

Integrated Resource Plan

Appendix 3A-34

2013 Resource Options Report Update

Firm Energy Cost Adjustments

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Firm Energy Cost Adjustments



Firm Energy Cost Adjustments

In the 2013 Resource Options Report (**ROR**) Update, the estimated costs of resources were shown in two ways: first, the total energy base UEC at the point of interconnection and, second, the adjusted firm energy UEC at the point of delivery (being the Lower Mainland which is the largest load centre).

The base unit energy costs (**UECs**) for each resource option at the point of interconnection (**POI**) reflect:

- Overall costs to the point of interconnect for total energy, i.e., both firm and non-firm energy;
- Costs within plant gate;
- Access road costs; and
- Transmission interconnection costs.

The adjusted firm energy UEC facilitates high level resource comparisons reflecting the total cost of the resource in meeting system needs. This process is similar to the approach taken in bid evaluation during acquisition call processes. The adjustments applied to each resource option are as follows¹:

- **Soft Cost Adder:** A 5 per cent cost adder, calculated off the UEC at POI and chosen based on BC Hydro's experience was included to reflect cost expenditures such as environmental assessment, First Nations and stakeholder engagement costs, etc.
- **Freshet Firm Energy Adjustment:** Additional energy in the freshet period (May through July) has limited value to the BC Hydro system. This is a result of high freshet inflows into BC Hydro reservoirs which limit the capability of the system to absorb additional energy combined with depressed prices in the Pacific North West electricity markets during that time. The amount of firm energy from a resource option during the freshet was thus limited to 25 per cent of the total firm energy for the year. Any excess energy was deemed to be non-firm.
- **3 x 12 Time of Delivery Price Adjustment:** A firm energy price (at POI) was calculated for each resource option such that the total revenue of the resource option using the firm price for the firm energy and a non-firm price for the non-firm energy would equal the annual levelized resource option cost². The non-firm energy was valued at the market price from BC Hydro's 2013 Market Scenario 1. In valuing the energy, a time of delivery factor applicable to the time of energy delivery was used. The time of delivery was determined based on the monthly energy profile of

¹ A 2 per cent annual inflationary factor was used in instances where it was necessary to inflate constant dollar values to \$F2013.

² Equal to the UEC at the POI multiplied by the resource options' total energy.

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each resource option³. The time of delivery factor accounts for the value of electricity delivered to BC Hydro at different time periods in a month and at different months in the year. The time of delivery factors used are the same factors used in the Clean Power Call⁴.

- **Cost of Incremental Firm Transmission (CIFT):** The CIFT provides a general indication of the long-term unit cost of bulk transmission system reinforcements from one transmission region to the next. CIFT is expressed as a region-to-region bulk transmission capacity cost. A CIFT for energy delivery to the Lower Mainland load centre was calculated for each resource option. The CIFT adjustment was based on the BC Transmission Corporation (**BCTC**) report titled: *Bulk Transmission System Cost of Incremental Firm Transmission for BC Hydro's 2008 LTAP Base Plan and Contingency Resource Plans CRP1 and CRP2* (January 15, 2009)⁵.
- **Line Losses Adjustment:** A calculation was carried out to determine the losses associated with delivering energy of each resource option to the Lower Mainland. Losses were calculated based on a BCTC report titled: *Peak Load Incremental Losses for the Bulk Transmission System* (January 2010).
- **Greenhouse Gas (GHG) Offset Costs:** Offset costs were calculated for coal, cogeneration (**cogen**) and combined cycle gas turbine (**CCGT**) resource options and added to the UEC. GHG offset cost was assumed to be \$30/tonne (\$2012) of CO₂ equivalents.
- **Capacity Credit:** A capacity credit was applied to resource options capable of delivering an hourly firm product. This credit of \$50/kW-year (\$2013 based on REV6 UCC) was applied to wood-based biomass, biogas, municipal solid waste (**MSW**), CCGT, coal, cogen, large hydro and geothermal resources.
- **Wind Integration Cost:** Due to the intermittent and variable nature of wind energy output, a \$10/MWh adjustment was added to the wind resource UECs to account for the incremental cost of integrating wind projects into the BC Hydro system.

