electricity.

- Rates should be set to get a demand response.

Price Differential between Blocks

- Blocks should be priced to meet three general ratemaking objectives or goals
  - First, essential electricity use should be kept affordable.
  - Second, rates should reflect cost causation. Customers that put greater demands on the system should be held responsible for those costs.
  - The pricing should be comprehensible to ratepayers and have some intrinsic logic to it.

Price Differential between Blocks

- The lowest Block should reflect the embedded costs of the system seeing that their usage is growing at a lower rate that the rate of growth of residential customers. Thus they are responsible for a smaller and smaller share of the system costs. Rate for this block should be low as possible.

- The second block should reflect the system average costs.

- Given the fact that the top two tiers are responsible for over 80% of growth in summer usage, they should pay higher rates that reflects the long run marginal costs of providing service.

SUPPLY-SIDE COSTS (MARGINAL COST OF NEW GENERATION)

Table 6.4 – Total Resource Cost for East Side Supply-Side Resource Options, $8 CO_2 Tax

Description	Capital Cost $/kW: Total Capital Cost	Capital Cost $/kW: Payment Factor	Capital Cost $/kW: Annual Payment ($/kW-Yr)	Fixed Cost: Fixed O&M $/kW-Yr: O&M	Fixed Cost: Fixed O&M $/kW-Yr: Other	Fixed Cost: Fixed O&M $/kW-Yr: Total	Fixed Cost: Total Fixed ($/kW-Yr)	Convert to Mills: Capacity Factor	Convert to Mills: Total Fixed Mills/kWh	Convert to Mills: Levelized Fuel ¢/mmBtu	Convert to Mills: Levelized Fuel Mills/kWh	Variable Costs mills/kWh: O&M	Variable Costs mills/kWh: Gas Transportation/ Wind Integration	Variable Costs mills/kWh: Tax Credits	Variable Costs mills/kWh: Environmental	Total Resource Cost (Mills/kWh)
East Side Options (4500')																
Coal																
Utah PC without Carbon Capture & Sequestration	2,934	8.40%	$ 246.57	$ 38.80	$ 6.00	$ 44.80	$ 291.37	91%	36.39	216.23	19.69	$ 0.96	-	-	5.10	62.14
Utah PC with Carbon Capture & Sequestration	5,306	8.25%	$ 437.60	$ 66.07	$ 6.00	$ 72.07	$ 509.68	90%	64.65	216.23	28.30	$ 6.71	-	-	0.78	100.43
