Elizabeth Brown - National Renewable Energy Laboratory (NREL)
June 16, 2008 memo to PacifiCorp

Company Response: In its analysis, Quantec (now The Cadmus Group) used assumptions that are relatively conservative. We believe this is appropriate as a conservation potentials assessment is designed for planning purposes and needs to provide the necessary reliability to be treated on an equal basis as supply options. However, we acknowledge there is inherent uncertainty in the assumptions leading to a range in levelized costs.

The NREL memo focused on three assumptions underlying the calculation of levelized, per unit cost of energy (LCOE) calculations: 1) installed costs, 2) O&M costs, and 3) the system capacity factor. These assumptions do carry an inherent level of uncertainty, but the assumptions chosen are within a reasonable range and consistent with estimates from existing literature. Table 1 summarizes the LCOE estimates for each sector under the initial assumptions and using all but one of the assumptions proposed by NREL. Individual assumptions and their isolated impacts of LCOE are discussed below. As can be seen, although these alternative assumptions combined lower LCOE, the decrease is not large enough for solar PV to be cost effective.

Table 1: LCOE Sensitivity Analysis incorporating NREL assumptions ($/kWh)

	Original Assessment	Combined Sensitivity Analysis*
Sector	Levelized Costs	Levelized Costs
Commercial	$ 0.79	$ 0.45
Residential	$ 0.70	$ 0.40
UT Average	$ 0.76	$ 0.44

* Excludes NREL assumption on Average System O&M costs explained below.

1- Average Installed System Cost

NREL agrees with the assumed cost of $9,000/kW for customer-site installations, but they recommend including the federal and state tax credits as a reduction to the cost. However, as this analysis is done on a total resource cost basis, it is not appropriate to include tax credits. The total resource cost is a measure of the *total* cost of a technology; it does not consider how the dollars are being provided: whether utility, participant, or government agency. As such, accounting for any federal or state tax credit would be inappropriate.

In addition, the federal tax credits are scheduled to sunset on December 31st, 2008 and may not get extended. This notwithstanding, a sensitivity analysis of LCOE, applying federal and state tax credits are presented in Table 2. The federal tax incentive for residential customers is 30% of installed costs with a cap of $2,000. The federal tax incentive for commercial customers is 30% of installed costs with no cap. The federal business modified accelerated cost recovery system was not included in the sensitivity analysis. Utah state tax incentive for residential customers is 25% of installed costs with a cap of $2,000. The state tax incentive for commercial customers is 10% of installed costs with a cap of $50,000.

Table 2: LCOE Sensitivity Analysis of Federal and State Tax Credits ($/kWh)

	Original Assessment	Applied Federal Tax Credits	Applied State Tax Credits	Combined Tax Credits
Sector	Levelized Costs	Levelized Costs	Levelized Costs	Levelized Costs
Commercial	$ 0.79	$ 0.58	$ 0.72	$ 0.51
Residential	$ 0.70	$ 0.56	$ 0.56	$ 0.42
UT Average	$ 0.76	$ 0.58	$ 0.68	$ 0.49

2- Average System O&M.

The memo references provided on O&M cost does not specify which factors contribute to the costs. In our analysis, a large percentage ($75 of the $100) accounts for inverter replacement, required after 10-15 years of operation.[1] At the time of inverter replacement, the summed $75 costs over the inverter life are comparable to the current national average price according to SolarBuzz.[2] The remaining $25 is the traditional fixed O&M generally referred to in reports and appears to be all the referenced studies consider, within the range from $25-$50.[3,4,5]

3- PV system capacity factor.

Only one weather file for each state within PacifiCorp's territory was chosen for this analysis. Given the population density in Salt Lake City compared to the rest of the state, we believe this location is the most appropriate weather file to use. However, we recognize some customers will have better performance. We disagree that our assumptions used in PVWatts to obtain our capacity factor result in a particularly low estimate. Note that 0.14 is a weighted average estimate between commercial and residential customers. Residential customers, with the 4/12 pitch roof (as opposed to the assumed flat roof of commercial customers) are expected to obtain a 0.15 capacity factor. The assumption that commercial customers will install PV modules at 0 degrees is conservative; the amount of PV production is likely larger as it is possible to install more modules at 0 degrees than at an angle. We use a DC to AC derate factor of 77%, another aspect NREL might consider conservative, but we do not believe this factor should be any more than 82%- most increasing the capacity factor from 0.14 to 0.15. Table 3 represents the LCOE when the new capacity factor assumptions are applied.

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[1] Based on inverter useful life estimates and the upper end of manufacturer's warranties. Sources include NREL: A Review of PV Inverter Technology Cost and Performance Projections, January 2006. p 5 and 37. SMA: Sunny Boy inverters are shipped with a standard 10 year warranty. The warranty can be extended for an additional 5 years, http://www.sma-america.com/solar-technology/products/grid-tied-inverters/sunny-boy/index.html.

[2] Solarbuzz - http://www.solarbuzz.com/Inverterprices.htm

[3] Arizona Renewable Energy Assessment, prepared by Black and Veatch, September 2007. Tables 4-14 and 4-25. Residential Fixed O&M costs are $50/KW-yr; Commercial Fixed O&M costs are $30/KW-yr.

[4] Comparative Costs of California Central Station Electricity Generation Technologies, Joel Klein and Anitha Rednam, California Energy Commission with Aspen Environmental Group, M Cubed and Navigant Consulting, Inc., December, 2007. Fixed O&M costs are $24.87/KW-yr.

[5] Renewable Energy Transmission Initiative, Phase 1a, Final Report, May 2008, Black & Veatch Project: 149148. Prepared for RETI Coordinating Committee, RETI Stakeholder Steering Committee, p.1-8 and Table 5-7. Fixed O&M costs are $35/KW-yr.

Table 3: LCOE Analysis of Capacity Factor ($/kWh)

	Original Assessment	Applied New Capacity Factor
Sector	Levelized Costs	Levelized Costs
Commercial	$ 0.79	$ 0.70
Residential	$ 0.70	$ 0.65
UT Average	$ 0.76	$ 0.69

4- PV Technical Potential Assumptions.

Including ground-mounted PV systems to increase technical potential is not particularly relevant in this analysis. The key factor is the market potential. Customer-owned, ground-mounted systems represent such a small percentage of the overall market that their omission has a minimal impact on the potential.[6]

[6] Similar reports have also excluded ground mounted systems in their analysis due the "negligible proportion of the market": PV Grid Connected Market Potential under a Cost Breakthrough Scenario by Navigant Consulting, Inc., September 2004.