Table 1 and Figure 1 summarize UECs that have been adjusted as described above. Additional details of resource options with adjusted firm UECs under \$200/MWh are presented in Table 2.

³ Within month profile was assumed to be flat except in instances where more detailed data was available.

⁴ Please refer to Table 5-3: Time of Delivery Factors of the "Clean Power Call Request for Proposals - Report on the RFP Process" available at http://www.bchydro.com/etc/medialib/internet/documents/planning_regulatory/acquiring_power/2010q3/cpc_rfp_process_report.Par.0001.File.CPC_RFP_Process_Report_August_3_2010.pdf

⁵ BC Hydro is in the process of reviewing/updating the CIFT adjustments. Preliminary sensitivity tests with different CIFT values have shown no material impact on the relative ranking of resource options based on adjusted firm energy costs.

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It should be noted that these cost adjusters do not reflect risks and uncertainties related to the level of study upon which resource option information is based, resource technology, earliest in-service date, and resource costs. They also do not reflect the cost of network upgrades required to interconnect the resource options to the bulk transmission system.

Table 1: Summary of Supply-Side Energy Resource Options Potential – UECs at POI and Adjusted Firm UECs

Energy Resource	Total Annual Energy (GWh/yr)	Total Dependable Generation Capacity (MW)	UEC at POI @ 7% Real Discount Rate (\$F2013/MWh)	Adjusted Firm UEC @ 7% Real Discount Rate (\$F2013/MWh)
Biomass – Wood Based	9,772	1,226	122 – 276	132 – 306
Biomass – Biogas	134	16	59 – 154	56 – 156
Biomass – MSW	425	50	85 – 184	83 – 204
Wind – Onshore	46,165	4,271	90 – 309	115 – 365
Wind – Offshore	56,700	3,819	166 – 605	182 – 681
Geothermal	5,992	780	91 – 573	90 – 593
Run-of-River	31,880	1,149	97 – 493	143 – 1,170
Site C	5,100	1,100	83	88
CCGT and Cogeneration	4,770	774	58 – 92	57 – 86
Coal-fired generation with CCS	3,896	556	88	103
Wave	2,506	259	440 – 772	453 – 820
Tidal	1,426	247	253 – 556	264 – 581
Solar	57	12	266 – 746	341 – 954

Note: The Site C values presented in this table are based on information provided in the Site C Environmental Impact Statement (EIS) submission filed in January 2013, and the UEC is calculated assuming a 5 per cent real discount rate.

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Figure 1: Resource Potential Supply Curve Summary – Adjusted Firm UECs