Utah IGCC with Carbon Capture & Sequestration	5,136	8.01%	$ 411.32	$ 53.24	$ 6.00	$ 59.24	$ 470.56	85%	63.20	216.23	23.40	$ 11.28	-	-	0.64	98.52
Wyoming PC without Carbon Capture & Sequestration	3,322	8.40%	$ 279.19	$ 36.00	$ 6.00	$ 42.00	$ 321.19	91%	40.12	238.45	21.97	$ 1.27	-	-	5.16	68.52
Wyoming PC with Carbon Capture & Sequestration	6,007	8.25%	$ 495.50	$ 61.37	$ 6.00	$ 67.37	$ 562.86	90%	71.39	238.45	31.58	$ 7.26	-	-	0.79	111.02
Wyoming IGCC with Carbon Capture & Sequestration	5,816	8.01%	$ 465.74	$ 58.00	$ 6.00	$ 64.00	$ 529.74	85%	71.14	238.45	26.34	$ 13.52	-	-	0.66	111.66
Existing PC with Carbon Capture & Sequestration (500 MW)	1,319	10.71%	$ 141.23	$ 66.07	$ 6.00	$ 72.07	$ 213.30	90%	27.05	238.45	34.27	$ 6.71	-	-	0.86	68.89
Natural Gas																
Utility Cogeneration	5,076	10.12%	$ 513.46	$ 1.86	$ 0.50	$ 2.36	$ 515.82	82%	71.81	699.22	34.78	$ 23.29	4.17	-	1.58	135.63
Fuel Cell - Large	1,794	8.72%	$ 156.34	$ 8.40	$ 0.50	$ 8.90	$ 165.24	95%	19.86	699.22	50.78	$ 0.03	6.09	-	2.30	79.06
SCCT Aero	1,126	9.08%	$ 102.21	$ 9.95	$ 0.50	$ 10.45	$ 112.66	21%	61.24	699.22	68.34	$ 5.63	8.20	-	3.10	146.51
Intercooled Aero SCCT	1,052	9.08%	$ 95.45	$ 4.04	$ 0.50	$ 4.54	$ 99.99	21%	54.36	699.22	65.74	$ 2.71	7.89	-	2.98	133.68
Intercooled Aero SCCT	1,052	9.08%	$ 95.45	$ 4.04	$ 0.50	$ 4.54	$ 99.99	21%	54.36	699.22	65.74	$ 2.71	7.89	-	2.98	133.68
Intercooled Aero SCCT	1,140	9.08%	$ 103.50	$ 4.39	$ 0.50	$ 4.89	$ 108.38	21%	58.92	699.22	65.74	$ 2.94	6.83	-	2.98	137.41
Internal Combustion Engines	1,324	9.08%	$ 120.18	$ 12.80	$ 0.50	$ 13.30	$ 133.48	94%	16.21	699.22	59.43	$ 5.20	7.13	-	2.70	90.67
SCCT Frame (2 Frame "F")	747	8.62%	$ 64.39	$ 3.74	$ 0.50	$ 4.24	$ 68.62	21%	37.30	699.22	81.53	$ 4.47	9.78	-	3.70	136.78
SCCT Frame (2 Frame "F")	810	8.62%	$ 69.82	$ 4.05	$ 0.50	$ 4.55	$ 74.37	21%	40.43	699.22	81.53	$ 4.85	8.47	-	3.70	138.97
CCCT (Wet "F" 1x1)	1,366	8.59%	$ 117.32	$ 12.79	$ 0.50	$ 13.29	$ 130.61	56%	26.62	699.22	51.06	$ 2.94	6.13	-	2.32	89.07
CCCT Duct Firing (Wet "F" 1x1)	558	8.59%	$ 47.88	$ 1.60	$ 0.50	$ 2.10	$ 49.98	16%	35.66	699.22	62.01	$ 0.39	7.44	-	2.81	108.32
CCCT (Wet "F" 2x1)	1,244	8.59%	$ 106.79	$ 7.77	$ 0.50	$ 8.27	$ 115.06	56%	23.46	699.22	49.63	$ 2.94	5.96	-	2.25	84.24
