



PacifiCorp Geothermal Studies

Oregon Geothermal Working Group

September 15, 2011

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PacifiCorp Service Territory



PacifiCorp

- Supply and distribute electric energy in six western states: California, Idaho, Oregon, Utah, Washington, and Wyoming
 - **PacifiCorp Energy:** Generation, Mining and Commercial & Trading
 - **Rocky Mountain Power:** Transmission & distribution services in Idaho, Utah, and Wyoming
 - **Pacific Power:** Transmission & distribution services in California, Idaho, and Oregon
- Part of Mid-American Energy Holdings
- Over 10,900 MW of generating resources (owned or under contract)
 - Thermal ~8,600 MW (coal and gas), over 6,100 MW is coal
 - Hydro ~1,200 MW
 - Renewables ~1,700+ MW (wind and geothermal)
- Added 1,628 MW of combined cycle gas in the last 5 years
- Added over 1,600 MW of new wind in the 2006 – 2010 time period

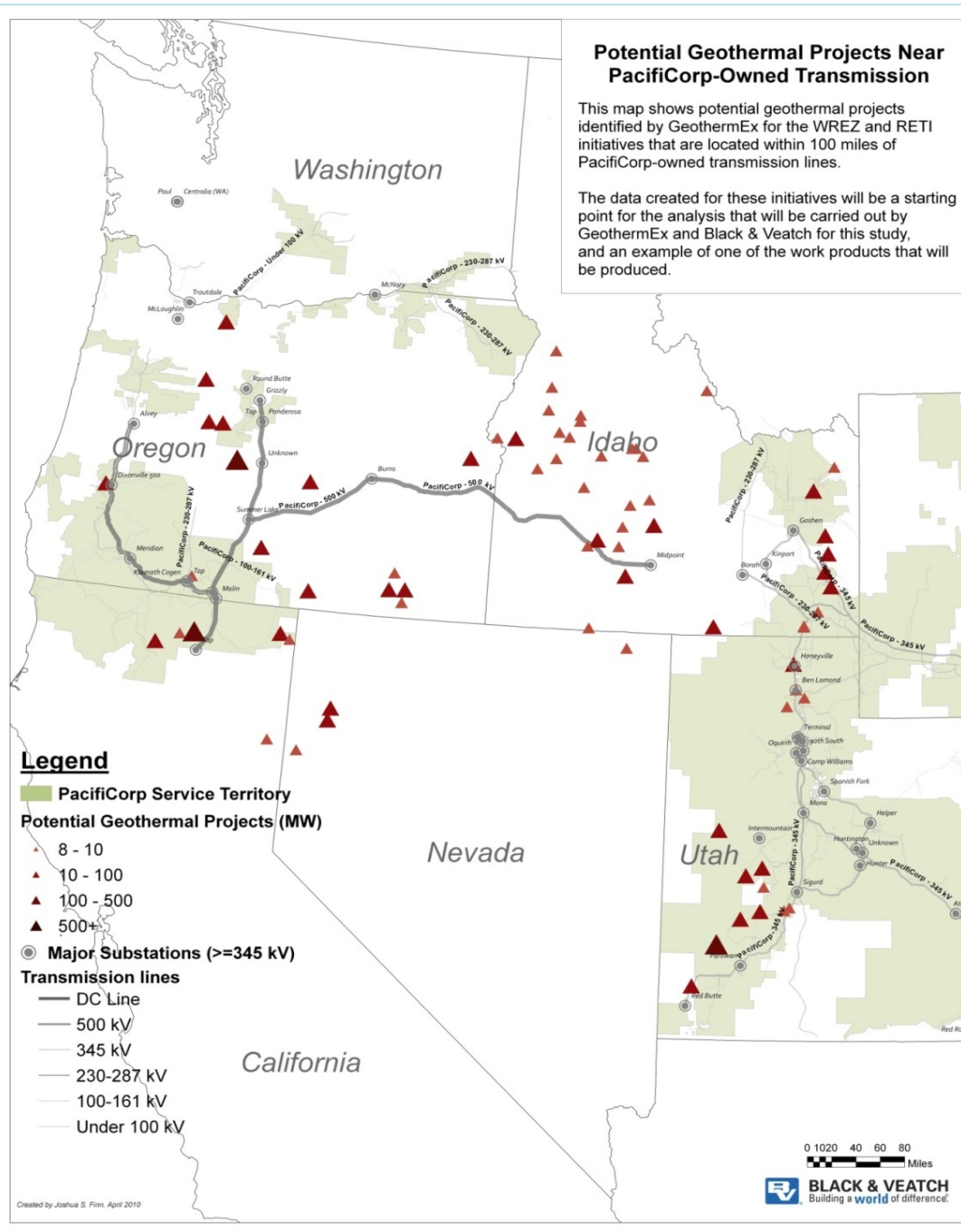
Geothermal Resources Study – Phase 1

- Recommended by Utah in April 1, 2010 acknowledgement order as a part of the IRP:
 - “The Division recommends that the Company conduct a geothermal commercial potential study for geothermal energy using both Blundell technology and other alternative geothermal technologies. The study should evaluate greenfield projects in both PacifiCorp’s east and west control areas. This study should be filed with the Commission for comments as soon as it is completed. Inasmuch as the Company does not currently have an estimate of the amount of economically developed geothermal resources in the states it serves, the Division recommends that the Company make this determination and include a description of all factor mentioned in the previously referred to in DPU data request 1.32e.”
- Commissioned Black & Veatch / GeothermEx in May 2010 with final report August 2010
- Identified 80 potential sites – narrowed to 8 commercial opportunities

Potential Geothermal Projects Near PacifiCorp-Owned Transmission

This map shows potential geothermal projects identified by GeothermEx for the WREZ and RETI initiatives that are located within 100 miles of PacifiCorp-owned transmission lines.

The data created for these initiatives will be a starting point for the analysis that will be carried out by GeothermEx and Black & Veatch for this study, and an example of one of the work products that will be produced.



Legend

- PacifiCorp Service Territory
- Potential Geothermal Projects (MW)**
- 8 - 10
- 10 - 100
- 100 - 500
- 500+
- Major Substations (≥ 345 kV)
- Transmission lines**
- DC Line
- 500 kV
- 345 kV
- 230-287 kV
- 100-161 kV
- Under 100 kV