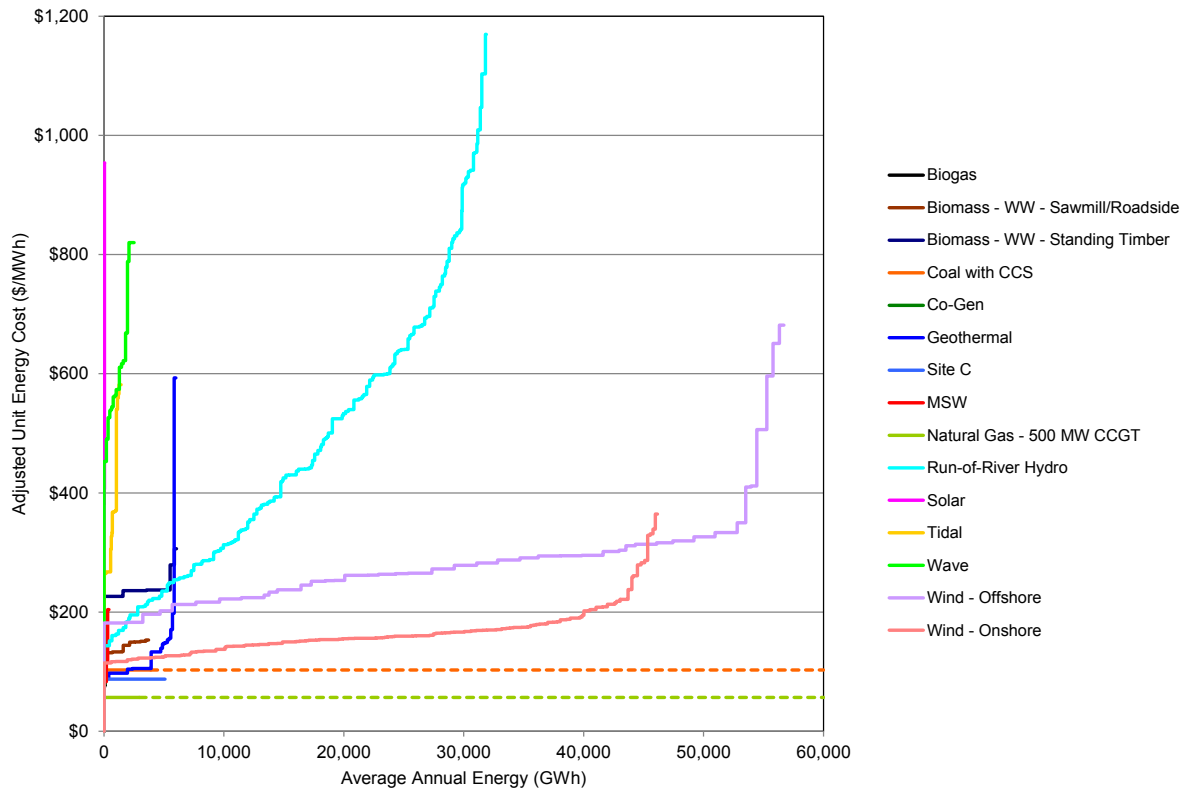


Table 2: Generation Resource Potential – Adjusted Firm UEC below \$200/MWh⁶

Resource Option	Project Name	Transmission Region ⁷	Average Annual Energy (GWh)	UEC at POI (\$/MWh)	Soft Cost Adder (\$/MWh)	Firm Energy Adjusters ⁸ (\$/MWh)	CIFT (\$/MWh)	Line Losses (\$/MWh)	GHG Cost (\$/MWh)	Capacity Credit (\$/MWh)	Wind Integration Cost (\$/MWh)	Adjusted Firm UEC (\$/MWh)
				1	2	3	4	5	6	7	8	Σ 1 to 8
Biogas	Bailey	LM	12	59	3	0	0	0	0	-6	0	56
Biogas	Comox Valley	VI	8	69	3	0	0	0	0	-6	0	66
Biogas	Minnie's Pit	LM	7	70	4	0	0	0	0	-6	0	68
Biogas	Alberni valley	VI	7	75	4	0	0	0	0	-6	0	73
Biogas	Cache Creek	KL	27	73	4	0	2	3	0	-6	0	75
Biogas	Foothills Blvd	CI	17	70	4	0	2	5	0	-6	0	76
Biogas	Glenmore	SL	18	73	4	0	3	6	0	-6	0	78
Biogas	Ecowaste	LM	13	96	5	0	0	0	0	-6	0	95
Biogas	Greater Vernon	SL	7	91	5	0	3	7	0	-6	0	99
Biogas	Campbell Mtn	SL	7	95	5	0	3	7	0	-6	0	104
Biogas	Mission Flats	KL	6	106	5	0	2	4	0	-6	0	112
Biogas	Campbell River	VI	4	154	8	0	0	-1	0	-6	0	156
Biomass WW - RSD/SMW ⁹	WBBio_VI	VI	707	132	7	0	0	-1	0	-6	0	132
Biomass WW - RSD/SMW	WBBio_WPR	NC	97	122	6	0	2	9	0	-6	0	133

⁶ Resource options presented alphabetically and values rounded to the nearest integer

⁷ Transmission Regions: CI = Central Interior, EK = East Kootenay, KL = Lower Mainland, MCA = Mica, NC = North Coast, PR = Peace River, REV = Revelstoke Ashton Creek, SL = Selkirk, VI = Vancouver Island

⁸ Firm Energy Adjusters = Freshet Firm Energy Adjustment and 3x12 Time of Delivery Price Adjustment