CCCT Duct Firing (Wet "F" 2x1)	628	8.59%	$ 53.88	$ 1.60	$ 0.50	$ 2.10	$ 55.98	16%	39.94	699.22	59.84	$ 0.39	7.18	-	2.71	110.06
CCCT (Dry "F" 2x1)	1,275	8.59%	$ 109.50	$ 9.69	$ 0.50	$ 10.19	$ 119.70	56%	24.40	699.22	51.52	$ 3.35	6.18	-	2.34	87.79
CCCT Duct Firing (Dry "F" 2x1)	644	8.59%	$ 55.25	$ 1.60	$ 0.50	$ 2.10	$ 57.35	16%	40.91	699.22	62.58	$ 0.11	7.51	-	2.84	113.95
CCCT (Wet "G" 1x1)	1,292	8.59%	$ 110.93	$ 6.75	$ 0.50	$ 7.25	$ 118.18	56%	24.09	699.22	48.14	$ 4.56	5.78	-	2.18	84.74
CCCT Duct Firing (Wet "G" 1x1)	547	8.59%	$ 46.96	$ 1.63	$ 0.50	$ 2.13	$ 49.09	16%	35.03	699.22	63.08	$ 0.36	7.57	-	2.86	108.89
CCCT Advanced (Wet)	1,427	8.59%	$ 122.49	$ 6.75	$ 0.50	$ 7.25	$ 129.74	56%	26.45	699.22	47.27	$ 4.56	5.67	-	2.14	86.08
CCCT Advanced Duct Firing (Wet)	700	8.59%	$ 60.10	$ 1.63	$ 0.50	$ 2.13	$ 62.24	16%	44.40	699.22	63.08	$ 0.36	7.57	-	2.86	118.27
Other - Renewables																
East (Wyoming) Wind (35% CF)	2,566	8.72%	$ 223.58	$ 31.43	$ 0.50	$ 31.93	$ 255.51	35%	83.34	-	-	-	11.75	(20.70)	-	74.38
East Side Geothermal (Blundell)	6,087	7.42%	$ 451.64	$ 110.85	$ 0.50	$ 111.35	$ 562.99	90%	71.41	-	-	$ 5.94		(20.70)	-	56.64
East Side Geothermal (Green Field)	7,608	7.42%	$ 564.55	$ 221.70	$ 0.50	$ 222.20	$ 786.74	90%	99.79	-	-	$ 11.88		(20.70)	-	90.97
Battery Storage	2,084	8.29%	$ 172.77	$ 1.00	$ 0.50	$ 1.50	$ 174.27	21%	94.73	699.22	83.91	$ 10.00	10.07	-	6.73	205.43
Pumped Storage	1,773	8.19%	$ 145.14	$ 4.30	$ 1.35	$ 5.65	$ 150.79	20%	86.06	699.22	90.90	$ 4.30	10.91	-	7.29	199.46
Compressed Air Energy Storage (CAES)	1,561	8.29%	$ 129.41	$ 3.80	$ 1.35	$ 5.15	$ 134.56	47%	32.89	699.22	83.77	$ 5.50	8.70	-	3.80	134.66
Recovered Energy Generation (CHP)	5,500	9.39%	$ 516.67	$ 91.92	-	$ 91.92	$ 608.59	84%	82.71	-	-	-	-	-	-	82.71
Nuclear	5,461	8.30%	$ 453.26	$ 146.70	$ 6.00	$ 152.70	$ 605.95	85%	81.38	113.98	12.21	$ 1.63	-	-	-	95.22
Solar Concentrating (PV) - 30% CF	6,520	6.48%	$ 422.43	$ 180.00	$ 6.00	$ 186.00	$ 608.43	30%	231.52	-	-	-	-	(1.59)	-	229.93
Solar Concentrating (natural gas backup) - 25% solar	4,150	6.48%	$ 268.88	$ 195.60	$ 6.00	$ 201.60	$ 470.48	33%	162.75	699.22	18.96	-	2.28	(1.59)	0.86	183.26
Solar Concentrating (thermal storage) - 30% solar	4,650	5.46%	$ 253.80	$ 139.50	$ 6.00	$ 145.50	$ 399.30	30%	151.94	-	-	-	-	(1.59)	-	150.35