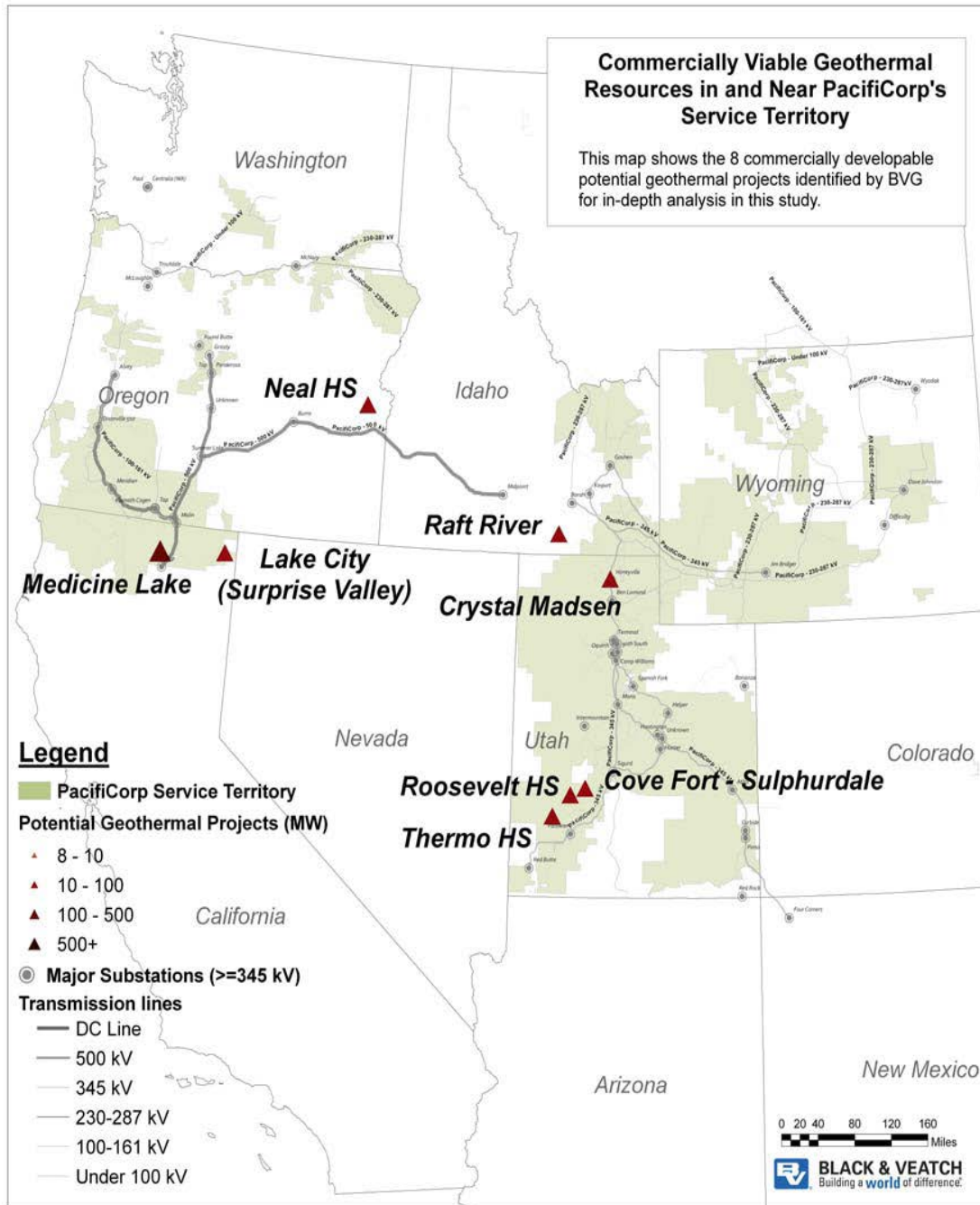
Created by Joshua S. Finn, April 2010

Commercial Geothermal

- Commercial Geothermal Defined
 - Exploration
 - Activities to first full-diameter well
 - Geologic mapping, sampling, surveys
 - Small diameter wells
 - Confirmation
 - Full-diameter wells up to 25% of target capacity
 - Development
 - Activities to full commercial operation
- For screening purposes – commercial was considered completion of the confirmation phase
- Consideration to be given to further define mitigating risk issues to better separate opportunities

Commercially Viable Geothermal Resources in and Near PacifiCorp's Service Territory

This map shows the 8 commercially developable potential geothermal projects identified by BVG for in-depth analysis in this study.



Prioritized Geothermal Options – Phase 1

Table 1-1. Sites Selected for In-Depth Review.							
Field Name	State	Additional Capacity Available (Gross MW)	Additional Capacity Available (Net MW)	Additional Capacity Available to PacifiCorp (Net MW) ^a	Anticipated Plant Type for Additional Capacity	LCOE (Low, \$/MWh) ^{b,c}	LCOE (High, \$/MWh) ^{b,c}
Lake City	CA	30	24	24	Binary	\$83	\$90
Medicine Lake	CA	480	384	384	Binary	\$91	\$98
Raft River	ID	90	72	43	Binary	\$93	\$100
Neal Hot Springs	OR	30	24	0	Binary	\$80	\$87
Cove Fort	UT	100	80	60 to 63	Binary	\$68	\$75
Crystal-Madsen	UT	30	24	0	Binary	\$93	\$100
Roosevelt Hot Springs	UT	90	81 ^d	81 ^d	Flash/Binary Hybrid	\$46	\$51
Thermo Hot Springs	UT	118	94	0	Binary	\$91	\$98
Totals		968	783	592 to 595			

Source: BVG analysis for PacifiCorp.

Note:

^a Calculated by subtracting the amount of resource under contract to or in contract negotiations with other parties from the estimated net capacity available.