⁹ Biomass Wood Waste - Road Side Debris / Sawmill Waste (WW - RSD/SMW)

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												1
Biomass WW - RSD/SMW	WBBio_LM	LM	707	133	7	0	0	0	0	-6	0	133
Biomass WW - RSD/SMW	WBBio_EPR	NC	98	123	6	0	2	9	0	-6	0	134
Biomass WW - RSD/SMW	WBBio_WK	SL	530	131	7	0	3	10	0	-6	0	144
Biomass WW - RSD/SMW	WBBio_PG	NC	106	137	7	0	2	10	0	-6	0	150
Biomass WW - RSD/SMW	WBBio_MAC	CI	325	137	7	0	2	10	0	-6	0	150
Biomass WW - RSD/SMW	WBBio_KM	KL	476	141	7	0	2	6	0	-6	0	150
Biomass WW - RSD/SMW	WBBio_SP	PR	446	132	7	0	3	16	0	-6	0	151
Biomass WW - RSD/SMW	WBBio_EK	EK	225	139	7	0	3	11	0	-6	0	153
Coal-fired generation with CCS	750 MW Integrated Gasification Combined Cycle	PR	3,896	88	4	0	4	10	3	-7	0	103
Cogen	Small Cogeneration projects	LM	80	74	4	0	0	0	7	-6	0	79
Geothermal	Mt. Garibaldi	LM	394	91	5	0	0	0	0	-6	0	90
Geothermal	Pebble Creek	LM	788	99	5	0	0	0	0	-6	0	98
Geothermal	South Meager Creek	LM	788	99	5	0	0	0	0	-6	0	98
Geothermal	Mt. Cayley	LM	394	105	5	0	0	0	0	-6	0	104
Geothermal	Mt. Edziza	NC	1577	97	5	0	2	7	0	-6	0	105

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				1	2	3	4	5	6	7	8	Σ 1 to 8
Geothermal	Hoodoo Mountain	NC	394	122	6	0	2	9	0	-6	0	133
Geothermal	Mt. Silverthorne	VI	394	134	7	0	0	-1	0	-6	0	133
Geothermal	Harrison Hot Springs	LM	140	139	7	0	0	0	0	-7	0	139
Geothermal	Kootenay Lake	SL	140	134	7	0	3	10	0	-7	0	147
Geothermal	Lakelse Lake	NC	140	136	7	0	3	10	0	-7	0	148
Geothermal	Canoe Creek / Valemont	KL	140	141	7	0	2	6	0	-7	0	149
Geothermal	Hudson's Hope	PR	140	134	7	0	4	16	0	-7	0	154
Geothermal	Upper Arrow Lake	REV	140	142	7	0	3	11	0	-7	0	156
Geothermal	Lower Arrow Lake	SL	140	155	8	0	3	12	0	-7	0	171
Geothermal	Okanagan Valley	SL	140	179	9	0	3	14	0	-7	0	198
MSW	MSW 2_LM	LM	211	85	4	0	0	0	0	-6	0	83
MSW	MSW 1_VI	VI	101	117	6	0	0	-1	0	-6	0	117
Natural Gas	500 MW Combined Cycle Gas Turbine	KL	2,940	58	3	-12	3	2	11	-8	0	57
Natural Gas	250 MW Combined Cycle Gas Turbine	KL	1,450	62	3	-13	3	3	11	-8	0	61
Natural Gas	50 MW Combined Cycle Gas Turbine	KL	300	92	5	-21	3	4	12	-8	0	86
Run-of-River Hydro	ROR_100-110_VI	VI	450	108	5	31	0	-1	0	0	0	143
Run-of-River Hydro	ROR_80-100_LM	LM	224	97	5	50	0	0	0	0	0	152
Run-of-River Hydro	ROR_100-110_LM	LM	329	104	5	52	0	0	0	0	0	161
Run-of-River Hydro	ROR_90-100_KN	KL	220	97	5	57	0	4	0	0	0	163