Supply-Side Costs (Marginal Cost of New Generation)

Table 6.6 – Total Resource Cost for East Side Supply-Side Resource Options, $45 CO_2 Tax

Description	Capital Cost $/kW: Total Capital Cost	Capital Cost $/kW: Payment Factor	Capital Cost $/kW: Annual Payment ($/kW-Yr)	Fixed Cost: Fixed O&M $/kW-Yr: O&M	Fixed Cost: Fixed O&M $/kW-Yr: Other	Fixed Cost: Fixed O&M $/kW-Yr: Total	Fixed Cost: Total Fixed ($/kW-Yr)	Convert to Mills: Capacity Factor	Convert to Mills: Total Fixed Mills/kWh	Convert to Mills: Levelized Fuel ¢/mmBtu	Convert to Mills: Levelized Fuel Mills/kWh	Variable Costs mills/kWh: O&M	Variable Costs mills/kWh: Gas Transportation/ Wind Integration	Variable Costs mills/kWh: Tax Credits	Variable Costs mills/kWh: Environmental	Total Resource Cost (Mills/kWh)
East Side Options (4500')																
Coal																
Utah PC without Carbon Capture & Sequestration	2,934	8.40%	$ 246.57	$ 38.80	$ 6.00	$ 44.80	$ 291.37	91%	36.39	216.23	19.69	$ 0.96	-	-	28.32	85.36
Utah PC with Carbon Capture & Sequestration	5,306	8.25%	$ 437.60	$ 66.07	$ 6.00	$ 72.07	$ 509.68	90%	64.65	216.23	28.30	$ 6.71	-	-	4.11	103.76
Utah IGCC with Carbon Capture & Sequestration	5,136	8.01%	$ 411.32	$ 53.24	$ 6.00	$ 59.24	$ 470.56	85%	63.20	216.23	23.40	$ 11.28	-	-	3.40	101.28
Vyoming PC without Carbon Capture & Sequestratic	3,322	8.40%	$ 279.19	$ 36.00	$ 6.00	$ 42.00	$ 321.19	91%	40.12	238.45	21.97	$ 1.27	-	-	28.66	92.02
Wyoming PC with Carbon Capture & Sequestration	6,007	8.25%	$ 495.50	$ 61.37	$ 6.00	$ 67.37	$ 562.86	90%	71.39	238.45	31.58	$ 7.26	-	-	4.16	114.39
Vyoming IGCC with Carbon Capture & Sequestratic	5,816	8.01%	$ 465.74	$ 58.00	$ 6.00	$ 64.00	$ 529.74	85%	71.14	238.45	26.34	$ 13.52	-	-	3.47	114.47
(500 MW)	1,319	10.71%	$ 141.23	$ 66.07	$ 6.00	$ 72.07	$ 213.30	90%	27.05	238.45	34.27	$ 6.71	-	-	4.51	72.54
Natural Gas																
Utility Cogeneration	5,076	10.12%	$ 513.46	$ 1.86	$ 0.50	$ 2.36	$ 515.82	82%	71.81	722.19	35.92	$ 23.29	4.17	-	8.87	144.06
Fuel Cell - Large	1,794	8.72%	$ 156.34	$ 8.40	$ 0.50	$ 8.90	$ 165.24	95%	19.86	722.19	52.44	$ 0.03	6.09	-	12.95	91.37
SCCT Aero	1,126	9.08%	$ 102.21	$ 9.95	$ 0.50	$ 10.45	$ 112.66	21%	61.24	722.19	70.58	$ 5.63	8.20	-	17.43	163.08
Intercooled Aero SCCT	1,052	9.08%	$ 95.45	$ 4.04	$ 0.50	$ 4.54	$ 99.99	21%	54.36	722.19	67.90	$ 2.71	7.89	-	16.77	149.62
Intercooled Aero SCCT	1,052	9.08%	$ 95.45	$ 4.04	$ 0.50	$ 4.54	$ 99.99	21%	54.36	722.19	67.90	$ 2.71	7.89	-	16.77	149.62
Intercooled Aero SCCT	1,140	9.08%	$ 103.50	$ 4.39	$ 0.50	$ 4.89	$ 108.38	21%	58.92	722.19	67.90	$ 2.94	6.83	-	16.77	153.36
Internal Combustion Engines	1,324	9.08%	$ 120.18	$ 12.80	$ 0.50	$ 13.30	$ 133.48	94%	16.21	722.19	61.38	$ 5.20	7.13	-	15.16	105.08
SCCT Frame (2 Frame "F")	747	8.62%	$ 64.39	$ 3.74	$ 0.50	$ 4.24	$ 68.62	21%	37.30	722.19	84.20	$ 4.47	9.78	-	20.79	156.55