^b Net basis

^c These screening level cost estimates are based on available public information. More detailed estimates based on proprietary information and calculated on a consistent basis might yield different comparisons.

^d While 81 MW net are estimated to be available, the resource should be developed in smaller increments to verify resource sustainability

Comments Received to Final Study

1. Expand list of non-commercial options (Appendix A) with additional information on development plans
2. The Company should proceed with the Blundell expansion
 - a. Model Blundell expansion in current IRP
 - b. Model other geothermal resources in current IRP
3. Compare the IRP LCOE methodology to the B&V LCOE methodology
4. Conduct a second, more in-depth geothermal resource study for the 2011 IRP Update to be available in March 2012

1. Response: Expanding Appendix A

- The non-commercial options (Appendix A of the study) can be expanded but would prefer not to expand the non-commercial list at this time but defer the additional work suggested to the more detailed study identified in Comment 4.

2. Response: Modeling Geothermal

- a. Blundell 3 will be included in the supply side table for modeling as the east-side geothermal resource equal to a unit 3 expansion (30-35 MW).
 - Blundell 3 requires additional resource characterization studies to be completed during the next year
 - Need to negotiate BLM royalty fees could slow down development

2. Response: Modeling Geothermal

- b. Alternative geothermal resources will be modeled as either a west-side geothermal or east-side geothermal resource equal to the average cost from the Geothermal Resource Study for resources other than Roosevelt Hot Springs.