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												1
Run-of-River Hydro	ROR_110-120_VI	VI	386	113	6	52	0	-1	0	0	0	169
Run-of-River Hydro	ROR_100-110_KN	KL	217	101	5	64	0	4	0	0	0	174
Run-of-River Hydro	ROR_110-120_NC	NC	135	115	6	54	1	8	0	0	0	183
Run-of-River Hydro	ROR_120-130_VI	VI	116	125	6	54	0	-1	0	0	0	185
Run-of-River Hydro	ROR_120-140_NC	NC	90	125	6	49	1	9	0	0	0	190
Run-of-River Hydro	ROR_120-130_LM	LM	649	125	6	64	0	0	0	0	0	195
Site C	Site C	PR	5,100	83	0	0	6	9	0	-11	0	88
Wind - Offshore	OBC24-1	VI	1892	166	8	-2	0	-1	0	0	10	182
Wind - Offshore	OBC25-1	VI	1347	167	8	-2	0	-1	0	0	10	183
Wind - Offshore	OBC28	VI	1442	181	9	-2	0	-1	0	0	10	196
Wind - Onshore	PC28	PR	591	90	5	-2	2	11	0	0	10	115
Wind - Onshore	PC21	PR	371	92	5	-2	2	11	0	0	10	117
Wind - Onshore	PC13	PR	541	92	5	-2	2	11	0	0	10	117
Wind - Onshore	PC19	PR	441	92	5	-2	2	11	0	0	10	117
Wind - Onshore	Wind_PC16	PR	377	95	5	-3	2	11	0	0	10	120
Wind - Onshore	Wind_PC14	PR	527	96	5	-3	2	11	0	0	10	121
Wind - Onshore	Wind_PC10	PR	1023	97	5	-3	2	11	0	0	10	123

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	1	2	3	4	5	6	7	8	9	10	11	12
Wind - Onshore	Wind_PC15	PR	382	98	5	-3	2	12	0	0	10	124
Wind - Onshore	Wind_PC20	PR	609	98	5	-2	2	12	0	0	10	124
Wind - Onshore	Wind_VI12	VI	151	113	6	-4	0	-1	0	0	10	125
Wind - Onshore	Wind_VI14	VI	113	113	6	-3	0	-1	0	0	10	126
Wind - Onshore	Wind_PC11	PR	473	101	5	-3	2	12	0	0	10	127
Wind - Onshore	Wind_PC09	PR	713	100	5	-2	2	12	0	0	10	127
Wind - Onshore	Wind_PC41	PR	155	101	5	-3	2	12	0	0	10	127
Wind - Onshore	Wind_PC42	PR	219	101	5	-2	2	12	0	0	10	128
Wind - Onshore	Wind_PC18	PR	486	101	5	-2	2	12	0	0	10	128
Wind - Onshore	Wind_VI13	VI	105	118	6	-3	0	-1	0	0	10	131
Wind - Onshore	Wind_PC26	PR	416	106	5	-3	2	13	0	0	10	133
Wind - Onshore	Wind_VI15	VI	126	121	6	-3	0	-1	0	0	10	134
Wind - Onshore	Wind_PC48	PR	505	106	5	-2	2	13	0	0	10	134
Wind - Onshore	Wind_NC09	NC	1025	113	6	-4	2	8	0	0	10	135
Wind - Onshore	Wind_PC06	PR	761	110	5	-3	2	13	0	0	10	137
Wind - Onshore	Wind_VI08	VI	113	128	6	-2	0	-1	0	0	10	141
Wind - Onshore	Wind_SI23	KL	569	122	6	-2	2	5	0	0	10	143