SCCT Frame (2 Frame "F")	810	8.62%	$ 69.82	$ 4.05	$ 0.50	$ 4.55	$ 74.37	21%	40.43	722.19	84.20	$ 4.85	8.47	-	20.79	158.74
CCCT (Wet "F" 1x1)	1,366	8.59%	$ 117.32	$ 12.79	$ 0.50	$ 13.29	$ 130.61	56%	26.62	722.19	52.73	$ 2.94	6.13	-	13.02	101.45
CCCT Duct Firing (Wet "F" 1x1)	558	8.59%	$ 47.88	$ 1.60	$ 0.50	$ 2.10	$ 49.98	16%	35.66	722.19	64.05	$ 0.39	7.44	-	15.82	123.36
CCCT (Wet "F" 2x1)	1,244	8.59%	$ 106.79	$ 7.77	$ 0.50	$ 8.27	$ 115.06	56%	23.46	722.19	51.26	$ 2.94	5.96	-	12.66	96.27
CCCT Duct Firing (Wet "F" 2x1)	628	8.59%	$ 53.88	$ 1.60	$ 0.50	$ 2.10	$ 55.98	16%	39.94	722.19	61.80	$ 0.39	7.18	-	15.26	124.57
CCCT (Dry "F" 2x1)	1,275	8.59%	$ 109.50	$ 9.69	$ 0.50	$ 10.19	$ 119.70	56%	24.40	722.19	53.21	$ 3.35	6.18	-	13.14	100.28
CCCT Duct Firing (Dry "F" 2x1)	644	8.59%	$ 55.25	$ 1.60	$ 0.50	$ 2.10	$ 57.35	16%	40.91	722.19	64.63	$ 0.11	7.51	-	15.96	129.13
CCCT (Wet "G" 1x1)	1,292	8.59%	$ 110.93	$ 6.75	$ 0.50	$ 7.25	$ 118.18	56%	24.09	722.19	49.72	$ 4.56	5.78	-	12.28	96.42
CCCT Duct Firing (Wet "G" 1x1)	547	8.59%	$ 46.96	$ 1.63	$ 0.50	$ 2.13	$ 49.09	16%	35.03	722.19	65.15	$ 0.36	7.57	-	16.09	124.19
CCCT Advanced (Wet)	1,427	8.59%	$ 122.49	$ 6.75	$ 0.50	$ 7.25	$ 129.74	56%	26.45	722.19	48.82	$ 4.56	5.67	-	12.06	97.55
CCCT Advanced Duct Firing (Wet)	700	8.59%	$ 60.10	$ 1.63	$ 0.50	$ 2.13	$ 62.24	16%	44.40	722.19	65.15	$ 0.36	7.57	-	16.09	133.57
Other - Renewables																
East (Wyoming) Wind (35% CF)	2,566	8.72%	$ 223.58	$ 31.43	$ 0.50	$ 31.93	$ 255.51	35%	83.34	-	-	-	11.75	(20.70)	-	74.38
East Side Geothermal (Blundell)	6,087	7.42%	$ 451.64	$ 110.85	$ 0.50	$ 111.35	$ 562.99	90%	71.41	-	-	$ 5.94		(20.70)	-	56.64
East Side Geothermal (Green Field)	7,608	7.42%	$ 564.55	$ 221.70	$ 0.50	$ 222.20	$ 786.74	90%	99.79	-	-	$ 11.88		(20.70)	-	90.97
Battery Storage	2,084	8.29%	$ 172.77	$ 1.00	$ 0.50	$ 1.50	$ 174.27	21%	94.73	722.19	86.66	$ 10.00	10.07	-	37.33	238.79
Pumped Storage	1,773	8.19%	$ 145.14	$ 4.30	$ 1.35	$ 5.65	$ 150.79	20%	86.06	722.19	93.88	$ 4.30	10.91	-	40.44	235.60
Compressed Air Energy Storage (CAES)	1,561	8.29%	$ 129.41	$ 3.80	$ 1.35	$ 5.15	$ 134.56	47%	32.89	722.19	86.52	$ 5.50	8.70	-	21.37	154.98
Recovered Energy Generation (CHP)	5,500	9.39%	$ 516.67	$ 91.92	-	$ 91.92	$ 608.59	84%	82.71	-	-	-	-	-	-	82.71
Nuclear	5,461	8.30%	$ 453.26	$ 146.70	$ 6.00	$ 152.70	$ 605.95	85%	81.38	113.98	12.21	$ 1.63	-	-	-	95.22
Solar Concentrating (PV) - 30% CF	6,520	6.48%	$ 422.43	$ 180.00	$ 6.00	$ 186.00	$ 608.43	30%	231.52	-	-	-	-	(1.59)	-	229.93
Solar Concentrating (natural gas backup) - 25% sola	4,150	6.48%	$ 268.88	$ 195.60	$ 6.00	$ 201.60	$ 470.48	33%	162.75	722.19	19.59	-	2.28	(1.59)	4.84	187.86
Solar Concentrating (thermal storage) - 30% solar	4,650	5.46%	$ 253.80	$ 139.50	$ 6.00	$ 145.50	$ 399.30	30%	151.94	-	-	-	-	(1.59)	-	150.35