2. Response: Modeling Geothermal

- Risk Adder
 - B&V / GeothermEx's estimate is that development costs through production well drilling (commercial level) will be 35% of total project cost including dry wells. This cost is in the current estimates
 - Lower levels of development such as exploratory wells, land acquisition and permitting can cost much less at about 5-10% of final costs.
 - Risk will be expressed as the ability to recover development costs should the project not move to completion.

2. Response: Modeling Geothermal

- No additional capital cost risk adder included in the modeling; risk was assessed based on development cost recovery uncertainty, and treated as an out-of-model consideration.
- Geothermal resources not included in the 2011 IRP preferred portfolio, but IRP Action Plan identified 100 MW of geothermal resources as cost-effective if development cost risk can be adequately addressed.

3. Response: LCOE Comparison

- Two types of levelized cost of electricity numbers:
 - 40 year nominal levelized cost of electricity
 - First year cost of electricity (IRP methodology)
- Recent review identified some issues with the B&V LCOE analysis (explained in the notes to the table)
 - Unlevered cash flows
 - 20 year Modified Accelerated Cost Recovery System (MACRS) depreciation

3. Response: LCOE Comparison

Geothermal \$/MWh Cost of Energy Comparisons

Summary of B&V Study results and IRP Methodology

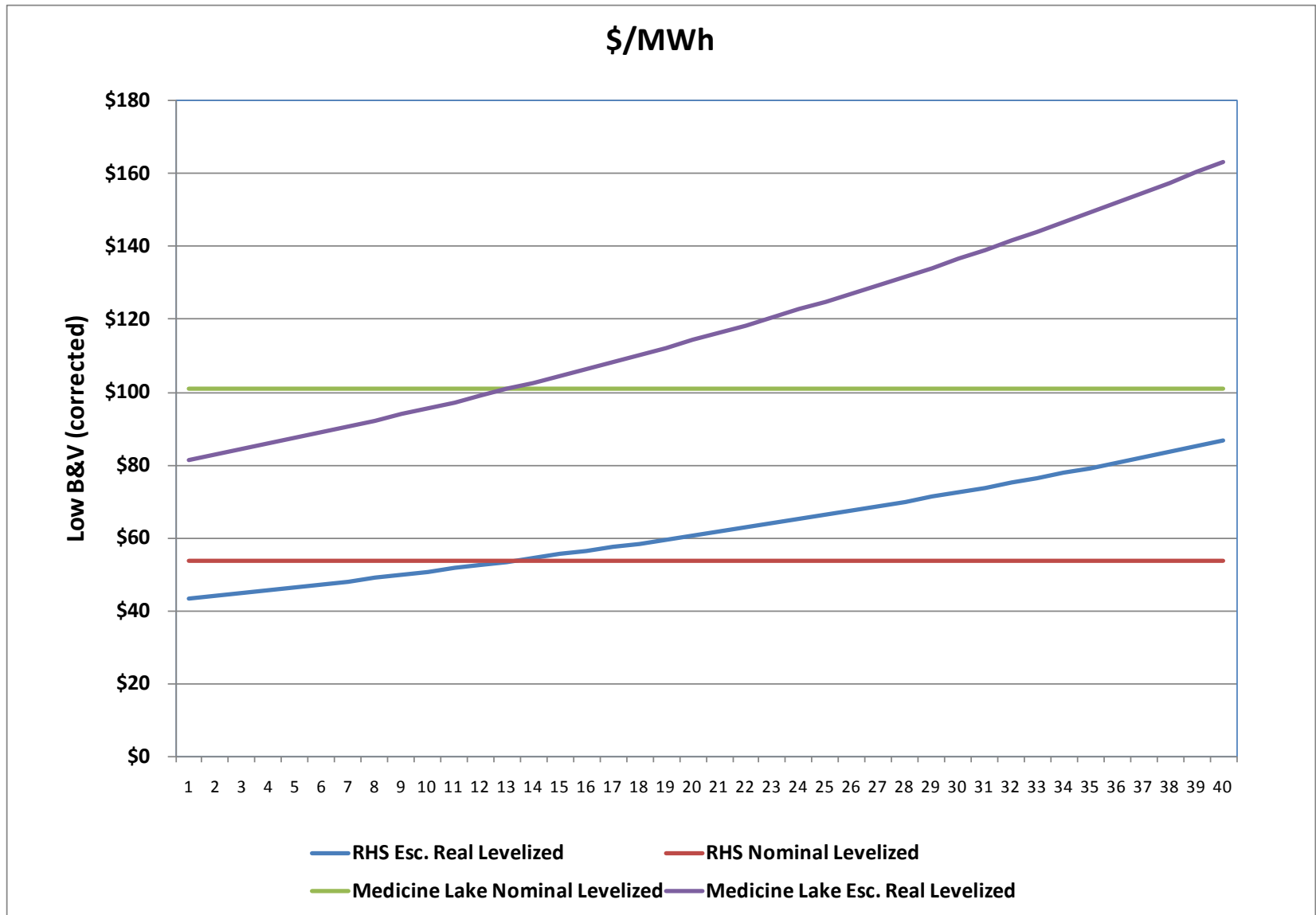
Low Capital	40-year Nominal Levelized Cost of Energy		
	B&V Original from Report	B&V with Corrected 20-year MACRS \1	B&V Corrected 20-year MACRS and Unlevered Cash Flows \2
Lake City	\$83	\$81	\$91
Medicine Lake	\$91	\$90	\$101
Raft River	\$93	\$93	\$104
Neal Hot Springs	\$80	\$77	\$86
Cove Fort	\$68	\$67	\$77
Crystal-Madsen	\$93	\$92	\$103
Roosevelt HS	\$46	\$45	\$54
Thermo HS	\$91	\$91	\$102