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	1	2	3	4	5	6	7	8	9	10	11	12
Wind - Onshore	Wind_PC27	PR	333	114	6	-3	2	14	0	0	10	143
Wind - Onshore	Wind_SI12	REV	545	119	6	-3	2	9	0	0	10	143
Wind - Onshore	Wind_SI20	KL	122	124	6	-3	1	5	0	0	10	143
Wind - Onshore	Wind_NC10	CI	280	122	6	-4	2	9	0	0	10	145
Wind - Onshore	Wind_PC40	PR	350	115	6	-2	2	14	0	0	10	145
Wind - Onshore	Wind_VI07	VI	502	131	7	-2	0	-1	0	0	10	145
Wind - Onshore	Wind_SI15	KL	814	126	6	-3	2	5	0	0	10	146
Wind - Onshore	Wind_VI05	VI	703	134	7	-3	0	-1	0	0	10	147
Wind - Onshore	Wind_PC25	CI	450	123	6	-3	2	9	0	0	10	147
Wind - Onshore	Wind_BC20	NC	294	127	6	-4	2	9	0	0	10	150
Wind - Onshore	Wind_SI22	KL	126	130	6	-3	2	5	0	0	10	150
Wind - Onshore	Wind_BC22	NC	697	127	6	-4	2	9	0	0	10	150
Wind - Onshore	Wind_SI10	KL	313	130	7	-3	2	5	0	0	10	151
Wind - Onshore	Wind_SI19	KL	148	133	7	-5	2	5	0	0	10	151
Wind - Onshore	Wind_PC05	PR	353	122	6	-3	2	14	0	0	10	152
Wind - Onshore	Wind_SI27	LM	249	137	7	-2	0	0	0	0	10	152
Wind - Onshore	Wind_NC07	NC	322	129	6	-3	2	9	0	0	10	153

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	1	2	3	4	5	6	7	8	9	10	11	12
Wind - Onshore	Wind_PC12	PR	308	123	6	-3	2	15	0	0	10	153
Wind - Onshore	Wind_SI04	KL	253	133	7	-3	2	5	0	0	10	153
Wind - Onshore	Wind_SI16	KL	1632	133	7	-3	2	5	0	0	10	154
Wind - Onshore	Wind_SI18	KL	335	135	7	-4	2	6	0	0	10	155
Wind - Onshore	Wind_PC17	PR	315	125	6	-3	2	15	0	0	10	155
Wind - Onshore	Wind_PC47	PR	108	125	6	-3	2	15	0	0	10	155
Wind - Onshore	Wind_PC43	PR	139	125	6	-3	2	15	0	0	10	156
Wind - Onshore	Wind_BC18	NC	426	132	7	-4	2	9	0	0	10	156
Wind - Onshore	Wind_NC01	NC	1729	132	7	-3	2	9	0	0	10	156
Wind - Onshore	Wind_VI10	VI	89	144	7	-4	0	-1	0	0	10	156
Wind - Onshore	Wind_SI05	KL	355	137	7	-4	2	6	0	0	10	157
Wind - Onshore	Wind_VI11	VI	112	145	7	-5	0	-1	0	0	10	157
Wind - Onshore	Wind_PC37	PR	231	126	6	-2	2	15	0	0	10	157
Wind - Onshore	Wind_SI14	REV	232	131	7	-2	2	10	0	0	10	158
Wind - Onshore	Wind_PC04	PR	349	128	6	-4	2	15	0	0	10	159
Wind - Onshore	Wind_NC12	NC	230	134	7	-3	2	10	0	0	10	159
Wind - Onshore	Wind_PC34	PR	906	129	6	-4	3	15	0	0	10	160

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Wind - Onshore	Wind_BC21	NC	589	135	7	-4	2	10	0	0	10	160
Wind - Onshore	Wind_BC19	NC	279	136	7	-4	2	10	0	0	10	160
Wind - Onshore	Wind_NC02	NC	666	136	7	-3	2	10	0	0	10	160
Wind - Onshore	Wind_VI02	VI	467	148	7	-4	0	-1	0	0	10	161
Wind - Onshore	Wind_VI06	VI	333	147	7	-3	0	-1	0	0	10	161
Wind - Onshore	Wind_NC11	CI	195	139	7	-5	2	10	0	0	10	164
Wind - Onshore	Wind_SI37	EK	87	138	7	-3	2	11	0	0	10	165
Wind - Onshore	Wind_BC25	CI	426	140	7	-4	2	10	0	0	10	165
Wind - Onshore	Wind_SI28	KL	261	141	7	-1	2	6	0	0	10	165
Wind - Onshore	Wind_SI03	KL	355	145	7	-5	2	6	0	0	10	165
Wind - Onshore	Wind_SI32	SL	89	135	7	1	2	10	0	0	10	166
Wind - Onshore	Wind_SI11	REV	330	139	7	-3	2	11	0	0	10	166
Wind - Onshore	Wind_PC32	PR	368	134	7	-4	3	16	0	0	10	166
Wind - Onshore	Wind_NC08	NC	463	141	7	-3	2	10	0	0	10	166
Wind - Onshore	Wind_SI01	KL	553	146	7	-4	2	6	0	0	10	168
Wind - Onshore	Wind_PC36	PR	425	136	7	-4	3	16	0	0	10	168
Wind - Onshore	Wind_SI13	REV	567	143	7	-5	2	11	0	0	10	169