Rationale for Price Differentials

- The high rates for Block 3 and 4 reflect the costs of new resources that will be required to meet their load.
- PacifiCorp's draft IRP indicates that new peaking resources will cost in the range of $.13 to $.14 for generation costs only. This does not include transmission, distribution or overhead costs. Embedded overhead and transmission is in the $.03 to $.04 range..
- Prices must be high enough to grab attention and change behavior.

Suggested Pricing of Blocks

Block 1	No rate increase	$.075389
Block 2	25% above Block 1	$.094236
Block 3	50% above Block 1	$.113083
Block 4	100% above Block 1	$.150788

- The price differentials may need to be adjusted to meet revenue requirements. The model used by the Company has the summer base rate as the rate that adjusts given percentage rate increases between blocks. To match revenue requirement either changes in the rate increases or a lowering of the base rate may be required.

Revenue Impacts of Block Rates with High Rates for Top Blocks

- The increases of rates in the different blocks should result in a demand response. The highest priced blocks should see the highest response.

- If this demand response (elasticity) is not taken into account in the ratemaking process and natural growth does not counteract its effects then the Company may experience a revenue shortfall.

- Regulatory Policy should be developed to mitigate these impacts.

Elasticity of Demand for Electricity

- Review of Literature

Article Title	Author	Year Published/ State	Type of Customer	Conclusions
Annual Energy Outlook 2008	U.S. Department of Energy/ U.S. Energy Information Administration	2008/ National	Residential and Business	Residential: price variations have a larger impact on natural gas usage than on electricity (i.e. demand for gas is more price elastic); energy use per person has remained fairly constant since 1990. Business: energy consumption and growth varies widely across industry sectors
Regional Differences in the Price Elasticity of Demand for Energy	Rand Corporation (Bernstein, Griffin); also published by NREL	2006/ National	Residential and Commercial	Residential elasticities can vary from state to state, but remain the same within regions; energy demand is relatively inelastic to price and has not changed much over 20 years; residential electricity short-run price elasticity is -0.2 and long-run is -0.32; Residential gas short run price elasticity is -0.12 and long term is -0.36; may see more elasticity in demand as prices exceed the range observed in studies thus far; Commercial electricity elasticity in the short run is -0.21 and the long run is -0.97
Household Electricity Demand, Revisited	The Review of Economic Studies (Reiss, White)	2005/ CA	Residential	Low income households were more sensitive to price changes; higher-income households tend to be more energy intensive but less responsive to price increases. Households with electric space heating or air conditioning exhibit much higher electricity price elasticity than households without such systems; 44% show no short-run sensitivity to fluctuations in the marginal price of electricity (primarily households with no major electric appliances other than a refrigerator); one in 8 households react to short-term price shifts with large changes in their electricity use.