Low Capital	First Year Cost of Energy			
	B&V Original from Report	B&V with Corrected 20-year MACRS \1	B&V Corrected 20-year MACRS and Unlevered Cash Flows \2	IRP First Year Real Levelized \3
Lake City	\$67	\$65	\$73	\$71
Medicine Lake	\$73	\$73	\$81	\$79
Raft River	\$75	\$74	\$83	\$81
Neal Hot Springs	\$64	\$62	\$69	\$67
Cove Fort	\$54	\$54	\$61	\$60
Crystal-Madsen	\$75	\$74	\$83	\$81
Roosevelt HS	\$37	\$36	\$43	\$42
Thermo HS	\$73	\$73	\$82	\$80

High Capital	40-year Nominal Levelized Cost of Energy		
	B&V Original from Report	B&V with Corrected 20-year MACRS \1	B&V Corrected 20-year MACRS and Unlevered Cash Flows \2
Lake City	\$90	\$88	\$98
Medicine Lake	\$98	\$97	\$109
Raft River	\$100	\$100	\$111
Neal Hot Springs	\$87	\$84	\$93
Cove Fort	\$75	\$74	\$84
Crystal-Madsen	\$100	\$99	\$111
Roosevelt HS	\$51	\$51	\$60
Thermo HS	\$98	\$98	\$109

High Capital	First Year Cost of Energy			
	B&V Original from Report	B&V with Corrected 20-year MACRS \1	B&V Corrected 20-year MACRS and Unlevered Cash Flows \2	IRP First Year Real Levelized \3
Lake City	\$72	\$71	\$79	\$77
Medicine Lake	\$78	\$78	\$87	\$85
Raft River	\$80	\$80	\$89	\$87
Neal Hot Springs	\$70	\$67	\$75	\$73
Cove Fort	\$60	\$60	\$68	\$66
Crystal-Madsen	\$81	\$80	\$89	\$87
Roosevelt HS	\$41	\$41	\$48	\$47
Thermo HS	\$79	\$79	\$88	\$86

3. Response: LCOE Comparison



3. Response: Notes to Table

1. The B&V model had a formula error which resulted in the 20-year MACRS depreciation being excluded.
2. The B&V model calculated an equivalent COE by solving for a required equity return. This equity cash flow approach results in disproportionately more debt capitalization throughout the analysis period than is consistent with the typical debt and equity weighting of a regulated utility (47.43% and 52.57%, respectively).
3. The first year real levelized COE derived with the IRP methodology provides results very similar to the COE derived with the corrected B&V analysis model.

4. Response: Expanded Study – Phase 2

- Commit to an in-depth geothermal resources study to look at specific resource issues and greenfield development opportunities for the 2011 IRP Update. Study should be ready by early 2012.
- Goals for the study:
 - Determine project status, from the company and regulatory viewpoint, by evaluating the costs and development readiness for geothermal renewable resources in PacifiCorp's service territory.
 - Determine company's interest in pursuing geothermal resources other than Roosevelt Hot Springs and to determine specific projects that could be taken to regulatory commissions for approval.

Geothermal Study – Phase 2

- Selected B&V with GeothermEx to do the study.
- Phase 2 will involve an RFI to solicit information from developers and interested parties.
- RFI will look at both developed and greenfield sites.
- RFI will be structured to address confidentiality
- RFI to be issued the week of September 19th, 2011 with information accepted for approximately 30 days.
- Contact Ken Clark @ ken.clark@pacificorp.com for RFI details

Questions?