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Wind - Onshore	Wind_PC38	PR	330	138	7	-4	3	16	0	0	10	170
Wind - Onshore	Wind_PC44	PR	105	138	7	-4	2	16	0	0	10	170
Wind - Onshore	Wind_SI30	KL	396	148	7	-3	2	6	0	0	10	170
Wind - Onshore	Wind_BC23	NC	278	145	7	-4	2	10	0	0	10	170
Wind - Onshore	Wind_PC01	PR	455	139	7	-4	2	16	0	0	10	171
Wind - Onshore	Wind_BC26	KL	376	151	8	-5	2	6	0	0	10	172
Wind - Onshore	Wind_SI29	KL	314	150	7	-2	2	6	0	0	10	173
Wind - Onshore	Wind_SI06	KL	294	152	8	-4	2	6	0	0	10	174
Wind - Onshore	Wind_SI09	KL	212	151	8	-3	2	6	0	0	10	174
Wind - Onshore	Wind_BC08	NC	490	149	7	-4	2	11	0	0	10	174
Wind - Onshore	Wind_BC13	NC	481	150	7	-5	2	11	0	0	10	175
Wind - Onshore	Wind_SI38	EK	237	147	7	-3	2	12	0	0	10	175
Wind - Onshore	Wind_SI08	KL	256	155	8	-3	2	6	0	0	10	178
Wind - Onshore	Wind_PC03	PR	222	145	7	-3	2	17	0	0	10	178
Wind - Onshore	Wind_PC24	CI	285	153	8	-4	2	11	0	0	10	179
Wind - Onshore	Wind_PC07	PR	325	145	7	-2	2	17	0	0	10	180
Wind - Onshore	Wind_PC23	CI	150	154	8	-4	2	11	0	0	10	180

**Integrated Resource Plan Appendix 3A-34
2013 Resource Options Report Update Appendix 12**

Resource Option	Project Name	Transmission Region ⁷	Average Annual Energy (GWh)	UEC at POI (\$/MWh)	Soft Cost Adder (\$/MWh)	Firm Energy Adjusters ⁸ (\$/MWh)	CIFT (\$/MWh)	Line Losses (\$/MWh)	GHG Cost (\$/MWh)	Capacity Credit (\$/MWh)	Wind Integration Cost (\$/MWh)	Adjusted Firm UEC (\$/MWh)
				1	2	3	4	5	6	7	8	Σ1 to 8
Wind - Onshore	Wind_PC29	PR	201	146	7	-4	3	17	0	0	10	180
Wind - Onshore	Wind_BC09	NC	438	157	8	-5	2	11	0	0	10	183
Wind - Onshore	Wind_SI31	KL	340	161	8	-4	2	7	0	0	10	183
Wind - Onshore	Wind_SI26	KL	263	159	8	-1	2	6	0	0	10	184
Wind - Onshore	Wind_SI02	KL	151	164	8	-4	2	7	0	0	10	187
Wind - Onshore	Wind_PC02	PR	371	154	8	-5	3	18	0	0	10	187
Wind - Onshore	Wind_BC24	CI	321	161	8	-5	2	12	0	0	10	188
Wind - Onshore	Wind_BC17	PR	824	156	8	-5	2	18	0	0	10	190
Wind - Onshore	Wind_VI04	VI	178	179	9	-5	0	-1	0	0	10	192
Wind - Onshore	Wind_PC08	PR	130	159	8	-3	2	19	0	0	10	195