Elasticity of Demand for Electricity

Article Title	Author	Year Published/ State	Type of Customer	Conclusions
Customer Strategies for Responding to Day-Ahead Market Hourly Electricity Pricing	Prepared for the California Energy Commission by Lawrence Berkeley National Labratories and Neenan Associates	2005/ NY	Large non-residential customers in Upstate NY (served by Niagara Mowhawk, a National Grid Co)	At the highest prices observed in the study period (5 times the off-peak price) the respondents collectively reduced demand by 50MW, which was 10% of their summper peak non-coincident demand; manufacturing firms were 45% more price responsive than the total group; two-thirds of customers had positive substitution elasticities; load management and energy information systems did not influence customer response to hourly prices; customers employed varied load response technologies - shifting, foregoing, and self-generation; only 15% of customers responded without obstacles to price response
Evaluation of the 2005 Energy Smart Pricing Plan	Prepared for Community Energy Cooperative (Chicago, IL) by Summit Blue Consulting (Boulder, CO)	2006/ IL	Residential	Cycling air conditioners during high price periods increases the elasticity, adding 4% during the day and 2% during the evening on high-price days (consistent with the expectations for an automated control system); participants who were new in 2005 tend to have a lower price elasticity relative to other participants (unclear if this is because of a time lag in learning how to respond to prices or because of changing demographics); participants who received e-mail notification had a higher elasticity during high-price periods than participants who received notification via telephone (not clear if this is because of the mode of notification itself or because of the selection bias of participants for one mode or the other); participants with central air conditioners are less sensitive to high-price notifications relative to other participants (this may be because they have permanently programmed their thermostats to be at a higher temperature, especially when not home); participants with a computer in their home are more responsive to high-price notifications

Review of the Literature Continued

- Review Continued

Article Title	Author	Year Published/ State	Type of Customer	Conclusions
Predicting California Demand Response	King/Chatterjee	2003/ CA	Residential	Strength of a customer response depends upon total consumption, appliance holdings, weather, and socio-demographic factors; volunteers for TOU programs have the same appliance holdings and usage patterns as non-volunteers (self-selection does not lead to revenue erosion for the utility); customers automatically placed on TOU programs were found to significantly reduce their usage (by 24% in the first summer season); own price elasticities show an average reduction in usage of 30% for every 100% increase in price
Not All Large Customers Are Made Alike: Disaggregating Response to Default-Service Day-Ahead Market Pricing	Lawrence Berkeley National Laboratory (Hopper, Goldman), Neenan Associates (Neenan)	2006/ NY	Large non-residential customers in Upstate NY (served by Niagara Mowhawk, a National Grid Co)	Individual company demand response varies greatly; two-thirds of participants exhibited some price response; about 20% of customers provide 75-80% of the aggregate load reductions; manufacturing customers are the most price-responsive as a group, followed by government/education customers, while other sectors are largely unresponsive; enabling technologies did not appear to enhance hourly price response (customers report using them for other purposes)
Time Bomb or Time Frame? Rate Freezes, Standard-Offer Service, and the Next Phase of Electricity Restructuring	E-Source (Mahler, Egan)	2004/ CA, NJ, FL, Ontario	Residential	Some TOU participants are signifcantly more satisfied than those not enrolled in programs; customer choice-driven pricing is seen as an alternative to restructuring the state's electric market. In CA, residential customers were found to have consistently produced the greatest short-term proportional reduction in demand as electric prices increase. Ranges for elasticies were as follows: gasoline 0.50-0.60; residential 0.20-0.35; industrial 0.15-0.30; large commercial 0.10; small business 0.03-0.05

"Turning on the lights, a meta analysis of residential Electricity demand elasticities" by James and Molly Espey

Journal of Agricultural and Applied Economics, 36,1(April 2004):65–81

Table 2. Variable Means

Variable	Short-run Price	Long-run Price	Short-run Income	Long-run Income
Elasticity	−0.35	−0.85	0.28	0.97

Elasticity Estimates

- The literature is mixed but several conclusions can be drawn.
  - Short run elasticity is generally lower than Long run elasticity
  - Short run elasticity estimates are more appropriate than long run given the fact that the Company can come in for a rate case if revenues fall.
  - Consumer sensitivity is higher at higher price levels.
  - Different income levels have different demand responses.
  - Residential estimates for short run elasticity is around .3 so a 10% increase in prices will lead to a 3% decrease in kWh sales

Possible Ways to adjust for elasticity effects

- Explicitly adjust kWh sales to reflect the impact of higher prices
  - This requires an estimate of the elasticity of demand
  - Difficult to measure ex post as demand is affected by weather, economic activity, growth etc.
- Frequent rate cases
  - This will lower the revenue impacts
- Assume that Natural growth in Demand with offset the demand response
- Other ideas?